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EFFECTS OF SOIL MATRIC POTENTIAL ON TUBER YIELD AND EVAPOTRANSPIRATION OF POTATO

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Abstract
This study has been carried out through field trials with irrigation in the river valley of Southern Morava, near Niš, at the alluvium soil type, in the period 2008-2009. The experimental field consisted of three treatments with irrigation (soil matrix potential of 20, 30 and 40 kPa), as well as unirrigated, control. Irrigation schedule was determined by tensiometers on the basis of the observed soil matrix potential values. The highest potato tuber yield (48.30 t ha^{-1}) was observed at the variant where soil matrix potential of 30 kPa was kept. Potato tuber yield was the highest when water consumption for evapotranspiration amounted from 491.3 to 498.6 mm, while at higher or lower values of water consumption for ET tuber yield dropped. Water use efficiency of potato during the studied period ranged from 81.23 to 98.21 kg ha^{-1} mm^{-1}. The data concerning tuber yield, evapotranspiration and WUE of potato point to the fact that, in order to reach high potato tuber yield and quality, one ought to keep soil matrix potential at levels around 30 kPa for the conditions of south Serbia.
Key words: potato, evapotranspiration, soil matrix potential, water use efficiency.

Introduction

The total world potato production amounts about 330 million tons on 18.3 million ha (FAOSTAT, 2010), or 18 t ha^{-1} as average. In Serbia it is grown on 80.000 to 90.000 ha, reaching the average tuber yield of 10 t ha^{-1} (Stat. Year. Serb. 2008). Genetic potential for potato tuber yield can be up to 100 t ha^{-1}. Water deficiency in soil leads to a decrease of potato tuber yield and quality, caused by the drop of photosynthetic activity per leaf square unit (Van Loon, 1981). Climatic conditions of south Serbia in the last few years were characterized by long drought periods without precipitation, and extremely high temperature during vegetation period. Optimal soil moisture for growing agricultural crops can only be reached in the conditions of irrigation. Insight in values of potential evapotranspiration (PET), or water demands by plants, is a necessary precondition for realizing an efficient water regime. Excessive irrigation leads to deep percolation of nutrients, higher potential for appearing plant diseases and pests, deterioration of soil structure and water losses, causing increased production costs. Potato PET depends on climatic conditions, soil moisture and potato cultivar. Potato evapotranspiration established by many researches amounted from 283-700 mm (Doorenbos and Kassam, 1979; Tanner, 1981; Wright and Stark, 1990; Pereira et al., 1995; Kiziloglu et al., 2006). Evapotranspiration and irrigation of potato in Serbia were studied only in the conditions of Vojvodina Province (Bošnjak and Pejić 1994; Bošnjak and Pejić, 1995; Bošnjak et al.,

1996; Bošnjak, 2006; Milić et al., 2009). Irrigation schedule is pretty important in order to avoid negative irrigation effects. Numerous reports confirmed efficiency of potato irrigation based on measuring soil matric potential (Phene and Sanders, 1976; Eldredge et al., 1992; Hegney and Hoffman, 1997; Pereira and Villa Nova, 2002; etc). Water use efficiency (WUE) is defined by tuber yield divided by water consumed for evapotranspiration (ET) of potato (Doorenbos and Pruitt, 1977). Having in mind the obtained results concerning potato irrigation, this investigation has been aimed to determine soil matric potential, potato PET, tuber yield, and WUE in the conditions of south Serbia.

Material and methods

Field trials with irrigation of potato have been set in the river valley of Southern Morava, near Niš, at the alluvium soil type, in the period 2008-2009. Local coordinates of the location were the following: latitude 43º 19 ', longitude 21° 54', altitude 194 m. The trial was set in random complete block design, and drip irrigation was applied. Elementary plot was 10.50 m^2 of area, and plots were separated by 2.5 m of each other. Determining irrigation term was done by tensiometers. Soil matrix potential (SMP) was measured at 8:30, daily. The experimental field consisted of three treatments with irrigation (SMP of 20, 30 and 40 kPa), as well as unirrigated control.

Potato planting (distance 70 cm between rows and 30 cm in the row) was done in the first half of April in both investigation years, with the cultivar Kennebec, original category, where tuber size was from 35-55 mm. After soil chemical analyses soil was fertilized before cultivation, as well as during vegetation by water soluble fertilizers through irrigation systems. The total amount of nutrients deposited to soil was: N -200 kg ha^{-1}, P_2O_5 - 120 kg ha^{-1}, K_2O - 300 kg ha^{-1}, CaO - 100 kg ha^{-1} and MgO - 60 kg ha^{-1}. During vegetation, the all modern agro technique measures were applied, and tuber harvest was carried out in the third decade of August in both years of the study.

Calculation of water consumption for evapotranspiration in the conditions of irrigation was done for each month and for vegetation period in whole, by balancing water from precipitation during vegetation period, soil supplies, irrigation, and potentially percolated or flown out water after heavy rains (Aksic *et al*., 2011).

The data of potato tuber yield were processed by analysis of variance, and significance of differences in tuber yield was determined by comparing them with LSD values for $P<0.05$ and $P<0.01$. The effect of soil matrix potential and evapotranspiration on potato tuber yield was analyzed by regression analysis.

The obtained values of texture analysis (table 1) were expected, because fractional relations confirm that this is a loamy alluvial soil.

Table 1. Mechanical properties of soil

Depth (cm)	Total sand (%)	Powder (%)	Clay (%)
	> 0.02 mm	0.02-0.002 mm	< 0.002 mm
0-20	42.1	40.5	17.4
20-40	40.3	37.8	21.9
40-60	38.7	36.3	25.0
60-80	36.7	35.9	27.4
80-100	35.1	32.3	32.6

Immediately before the study began, water-physical properties of soil in the experimental field were determined (Table 2).

Table 2. Water-physical properties of soil

Depth (cm)	FWC (weight %)	Specific weight (g cm^{-3})	Bulk density (g cm^{-3})	Total porosity (vol. %)	Capacity for water (vol. %)	Capacity for air (vol. %)
0-20	27.32	2.65	1.35	49.05	36.88	12.17
20-40	25.94	2.58	1.34	48.06	34.76	13.30
40-60	24.44	2.56	1.34	47.65	32.75	14.90

Air temperature was observed at meteorological station Niš and precipitation was measured by a rain gauge at the experimental field (Table 3). Vegetation 2008 was wormer by 1.8 °C than the average, and the greatest difference from the mean value was observed in June, which was wormer by 2.8 °C than the many-year mean. Precipitation regime in this period was basically characterized by a great dispersion of precipitation, and existence of longer or shorter dry periods in May, June, early July, and August, which had a negative effect on the observed potato tuber yield in the conditions without irrigation.

Precipitation deficiency in April 2009 was flagrantly expressed in the first part of the month, causing a decrease of water supplies in soil. High temperatures and precipitation deficiency in May had a bad effect on plants growth and development. June 2009 was characterized by a relatively warm weather with high amount of precipitation, especially near the end of month. The first half of the July was droughty, which had a negative effect to potato crops, being then in full flowering stage. August was deficient with precipitation having a bad influence to tuber growth.

Table 3. Mean monthly temperatures (ºC) and monthly amount of precipitation (mm)

Year	Month					
	IV	V	VI	VII	VIII	IV-VIII
Mean monthly temperatures						
2008	13.1	17.9	22.3	22.6	23.5	19.9
2009	14.3	18.3	20.5	22.8	23.0	19.8
1961-1990	11.9	16.6	19.5	21.3	21.1	18.1
Amount of precipitation						
2008	65.5	38.7	32.5	61.2	24.8	222.7
2009	28.4	27.0	91.5	46.0	38.3	231.2
1961-1990	51.3	66.7	69.7	43.6	43.3	274.6

Results and discussion

Concerning the all irrigated variants, tuber yield was high-significantly higher in regard to the unirrigated control. The highest potato tuber yield (48.30 t ha^{-1}) was observed at the variant with soil matrix potential of 30 kPa (Table 4). Statistically high-significantly important differences in tuber yield were observed between the treatment with SMP of 30 kPa and the treatments with SMP of 20

and 40 kPa. However, at the treatment with SMP of 20 kPa, tuber yield was significantly higher regarding the treatment with SMP of 40kPa.

During the two-year investigation of potato irrigation the highest tuber yield was reached with SMP of 30 kPa, which was in accordance with the results of Shock *et al*. (2002) and Shae *et.al*. (1999). When potato tuber yield is concerned the optimal soil humidity before irrigation (SMP of 30 kPa) observed in our study are in opposition with the following reports: Epstein and Grant (1973) – SMP of 25 kPa; Eldredge *et al*. (1992, 1996) – SMP from 50 to 60 kPa; Hegney and Hoffman (1997) – SMP of 20 kPa; Pereira and Villa Nova (2002) – SMP of 15 kPa; and Kang *et al*. (2004) – SMP of 25 kPa.

Decreased potato tuber yield caused by increased soil humidity (SMP of 20 kPa) is in accordance with the results of Wang *et al*. (2006), Pereira and Shock (2006) and others. Bošnjak (2006), in the conditions of Vojvodina Province (Serbia), also found that higher soil humidity (80% FWC) decreased potato tuber yield. Differences in optimal values of SMP for the irrigation start are primarily caused by irrigation method, soil type and studied environment.

Table 4. Tuber yield of potato (t ha^{-1})

Year (B)	Soil matric potential (A)				Average (B)
	20 kPa (A_1)	30 kPa (A_2)	40 kPa (A_3)	Control (A_4)	
2008 (B_1)	44.71	47.64	36.49	24.52	38.34
2009 (B_2)	45.48	48.97	39.13	26.78	40.09
Average (A)	45.09	48.30	37.81	25.65	39.21
LSD		A	B		AB
0.05		1.95	1.39		2.76
0.01		2.15	1.54		3.05

Tuber yield dependency on soil matrix potential was described as $y=–2440.0+3747.2x–68.3x^2$ based on regression analysis (Figure 1), together with high, positive correlation (r=0.93**). The highest potato tuber yield was observed at the treatment with SMP of 30 kPa, while lower (SMP of 40 kPa) or higher (SMP of 20 kPa) soil humidity led to a decrease of tuber yield.

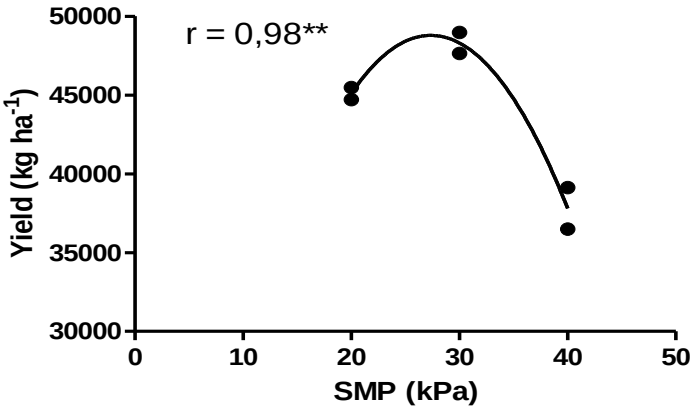


Figure 1. Effect of SMP on potato tuber yield

Regression analysis defined tuber yield dependency on water consumption for ET as follows: $y=22543.9–37.8x+0.2x^2$ (Figure 2). Correlation between these two parameters was high and positive (r=0.93**). The highest potato tuber yield was found when water consumption for evapotranspiration was from 491.3 to 498.6 mm, while at higher or lower water consumption for ET tuber yield decreased.

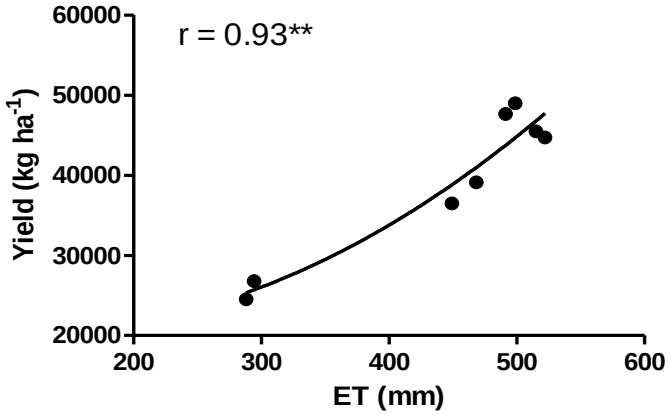


Figure 2. Effect of ET on potato tuber yield

The established value of evapotranspiration in our experimental field ranged from 294.4 mm at the variant without irrigation to 522.1 mm at the irrigated variant with SMP of 20 kPa (table 5). According to many researches water demands of potato vary over a great range, depending above all on studied environment. For high tuber yield vegetation demands of potato for water ranged from 500 to 700 mm, depending on climatic conditions (Doorenbos and Kassam, 1979). During a three-year investigation potato evapotranspiration in Wisconsin (USA) was between 293 and 405 mm (Tanner, 1981). Wright and Stark (1990), stated water consumption of potato for evapotranspiration from 640 to 700 mm in irrigated areas of Oregon and Washington (USA). Pereira *et al*. (1995), found potato evapotranspiration of 283 mm. Kiziloglu *et al*. (2006), stated that in the conditions of Erzurum (Turkey) potato evapotranspiration ranged from 167 mm without irrigation to 610 mm in the conditions of irrigation. According to Erdem *et al*. (2006), in Trakia Region (Turkey) potato evapotranspiration was between 464 and 683 mm.

The highest and also stable tuber yield in the two-year period of study was reached when water consumption for evapotranspiration was between 491.3 and 498.6 mm, so that value could be considered as potential evapotranspiration (PET) of potato, i.e. its water demands in the conditions of south Serbia. The measured value of potato PET in our study is greater in regard to the value of potential evapotranspiration (460-480 mm) established by Bošnjak and Pejić (1994) for the conditions of Vojvodina Province (north Serbia).

Water use efficiency during the studied period was between 81.23 and 98.21 kg ha^{-1} mm^{-1} (table 5). The best ratio between water consumption for ET and potato tuber yield (96.97-98.21 kg ha^{-1} mm^{-1}) was observed at the treatment with SMP of 30 kPa.

Table 5. Evapotranspiration and WUE of potato

Year	SMP (kPa)	Soil water supplies (mm)	P (mm)	I (mm)	ET (mm)	Yield (kg ha^{-1})	WUE (kg ha^{-1} mm^{-1})
2008	20	21.4	222.7	278	522.1	44710	85.63
	30	32.6	222.7	236	491.3	47640	96.97
	40	51.5	222.7	175	449.2	36490	81.23
	Control	65.4	222.7	-	288.1	24520	85.11
2009	20	27.8	231.2	256	515.0	45480	88.31
	30	48.4	231.2	219	498,6	48970	98.21
	40	53.1	231.2	184	468,3	39130	83.56
	Control	63.2	231.2	-	294.4	26780	90.96

Water use efficiency during the studied period was between 81.23 and 98.21 kg ha^{-1} mm^{-1} (table 5). The best ratio between water consumption for ET and potato tuber yield (96.97-98.21 kg ha^{-1} mm^{-1}) was observed at the treatment with SMP of 30 kPa. In the conditions of irrigation the highest average value of potato WUE of 97.59 kg ha^{-1} mm^{-1} was observed at the variant with SMP of 30 kPa. WUE values of potato obtained by this study (from 81.23 to 98.21 kg ha^{-1} mm^{-1}) were similar to the values reported by Wright and Stark (1990) and Beheral and Panda (2009). Our values of potato WUE are not in accordance with the values stated by Wang *et al*. (2006) from 50.4 to 77.1 kg ha^{-1} mm^{-1} in season 2001 and 103.2-131.6 kg h^{-1}a mm^{-1} in season 2002 in the conditions of North China Plain. Values of WUE in our study were higher than the ones determined by Kiziloglu *et al*. (2006), which were from 40.2 to 63.4 kg ha^{-1} mm^{-1}, as well as the ones of Rashidi and Gholami (2008) who stated WUE ranging from 19.2 to 52.5 kg ha^{-1} mm^{-1}.

Conclusions

High and stable potato tuber yield was reached when water consumption for evapotranspiration was between 491.3 and 498.6 mm, so that value could be considered as potential evapotranspiration (PET) of potato in the conditions of south Serbia. The highest water use efficiency of potato, which was from 96.97 to 98.21 kg ha^{-1} mm^{-1}, was observed at the variant with SMP of 30 kPa. Results of tuber yield, evapotranspiration and WUE of potato revealed the fact that, in order to reach high potato tuber yield and quality, one ought to keep soil matrix potential at levels around 30 kPa, for the conditions of South Serbia.

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ЕФЕКТИ НА ПОЧВЕНИОТ МАТРИКС ПОТЕНЦИЈАЛ ВРЗ ПРИНОСОТ И ЕВАПОТРАНСПИРАЦИЈАТА НА КОМПИР

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Апстракт

Ова истражување е спроведено преку теренски испитувања, со наводнување во речната долина на Јужна Морава, во близина на Ниш, на алувијален тип на почва, во периодот 2008-2009 година. Експерименталниот опит се состоеше од три третмани со наводнување (почвен матрикс потенцијал на 20, 30 и 40 kPa), како и еден ненаводнуван, како контрола. Распоредот на наводнување е утврден со тензиометри врз основа на набљудуваните вредности на почвениот матрикс потенцијал. Највисок принос на компир (48,30 т ха-^{1}) е забележан кај варијантата каде почвениот матрикс потенцијал изнесувал 30 kPa. Приносот на компир бил највисок кога потрошувачката на вода за евапотранспирација изнесувала 491,3-498,6 милиметри, додека при повисоки или пониски вредности на потрошувачка на вода за ЕТ приносот паднал. Користењето на водната ефикасност на компирот за време на анализираниот период се движеше 81,23 до 98,21 кг ха-^{1} мм-^{1}. Податоците кои се однесуваат на приносот на клубени, евапотранспирацијата и користењето на водната ефикасност кај компирот за услови во јужна Србија, укажуваат на фактот дека за да се постигне висок принос и квалитет на компир, почвениот матрикс потенцијал треба да се задржи на ниво од околу 30 kPa.

Клучни зборови: компир, евапотранспирација, почвен матрикс потенцијал, користењето на водната ефикасност.

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ANALYSIS OF PRODUCTION AND PURCHASE OF ORIENTAL TOBACCO IN BALKAN

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Abstract
Production of tobacco in the Balkan in the past five years rapidly decline. In Greece, tobacco production is drastically reduced as well, because as a member of the EU (European Union) in recent years high subsidies for tobacco production were available for the reorientation of tobacco producers to grow some other crops. In Bulgaria, tobacco production is also reduced because, as a recent EU member, the country was urged to cut production areas with tobacco (the quota for tobacco production dropped towards production before becoming an EU member). In Serbia, the production of oriental tobacco is almost eliminated, produce only Virginia and Burley type of tobacco (average of 5.000-6.000 tons). Albania, as a producer of oriental tobacco has a symbolic participation of about 2.000 tons annually. Macedonia produce only oriental type of tobacco. The production oscilate from 16.128 tons up to 26.314 tons for the past years. It has stable production with high quality of tobacco well known to the biggest World tobacco companies.
Key words: oriental tobacco, type structure, production, purchase.

Introduction

The production of raw tobacco (1999-2004 year) in Balkan's region is declining, both in absolute amount and average per year (*Arsov, at all.,* 2005). The largest producer was Turkey with 212.835 tons or 48,67 % share in total production, while the lowest was Albania with 5.716 tons or 1,31 %. Macedonia occupied the fourth place with an average production of 22.372 t or 5,12 % of the analyzed period. The share of Serbian oriental tobaccos significantly dropped after 2003, both as a result of the transition period for tobacco industry in this country and because of the lack of interest among the new oweners (Philip Moris, British American Tobacco-BAT etc.), *Filipovski at all.* (2010). The trend of declining production is evident in all countries except Bulgaria, where it period 2001-2004 was increased and Macedonia where there is a stagnated at around 22.897 tones for the same period (*Stojanoska, S.and Stojanoski L.,* 2007). In the world production of tobacco Macedonia participated with 0,32 %, which represented insignificant participation, while all other countries together participated with 6,23 %. Oriental type of tobacco present special group of tobacco which gives bouquet, through the process of blending of cigarettes. The main characteristics are: small leaves and strong specific aroma. The production directly depend on specific soil and climate conditions, mixed with good agricultural practice. Many of the early brands of cigarettes were made

mostly or entirely of oriental tobacco. According to official data from the tobacco international market, the demand for oriental type of tobacco is increasing in past few years (Universal Leaf Tobacco Company, 2007/2008).

Purpose of the paper is to analyze the current situation in the Balkan, on the basis of the obtained data and to get recommendations for overcoming the problems facing the tobacco economy.

Material and methods

Data used from Analyses of the Ministry of Agriculture, Forestry and Water Economy of Republic Serbia, Ministry of Agriculture, Forestry and Water Economy of Republic Macedonia, Ministry of Agriculture and Food of Republic Albania, Ministry of Agriculture and Food of Republic Bulgaria. The link of ec.europa.eu/agricultural/markets was used as a source for investigation on the oriental tobacco production in the Balkan's countries (Greece and Bulgaria). The investigations were carried out for the period 2005/2010. For easier data processing tobacco has been grouped, in eight groups of tobacco varieties (types) described in the EU Common Market Organization (CMO) - regulation 2075/1992:

I - Flue-cured: tobacco dried in ovens with controlled air circulation, temperature and humidity;

II - Light air-cured: tobacco dried in the air under cover, not left to ferment;

III - Dark air-cured: tobacco dried in the air under cover, left to ferment naturally before being marketed;

IV - Fire-cured: tobacco dried by fire;

V - Sun-cured: tobacco dried in the sun;

VI - Basmas (sun-cured, oriental);

VII - Katerini (sun-cured, oriental);

VIII - Kaba-Koulak (classic) and similar (sun-cured, semioriental);

Groups VI and VII are related to oriental tobacco and the group VIII applies to semi-oriental tobacco. While the production of certain groups of tobacco (especially to the group VIII) have been drastically reduced during the analyzed period, due to easier data processing all tobacco from VI th to VIII th group have been grouped together in group V, as data in 2011 are already presented from: ec.europa.eu / agricultural / markets.

Data on area and production are presented as crop, but not as a calendar year. The reason for is that buying tobacco usually begins in November, in the same year when the production is, but ends in March next year. The official statistics summarize data by calendar year, so the effect of harvest is not visible because in one calendar year occurs mixing data from two harvests. For data processing, table and figure presentations were used, thereat, mainly the comparative method has been used (natural and financial parameters, searching the movement of official statistical data about production, processing, purchase prices).

Data in these sources are usually represented as absolute indicators, but we calculated data in relative ratio as a need of this work, according to the conception of the authors.

Agricultural Policy for Tobacco Production

Tobacco is one of the most economically important agricultural crop in the world. Tobacco production provide a stable source of income. Also, the processing, manufacture, and distribution of tobacco products provide employment for thousands of other people throughout the globe. EU (European Union) tobacco production represents about 6 % of worldwide production. Only thirteen EU member countries produce tobacco, a few regions in: Italy, Bulgaria, Poland, Spain and Greece

being particularly active. From these, only Bulgaria and Greece produce oriental type of tobacco. The arable land devoted to tobacco production in the EU is shrinking rapidly (currently some 100.000 hectares cultivated by approximately 80.000 producers). On average, each producer cultivates 1,25 hectares of tobacco. Tobacco needs at EU level is about 600.000 annually tons. Its own production is around 370.000 tons tobacco and over 50 % meet the needs of the tobacco industry. Exports accounted for about 190.000 tons. The difference to the required quantity (Utilization = Imports + Production - Exports + / - stocks) being met by imports. Tobacco production in EU is strictly based on certain regulations arised from EU Common Agricultural Policy (CAP). During the analyzed period, major changes have occurred in EU policy regarding the production of tobacco. Some of the measures are presented in the Table 1.

The exception to this is Bulgaria[1], where as of 2009 crop subsidies were paid from the state agricultural budget through the Ministry of Agriculture – Department Tobacco Fund. The amount of subsidy was approved by the EU. The subsidy was the highest for oriental tobacco, about 1,6 Euros/kg and 1,0 Euros/kg, for semi-oriental tobacco, while the Virginia and Burley with about 0,73 Euros/kg. Since the end of 2010 Bulgaria's government decided that Tobacco Fund should be closed and tobacco production is subsidized under the scheme of payment per unit area, as any other EU countries. Through the State Fund Agriculture called as national payment, where tobacco is excluded from the scheme subsidies per unit area where funds are obtain from EU funds (Ordinance № 2 of February, 21.2011 – Special Requirements For Participation in National Schemes Approved Payments and Specific Support).

In the analyzed period, Macedonia and Serbia (non-member countries of EU) begin in applying measures to encourage the production of tobacco. Thus, in some countries subsidize quantity produced or obtained subsidy per kilo purchased tobacco regardless of its quality and surfaces. While in other countries, subsidize only the quality of tobacco or higher classes. In both cases the subsidy is paid directly at farmers' account.

Macedonia has the first (linear) system all types and classes of tobacco are equally subsidized. The policy of subsidizing the production of tobacco began in 2006 with 0,24 Euros/kg and then for each subsequent crop is increasing. The subsidy for the last tree tobacco crops (2009-2011) amounted to 0,98 Euros/kg. There is no announced change in the value and way of subsidizing tobacco for the crop 2012.

Serbia in 2005 made changes in the way of subsidizing tobacco. Appropriate regulations and conditions on tobacco subsidies have been changed and directed towards improving the quality of certain types of tobacco, so they are contracted and certain quantities of purchased tobacco per kilogram, depending on the type of tobacco and, as request of primary producers and processing of tobacco. However, in 2006 the subsidy for tobacco was returned per hectare and only for registered farms that are eligible for a premium, in the amount of about 1.000 Euros/ha.

In 2007 the subsidy was made also per kilogram of purchase tobacco, the four-classes quality and the reference yield of 1,3 tons per hectare for Virginia and Burley varieties and 0,7 tons per hectare for the Oriental tobacco. In 2008, the subsidy was also per kilogram of tobacco in the four-class quality, while the reference yield was 1,8 tons per hectare for Virginia, 1,3 tons per hectare for Burley and 0,7 tons per hectare for the Oriental tobacco. In 2009 there were no direct subsidies for tobacco. Producers of tobacco which are registered farmers, have eligible an additional subsidie

[1] Accession of Romania and Bulgaria into the European Union on January 1, 2007

about 200 Euros/ha, and 120 Euros/ha for the reimbursement of raw materials intended for crop production.

Table 1. EU Common Agricultural Policy for Tobacco Production

Crop	Changes	Quotas	Subsidy	Market rules
2004/2005	No changes compared to the current system	Same	Same per kilo	Same
2006/2009	The total aid to tobacco farmers remains unchanged		Farmers will receive of their subsidy at least 40 percent in the form of a "decoupled" payment, without any obligation to produce tobacco. Individual countries can increase this decoupled percentage up to 100 percent, if they wish, for specific varieties or producing areas. The remaining portion of the subsidy (60 percent or less) will be distributed to farmers only if they produce tobacco.	
2010/2012			Farmers will receive 50% of their subsidy in decoupled form. The remaining 50 % will be paid into a Restructuring Fund, to be used to finance alternatives to tobacco farming and processing.	
2013	The entire E.U. Common Agricultural Policy will be discussed			

Source: Common Market Organization (CMO) consensus for tobacco, April 20-21, 2004, Luxemburg, Universal Leaf obacco Company, Inc. Supply and Demand 2006, 2007, 2008.

Results and discussion

Production of tobacco by types and states will be analyzed by the tobacco planted area (ha), purchased quantities (tons) and the average purchase price per kg.

Production of tobacco in the Balkan's countries represented by area under tobacco production (Table 2).

The data in Table 2 shows that the area under tobacco have large oscillations. After harvest in 2005 the areas under tobacco fall until harvest in 2007 (81,76 %), then there is a growth and an increase in harvest in 2010 (9,17 %) above the areas under tobacco of the harvest in 2005. However, in other tobacco producing countries the situation is different.

Table 2. Areas covered by the contracts

CROP	Albania		Bulgaria		Greece		Macedonia		Serbia		Total	
	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
2005	1700	100	40200	100.00	48538	100.00	15808	100.00	5000	100.00	111246	100
2006	1630	95.88	27369	66.97	18953	39.05	15072	95.34	5100	102.00	68124	84.45
2007	1590	93.53	27981	68.47	14438	29.75	16844	106.55	5100	102.00	65953	81.76
2008	1530	90.00	31359	76.73	15477	31.89	16764	106.05	5653	113.06	70783	87.75
2009	1445	85.00	41865	102.44	15714	32.37	16212	102.56	4605	92.10	79841	98.97
2010	1568	92.24	49241	120.48	15571	32.08	16140	102.10	5545	110.90	88065	109.17
Average 2005-10	1577.2		36335.8		21448.5		16140.0		5167.2		80668.67	100

Bulgaria has the largest cultivated area under tobacco, averaging 36.335,8 ha, while Albania has the lowest average cultivated area 1.577,2 ha for the analyzed period. Macedonia is on third place with 16.140,0 ha, right after Greece with 21.448,5 ha cultivated area under tobacco. Also the data is noted that the cultivated area under tobacco in some of the analyzed countries has been reduced, and in others increased. The decrease is particularly pronounced in Greece, where the cultivated area under tobacco in 2010 amounted to 32,08 % of the cultivated area which has been in 2005.

Increases were recorded in Serbia, where the increase is 10,90 % and especially in Bulgaria 20,48 % in terms of cultivated area since 2005. In Macedonia, the cultivated area under tobacco registered a small increase of 2,10 %.

Production of tobacco in the Balkan's countries is represented by the purchased quantity of tobacco companies for purchasing and processing tobacco by first prosessor, Table 3.

The data in Table 3 shows that tobacco purchased quantities have large fluctuations and a downward trend. After harvest in 2005 buyout in general decline in all analyzed countries to harvest in 2008 (40,10 %) when it reaches the lowest level. Then there is a growth, so the purchased quantities in harvest 2010 reach a level of 72,48 % compared with quantities of purchased tobacco in 2005.

Table 3. Purchased quantity of tobacco / first processor (tons**)**

CROP	Albania		Bulgaria		Greece		Macedonia		Serbia		Total	
	tons	%	tons	%	tons	%	tons	%	tons	%	ha	%
2005	2231	100.00	58300	100.00	107447	100.00	22806	100.00	7500	100.00	198284	100.00
2006	2350	105.33	41956	71.97	22891	21.30	19681	86.3	7660	102.13	94538	47.68
2007	2241	100.45	30516	52.34	21994	20.47	16288	71.42	8480	113.07	79519	40.10
2008	2211	99.10	36272	62.22	20536	19.11	16128	70.72	8775	117.00	83922	42.32
2009	2145	96.15	48609	83.38	22556	20.99	23163	101.57	7362	98.16	103835	52.37
2010	2272	101.84	83615	143.42	21344	19.86	26314	115.38	10065	134.20	143610	72.43
Average 2005-10	2242		49878		36128		20730		8307		117285	

In other tobacco producing countries the situation is different. Bulgaria has the highest tobacco production, averaging 49.878 tons, while the lowest production of tobacco has Albania with 2.242

tons of analyzed period. It also notes that tobacco production in Albania is quite stable. Macedonia is on third place with an average production of 20.730 tons with large fluctuations during the analyzed period. It has been noted that in some of the analyzed countries, the production of tobacco has trend of reduction and increasing in some of them. The decrease is particularly pronounced in Greece, where production in 2010 amounted to only 19,86% of production in 2005. Increases were recorded in Serbia, where the increase is 34,20% and especially in Bulgaria 43,42% compared to production in 2005. In Macedonia tobacco production has increased for about 15% in the past five years. Regarding the structure of the type of tobacco in analyzed countries some changes are also evident (Table 4, Graph 1). Data presented in Table 4 show that, especially after the conversion the way of subsidizing tobacco of 2006 crop in EU zone, notes a dramatic drop in production of all types of tobacco and then gradually increase the purchased quantity of tobacco. Situation for tobacco of 2010 crop was quite different: the group: Group I – 35,07 %, than Group II – 73,24 % and Group V – 93,02 %, compared to 2005 crop. The greatest reduction is observed in Group I (*Virginia*) and Group II (*Burley*) tobacco. For oriental and semi-oriental tobacco production has gradually stabilized at the level of 2005 crop. Structure of tobacco production by type for the crops 2005-2010 is presented on Figure 1.

Figure 1 shows that participation of oriental and semi-oriental tobacco (Group V) in total quantity produced in the analyzed period is increased from 59,26 % in 2005 crop to 76,07 % in 2010 crop, while tobacco from Group I is reduced from 32,74 % in 2005 crop to 15,85 % in 2010 crop. Tobacco production of Group II is stabilized at around 8 %.

Table 4. Structure of the type of tobacco (analyzed countries)

Crop	Group I	Group I, %	Group II	Group II, %	Group V	Group V, %	Total all types, tons	Total all types, %
2005	64922	100,00	15865	100,00	117497	100,00	198284	100,00
2006	10983	16,92	12496	78,76	71059	60,48	94538	47,68
2007	13981	21,54	5266	33,19	60272	51,30	79519	40,10
2008	15508	23,89	7597	47,89	60817	51,76	83922	42,32
2009	15338	23,63	8770	55,28	79785	67,90	103893	52,40
2010	22768	35,07	11620	73,24	109300	93,02	143688	72,47
Average 2005-10	23917		10269		83122		117307	

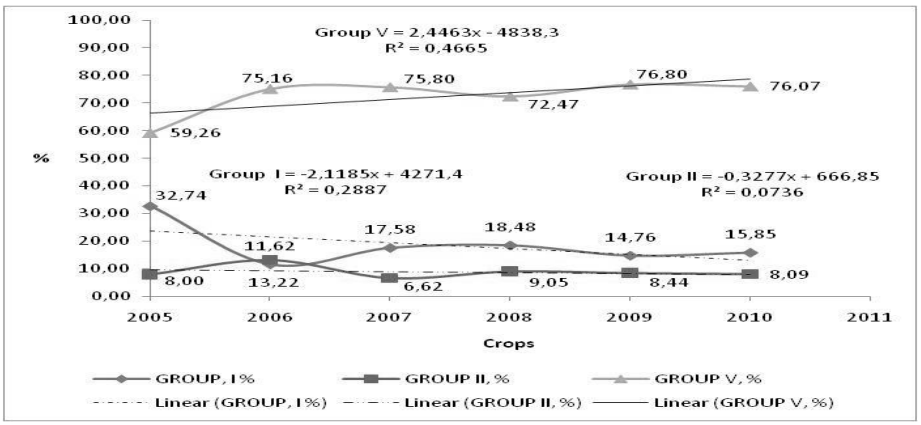


Figure 1. Structure of tobacco production by types from total tobacco production (crops 2005/2010)

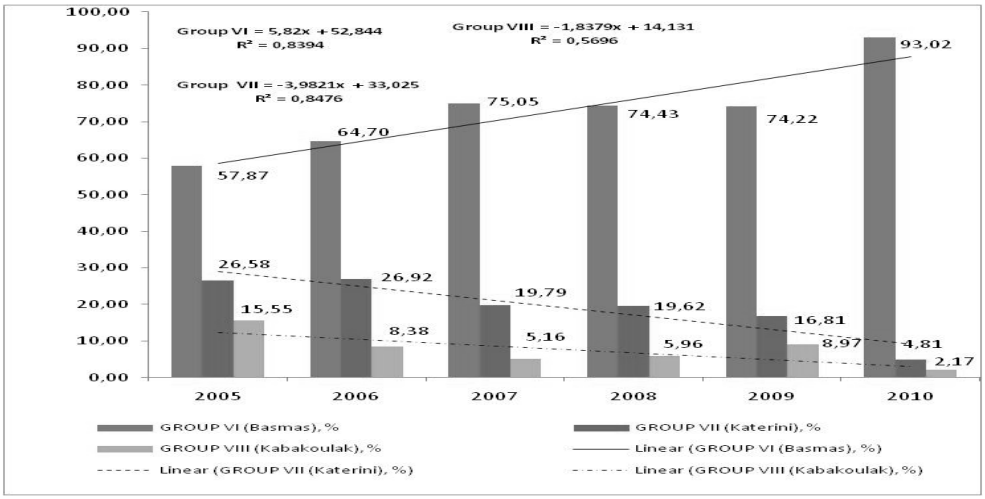


Figure 2. Participation of Groups VI, VII* and VIII in Group V
*Tobacco from Group VII is still grown in Greece and small area in Albania

Production of tobacco in the Balkan is represented by quantity of purchased tobacco from the Group V (Table 5).

Production of oriental tobacco is on the same level for the last five years in Albania (average of 2.242 tons). It is quite stable as well in Serbia, also with average of 407 tons of oriental tobacco. The highest fluctations are in Bulgaria in time when the country entered as a new member in EU and the production failed from respective 39.000 tons on 26.468 tons in 2006 and continue to decrease rapidly on 19.583 tons in 2007. In the year 2010-th, the production was almoust doubled for the last five years with quantity of 61.833 tons. The country is still number one in production of oriental tobacco in the Balkan's region. Macedonia is right behing with stable average production of 20.730 tons in the last years (because of the bad the weather conditions, crop 2007 and 2008 give low yield per unit area). From total average production for the analyzed period the largest share in

the production of oriental and semi-oriental type of tobacco has Bulgaria 40.10 %, and lowest Albania with 2.70%. Macedonia with 24.95% is in third place, right after Greece (31.76%).

Table 5. Quantity delivered, group V – oriental and semi-oriental tobacco

CROP	Albania		Bulgaria		Greece		Macedonia		Serbia		Total	
	tons	%	tons	%	tons	%	tons	%	tons	%	tons	%
2005	2231	100.00	39000	100.00	53085	100.00	22806	100.00	375	100.00	117497	100.00
2006	2350	105.33	26468	67.87	22177	41.78	19681	86.30	383	102.13	71059	85.51
2007	2241	100.45	19583	50.21	21736	40.95	16288	70.42	424	113.07	60272	72.53
2008	2211	99.10	21515	55.17	20524	38.66	16128	70.72	439	117.00	60817	73.19
2009	2145	96.15	31557	80.92	22542	42.46	23163	101.57	320	85.33	79727	95.94
2010	2272	101.84	61833	158.55	18300	34.47	26314	115.38	503	134.20	109222	131.44
Average 2005-10	2242		33326		26394		20730		407		83099	
% of Total Average		2.70		40.10		31.76		24.95		0.49		100.00

The average purchase price of oriental tobacco (Group V) is different in the analyzed countries (Table 6).

For example, two crops affected by drought (2007 and 2008) have reduced the purchased quantities of tobacco and this has caused greater demand for tobacco in the next 2009 crop, and increase the purchase price. So, in 2010 production has been increased (more agreements) and environmental conditions were also favorable (raw tobacco are distinguished by good quality and higher yield), but the purchasing companies have decided to keep the price lower. At the same time, this situation caused major strikes of farmers in Macedonia and Bulgaria, but the purchase of tobacco was realized as responding to major purchasing companies.

Table 6. Average price (paid by 1st processing enterprises) group V - oriental tobacco

CROP	Macedonia		Bulgaria		Greece	
	Euro/kg	%	Euro/kg	%	Euro/kg	%
2006	1.58	100,00	1.43	100,00	3.50	100,00
2007	2.43	153,80	2.14	149,65	4.10	117,14
2008	2.79	176,58	2.40	167,83	4.23	120,86
2009	3.26	206,33	2.98	208,39	4.20	120,00
2010	2.26	143,04	2.74	191,61	3.50	100,00
Average 2006-10	2.46		2.34		3.91	

Conclusions

The international market for oriental tobacco is mainly consisted from the following countries, the leading producers of oriental tobacco: Turkey, Bulgaria, Greece, and Macedonia. These countries are the largest exporters of oriental tobacco as well.

The volume of tobacco production in every country, producer of tobacco, depend on available land, interest in tobacco production, quality of purchased tobacco, etc. However, as the limiting factor

appears supply and demand in the market. In some countries like Greece, a factor that determine the interest subsidies for tobacco production, but in the negative sense. Bulgaria with subsidizing, tobacco production has increased and in a smaller volume in Serbia. For Macedonia positive impact of subsidies is observed only for vintage 2009 and 2010.

Since interest of quality oriental tobacco on the world market is large (due to quality and relatively low export price EUR 4-5 kg^{-1}) and Macedonian oriental tobacco has been entered into the recipes of many international brands of cigarettes, interest and orientation of the country in the future is to take advantage of natural resources and to increase production of quality raw material, designed primarily for foreign markets.

Since some of the factors which influence on production of tobacco are variable sizes, their continuous monitoring and analysis are necessary in terms of economic and technological problems, to find real solution in practice. Only thus is possible to develop an optimal strategy for further development of tobacco production.

After the conversion the way of subsidizing of 2006 crop participation of oriental and semi-oriental tobacco in Balkan's countries (Group V) in total quantity produced in the analyzed period is increased from 59,26 % in 2005 crop to 76,07 % in 2010 crop, while tobacco from Group I is reduced from 32,74 % in 2005 crop to 15,85 % in 2010 crop. Tobacco production of Group II is stabilized at around 8 %. From all these mentioned above, the oriental tobacco production still dominated in the region. As for Macedonia, there is a stable production of 25 % from total quantity of oriental tobacco production in the Balkan.

Purchased prices for oriental tobacco are quite different in each of the analyzed countries, as follows: highest purchased prices has Greece, averaging 3,91 Euros/kg, on the second place is Macedonia with 2,46 Euros/kg, and Bulgaria is third with 2,34 Euros/kg. There are also the large fluctuations in purchasing prices in Macedonia and Bulgaria, while more constant with growing trend are purchasing prices. In Greece the situation is different. There is a higher standard of living. Tobacco producers are stimulated to leave tobacco production and switch to other crops (mainly cotton and olives) *Keyser, J.C.* (2007). So, cultivated area under tobacco in 2010 amounted to 32,08 % of the cultivated area which has been in 2005. The purchased quantity in 2010 amounted to only 19,86 % of production in 2005. Because of that, tobacco production is a steady decline during this period and likely purchase prices are held to a higher level, again in order to increase production.

After all, it seems in future there will be small increasing of oriental tobacco production in Bulgaria and Macedonia. It comes from the fact that the production and purchase of tobacco in Bulgaria is liberalized during 2011 (amended Law on tobacco and tobacco products).

As one market (EU), the produced raw tobacco purchases in Bulgaria and then is being processed in other states-EU members, mainly in Greece where there are facilities for processing and production are reduced. For Macedonia, this means possibility of increasing production, especially because the same companies (in neighboring countries), are present in purchasing and processing facilities in Macedonia. In the last few years, two new and modern facilities for manipulation of soft-drying system and processing of tobacco (SOCOTAB near Bitola, and ALLIANCE ONE in Kavadarci) have been raised in Macedonia as well. This would mean that foreign companies are interested in a presence in this region.

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АНАЛИЗА НА ПРОИЗВОДСТВОТО И ОТКУПОТ НА ОРИЕНТАЛСКИ ТУТУН НА БАЛКАНОТ

Арсов Златко, Кабранова Ромина, Димов Зоран, Спирковска Маријана

Апстракт

Производството на тутун во земјите на Балканот во изминатите пет години опаѓа. Во Грција, производството на тутун е драстично намалено, бидејќи како членка на ЕУ (Европска Унија), во последниве години високите субвенции за производство на тутун биле достапни за пренасочување на производителите на тутун со производство на некои други култури. Во Бугарија, производството на тутун е исто така намалено, бидејќи, како една неодамнешна членка на ЕУ, од земјата беше побарано да го намали производството на тутун (квотата за производство на тутун падна кон производството пред да стане членка на ЕУ). Во Србија, производството на ориентален тутун е речиси елиминирано, се произведува само Вирџинија и Берлеј тип на тутун (просек од 5.000-6.000 тони). Албанија, како производител на ориентален тутун има симболично учество на околу 2.000 тони годишно. Македонија произведува само ориентален тип на тутун. Производството во изминатите години осцилира од 16.128 тони до 26.314 тони. Таа има стабилно производство со висок квалитет на тутун, добро познат на најголемите светски тутунски компании.

Клучни зборови: ориентален тутун, типска структура, производството, откуп.

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CORN YIELD IN SOUTHERN SERBIA IN DEPENDENCE ON CLIMATIC CONDITIONS OF THE YEAR

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Abstract
Corn yields are unstable and largely depends on climatic conditions, hybrids and breeding technology. The aim of this paper is to analyze the variation of corn yield in the period from 2000 to 2009 from the viewpoint of rainfall and temperature regimes. Based on the information given by the Republic Hidrometeorological institute and Agricultural expert and education service in Leskovac, it is analyzed the influence of rainfall and medium temperature of air on the yields of corns in South Serbia (Leskovac). The special emphasis places on precipitation during the three summer months (June - August), because it is considered critical for the yield. Out of nine tested years, there were separated two with unfavourable (2000 and 2008) and two with favourable climatic conditions for the production of corn (2002 and 2005). So, the average corn yield in unfavourable years was 1.7 t ha^{-1} relatively 1.4 t ha^{-1} when the amount of rainfall in the critical months (June - August) was 89 mm relatively 137 mm and the average air temperature in the same period 21.7º C relatively 20.9 ºC. The average yield of corn in favourable years was 4.1 t ha^{-1} relatively 5.7 t ha^{-1} when the amount of rainfall (June-August) was 257 mm relatively 242 mm and the average temperature of 21,4 ºC relatively 19,8 ºC. For the yield of corn it is not important total quantity of rainfall during the year or vegetation, but their arrangement in stages when corn has a great need for water. To achieve genetic potential for yield, which is more than 10 t ha^{-1} (early hybrids) or more than 15 t ha^{-1} (late hybrids), in addition to hybrids and crop management it is necessary benignity agro climatic conditions of the region, especially enough rainfall and their regular schedule.
Key words: corn, yield, precipitation, air temperature.

Introduction

Corn for its economic importance is one of the most important field crops. The great importance of corns derived from a variety of use, big yield and production volume. According to statistics, in the Republic of Serbia, it is grown over 1200000 hectares. Corn yields are unstable and largely depend on climatic conditions, hybrids and breeding technology. Since last year we have drier summers, and that a very small percentage of the area (less than 2%) to be irrigated, production and yield of maize are increasingly dependent on rainfall. To form yield of corn, it is not important total amount of precipitation during the year or vegetation, but their arrangement in stages, when corn has a need for water. Special importance is attached to rainfall in the summer months (June-July-August)

because it is a period when corn has expressed need for water and the period when it is determining the formation of yield. The impact of rainfall and temperature on the yield of corn are spoken and earlier works some authors (Josipović et al., 2005; Šoštarić and Josipović, 2006; Kovačević et al., 2009; Maklenović et al. 2009, Paunović et al., 2010, Kovačević et al., 2010).
The aim of this study was to analyze the variation of corn yield in the period 2000 to 2009, depending on rainfall and temperature regimes.

Material and methods

Based on the information given by the Republic Hidrometeorological institute and Agricultural expert and education service in Leskovac, it is analyzed the influence of rainfall and medium temperature of air on the yields of corns in South Serbia (Leskovac). Special emphasis is placed on precipitation during the three summer months (June-July-August),because it is considered critical for the yield. Of the ten analyzed years it is separated two (2000 and 2008) when the yields of corn were lowest, and two (2002 and 2005) when yields were highest. For the analysis of variations in the yield of corn per year (from 2000 to 2009.) from the standpoint of specific weather events are given appropriate data (grain yield, rainfall and mean air temperature in June-July-August, and the average monthly precipitation and temperature in the growing season from April to September).

Results and discussion

Corn yield

Grain yield is a difficult category on the basis that govern all manufactures and he depands on many factors as well as the production of the region. In table 1 it is given the average yield of corn in the period from 2000 to 2009 in Central Serbia, Vojvodina and Jablanica (Leskovac). Surely that the conditions for corn production it these regions are different, as evidenced by average yields. It is known that the soil in Vojvodina and Serbia better than in the southern part of Serbia, while the southern part of Serbia is warmer.
The average yield of corn in the Jablanica district (Leskovac) during the study period was 3.3 t ha^{-1}, in Vojvodina 5.1 t ha^{-1}, in Central Serbia 3.8 t ha^{-1}, which means that the average corn yield in the region of Leskovac was less to 35.3% than in Vojvodina, or 26.7% than in Central Serbia. Also, the average corn yield in Vojvodina was 25.5% higher than in Central Serbia.These data indicate favourable agro-ecological conditions of certain regions for corn production. During the analyzed period we have selected two years when the average yield was the lowest and two years when the average yields were highest. We note that this are not the same years in all regions, which once again testifies to the diversity of agro-climatic conditions in some regions. Thus, in Central Serbia lowest yields (1.9 and 2.3 t ha^{-1}) were in 2000 and 2007 year, and the highest (4.5 and 5.0 t ha^{-1}) in 2009 and 2005 year. The lowest yield in Vojvodina (2.9 and 3.4 t ha^{-1}) were in 2000 and 2003 year, and the highest (5.9 and 6.5 t ha^{-1}) in 2009, 2004 and 2006, respectively in 2005 year. In the municipality of Leskovac lowest yields (1.7 and 1.4 t ha^{-1}) were 2000 and 2008 year, and the highest (5.7 and 4.1 t ha^{-1}) in 2005 and 2002 year. The difference between the lowest average yield (the unfavourable years) and the highest average yield (favourable years) was 3.3 t ha^{-1} in favour of favourable years. These differences are largely the result of weather conditions. Kovacevic et al. (2010) point out that the below-average rainfall and above-average air temperature in a certain relation to below-average yields of corn.

Table 1. Yields of maize

Year	Grain yields of maize (t ha^{-1})				
	Republic of Serbia and the regions				
	Serbia total*	Central Serbia	Vojvodina	Jablanica area	Leskovac
2000	2,4	1,9	2,9	1,6	1,7
2001	4,9	4,1	5,6	3,8	3,9
2002	4,7	4,3	5,0	3,7	4,1
2003	3,2	2,9	3,4	3,7	3,5
2004	5,5	5,0	5,9	2,3	2,3
2005	5,8	5,0	6,5	5,3	5,7
2006	5,1	4,3	5,9	4,2	3,5
2007	3,2	2,3	4,1	3,6	3,6
2008	4,8	4,0	5,5	1,3	1,4
2009	5,3	4,5	5,9	3,7	3,7
mean	4,5	3,8	5,1	3,3	3,3

*without Kosovo and Metohija

Climatic factors, especially temperature and precipitation, according to many researchers involved in the formation yield of about 30%. Our country, in the course of the year, has sufficient rainfall. However, their distribution is irregular, so that it has the highest when plants are not needed. For many researchers it is very important distribution of rainfall during the vegetation, especially in the months (June-July-August) when it is most needed to corn. According to Rosić and Bajic (1989) the ideal amount of rainfall for corn during the three summer months is 317 mm (127 mm in June, in July 100 mm, and in August 90 mm). Because we are in Tab.2. analyzed the distribution of rainfall and temperature during the growing season of maize (April-September), and the amount of rainfall and average temperatures in critical months of the grain yield of maize (June-July-August). It is analyzed period of 10 years (2000-2009) for the area of Leskovac.Ten-year average precipitation in the growing maize (April-September) amounted 328.9 mm and the average temperature 18.1 ºC.
The average amount of rainfall for the month of June-July-August was 164.6 mm, while the average temperature was 21.2 ºC. In the analyzed period, there were selected two years with at least of rainfall in the June-July-August, and two years with at least with the highest rainfall in the same period. Thus, the years with the highest rainfall (257 mm and 242 mm) were 2002 and 2005, when the average temperature was 21.4 ºC and 19.8 ºC. In those years, the corn yield was the highest (4.1 and 5.7 t ha^{-1}), and total precipitation during the growing season were higher than 400 mm.Years with at least rainfall in the June-July-August (78 mm and 89 mm) were 2007 and 2000, and then the average temperature was 22.8º C and 21.7º C. However, the lowest yield (1.7 t ha^{-1}) was the year 2000, while the 2007 (although it had at least rainfall) yield was 3.6 t ha^{-1}. This is due to heavy precipitation in May (115 mm) which had accumulated enough moisture so it is offset by the lack of rainfall in the June-July-August. We note that the highest yields were achieved in the year with the highest rainfall in June-July-August and favourable temperatures, while the lowest yields were not always in the years when and amount of rainfall in month of June-July-August were the least.
Once again it is confirmed that the climatic conditions, especially in the June-July-August

determine and total yield of corn. Our results are in agreement with results Kovacevic et al. (2010) point out that the weather in the summer months (June - July - August) have a significant effect on the yield of maize in Croatia and Serbia. If corn production takes place in conditions without irrigation, which is most often the case, the consequences caused by adverse weather conditions can be somewhat mitigated breeding hybrids resistant to drought and better agrotechnics (tillage, fertilization, sowing dates).

Table 2. Weather data for Leskovac

Weather data - Leskovac										
Year	Precipitation (mm) and mean air-temp. (ºC) in June, July and August and during vegetation									
	June		July		August		Σ	x	April-september	
	mm	ºC	mm	ºC	mm	ºC	mm	ºC	Σ mm	x ºC
2000	47	18.9	38	22.4	4	23.9	89	21.7	234	18.0
2001	72	18.4	44	21.5	28	22.7	144	20.8	423	17.5
2002	57	20.5	53	23.3	147	20.6	257	21.4	406	18.7
2003	26	22.6	37	22.3	28	24.0	91	22.9	228	18.8
2004	74	19.5	76	21.7	36	19.3	186	20.1	319	17.5
2005	75	18.5	99	21.5	68	19.6	242	19.8	433	17.2
2006	80	19.3	33	21.5	118	20.6	231	20.4	365	17.8
2007	26	22.2	10	22.4	42	24.0	78	22.8	270	18.8
2008	48	18.7	43	21.6	46	22.6	137	20.9	282	17.6
2009	121	19.7	43	22.3	55	21.7	219	21.2	329	18.7
Average	62.6	19.8	47.6	22.1	55.7	57.2	167.4	21.2	328.9	18.1

Conclusions

Based on the analysis of the influence of climatic factors on the yield of maize in Leskovac (Jablanica) we can conclude the following:

In the ten-year period (2000-2009) were separated by two years (2002 and 2005) when the yield was the highest and the two years when yields were lowest (2000 and 2008).

In years when the average yield was the highest (4.1 and 5.7 t ha^{-1}) and climatic factors, particularly rainfall, were favourable.

Years with the lowest average yields (1.7 and 1.4 t ha^{-1}) were characterized by poor climatic conditions, especially precipitation distribution.

Average yields in favourable years were for 3.35 t ha^{-1} higher than the average yield in unfavourable years.

It is consulted influence of the amount of rainfall in June-July-August on yield of corn.

When the precipitation in these months were the greatest and yields were highest.

For the yield of corn is not important total precipitation during the year or vegetation, but their arrangement in stages when corn has a great need for water.

The breeding of resistant maize to drought and better agrotechnics can mitigate the consequences caused by unfavourable weather conditions.

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ПРИНОС НА ПЧЕНКА ВО ЈУЖНА СРБИЈА ВО ЗАВИСНОСТ ОД ГОДИШНИТЕ КЛИМАТСКИ УСЛОВИ

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Апстракт

Приносите од пченка се нестабилни и во голема мера зависат од климатските услови, хибридите и технологијата на одгледување. Целта на овој труд е да се анализира варирањето на приносот на пченка, во периодот 2000-2009 од гледна точка на врнежите и температурниот режим. Врз основа на информациите кои се дадени од страна на Републичкиот хидрометеоролошки институт, земјоделски експерти и образовниот сервис во Лесковац, анализирани се влијанието на врнежите и средната температурата на воздухот врз приносите на пченка во Јужна Србија (Лесковац). Посебен акцент се става на врнежите за време на трите летни месеци (јуни - август), затоа што се смета дека тие се од клучно значење за приносот. Од девет тестирани години, беа одделени две, со неповолни (2000 и 2008) и две со поволни климатски услови за производство на пченка (2002 и 2005). Просечниот принос на пченка во неповолните години беше 1,7 т ха$^{-1}$, односно 1,4 т ха$^{-1}$ кога износот на врнежи во критичните месеци (јуни - август) беше 89 мм, односно 137 mm, а просечната температура на воздухот во истиот период 21,7 ºC, односно 20,9 ºC. Просечниот принос на пченка во поволни години изнесуваше 4,1 т ха-^{1}, односно 5,7 т ха-^{1} кога износот на врнежи (јуни-август) беше 257 мм, односно 242 mm и просечна температура од 21,4 ° C, односно 19,8 º C. Вкупното количество на врнежи во текот на годината или вегетацијата, не е значајно за приносот на пченка, туку нивната распределба во фази, кога пченката има потреба за вода. За да се постигне принос соодветно на генетскиот потенцијал, што е повеќе од 10 т ха$^{-1}$ (кај рани хибриди), или повеќе од 15 т ха$^{-1}$ (кај касни хибриди), во прилог на хибридите и производното менаџирање, неопходни се благопријатни агроклиматски услови во регионот, посебно доволно врнежи и со правилен распоред.

Клучни зборови: пченка, принос, врнежи, температура на воздух.

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Original scientific paper

GRAIN YIELD OF TRITICALE AND RYE IN DEPENDENCE ON ACID SOILS FERTILIZATION

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Abstract
This paper gives a report on the influence of fertilization systems in acid soils, and the effect of mineral fertilization on 1000 grain mass, hectoliter mass and grain yield of triticale and rye. The trial was carried out in 2009-2010 in the Center of Agricultural and Technological Research - Zaječar, involving three fertilization variants and two plant species (triticale and rye). The first fertilization variant was characterized by NPK ratio of 120:80:53, in the second variant phosphorus content was doubled, and in the third variant, besides NPK fertilizers, there were applied 5 t/ha of lime fertilizer „Njival Ca" and 20 t/ha of manure. The trial was set in random complete block design (RCBD) with three repetitions. This investigation results showed a significant effect of fertilization on increase of 1000 grain mass, hectolitre mass and grain yield. The highest 1000 grain mass in triticale and rye (52.0 and 36.0 g) was reached by the combination of mineral, lime and organic fertilizers, while the highest hectolitre mass (77.9 and 74.5 kg) was obtained by the application of mineral fertilizers with doubled phosphorus dose. The highest grain yield (4180 kg ha^{-1}) in triticale was reached by combined application of NPK, lime and manure, while the highest grain yield in rye (2913 kg ha^{-1}) was obtained by NPK with doubled phosphorus dose. The difference between triticale and rye regarding the average grain yield was 1267 kg ha^{-1}. Numerous reports from our country and worldwide showed that proper application of lime fertilizers, combined with organic and mineral ones, is the most efficient way to remediate low production properties of acid soils, which could double crop grain yield.
Key words: triticale, rye, fertilization, absolute mass, hectoliter mass, yield.

Introduction

By opinion of many researchers triticale is plant species with a high genetic potential for yield and favourable nutritive values, so it is considered as a perspective plant species (Borojević, 1981, Cvetkov, 1982, Đokić, 1988). Rye, as an older grain sort, somewhat forgotten, takes the distinguished place again, at the first place in the organic production system and healthcare food.
In Nozinic and associates researches (2009) rye sorts had proven as very resistible to extremely acid reaction of soil in regard triticale. The same authors emphasize that both of those plant spicies showed satisfactory yield in extremely dry seasons.
According to results Impiglia (1987) triticale has more modest requests in regard wheat and more adaptability on acid soil, as more resistance to common diseases. Vertisols are soils of bad watery-aero and fizicly-mechanicly characteristics. On this kind of soil plant production is unstable. According to allegations of Aniolo and Madej (1996) the greatest tolerance to acid soil shows rye,

than triticale and wheat, yet barley is most sensitive. Numerous researches here and abroad point up that adequate usage of lime fertilizers combined with organic and mineral fertilizers represents the most efficient way of rejection of unfavorable productive characteristics of acid soil and affect to multiply yield increase (Jovanovic et al., 2006; Kovacevic et al., 2006; Jelic et al., 2006).
In selection of the kind and the quantity of fertilizer, it is necessary to consider fertility of the soil. So less quantity of fertilizers is used on more fertile soil than on poor one, in order to achieve the same yield (Jelic and associates, 2002).
The goal of our researches was to determine triticale yield and rye on acid soil in dependence of quotes and used fertilizers sorts.

Material and methods

The trial was carried out in 2009-2010 in the Canter of Agricultural and Technological Research in Zajecar, set up by block system in three repetition, involving control and three fertilization variants – mineral, lime and organic and two plant species (triticale, Tango sort and rye, Rasha sort). Amounts and schedule of nutrients in variants are given in a Table 1.

Table 1. Amounts of pure nutrients used in the experiment

Fertilization variants	Amounts of nutrients (kg ha^{-1})				
	N	P_2O_5	K_2O	$CaCO_3$	Manure
Control	0	0	0	0	0
NP_1K	120	80	53	0	0
NP_2K	120	160	53	0	0
$NP_1K+CaCO_3$ + manure	120	80	53	5.000	20.000

The size of the basic trial parcel was $50m^2$. Total amounts of phosphorus and potassium fertilizers with one third of nitrogen are dispersed handy, before the pre-planting soil preparation. In variant with calcization usage lime fertilizer „Njival Ca“ was dispersed and there were applied manure and mineral fertilizer. The remained quantity of nitrogen was used in a sole top dressing in a phase of full tillering. From mineral fertilizers, complex NPK fertilizers (8:24:16), super phosphate (17% P_2O_5) were used, while in the top dressing was used ammonium-nitrat (AN) with 34.4% N. Basic processing and preparation of soil for planting are done on the classical way (to 25cm depth), immediately after the corn harvest and corn stover removal. The rest of technology production used in the trial was standard. The harvest was done in the phase of the dead ripe.

Soil and climate conditions

This is non-calcereous Vertisol soil and is distinguished by high level of acidity (pH in KCl 4,84 – 5,15). The content of nitrogen in profile to 20cm is 0,12% and decrease with depth. The content of the available phosphorus in profile to 20 cm is 16,68 mg/100g, and in deeper layers 12,34mg. This soil is heavy with available potassium (29,53 mg/100 g in the plough-field layer). Those soils have a cubage change predispositions, swelling and hardening tendencies so very heavy for treat. Those soils pertain to minute soils, which means that their optimal term for treat is very short. Repairments are necessary, in order to yield should have been satisfactory.

Table 2. Chemical properties of soil

Depth (cm)	pH		N (%)	Available (mg/100 g)	
	H_2O	nKCl		P_2O_5	K_2O
0-20	5.23	4.84	0.12	16.68	29.53
20 - 40	5.54	5.15	0.11	12.34	27.22

October had a highly amount of precipitation, which had a good influence on harvest and grain germination. During March and April conditions for growing process and development were very favourable, especially for swelling, rooting and increasing of leaves mass of plants. Vegetative development of plants during the spring time had favourable temperature conditions with satisfactory amount of precipitation, witch increased plants development. In final phases of grow and development, during June and July, temperatures were optimal, but heavy precipitations delayed harvest and led to loss of the part of yield and his quality.

Table 3. Meteorological conditions during the experiments

Months	Mean monthly	Monthly sum of precipitation (mm)	Relative
X	12	104	75
XI	9	94	74
XII	1	124	79
I	-2	53	81
II	1	100	74
III	7	59	73
IV	12	72	70
V	17	57	71
VI	20	94	71
VII	23	88	67
Average-sum	10	845	73.5

Results and discussion

Yield and yield components of triticale grain

Absolute grain mass is the significant of its magnitude or grain dimension and its mostly dependable of climate factors and plants density. Triticale has a large grain (40-65g) and surpasses wheat and rye (Popovic and Milovanovic, 1986, Rehmetulin and ass., 1988, Przulj, 1989. etc.).

The highest absolute mass (59g) of triticale is accomplished in third variant, where was used the combination of NPK fertilizers, lime fertilizers and manure, and the lowest was on control variant (52.0) – those differences were statistically very significant. Fertilizers usage led to increase of the absolute mass of grain, although there were no statistically significant differences between variants.

Characteristic of the hectolitre mass is that there were no statistically significant differences between fertilizing and control variants, although the highest values were achieved in the second variant (77.9kg). It is explained by the fact that on the control variant were significantly less number of plants (because of higher presence of weed), which grain were bigger.

Table 4. Components of grain yield of triticale depending on fertilization

Fertilization variants	Components of grain yield		
	Absolute mass (g)	Hectoliter mass (kg)	Grain yield
O. control	52.0	74.9	1927
I. NP_1K	57.9	77.4	3550
II: NP_2K	58.5	77.9	4020
III. $NP_1K+CaCO_3$+manure	59.0	76.8	4180
Average	57.9	76.7	4003
LSD- test			
5 %	3.2	4.6	360
1%	3.5	4.8	378

Fertilizing showed very significant influence to grain yield of triticale. So yield in all variants of fertilizing was significantly higher in regard to control variant. The highest yield (4180 kg ha^{-1}) was achieved on the third variant where was used NPK combination of lime and manure. Yield in the second and third variant was approximately equal, but significantly higher in regard to the first variant, where was used NPK fertilizers with lower dose of phosphorus. Variant with increased dose of phosphorus (II) showed good results in yield increase, so yield in this variant was significantly higher than in variant I. Higher effect of NPK usage with increased dose of phosphorus is result of high soil acidity and lower content of available phosphorus in this soil, also. Positive effect of enlarged doses of phosphorus fertilizers on grain yield height, got also another authors earlier (Jelic et al., 1998; Jovanovic et al., 2006; Kovacevic et al., 2006). Numerous earlier researches showed that on soils of acid reaction, the complete usage of NPK, lime and manure have a significant effect to grain yield (Ognjanovic et al., 1994; Jelic et al., 1995; Jelic et al., 2004), which is in accordance with our results, too.

Yield and grain yield of rye components

Rye belongs to plant species which have a good resistance to soil acidity, significantly better than other grains.

Table 5. Components of grain yield of rye depending on fertilization

Fertilization variants	Components of grain yield		
	Absolute mass (g)	Hectoliter mass (kg)	Grain yield
O. control	31.6	72.5	1077
I. NP_1K	33.6	73.5	2443
II: NP_2K	35.5	74.5	2913
III. $NP_1K+CaCO_3$+manure	36.0	73.7	2727
Average	34.1	73.6	2290
LSD- test			
5 %	2.3	4.1	280
1%	2.9	5.0	294

Absolute mass of rye grain with the fertilizer usage increased from I to III variant. The highest (36g) was in variant III and it was significantly higher in regard to variant I but significantly higher in regard to control variant. There were no significant differences between variants II and III and between variants I and control variant.

Similar to triticale results, and rye results, there were no statistically significant differences in the hectolitre mass, although it was the highest (74.8kg) in variant II, where was used higher dose of phosphorus.

If we compare triticale and rye yield on acid soils in regard to average, we could see it is lower evasion at rye. In opposition with absolute and hectolitre mass, grain yield of rye is significantly increased with fertilizers usage in regard to control. So the highest yield was achieved in variant II, where was used higher dose of phosphorus and it was significantly higher in regard to control and variant I. This confirms the fact of positive effect of phosphorus on acid soils. There were no significant differences in yield between variants II and III, while yield on those variants was significantly higher in regard to control variant and variant I. Differently from triticale, usage of combination NPK, lime and manure, didn't give the highest yield on rye. It could be explained with a fact that rye stands better acid soils and the effect of enlarged doses of phosphorus is more expressed.

Relatively favourable time conditions during the vegetation period, with enough amount of precipitations which were present until the earliest phases of plant development to the maturation phase, made the satisfactory grain yield was accomplished. Numerous researches show that favourable usage of nutrients from fertilizers effects and favourable meteorological conditions, also (Jelic, 1995; Zivanovic-Katic et al., 2000; Jelic et al., 2007).

Conclusions

On the bases of investigation of fertilizing influence on absolute mass, hectolitre mass and grain yield of triticale and rye, we can conclude/abstract the following:

Fertilizers usage positively effected on increase of grain yield of triticale and rye.

The biggest absolute mass in triticale and rye also, is achieved by usage of NPK, lime and manure fertilizers combination.

The highest hectolitre mass in triticale and rye also, is achieved by usage of NPK fertilizers with increased dose of phosphorus.

The highest triticale yield is achieved by usage of NPK, lime and manure fertilizers combination.

The highest rye yield is achieved by usage of NPK fertilizers with increased dose of phosphorus.

Lower evasions in yield from the average, are notified in rye, considering it better stands acid reaction of soil.

Differences in triticale yield and rye yield were 1267 kg ha^{-1}.

In order to raise the level of fertility of acid soils and increase of cultivated plants yield it is necessary to use the combination of NPK, lime and manure fertilizers, and usage of NPK fertilizers with increased dose of phosphorus.

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ПРИНОС НА ТРИТИКАЛЕ И ’РЖ ВО ЗАВИСНОСТ ОД ЃУБРЕЊЕТО НА КИСЕЛИ ПОЧВИ

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Апстракт

Во овој труд е претставено влијанието на системи за ѓубрење во кисели почви, и ефектот од минералното ѓубрење врз апсолутната маса, хектолитарската маса и приносот кај тритикале и 'рж. Опитот беше спроведен во периодот 2009-2010 година, во Центарот за земјоделско и технолошко истражување - Зајачар, со вклучени три варијанти на ѓубрење и два растителни видови (тритикале и 'рж). Првата варијанта се карактеризира со NPK = 120:80:53, во втората варијанта содржината на фосфор е удвоена, а во третата варијанта, покрај NPK ѓубрива, беа применети и "Njival Ca"-ѓубриво со 5 т/ха и 20 т/ха арско ѓубре. Опитот беше поставен во целосно рандомизиран блок систем (RCBD), со три повторувања. Резултатите покажаа значаен ефект од ѓубрењето, со зголемување на апсолутната маса /1000 зрна, хектолитарската маса и приносот. Највисока апсолутна маса беше постигнат со комбинација на минерално ѓубре, варовник и органски ѓубрива, кај тритикале и 'рж (52,0 и 36,0 g) додека највисока хектолитарска маса (77,9 и 74,5 кг) е добиена со примена на минерални ѓубрива со двојната доза на фосфор. Највисок принос (4180 кг $ха^{-1}$) беше постигнат кај тритикалето, со комбинирана примена на NPK ѓубриво, вар и арско ѓубре, додека највисок принос од 'рж (2913 кг $ха^{-1}$) е добиен со NPK ѓубриво, со двојна доза на фосфор. Разликата помеѓу тритикалето и 'ржта во однос на просечниот принос беше 1267 кг $ха^{-1}$. Бројни извештаи од нашата земја и светот, покажаа дека со правилна примена на варовнички ѓубриња, во комбинација со органски и минерални, се постигнува најефикасен начин да се санираат ниските производни својства на кисели почви, и да се добие двоен принос.

Клучни зборови: тритикале, 'рж, оплодување, апсолутна маса, хектолитарска маса, принос.

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INFLUENCE OF FOLIAR FERTILIZATION ON AGROMORPHOLOGICAL TRAITS OF WHEAT AND TRITICALE

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Abstract
The aim of this study was to monitor the effect of nitrogen application both as soil as well as foliar fertilization on agromorphological traits of wheat and triticale. The experiment was conducted at the production fields of Crveni Bregovi, Macedonia, during the growing season 2010/11. Two soft wheat varieties and one triticale variety were exposed to seven fertilization treatments. All treatments included soil application of 200kg/ha KAN (27% N) in tillering phase, and the first one with no additional fertilization was used as a control. The other treatments consisted of various doses and different application time of the fertilizers Magnisal 6 and ammonium nitrate NH_4NO_3 (17.5% N) applied by foliar spraying. Different treatment combinations significantly affected almost all agronomic characteristics. Plant height in cultivar Podobrena Orovcanka (79.4 cm) and kernel weight per spike in cultivar Olga (1.46 g) were not significantly changed by the use of foliar fertilizers. In triticale variety, plant height, spike length, number of spikelets per spike and kernel weight per spike didn't show significant differences when treatment 1 and treatment 7 were applied. Therefore, the results obtained by this research confirm that it is possible to obtain improvement of agromorphological traits of wheat and triticale through soil and foliar application of nitrogen. Furthermore, preliminary information on the influence of split doses of fertilizers at various growth stages to get appreciable growth and agronomic characteristics of these cereal crops is given.
Key words: foliar fertilization, agromorphological traits, wheat, triticale.

Introduction

Cereals are major source of nutrition in the world, because they constitute the main protein and energy supply in most countries (Bos et al., 2005). Wheat is the major cereal crop and is grown around the world in diverse environmental conditions. Triticale is cultivated under a wide range of environments because of its ability to tolerate adverse conditions such as drought, nutrient deficiency, etc. (NRC, 1989). Much of the production (FAO, 2004) is as triticale grain, but triticale is also grown as a forage crop and as a dual-purpose crop (both forage and grain) and is more cost-effective than its competitors, as its high lysine content means less protein supplements are required (Kinaci and Gulmezoglu, 2007).

Balanced nutrition plays a significant role in increasing crop production and its quality and presents an essential component of nutrient management. Nutrients like N, P, K, S and Mg are essential for the major processes of plant development and yield formation (Randhawa and Arora, 2000).

Nitrogen rate, type and timing of its application are important factors to increase wheat yield and improve its flour quality (Garrido-Lestache et al., 2005).
It has been observed that foliar fertilizer application methods ensure the availability of nutrients to crops for obtaining higher yield (Alaru et al., 2003; Arif et al., 2006).
Foliar application of N at different growth stages of wheat and triticale enhances the seed quality, boosts yield components and ensures high yield (Brar and Brar, 2004; Saeed et al., 2012). Efficient remobilization of urea (N) to grain after foliar fertilization on wheat at optimum timings, i.e., at and after anthesis stage, increases grain protein content and improves bread-making quality (Tea et al., 2007). Foliar application of nutrients to triticale may be advantageous when there is a high risk that the necessary nutrients will be unavailable to plant roots due to adverse soil and climatic conditions (Alaru et al., 2003).
The present study was therefore designed to investigate the possibility to improve agromorphological traits and to assess the response of wheat and triticale cultivars to soil and foliar fertilization.

Material and methods

The experiment was conducted at the production fields of Crveni Bregovi, Macedonia, during the growing season 2010/11. The experimental setup was randomized complete block (RCB) design with three replications. Plot size was $5m^2$ with a sowing density of 500 grains/m^2. Two soft wheat varieties (Olga and Podobrena Orovcanka) and one triticale variety (Agrounija), often used in the large scale production, were used for the experiment. Standard agrotechnical measures were applied with no autumn soil application of fertilizer.
All treatments included soil application of 200kg/ha KAN (27% N) in tillering phase, and the first one with no additional fertilization was used as a control (Treatment 1). The other treatments (7 in total) consisted of various combination of dose and application time of the fertilizers Magnisal 6 (NPK 31:0:0 + ME, released by Alkaloid AD Skopje in 2010, consisted of ammonium, nitrate and amid form of N and helated form of Fe and Mg) and amonium nitrate NH_4NO_3 (17.5% N) applied by foliar spraying. Details of the fertilizer treatments are as follows: *Treatment 1:* soil application of 200 kg/ha KAN at tillering phase; *Treatment 2:* soil application of 200 kg/ha KAN at tillering phase + 100 kg/ha KAN at booting stage; *Treatment 3:* soil application of 200 kg/ha KAN at tillering phase + 4l/1000l/ha NH4NO3 at grain filling; *Treatment 4:* soil application of 200 kg/ha KAN at tillering phase + 3l/1000l/ha Magnisal 6 at heading; *Treatment 5:* soil application of 200 kg/ha KAN at tillering phase + 4l/1000l/ha NH4NO3 at heading + 4l/1000l/ha NH4NO3 at grain filling; *Treatment 6:* soil application of 200 kg/ha KAN at tillering phase + 3l/1000l/ha Magnisal 6 at heading + 3l/1000l/ha Magnisal 6 at grain filling; *Treatment 7:* soil application of 200 kg/ha KAN at tillering phase + 3l/1000l/ha Magnisal 6 at heading + 4l/1000l/ha NH_4NO_3 at grain filling.
After the harvest, the influence of these treatments was evaluated on six agromorphological traits: three important characters: plant height, spike length, number of spikelets per spike, number of kernels per spike, kernel weight per spike and 1000 kernel weight. The data for the three replications were analyzed for variance using the statistical package R. The differences between means were compared by Tukey's hsd test. Statistical significance was considered at $P<0.05$.

Results and discussion

The findings of the research showed that different fertilization treatments had significant effects on all analyzed traits in wheat cultivar Podobrena Orovcanka (Table 1) and triticale cultivar Agrounija (Table 3). In wheat cultivar Olga (Table 2), the applied fertilizers did not show significant effect on number of kernels per spike. It is evident from the data that the application of N either as soil applied or as foliar applied had a significant effect on plant height in Podobrena Orovcanka and Agrounija. The treatment 4 had highest positive effect for number of spikelets per spike, number of kernels per spike and 1000 kernel weight in Podobrena Orovcanka (Table 1). For the other analyzed traits, values obtained after application of this treatment did not differ significantly from the highest values. The lowest plant height (69.33 cm) and kernel weight per spike (1.43 g) were observed in treatment 5.

Table 1. Effect of fertilization treatments on agromorphological traits in wheat cultivar Podobrena Orovcanka

Fertilization treatment	Plant height	Spike length	Number of spikelets per spike	Number of kernels per spike	Kernel weight per spike	1000 kernel weight
1	79,40e	10,64bc	18,53ab	33,43b	1,53a	35,90a
2	77,90cde	10,28a	18,50ab	34,57c	1,56ab	47,43d
3	73,28b	10,74cd	19,13b	36,40d	1,60ab	44,10c
4	78,30de	10,72bcd	19,30bc	40,40e	1,89c	48,40e
5	69,33a	10,29a	18,25a	31,58a	1,48a	46,67d
6	76,57cd	10,95d	20,13c	36,50d	1,66b	44,47c
7	75,77d	10,47ab	17,77a	30,83a	1,52a	43,23b

In cultivar Olga (Table 2), the highest values for number of spikelets per spike (22.47), number of kernels per spike (40.40) and 1000 kernel weight (44.10 g) were achieved under treatment 5. Plant height did not differ significantly between treatments 3 (69.07 cm), 2 (70.03 cm), 1 (70.10 cm) and 5 (70.17 cm).

Saeed et al. (2012) stated that the probable reason for increasing plant height could be the increased vegetative growth at high doses of applied N, greater and more efficient absorption of N or the genetic makeup of the concerned varieties. These results are in agreement with those reported by Ling and Silberbush (2002), Matsi et al. (2003) and Bakht et al. (2010). A positive effect of the foliar application of N over different agromorphological traits have been observed by Londero et al. (2003), Seadh et al. (2009), Parvez et al. (2009), Yassen et al. (2010) and Njuguna et al. (2011). In triticale cultivar Agrounija (Table 3), the treatment 7 caused lowest values for number of spikelets per spike, number of kernels per spike and kernel weight per spike, and the highest value for 1000 kernel weight. Plant height had lowest, while spike length and number of spikelets per spike had highest values under treatment 4.

Kinaci and Gulmezoglu (2007) and Gulmezoglu and Aytac (2010) revealed that foliar treatments had significant positive effect on grain yield, spikelet number per spike, number of grain per spike, 1000 grain weight and harvest index of triticale. On the other hand, Londero et al. (2003) observed that in hexaploid triticale the fertilizer effect was negative, except on harvest index.

Table 2. Effect of fertilization treatments on agromorphological traits in wheat cultivar Olga

Fertilization treatment	Plant height	Spike lenght	Number of spikelets per spike	Number of kernels per spike	Kernel weight per spike	1000 kernel weight
1	70,10ab	9,79ab	21,80bcd	33,27a	1,46a	41,17cd
2	70,03ab	10,38b	22,33de	38,10ab	1,61a	43,93e
3	69,07a	10,52b	22,10cde	32,43a	1,42a	40,13c
4	73,57d	9,94ab	21,53bc	36,07ab	1,51a	38,07b
5	70,17ab	10,15b	22,47e	40,28b	1,52a	44,10e
6	72,10cd	9,32a	20,60a	33,40a	1,42a	41,87d
7	71,60bc	10,51b	21,37b	34,27ab	1,52a	33,70a

Table 3. Effect of fertilization treatments on agromorphological traits in triticale cultivar Agrounija

Fertilization treatment	Plant height	Spike lenght	Number of spikelets per spike	Number of kernels per spike	Kernel weight per spike	1000 kernel weight
1	96,20b	9,90a	26,83a	41,18b	1,37ab	35,87cd
2	99,55c	10,46b	29,56bc	53,61f	2,19e	35,70cd
3	103,87e	10,88c	30,42cd	57,63g	2,41e	31,60a
4	86,47a	11,38d	30,98d	47,65d	1,76d	35,24bc
5	105,30f	10,93c	29,50bc	49,73e	1,93d	36,37d
6	102,87d	11,19d	29,11b	45,63c	1,53bc	34,40b
7	95,57b	9,97a	26,59a	35,36a	1,29a	37,70e

The overall positive effect of the foliar fertilization on analyzed traits in cereal cultivars included in this study may be due to the multiple advantage of the foliar application method, such as rapid and efficient response to plant needs, its relatively quick absorption, less product needed and independence of soil conditions (Römheld and El-Fouly, 1999; Yildirim et al., 2007).

Conclusions

The current study revealed that foliar and soil application of nitrogen at various growth stages of wheat and triticale improved the analyzed agromorphological traits. In Podobrena Orovcanka treatment 4 had the highest positive effect on number of spikelets per spike, number of kernels per spike and 1000 kernel weight. In cultivar Olga the highest values for most of the analyzed traits were obtained under treatment 5. Treatments 1 and 7 had lowest effect on almost all traits in triticale cultivar Agrounija, while the other treatments had variable influence. Further research is needed to identify more precisely the effect of various foliar fertilization treatmens (different combinations of application dose and time) in wheat and triticale.

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ВЛИЈАНИЕТО НА ФОЛИЈАРНАТА ИСХРАНА ВРЗ АГРОМОРФОЛОШКИТЕ СВОЈСТВА КАЈ ПЧЕНИЦА И ТРИТИКАЛЕ

Бошев Дане, Ивановска Соња, Јанкуловска Мирјана, Јанкулоски Љупчо, Кузмановска Билјана

Апстракт
Целта на ова истражување беше да се испита ефектот на ѓубрењето со азот, како преку почвата, така и фолијарно, врз агроморфолошките својства на пченицата и тритикалето. Експериментот беше поставен на производното поле на Црвени Брегови, Македонија, за време на вегетацискиот период 2010/11. Две сорти мека пченица и една сорта тритикале беа подложени на седум различни третмани на ѓубрење. Сите третмани вклучуваа почвена апликација на 200kg/ha KAN (27% N) во фазата братење, а првиот беше без дополнително ѓубрење, како контрола. Другите третмани беа со различни дози и различно време на фолијарна апликација, со примена на Magnisal 6 и амониум нитрат NH4NO3 (17,5% N). Различните комбинации од третмани значајно влијаеа врз речиси сите агрономски карактеристики на растенијата. Со користење на фолијарна исхрана не беа значително променети височината на растенијата кај сортата *подобрена оровчанка* (79,4 см) и тежината на зрната по клас кај сортата *олга* (1.46 g). Кај сортите тритикале, височината на растенијата, должината на класот, бројот на зрна од клас, и тежината на зрната од клас, не покажуваат значајни разлики при примена на третманот 1 и на третманот 7. Резултатите од ова истражување потврдија дека е можно да се добие подобрување на агроморфолошките својства на пченицата и тритикалето преку почвена и фолијарна прихрана со азот. Дадени се прелиминарни информации за влијанието на соодветни дози ѓубрива во различни фенофази, за добивање значаен пораст и влијание врз агрономските карактеристики на овие житарки.
Клучни зборови: фолијарна исхрана, агроморфолошки карактеристики, пченица, тритикале.

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EVALUATION OF DURUM WHEAT CULTIVARS UNDER ORGANIC FARMING CONDITIONS

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Abstract
Five Bulgarian durum wheat cultivars were grown in the Certificated Field of the Field Crops Institute – Chirpan, Bulgaria under organic farming conditions during two growing seasons with aim to evaluate agronomic traits and identify the most suitable cultivars for this farming system. Weather conditions were more favorable for durum wheat in 2012. Significant differences were found among the genotypes for grain yield and yield related traits – productive tillering, spike length, kernel number per spike, kernel weight per spike. The grain yield of durum wheat genotypes varied from 500.8 kg/ha in cultivar Progres in 2010, to 2330.8 kg/ha in cultivar A-233 in 2012. The modern cultivar Predel showed the best yield - 2070.8 kg/ha average for two years followed by old cultivar A-233 with mean yield of 1995 kg/ha. The conducted analysis of variance determined that the effects of Genotype. Years and Interaction on seed yield were significant. The observed variation of yield under organic conditions is due to the genotype and the year in almost equal extent – 30.5 and 31.3 % respectively from total variation and to the Interaction of both factors in a much lesser extent – 10 %. The highest yielding cultivars were most stable one based on the coefficient of variation: Predel - CV - 14 % and A-233 - 24 %. Both genotypes were characterized by high number of productive tillering, grains per spike, grains weight of spike and lower length of spike.
Key words: durum wheat, organic farming, yield, yield related traits.

Introduction

In Europe there are growing demand for stable crop production characterized by reduced inputs of pesticides and synthetic fertilizers and biodiversity increasing. This demand is reflected in the efforts to integrate environmental aspects into the Common Agricultural Policy (CAP). Organic farming is the strictest production system with low-input defined by Directive 2092/91 EU.

The production of organic food in EU countries is expected to grow steadily in the next 10 years due to the trends in the CAP of EU to restrict the support to conventional agriculture at the expense of broader support to organic production. Cereals are some of the important crops that are grown organically and occupy 40% of the market for organic products in the world.

In Bulgaria area planted under organic farming increased approximately 10 times since 2008 and 25 648 hectares were farmed organically at the end of 2010, constituting only 0.47 percent from the total cultivated area (Apostolov, 2012). The most preferred crops are cereals - mainly wheat, barley,

rice, corn and rye. They occupied 5338 ha and represented the greatest percentage - 20.8 % of the total area cultivated under organic way. The durum wheat with high protein content and gluten strength is preferred as raw material for the production of pasta.

Bulgaria is a region with very favorable conditions for growing of high quality durum wheat grain. It is expected the interest in organic cultivation of durum wheat to increase due to rise of scientific evidence that the durum products are very important and desirable part of a healthy diet of the modern mankind (Silano, 2007). At the present 10 % of the total Italian durum wheat area are managed organically and represent more than 20 % of the national organically cultivated area (Camerini et al., 2011).

Recently in Bulgaria despite the steady growth in the organic sector there has been comparatively little research focused on the specific problems of organic cultivation (Stolce, 2005). The choice of appropriate cultivars is one of the key factors for the success of anyone cultivation system. The growing conditions between organic and conventional production system are distinguished to a great extent. The productivity of organic compared to conventional farming strongly depends on soil and climate conditions. Therefore the ideotype of varieties adapted to both farming systems is different. The main traits associated with superior performance of cereal variety in organic system are: efficiency of absorption and use of nutrients, competitiveness against weeds, tolerance to climatic and environmental stresses, stability of the yield and the qualitative parameters (Lammerts van Bueren et al., 2002).

For the time the problems concerning: the defining of ideotype; a choice of appropriate plant breeding methods and funding of special plant breeding programs; production and certification of organic seeds are time-consuming and difficult to resolve (Bozhanova and Dechev, 2010). As first step, conventional varieties testing under organic management can provide useful information to organic farmers in Bulgaria.

The objective of this study is to evaluate agronomic traits in old and modern durum wheat cultivars under organic farming conditions with a view to identify the most appropriate – high yielding and stable cultivars for this farming system in South Central Bulgaria.

Material and methods

Plant materials and experimental design

The experiment was performed at the Certified Organic Field of the Field Crops Institute – Chirpan, Bulgaria (42°12'58" N, 25°17'00" E, 175 m altitude) during two growing seasons 2010 and 2012. Five Bulgarian durum wheat cultivars: two old - A-233 (created in 60th years of the 20th century) and Progres (created in 80th years) and three modern cultivars – Victoria, Predel and Elbrus (created in recent years) were used. The cultivars were sown in a randomized, complete block design with four replications after cotton as predecessor. The total plots were 20 (5 cultivars × 4 replications) at area of basic plot of 10 m^2. The seeds were sown at a density of 400 plants per m^2 at end of October and were grown under organic farming conditions. No fertilizers, herbicides, fungicides and insecticides were applied. The cultivars were harvested in beginning of July at physiological maturity.

The soil and climatic characteristics

The soil type of the Certified Organic Field is Eutric Vertisols (by FAO), characterized by medium organic matter (1.5-2.4 %), with slightly acid to neutral soil reaction, with low to middle mineral nitrogen supply, low content of phosphates (0.5-3.2 mg/100 g soil) and well provided with available

potassium (15-38 mg/100 g soil). The soil is clay, with high humidity capacity and small water-permeability, defined by the sand-clay composition. The test field was with bulk weight of the plough soil layer - 1.2 g/m^3, and specific gravity - 2.45. The sorbcium capacity is 35-50 mequ/100 g soil.

Growing season 2009/2010 was characterized with a higher than the usual mean temperatures and rainfall unevenly distributed during the growing season and was favorable for durum wheat growth and development. Growing season 2011/2012 was distinguished with severe drought in autumn and severe winter weather with prolonged snow cover. In early April the temperature rises quickly, leading to a rapid passage of growth stages from stem elongation to anthesis. Despite the unfavorable combination of climatic factors until anthesis, the large amount of rainfall in May-June during the next important growing stage (flowering and grain fill) led to near-normal grain yields.

Collected Date and Statistical analyses

Twenty plants were taken from each replication per cultivar before the harvest and were analysed for the following traits: general and productive tillering, spike length, number of grains in spike, grains weight of spike, TGW. The degree of brown and yellow rust resistance, powdery mildew resistance and leaf spots were expressed by a score in accordance with symptoms of a disease on plants (9 = resistance). Yield was recorded in kg per hectare (kg/ha) after combine harvesting.

The data were analyzed statistically using two-way analysis of variance (ANOVA), and the means were compared by Duncan multiple range test at 0.05 probability level. Basic statistics for means, coefficients of variation (CV) was calculated as the ratio of standard deviation and arithmetic mean, expressed in percentages) and coefficients of correlation was applied, too. The above statistical methods were completed using the statistical software STATISTICA (StatSoft, Inc. (2004). STATISTICA (data analysis software system), version 7. www.statsoft.com).

Results and discussion

Significant differences were found in grain yield and yield related traits among durum wheat cultivars included in our study under organic environment during two growing seasons.

All studied cultivars realized significant higher grain yield during the second growth season – 2011/2012. The average yield of all varieties in 2010 was 1440 kg/ha, while in 2012 the average one was with 45 % higher - 2090,1 kg/ha (Table 1). The causes for this variation can be associated with neither the differences in the applied agricultural technology, nor the disease attack. During the both growing seasons all cultivars expressed resistance to brown and yellow rust except cultivar Victoria – with moderate resistance. All cultivars were affected by powdery mildew and leaf spots an approximately equal negligible extent (2-3 score). A combination of climatic factors in 2011/2012 and especially the large amount of rainfall during the important growing stages was contributed to the realization of a higher yield at all varieties tested.

The modern cultivar Predel was highest yielding average from both growing seasons with 2070 kg/ha followed by old cultivar A-233 with mean yield of 1995 kg/ha, but A-233 realized the best yield 2330.8 kg/ha among all studied cultivars in 2012 (Table 1.). Both cultivars were characterized by high number of productive tillering, grains per spike, grains weight of spike and lower length of spike. The lowest yielding cultivar average from both growing seasons was Progres – 1165.7 kg/ha characterized by lower grains per spike, grains weight of spike and the higher length of spike. The cultivars Victoria and Elbrus gave medium grain yield value (1860.6 kg/ha and 1715.6 kg/ha, respectively).

Table 1. Average yield and yield related traits at durum wheat cultivars grown under organic conditions during two growing seasons

Cultivar	Yield (kg/ha)	Tillering		Spike length (cm)	Number of grains in spike	Grains weight of spike (g)	TGW (g)
		General	Productive				
2010							
Progres	500.8^{a}	5.9^{b}	3.2^{ab}	6.3^{a}	33.0^{b}	1.4^{b}	42.9^{ab}
Elbrus	1400.8^{bc}	5.7^{c}	3.9^{c}	6.1^{ab}	40.7^{a}	1.6^{ab}	39.9^{b}
Victoria	1640.3^{cd}	5.7^{c}	3.5^{c}	5.5^{bc}	38.9^{a}	1.7^{ab}	42.2^{ab}
A-233	1660.0^{cd}	7.4^{a}	5.7^{a}	5.1^{c}	42.8^{a}	1.8^{a}	41.9^{ab}
Predel	1980.8^{e}	6.6^{b}	3.6^{bc}	5.7^{abc}	38.5^{ab}	1.8^{a}	46.7^{a}
2012							
Progres	1830.5 ^{a}	3.0^{bc}	2.0^{b}	6.0^{a}	25.7^{bc}	1.3^{ab}	47.0^{a}
Elbrus	2030.3 ^{a}	2.4^{c}	1.9^{b}	4.9^{b}	22.4^{c}	1.0^{b}	45.5^{a}
Victoria	2080.8 ^{a}	3.1^{bc}	2.2^{b}	5.0^{b}	28.2^{bc}	1.3^{ab}	47.1^{a}
A-233	2330.8 ^{a}	4.3^{a}	3.3^{a}	4.6^{b}	35.2^{a}	1.6^{a}	45.3^{a}
Predel	2160.3 ^{a}	3.5^{ab}	2.7^{ab}	5.9^{a}	33.1^{ab}	1.4^{ab}	45.6^{a}

*Mean values (in each column, separately for each year) followed by the same letters are not significantly different at $p<0.05$ according to Duncan's multiple range test.

The conducted analysis of variance for 5 genotypes over two years reveals that the effects of genotype (G), years (E) and interaction of both on grain yield were significant (Table 2). The significance of the interaction G×E complicates the choice of suitable cultivars for organic farming. Percentages of total sums of squares accounted for genotype, year (environment), and G×E interaction were used to indicate the variation attributed to each component. The observed variation of yield under organic conditions is due to the genotype and the year in almost equal extent - 30,5 % and 31,3 % respectively from the total variation and to the interaction of both factors in a lower extent – 10 %.

Table 2. Analysis of variance of yield

Source of variation	*df*	MS	SS	η^2 (%)
Total			135461	
Genotype (G)	4	10337***	41348	30.5
Environment (E)	1	42120***	42120	31.3
Interactions	4	3664**	14656	10.8
Error	30	1245	37337	27.6

*** Significant at $p< 0.001$; ** Significant at $p<0.01$

The effects of the genotype and the year were significant for almost studied yield related traits (productive tillering, spike length, number of grains per spike, grains weight per spike) in contrast to the interaction between both factors (G×E) (Table 3).

The interaction was significant only for TGW, furthermore this interaction determined in the highest degree detected variation for this trait. The observed variation of means for general and productive

tillering and number of grains in spike is due to the highest degree of year of cultivation, while for spike length – due to the genotype.

Table 3. Analysis of variance of yield related traits

Traits	Source of variation and % from total variation					
	Genotype (G)		Environment/Year (E)		Interaction (G×E)	
	MS	η^2, %	MS	η^2, %	MS	η^2, %
General tillering	3.77***	11.8	101.12***	79.1	0.44^{NS}	1.4
Productive tillering	3.53**	7.1	161.60***	81.7	1.38^{NS}	2.8
Spike length	1.93***	42.0	1.89**	10.3	0.50^{NS}	10.9
Number of grains in spike	112.56***	20.2	975.16***	43.7	51.30^{NS}	9.2
Grains weight of spike	0.24*	23.5	0.94**	23.1	0.05^{NS}	5.1
TGW	1.97^{NS}	11.4	147.46*	9.8	132.64**	35.4

*** Significant at p< 0.001; ** Significant at p<0.01; * Significant at p<0.05

Our results support the widely accepted opinion that the environment variability had a considerably influence on a genotype's response in organic and low input conditions (Wolfe et al., 2008). As the environmental component in organic agriculture is more variable than in conventional one, the yield stability is more important than yield alone (Lammerts van Bueren, 2002). Furthermore, the information on yield stability is especially important in the presence of a significant genotype-environment (G×E) interaction as in our trial. Taking into account the above fact we evaluated yield stability per each cultivar separately based on the coefficient of variation averaged over replications and years (Table 4). The coefficients of variation on yield of studied genotypes ranged from 14 % at highest yielding cultivar Predel to 63.8 % at lowest yielding cultivar Progres. The other three cultivars are characterized by approximately the same moderately high coefficients of variation from 24 % at A-233 to 27, 4 % at Victoria. It is considered that the coefficient of variation can be useful statistic parameter taking aim at identification of cultivars with high and stable yield (Ortiz et al. 2001). Both high yielding cultivars in our experiment were distinguished by lowest CV - 14 % for Predel and 24 % for A-233 and therefore they were most stable.

Table 4. Basic statistic parameters for yield at durum wheat cultivars averaged over replication and years

Cultivars	Means	Min	Max	CV, %
Progres	117.1± 26.4	26	209	63.8
Predel	207.7± 10.4	158	255	14.0
Viktoria	186.5± 18.1	102	257	27.4
A-233	199.9± 17.1	150	295	24.0
Elbrus	172.0± 15.9	125	260	26.3

These cultivars are selected at different times and at different growing conditions – low and high input. A-233 is an old cultivar, created in 60th years of the 20th century, while Predel is a modern one, certified in 2008 and therefore they considerably differ in theirs morphological and

agronomical traits. Our results not fully confirmed the assumption that old cultivars selected under low input conditions are better suitable for organic farming than cultivars selected under conventional high input conditions. Although the old cultivar was one of the best among all studied cultivars and realized the highest yield in one of the growing seasons, yet the modern one showed highest yield and yield stability average from both growing seasons. Thus it is confirming that modern cultivars selected for conventional farming can be also suitable for cultivation under the nutrient restricted conditions in organic farming (Guarda et al., 2004; Hildermann, 2010). Our results do not diminish the importance of conduction of special plant breeding for organic farming and selection for suitable genotypes under organic environments at least in later generations (Löschenberger et al., 2008). Results of conducted correlation analysis between yield and yield related traits separately for each growing season are presented in Table 5. The yield of durum wheat cultivars, grown under organic farming conditions was positively associated with traits: number of grains in spike, grains weight of spike during both years of cultivation. But only the correlation with grains weight of spike was significant and only in the first cultivation year. High positive and significant correlation was detected between yield and productive tillering only in a second cultivation year. These results are in accordance with our previously study at durum wheat grown in conventional conditions (Bozhanova and Dechev, 2009) and findings of other researchers (Koutis et al., 2012, Marque et al., 2004). High negative but not significant correlation between yield and spike length was found during both years of cultivation.

Table 5. Correlation coefficient between yield and yield-related traits in durum wheat under organic growth conditions in different seasons

Correlation coefficient between yield and yield related traits					
General tillering	Productive tillering	Spike length	Number of grains in spike	Grains weight of spike	TGW
2009/2010					
0.41	0.36	-0.69	0.74	0.96***	0.33
2011/2012					
0.76	0.88***	-0.61	0.79	0.63	-0.67

*** Significant at $p < 0.001$

There is contradicting information on the relationship between the spike length and yield and the most researchers pointed that genotypes with longer spike length produce higher yields as compared to those with shorter spike length under the conventional agriculture conditions (Wang et al., 2001, Karimizadeh et al., 2012). In our evaluation the highest yielding genotypes under organic conditions distinguished with shortest but most compact spikes with highest grain numbers. These yield formation strategy is probably a consequence of the combination of specific climatic conditions in our region and conditions of organic cultivation. It is considered that the density of spike in durum wheat is more important for the yield in relatively cool and wet regions (Daaloul et al., 1998) as is the region in which this study was conducted. In the view of achieved results it can be suggested that the traits: productive tillering, number of grains in spike, grains weight of spike and short and compact spike are favorable characteristics for the selection of suitable for organic farming conditions durum wheat cultivars.

Conclusions

Significant differences were found in grain yield and yield related traits among durum wheat cultivars included in our study under organic environment during two growing seasons.

Modern durum wheat cultivar Predel and old cultivar A-233 were identified as high yielding and stable cultivars therefore both cultivars had good capacity to adapt to organic cultivation in South Central region of Bulgaria.

The effects of genotype, years and interaction of both factors on seed yield and almost studied yield related traits were significant. The observed variation of yield under organic conditions is due to the genotype and the year in almost equal extent. Therefore our results support the widely accepted opinion that the environment variability had a considerable influence on a genotype's response in organic and low input conditions.

The identified in our experiment highest yielding and stable genotypes are characterized by high number of productive tillering, grains per spike, grains weight of spike and lower length of spike. These yield formation strategy is probably a consequence of the combination of specific climatic conditions in our region and conditions of organic cultivation.

Some modern cultivars selected for conventional farming could be also suitable for cultivation under the nutrient restricted conditions in organic farming. This fact does not diminish the importance of special plant breeding conduction for organic farming and selection for suitable genotypes under organic environments at least in later generations.

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ПРОЦЕНКА НА СОРТИ ТВРДА ПЧЕНИЦА ВО УСЛОВИ НА ОРГАНСКО ЗЕМЈОДЕЛСТВО

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Апстракт

Пет бугарски сорти тврда пченица беа одгледувани на сертифицираното поле на Институтот за поледелски култури - Чирпан, Бугарија во услови на органско земјоделство, во текот на две вегетациони сезони, со цел да се оценат агрономски црти и да се идентификуваат најсоодветните сорти за овој земјоделски систем. Временските услови беа поповолни во 2012 година. Беа пронајдени значителни разлики меѓу генотиповите за приносот и поврзаните со приносот својства – продуктивно братење, должина на класот, број на зрна на клас, тежина на зрна по клас. Приносот на тврдата пченица по генотипови варира од 500,8 кг /ха кај сортата Progres во 2010 година, за да 2330,8 кг/ха кај сортата А-233 во 2012 година. Атрактивната сорта Predel покажа најдобар принос - 2070,8 кг /ха, просек за две години, следеше старата сорта А-233 со среден принос од 1995 кг/ха. Извршената анализа на варијанса го утврди ефектот од генотипот. Годините и интеракцијата на приносот на семе се статистички значајни. Набљудуваните варијации на приносот во услови на органско производство се должи на генотипот и годината, речиси во иста мерка - 30,5 и 31,3%, соодветно од вкупната варијација, и во многу помала мерка со интеракцијата на двата фактори (10%). Највисоко приносните сорти беа и најстабилни врз основа на коефициентот на варијација: Predel, CV-14% и А-233 CV -24%. Двата генотипа се карактеризират со голем број на продуктивни братимки, зрна на класот, тежина на зрната на класот и со помала должина на клас.

Клучни зборови: тврда пченица, органското земјоделство, принос, карактеристики.

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RESULTS OF THE EXAMINATIONS OF THE BURLEY VARIETY PELAGONEC CMS F1

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Abstract
The aim of these researches is putting on hold the production of Burley type in the Republic of Macedonia and exploring the possibilities for restarting it in order to avoid the total dependence of the Macedonian cigarette industry from raw material of this type of tobacco. Guided by these considerations we decided on prior examinations with some Burley varieties. Our attention was directed at the Macedonian perspective variety Pelagonec CMS F1 which was used for certain examinations during 2008. The results from the examinations (morphological, yield, quality, physical properties and tasting of raw material) confirmed the high economic value of this variety.
Key words: tobacco, Burley, variety, yield, quality.

Introduction

In the Scientific Tobacco Institute – Prilep, in the last decade, as a result of intensive selection efforts, particularly with the Burley type, are created a number of varieties and lines of both, fertile and male-sterile form. From all of them, because of its properties (yield, quality, resistance to diseases, etc.) the most attention got the male sterile hybrid variety Pelagonec. Taking into consideration the fact that in Republic of Macedonia, the production of the Burley type and Virginia type after 2002 was put on hold, Pelagonec variety can present a challenge for activating the production of this type of tobacco in regions where real conditions and interest exist. Otherwise, the Macedonian fabrication will continuesly depend on import of this type of tobacco. All previously said was a challenge enough to conduct certain examinations with this type of tobacco and the Pelagonec variety. The results obtained from these examinations can be a good basis for serious thoughts on reorganizing the production of this type of tobacco in the Republic of Macedonia.

Material and methods

Included in the examinations was the male sterile hybrid Burley variety Pelagonec. The experiment was set on the premises of the Scientific Institute in 2008, on a colluvial type of soil. The first ploughing was carried out in the autumn of 2007, at a depth of around 40cm. In the spring of 2008 the surface was fertilized with 300 kg/ha artificial fertilizer NPK in the ratio of 8:22:20 and was ploughed two more times. Before transplantation the soil was treated with herbicide and harrowed. The healthy seedlings were manually transplanted, transplanting 163 stems with transplanting density of 90 x 50 cm (73,35 m^2). Before the first and second hoeing a manual fertilization was performed with about 5 g/stem of KAN, 26%. Because during vegetation (V – IX month) the total amount of rainfall was 183,3 mm, several additional irrigations were necessary. The morphological

measurements were carried out on 30 plants from which the average values were established at the end. The tobacco was hand picked, separately from each priming range (from lugs to tips – seven pickings) in order to get a comprehensive picture of the variety in relation to the total yield. The picked tobacco was manually strung and dried in special dryers for the Burley type (air curing). In order to adjust the classification with the international classes which apply to the international commerce with this type of tobacco, the classification of raw material was performed twice. The first time the tobacco was classified according to the current Rules on standards for qualitative and quantitative assessment of raw tobacco leaf (Official gazette of the Republic of Macedonia No 16/2007, No 144/2010 and No 20/2011). The second time according to the Official Standard Grades For Burley tobacco-foreign type 93.

The yield per stalk was determined when the total quantity of dry tobacco with 15% humidity was divided by the total number of stalk (g/stalk) and the yield by hectare was determined by establishing the number of stalk per hectare (22222 stalk x yield per stalk).The physical properties of the raw material were tested in the certified laboratory of the Scientific Tobacco Institute – Prilep, and the tasting properties were examined by the tasting committee of the JSC "Tutunski Kombinat" – Prilep. In these two examinations, a raw material from the middle priming range was used.

Results and discussion

Morphological properties

The character of tobacco's morphological properties is mostly influenced by genetic factors, agricultural and environmental conditions and applied agricultural technology during vegetation.

In different varieties of tobacco from the Burley type, morphological properties (the number of leaves and their dimensions, stem height, etc.) are different and that is why they are different from each other.

Our examinations covered the dimensions of the 5th, 10th and 15th leaf, as well as the average number of leaves and the stem height with flower. These data are shown in Table 1. From the data presented in Table 1, can be concluded that dimensions of leaves in the lower priming range (the 5th leaf) and middle priming range (the 10th and 15th leaf) are typical of the Burley type. Uzunoski (1985) describing the American variety B-21 mentioned that the length of the largest leaf from this variety ranged from 55–70 cm, and the width from 26 – 30 cm. Risteski (2006), performing three-years examinations with six Burley types in the region of Prilep came to a conclusion that with the largest length of the 5th leaf distinguished was the variety Podravac, and with the largest length of the 10th leaf (61 cm) and the 15th leaf (62 cm) distinguished was the variety B-2/93. Dyolgerski (2009), gave certain parameters and directions for creating good (ideal) varieties of the Burley type where he recommended no limit in the size of the robust variety of tobacco, and for type Burley he recommended length of leaves no lesser than 60-62 cm and width 30-32 cm.

Table 1. Results of morphological measuring – average values

Variety Pelagonec CMS F1	5th leaf in cm		10th leaf in cm		15th leaf in cm		Number of leaves	Stalk height with flower, cm
	L	W	L	W	L	W		
	46,80	31,00	68,10	38,90	65,00	31,60	33,60	177,60

From data for the number of leaves per stalk it can be seen that the average number of leaves in the Pelagonec variety in average was 32,6 leaves.

According to Beljo (1996), varieties with this number of leaves belong to the group of high-yield tobacco, and according to the height of the stalk with flower (177,6 cm) the Pelagonec variety belongs to the category of middle-height tobacco. Stoyanov and Apostolova (1999 and 2000), point out that stalk heights of the newly created Bulgarian Burley varieties B-1317 and B-1351 are 158 cm and 165 – 170 cm accordingly. From data of the analyzed morphological properties and available literary data it can be concluded that the Pelagonec variety has all the characteristics of a typical Burley variety.

Yield and quality

Tobacco yield as a measurable category together with the quality represent an illustrative indicator when assessing the economic value of a variety. These two indicators despite from being genetically controlled are largely depend on agricultural and environmental conditions and the agricultural technology applied during tobacco vegetation. Pelivanoska et.al. (2001), report that by implementing different versions of fertilization and irrigation, yields of the Burley type B-2/93 in the region of Ohrid and Struga could reach up to 6 000 kg/ha. Budin (1988), reports that yields of the Burley type in Zimbabwe in the period of 1980 – 1985 ranged in average from 1 202 to 1 760 kg/ha. Risteski (2006), reports that three-year yield average of the six Burley varieties cultivated in the Prilep production area from the variety picked – strung ranged in the borders of 2278 to 2910 kg/ha.

How the yield per stalk (g/stalk) and area (kg/ha) ranged in our researches, it can be seen from data in Table 2.

Table 2. Yield per stalk (g/stem) and area (kg/ha)

Pelagonec variety CMS F1	Number of picked Stalk	Total quantity of raw tobacco from the picked stems in g	Yield per stem g/stalk	Yield per hectare kg/ha (196,3 g x 22222 stalk)
	163,00	31960,00	196,30	4362,00

From data in Table 2 it can be concluded that yields given by the Pelagonec variety (196,3 g/stalk and 4362 kg/ha) are quite acceptable so that this variety can be freely included in the group of high-yielding varieties. These results are strongly influenced by dimensions and number of leaves per stalk. In areas that are typical for production of the Burley type, higher yields of the Pelagonec variety can also be expected.

The quality of produced tobacco raw material is also a measurable category. In the beginning, the quality of raw material is assessed visually – organoleptically according to the Measures for Purchase of Raw Leaf Tobacco where inertia, dimensions and color of the leaf, thickness and delicacy of the leaf blade, content of the rib, etc. are taken into consideration. If more accurate results are needed, physical and chemical analyses are made.

However as a final and definitive indicator of the tobacco quality, results from tasting of raw material are taken. All these indicators of quality are largely dependent on agricultural and environmental conditions, applied agricultural technology, proper harvesting, curing, etc. How the

quality of the produced raw material ranged assessed by the Measures for Quality Assessment of Raw Leaf Tobacco for the Burley type, it can be seen from data in Table 3.

Table 3. Raw material quality

Pelagonec variety CMS F1	Total cured tobacco, g	I class	II class	III class	IV class	V class	Participation I-III class	
		%	%	%	%	%	Weight, g	%
	31960	46	20	8	14	12	23660	74

From data in Table 3 it can be seen that out of the produced total of raw tobacco from 31960 g, 14774 g or 46% belong to class I, which is an evidence that leaves from the middle picking range with larger dimensions (over 40 cm), full of content, delicate and with color characteristic of the high-quality Burley type were dominant in the produced raw material. The second class is represented with 6242 g or 20%, and 2644 g or 8% fall into the third class. The fourth class participates with 4 564 g or 14%, and the fifth class where the lowest quality of tobacco from all harvests is being classified participates with 3736 g or 12%. Much clearer picture of tobacco raw material quality is presented by the percentage share of high classes (I, II and III) in the total yield. From results shown it can be seen that from the total quantity of dry tobacco 23660 g or 74% fall into these three classes, which is an indicator that this variety gives high quality raw material.

Raw material quality

According to the classification (Official Standard Grades for Burley tobacco, Foreign type 93, U.S. Department of Agriculture, Washington D.C. 1990) of dry leaves, in the Pelagonec CMS F1 variety, a high percentage of classes with excellent use value were determined. In Table 4 presented are the values of the qualitative assessment of dry leaves from the examined material.

The insertion C – cutters, accounted for 42,9% of the total examined material of 30 000g. Within this insertion, the first class (C1F) accounted for 16,4% or 4920 g the second class (C2F) accounted for 15,6% or 4680 g and the third class (C3F) accounted for 7,8% or 2340g. The total value of the first, second and third class was 11940 g or 38,9%.

The insertion B – leaf, accounted for 31,2% or 9360 g. The percentage of participation of the first class (B1F) added up to 10,9%, the second class (B2F) added up to 8,6% and the third class (B3F) added up to 9,4% . The insertions C – cutters and B – leaf, cover the middle range of the plant habitus, leaves are very similar to each other and have a high use value in fabrication. Because of this, the total value of these 2 insertions, which added up to 74,1% or 22230 g of the total examined material, was a clear indicator that this variety is characterized by a high use value.

Class composition of leaves from the first insertion X – flyings, included 19,5% from the total examined material or 5850 g. The first class (X1L) added up to 2 340 g or 7,8%, the second class (X2L) up to 1410 g or 4,7%, and the third class (X3L) added up to 1 170 g or 3,9%. The total presented value of the three classes added up to 4920 g or 16,4% of the total examined material.

During classification of dry leaves from the T – tips insertion, it was determined that it was characterized by a low percentage of participation in the examined material that added up to 6,4% or 1930 g. The first class (T1F) accounted for 1,6% or 480 g. The (T2F) class accounted for 1,8% or

540 g and the third class (T3F) accounted for 1,6% or 480 g. The total values of the three classes added up to 5% of the total examined material or 1500 g.

Table 4. Classification of materials by Official Standard Grades, Burley tobacco foreign type 93

Insertion X	Total dry tobacco in g	1L	2L	3L	4L	5L	Participation 1-3 class	
		%	%	%	%	%	g	%
	5 850	7,8	4,7	3,9	3,1	/	4920	16,4
Insertion C	Total dry tobacco in g	1F	2F	3F	4F	5F	Participation 1-3 class	
		%	%	%	%	%	g	%
	12870	16,4	15,6	7,8	3,1	/	11940	39,8
Insertion B	Total dry tobacco in g	1F	2F	3F	4F	5F	Participation 1-3 class	
		%	%	%	%	%	g	%
	9360	10,9	8,6	9,4	2,3	/	8670	28,9
Insertion T	Total dry tobacco in g	1F	2F	3F	4F	5F	Participation 1-3 class	
		%	%	%	%	%	g	%
	1920	1,6	1,8	1,6	1,4	/	1500	5,0

Physical properties of raw material

Physical properties as part of the properties of tobacco raw material represent an objective indicator of its quality therefore they are implemented as a segment in the current classification systems, according to which the tobacco assessment is made. These properties are in co dependence with environmental conditions, the applied agricultural technology during vegetation, insertion, maturity of leaves when picked, time spent in yellowing, water quantity in picked leaves, way of harvesting and curing, etc. From physical properties, studied were the main rib content and leaf's thickness and materiality. According to Darkis (loc. cit. Uzunoski, 1985), the main rib content in the total leaf weight in the Burley type amounted to approximately 30%. Perovič and Prpič (1983), examining some physical properties of the Burley type in Jastrebarsko (Croatia) came to a conclusion that the main rib content in middle harvests was 27,78%. Arangelovič et al. (1973), examining the Burley varieties in eight regions in Serbia came to a conclusion that the main rib content ranged up to 29,40% and mentioned that in the Burley raw material produced in the USA (N. Carolina) this number was 35,48%. Smokvoski (1999), came to a conclusion that the leaf blade of the Burley type cultivated in Prilep production area ranged from 57,25 to 62,63 μm. Risteski (2006) reported that the average values of leaf thickness from three-year examinations in Prilep production area with Burley varieties ranged from 61,00 to 71,83 μm. In regards to materiality of the leaf, the same author mentioned that in average it ranged from 37,40 g/m^2 to 42,95 g/m^2. Pelivanoska (1999), came to a realization that the mutual influence of tobacco fertilization and irrigation during vegetation lowered the materiality of dry leaves. Which physical properties characterized the raw material in our examinations can be seen from data in Table 5.

Table 5. Physical properties of raw material

	Rib %	Thickness of leaf tissue, µm	Materiality g/m^2
Pelagonec CMS F1	31,45	83,25	35,91

From data presented in Table 5, it can be concluded that the main rib content in the leaf composition (31,46%) is within the boundaries typical for the Burley type, which is supported by the previously cited data by many authors and is within the expectations. The leaf thickness (83,25 µm) is also typical of the Burley type and corresponds with values from the cited literary data.

Regarding data of leaf materiality (35,91 g/m^2) it can be stated that it is somewhat lower than usual for the Burley type. But it is known that tobaccos with lower materiality produce a greater number of cigarettes. Taking into account the fact that today the Burley type participates with around 30% in cigarettes composition, lower materiality promises higher economic effects and vice versa.

Tasting properties of raw material

Unlike all other products that human consumes in solid or liquid state, tobacco is mostly consumed in the form of smoke. All products that are released in the process of pyrolysis, as a rule should give the consumer a pleasant feeling of taste, aroma, and relaxation that comes from the physiological influence of the nicotine on the nervous system.

These tobacco properties are very closely related to certain chemical components in the tobacco (soluble sugars, essential oils and resins, nicotine, proteins, etc.) and their mutual ratio. Although subjective, most authors consider the tasting method as the final and definitive indicator of tobacco quality. Nikolič et al. (1998), in 1994 and 1995 examined several lines of the Burley type in Serbia and concluded that when smoking this type of tobacco one should not expect some distinctive aroma, which will burn and irritate us, but to expect excellent flammability, white and compact ash.

Risteski (2006), stated that the raw material of all 6 Burley varieties examined in Prilep production area in the period of 1999-2001, by the tasting committee was rated as very strong. The author related this with the somewhat higher content of nicotine (over 2%). Which tasting properties characterized the raw material produced in our researches can be seen from data in Table 6.

Table 6. Tasting properties of raw material

Tasting components	Points
Irritation	17,80
Taste	17,70
Aroma	16,80
Intensity	13,00 (strong)
Flammability	4,00
Compactness	4,00
Total	73,30

The subject of assessment in Table 6 was a tobacco leaf mixture from the entire plant. According to tasters' opinion, the examined material was characterized by typical irritation with sugary taste with

good quality and intensity. Aromatic characteristics were representative of the typical Burley aroma with good quality. The physiological intensity was clearly defined and was consistent with the taste and aroma complex. The flammability and compactness fully met the standards of the Burley type. The opinion of the tasting committee at Cigarettes - LLC Prilep is presented in Table 6 and Table 7.
In the insertions, there was a clear definition of tasting properties. In the insertions C and B, the raw material was characterized by the typical Burley features with a rather more specified aroma (piquancy), sweetish and discreet refreshment. The physiological intensity was better expressed in comparison to X and T insertions. The material in all examined insertions was characterized by a good and solid compactness.
According to the values presented in Table 6. and Table 7. the highest points got the insertion C-cutters with 73,31 points, the second place got the tobacco mixture from the entire stem with 73,00 points, and the third place was for the insertion B-leaf with 73,21 points. The fourth and the fifth place were the insertions T - tips with 73,20 points and insertion X-flyings with 73,18 points.

Table 7. Tasting properties of tobacco row materials classified by Official Standard Grades, Burley tobacco foreign type 93

Tasting components	Insertions			
	X	C	B	T
Irritation	17,80	17,80	17,80	17,80
Taste	17,64	17,70	17,67	17,70
Aroma	16,74	16,81	16,80	16,70
Intensity	13,00 (strong)	13,00(strong)	13,00 (strong)	13,00
Flammability	4,00	4,00	4,00	4,00
Compactness	4,00	4,00	4,00	4,00
Total	73,18	73,31	73,27	73,20

Conclusions

Based on the above we come to the following conclusions:
With regards to morphological characteristics of the Pelagonec CMS F1 variety (height of stalk, number and dimensions of leaves) it can be stated that it is closely related to some eminent foreign varieties. The average yield per hectare (4 362 kg) and the average of the upper classes I-III (74%) achieved in a region atypical for the Burley type (Prilep) guarantees enough that this is a variety with high potential. Indicators of physical properties of raw material, rib participation (31,46%), leaf thickness in micrometers (83,25) and leaf materiality (35,91 g/m^2) are within the range for the Burley type. Results from the tasting properties of raw material show that it is typically Burley and it can be freely included in the mix of blended cigarettes. All these indicators tell us that in the Scientific Tobacco Institute– Prilep, a Burley type (Pelagonec CMS F1) was created, which can be used to restart the production of the Burley type in the Republic of Macedonia to a general satisfaction of the primary producers and cigarette manufacturers.

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РЕЗУЛТАТИ ОД ИСПИТУВАЊАТА ОД БЕРЛЕЈСКАТА СОРТА ПЕЛАГОНЕЦ ЦМС F1

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Апстракт

Целта на овие истражувања е ставањето во мирување на производството на типот берлеј во Р. Македонија и испитување на можностите истото да се рестартира и да се избегне целосната зависност на македонската фабрикација со суровина од овој тип на тутун. Водени од вакви размислувања се одлучивме за претходни испитувања со некои берлејски сорти. Вниманието беше насочено кон македонската перспективна сорта Пелагонец ЦМС F1 со која беа извршени одредени испитувања во текот на 2008 год. Резултатите од испитувањата (морфолошки, приноси, квалитет физички својства и дегустација на суровината) ја потврдија високата стопанска вредност на оваа сорта.

Клучни зборови: тутун, берлеј, сорта, принос, квалитет.

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PLANTH GROWTH PROMOTION EFFECT AND SURVIVAL RATE OF AZOTOBACTER IN ACID SOIL

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Abstract
Azotobacter is a soil bacterium which, apart from fixing atmospheric nitrogen, produces growth substances (e.g. indole acetic acid, IAA). For that reason, it is used as a biofertilizer in plant production. Due to the need to apply biofertilizers in acid soils, too, research has been focusing on creating acid resistant strains of azotobacter. In this research, nine strains of azotobacter were isolated from halomorphic soil (pH 9). The production of IAA in all strains was determined by colorimetric method. Their survival rate in acid soil (pH 5) and their effect on the early growth of wheat were investigated. The experiment was conducted in controlled conditions, in pots. The strains of azotobacter were introduced into the soil. The control variants were not inoculated. The number of azotobacter, the height and the dry mass of the plant were determined thirty days later. IAA production ranged from 3.73 to 10.4µg ml^{-1}. The survival rate of the introduced azotobacter was low. Its number decreased from 10^6g^{-1} to 10^3g^{-1}, but it was still larger than in the non-inoculated variant (10^1g^{-1}). The applied azotobacter strains promoted the early growth of wheat. The length of the part above ground in the inoculated variants was 3% to 35% greater than in the control, whereas the dry mass was 0,6 to 58% greater. The increase in the length and dry mass was mostly in correlation with the amount of IAA.
Key words: azotobacter, acid soil, wheat.

Introduction

Many bacterial species are well known for their growth promotion effects on plants (Tilak et al., 2005; Egamberdiyeva, 2005). PGPR promote plant growth by production of metabolites, i.e., phytohormones or enhanced availability of nutrients (nitrogen, phosphorous). For example, about 80% of the naturally occurring bacteria in soil are capable of producing auxin which is considered as an important plant growth regulator (Patten and Glick, 1996). These bacteria utilize tryptophan secreted by plants as root exudates to synthesize auxin. The positive role of PGPR in stimulating the plant growth has also been confirmed by Barea et al. (1976), Dazzo et al. (2000), Djuric et al. (2011). Enhanced availability of nitrogen are capable diazotrophic microorganisms. There are known to provide fixed nitrogen in exchange of fixed carbon secreted by plant as root exudates (Glick, 1995). One of these microorganisms is azotobacter. Azotobacter is a soil bacterium which,

apart from fixing atmospheric nitrogen, produces growth substances (e.g. indole acetic acid, IAA). For that reason, it is used as a biofertilizer in plant production (Mrkovacki et al., 2006., Mrkovacki and Bjelic (2011), Okon et al (1995), Jarak et al.(2011). Due to the need to apply biofertilizers in acid soils, too, research has been focusing on creating acid resistant strains of azotobacter.

Material and methods

In this research, nine strains of azotobacter were isolated from halomorphic soil (pH 9). IAA was assayd by colorimetric method. Development of pink color was assayed with spectrophotometer at 530 nm. Concentration of produced IAA was determined from a standard curve of IAA (1-50 μg ml^{-1}). Their survival rate in acid soil (pH 5) and their effect on the early growth of wheat were investigated. The experiment was conducted in controlled conditions, in pots. Azotobacter was grown on medium with manitol. $4x10^6$ g^{-1} of cells of each strain was introduced into the soil. The control variants were not inoculated. Twenty sterilized wheat seeds were planted in the pots. The number of azotobacter, the height and the dry mater mass of the plant were determined thirty days later.

Results and discussion

The survival rate of the introduced azotobacter 30 days after inoculation was low. Its numberdecreased from $4x10^6$ g^{-1} to 5.2 - $6.6x10^3$ g^{-1}, but it was still larger than in the non-inoculated variant ($2x10^1g^{-1}$) (Table 1). IAA production ranged from 3.73 to 10.4 μg ml^{-1} (Table 1).

Table 1. The IAA production and survival of azotobacter in acid soil 30 days after inoculation

Strains of azotobacter	The number of azotobacter ($CFUg^{-1}$ soil)	IAA μg ml^{-1}
22	$5.2x10^3$	6.23
23	$5.2 x10^3$	3.73
24-1	$6.1 x10^3$	8.28
24-2	$6.6 x10^3$	10.4
25-1	$5.5 x10^3$	5.56
25-2	$5.5 x10^3$	5.20
26	$5.4 x10^3$	4.54
27-1	$6.2 x10^3$	9.32
27-2	$5.3 x10^3$	6.35
Control	$2.1x10^1$	-
The starting number	$4x10^6$	-

The number of azotobacter is very low in acidic soil (Jarak at al., 2005), moreover some results shown that there is no azotobacter in acid soil. Acid enwiromental have negatively influence on azotobacters growth and that azotobacter never produce pigment in acid soil.

However, if azotobacter is introduced into the soil, one part of the introduced cells adapts to acid environment and their number increases (Jarak et al., 2005; Čolo and Jarak, 2006). Miličić et al. (2006) stated that the survival of *Azotobacter* in pH-5.4 soil was satisfactory after 20 days, whereas after 40 days the number of *Azotobacter* decreased.

Several studies have shown that *Azotobacter* as soil inoculant is not only effective in N fixation but also has other properties such as production of growth hormones, like gibberellins, auxins and cytokinins (Rajaee et al., 2007), and the property to solubilize phosphate (Narula et al., 2000). In our investigations the applied azotobacter strains promoted the early growth of wheat. The length of the part above ground in the inoculated variants was 3.6% to 35.5% greater than in the control, whereas the dry mass was 0.6 % to 58% greater. The increase in the length and dry mass was mostly in correlation with the amount of IAA.

Many field trials have demonstrated that under certain enviromental conditions, inoculation with azotobacter has beneficial effects on plant yields (Emtiazi et al., 2004), due to the increase of fixed nitrogen centent in soil (Pandey et al., 1989). Several authors have shown the beneficial effects of *Azotobacter* on vegetative growth and yields of maize (Hajnal et al.2005, Jarak et al., 2012). Inoculation with *Azotobacter chroococcum* has a positive effect on the increase in yield, seed germination and early growth of maize plants, as well as on the length of the part above ground and root (Egamberdiyeva, 2007).

Table 2. The effect of azotobacter on the early growth of wheat plants

Strains of azotobacter	Hight of plant (cm)	Increase to control (%)	Dry mater mass of plant (g)	Increase to control (%)
22	28.47	17.2	1,98**	23
23	25.17	3.6	2,54**	58
24-1	29.13*	19.8	1,45	0.6
24-2	32.90**	35.4	2,01**	25
25-1	27.27	12.2	2,38**	48
25-2	26.40	8.6	2,02**	26
26	26.13	7.5	1,95**	21
27-1	29.37*	20.8	1,88*	17
27-2	28.50	17.3	2,17**	35
control	24.30		1,60	
LSD 5%	4.66		0.245	
1%	6.36		0.335	

*Significant effect at P>5%; ** sinificant effect at P> 1%

The growth promotive effects of azotobacter on sugar been plants have been reported in results Mrkovački et al. (2006), as well on potato plants in results Azcon and Barea (1975) and Najdenovska et al. (2005). Khalid et al.(2004) demonstrated increases in root elongation (up to 17.3%), root dry weight (up to 13.5%), shoot elongation (up to 37.7%) and shoot dry weight (up to 36.3%) of inoculated wheat seedlings with azotobacter. Jarak et al. (2006) and Kizikaya (2008) recorded a positive effect of inoculation with azotobacter on wheat yield.

Conclusions

The survival rate of the introduced azotobacter was low, but it was still larger than in the non-inoculated variant.

IAA production ranged from 3.73 to 10.4 μg ml^{-1}.
The length of the part above ground of wheat in the inoculated variants was 3.6% to 35.5% greater than in the control.
The dry mass of above ground of wheat was 0.6 % to 58% greater than in the control.
The increase in the length and dry mass was mostly in correlation with the amount of IAA.

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ПРОМОЦИЈА НА ЕФЕКТОТ НА ПОРАСТ НА РАСТЕНИЈАТА И ИЗДРЖЛИВОСТ НА АЗОТОБАКТЕРОТ ВО КИСЕЛА ПОЧВА

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Апстракт

Азотобактерот е почвена бактерија која, покрај фиксација на азотот од атмосферата, произведува и супстанци на пораст (пр. индол оцетната киселина - ИОК). Поради тоа, се користи као биоѓубриво во растителното призводство. Потребата да се користат биоѓубрива у кисели почви, е всушност и причината за ова истражување да се фокусира на создавањето отпорни на киселини соеви азотобактер. Во ова истражување се предмет девет соеви азотобактер, претходно изолирани и од халоморфна почва (pH 9). Произведувањето на ИОК кај сите соеви е одредено со колориметриската метода. Беа испитувани нивниот степен на преживување во кисела почва (pH 5) и нивното влијание врз раниот пораст на пченицата. Експериментот е изведуван во контролирани услови, во саксии. Во почвата беа внесени соеви од азотобактер, а контролните варијанти не беа инокулирани. По триесет дена беа одредени: бројот на азотобактер, висината на растенијата и сувата маса на растенијата. Производството на ИОК се движеше од 3,73 до 10,4 микрограма мл-^{1}. Степенот на преживување на инокулираниот азотобактер беше низок. Бројот се намали од 106 г-^{1} до 103 г-^{1}, но сепак беше поголем одошто кај неинокулираните варијанти (101г-^{1}). Применетите соеви азотобактер промовираа ран пораст на пченицата. Должината на надземниот дел кај инокулираните варијанти беше од 3% до 35% поголем одошто кај контролата, додека сувата маса беше поголема од 0,6 до 58%. Зголемувањето на должината и сувата маса, главно беше во корелација со количеството ИОК.

Клучни зборови: азотобактер, кисела почва, пченица.

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RESPONSE OF BARLEY GENOTYPES TO LIMING AND FERTILIZATION ON PSEUDOGLEY SOIL

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Abstract
In this study evaluated the response of four barley genotypes (Rekord, Jagodinac, Kristal and Premijum) to three fertilization method (120 kg N ha^{-1}, 80 kg $P_2O_5ha^{-1}$, 53 kg K_2O; 120 kg N ha^{-1}, 160 kg $P_2O_5ha^{-1}$, 53 kg K_2O; 120 kg N ha^{-1}, 80 kg $P_2O_5ha^{-1}$, 53 kg K_2O + 5 t ha^{-1}"Njival Ca" ha^{-1} + 20 t manure ha^{-1}) on pseudogley soil. The results showed that the examined genotypes gave poor yields at low soil pH, under low phosphorus and low humus cotent. The use of NPK fertilizer with a higher content of phosphorus had a positive effect on the yield that was increased twice.The combined ameliorative use of lime, manure and NPK fertilizers led to a significant increase in grain yield, particularly in cv. Kristal. Barley productive traits were highly significantly and positively correlated with soil pH and P_2O_5 and CaO content, while correlations with Mn and Al soil content were significant, but negative.
Key words: barley, fertilizer, genotype, liming, pseudogley soil.

Introduction

Soil acidity influences many chemical and biological reactions that control plant nutrient availability and element toxicity (Sumner et al., 1991; Lavelle et al., 1995). Worldwide, soil acidification affects an estimated 30% of the total topsoil (Sumner and Noble, 2003). Furthermore, 75% of acid topsoils are also affected by subsoil acidity, and failure to address topsoil acidity may result in subsoil acidifi cation of even neutral to alkaline soils (Sumner and Noble, 2003). Pseudogley and other types of acid soils are widespread in the Republic of Serbia, accounting for over 60% of total arable land (Stevanović et al., 1995). The acidity of these soils, their high contents of H^+ ions and low contents of essential plant nutrients, primarily P and Ca, are constraints to high and stable wheat yields. Low calcium levels, phosphorus deficiency and aluminum toxicity affect root growth, the absorption of water and nutrient uptake by plants, generally causing crop yield reduction in acid soils (Pavan et al., 1982; Sumner, 2004). The effect of fertilization and liming on crop yield has been observed in many studies; the trials, however, show differences in the intensity of the effect. Crop yield is also significantly affected by soil conditions, climatic factors and weather conditions in a given year (Eduardo et al., 2005, Ito et al. 2009, Chimdi et al., 2012). A large effect on the grain yield of cereals has been reported at combined application of manure, lime and mineral fertilizers (Manna et al. 2005). The objective of the present study was to evaulate the effect of

different fertilization methods and fertilizer types on grain yield and yield components in four winter barley genotypes (Rekord, Jagodinac, Kristal amd Premijum) on pseudogley soil.

Material and methods

The study was conducted at the experimental field of the Dr. Đorđe Radić Secondary School of Agriculture and Chemistry in Kraljevo, on pseudogley soil, over a period of three years (2008-2010). The trial included an untreated control (B_1) and three different fertilization methods: B_2 (120 $kgNha^{-1}$, 80 $kgP_2O_5ha^{-1}$, 53 kgK_2O ha^{-1}), B_3 (120 $kgNha^{-1}$, 160 kgP_2O_5 ha^{-1}, 53 kgK_2O ha^{-1}) and B_4 (120 $kgNha^{-1}$, 80 $kgP_2O_5ha^{-1}$, 53 kgK_2O ha^{-1}+5 t "Njival Ca" ha^{-1}+20 t manure ha^{-1}). Fertilization treatments were set up in a randomized block design in three replications. Plot size was 50 m^2. The fertilizers used included complex NPK fertilizer (8:24:16), superphosphate (17% P_2O_5) and ammonium nitrate (AN=17% N) used as a nitrogen fertilizer at the end of winter. Four different winter barley cultivars (Rekord- A_1, Jagodinac- A_2, Kristal- A_3 and Premijum- A_4) were grown at the trial field. Sowing was performed at optimum dates, at a seeding rate of 500 viable seeds per square meter, using a tractor-drawn seed drill. Conventional production technology was employed. The crop was harvested at full maturity, using a Sampo harvester. Barley yield was weighed and adjusted to 14% moisture. Harvest index was calculated as the ratio of grain yield to straw yield. Grain number per ear were determined. Soil sampling was carried out after the harvesting operation. The soil was analyzed by the following standard chemical methods: soil pH was determined in a 1:2.5 soil - 1 M KCl suspension after a half-hour equilibration period; the humus content was determined using the Kotzmann method, the content of available P_2O_5 and K_2O was assessed by the Al method of Egner-Riehm. A colorimetric method using the aluminon acetate buffer was employed to analyze the content of mobile Al. The obtained data were evaluated using analysis of variance and the significance between mean values was performed according to Mead (1996).

Results and discussion

The soil used in the trial was pseudogley, previously (Dugalić, 1998) characterized as having poor physical properties (a high level of compaction, a high proportion of powder and clay particles, low water permeability) and being extremely acid (pH< 4.5). The soil was low in both humus and readily available phosphorus (about 2.18% and 7.0-8.0 mg 100 g^{-1} soil, respectively), and had a moderate supplay of readily available potassium (13-18 mg 100 g^{-1} soil) and a satisfactory amount of total nitrogen (0.10-0.13%), but showed very low microbial activity (89.4-145.3x10^5 ammonifiers, 0.0x10^1 azotobacter and 31.9-41.1x10^3 fungi).

The average air temperature during 2007-2010 growing season was considerably higher than the long - termmean (LTM) (Table 1). Total rainfall during 2009/10 growing season was about 41% above the LMT and 34% and 39% above the values reported for 2008/09 and 2007/08, respectively.

One part of the 2008 and 2009 growing seson (April and May) was characterized by decreased rainfall and increased air temperatures relative to the LTM. Barley yields on pseudogley soil are low and constrained by a range of agronomic and climate factors, with low soil fertility being one of major limiting factors. Unfavorable chemical properties can be improved by soil ameliorative operations (liming, phosphate fertilization and humification). In other words, the soil should be adapted to specific plant i.e. genotype requirements. The results obtained show that the effect of chemical soil amendment measures on barley grain yield on low-fertility soils was considerably higher than that of genotype (Table 2). The test winter barley genotypes exhibited different

responses to the stress induced by low soil pH. The data clearly show that cv. Premijum (A_3) gave a much higher yield as compared to the other cultivars, and produced the highest maximum grain yield (4.78 t ha^{-1}). Yield differences among genotypes were also observed in the untreated control, with Premijum having the highest average grain yield (2.37 t ha^{-1}).

Table 1. Weather characteristics

Rainfall (R mm) and mean air temperatures (^{0}C) for period 2007-2010 and long- term means- LTM (1961-1990)										
Period	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	∑x
2007/08 R mm	117	116	39	33	22	72	63	40	73	576
2007/08 t ^{0}C	10.6	3.2	0.2	1.6	4.5	8.0	12.4	17.2	21.1	8.7
2008/09 R mm	40	48	41	47	55	72	23	36	194	557
2008/09 t ^{0}C	12.8	8.0	4.4	0.4	2.3	6.6	13.4	18.1	20.1	9.6
2009/10 R mm	138	63	98	34	82	39	100	84	136	774
2009/10 t ^{0}C	11.3	8.2	3.8	1.1	2.7	7.2	12.1	16.6	20.2	9.2
LTM R mm	58	89	50	42	38	48	54	86	83	548
LTM t ^{0}C	11.1	4.2	1.2	-0.2	1.7	6.8	11.5	16.8	19.6	8.1

The average air temperature during 2007-2010 growing season was considerably higher than the long - termmean (LTM) (Table 1). Total rainfall during 2009/10 growing season was about 41% above the LMT and 34% and 39% above the values reported for 2008/09 and 2007/08, respectively. One part of the 2008 and 2009 growing seson (April and May) was characterized by decreased rainfall and increased air temperatures relative to the LTM. Barley yields on pseudogley soil are low and constrained by a range of agronomic and climate factors, with low soil fertility being one of major limiting factors. Unfavorable chemical properties can be improved by soil ameliorative operations (liming, phosphate fertilization and humification). In other words, the soil should be adapted to specific plant i.e. genotype requirements. The results obtained show that the effect of chemical soil amendment measures on barley grain yield on low-fertility soils was considerably higher than that of genotype (Table 2). The test winter barley genotypes exhibited different responses to the stress induced by low soil pH. The data clearly show that cv. Premijum (A_3) gave a much higher yield as compared to the other cultivars, and produced the highest maximum grain yield (4.78 t ha^{-1}). Yield differences among genotypes were also observed in the untreated control, with Premijum having the highest average grain yield (2.37 t ha^{-1}).

The combined use of lime, manure and NPK fertilizer had a significant effect on grain yield (Table 2). NPK fertilization (B_2) induced a significant (90%) increase in grain yield as compared to the control. Fertilization with NPK having high phosphorus levels (B_3) led to a significant yield increase in the test genotypes as compared to the other treatments. Therefore, the use of integrated nutrient management is very important and best approach to maintain and improve soil fertility (Lander et al., 1998) thereby to increase crop productivity in an efficient and environmentally benign manner, without sacrificing soil productivity of future generations. Grain yield of winter barley exhibited significant variations across years, being highest in 2009/10 which was marked by the highest amount of rainfall and the most favorable distribution during the growing period. The results obtained are consistent with those reported in our previous studies (Jelić et al., 2007; Jelić et

al., 2009). Furthermore, the pronounced effect of the treatment with NPK that had an increased phosphorus level was the result of a low content of available phosphorus in the soil due to its low pH value.

Table 2. Average values of grain yield of winter wheat cultivars (t ha^{-1}) (A- cultivar, B- fertilization variant, C- years, AB-, AC-, BC-, ABC- interaction)

Cultivar	Years	Fertilization variants (B_1- control, B_2- NP_1K, B_3- NP_2K, B_4- $NP_1K + CaCO_3$ + manure				Average for years	Average for cultivars
		B_1	B_2	B_3	B_4		
Rekord	2007/08	1.38	3.26	3.59	4.28	3.13	3.09
	2008/09	1.09	2.73	2.80	2.58	2.30	
	2009/10	2.28	4.33	4.43	4.38	3.85	
Jagodinac	2007/08	1.20	3.18	3.47	4.29	3.03	3.01
	2008/09	1.66	1.92	2.54	3.16	2.32	
	2009/10	2.34	4.01	4.23	4.20	3.69	
Kristal	2007/08	1.46	3.36	3.66	4.26	3.18	3.14
	2008/09	1.89	2.56	2.27	3.08	2.48	
	2009/10	1.95	4.09	4.30	4.68	3.75	
Premijum	2007/08	1.57	3.40	3.82	4.52	3.33	3.22
	2008/09	1.54	2.03	2.28	2.96	2.20	
	2009/10	2.37	4.63	4.78	4.75	4.13	
Average		1.73	3.29	3.51	3.93	3.11	
LSD	A	B	AB	C	AC	BC	ABC
0.05	0.039	0.039	0.078	0.034	0.067	0.067	0.135
0.01	0.051	0.051	0.103	0.044	0.089	0.089	0.178

The positive effect of increased phosphorus application rates on grain yield in winter barley grown on acid soils was also previously observed (Soon, 1992; Kulhanek et al., 2007). Coefficients of correlation between soil chemical properties and wheat yield parameters were also calculated (Tab. 3). The average grain yield in fertilized treatments was significantly positively correlated with pH value ($r=0.96^{**}$), P_2O_5 in the soil ($r=1.00^{**}$) and CaO in the soil ($r=0.91^{**}$). However, grain yield, harvest index and grai mass per head were negatively correlated with Al and Mg soil content. Correlation coefficients were lower ($r=-0.91^{**}$, $r=-0.80^{**}$ and $r=-0.79^{*}$) for Mg content and measured parameters, but higher ($r=-0.99^{**}$ i $r=-0.94^{**}$) for Al content and measured parameters. Ameliorative application of lime caused decreasing of soil content of mobile Al and content of active Mg, because of antagonistic action of increased Ca content. Decreased Al mobility at soil influenced efficiency of utilization of some biogenic elements, especially phosphorus, causing increasing of yield of tested winter barley genotypes.

Additionally, available phosphorus in the soil had a significant effect on grain harvest indeks and grain weight per ear (0.79^{**} and 0.95^{**}, respectively). A significant positive correlation was also observed between soil pH and grain harvest index ($r=0.82^{**}$), as well as between soil pH and grain weight per ear ($r=0.89^{**}$).

Table 3. Coefficients of correlation between different soil chemical characteristics and productivity parameters of the barley for the fertilized treatments

Soil characteristics	Productivity parameters			
	Yield (t ha^{-1})	Grain harvest index	Grain number/ear	Grain weight/ear (g)
$pH_{(KCl)}$	0.96**	0.82**	ns	0.89**
Humus	Ns	ns	-0.81**	ns
P_2O_5	1.00**	0.79**	ns	0.95**
K_2O	Ns	ns	-0.84**	ns
CaO	0.91**	0.82**	ns	0.82**
Mg	-0.91**	-0.80**	ns	-0.79**
Al	-0.99**	-0.99**	ns	-0.94**

ns- there is no statistical significance; **statistically significant on the probability level of 0.01; *statistically significant on the probability level of 0.05

Table 4. Coefficients of correlation between soil chemical characteristics and grain yield of winter barley genotypes for the fertilized treatments

Soil characteristics	Genotypes			
	A_1	A_2	A_3	A_4
pH	0.88**	0.92**	1.00***	0.95***
Humus	ns	ns	ns	ns
P_2O_5	0.96**	0.98***	0.99**	0.99**
K_2O	ns	ns	ns	ns
CaO	0.81**	0.86**	0.98**	0.89**
Mg	-0.84**	-0.89**	-0.90**	-0.90**
Al	-0.95**	-0.98**	-0.98**	-0.99**

ns- there is no statistical significance; **statistically significant on the probability level of 0.01; *statistically significant on the probability level of 0.05

No significant correlation was found between humus content and soil chemical properties, except grain number per head, whose correlation was significant and negative (r=-0.81**). Obtained results are in accordiance with earlier results (Bashirov, 2009; Brown et al., 2008). A high positive correlation was observed (Tab. 4) between pH, P_2O_5 and CaO content in the soil with grain yield all genotype (r=0.84** to r=1.00**). Takođe, svi testirani genotipovi pokazali su jaku negativnu korelaciju sa sadržajem Mn i Al u zemljištu (r=-0.84** to r=-0.99**). Expressed interrelationships of grain yield of tested barley and some soil traits are results of improvement of soil fertility caused by application of NPK and liming. So, plant growth and grain yield of studied barley genotypes were improved, in conditions of decreased soil acidity and content of mobile Al, as well as increased P_2O_5 and CaO content (Haynes and Mokolobode, 2001; Wildey, 2003; Bashirov, 2009). The response of barley genotypes to the other soil chemical properties analyzed was not observed.

Conclusions

The increased soil acidity and the low content of available phosphorus and humus in pseudogley soil are constraints to grain yield and productivity parameters in winter barley. As compared to the control, application of NPK fertilizer with increased phosphorus content, like as ameliorative application of lime and manure with NPK fertilizer, induced a significant increase in grain yield (2.27-fold increase), as well as grain number per spike and grain weight per spike in the genotypes studied, particulary in 2009/10. year. The obtained correlation coefficients suggest that the highest yield response in barley genotypes, was produced by low pH, P_2O_5, CaO and Al content in the soil. Among the soil properties analyzed, the increase in P_2O_5 and CaO, and decrease of Al content in the soil led to a significant increase in grain yield in all genotypes tested.

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РЕАКЦИЈА НА ГЕНОТИПОВИТЕ ЈАЧМЕН НА ВАРОВНИК И ЃУБРЕЊЕ КАЈ ПСЕВДОГЛЕЈНА ПОЧВА

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Апстракт

Во оваа студија е прикажана реакцијата на четири генотипови јачмен (Rekord, Jagodinac, Kristal и Premijum) со три методи на ѓубрење (120 kg N ha^{-1}, 80 kg P_2O_5 ha^{-1}, 53 kg K_2O; 120 kg N ha^{-1}, 160 kg $P_2O_5ha^{-1}$, 53 kg K_2O; 120 kg N ha^{-1}, 80 kg $P_2O_5ha^{-1}$, 53 kg K_2O + 5 t ha^{-1}"Njival Ca" ha^{-1} + 20 t ѓубриво xa^{-1}) на псеудоглејна почва. Резултатите покажаа дека испитаните генотипови дадоа сиромашни приноси при ниска pH вредност на почвата и при ниска содржина на фосфор и хумус. Употребата на NPK ѓубриво со повисока содржина на фосфор имаше позитивен ефект врз приносот кој беше двојно зголемен. Комбинација од мелиоративни употреба на вар, ѓубриво и NPK ѓубрива доведе до значително зголемување на приносот, особено сортата Kristal. Продуктивните карактеристики на јачменот беа значајни и во позитивна корелација со pH и P_2O_5 на почвата и содржината на CaO, додека корелациите во однос на содржината на Mn и Al во почвата беа значајни, но негативни.

Клучни зборови: јачмен, ѓубриво, генотип, ѓубрење со варовник, псеудоглејна почва.

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DYNAMICS OF GRAIN DRY MATTER CONTENT IN SOME TRITICALE VARIETIES

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Abstract
The dynamics of dry matter content in the grain was followed in 8 triticale varieties (*Malesh, Triglav, Agrounija, Odisej, Novisadsko triticale, Triumph* and *KG - 20*) during 2009 and 2010. During the test period the varieties showed a difference in grain dry matter content increasement. Earlier triticale cultivars (*Malesh, Odisej*) show faster rate of accumulation of dry matter in the grain, while the later varieties (*Agrounija, Triglav, Triumph* and the *KG-20*) show slower rate of accumulation of dry matter. The average increase rate of early varieties was 87.6% (*Malesh*) and 91.2% (*Odisej*). For the later varieties the average increase rate was 84.7% (*Agrounija*) and 85.7% (*Triglav*). The obtained results gave the information on the dinamics of dry matter increasment in triticale grain, the effect of environmental factors on this trait and the variability of grain yield in triticale. The data will be used in selection of varieties for production and future breeding of triticale.
Key words: dry matter content, grain filling, *Triticosecale sp*.

Introduction

The dynamics of dry matter content in triticale grain during grain formation and filling as a physiological process depends on the genetic characteristics of varieties and growing conditions. This growth stage, in the climatic and soil conditions in Macedonia, occures during the second decade of May, June, and the first decade of July. Because of the genetic constitution of triticale (inherited traits from wheat and rye), it has longer reproductive period in comparison with wheat and other grain crops. In heksaploid triticale (2n = 6k = 42), amfidiploid between durum and rye, the period of grain formation starts 10-16 days after flowering stage (*Milovanovic et al*., 1998). According to the same author, the development of the endosperm starts from 14 to 27 days after flowering stage. The first 7-10 days after flowering, wheat grain is formed with all its dimensions (width and length) (*Jevtic*, 1981). The same period for triticale occures 10 to 16 days after flowering. At the beginning of its development, the triticale grain has low intensity of increasment of the dry matter. The intensity increases until the end of milk ripening, and then declines over the mealy ripening. At the end of this phase the grain filling ends and the full maturity stage begins. The aim of this work was to study the dinamics of dry matter increasment in triticale grain, and based on environmental factors in the grain filling and ripening period (May, June, July), to examine the variability of grain yield in triticale.

Material and methods

Dry matter content was followed in the grains from the main triticale spike in different growth stages, from heading to ripening, during 2009 and 2010 years. From the main spike of 8 triticale varieties, every seventh day the average samples were taken. Spikes were dried at room temperature (22-26°C) and then, the grains were separeted from the spike with labolatory trasher. For each testing period, the weight of 1000 grains was calculated. Based on average weight increasment of 1000 grains for each period, the percentage increase rates of dry matter in the grain were calculated.

Climatic conditions

Climatic factors (temperature and precipitation) during formation, filling and rippening of the grain are critical for optimal accumulation of dry matter content in the grain.

Table 1. Weather data for the region of Skopje

1.1. Average decade temperature (°C) for May, June and July

Decade	May			June			July		
	2009	2010	1967/90	2009	2010	1967/90	2009	2010	1967/90
I	16,5	8,3	16,6	21,6	20,0	19,0	23,2	24,4	21,8
II	18,9	16,1	17,0	29,8	16,1	21,0	23,9	25,6	24,2
III	19,5	19,0	18,0	18,7	18,7	22,2	25,2	23,5	23,0
Average	18,3	17,8	17,2	21,0	21,9	20,6	24,0	24,1	23,0

1.2. Average decade precipitation (mm) for May, June and July

Decade	May			June			July		
	2009	2010	1967/90	2009	2010	1967/90	2009	2010	1967/90
I	10,5	3,2	18,5	9,8	23,9	17,0	6,6	15,2	10,2
II	15,0	27,2	25,3	1,0	9,7	15,5	3,6	8,8	15,0
III	32,5	8,7	17,0	93,5	23,9	16,0	0,3	23,4	10,0
Total	57,5	39,0	60,8	104,3	57,4	48,5	10,2	47,0	35,2

The presented data (Table 1) show that the precipitation in June 2009 is almost two times higher than in 2010. In our climatic and soil conditions in different regions and years the reported temperatures above 30°C, followed by low soil moisture and low relative humidity, which stop rate of dry matter in the grain, and so-called "thermal shock" at the plants occurs. When such environmental factors forced grain ripens, it becomes wrinkled grain, which result with low overall yield per unit area.

Results and discussion

The dynamics of dry matter increasement in triticale goes through several stages. According to *Jevtic et al.* (1984), there are significant morphological, biological and other changes in the phase of formation and grain filling. In the conditions of Skopje, on average, the triticale grains are formed and filled during the second decade of May, June, and the first decade of July.

The weight of 1000 grains has been analyzed each year during the testing period, and obtained results are presented in Table 2.

Table 2. The dynamics of increase in 1000 grain weight (g)

2009						
Variety / period	22.V	29.V	6.VI	12.VI	26.VI	9.VII
Malesh	4,2	18,0	36,0	41,0	47,0	56,0
Triglav	4,5	13,5	34,0	38,5	49,0	58,0
Agrounija	4,1	13,1	21,5	33,2	43,3	53,0
Bt-04-002	7,7	21,0	30,0	42,5	46,0	52,5
Odisej	9,1	22,6	34,0	41,0	45,5	52,0
Novosadsko triticale	4,0	12,5	20,0	31,0	42,0	47,5
Triumph	4,4	9,9	24,0	33,5	40,0	49,5
KG-20	5,7	15,1	29,0	30,0	41,0	48,5
Average	5,5	15,7	28,6	36,3	44,2	52,1
2010						
Variety / period	20.V	27.V	4.VI	11.VI	24.VI	8.VII
Malesh	3,3	10,5	27,6	41,6	47,6	52,0
Triglav	1,7	4,3	14,9	36,1	46,8	53,0
Agrounija	1,2	3,4	12,5	30,1	42,7	48,0
Bt-04-002	3,3	12,6	24,0	38,1	46,0	51,0
Odisej	5,3	10,2	24,3	40,0	47,5	50,0
Novosadsko triticale	1,0	2,4	10,9	29,7	40,0	45,5
Triumph	1,3	4,5	16,0	30,7	42,0	47,0
KG-20	3,9	9,7	20,0	33,4	40,2	46,5
Average	2,6	7,2	18,8	35,0	44,1	49,1

From the presented data, in all analyzed varieties the values of dry matter are continuously increasing. The average weight of 1000 triticale grains (6.VI and 4.VI) was higher in 2009 (28.6 g) in comparison to 2010 (18.8 g) (Table 2).

After grain forming, the increase of dry matter in triticale grain has been intensified till the end of milky ripening stage, and then gradually decreases and is terminated in early mealy ripening stage (Table 3). *Milovanovic et al*. (1998) observed that due to a genetic trait inherited from parents, the triticale has longer reproductive development (from 7 to 10 days) than the wheat, and is later maturing (10-15 days) compared with soft wheat.

The tested triticale varieties extremly differ in terms of the dynamics of increase of dry matter in grain. The longest period of formation and grain filling has *Agrounija* variety, while *Odisej* variety has the shortest period (Table 4). This period duration is determined by genetic characteristics of the variety and environmental conditions. In our study, the average weight of 1000 grains at the end of June was found to be lower by 12.7% from the same average in the stage of full ripeness. In this period, minimum average weight of 1000 grains was found in *Agrounija* variety (84.7 %), and the highest was in *Odisej* variety (91.2%) of the total weight of 1000 grains at full maturity stage.

Table 3. Average dynamics of 1000 grain weight (g) for 2009/2010

Variety / period	20-22 V	27-29 V	3-6 VI	10-12 VI	24-26 VI	8-9 VII
Malesh	3,7	14,2	31,8	41,3	47,3	54,0
Triglav	3,1	8,9	24,4	37,3	47,6	55,5
Agrounija	2,6	8,2	17,0	31,6	42,6	50,5
Bt-04-002	5,5	16,8	27,0	40,3	46,0	51,7
Odisej	7,2	16,3	29,2	40,5	46,5	51,0
Novosadsko triticale	2,5	7,5	15,5	30,3	41,0	46,5
Triumph	2,8	7,2	20,0	32,1	41,0	48,2
KG-20	4,0	12,6	24,5	31,7	40,6	47,5
Average	3,9	11,5	23,7	35,6	44,1	50,6

Table 4. Average of increase rates of dry matter in grain (%)

Variety / period	20-22V	27-29V	3-6VI	10-12VI	24-26VI	8-9VII
Malesh	6,8	26,1	58,3	75,8	87,6	100
Triglav	5,4	15,7	43,2	66,0	85,7	100
Agrounija	5,3	16,7	34,7	64,5	84,7	100
Bt-04-002	10,3	31,5	50,7	75,7	90,0	100
Odisej	13,9	31,6	56,7	78,6	91,2	100
Novosadsko triticale	5,0	14,9	30,8	60,3	88,2	100
Triumph	5,8	14,3	41,5	66,6	85,1	100
KG-20	9,9	26,1	50,8	65,7	85,5	100
Average	7,8	22,1	45,8	69,2	87,3	100

In terms of Skopje, grain filling phase occurs in June and early July. If in this period the environmental conditions are favorable, it seems that more assimilates translocate from vegetative parts to the grain. During this period, the amount of yield per unit area could be determined. In our climatic and soil conditions in different regions and years the reported temperatures above 30°C, followed by low soil moisture and low relative humidity, which stop rate of dry matter in the grain, and so-called "thermal shock" at the plants occurs. When such environmental factors force grain ripening, it becomes wrinkled grain, which results with low overall yield per unit area.

Based on the obtained results (Table 3 and Table 4), when an unfavorable climatic conditions for grain filling occurs at the same phase, the later varieties (*Agrounija*, *Triglav*) will have less grain accumulation or lower weight on 1000 grains which contributes to lower yield per unit area.

From the results shown in Table 5 and Table 6, it is found that the highest average yield was obtained in 2009 (5.69 t/ha), while in 2010 the yield was 4.88 t/ha. The highest average yield gave *Agrounija* (5.5t/ha), followed by *Malesh* (5.9 t/ha) and *Bt-04-002* variety (5.8 t/ha), which were significantly higher than the standard variety *Triglav* (4.80 t/ha).

Table 5. Grain yield by variety and year (t / ha)

Variety/ year		2009	2010	Average
Malesh		6,3	5,5	5,9**
Triglav		4,6	5,0	4,8
Agrounija		6,0	5,0	5,5*
Bt-04-002		5,6	5,0	5,8**
Odisej		6,0	4,8	5,4
Novosadsko triticale		5,8	4,6	5,2
Triumph		5,8	4,5	5,1
KG-20		5,4	4,6	5,0
Average		5,69	4,88	5,34
LSD	0,05*	0,63	0,75	0,69
	0,01**	0,85	1,03	0,94

The favorable weather conditions during the examination period contributed to higher average grain yield in 2009 (5.69 t/ha) compared with 2010 (4.88 t/ha) (Table 5).
Data in Table 6, show an average values of weight of the grains in different growing periods.

Table 6. Average grain weight per growing period (kg/ha)

Variety / period	20-22 V	27-29 V	3-6 VI	10-12 VI	24-26 VI	8-9 VII
Malesh	401	1540	3440	4472	5168	5900
Triglav	290	753	2073	3168	4113	4800
Agrounija	297	863	2376	3630	4713	5500
Bt-04-002	597	1827	2941	4391	5220	5800
Odisej	751	1706	3062	4244	4925	5400
Novosadsko triticale	260	775	1602	3135	4586	5200
Triumph	296	729	2116	3397	4340	5100
KG-20	495	1305	2540	3285	4275	5000
Average	421	1187	2518	3715	4667	5960

Conclusions

Based on the results obtained in this study, the following conclusions can be drawn:
The dynamics of increase rate of the dry matter content in the grain differs between the examined triticale varieties.
In terms of the Skopje region, grain formation takes place during the second decade of May, while grain filling occures during the third decade of May, June and the first decade of July. The duration of this period depends on environmental conditions in the area of cultivation.
The accumulation of the dry matter content in the grain starts with less intensity at the begining, gradual intensification, and then decreasing in the mealy ripening stage (end of June) and at the end (the first decade of July) it completely finishes when grain is fully mature.
Earlier triticale cultivars (*Malesh, Odisej*) show faster rate of accumulation of dry matter in the grain, while the later varieties (*Agrounija, Triglav, Triumph* and the *KG-20*) show slower rate of accumulation of dry matter, but it lasts longer compared to earlier varieties.

In average, maximum difference in dynamic of dry matter increase in grain (%) is observed at the end of the third decade of June. The average increase rate of early varieties was 87.6% (*Malesh*) and 91.2% (*Odisej*).

For the later varieties the average increase rate was 84.7% (*Agrounija*) and 85.7% (*Triglav*). That is why the earlier varieties (*Malesh* and *Odisej*) are biologicaly more adaptable to different environmental conditions, and at the same time with more stable average grain yield per unit area.

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ДИНАМИКА НА ПРИРАСТОТ НА СУВАТА МАСА ВО ЗРНОТО КАЈ НЕКОИ СОРТИ ТРИТИКАЛЕ

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Апстракт

Динамиката на содржината на сува материја се следеше кај 8 сорти на тритикале (*малеш, триглав, агроунија, одисеј, новосадско тритикале, триумф* и *КГ-20*) во текот на 2009 и 2010 година. Испитуваните сорти тритикале покажаа разлика во прирастот на сува маса во зрното во текот на испитуваниот период. Резултатите покажаа дека пораните сортите (*малеш*, *одисеј*) покажуваат побрза акумулација на сува материја во зрното, а подоцните сорти (*агроунија*, *триглав, триумф и КГ-20*) покажуваат побавна акумулација на сува материја. Просечниот пораст на сува маса изнесува 87,6% (*малеш*) и 91,2% (*одисеј*). За покасните сорти, просечниот пораст насува маса изнесуваше 84,7% (*агроунија*) и 85,7% (*триглав*). Добиените резултати дадоа информација за динамиката на прираст на сува материја во зрното на тритикале, ефектот од влијанието на еколошките фактори врз оваа особина и варијабилноста на приносот на тритикале. Добиените податоци ќе се користат во изборот на сорти за производство и понатамошна селекција на тритикале.

Клучни зборови: прираст на сува маса, налевање на зрното, *Triticosecale sp.*

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DRY TOBACCO YIELD IN SOME PRILEP TOBACCO VARIETIES

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Abstract
Tobacco is industrial culture grown for its leaf mass. Dry tobacco yield is one of the most important quantitative properties, because in normal conditions of growing and suitable agro techniques it reflects the biological potential of each tobacco variety. Investigations of this character were carried out in 2009 and 2010 on the Experimental field of Tobacco Institute-Prilep with six oriental tobacco varieties of the type Prilep: P-23 (Ø) P12-2/1, NS-72, P-79-94, P-66-9/7 and Prilep Basma 82. Determination was made on dry tobacco yields per stalk (in grams) and per unit area (kg/ha). According to the results of the two-year investigations, the highest yield was achieved in P-66-9/7 (21,88 g/stalk, i.e. 3297,45 kg/ha), and the lowest in P-12-2/1 (14,35 g/stalk i.e. 2164,90 kg/ha). The yield of the standard variety P-23 was 18,07 g/stalk i.e. 2717,75 kg/ha. Statistical processing of the results has shown significant differences in yields, which denotes that each of the investigated varieties has a different biological potential, which is undoubtedly governed by its own genotype.
Key words: dry tobacco yield, type Prilep, varieties, genotype.

Introduction

Republic of Macedonia is a well-known producer of high quality oriental aromatic tobaccos which are constituent part of the best quality cigarette brands. Tobacco takes an important place in the economy of the country and it is one of its main export products on world market. In recent years, the dry tobacco production in the country has ranged between 20 and 25 million kilograms, with a tendency to increase. The most represented types are Prilep, Yaka, Jebel and Basmak, but predominant type is Prilep, with about 70% share in the total production. When creating new varieties, geneticists and breeders pay great attention not only to tobacco quality but also to yield - a major quantitative trait which affects the effectiveness of work and farmer's gains. This trait was a subject of investigation to many authors in different tobacco varieties (Gornik, 1973; Uzunoski, 1985; Karajankov, 1995; Korubin - Aleksoska and Mitreski, 2005; Dimitrieski and Miceska, 2011). The aim of our research was to estimate the dry yield of Prilep tobacco cultivated under the same conditions in the Experimental field of Tobacco Institute-Prilep, expressed in g/stalk and kg/ha, which will reveal the biological potential of the investigated varieties.

Material and methods

Six Prilep tobacco varieties were used as material for the investigation: Prilep P-23 - Ø (control); Prilep, P 12-2/1; Prilep, NS-72; Prilep, P-66-9/7; Prilep P-79-94 and Prilep Basma-82.

These varieties have marked certain period in the past and present and dictated the structure of production of Prilep type tobacco in Macedonia. They also show the direction in which selection of this type has moved in the last two decades, aiming to meet the requirements of tobacco industry. These varieties present an important genetic basis for creation of new genotypes with improved yield and quality.

- Prilep P-23 - created through hybridization and selection in Tobacco Institute - Prilep by Nikoloski Kostadin and Mitreski Milan; recognized (approved) by the Ministry of Agriculture, Forestry and Water Management of the Republic of Macedonia in 1995. Characterized by elliptical – conical habitus, with 50-55 leaves densely arranged on stem.
- Prilep P 12-2/1 - created in Tobacco Institute - Prilep, in the 30ies of the 20th century by Gornik Rudolf, the founder of tobacco science in Macedonia and former Yugoslavia; obtained by individual selection from local variety Jumai-Bale from Bulgaria. Characterized by cup-like habitus, with small number of leaves (30 to 35), with characteristic lanceolate form. Of all tobacco varieties in the trial, it is the shortest in size and achieves the lowest yield.
- Prilep NS-72 - created through hybridization and selection by Boceski Dushko and Karayankov Simeon; recognized in 1984 in former Yugoslavia, as the first variety of the type Prilep obtained by crossing. Cylindrical-elliptical habitus with approximately 50 sessile leaves, elliptical in shape.
- Prilep P-66-9/7 - created through hybridization and selection in Tobacco Institute - Prilep, by Dimitrieski Miroslav and Miceska Gordana; recognized by the Ministry of Agriculture, Forestry and Water Management of R. Macedonia in 2004. Elliptical-conical habitus, with 54 - 60 ovate leaves, sessile and evenly distributed on the stem. The most represented tobacco variety in our country in recent years.
- Prilep P-79-94 - created in Tobacco Institute - Prilep through crossbreeding and selection by Bogdanceski Milan; recognized by the Ministry of Agriculture, Forestry and Water Management of R. Macedonia in 2001. Cylindrical-elliptical habitus with 56 – 60 sessile leaves densely distributed, especially in the upper part of stem.
- Prilep Basma-82 - created through hybridization and selection in Tobacco Institute - Prilep, by Boceski Dushko; recognized by the Ministry of Agriculture, Forestry and Water Management of R. Macedonia in 2010. Cylindrical habitus with a slight narrowing in the upper part. This is the highest variety, with the highest leaf number (80 - 90) among all investigated Prilep tobacco varieties. Leaves are sessile, elliptical in shape.

Field trials were set up in Tobacco Institute - Prilep in 2009 and 2010 on diluvial-colluvial soil, arranged in randomized block system with four replications.

Data on climatic conditions during the investigation were obtained by the Meteorological station located in the Experimental field of Tobacco Institute-Prilep.

One deep autumn plowing (35 cm depth) and three spring plowings were applied on the trial surface. Fertilization was made prior to the second spring plowing, with 300 kg/ha complex fertilizer NPK 10:30:20, in compliance with agrochemical properties of soil and the requirements of tobacco plants.

Tobacco seedlings were produced in the field of Tobacco Institute, in seedbeds covered with polyethylene. The period for seedling production lasted 50 days in 2009 and 52 days in 2010. Transplanting was performed manually, on 3 June 2009 and 11 June 2010, with 40 cm spacing between rows and 12 cm between stalks, on a soil previously treated with herbicide Treflan EC (a.s. Trifluralin 48 %) agains weeds. The area of each plot was 12 m^2, with six rows of tobacco and 42

stalks in the row. The first digging was done in June (fifteen days after transplanting), and the second followed ten days after, in order to obtain normal growth and development of plants. During this period, preventive protection of tobacco was made with the fungicide Ridomil MZ 72 (a.s. Metalaksil+Makonzeb) and insecticide Confidor SL-200 (a.s. Imidachorpirid).

During the growing season, sprinkler irrigations were applied three times in 2009 and twice in 2010, with irrigation norm of 250 m^3 water per hectare. Each irrigation was followed by harrowing of the soil in order to improve its water-air regime. In both years of investigation, fertilization of tobacco was made after the third priming, with nitrogen fertilizer (calcium ammonium nitrate, CAN), with 60 kg N / ha (27% N).

Tobacco harvesting was performed by insertions, in the technical maturity of leaves from each variety. Four rows were picked from each plot, while the other two rows served for monitoring and protection. Tobacco leaves were strung manually and sun-cured in traditional way, on scaffolds covered with polyethylene.

On the basis of measurements and grading, dry tobacco yield was calculated in grams per stalk (g/stalk) and kilograms per hectare (kg/ha), using standard forms and formulas for corrected yield.

The data obtained in the investigation were processed by Method of analysis of variance and LSD-test (Najcevska, 2002).

Climate characteristics

Tobacco belongs to the group of plants which are highly affected by climatic factors, giving maximum yield and highest quality at optimal temperatures, precipitations and relative air humidity. With regard to the temperature in the period of investigation (2009 and 2010), it can be concluded that it meets the requirements for obtaining a good quality raw material (Table 1).

The amount of precipitations from May to September ranged 196 l/ m² in 2009 and up to 298 l/ m² in 2010, but in both years their distribution was uneven and unfavorable for tobacco growth, especially in July and August. For this reason, additional irrigations were applied - three in 2009 and two in 2010. With regard to mean monthly relative humidity of the air, in both years it ranged within the optimum, except for July 2009 (42%).

Table1. Mean monthly air temperatures in 2009 and 2010

Meteorological factor	Year	Months					$\bar{x}$
		V	VI	VII	VIII	IX	
Mean monthly air temperatures, ºC	2009	15,8	18,5	21,9	21,4	17,1	18,9
	2010	15,3	18,8	21,3	23,1	15,9	18,9
Precipitations, mm	2009	55,0	75,0	8,0	43,0	15,0	**Σ** 196,0
	2010	64,0	87,0	55,0	45,0	47,0	298,0
Mean monthly relative air humidity, %	2009	58,0	57,0	42,0	50,0	54,0	52,2
	2010	57,0	59,0	53,0	50,0	61,0	56.0

Results and discussion

Tobacco is an industrial crop grown for its dry leaf mass. The amount of yield is a type and variety characteristic which largely depends on agri-environmental conditions and applied cultural practices during the growing season. The selected varieties were cultivated under the same conditions in order to investigate their genetic potential.

In our investigations measurements were made on dry tobacco yield per stalk in grams and estimations of yield in kilograms per hectare.
The results in 2009 showed the highest yield per stalk in P-66-9/7 (21,55 g), the check variety P-23 gave 16,07 g/stalk and the lowest yield of 13,36 g/stalk was obtained in P 12-2/1 (Table 2).

Table 2. Dry tobacco yield, g/stalk (2009)

No.	Variety	Replications				Average	Index
		I	II	III	IV		
1.	Prilep P-23 (Ø)	15,60	17,88	15,17	15,64	16,07	100,00
2.	Prilep P 12-2/1	13,69	12,32	13,81	13,63	13,36	83,14
3.	Prilep NS -72	16,38	14,77	13,79	18,54	15,87	98,76
4.	Prilep P-66-9/7	21,12	22,80	17,91	24,38	21,55***	134,10
5.	Prilep P-79-94	14,74	16,51	15,20	14,93	15,35	95,52
6.	Prilep Basma-82	19,93	21,42	18,96	20,94	20,31***	126,38
Average		16,91	17,62	15,81	18,01	17,08	106,28

LSD 0,05 = 2,15 g; LSD 0,01 = 2,97 g; LSD 0,001 = 4,11 g

Statistical processing of the data for 2009 showed highly significant differences resulting from the genetic potentials of the varieties (leaf number, leaf size, substantiality, etc.).
All investigated varieties in 2010 show higher average yields per stalk due to the favorable climatic conditions, but differences among the varieties are identical to those in 2009.
The highest average yield of dry tobacco was recorded in Prilep Basma-82 (23,09 g/stalk), P 66-9/7 (22,22 g/stalk) and in the check variety P-23 (20,07 g/stalk), while the lowest yield (15,34 g/stalk) was observed in P 12-2/1 (Table 3).

Table 3. Dry tobacco yield, g/stalk (2010)

No.	Variety	Replications				Average	Index
		I	II	III	IV		
1.	Prilep P-23 (Ø)	16,58	23,27	18,51	21,92	20,07	100,00
2.	Prilep P 12-2/1	16,32	15,33	12,98	16,73	15,34	76,43
3.	Prilep NS -72	17,57	19,53	15,47	19,93	18,13	90,33
4.	Prilep P-66-9/7	20,74	23,80	20,87	23,45	22,22*	110,71
5.	Prilep P-79-94	18,31	20,81	15,60	19,39	18,53	92,33
6.	Prilep Basma-82	21,60	25,31	20,60	24,83	23,09**	115,05
Average		18,52	21,34	17,34	21,04	19,56	97,46

LSD 0,05 = 1,78 g; LSD 0,01 = 2,46 g; LSD 0,001 = 3,40 g

Data presented in this Table also reveal significant differences between the varieties investigated, which is confirmation of heritability of this trait.
The highest average values for dry tobacco yield during the two-year investigations were obtained in variety P-66-9/7 (21,88 g/stalk), and the lowest values were reported in P 12-2/1 (14,35 g/stalk). The yield of the check variety P-23 was 18,07 g/stalk (Table 4).

Table 4. Average yield of dry tobacco, g/stalk

No.	Variety	Year		Average	Index
		2009	2010		
1.	Prilep P-23 (Ø)	16,07	20,07	18,07	100,00
2.	Prilep P 12-2/1	13,36	15,34	14,35	79,41
3.	Prilep NS -72	15,87	18,13	17,00	94,08
4.	Prilep P-66-9/7	21,55	22,22	21,88	121,08
5.	Prilep P-79-94	15,35	18,53	16,94	93,75
6.	Prilep Basma-82	20,31	23,09	21,70	120,09
Average		17,08	19,56	18,32	101,38

The yield of dry tobacco per stalk has been a subject of investigation by many research workers and tobacco professionals. Dimitrieski (1995), based on his three-year investigations, reported an average yield of 14,25 g/stalk in the variety P 12-2/1. Karajankov (1995), obtained relatively high yields in the variety NS-72, ranging from 14 - 15 g/stalk on hilly and mountainous terrains to over 30 g/stalk in plains and fertile soils. Dimitrieski et al. (2001), in investigation of several Prilep tobacco varieties in conditions of irrigation, reported the following results for this trait: P 12-2/1 - 14,12 g/stalk, P-23 - 16,18 g/stalk and NS 72 - 14,70 g/stalk. Korubin-Aleksoska (2004-a), in a dialel of four oriental and two semi-oriental varieties, reported a yield of 26,4 g/stalk in P-23. Mitreski (2005), studying the inheritance of some morpho-bilogical traits in tobacco, reported a yield of 19,98 g/stalk in the variety P-23.

The dry tobacco yield per unit area (ha), in the first year of investigation (2009) ranged from 2020,2 kg/ha in P 12-2/1 to 3266,2 kg/ha in P-66-9/7. Lower yields, compared to the check P-23 (2426,6 kg/ha), were observed in P 12-2/1, NS-72 and P-79-94, while higher yield was obtained in Prilep Basma-82 and P-66-9/7 (Table 5).

Table 5. Dry tobacco yield, kg/ha (2009)

No.	Variety	Replications				Average	Index
		I	II	III	IV		
1.	Prilep P-23 (Ø)	2340,0	2690,6	2297,7	2378,0	2426,6	100,00
2.	Prilep P 12-2/1	2060,4	1874,0	2082,0	2064,4	2020,2	83,25
3.	Prilep NS -72	2490,0	2230,0	2082,0	2800,0	2400,5	98,92
4.	Prilep P-66-9/7	3210,0	3454,2	2694,7	3706,0	3266,2 ***	134,60
5.	Prilep P-79-94	2240,0	2501,8	2295,0	2262,4	2324,8	95,80
6.	Prilep Basma-82	3018,9	3201,7	2832,5	3151,2	3051,1 **	125,74
Average		2559,9	2658,7	2380,6	2727,0	2581,6	106,39

LSD 0,05 = 328,8 kg/ha; LSD 0,01 = 454,7 kg/ha; LSD 0,001 = 628,4 kg/ha

Statistical analysis of the data (Table 5) for determination of comparative differences between varieties confirms that they are highly significant.

The results of the trials carried out in 2010 revealed again the existence of differences among the investigated tobacco varieties which result from their genetic structure. The average yield in the

control variety P-23 was 3008,9 kg/ha. The lowest yield was recorded in P 12-2/1 (2309,6 kg/ha) and the highest in P-66-9/7 (3328,7 kg/ha) and Prilep Basma-82 (3452,5 kg / ha) (Table 6).

Table 6. Dry tobacco yield, kg/ha (2010)

No.	Variety	Replications				Average	Index
		I	II	III	IV		
1.	Prilep P-23 (Ø)	2470,0	3488,4	2767,4	3310,0	3008,9	100,00
2.	Prilep P 12-2/1	2420,5	2323,0	1960,0	2535,1	2309,6	76,76
3.	Prilep NS -72	2670,0	2959,3	2343,2	2979,5	2738,0	91,00
4.	Prilep P-66-9/7	3090,0	3615,8	3141,1	3468,0	3328,7*	110,63
5.	Prilep P-79-94	2737,1	3110,8	2340,0	2898,7	2771,6	92,11
6.	Prilep Basma-82	3203,3	3794,4	3100,7	3711,7	3452,5**	114,74
Average		2765,1	3215,3	2608,7	3150,5	2934,9	97,54

LSD 0,05 = 259,10 kg/ha; LSD 0,01 = 358,31 kg/ha; LSD 0,001 = 495,22 kg/ha

Here again, the statistical processing of the results showed that the existing differences among the investigated tobacco varieties are statistically significant. The average two-year results (Table 7) show that the highest dry tobacco yield was obtained in P-66-9/7 (3297,45 kg/ha) and the lowest in P 12-2/1 (2164,90 kg/ha). The check P-23 is on the third place with 2717,75 kg/ha.

The yield of dry tobacco per unit area is of great interest both to farmers and buyers – manufacturers and therefore it has been a subject of investigation by many research workers and tobacco professionals. Korubin-Aleksoska (2004-b) reported that dry yield mass in P 12-2/1 approximated 1500 kg/ha, and in P-23 it ranged from 2000 to 2500 kg/ha.

Table 7. Average dry tobacco yield, kg/ha

No.	Variety	Year		Average	Index
		2009	2010		
1.	Prilep P-23 (Ø)	2426,6	3008,9	2717,75	100,00
2.	Prilep P 12-2/1	2020,2	2309,6	2164,90	79,66
3.	Prilep NS -72	2400,5	2738,0	2569,25	94,53
4.	Prilep P-66-9/7	3266,2	3328,7	3297,45	121,33
5.	Prilep P-79-94	2324,8	2771,6	2548,20	93,76
6.	Prilep Basma-82	3051,1	3452,5	3251,80	119,65
Average		2581,6	2934,9	2758,25	101,49

In P-79-94 variety the yield was somewhat higher, ranging from 500 to 3000 kg/ha. Pelivanoska (2009), in her investigation on the impact of fertilization and irrigation found that the highest yield of 3988 kg/ha was achieved in the variety P-66-9/7, with NPK variant 40-80-100 and soil moisture content remaining at 55% of field capacity. According to Dimitrieski and Miceska (2011), dry tobacco yield in P-66-9/7 ranged from 2000 to 3600 kg/ha, depending on the conditions of growing and cultural practices applied. The results of our research are in correlation with the data reported by the above authors.

Conclusions

Comparative investigations were made during 2009 and 2010 on dry yield in different varieties of the oriental tobacco Prilep (P-23 (Ø), P 12-2/1, Prilep NS-72, P-66-9/7, P-79-94 and Prilep Basma-82) grown under same conditions. The following conclusions can be drawn:

The highest yield of 21,88 g/stalk was recorded in P-66-9/7 and the lowest - 14,35 g/stalk in P 12-2/1. The yield obtained in the check variety P-23 was 18,07 g/stalk.

The highest yield per unit area was recorded in P-66-9/7 (3297,45 kg/ha) and the lowest again in P 12-2/1 (2164,90 kg/ha). The values obtained for the other varieties are as follows: Prilep Basma 82 - 3251,80 kg/ha, the check variety P-23 - 2717,75 kg/ha, NS-72 - 2569,25 kg/ha and P-79-94 - 2548,20 kg/ha.

Statistical procession of the results showed significant differences in the yield, which indicates that each of the investigated varieties has different biological potential, undoubtedly governed by its own genotype.

According to the results obtained in the study, the investigated tobacco varieties are a huge source for breeders in creation of new more productive and high quality tobacco genotypes which will find their place in mass production.

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ПРИНОС НА СУВ ТУТУН КАЈ НЕКОИ СОРТИ ОД ТИПОТ ПРИЛЕП

Ана Корубин-Алексоска, Валентина Пеливаноска, Милан Митрески,
Јордан Трајкоски, Робин Мавроски

Апстракт
Тутунот е индустриска култура која се одгледува заради неговата лисна маса. Приносот на сув тутун е едно од најважните квантитативни својства, кое во нормални услови и адекватна агротехника го рефлектира биолошкиот потенцијал на секоја сорта. Испитувањата беа извршени во 2009 и 2010 година на Опитното поле при Научниот институт за тутун - Прилеп, со шест ориенталски тутунски сорти од типот прилеп: П-23(Ø), П12-2/1, НС-72, П-79-94, П-66-9/7 и Прилеп Басма 82. Беше одреден приносот на сува маса по страк (g) и по единица површина (kg/ha). Според резултатите од двегодишните истражувања, највисок принос беше регистриран кај П-66-9/7 (21,88 g/страк, т.е. 3297,45 kg/ha), а најнизок кај П-12-2/1 (14,35 g/страк, т.е. 2164,9 kg/ha), Приносот кај стандардната сорта П-23 беше 18,07 g/страк, т.е. 2717,75 kg/ha. Статистичката обработка на резултатите покажа сигнификантни разлики во приносот, што укажува на фактот дека проучуваните сорти имаат различен биолошки потенцијал како резултат на нивниот генотип.
Клучни зборови: принос на сув тутун, тип прилеп, сорти, генотип.

UDC: 633.511(497.7)
UDC: 633.511(497.2)
Review paper

COTTON PRODUCTION IN BULGARIA AND MACEDONIA THROUGH THE YEARS

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Abstract
Bulgaria and Macedonia are situated in the northern part of the favorable for cotton growing climatic belt. Cotton has been introduced into Bulgarian-Macedonian territories still in Roman Empire; it was cultivated during medieval centuries and during the Ottoman rule on the Balkans. The American varieties *G. hirsutum L.* type were spread over in 19th century. A historical review of the last 50 years of the cotton production, harvested area, export, yield and domestic consumption in Bulgaria and Macedonia, as registered by the US Department of Agriculture, is presented. An interruption of cotton production Macedonia is observed from 2006 to 2012. Bulgarian growing varieties are of the type *Gossypium hirsutum L.* and cross lines of *Gossypium hirsutum L.*× *Gossypium barbadense L.*, while Macedonian ones are only of *Gossypium hirsutum L.* type. The advantage of the varieties, grown in our countries is their early maturing. Cotton breeding in Bulgaria is done in Field Crops Institute near the town of Chirpan. Presently One variety is in the EU Catalogue – Rumi, and six varieties more are pretending to be also in - Beli Izvor, Ogosta, Chirpan 539, Chirpan 603, Avangard 264, and Perla 267. A brown-fiber variety "Isabell" has been recently recognized. For Bulgarian moderate-continental and continental-Mediterranean climate conditions, the needed irrigation application number in dry and medium dry years is 2-3 with an application depth of 400-600 m^3/ha. Cotton response to irrigation is by yield increase of around 40-60%. Specific water saving irrigation scheduling is recommended - just one application before flowering. Thus, by saving 57% irrigational water, a 30% yield reduction is tolerated. For Macedonian transitional-Mediterranean climate conditions, the number of irrigation applications in a medium dry year varies from 5 to 6, with total irrigation amount for the vegetation period - from 3000 to 3500 m^3/ha, while in a medium year only 2-3 applications of 600 m^3/ha per application are enough for proper crop production. Manure fertilization with 10000 kg/ha has proved to be efficient. New cultivation practices with a yield increase of 15% are being developed - 80-cm inter-row spacing instead of the traditional 60-cm and a plant density of 180000 plants per hectare. Common Agricultural Policy, starting from 2014, will fix for Bulgaria a quota of sawn area - 3340 ha and a subsidy of 2690000 EUR yearly.
Key words: cotton, harvested area, yield, subsidies, agricultural practices.

Introduction

Cotton is one of the most valuable agricultural crops. Cotton area in the world takes around 3% of the arable lands and is classified of 6th rank after wheat, rice, maize, barley and sorghum. Net income is one of the highest. The main world producers are China (24%), USA (20%) and India (14%). In EU, the maximum cultivated area is 45060 ha (2%), but cotton has regional significance for the member-states, in which it is cultivated - mainly Greece and Spain. Portugal no longer produces cotton.

Around 76% of the total production in EU comes from Greece. Bulgaria has a small share in the European cotton production – from 10327 in 2007 (Regulation (EC), 2007) base area decreased to 3342 ha after 2009 (Regulation (EC), 2009). Only 400-700 ha have been sawn recently (Agrostatistics, MZH).

Cotton is a warm-climate and photophilic crop. Therefore it is often called "Sun child". Bulgaria and Macedonia are situated in the northern part of the favorable for cotton growing climatic belt. The conditions of both countries – minimum 3600°C temperature totals and 2000 h sunshine duration – ensure a vegetation period of 120 days). Cotton is sown at the end of April, when the mean air temperature is favorable for emergence - minimum 16°C, optimum 25-30°C. The necessary seasonal water for cotton growing in our territories is 300-350 mm, but it is not ensured by the atmospheric rainfalls (Nikolov et al., 2001; Stoilova, 2012a). High and steady yields are obtained only by irrigation.

Bulgarian soils, on which cotton is grown are deep and fertile - chenozems, smalnitsa, alluvial and cinnamonic soils (Nikolov et al., 2001; Saldzhiev et al., 2007). The best soils for growing cotton in Macedonia, according to its thermal regime, are deep clayey–sandy or light sandy–loamy alluvial sediments, which do not suffer from high groundwater's and have medium water capacity.

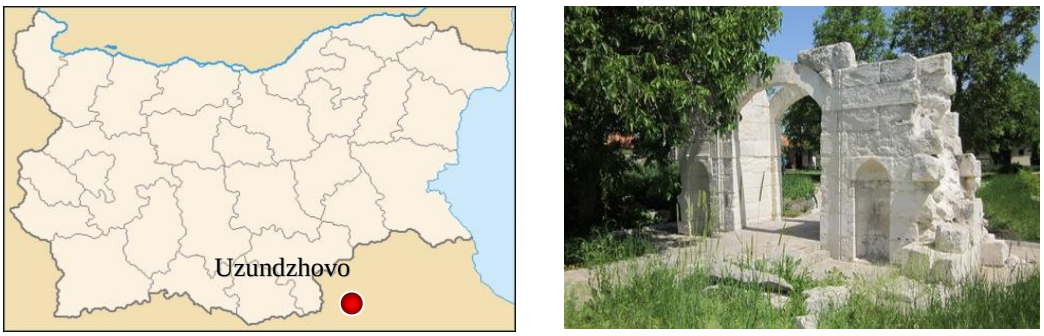


Figure 1. Situation of Uzundzhovo village and a photo of the caravan-saray gate, built with the donation of Sinan Pasha

Beginnings of cotton cultivation in Bulgaria and Macedonia

Cotton was introduced into the Balkan territories during the time of Roman Empire. Later on, historical documents show that in has been grown in Bulgaria in 9th century in the period of First Bulgarian Kingdom. It was imported as a processed or semi-processed material, or as seeds from Asia Minor, Egypt or Cyprus. Cotton has been grown actively over Bulgarian-Macedonian territories during the Ottoman rule on the Balkans. In 18th century the famous Uzundzhovo Trade Fair played a key role in distribution of cotton seeds (Cotton in Bulgaria, 1983). The Fair was

founded by Sinan Pasha in 1593 who donated 30000 Turkish Grosz for a caravan-saray, a mosque, a hospice and a bath to be built in the village of Uzundzhovo and ordered a 40-day market fair to take place yearly. The village of Uzundzhovo is situated near the Bulgarian-Turkish border (haskovo-online.com) (Fig. 1). Later on, in 19th century the Anatolian variety *G. herbaceum* was replaced by the American one – Upland type *G hirsutum*, introduced from Istanbul. In 1836 the new American varieties were sawn on an area of 800 ha and cotton production started slowly developing. It prospered from the beginning of 20th century.

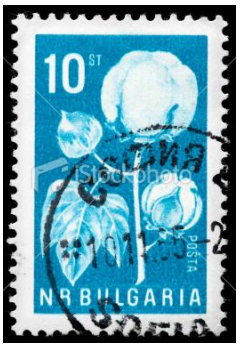


Figure 2. A Bulgarian post stamp with an image of a cotton plant

During World War II (1941-1945) around 23000 ha were sawn and 2180 kg fiber yield was obtained yearly. The greatest progress of cotton production in Bulgaria occurred in the '50-ies of 20th century, when 143000 ha were sawn and 66700 t unginned cotton was obtained per year (Fig. 2). Since then cotton areas in North Bulgaria were liquidated and till 1980 gradually reduced to 16000 ha and 5370 t fiber yield (Cotton in Bulgaria, 1983). After 1980, cotton import expanded - mostly from Central Asia. Since 1990, cotton manufacturing in Bulgaria strongly fell off and the sawn area was reduced. A 55% drop of cotton acreage was reported since 2005 (Sekliziotis, 2009). In 2008 only 700 ha were sawn and the raw cotton obtained was around 750 t. In 2011 952 ha were sawn, but 414 ha was harvested in Southern Bulgaria. The technology is mainly rain-fed. The average yield of raw cotton is 990 kg/ha (Agrostatistics, 2012).

Cotton was intensively grown in Macedonia in the period of World War II and a long time after. An area of 16419 ha was sawn in 1948, which is 3 times more compared to 1939, with production of 6200 t raw cotton. In the late '60-ies and early '70-ies of 20th century, the area under cotton occupied almost 10000 ha from which the raw cotton production was 7700 t. Average yield has increased from 380 to 1000 kg/ha of raw cotton i.e. from 75 to 237 kg/ha pure fiber. In the region of Strumica and Gevgelija (south part of the country) a yield of 260 kg/ha has been registered. In 1959 in Agricultural cooperative in Bogdanci applying measure of planting of cotton plants, 460 kg/ha raw cotton has been achieved (Gjorgevski, 1964). From period after '70-ies areas under cotton rapidly start to decrease. This industrial crop was last recorded in a public register in 1997, when only 6 ha were planted. After a break of 15 years, the crop was planted again this year (2012) on area of 15 ha in the region of Stip, with a tendency of around 50 ha to be sawn in 2013.

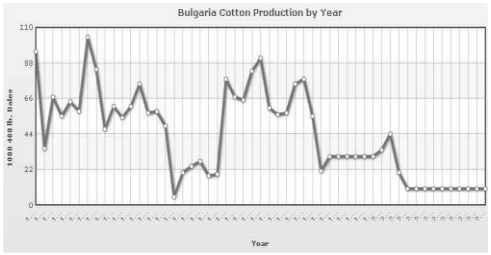
The history of cotton production - harvested area, export, yield, and domestic consumption of cotton in Bulgaria and Macedonia has been reviewed by the US Department of Agriculture. All the indices have decreasing tendencies through the years – from 1962 to 2012 for Bulgaria and from 1992 to 2012 for Macedonia. The flourishing period of Bulgarian cotton production is 1982-1994, when the indices' values are at the maximum. Later on, the total area under cotton decreases due to low farm-gate prices and highly competitive imports of long-fiber cotton. The average yield fluctuates widely through the years as irrigation for the biggest part of the sawn area is missing (Index Mundi) (Figs 3 and 4).

According to the 'Agro-statistics' of Bulgarian Ministry of Agriculture and Forestry, the area under cotton in 2001 is 14700 ha; in 2002 - 6300 ha, and in 2003 - 2000 ha only. The yields of unginned

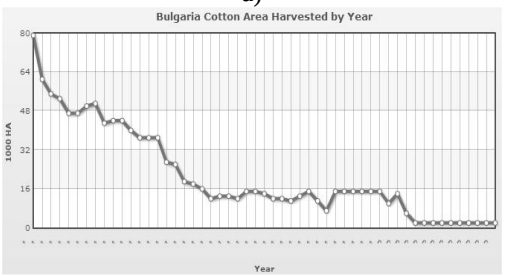
cotton are low - 740 kg/ha in 2000 and 690 kg/ha in 2001. The total output in 2000 is 7000 t, in 2002 - 10000 t but in 2003 - 2000 t only (Agrostatistics, MZH).

The environmental potential for cotton production in Bulgaria includes 60000 ha favorable areas, 30000 ha of them have exclusively favorable soils and climatic conditions for cotton growing. These areas are situated mainly in South and South-Eastern Bulgaria (Thracian Valley and Burgas Lowland) and less in Central North Bulgaria. Most suitable soil and climatic conditions for cotton growing can be found in Haskovo, Stara Zagora, Blagoevgrad and par of Plovdiv regions (Fig. 5). There are suitable conditions also in Burgas, Yambol, Sliven and regions and some parts of Vratsa, Pleven, Veliko Tarnovo, Ruse and Silistra regions (Cotton in Bulgaria, 1983; Nikolov et al., 2001; Saldzhiev et al., 2007). They are equipped with irrigation networks for surface and pressurized irrigation (CONF BG 43/01). The variety Beli Izvor which has great adaptability and high fiber quality has been grown from 1980 to 1999. It was substituted by Chirpan 603 and Chirpan 539. At present, mainly the following Bulgarian varieties are grown: Chirpan 539, Chirpan 603, Avangard 264, Perla 267, Beli Lom, Beli Iskar, and Vega. Chirpan 539 is a standard for early ripening and Avangard 264 – for fiber quality. Avangard 264 has 3 mm longer fiber than Beli Izvor (Stoilova, 2012a).

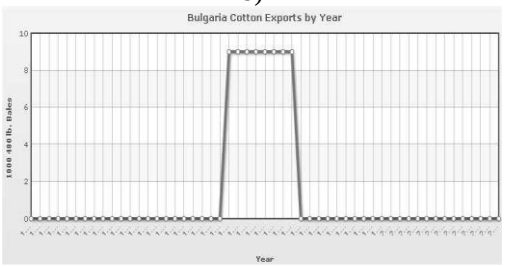
The strongest aspects of the fiber crop production and processing in the country has been that the textile industry was well developed in the past. Unfortunately, Bulgarian potential cotton production was enough to supply only 50% of the capacity of Bulgarian cotton industry. Because of a strongly developed textile industry and comparatively low actual production of cotton fiber in the country, Bulgaria imported about 90% of cotton fiber. In Bulgaria there were 5 enterprises for primary manufacturing of raw cotton which had the potential to early processing of 100000 t. The main ones were “Trakia Cotton” Ltd. - Stara Zagora, and “Textile fibres” Ltd – Haskovo, still functioning. The sector provided yearly permanent employment for 10000 workers and temporary seasonal employment for 3000 workers. An Association of the Cotton Growers and Users for defending the rights of the cotton producers and users has been founded in Bulgaria.



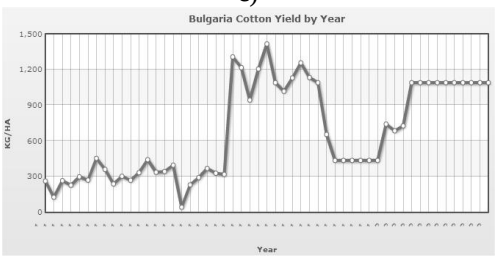
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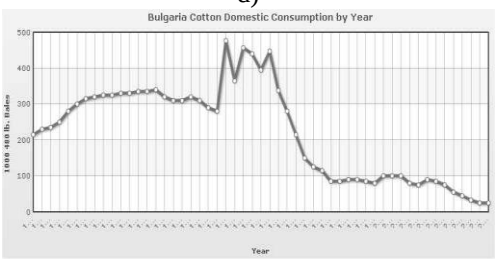
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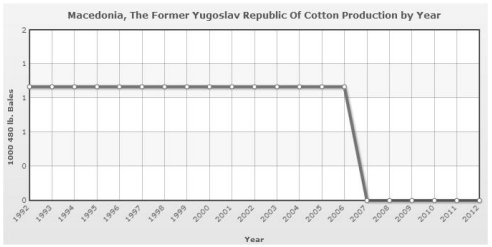


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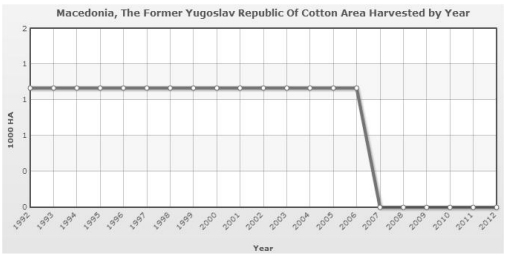


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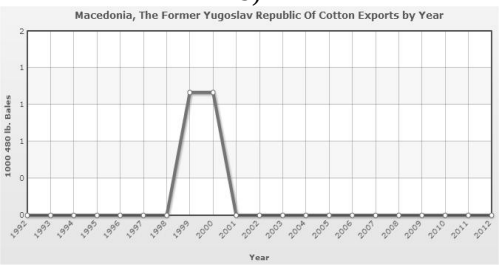
Figure 3. Cotton production (a), cotton area harvested (b), cotton export (c), cotton yield (d), and cotton domestic consumption (e) by year in Bulgaria (Source: Index Mundi)



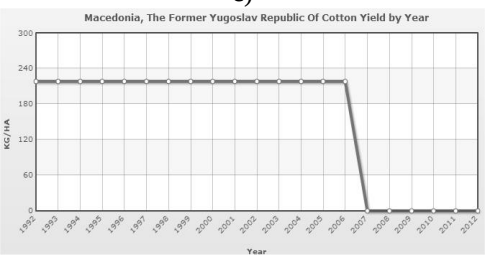
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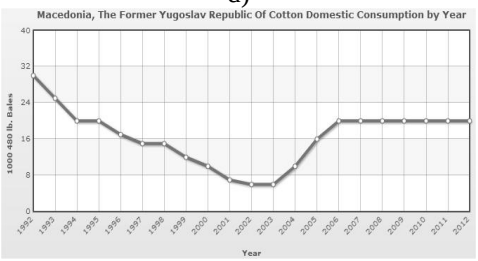
b)



c)



d)



e)

Figure 4. Cotton production (a), cotton area harvested (b) cotton export (c), cotton yield (d), and cotton domestic consumption (e) by year in Macedonia (Source: Index Mundi)

The potential districts, where cotton can be grown in Macedonia, are along the Valley of Vardar River, south-west of the city of Strumica, and around in Stip and Kochani region, where the textile industry is pretty developed. The regions where cotton was cultivated in the past were Strumica, Stip, Bogdanci, Valandovo and Veles and in smaller scale Kumanovo and Skopje (Egumenovski et al., 1998) (Figure 6).



Figure 5. Cotton growing regions in Bulgaria



Figure 6. Cotton growing regions in Macedonia

Benefits of cotton growing in Bulgaria

For many economic reasons, EU subsidies for the agricultural production in Bulgaria are low (Fig. 7).

The initial regime of subsidizing cotton manufacturing by EU was based on a "deficiency payment" to cotton processors who paid a minimum price to the farmers that supplied them with unginned cotton. This regime stimulated cotton sector in EU.

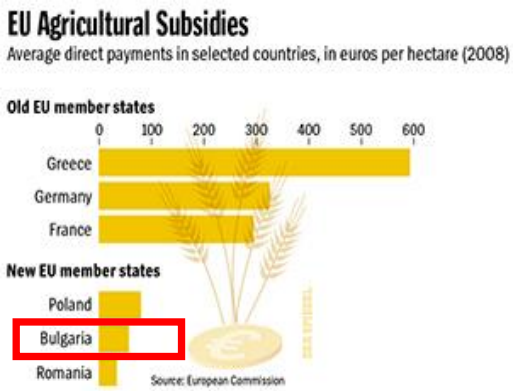


Figure 7. EU Agricultural Subsidies in 2008 (Source: EC)

Common Agricultural Policy of EU (CAP) from 2009 on fixes a quota for Bulgarian sawn area of 3342 ha, basic yield - 120 kg/ha and a subsidy of 671.33 EUR/ton (=804.91 EUR/ha; =2690978 EUR/year) (Regulation (EC) № 73/2009). The tendency of subsidizing cotton production in 2016 is 660 EUR/ha. The state aid in 2012 is a subsidy "*deminimis*", which completes 290 EUR/ha but maximum 7500 EUR for the period 2010-2012 per producer (Instructions…, 2012). The national subsidy in 2014 will be maximum 556523 EUR, and in 2015 – 295687 EUR (Novinar, 2011).

Cotton breeding and the investigations on agro-technologies for cotton production in Bulgaria are done at the Field Crops Institute (former Cotton and Durum Wheat Research Institute), situated in Central South Bulgaria near the town of Chirpan (Fig. 8). The Institute has long traditions, since it has been founded in 1925. Breeding is oriented to early maturing, high productivity and high fiber quality. Individual traditional selection methods are being practiced - intraspecific and interspecific hybridization; experimental mutagenesis; in vitro techniques; study of resistant to biotic and abiotic stress factors; genotype-environment interaction and phenotype stability; creation of ecological cotton forms with naturally colored fiber; early leaf-fall and naked seeds; and keeping, evaluation and use of cotton genetic resources.

The following elements of cotton growing technologies are being improved: crop rotation; fertilization; sowing density; irrigation; development of pest, weed and disease control; growth regulators; low-input technologies; and economic efficiency of production. The Institute offers certificated sawing material of cotton, as well as stock production of cotton (http://www.iptp-chirpan.org/).



Figure 8. The building (left) and Logo (right) of Field Crops Institute, 6200 Chirpan, Bulgaria, http://www.iptp-chirpan.org/

The specific soil and climatic conditions in Bulgaria are good for growing varieties of *Gossypium hirsutum L.* type and, to some extent, of *Gossypium barbadense L.* type. The cotton fibers are 29-33 mm long; have moderate fineness, good strength and good fiber uniformity. The advantage of Bulgarian varieties is their early maturing. The selection is being done in two directions – 1) of early maturing varieties with great genetic potential for yield and 2) of varieties with improved fiber quality. The following breeding methods for early maturing with high genetic potential varieties are used: intraspecific hybridization within *hirsutum* variety and experimental mutagenesis, i.e. local and foreign varieties are crossed (Stoilova, 2012b). Best of them in the country are: Beli Izvor, Garant, Ogosta, also – Chirpan 539 (standard), Chirpan 603, Beli Iskar and Beli Lom. A basic breeding method for the second direction is interspecific hybridization between the chromosome varieties *G. hirsutum L.* and *G. barbadense L.*, as well as *G. hirsutum* and bred lines of *G. hirsutum* L. × *G. barbadense L.* origin. On the basis of this method the following varieties have been obtained: Avangard 264 (standard), Perla 267, Vega (Stoilova, 2012ab). In 2007 and 2008 the varieties Kolorit, Darmi, Natalia and Dorina were certificated. Trakia, Helius, allied to the first breeding direction, were lately certificated too. Kolorit and Darmi are good for mechanized harvesting, and Natalia's fiber is of very high quality. Darmi and Natalia have the best combination of productivity and fiber quality (Stoilova, 2011; Stoilova 2012a). The newest varieties are Rumi and Plovdiv, recognized in 2011 (Stoilova, 2012b). Currently variety Rumi is included (EU

Catalogue…, 2011) Six varieties more, given in Table 1, are pretending to be in the EU Catalogue (CONF BG 43/01).

Table 1. Bulgarian cotton varieties presently pretending to be in the EU Catalogue (Nikolov et al. 2001; Saldzhiev et al., 2007; Stoilova, 2012a)

Variety	Vegetation Period, days	1000-seed Weight, g	Ball Weight, g	Fiber length, mm	Yield (pure fiber), kg/ha	Lint percentage, %
Beli Izvor	115-120	110-112	5,7	29-31	330	35-36
Ogosta	110-117	110-116	5,1-5,4	28-30	NA	36-37
Chirpan 539	109-116	105-112	5,2-5,8	29-31	170-250	37
Chirpan 603	110-117	110-115	5,3-5,8	29-32	NA	37-38
Avangard 264	115-122	105-112	5,0-5,7	31-34	170-240	34
Perla-267	115-120	NA	NA	31-34	170	35-37

A new variety “Isabell” with light brown fibers has been recognized in 2010. Its quality is equal to the foreign ones of USA, Turkey and Brazil. “Isabell” has high productivity, early ripening, and suitability for mechanized harvesting. Its fiber is short, moderately fine, with good elasticity and strength, but as a whole is of lower quality compared to the commercial varieties (Fig. 9). Bulgarian breeders have also obtained varieties of dark brown and green color (Stoilova 2012ab).



Figure 9. Yarn from Bulgarian colored cotton

Strong dependence of yield and fiber length on July-August rainfall totals (mostly from 11th July to 10th/20th August) and on July-August air temperature (especially 21st Jul to 10th August) has been established hence one of the goals of cotton breeding in Bulgaria is genesis of drought resistant and high temperature tolerable varieties (Stoilova 2012a).

The most popular varieties of *Gossypium hirsitum* grown during the intensively cotton growing period in Macedonia were: No 3279, No 996, No 4521, Makedonija and Strumica 105. The first three varieties are Bulgarian (Cotton in Bulgaria, 1983), while the last two are domestic varieties, created by the former Cotton Institute in Strumica (Gjorgevski, 1964; Spasova, Dimov, 2003).

Despite of the objection of the public, GMO Act/1.06.2005 in Bulgaria allowed cotton GMO varieties to be grown in the country with a buffer zone of 400 m. GMO cotton is still not grown in Bulgaria, because there is no approbation from EU (GMO Act, 2005).

Irrigation and fertilization of cotton

The practice of irrigation is definitely necessary in Bulgarian and Macedonian conditions. Potential evapotranspiration (ETP) of cotton in Bulgaria, estimated in lysimeters is 550 mm, while the maximum one (ETM) in water unlimited field conditions varies from 380 to 430 mm, dependent on the occurrence of the meteorological factors (Nikolov, 1980; Nikolov et al., 2001). A small part of it - 5% is established in the initial stage, 11% - in the vegetative stage, 24% - in the podding-flowering

stage and the rest 60% - in flowering-maturing stage. Daily evapotranspiration varies from 1.1-1.6 mm/d at the initial stage to 3.7-4.8 mm/d at flowering. For a short time, maximum daily evapotranspiration can reach 6.0 -6.5 mm/d (Nikolov et al., 2001) (Fig. 10). Autumn-winter soil moisture usually shares 41-42% of ETM, rainfalls – 34-35%, but irrigation – 23-25%. Cotton consumes irrigational water mainly during flowering (40-42% of the total ETM). Irrigational water is mainly needed in the period from podding to ball formation. Generally, irrigation must be cancelled on 5th August (Bozhinov et al., 1988; Bozhinov et al., 1995; Nikolov et al., 2001). ETM is best managed at a refill point of 70% of field capacity (FC) in the to 50 cm soil layer. Thus, in a medium dry year, 3 irrigation applications are given.

Water saving irrigation scheduling can be managed by one application before flowering. The application depth depends on the maximum allowed water depletion in soil and is 40, 60 or 80 mm. Thus 57% irrigational water is saved; the yield increase vs. rain-fed yield is 42-44%; the relative yield is 69-72% of the maximum yield at full irrigation; and water use efficiency (WUE) is 1 kg/m^2. This irrigation scheduling ensures on-time ripening. When optimal irrigation scheduling is applied, the yield obtained is 220-300 kg/ha raw cotton vs. 120-130 kg/ha under rain-fed conditions (Bozhinov et al., 1995).

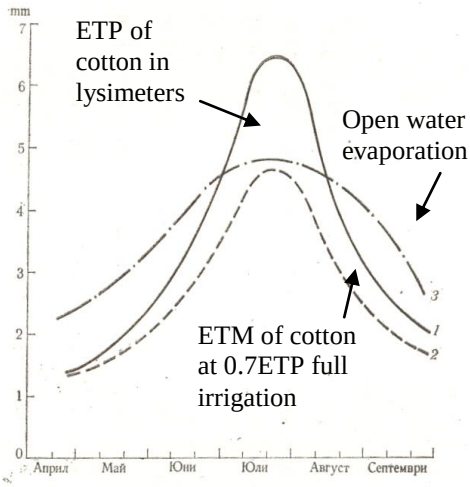


Figure 10. Daily evapotranspiration of cotton (Nikolov, G., 1980)

Cotton in Bulgaria can be irrigated by sprinkling or gravitationally, or by drip irrigation. If surface irrigation is applied, it is recommended the every-other-furrow technique (Nikolov et al., 2001). Sprinkling vs. surface irrigation ensures 11-22% higher yields (September yield). Reel rain traveler and side-roll wheel line can be used. For small areas medium and low pressure sprinklers are recommended. Surface irrigation is not quite recommended, because the soils, on which cotton is grown, make cracks at the moisture level of 85% of FC. Further, long furrows are risky for over-moisturizing. It is difficult to dosage the water and often the irrigational water is 1.5-2.0 times greater than crop needs. WUE at surface irrigation is very low. For uniform distribution of water it is good to use flexible plastic pipes, equipped with irrigation siphons and irrigation narrow pipes. Drip irrigation contributes for 9-13% yield increase and 9-20% increase in WUE (Technology for cotton production, 1997; Nikolov et al., 2001).

Depending on soil nutrient supply, fertilization of cotton under rain-fed conditions is recommended as 100-120 kg N/ha, 80-100 kg P_2O_5/ha and 60-70 kg K_2O/ha. When irrigated, the fertilizer efficiency is higher hence the quantities are smaller – 140-160 kg N/ha, partially given before sowing and during the stage of flowering-ball formation. Manure fertilization with around 10000 kg/ha has proved to be efficient (Technology for cotton production, 1997).

New cultivation practices are being developed. Wide inter-row spacing 80 cm instead of the traditional 60 cm is being introduced. When combining 80-cm inter-row spacing with plant density of 180000 plants/ha, the yield is 15% higher. Cotton crop rotation, soil tillage systems, physical and

chemical properties of soil are in the focus of cotton-growing science, as well as the fertilizing practices and their impact on soil fertility. Science pays attention to overcoming weeds, cotton diseases and pests (Stoilova, 2012).

According to the Macedonian literature (Iljovski, Cukaliev, 1994), the total water consumption during the vegetation is as follows: from initial to podding stage 8-10%; from podding to flowering stage 18-20%; from flowering to beginning of the ripening stage 50-60%; and in the ripening stage 14-20%. The total irrigational amount for the vegetation period and the number of applications depend on the meteorological peculiarities of the year. In a medium dry year, the irrigation application number vary from 5 to 6, with a total irrigation amount for the vegetation period - from 3000 to 3500 m^3/ha. In a medium year, only 2-3 applications with 600 m^3/ha per application are enough for proper crop production. The yield of raw cotton can be 250-300 kg/ha when optimal irrigation scheduling is applied. The most applied techniques for irrigation in cotton crop production are furrow and sprinkler irrigation. In last two decades, the drip irrigation technique is usually used in cotton crop production in the world. According to the results for better efficient use of water and fertilizers, as well as quality and higher yield production (Janat et al., 2002); the drip fertigation is recommended in further cotton production in both countries.

Lastly, cotton has an age-old tradition over Balkan lands. It follows the cultural traditions of the people inhabiting these lands. It has always been important for the livelihood of the population. Nowadays cotton breeding and agrotechnologies note original achievements and useful practical results. The most important of them is creating early maturing varieties, also varieties with longer and of highest quality fiber and ecological varieties with natural coloration. The scientific collaboration between Bulgaria and Macedonia in study of cotton is a good basis for further developing of its production in the region, for meeting the people needs in cotton textiles, for reviving and prosperity of the textile industry of the two countries, for taking the rightful place in cotton production in Europe and in the world.

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ПРОИЗВОДСТВОТО НА ПАМУК ВО БУГАРИЈА И МАКЕДОНИЈА НИЗ ГОДИНИТЕ

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Апстракт

Бугарија и Македонија се наоѓаат во северниот дел на поволниот климатски појас за одгледување на памук. Памукот беше воведен во Бугаријс и Македонија уште за време на римската империја, беше одгледуван и во текот на средниот век и за време на османлиското владеење на Балканот. Американската сорта памук, тип Gossypium hirsutum L., започнува да се шири во текот на 19 век. Од страна на американското Министерство за земјоделство е претставен историски преглед за последните 50 години од производството на памук, и се регистрирани ожнеаните површини, извозот, приносот и домашната потрошувачка во Бугарија и Македонија. Прекин на производството на памук во Македонија е забележано 2006-2012. Бугарското производство расте со сорти од типот Gossypium hirsutum L. и крстоските на Gossypium hirsutum L. × Gossypium barbadense L, додека македонските се само од типот Gossypium hirsutum L.. Предноста на овие сорти е нивното рано зреење. Одгледувањето памук во Бугарија е од страна на Институтот за поледелски култури во близина на градот Чирпан. Во моментов една сорта е регистрирана во Каталогот на ЕУ - Rumi, а шест варијанти претендираат исто така да бидат на листата: Beli Izvor, Ogosta, Chirpan 539, Chirpan 603, Avangard 264, и Perla 267. Сортата "ISABELL" , со кафеаво влакно е призната неодамна. За бугарските услови на одгледување во умерено-континентална и континентално-медитеранска клима, потребно е наводнување во суви и средно сушни години со апликација од 400-600 m^3/ha. Памукот го зголемува приносот како одговор на наводнувањето за околу 40-60%. Се препорачува специфичен распоред за наводнување за заштеда на вода - само една апликација пред цветање. За правилно производство на памук во македонски услови на одгледување во преодна-медитеранска клима, бројот на наводнувања во средно сува година варира од 5 до 6, со вкупен износ на наводнување за периодот на вегетација 3000-3500 m^3/ha, додека во средно сушна година доволни се само 2-3 апликации од по 600 m^3/ha. Како ефикасно се покажа ѓубрењето со арско ѓубре во количество од 10 т/ха. Се развиваат нови практики на одгледување, со зголемување на приносот од 15% - при 80 цм внатредово растојание, наместо традиционалните 60 см. и склоп од 180.000 растенија по хектар. Заедничката земјоделска политика (CAP), почнувајќи од 2014 година, за Бугарија ќе овозможи квота за посеана површина од 3340 ха и субвенции од 2.690.000 евра годишно.

Клучни зборови: памук, ожнеана површина, принос, субвенции, земјоделски практики.

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EFFECT OF BIOPRODUCTS ON DURUM WHEAT (TRITICUM DURUM *DESF.)* UNDER CONDITIONS OF ORGANIC FARMING IN SOUTHERN BULGARIA

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Abstract
The purpose of this investigation was to establish the efficiency of the bioproducts Biohumax and Humustim on the development, yield and quality on the Bulgarian durum wheat cultivar Progress, grown organically at the certificated field of the Field Crops Institute, Chirpan, Bulgaria on soil type of Eutric Vertisols in the period 2008-2010. The influence of bioproducts in dozes of 1 and 1.5 $l.ha^{-1}$ was tested as spring foliar application. The grain yield, test weight (kg), 1000 kernel weight (g), glassiness (%), crude protein and gluten (%) and grain N, P, K concentrations were determined on harvested grain. The results showed that the bioproducts affected the durum wheat growth, productivity and grain quality. The grain yield surpassed the unfertilized with 8.6-14.1 % and reached 3.43 $t.ha^{-1}$ at double spring foliar feeding in rate 1.5 $l.ha^{-1}$. No significant differences in the efficiency of the two products were seen and their action was one-sided. The grain yield was mostly influenced to the highest extent by the yearly conditions and by the applied rates, while the fertilizer type made an insignificant influence. The plant height increased with 11.5 to 18.5 %, content of protein – with 2.4-4.7 %, wet gluten – to 1.2 %. The experiment demonstrated that organic farming can produce high quality grain of durum wheat.
Keywords: organic farming, durum wheat, biofertilizers.

Introduction

Obtaining ecologically clean plant products intended for food for people and preserving the environment are connected to using organic based products. Limiting the negative influence of chemical fertilizers and eliminating their consequences is important for modern agriculture.

Organic agriculture is an integrated system of management and production of food and other products, which includes a combination of good agricultural practices, high level of biodiversity, preservation of natural resources and use of natural substances (Diver, 2001; Manojlovic et al., 2010). The organic production insists on an exclusive use of organic and microbial fertilizers, while taking special care of mutual interactions between soil, plants, animals and humans (Manojlovic et al., 2010; Oxouzi and Papanagiotou, 2010).

The initiation and development of biological farming in Bulgaria is part of the European strategy for ecological integration and sustainable development within the frame of the Common Agricultural Policy whose reforms encourage the market orientation in the production of biological products.

The organic farming is an optimal choice for the future development of the farming sector as it preserves the natural resources and the environment, meets the needs of the increasing number of consumers and uses safe methods of production. The organic products market is sustainable, constantly increasing, efficient and has good prospects. The expansion of the EU creates a large home market in regard to the purchasing power, which opens broad range of opportunities before the organic farming.

The conventional farming varieties are not always suitable for organic growing, because they are bred for high yield and quality at growing on high soil fertility, with high doses of synthetic fertilizers and pesticides. Maintaining the biodiversity is an important principle in organic farming, and in this regard steps should be taken for the farmers who are to be provided with a number of varieties, including in local companies adapted for growing at organic farms.

The farmers occupied with organic farming don't have the necessary qualification in the area of seed production and at this stage they are not capable of managing by themselves the growing of biological seeds, and even less with a targeted breeding.

So far there is no research related to selection of varieties suitable for biological growing and development of production technologies for organic seeds from field crops. The production of organic seeds is more difficult as compared to conventional farming seed production. The problems depend on the specific plant, but they can be summed up to the following: growing healthy vital seed; reaching the seed quality standards, defined for the conventional seed production – disease, pest and weed control with no use of pesticides and a special attention should be paid to the seed-transmitted diseases; big production expenses. At this stage of conventional farming cereal crops are the main crop rotation unit, produced by the Bulgarian farmers. Its growing in organic farming, especially in rural areas with available work hands would contribute to stimulating the production for gaining additional income for the population. where the durum wheat is the main crop and the grain is used to make flour and pasta as food for the people.

The conventional and low-input farming practices (effect of organic and mineral fertilizers, manure and crop rotation) were studied at the Field Crops Institute - Chirpan to document changes in soil fertility properties, nutrient storage and productivity of durum wheat. Two farming systems which differed in crop rotation and the use of external inputs were established on land that had been previously conventionally managed.

The low-input system was managed using a long-term manure and cover crops. The application of 30 $t.ha^{-1}$ manure lead to better results toward fertilization with $N_{60}P_{48}$ and was equal to N_{120}. Inputs of C, P, K, Ca, and Mg were higher in the organic and low-input systems as a result of manure applications and crop incorporations. After 4 yr of production, soils in the organic and low-input systems had higher soil organic C, soluble P, exchangeable K. Organic and low-input farming systems indicated small but important increases in soil organic C and larger pools of stored nutrients which are critical for long-term fertility maintenance. The reduction of the negative effect of chemical fertilizers on the soil properties or eliminating their consequences is an issue of pressing interest for the modern agriculture; it is related to protecting the environment by obtaining ecologically clean plant products.

Some consumers purchase organic food because they perceive the products to have superior quality attributes over conventional foods (Yiridoe et all., 2005). Despite perceived benefits of consuming organic foods, organic certification is based on the process used to produce the good, not on the product itself. This suggests that organic products may not be superior to conventional ones (Brandt

and Molgaard, 2007). Research into nutritional differences of organic and conventional products has not yielded consistent results (Bourn and Prescott, 2002). Soil, climate, crop type and cultivar, management practices and post-harvest factors can all affect the nutritional quality of crops.

In the last years the biological and ecological production of plant products has been one of the fastest developing branches in Europe. According to data of the International federation of organic agriculture the annual increase in a large number of European countries has been 20-25 %.

Recently further attention has been paid to the foliar corrective nutrition. The use of foliar fertilizers creates an opportunity to increase the effect of fertilization, to reduce the environment pollution by reducing the fertilizer type and norms and their use to the best advantage. It provides better efficiency of the applied products as the nutrient and biologically active substances are fully absorbed by the plants without the soil mediation where secondary processes of nutrient immobilization might occur or it might be washed out of the root development soil layer. The foliar fertilizers may help overcome quicker the plants' functional diseases when a certain nutrient is missing. Foliar fertilizer treatment was applied during the cultures' vegetation, doses were applied in accordance with the plant needs in the particular stage.

Subject of research for different cultures are the humat formulations created in the last years such as extracts of organic sludge, coal, peat, kinds of manure, as well as products from red Californian worm. The results published in the last years show that they have a stimulating effect on the development and productivity of a number of cultures (Delfine et al., 2005, Gramatikov, 2005; Gramatikov and Koteva, 2004; Nankova et al., 2004; Nenov et al., 2004; Sengalevich et al., 2004).

Our objectives were to determine the efficiency of the bioproducts Humustim and Biohumax on the development, yield and quality of the Bulgarian durum wheat (*Triticum durum Desf*.) cultivar Progress, grown organically on Eutric Vertisols at the certificated field of the Field Crops Institute, Chirpan, Bulgaria.

Material and methods

The investigation was carried out in the period 2008-2010 on the certificated bio-field of the Field Crops Institute, Chirpan, situated in a major durum wheat-growing region of Bulgaria. The durum wheat cultivar Progress was grown under non-irrigated conditions after cotton. Randomized block design with four replications was used. The net plot size of individual trial plots was 10 m^2.

The bio-fertilizers were applied two times as foliar feeding at the beginning of the spring vegetation (tillering) and at early boot stage in dozes 1 and 1.5 l/ha with 300 l water/ha. The results were compared with untreated (water control).

The bioproducts "Biohumax" and "Humustim" (potassium humate), according to information by the producers, is ecologically clean, highly concentrated humic natural product, which contains a number of humic acids and fulvoacids, vitamins, phytohormones, microelements, enzymes and others, which are quickly and directly included in the metabolism and stimulates the cultures' growth, development and productivity as well as the micro organisms' development.

The durum wheat was cultivated after a technology approved for the region of Central South Bulgaria. (Yanev et al., 2005), but without application of synthetic fertilizers and pesticides. The seeds were sown on October 25-30. The sowing rate was about 500 germinated seeds per m^2. The harvest with plot combine was carried out in the period July10-15.

The grain yield (kg/ha), test weight (kg/hl), 1000 kernel weight (g), virtuousness (%), crude protein and gluten (%) were determined on the harvested grain. The test weight was determined by

hectoliter, 1000 kernel weight – by weighing two samples of 500 kernels, total virtuousness – by cutting with pharinotom of Heinsdorf, the content of crude protein - by Kjeldahl standard method and derived according to: Protein, % = N (% DM).5.83. N, P, K concentration (%) in plants was analyzed in phases of development.

The data was statistically analysed according to the method of variance analysis (ANOVA) and LSD test for evaluation of significant differences.

Agrochemical characteristic of the Eutric Vertisols at Biofield was made by conventional methods for determination of mineral nitrogen (by Kjeldahl), available P_2O_5 and K_2O (acetate-lactate method).

Table 1. Meteorological conditions during vegetation period of durum wheat 2008-2010

Period	Temperature sum, ^oC			Rainfall, mm/m^2		
	X-II	III-VI	X-VI	X-II	III-VI	X-VI
2008	734	1744	2478	322	210	532
2009	1011	1783	2794	137	95	232
2010	879	1734	2613	311	206	517
1928-2008	705	1670	2375	238	203	442

In regard with the meteorological conditions the studied years were characterized by higher temperatures in the autumn-winter period, unevenly distributed precipitation and they were not particularly favorable to the optimal growth, development and productivity of the durum wheat (Table 1). Temperature sums total for the vegetation period of durum wheat (X-VI) in 2008, 2009 and 2010 exceeded the average amount (2375°C) with 103, 419 and 238°C, respectively. With respect to rainfall for the vegetation period in 2008 and 2010 the amount of rainfall was respectively 90 and 75 mm/m^2 more, and in 2009 with 210 mm/m^2 less than average (442 mm/m^2).

Results and discussion

The soil in the field of organic farming was Eutric Vertisols (FAO). It was clay, with high humidity capacity and small water-permeability, defined by the sand-clay composition. The test field was with bulk weight of the plough soil layer - 1.2 g/m^3 and specific gravity - 2.45. The sorbcium capacity was 35-50 mequ/100 g soil.

As the focus is on organic soil, it is very important to maintain and increase soil fertility. The analysis results before the experiments in the 0-60 cm soil layer indicated slightly acid to neutral soil reaction (Table 2). The values of $pH_{(KCl)}$ were within the favourable scope for growing cereal crops. In the 0-20 cm layer the soil had slightly acid reaction, and in the deeper soil layers (20-60 cm) the acidity decreased and the values ranged within 5.8-6.5. Acorging to the total humus content (1.54-2.40 %) the soil had from low to middle supply of organic matter. The content of mineral nitrogen as a sum of NH_4-N + NO_3-N varied significantly, it changed dynamically under the influence of the meteorological conditions and the grown crops had low values, reaching a maximum of 25 mg/kg soil. As for the available phosphates supply, it was established that in the 0-60 cm soil layer the phosphates supply was low - 0.3-3.2 mg/100 g soil. The phosphates regime was unfavourable for the durum wheat development. The leached smolnitzha in the field was well

provided with available potassium. Its content ranged within 15-38.0 mg/100 g soil with its highest values being for the plough layer.

The combination of temperature and rainfall was the main regulatory factor for the phonological development of durum wheat plants (Table 3). During the period of research an insignificant delay was observed in the culture development – the tillering occurred in February, the stem elongation – at the beginning of April. Temperatures below -14°C in February 2010 caused partial freezing of the crops and lower grain yield.

The highest temperatures and draught in May 2010 hindered the obtaining of record yield.

The abundant rainfall in June 2008 led to lodging of the durum wheat and deteriorated the grain appearance. Year 2010 was favorable for the durum wheat development and obtaining a good yield, but it was very unfavorable to the grain quality due to the July rainfalls (114.4 mm/m^2). Overall durum wheat riping was reported in the period July 5-13.

There were no pathogens and pests above the threshold of harm during the durum wheat vegetation period in the three years of cultivation.

Table 2. Agrochemical properties of the Eutric Vertisols, 0-60 cm

Depth, cm	pH $_{(KCl)}$	Humus, %	Mineral N (NH_4+NO_3), mg/kg soil	Available forms, mg/100 g	
				P_20_5	K_20
0 -10	5.5 - 5.8	2.05 - 2.20	15 - 18	0.3 - 0.5	32-38
10-20	5.5 - 5.8	2.10 - 2.40	20 - 25	0.5 - 1.4	25-35
20-40	5.8 - 6.5	1.95 - 2.25	23 - 25	2.5 - 3.0	19-28
40-60	6.0 - 6.5	1.54 - 1.70	20 - 22	2.0 - 3.2	15-26
Average	5.5 - 6.5	1.54 - 2.40	15 - 25	0.5 - 3.2	15-38

Table 3. Phenological stages in durum wheat development, 2008-2010

Stage	2008	2009	2010
Emergence	10. XI	15. XII	25. X
Tillering	25. XII	25. II	10. II
Stem elongation	01. IV	03. IV	22. IV
Ear emergence	15. V	18. V	12. V
Flowering	22. V	28. V	24. V
Maturity	10. VII	05. VII	13. VII

Acording to the results the bioproducts Humustim and Biohumax affected the durum wheat growth and productivity. Foliar treatment with Humustim at doses 1 и 1.5 l.ha^{-1} increased the productiviy by 9.1 and 13.7 % respectively, and at the same doses of Biohumax - by 8.6 and 14.1 % (Table 4). The grain yield reached 3.43 t.ha^{-1} at twofold spring feeding with Biohumax in rate 1.5 l.ha^{-1}.

The net profit increased to a higher degree at 1.5 l.ha^{-1} biofertilizer – 82.0-85.2 lv/ha. Twofold spring foliar feeding in rate 1.5 l.ha^{-1} was an effective activity. No significant differences in the efficiency of the two products were seen and their action was one-sided. The data showed that the grain yield was influenced to the highest extent by the yearly conditions and by the applied rates (LSD = 0.001), while the fertilizer type had an insignificant influence.

Table 4. Grain yield of durum wheat cultivar Progress and effect of bio-fertilizers, 2008-2010, kg.ha^{-1}

Variant	Grain yield					Net profit, lv/ha
	2008	2009	2010	Average		
				kg.ha^{-1}	%	
Water check	2870	3452	2698	3007	100.0	-
Humustim - 1 l.ha^{-1}	3098	3696	3046	3280	109.1	54.2
Humustim - 1.5 l.ha^{-1}	3187	3942	3127	3419	113.7	82.0
Biohumax - 1 l.ha^{-1}	3126	3689	2985	3266	108.6	50.8
Biohumax - 1.5 l.ha^{-1}	3223	3870	3202	3432	114.1	85.2
LSD 0.05	285	347	296	324	7.75	
LSD 0.01	312	397	362	340	13.07	
LSD 0.001	348	468	509	358	19.06	

Delchev (2000) also reported that the foliar feeding increased yield and it was the highest at complex foliar fertilizers treatment during stem elongation stage. The foliar treatments during ear emergence and milk development stages had a weak effect on the yield, but increased grain quality (Delchev, 2000).

The results showed that decisive influence for increasing the grain yield had higher levels of structural elements. The spike length, number of spikelets in spike, number of kernels, formed in a spike and the weight of kernel in spike increased to a greater extent at a higher doze biofertilizers (Table 5). A tendency was seen for Biohumax to be more effective than Humustim. The structural analysis of the yield showed that the foliar feeding additionally stimulated the formation and growth of the durum wheat grain.

The application of foliar fertilizers stimulated the durum wheat growth processes. The height of the plants at the end of vegetation increased by 11.5 to 18.5 % over the water control (78.2 cm) and reached higher values (90.4-92.7 cm) under tested doses 1.5 l.ha^{-1}. In 2010 the plants was characterized by better height in maturity – average 90.3 cm, while in 2008 the average height was 82.5 cm. (Figure 1).

Table 5. Structural elements of durum wheat yield, average for 2008-2010

Variant	Length of the spike, cm	Number of spikelets in spike	Number of kernel in a spike	Weight of kernel in spike, g
Check	5.5	16.1	25.6	1.4
Humustim - 1 l.ha^{-1}	5.6	16.8	28.4	1.5
Humustim - 1.5 l.ha^{-1}	5.8	18.1	29.0	1.6
Biohumax - 1 l.ha^{-1}	5.7	17.1	28.9	1.5
Biohumax - 1.5 l.ha^{-1}	5.8	18.9	29.5	1.5

The test weight is an indirect classification parameter, normally in direct correlation with flour output**,** criterion for the health state of durum wheat. It is desirable that the test weight is over 78 kg.hl^{-1}. In western Canada, grain samples of top grade (No. 1) Canada Western Amber Durum wheat must contain at least 80 % hard vitreous kernels and have a test weight of 80 kg.hl^{-1} or higher

(May et al., 2008). From the physical properties in organic conditions the test weight meant that the 3-year period was good – from 78.2 to 80.3 kg.hl^{-1} (Table 6). The test weight values were lower in 2008 and 2010 (78.2-79.1 kg). They were characterized by high moisture supply, while in 2009 under the influence of the favourable combination of temperature and precipitation the values were higher – 79.4-80.3 kg. There were no significant differences established in regards with test weight of grain under foliar application.

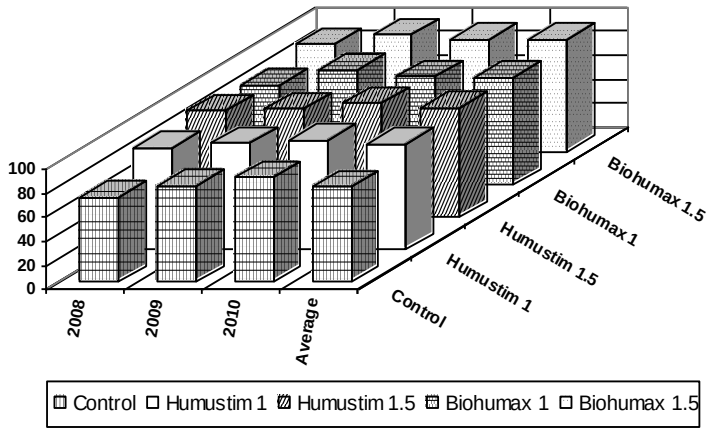


Figure 1. Influence of bio-fertilizers on the height of durum wheat plants in maturity, 2008-2010

Table 6. Influence of bio-fertilizers on the test weight of durum wheat grain, 2008-2010, kg.hl^{-1}

Treatment	Year			Average	
	2008	2009	2010	kg.hl^{-1}	%
Water check	79.1	79.8	78.2	79.0	100.0
Humustim -1 l.ha^{-1}	79.0	80.2	78.6	79.3	100.3
Humustim-1.5 l.ha^{-1}	79.1	80.3	79.1	79.5	100.6
Biohumax -1 l.ha^{-1}	79.1	79.7	78.5	79.1	100.1
Biohumax-1.5 l.ha^{-1}	79.2	79.4	78.3	79.0	100.0
Average	79.1	79.9	78.5	79.2	-
LSD 0.05	0.84	0.97	1.07	0.92	

Average for the period, the 1000 kernel weight value was high - 51 to 63 g (Table 7). The values were highest in 2009 – 61 to 63.4 g. The meteorological conditions strongly influenced the 1000 kernel weight. Without fertilization the grain was formed in average weight of 56.2 g. The double foliar fertilization with Humustim in dose 1.5 l/h increased the 1000 kernel weight the most. The total vitreousness in organic production meant that the period was low - 53.7%, varying from 44.2 to 58.6%. An exceptionally low vitreousness was formed in 2010 – average of 48.5 % (44.2-54.0 %), when during the maturity stage the weather conditions were mainly dry, with temperatures higher than average. Positive changes were found in all the years in the period, regardless whether they are wet or dry. The bio-fertilization with 1.0 and 1.5 l.ha^{-1} increased the vitreousness respectively with 5.1-6.2 and 11.1-13.4% compared to the unfertilized. The protein and gluten

content are important indexes for the grain quality intended for pasta products. The genetic potential of the Progress varieties is good, enough for the Bulgarian and international standarts. Average for the period the protein content, wet and dry gluten for the grain of check were respectively 12.6 %, 25.4% and 9.6 % (Table 8). There has been a trend towards lower protein content in cereal grains produced organically. The fertilization with liquid bio-fertilizers was an additional factor for stabilizing the technological properties of durum wheat grain. The content of crude protein increased with 7.7-11.2% at biofertilization, the wet gluten – to 5.9 %, and dry gluten – from 6.2 to 9.4 % over the check.

Table 7. Influence of bio-fertilizers on the 1000 kernel weight and vitreousness of durum wheat grain, 2008-2010

Variant	1000 kernel weight, g					Vitreousness, %				
	2008	2009	2010	Average		2008	2009	2010	Average	
				g	%				%	to C
Water check - C	56	61	51	56.2	100.0	53.2	53.0	44.2	50.1	100.0
Humustim -1 l/ha	57	62	52	57.1	101.5	56.2	55.6	46.2	52.7	105.1
Humustim-1.5 l/h	57	63	54	57.8	102.8	57.4	57.2	52.4	55.7	111.1
Biohumax -1 l/ha	56	61	53	56.7	100.9	57.5	56.6	45.5	53.2	106.2
Biohumax-1.5 l/h	57	61	54	57.3	102.0	57.8	58.6	54.0	56.8	113.4
Average	57	62	53	57.0	-	56.4	56.2	48.5	53.7	-
LSD 0.05; 0.01; 0.001 = 1.12; 1.48; 1.90						LSD 0.05; 0.01; 0.001 = 7.1; 9.7; 12.7				

Table 8. Technological properties of durum wheat grain, average for 2008-2010

Treatment	Crude protein		Gluten	
	%	% to check	Wet, %	Dry, %
Water check – C	12.62	100.0	25.4	9.6
Humustim -1 l/ha	13.64	108.1	26.4	10.3
Humustim-1.5 l/h	13.97	110.7	26.9	10.5
Biohumax -1 l/ha	13.59	107.7	26.2	10.2
Biohumax-1.5 l/h	14.04	111.2	26.8	10.5
Average	13.57	-	26.34	10.22
LSD 0.05	1.12	8.87	4.07	1.26
LSD 0.01	1.54	12.20	5.37	1.51
LSD 0.001	2.14	16.96	6.90	1.99

The increase of protein in the grain follows the application of increasing dozes of fertilizers. The application of 1.5 $l.ha^{-1}$ had a better positive effect on the protein and gluten content. As for the extensibility of gluten no differences were established under the influence of year conditions, type of fertilizer and level of fertilization.

The study confirms that fertilization is a factor that is crucial to the nitrogen content of the wheat plants. The average N concentration in the tillering stage was 2.63 %, in the stage of stem elongation – 2.34 %, while in flowering was reduced to 1.56 %, i.e. with the advance of vegetation,

the percentage of N was reduced (Table 9). All levels of the nitrogen content in plants grew at increasing the fertilization.

Table 9. N, P_2O_5 and K_2O concentration in durum wheat plants, 2010

Dose /Stage	$N_0P_0K_0$	1.0 l.ha^{-1}	1.5 l.ha^{-1}	Average %
N, %				
Tillering	2.46	2.64	2.80	2.63
Stem elongation	2.16	2.35	2.52	2.34
Flowering	1.49	1.55	1.64	1.56
P_2O_5, %				
Tillering	0.38	0.40	0.39	0.39
Stem elongation	0.40	0.36	0.38	0.38
Flowering	0.40	0.38	0.36	0.38
K_2O, %				
Tillering	4.35	4.78	5.14	4.76
Stem elongation	3.41	4.21	4.24	3.95
Flowering	2.01	2.26	2.29	2.19

The influence of fertilization was manifested most in the tillering stage. The phosphorus concentration in wheat plants was lower than that of N and K. The P_2O_5 content insignificantly decreased with the development advancing - an average of 0.39 % during the tillering to 0.38% in stem elongation and flowering. Potassium concentration decreased with increasing vegetation – 4.76 % to 2.19 % at tillering to flowering. By increasing the nutrition rate, the K_2O content increased.

Conclusions

The results showed that the bioproducts affected the durum wheat growth, productivity and grain quality. The grain yield surpassed the unfertilized with 8.6-14.1 % and reached 3.43 t.ha^{-1} at twofold spring foliar feeding in rate 1.5 l.ha^{-1}. No significant differences in the efficiency of the two products were seen and their action was one-sided. The grain yield was mostly influenced to the highest extent by the yearly conditions and by the applied rates, while the fertilizer type made an insignificant influence. The plant height increased with 11.5 to 18.5 %, content of protein – with 2.4-4.7 %, wet gluten – to 1.2 %. The experiment demonstrated that organic farming can produce high quality grain of durum wheat. From ecological point of view outcast the synthetic fertilizers, may be successfully applied feeding with organic fertilizers during vegetation of the durum wheat, whereat the productivity increases and the production economical indexes do not get worse.

Aknowledgement

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ЕФЕКТ НА БИОПРОДУКТИ КАЈ ТВРДА ПЧЕНИЦА (TRITICUM DURUM *DESF.*) ВО УСЛОВИ НА ОРГАНСКО ПРОИЗВОДСТВО ВО ЈУЖНА БУГАРИЈА

Галија Панајотова, Виолета Божанова, Светла Костадинова, Нели Валкова

Апстракт

Целта на ова истражување беше да се утврди ефикасноста на биопродуктите Biohumax и Humustim врз развојот, приносот и квалитетот на бугарската сорта тврда пченица Progress, органски одгледувана на сертифицираното поле, при Институтот за поледелски култури, Чирпан, Бугарија, на почвен тип промиена смолница, во периодот 2008-2010 година. Влијанието на биопродуктите во дози од 1 и 1,5 l.ha-^{1} беше тестирано со пролетна фолијарна апликација. При тоа, беа определени: приносот (kg), апсолутната маса (g), стаклавоста на зрното (%), суровите протеини и глутенот (%) и концентрациите на N, P, K кај ожнеаното жито. Резултатите покажаа дека биопродуктите влијаеле на порастот, продуктивноста и квалитетот на житото кај тврдата пченица. Приносот на жито изненади кај неѓубрената варијанта за 8,6-14,1% и достигна 3,43 t.ha-^{1} при двојното пролетно фолијарно ѓубрење со 1,5 l.ha-^{1}. Нема значајни разлики во ефикасноста на овие два производи, и нивното влијание е едностранo. Приносот на жито беше условен главно од влијанието на климатските услови и применетите апликации, додека типот на ѓубриво немаше значајно влијание. Височината на растенијата се зголеми од 11,5% на 18,5%, содржина на протеини со 2,4%-4,7%, влажниот глутен до 1,2%. Експериментот покажа дека органското земјоделство може да даде високо квалитетни зрна тврда пченица.

Клучни зборови: органско земјоделство, тврда пченица, биоѓубрива.

UDC: 633.511-183
Orginal scientific paper

THE EFFECTS OF POTASSIUM AND ZINC APPLICATION TO RATE OF PHOTOSYNTHESIS, FIBER YIELD AND QUALITY ON COTTON

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Abstract
Optimal quantities of mineral nutrients and using balanced macro and micro nutrient to growing crops plays important to improve yields and quality. Potassium and zinc involved in key many metabolic processes and enzyme activities in plants. The efficiency of such type of elements is improved when it is used in combination with other macro and micro elements. In this study was conducted to determine the effects of different potassium and zinc application to fiber yield and quality of Berke cotton varieties in experimental area of Dicle University Faculty of Agriculture in 2010. Photosynthesis rate, number of sympodial branches fiber properties of fiber length, fiber fineness and fiber strength were investigated. According to the results, for all traits studied doses of potassium × zinc application and interaction were significant. Effects of potassium and zinc applications were determined significant to properties of photosynthesis rate, number of sympodial branches, boll number, fiber length, fiber fineness, fiber strength.
Key words: cotton, potassium, zinc, yield, quality.

Introduction

Cotton maintains its place and importance in spite of synthetic fiber as a, raw materials used by the textile industry. Currently, 60% of the raw material used in the weaving technology was provided by cotton. As an industrial crop, cotton has been used by textile industry for its fibers; oil industry feed industry for its seeds. Cotton is also used by a wide range of industry for chemical, oil and artificial textile (Usta, 2003; Lukonge *et al.*, 2005; Zengin 2010).

To increase crop production, together with other measures, balanced and adequate amounts of nutrients are very important.

Supplying optimal quantities of mineral nutrients and using balanced macro- and micronutrient doses to growing crop plants is one way to improve crop yields (Zubillaga *et al.* 2002).

Potassium has a vital role in the plants in terms of plant metabolic, physiological and biochemical functions. Quantity and quality of the product increase as a result of the effect of these functions in plants. Potassium has also important role in terms of plant water relations and turgor pressure which is required for cell expansion, growth of new tissues, photosynthesis, water balance, carbohydrate and sugars needed quantity of transport, and plant metabolic enzymes (Rogalski, 1994; Narang *et al.*, 1997; Sangakkara *et al.* 2000; Coker *et. al.*, 2003).

Among the macro-nutrients, potassium nutrition program is known to be a key element in terms of high-efficiency and high-quality cotton production (Kaçar, 2004).

Potassium is involved in providing the turgor pressure for the fiber cells. During active fiber growth, deficiency of potash (K) resulted in reduction in the turgor pressure of the fiber resulting in less cell elongation and shorter fibers at maturity (Oosterhuis, 1994).

Between trace elements, zinc has an important role in terms of auxin content (growth hormone) that contains the functional parts of enzymes, carbohydrate metabolism, protein synthesis, and stem growth too (Oosterhuis *et al.* 1991; Rajput *et al*., 1995; Kaya *et al.*, 2005; Marschner, 1995).

Zinc is sufficient, although at very low doses, deficiency of this element can lead to significant problems. (Rajput *et al*., 1995; Çakmak, 1994; Kaya *et al*., 2005).

Zinc deficiency appears especially in dry and hot conditions, high level of pH, lime and clay content and lower organic matter and in case of excessive phosphorus application (Cakmak, 1994; Marschner, 1995). Zinc deficiency symptoms include, i.e. small leaves, shortened internodes giving the plant a stunted appearance, reduced boll set and small boll size (Oosterhuis *et al.* 1991). The most obvious view of zinc deficiency in plants is dwarf growth (Oren and Basal, 2006).

This study was carried out to determine the effects of different amount of potassium and zinc applications to the rate of photosynthesis, yield and fiber quality of the cotton plant cultivated in large areas in our country and aimed to help this kind of studies in the future.

Material and methods

The research was carried out at research areas of Faculty of Agriculture at Dicle University in 2010. The experiment was conducted as a randomized complete block design with factorial treatment structure with three replications. Berke cotton variety was used as material. Parcels were composed of rows in 12 m length. Row spacing was 70 x15 cm. Plots were consisted of 4 rows and during harvesting; two out of four rows in the middle were sampled. Fertilizer was applied as 7 kg pure N and 7 kg pure P, and 7 kg pure N with the first irrigation for per decare. Due to its clay content (49-67%), soil enlarges and swells in the winter, and shrinks in the summer with deep cracks. Soil pH was between 7.73-7.86. Hoeing was accomplished 3 times by tractor, 2 times by hand. During the research, irrigations were done 8 times, and the bolls were harvested in two different dates with hand. Soil samples were taken from different points of the field at 0 cm-30 cm depth before planting and analyzed in the Soil Analysis Laboratory of GAP Soil and Water Resources and Agricultural Research Institute. Results of soil sample analysis were presented Table 1.

Table 1. Some physical and chemical properties of the soil taken from the of experimental area

Org Subst (%)	$P_2 0_5$	$K_2 0$	PH	Salt (%)	Water Saturat. (%)	Soil Depth (cm)	$CaCo_3$	Cu (mg/l)	Mn (mg/l)	Fe (mg/l)	Zn (mg/l)	Sand (%)	Clay (mg/l)	Silt (%)	Soil Structure
1.45	1.83	105.8	7.49	0.045	79	0-30	10.2	1.31	13.71	7.50	0.34	14.8	66.48	18.72	Clay

GAP Soil and Water Resources and Agricultural Research Institute / Şanlıurfa

The province of Diyarbakir has Southeastern Anatolian steppe climate. The average annual rainfall is 490 mm falling 18% in autumn, 44% in winter, 37% in spring and 1% in summer months. Most of the rainfall obtained in the winter and the spring. The annual average temperature is 15.8 ^{o}C, the driest and hottest months are July and August. The meteorological data of the experimental site during the study period is presented in Figures 1, 2 and 3.

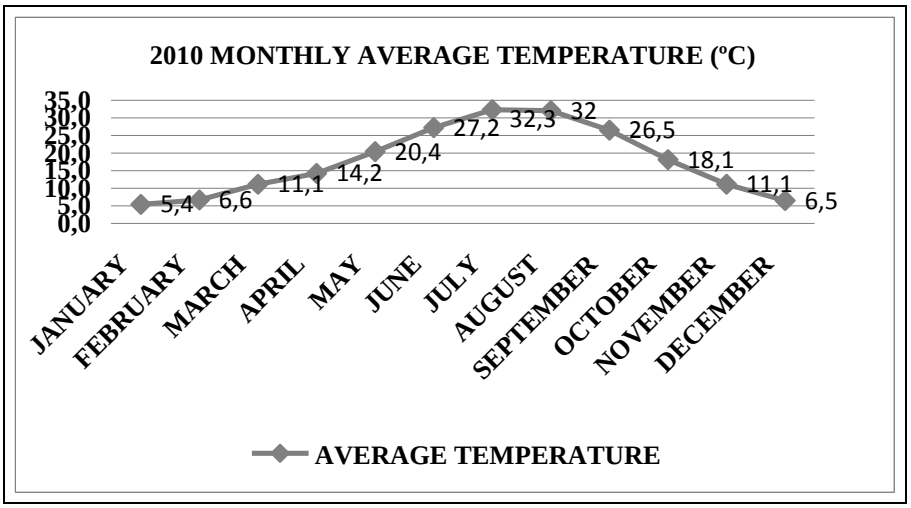


Figure 1. The monthly average temperature (°C) in the province of Diyarbakir in 2010

As seen Figure 1. in 2010, monthly average air temperature in the province of Diyarbakir 5.4ºC - 32.3ºC throughout the growing period ranged from 11.1° C to 32.3° C. According to the mean values of the year 2010, the average monthly rainfall in the province of Diyarbakir was 0 mm-55.6 mm. Rainfalls during the experimental period, ranged from 0 mm-21.6 mm (Figure 2). Monthly average moisture ranged from 17.5% - 80.9% in the province of Diyarbakir in 2010 but during the cotton growing period, monthly average moisture varied between 41.1% and 49.3% (Figure 3).

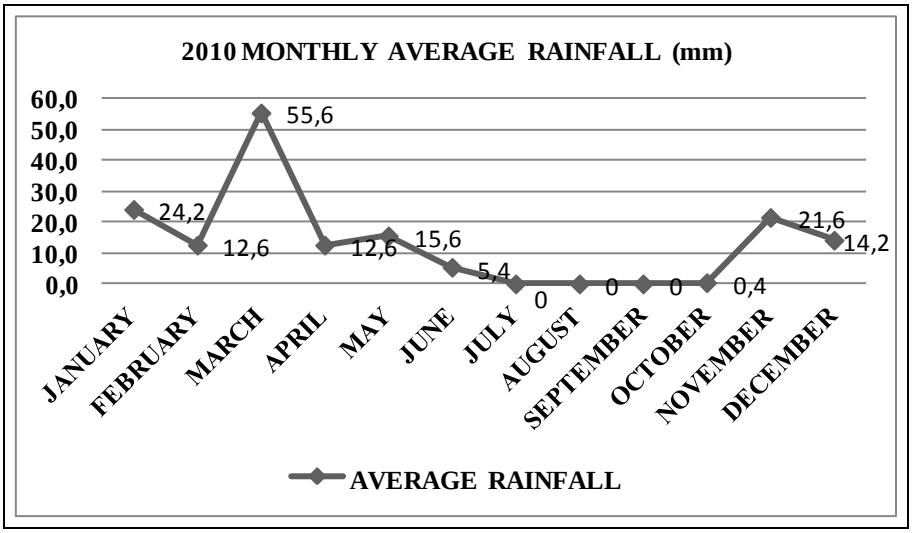


Figure 2. The monthly average rainfall (mm) in the province of Diyarbakir in 2010

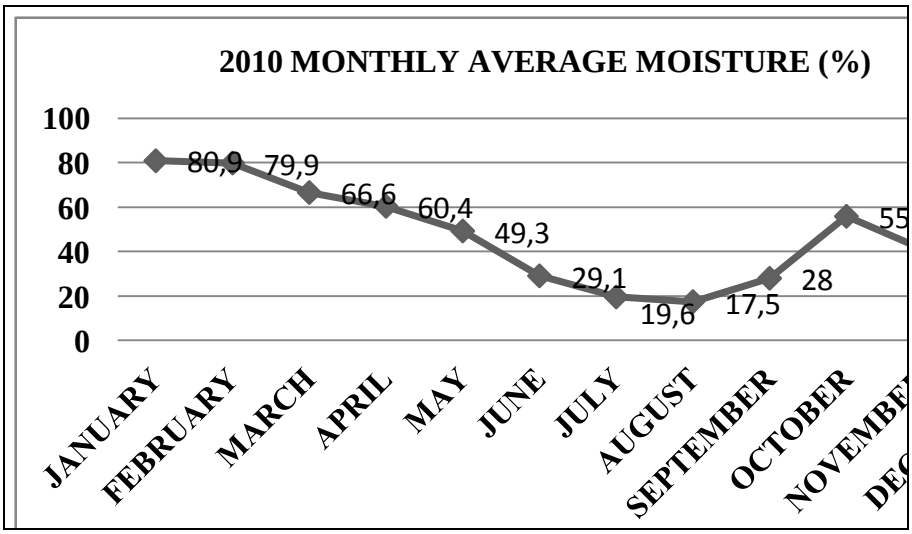


Figure 3. The monthly average amount of moisture (%)in the province of Diyarbakir in 2010

Applications of potassium doses were performed 2 times in the stages of blooming and top of flowering as 0 (without application); 300 g.da^{-1}; 500 g.da^{-1}; 700 g.da^{-1}. Zinc applications were also done 2 times, blooming and top of flowering as 0 (without application); 100 cc da^{-1}; 200 cc da^{-1}; 300 cc da^{-1}. Zinc and potash were applied to the plants as foliar spray in the form of EDTA chelated $ZnSO_4$ $7H_2O$ and K_2SO_4 respectively.

Parameters observed were photosynthesis rate (mg CO_2 cm^{-2} h^{-1}), number of sympodial branches (number plant^{-1}), number of bolls (number plant^{-1}) fiber length (mm), fiber fineness (mic.) and fiber strength (g tex^{-1}). Fiber properties were determined with the HVI 900 (High Volume lnstrument) device. Data obtained from research were evaluated with JMP 7.0 (Copyright © 2007, SAS Institute Inc.), statistical software package, averages (%) grouped according to LSD significance test.

Results and discussion

Interaction between potash and zinc was found significant in terms of all the investigated parameters. Applied doses of potassium and zinc, mean values of plant height, number of siypodial branches and number of bolls LSD groupings given in Table 2.

Photosynthesis rate varied between 37.00 (mgCO_2 cm^{-2} h^{-1}) and 48.33 (mg CO_2 cm^{-2} h^{-1}) by effect of applications and average photosynthesis rate was 42.24 (mgCO_2 cm^{-2} h^{-1}). The highest photosynthesis rate (48.33 mg CO_2 cm^2 h^{-1}) was obtained from K500(g.da^{-1})+Zn200(cc.da^{-1}) dose while the lowest photosynthesis rate (37 mg Co_2 cm^2 h^{-1}) was obtained from K0Zn0(control plot) and Zn.100(cc. da^{-1}) dose (Table 2). Findings in terms of photosynthesis rate similar those of Narang *et al.,* (1997); Sangakkara *et al.* (2000); Kacar, (2004) who reported that photosynthesis rate is affected potash and zinc application methods. Sympodial branches varied between 9.66 number. plant^{-1} and 15.00 by effect of applications and average number of sympodial branches was 11.71 number. plant^{-1}. The highest number of sympodial branches was obtained from K.500 (g. da^{-1})+Zn.300(cc. da^{-1}) dose while the lowest sympodial branches was obtained from Zn.200 (cc. da^{-1}) dose (Table 2). Findings are conformity with those of Oosterhuis *et al.* (1991); who reported zinc deficiency symptoms include, i.e. small leaves, shortened internodes, reduced boll set and small boll size.

Table 2. Average values of potassium and zinc applications of cotton plant and LSD groupings belong to photosynthesis rate, number of sympodial branches and number of bolls

Aplications	Photosynthesis Rate (mg CO_2 cm^{-2} h^{-1})		Aplications	Sympodial Branches (number $plant^{-1}$)		Aplications	Boll Number (number $plant^{-1}$)	
K500 Zn	48.33	A	K500 Zn300	15.00	A	K500	17.66	A
K300 Zn	47.00	AB	K500 Zn200	13.00	B	Zn 300	16.26	AB
K500	44.33	ABC	K500 Zn 100	13.00	B	K500	15.66	ABC
K700	44.33	ABC	K300	12.00	BC	K300 Zn	15.06	ABC
K500	43.66	BC	K700	12.00	BC	Zn200	15.00	ABCD
K700	43.66	BC	K300 Zn 200	12.00	BC	K700	15.00	ABCD
K500	43.33	BCD	K700 Zn 300	12.00	BC	K700	15.00	ABCD
K700	43.00	BCD	K500	12.00	BC	K500	14.83	BCD
K300	42.66	BCD	K700 Zn200	11.13	CD	Zn100	14.56	BCD
K 700	42.00	CD	K300 Zn 300	11.00	CD	K500	14.12	
K300	40.18	CDE	K700 Zn100	11.00	CD	K300	14.00	
K300	40.00	CDE	K300 Zn 100	11.00	CD	K700	13.83	
Zn200	40.00	CDE	Zn100	11.00	CD	K700	13.33	
Zn300	39.00	DE	K0 Zn0	10.88	CD	K300	12.30	
K0 Zn0	37.33	E	Zn300	10.66	CD	K0 Zn0	11.66	
Zn 100	37.00	E	Zn 200	9.66	D	K300	11.66	
Ortalama	42.24		1.71			14.37		
$EGF_{0.05}$	4.36		1.62			2.72		

Number of bolls varied between 11.66 and 17.66 number. $plant^{-1}$ by effect of applications and average number of bolls were 14.37 number. $plant^{-1}$. The highest number of bolls were obtained from K.500(g. da^{-1}) +Zn.300(cc. da^{-1}) dose while the lowest number was obtained from K.300 (g. da^{-1}) and K0 Zn0 dose (Table 2). These results are in the conformity with those of Knowles *et al.* (1999) who reported that zinc practices that increase the fruit of cotton similarly Haliloğlu *et al.* (2006), also reported that foliar spray of macro and micro nutrient increased the number of cotton bolls.

Dose applications of potassium and zinc, mean values of fiber length, fiber strength and fiber fineness and according to the test groups of EGF given in Table 3.

Fiber length varied between 25.03 mm and 27.98 mm by effect of applications and average fiber length was 26.86 mm. The highest fiber length was obtained from K500(g, da^{-1})+Zn300(cc da^{-1}) dose while the lowest fiber length was obtained from Zn100(cc da^{-1}) dose (Table 3). These findings are in the conformity with those of Oosterhuis 1994; Anac, 2010 who reported that zinc and potassium deficiency have reduced the quality of fiber. Fiber fineness varied between 3.69 mic and 5.54 mic. by effect of applications and average fiber fineness was 4.49 mic. The highest fiber fineness was obtained from K500(g, da^{-1})+Zn300(cc da^{-1}) dose while the lowest fiber fineness was obtained from K700(g da^{-1})+Zn,200(cc da^{-1}) dose (Table 3). Findings are similar with those of Sawan (2008)who reported that cotton productivity and quality due to the application of potash and zinc. Fiber strength varied between 26.03 g tex^{-1} and 31.30 g tex^{-1} by effect of applications and average fiber strength was 28.94 g, tex^{-1} The highest fiber strength was obtained from K700(g da^{-1})+Zn200(cc da^{-1}) dose while the lowest fiber fineness was obtained from K700(g da^{-1})+Zn100(cc

da^{-1}) doses (Table 3). Results are conformity with those of Sawan (2008) who reported that potash and zinc applications play important role on cotton productivity and quality.

Table 3. Potassium and Zinc Applications of Cotton Plant Average Values and groups belong to fiber length, fiber strength and fiber fineness

Aplications	Fiber Length (mm)		Aplications	Fiber Strength (g tex^{-1})		Aplications	Fiber Fineness (mic)	
K500	27.98	A	K700 Zn200	31.30	A	K0 Zn0	5.54	A
K300Zn300	27.78	AB	K300 Zn300	31.19	AB	Zn100	5.42	AB
K300	27.65	ABC	K700 Zn300	30.76	ABC	K300	5.06	ABC
K500	27.46	ABCD	K500 Zn200	30.23	ABCD	Zn200	4.88	ABCD
K700	27.14	BCD	K500 Zn300	29.90	BCDE	K500	4.73	BCDE
K700	27.09	BCD	K700 Zn100	29.66	CDEF	Zn300	4.60	CDE
K700	27.03	CDE	K300 Zn200	29.60	CDEF	K700	4.43	CDEF
K500	27.01	CDE	K500 Zn100	29.24	DEFG	K300	4.43	CDEF
K300	26.88		K700	28.80	EFG	K500	4.42	
K700	26.82		K500	28.43		K300Zn100	4.42	
K500	26.81		Zn300	28.40		K700	4.27	
K300	26.38		K300 Zn100	27.96		K300	4.18	
Zn300	26.28		Zn200	27.36		K500Zn100	4.14	
Zn200	26.13		K0 Zn0	27.23		K700	3.88	
K0 Zn0	26.13		K300	26.93		K700	3.74	
Zn100	25.13		Zn100	26.03		K500	3.69	
Ortalama	26,86			28,94			4,49	
EGF $_{0,05}$	0,70			1,39			0,70	

Conclusions

This study was carried out to determine the effect of different amount of potassium and zinc applications the increased K and Zn doses led to more photosynthetic capacity and more yield and quality per plant. K500g da^{-1} Zn300cc da^{-1} dose was higer than the other aplications in terms of photosynthesis rate, sympodial branches, number of bolls, fiber length, fiber fineness. Applicatin of Zn and K together gave better results in terms of yield and quality properties.

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ЕФЕКТИ ОД ПРИМЕНАТА НА КАЛИУМ И ЦИНК ВРЗ СТЕПЕНОТ НА ФОТОСИНТЕЗА ВРЗ КВАЛИТЕТОТ НА ВЛАКНОТО И ПРИНОСОТ НА ПАМУК

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Апстракт

Оптималното количество на минерални материи и избалансирано користење на хранливи макро и микро елементи за одгледување на културата, игра важна за подобрување на приносот и квалитот. Калиумот и цинкот учествуваат во многу важни метаболички процеси и ензиматски активности во растенијата. Ефикасноста на таков тип на елементи е подобрена кога се користи во комбинација со други макро и микро елементи. Ова истражување беше спроведено за да се утврдат ефектите од апликација на различни дози калиум и цинк врз приносот и квалитетот на влакното кај Berke - сорти на памук во експерименталното поле на Дикле универзитетот на Земјоделскиот факултет, во 2010 година. Беа испитани степенот на фотосинтеза, бројот на симоподијални гранки и својствата на влакната по должина, финост и јачина на влакното. Резултатите од испитуваните дози на апликација на калиум × цинк и интеракција, покажаа значајни разлики во однос на сите карактеристики. Беа утврдени значајни ефекти од апликацијата на калиум и цинк за: степенот на фотосинтеза, бројот на симоподијални гранки, бројот на чушки, својство на влакната по должина, финост и јачина на влакното.

Клучни зборови: памук, калиум, цинк, принос, квалитет.

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YIELD AND TECHNOLOGICAL QUALITY IN SOME MACEDONIAN WHEAT VARIETIES

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Abstract
Common wheat (*Triticum aestivum L.*) is one of the most important cereal food crops. Breeding for high yielding what varieties is curtail role but no less is importance of breeding high quality wheat varieties that is essential for bread making industry. Wheat quality is assessed on the basis of physical, chemical, rheological and baking tests. For this reason at cereals industry has been a long history of using descriptive empirical measurements of rheological properties to predict bread-making quality. In this paper, grain yield and technological quality of five wheat varieties (Radika, Milenka, Bistra, Treska and Altana) from the breeding program at Institute of Agriculture-Skopje, Macedonia, were examined in two years (2007/2008 and 2008/2009). Bistra has shown significantly the highest yield among wheat varieties over two years of study carried out. Altana has shown the highest protein content, sedimentation value, dough energy, extensograph extensibility and ratio (resistance/extensibility).According to technological quality among varieties, Altana has shown the best quality and belongs to A1-A2 quality class, following Treska and Milenka (A2-B1) and Radika and Bistra (B1).
Key words: wheat, variety, yield, technological quality.

Introduction

Wheat (*Triticum aestivum* L.) is an important cereal crop used as staple food in Macedonia. Wheat is grown in almost every part of the country. In the period 2006-2011, the average sown area with wheat was 49,4% out of the average sown area with cereals (176666 ha). The average wheat production in the same period was 262246 t, or in average 3048,7 kg/ha (Statistical yearbook of the Republic of Macedonia, 2012). It is a principal source of carbohydrates for human beings while its straw can be used as an integral part of livestock feed. Compared with other cereals, it provides food for human with more calories and proteins in the daily diet. In many common wheat varieties grain contains carbohydrates 60-80%, protein 8-15 %, fat 1.5-2.0%, inorganic ions 1.5-2.0% and vitamins such as B complex and E (Schellenberger, 1996). Despite to higher yield potential, average yield, of different varieties, in Macedonia is much less than the most countries of the world. To meet the increasing demand of food grains, it is desired to have higher yield per unit area. A number of factors including, time of sowing, land preparation, seed bed preparation, fertilizer application, weed management, and irrigation scheduling are responsible for the variation in yield of wheat, but all these factors are agronomic and greatly influenced by temperature, rainfall and humidity. The vital factor for harvesting suitable environment into grain yield is the genetic potential of the wheat

variety. Its suitability and superiority in breadmaking with viscoelastic dough properties has been well known and documented (Branlard *et al*., 2011). The developments of high grain yield potential with good breadmaking quality and tolerance to biotic and/or abiotic stress factors and which respond to improved agricultural practices are the main achievements for bread wheat breeding programmes. It is known that the baking quality of wheat is under genetic as well as environmental control. It is genetically controlled but may vary widely depending upon the variety, climatic conditions, location, soil fertility, etc and the complex interactions between these factors. In general, high protein flours give rise to better results since they have a high loaf volume potential with higher water absorption. Genotype-by-environment (G x E) interactions and the negative correlation between grain yield and grain protein content of wheat had been established in different studies (Feil, 1997, Qury and Godin, 2007). If a genotype has a high stability and shows low interactions with the environment is desirable in plant breeding. Generally, wheat quality is defined by: physical properties (hectoliter weight, thousand kernels weight, grain hardness), protein-linked properties (total protein and gluten contents, gluten index, sedimentation volume, protein and amino-acid composition), rheological properties (farinograph test, alveograph value, extensograph test), enzymatic properties (hagberg falling number, amilograph test) and other properties (test backing, micotoxin content, residues of pesticides and insecticides). Nutrition value and bread-making quality in winter wheat depends on: starch from the endosperm, fats from the embryo and aleuronic layer, mineral substances in pericarp, vitamins in tegument and pericarp, and protein content (Bunta and Bucurean, 2011). The rheological properties of wheat-flour dough, among other parameters, include the extensibility and resistance to extension, which influence the processing behaviour very strongly, and are thus important factors of the wheat varieties' bread-making quality (Ma *et al*., 2005). The present study was, therefore, designed to determine the yield potential and quality of some Macedonian varieties namely, Radika, Milenka, Bistra, Treska and Altana.

Material and methods

Five Macedonian wheat varieties (Radika, Milenka, Bistra, Treska and Altana) were used to study yield and technological quality. The field experiment was carried out in Skopje in 2007/2008 and 2008/2009. The experiment was designed as a completely randomized block with three replicates. The plots consisted of 5 m^2, spaced at a distance of 12,5 cm. The harvested grain from three replicates was subjected to yield and quality analyses. Determination of hectolitre weight was determined by standard methods. Grain protein content was determined by Kjeldahl method (ICC standard method No.105, 2001). The preparation of test flour from wheat samples for sedimentation test was performed according to ICC standard method No.118 (ICC, 2001) and determination of Zeleny sedimentation value according to standard methods described in ICC (ICC standard method No.116, 2001). Determination of water absorption of flours, dough stability and quality number was performed by Brabender farinograph according to ICC standard method No.115 (ICC, 2001). Determination of rheological properties of wheat flour dough (energy, resistance and extensibility) was done by Brabender extensograph according to ICC standard method No.115 (ICC, 2001). Wheat yield and quality parameters are agronomic and greatly influenced by temperature, rainfall and humidity. The average temperature and total rainfall prevailing in Skopje region is given in Table 1.

SPSS software was used for statistical analysis. Mean values were tested by ANOVA, whereas differences among individual mean values were determined by Tukey test at significance level of 0,05.

Table 1. Weather data for Skopje region

Climatic parameters	Years	Months									
		X	XI	XII	I	II	III	IV	V	VI	
Average	2007/08	12,7	4,3	1,0	1,4	5,6	9,6	13,7	18,0	22,4	
temperature	2008/09	14,2	8,5	5,0	1,0	3,3	7,1	13,4	18,0	21,0	
(ºC)	1951-90	12,4	5,9	1,3	0,0	3,1	7,5	12,2	17,2	20,6	
											Sum
Total	2007/08	140,0	69,4	14,6	7,7	0,5	29,8	18,7	40,7	46,9	368,3
rainfall	2008/09	27,3	37,5	68,3	72,8	12,2	68,6	65,3	70,2	104,3	526,5
(mm)	1951-90	41,0	51,0	50,0	36,0	36,0	37,0	40,0	61,0	48,0	400,0

Results and discussion

Wheat grain yield is influenced by genotype, environment, planting date, crop rotation, seeding rate, fertilization, biotic-abiotic stresses, etc and their interactions. Year-to year variations in climate gave rise to considerable variations in grain yield in the study. The distribution of rainfall over wheat growing seasons is of great importance. And also daily high temperatures and water stress in spring time shorten the grain filling period, resulting in earlier maturity of the grain, which result in lower grain yield with higher protein content. Grain yield is a polygenic trait and is a product of expressions of many genes (number of tillers/plant, 1000-grain weight, spike length, numbers of grains per spike and spikelet etc.). Several research studies have been carried out on relationship of various yield component and also climatic factors with grain yield and its related traits (Kneževic *et al*., 2008, Yousaf *et al*., 2008). There is large gap between yield potential of our modern wheat varieties and yield production which indicated that crop yield can be improved through better crop husbandry.

From the results in this study over two years the average grain yield was 6,11 t/ha (Table 2). The average grain yield in 2009 (6,40 t/ha) was 10% higher compared to 2008 (5,82 t/ha) due to the total rainfall and distribution of rainfall (Table 1). In 2008 variety Bistra had significantly higher yield (6,30 t/ha) among varieties used in this study, except to variety Treska (6,10 t/ha) where significant differences were not found. In 2009, also Bistra (7,20 t/ha) has shown the highest grain yield significantly higher compared to other varieties. In both sessions the highest average grain yield was obtained from Bistra (6,75 t/ha).

Table 2. Grain yield of the varieties investigated over two years

	Year	Varieties					Average
		Radika	Milenka	Bistra	Treska	Altana	
Grain yield (t/ha)	2008	5,40 a	5,70 abc	6,30 c	6,10 bc	5,58 ab	5,82
	2009	6,40 b	6,50 b	7,20 c	5,70 a	6,20 ab	6,40
	Average	5,90 a	6,10 a	6,75 b	5,90 a	5,89 a	6,11

Note:Values with the same letter in one row are not significantly different from each other

Hectolitre mass or test weight, usually expressed as kilograms per hectolitre (kg hl^{-1}), is a measure of volume grain per unit and it is an important wheat grading factor (Donelson *et al*., 2002). Well-filled, plump kernels result in higher hectolitre mass, because they pack more uniformly compared to small, longer kernels which exhibit lower hectolitre mass because they pack more randomly.

Although some cultivars might have the ability to always have higher hectolitre mass than others grown under similar conditions, hectolitre mass is affected by growing conditions as well as genetic factors (Bordes *et al*., 2008). A hectolitre mass of 74.00 kg hl^{-1} is required for bread making purposes (Nel *et al*., 1998), but Koekemoer (2003) reported a hectolitre mass of 76.00 kg hl^{-1} and higher to be preferable. Posner and Hibbs (1997) stated that hectolitre mass can be an indication of expected flour yield to millers.

The hectoliter mass was in the range of 73,0 kg hl^{-1} to 80,3 kg hl^{-1} in wheat varieties over two years of experiment. In average, the hectoliter mass had higher value among wheat varieties in 2009 (78,9 kg hl^{-1}) compared to 2008 (75,7 kg hl^{-1}). Altana had shown significantly the highest hectoliter mass among varieties used in this study in 2008 (79,3 kg hl^{-1}). Although Altana (80,3 kg hl^{-1}) had a highest hectoliter mass in 2009, the differences were not significant to Milenka (79.4 kg hl^{-1}) and Treska (80,1 kg hl^{-1}), except for Radika (76,5 kg hl^{-1}) and Bistra (78,4 kg hl^{-1}).

Protein content (quantity) as well as protein quality (composition) determines wheat flour quality. Stable flour composition and quality are desired traits in wheat quality despite the environmental influence (DuPont *et al*., 2007). According to their solubility, four protein-types, namely albumins, globulins, prolamins and glutelins were originally classified by Osborne (1907). Gluten, the storage protein in wheat, mainly located in the endosperm and known for having an influence on functional properties of wheat as determined on a mixograph, farinograph, alveograph, SDS-sedimentation volumes and loaf volumes (Finney *et al*., 1987, Branlard *et al*., 2001; Rakszegi *et al*., 2005) can vary within and between genotypes regarding their proportions, structures and properties. Protein content is strongly affected by environment and less affected by genotype. Depending on environmental conditions, wheat grain protein content can vary between 6% and 25% as affected by nitrogen availability. Total protein content as well as the amount of each different protein is mainly determined by genotype.

Flour protein content between wheat varieties was between 12,7% to 15,5% over two sessions of study. The average protein content among varieties in 2008 and 2009 was 14,1%.

The flour protein content was significantly higher in Altana in both sessions (15,1 % and 15,5%, respectively). While in 2008 no significant differences were found among Radika, Milenka Bistra and Treska, in 2009 there were significant differences among these varieties. The lowest protein content was obtained in Radika (12,7%) in 2009.

The obtained results for grain yield and protein content confirm the negative correlation with grain yield and protein content. The high yielding variety Bistra was among lowest wheat varieties containing 13,9% protein content in 2008 and had a moderate protein content (13,5%) among varieties in 2009.

Sedimentation test is a good indicator of end-use quality, especially where wheat contains a low to medium protein content. SDS-sedimentation volume is effective in differentiating between different wheat quality-types. In addition, the sedimentation volume is independent of whether whole meal or white flour is used, but a disadvantage is the ineffectiveness of this test to distinguish between medium to strong quality flour samples when protein content is higher than 13% (Carter *et al*., 1999). Higher SDS-sedimentation volumes usually indicate stronger gluten and better quality (Eckert *et al*., 1993, Carter *et al*., 1999). Fowler and De la Roche reported (1975) that SDS-sedimentation volume reflects protein quantity and dough development time, both being important basic quality characteristics. Wheat breeding programmes utilise this test to get an indication of differences in protein content as well as gluten quality, where both these characteristics are of great importance regarding end-use quality.

Table 3. Quality characteristics of the varieties investigated over two years

Quality parameters	Year	Varieties					
		Radika	Milenka	Bistra	Treska	Altana	Average
HLM (kg hl^{-1})	2008	73,0 a	74,3 a	75,8 b	76,3 b	79,3 c	75,7
	2009	76,5 a	79,4 bc	78,4 b	80,1 c	80,3 c	78,9
FPC (%)	2008	14,0 a	13,8 a	13,9 a	13,9 a	15,1 b	14,1
	2009	12,7 a	14,4 c	13,5 b	14,4 c	15,5 d	14,1
S (mL)	2008	32,0 a	42,0 c	32,0 a	37,0 b	53,0 d	39,2
	2009	34,0 a	46,0 c	38,0 b	46,0 c	64,0 d	45,6
FARINOGRAPH							
FABS (%)	2008	57,0 c	58,0 d	56,0 b	53,0 a	58,0 d	56,4
	2009	62,0 b	62,0 b	63,0 c	63,0 c	61,0 a	62,2
DS (min)	2008	1,0 a	3,0 d	1,5 b	2,5 c	4,0 e	2,4
	2009	2,5 a	6,5 d	3,5 b	5,0 c	6,5 d	4,8
QN	2008	55,2 a	67,8 c	55,6 a	66,7 b	83,5 d	65,8
	2009	71,0 a	75,6 c	74,5 b	76,5 d	88,5 e	77,2
Quality level		B1	A2/B1	B1	A2/B1	A1/A2	
EXTENSIOGRAPH							
En (cm^2)	2008	37,0 a	77,0 c	40,0 b	78,0 d	85,0 e	63,4
	2009	44,0 b	86,0 d	43,0 a	82,0 c	102,0 e	71,4
R (BU)	2008	230,0 a	310,0 e	270,0 b	290,0 d	280,0 c	276,0
	2009	260,0 c	290,0 d	240,0 a	250,0 b	340,0 e	276,0
Ex (mm)	2008	150,0 b	157,0 d	125,0 a	155,0 c	157,0 d	148,8
	2009	150,0 a	160,0 c	155,0 b	170,0 d	180,0 e	163,0
Ratio (R/Ex)	2008	1,73 c	1,81 d	1,55 b	1,47 a	1,90 e	1,7
	2009	1,53 a	1,97 d	2,16 e	1,87 c	1,78 b	1,9

HLM=Hectolitre mass, FPC=flour protein content, S=Sedimentation value, FABS=Farinograph water absorption,

DS=Dough stability, QN=Quality number, En=Energy, R=Resistance (BU=Brabender Units), Ex=Extensibility

* Values with the same letter in one row are not significantly different from each other.

Results obtained from the sedimentation test had significant differences among varieties in both sessions. The sedimenatation value of the varieties had a range of 32,0 mL to 64,0 mL. The sedimentation value was highest in Altana and significant to other varieties used in this study in both years (53,0 mL and 64 mL, respectively). The lowest sedimentation value was Obtained in Radika in both sessions (32,0 mL and 34,0 mL, respectively).

Farinograph dough stability time is important index for classifying wheat, and it often indicates the most appropriate end use for the wheat cultivars (Tian *et al.*, 2007). Water-absorption gives an indication of the potential of the protein molecules to absorb the added water, and therefore is an indicator of baking quality (MacRitchie, 1984). Van Lill and Smith (1997) reported that grain with higher protein content tended to be harder and give higher ash-content flour, which then results in higher water-absorption.

Stability is an indication of the flour tolerance to mixing and stronger flour tends to be more stable (Miralbés, 2004). Miralbés (2004) also reported a linear relationship between stability and protein content. There is positive correlation between the globulin protein fraction and dough development time. Gliadin and glutenin are significantly correlated with flour protein content, dough development time, stability, and water-absorption as well as loaf volume. There exist several rheological tests to evaluate dough characteristics during mixing and fermentation processes. Among them, water absorption capacity of the flour is important to obtain acceptable dough consistency during the mixing time. In general, waterabsorption increases as protein content increases, although water-absorption is a function of protein quantity and protein quality (Finney *et al*., 1987). Zounis and Quail (1997) reported significant correlations between farinograph water-absorption (FABS) and mixogram peak height as well as between FABS and maximum mixograph bandwidth.

Comparison of some rheological parameters of examined wheat varieties is presented in Table 3. According to the presented values, farinograph water absorption was significant among varieties in both years of study. In 2008, Milenka (58,0%) and Altana (58,0%) were with slightly significant differences in comparison with Radika (57,0%), Bistra (56,0%) and Treska (53,0%). In 2009, Bistra (63,0%) and Treska (63,0%) have the the highest water absorption capacity. Dough stability time was highest in Altana in both years (4,0 min and 6,5 min, respectively). Treska has shown the same dough development time with Altana in 2009. From the values presented in Table 3, it is remarkable that the average value for dough stability in 2009 (4,8 min) was two times higher in comparison to 2008 (2,4 min). According to farinograf results the highest quality class has Altana (A1/A2), following Treska and Milenka (A2/B1) and Radika and Bistra (B1). The extensograph determines the resistance and extensibility of a dough by measuring the force required to stretch the dough with a hook until it breaks. Extensograph results include resistance to extension, extensibility, and area under the curve. Resistance to extension is a measure of dough strength. A higher resistance to extension requires more force to stretch the dough. Extensibility indicates the amount of elasticity in the dough and its ability to stretch without breaking. Extensograph is employed to predict the dough characteristics during the fermentation process. Flours with high protein contents and high gluten strength result in doughs with a nearly perfect gluten matrix. The breads made of such doughs could benefit from near to perfect texture and bread volume (Bloksma and Bushuk, 1988). Therefore, accurate prediction of dough rheology could provide many benefits to the baking industry for satisfying consumer demands.

The results from extensograph evaluation showed that the high protein content variety Altana (85 cm^2 and 102 cm^2) possessed highest dough energy, significant among varieties in both years (Table 3). The extensogrph resistance and extensibility were significantly different among varieties in both years. Treska (290,0) owned significantly higher dough resistance in 2008, but not in the 2009 (250,0), having with Bistra (240,0) the lowest dough resistance. Dough extensibility was significantly higher in Altana (157,0 mm and 180,0 mm) in two years of study, except to Milenka (157,0 mm) in 2008 where no significant difference was found.

Conclusions

Presented two-year trial showed that differential results were obtained for grain yield and quality of the bread wheat varieties evaluated. It can be concluded that wheat variety Bistra performed significant high grain yield over two years of study carried out. Obtained results for grain yield

demonstrate strong influence from the environment and climate conditions showing increased grain yield of 10% in 2009 due to the total rainfall and distribution of rainfall.

Since there are, generally, negative correlations between yield and protein content in wheat, the typical negative correlations between grain yield and protein content was found in this experiment in high yielding variety Bistra. Beside high yield obtained, variety Bistra is ranked among varieties with lowest to moderate protein content.

Sedimentation values of flour above 36 mL are characterized as very good and also there is positive correlation between sedimentation value and baking. The sedimentation values of the varieties had a range of 32,0 – 64,0 mL which was included in very good category, except variety Radika (32,0 mL and 34,0 mL) owning low sedimentation value in both sessions. Wheat variety Bistra (32,0 mL) although has sedimentation value under the range in 2008, but not in 2009 (38,0 mL) which is influenced from the climatic conditions.

The high flour protein content variety Altana, also possessed high hectoliter mass, sedimentation value, water absorption capacity, dough stability time, dough energy, dough resistance and dough extensibility, that in general are positively correlated parameters with high protein content and mainly with protein structure. Most rheological properties obtained from farinograph curves in accordance to extensograph dough properties were also affected by climatic conditions. In accordance to farinograph and extensograph parameters Altana is wheat variety with good technological properties having quality level A1/A2 depending of the year of study. It can be concluded that wheat grain yield and technological quality are strongly influenced by the environment and climatic condition. It may be concluded that wheat variety Bistra is high yielding variety and Altana is variety whit good quality (A1/A2 quality level) preferable for bread-making industry.

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ПРИНОС И ТЕХНОЛОШКИ КВАЛИТЕТ КАЈ НЕКОИ МАКЕДОНСКИ СОРТИ МЕКА ПЧЕНИЦА

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Апстракт
Пченицата (*Triticum aestivum L.*) претставува најважното лебно жито. Освен одгледување на високопродуктивни сорти, многу е значајно и одгледувањето на високо квалитетни сорти пченица, особено за потребите на пекарската индустрија и производството на леб. Квалитетот на пченицата се оценува врз основа на физички, хемиски и тестови за технолошкиот квалитет. Преку емпириски испитувања од ваков вид, се овозможува предвидување на квалитетот на лебот. За да се следи стабилноста на квалитетот на некои сорти пченица, испитуван е технолошкиот квалитет на пченициte од производните 2007/08 и 2008/09 год. кај сортите *Миленка, Радика,Бистра,Треска и Алтана*, селекции на Земјоделски институт, Скопје.Сортата *Бистра* покажа статистички највисок принос на семе во однос на останатите сорти, текот на двегодишното истражување.Сортата *Алтана* се одликува со највисока содржина на протеини, седиментациона вредност, енергија на тестото, отпорност на растегливост и растегливост. Според технолошкиот квалитет, сортата *Алтана* покажа највисок квалитет и припаѓа на А1-А2 класа на квалитет, потоа следат сортите *Треска и Миленка* (А2-Б1) и сортите *Радика и Бистра* (Б1).
Клучни зборови: пченица, сорта, принос, технолошкиот квалитет.

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THE INFLUENCE OF MINERAL NUTRITION ON THE GRAIN HARVEST INDEX OF THE WINTER WHEAT

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Abstract
Examinations were held at stationary field experiment with fertilizing during period of three years (2004/2005, 2005/2006 and 2006/2007) the property of Center for small grains in Kragujevac.The experimental examinations, beside control, included six fertilizing variants: 1) N_0 P_0 K_0; 2) $N_{80, 120}$ P_0 K_0; 3) $N_{80, 120}$ P_{60} K_{60}; 4) $N_{80, 120}$ P_{100} K_{60}; 5) $N_{80, 120}$ P_{60} K_0; 6) $N_{80, 120}$ P_{100} K_0; 7) $N_{80, 120}$ P_0 K_{60}. During experiment individual fertilizings were implemented as follows: KAN (as nitrogen fertilizing), superphosphate (as phosphate fertilizing) and 60% of potassium salts (as potassium fertilizing). In the experiment were included seven cultivars of winter wheat: Takovčanka, Ana Morava, KG 100, Lazarica, KG 56S, KG 4 and KG 5. The aim of this work was to examine the effect of various dosages and relation of mineral fertilizers on grain harvest index of different of winter wheat cultivars. The usage of fertilization increased grain harvest index. The highest value of harvest index was reached by applying nitrogene phosphorus and only nitrogene (ferilizers). Depending on cultivars, the highest grain harvest index was obtained at cultivar Lazarica (46%), and the lowest at cultivar KG 4 (41%). The highest grain harvest index of winter wheat in period of triennial examination, obtained cultivar Lazarica (48%) at NP_2 variant of fertilizing, at higher nitrogene dosage.
Key words: wheat, fertilizing variants, grain harvest index, cultivars.

Introduction

From the aspect of achieving of high grain yield of desired technological quality, the most efficient, but at the same time the most expensive agrotechnical measure in production of small grains is fertilizing (Djokić et al., 1998). In the last decades of 20 th century, their excessive utilization in planting system of small grains became economic unjustified. Because of this, genotypes of small grains which are characterized by better absorbtion of nutrition, above all nitrogen from ground resources and applied fertilizers and their efficient exploitation in the plant for producing assimilats for pouring of grain and formation of yield and protein synthesis, the aim of modern selection and improvement of small grains.

Such a strategy demands implementation of new methods and parameters in sense of criteria, that is, active inclusing accomplishments from other sciences in the process of improvement of wheat, as the most important cultivar of small grains (Fisher, 1981; Baker et al., 2004; Flawers et. al., 2004).

Since the indexes of effectivness of wheat plant are in positive correlation to level and quality of grain yield, it is supossed that those physiological parameterscould be significant in obtaining desired results in wheat improvement (Djokić, 1996).

Harvest index of grain represents agronomucal part of biological yield, that is, it represents relation between agronomical (wheat grain yield and biological (grain yield and straw yield). Many authors recommend grain harvest index as the criteria in selection and improvement of wheat, for higher wheat yield (Sharma et al., 1987), because most investigations confirmed positive correlation between it's value and grain yield level.

Latest investigations demonstrate that the range of this parameter is 36-58%. Borojević (1983) states two methods for increasing grain yield by increasing grain harvest index above 50% with keeping biomass at the same level or with keeping value of grain harvest index at 50% with increasing biomass.

The aim of this word was to examine the effect various dosages and relation of mineral fertilizers on grain harvest index of different cultivars of winter wheat.

Material and methods

Examinations were performed at stationary field experiment with fertilizing that has been applied for many years (over 30), at the property of Center for small grains in Kragujevac. The experiments were performed in three years period (2004-2007). The experiment on which examinations have been performed includes also six variants of fertilizing: 1) N_0 P_0 K_0; 2) $N_{80, 120}$ P_0 K_0; 3) $N_{80, 120}$ P_{60} K_{60}; 4) $N_{80, 120}$ P_{100} K_{60}; 5) $N_{80, 120}$ P_{60} K_0; 6) $N_{80, 120}$ P_{100} K_0; 7) $N_{80, 120}$ P_0 K_{60}. Individual fertilizers were used: KAN as the nitrogen fertilizer, superphosphate as the phosphate fertilizer, and as the potassium fertilizer it was used 60% potassium salt. Besides mentioned variants of mineral nutrition, in experiment it was included also seven different cultivars of winter wheat from the region of Kragujevac:,Takovčanka, Ana Morava, KG 100, Lazarica, KG 56 S, KG 4 and KG 5. The area of the basic experimental parcels is 100 m^2 for fertilizing with phosphor and potassium, and for fertilizing with two dosages of nitrogen of 80 and 120 kg ha^{-1}, basic parcel was divided in two parts of 50 m^2 each.

The experiment was set up at random block system in 5 repetitions. It was used standard agrotechnics. Plant samples for for analysis were taken in the phase of full maturity. After drying to the stage of dry mass, it was depined the mass of overground part of the plant (g). Besides it was separately defined grain mass (g) and straw mass (g). Grain harvest index was determined as the relation of grain yield to total biomass.

About average monthly temperatures and quantity of precipitations during our examinations, we can conclude that the weather conditions differed in each experimental year, table 1. The most favorable weather condition were in the first vegetation period, 2004/2005, when the highest total quantity of precipitations was registered, with the most favorable disposition through months. Also the temperatures were optimal for planting the wheat, especially during the most important phases of its growth.Vegetation period in the years 2006/2007 was also favorable for winter wheat growing, while the most unfavorable weather conditions for growth of winter wheat were in second year of experiment.

Table 1. Temperature and water in the course of the vegetation (2004-2007)

Month	Temperature tº C				Water lm^{-1}			
	Year			Average	Year			Average
	2004/ 2005	2005/ 2006	2006/ 2007	perennial 1961/99	2004/ 2005	2005/ 2006	2006/ 2007	perennial 1961/99
September	16,2	17,4	17,7	16,7	31,0	57,4	115,6	50,5
Oktober	14,7	11,5	13,3	11,3	50,1	16,7	49,0	42,8
November	6,8	5,6	7,6	6,5	90,7	13,7	54,8	46,4
December	3,0	3,3	3,5	1,1	170,0	51,9	47,1	46,8
January	1,5	- 1,7	6,1	- 1,8	36,6	45,3	27,9	38,3
February	- 1,5	1,5	6,3	3,0	66,9	32,1	38,1	35,7
March	4,5	5,6	9,1	6,5	178,7	62,9	116,1	40,4
April	11,6	12,7	12,1	11,3	72,3	3,6	29,6	53,1
May	16,4	16,4	18,2	16,3	70,2	118,4	86,3	66,7
Jun	19,2	19,7	22,8	19,0	39,1	25,3	84,8	80,3
Juli	21,6	23,0	24,8	21,1	86,2	10,1	22,4	70,6
(IX - VII)	10,6	10,6	12,9	10,4	891,8	437,4	671,7	571,6

Results and discussion

Wheat requires more or less fertile ground of optimum physical characteristics.The experimental field is of type vertisol in the process of degradation. It has A-Bt-C type of profile. Upper part of A horizon is of grey color, and due to ongoing rinse process it is significantly impoverished of alkalis and humus. Reaction of the upper part of A horizon is in range of very high acidity to normal acidity with the level of saturation with alkalis less than 70%. In deeper levels of this terrain Bt horizon has been formed, and it is very rich with clay and more watertight. During periods in the year with more humidity, under it surface water collects and that causes forming of rusty deposits of Fe-hydroxide as well as small granules of orstajn.

Besides heavy mechanical composition and rough and unstable structure, this terrain has not favorable condition of porosity, what additionally worsens unfavorable physical characteristics of this parcel. With the purpose of determining fertility of the parcel, before the beginning of experiment, analysis of basics fertility parameters of samples were made, according to fertilizing variants table 2.

The ground of the experimental parcel has very strong acid reaction (pH in KCl < 4.5). The highest acidity exchanging potency of the terrain is with NP and NK variants of fertilizing, while the content of humus is average. Fertilized variants had average higher percentage of humus comparing control. The highest content of humus was found with NP_1K and NP fertilizing variants.

The total content of nitrogen was average (according to Wohtmann's classification), there with fertilizing variants had higher content of total nitrogen comparing control. The content of easily accessible nitrogen is low (2,20-9,83 mg/100g of sample of ground), while the content of easily accessible kailium is in the range of average to high (17,40-27,47 mg/100g of sample). Grain harvest index is genetic characteristic and it mostly changes depending to cultivar as well as under the influence of applied mineral nutrition.

Table 2. Facts of ground fertility at experimental field

Fertilizing variant	Profound (cm)	Humus (%)	pH		N overall (%)	P_2O	K_2O
			H_2O	KCl		mg/100g ground	
O	20	2.13	5.85	4.37	0.12	2.60	18.67
N		2.10	5.83	4.26	0.14	2.20	17.60
NP_1K		2.39	5.58	4.27	0.15	8.17	27.47
NP_2K		2.25	5.72	4.28	0.14	9.83	24.00
NP		2.34	5.63	4.15	0.15	9.00	17.40
NK		2.24	5.73	4.22	0.16	2.83	23.53
						9.02.83	23.53

Table 3. Grain harvest index % of examined wheat cultivars

Variant fertilizing	Dosage N	Cultivars								
		1.	2.	3.	4.	5.	6.	7.	Average	
O		41	42	43	45	41	41	43	42	42
N	N_1	42	46	43	45	42	38	43	43	44
	N_2	43	45	44	47	44	42	44	44	
NP_1K	N_1	42	40	45	45	41	40	41	42	42
	N_2	42	45	44	43	42	41	42	42	
NP_2K	N_1	42	44	43	43	41	40	40	42	43
	N_2	44	45	46	47	43	42	41	44	
NP_1	N_1	43	46	44	46	44	39	42	43	44
	N_2	43	45	45	46	43	46	43	44	
NP_2	N_1	43	43	44	45	41	39	45	43	44
	N_2	47	44	46	48	43	41	42	44	
NK	N_1	44	44	44	46	42	39	38	42	43
	N_2	44	45	45	46	44	40	43	44	
Average	N_1	42	43	44	45	42	39	42	42	43
	N_2	43	44	45	46	43	42	43	44	
Average	N_1 / N_2	43	44	45	46	43	41	43	43	

LSD	A	B	AB	C	AC	BC	ABC
0.05	1.188	1.188	3.143	0.635	1.680	1.680	4.445
0.01	1.567	1.567	4.146	0.837	2.216	2.216	5.863

1. Takovčanka, 2. Ana Morava, 3. KG - 100, 4. Lazarica, 5. KG - 56S, 6. KG - 4, 7. KG - 5
A-variant fertilizing, B-cultivar, C-nitrogen fertilizer dosage, AB, AC, BC, ABC - interaction

Grain harvest index is indicator of efficiency of exploitation of dry matter of plant for grain pouring and syntesis of proteins. During triannual period, the lowest grain harvest index was found at control 42%, while fertilizing brought to increasing of grain harvest index table 3. The most important statistical increase of grain harvest index was accomplished with appling nitrogen-phosphorus and only nitrogen fertilizers (Savić Nadica, 2009). Between these fertilizing variants

with NP and N there wasn't statisticaly significant differences. Earlier investigations have already shoued that in conditions of poor content of nutrition in ground, plants of small grain show better efficiency in absorbing them and exploting them for pouring of grain and protein synthesis (Djokić and Lomović, 1990). Complete plant nutrition in sense of adding all of three necessary elements (N, P and K) to crops, haven't influenced increase of grain harvest index. Applyng higher dose of nitrogene fertilizer brought to higher grain harvest index at all the fertilized variants, with exception of NP_1K. In triannual average grain harvest index showed significant verying depending on cultivar. The highest grain harvest index was achieved with cultivar Lazarica 46%, and the lowest with cultivar KG 4 41%. The highest grain harvest index in average obtained cultivar Lazarica 48% with NP_2 fertilizing variant, using higher nitrogen dosage

Conclusions

Based on results of examination, it can be concluded that the nutrition of wheat plant in form of adding certain fertilizers, has influence on value of grain harvest index, that is better exploitation of dry matter and nitrogen for grain pouring and protein sinthesis.

The most important statistical increase of grain harvest index was accomplished with appling nitrogen-phosphorus and only nitrogen fertilizers. Applyng higher dose of nitrogene fertilizer brought to higher grain harvest index at all the fertilized variants, with exception of NP_1K. In triannual average, grain harvest index showed significant varying depending on cultivar. The highest grain harvest index was achieved with cultivar Lazarica 46%, and the lowest with cultivar KG 4 41%. The highest grain harvest index in average obtained cultivar Lazarica 48% with NP_2 fertilizing variant, using higher nitrogen dosage.

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ВЛИЈАНИЕ НА МИНЕРАЛНАТА ИСХРАНА НА ЖЕТВЕНИОТ ИНДЕКС КАЈ ЗИМСКАТА ПЧЕНИЦА

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Апстракт

Испитувањата беа изведени на експерименталното поле во сопственост на Центарот за ситнозрнести култури во Крагуевац, со ѓубрење во текот на период од три години (2004/2005, 2005/2006 и 2006/2007). Во експерименталните испитувања, покрај контрола, беа опфатени и шест варијанти на ѓубриња: 1) N_0 P_0 K_0; 2) N_{80}, $_{120}$ P_0 K_0; 3) N_{80}, $_{120}$ P_{60} K_{60}; 4) N_{80}, 120 P_{100} K_{60}; 5) N_{80}, $_{120}$ P_{60} k_0; 6) N_{80}, $_{120}$ P_{100} K_0; 7) N_{80}, $_{120}$ P_0 K_{60}. Во текот на експериментот, беа имплементирани индивидуални ѓубриња, како што следува: КАН (како азотно ѓубре), суперфосфат (како фосфатно ѓубре) и 60 % на калиумови соли (како калиумово ѓубре). Во експериментот биле вклучени седум сорти на зимската пченица: Таковчанка, Ана Морава, KG 100, Лазарица, KG 56S, KG 4 и KG 5. Целта беше да се испита ефектот на различните дози и односот на минерални ѓубрива врз жетвениот индекс на различни сорти зимска пченица. Користењето на ѓубриња, го зголемува жетвениот индекс. Највисоката вредност на жетвениот индекс беше постигната со примена на азотно фосфорни и само азотни ѓубриња. Во зависност од сортата, највисок жетвен индекс е добиен кај сортата Лазарица (46%), а најнизок кај сортата KG 4 (41%). Во периодот од три години, највисок жетвен индекс на зимската пченица е добиен кај сортата Лазарица (48%) во варијантата на ѓубре NP_2, со повисока доза на азот.

Клучни зборови: пченица, варијанти на ѓубре, жетвен индекс, сорти.

UDC:635.657"324"(560)
Original scientific paper

THE POSSIBILITIES OF WINTER CHICKPEA (*CICER ARIETINIM* L.) PRODUCTION IN MEDITERRANEAN CLIMATE CONDITIONS OF TURKEY

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Abstract
Chickpea (*Cicer arietinim* L.) is very important legumes in Turkey, and can be grown in rotation with wheat in semi-arid land under the Mediterranean climate conditions. It is traditionally sown in spring in this region and about 800-900 kg ha^{-1} seed yield can be obtained in this season, yet winter chickpea production has recently been spread in coastal regions of Turkey, and according to some research results, seed yield is about 2000-3000 kg ha^{-1} in fall sowing season under the Mediterranean conditions. But, one of the major problems is *Ascochyta blight* damage which occurs in winter crop production in this environment. Therefore, the varieties with resistance to blight disease should be used by farmers. There are some varieties resistance to related disease in this region. Late autumn or early winter sowing (Mid-November to Mid December) should be done for avoid from disease in the Mediterranean climate conditions of Turkey. Chickpea should be sown in 30-40 plant m^2 in these environmental conditions.
Key words: Winter Chickpea, Growing, Yield, *Ascochyta blight*, Mediterranean condition.

Introduction

Chickpea is the second most important pulse crop after dry bean for production in the world (FAO, 2010). Also, it is the most important food–legume crop in Turkey and Chickpea is used in cooking and as nuts. In recent years, although chickpea sowing area has been decreasing in Turkey due to increase in exports of Australia and Mexico, it is still 446.000 ha and average yield of chickpea is 1090kg ha^{-1} in Turkey (Anonymous, 2011). The Mediterranean region of Turkey is in the first rank in terms of chickpea sowing areas. In this region Chickpea is traditionally sown in spring. Therefore, seed yield is low because of drought climate during growth and ripening period and average seed yield of spring sown chickpea is 800-900 kg ha^{-1}. On the other hand the Mediterranean environment has a important potential for winter chickpea production. Because of the increasing the yield, instead of spring sowing, winter sowing of the chickpea enable to well results in the Mediterranean region. In recent years, winter chickpea area has been increasing in Mediterranean environment, but heavy soil is not favourable for winter chickpea production especially because of *Ascochyta blight* and overly vegetative growth. Permeable soil is more suitable than heavy soil for chickpea production. Chickpea can be grown in rotation with wheat in the Mediterranean climate conditions.

Techniques of Winter Chickpea Production

Selection of Cultivar

Selection of cultivar is very important for winter chickpea. *Ascochyta blight* is major problem in winter chickpea production because of rainy seasons. *Ascochyta blight*, caused by the fungus *Ascochyta rabiei* is the most serious disease of chickpea in Mediterranean region. The fungus can infect all above ground parts of the plant and it is highly prevalent in areas where cool, cloudy and humid weather occurs during the crop season. Unlike some insect control strategies, there is no economic threshold for ascochyta. Management strategies are aimed at preventing the occurrence of disease and limiting its spread. *Ascochyta blight* is managed through crop rotation, hygiene, seed treatment, prophylactic fungicide application and growing varieties with improved resistance. As seen figure 1, Mediterranean region has warm and humidity condition during the chickpea growing season in winter season. For this reason, the cultivars with resistance to *Ascochyta blight* such as Seçkin, İnci, Hasan bey, Izmir, Menemen-92, Aydın-92 originated in Turkey should be grown in the Mediterranean environment (Mart et al.,2011; Karaköy, 2011; Karaköy et al.,2011). Above mentioned cultivars have high potential for seed yield in winter chickpea production. Also as shown in the some research results, seed yield of chickpea is 2000-3000 kg ha^{-1} in winter sowing (Engin,1989; Singh and Saxena,1996; Anlarsal et al.,1999; Mart and Anlarsal, 2001;Yücel and Anlarsal, 2006).

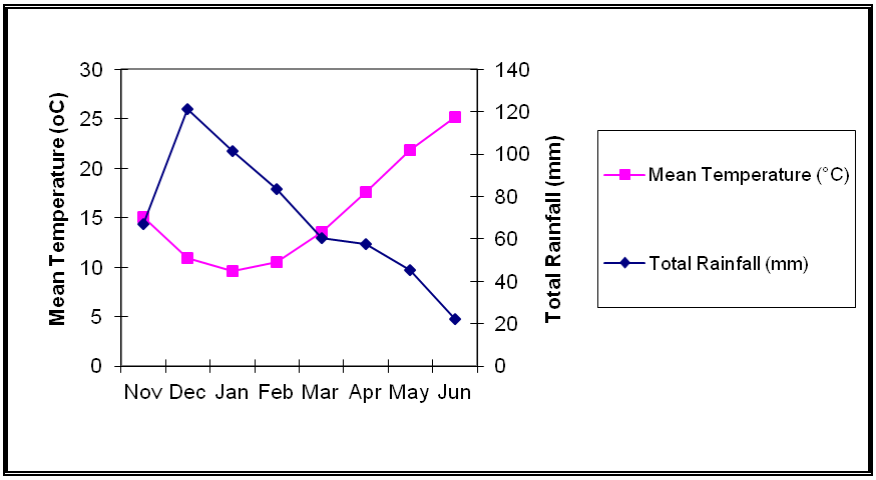


Figure 1. Long term avarage of precipitation and temperature of Adana (mediterranean region) in Turkey

In Mediterranean environmental conditions (Adana) in Turkey 100-seed yield and seed yield of some winter chickpea cultivars is given in Table 1.

Sowing Methods and Date

Date of sowing affects the growth and yield of chickpea. In the Mediterranean conditions early sowing (October) can increase the growth and seed yield. However, the plant can lodge because of overgrowth, which leads to a difficult harvest.

Also, the risk of *Ascochyta blight* increases in the seedling stage especially in rainy and warm of year. Chickpea sowing can be done during early winter, but very late sowing delays time to flowering and ripening of crop thus seed yield drastically decreases. Therefore, as seen Table 2, previously research carried out in Mediterranean condition indicated that the most suitable sowing

time can be from Mid-November to Mid-December to obtain higher seed yield and avoid the disease risk.

Table 1. The seed yield (kg/da) and 100- seed weight on the some chickpea genotypes*

Genotypes	100-Seed Weight (g)	Seed Yield(kg/ha^{-1})
1.Inci	36.2	3223
2.Eser-99	46.5	2676
3.Gökçe	45.9	2683
4.İzmir-92	43.9	2393
5.Menemen-92	43.9	2606
6.Cevdet Bey	52.2	280.6
7.Damla	45.4	2844
8.Diyar-95	49.1	2743
9.FLIP 94-88C	36.4	3406
10.FLIP-91-222C	37.7	3311
11.FLIP 98-22C	45.8	3168
12.FLIP 98-106C	41.5	3644
13.FLIP 98-63C (Seçkin)	44.0	3089
14.FLIP98-56C	45.3	2939
15.FLIP 98 100C	41.8	3037
16.FLIP 98-101C	44.7	2540
17.FLIP 97-2111C	44.1	2799
18.FLIP 98-55C (Hasanbey)	46.9	2937
19.FLIP 92-164C	38.7	2868
Mean	43.7	2904

***** Karaköy et al., (2010)

A high plant population shows a good response to soil moisture. For this reason, in rainy conditions, high plant density increases the seed yield of winter chickpea (Saxena and Sing,1987; Ozveren and Anlarsal 2001). It is sown with a row spacing of 45-60 cm and the recommended seed rate is 100-160 kg ha^{-1} by using machines depending on the seed size of cultivars. Compact and upright types give better response to high plant density than spreading types. Chickpea should be sown in 30-40 plants m^2 (Yücel and Anlarsal, 2006; Özdemir et al.,1996), but generally, in Turkey, sowing is done by broadcast methods.So, plant population gives a poor stand.

Seeding depth is an important factor affecting the germination. Chickpea is sown at 5-10 cm depth if there is enough soil moisture for germination. But, the seeding should be done in depth of 15 cm if soil moisture is deficient for germination (Singh and Saxena, 1999; Ozveren,1998).

Table 2. The effect of different sowing dates of chickpea cultivars on the seed yield and 100- grain weight *

Cultivars	Seed Yield(kg/da-1)	100-Seed Weight (g)
Akçin-91	174.6	39.5
FLIP 84-19C	177.1	36.0
FLIP 85-46C	102.6	39.4
FLIP 90-4C	192.5	42.2
Sowing Dates		
OCT, 2	145.1	39.7
OCT, 17	180.4	38.6
NOV, 2	191.9	38.9
NOV, 17	148.7	37.2
DEC, 2	142.5	42.2

*Mühür and Anlarsal (1996)

Table 3. The effect of different sowing depth on the seed yield (kg ha^{-1})*

	Sowing Depth (cm)				
Cultivars	4	8	12	16	Mean
FLIP 92-164C	3781	3924	3912	4017	3908
FLIP 91-149C	3100	2686	2897	3107	2948
FLIP 91-61C	4204	4012	363.9	4154	4002
Mean	3695	3541	3483	3759	3619

*Ozveren (1998)

Fertiliser

Soils of the Mediterranean region are generally rich in Rhizobium bacteria**.** The good nodulation occurs under these conditions. Therefore inoculation of Rhizobium bacteria is not necessary in this region generally. For that reason, 30-40 kg ha^{-1} nitrogen as starter doses and application of 50-60 kg P_2O_5 kg ha^{-1} is favourable for before seeding. Although, some environmental conditions (pH precipitation and dry climate) affect nitrogen fixation negatively. In this case, inoculation of bacteria can increase N_2-fixation. Soils of Turkey have adequate amounts of potassium. So, the potassium (K) fertilizer is not required for chickpea. Iron-deficiency is common in many high pH calcareous soils in the Mediterranean region of Turkey.

Table 4. The effect of rhizobium bacteria strains on seed yield (kg/ha^{-1}) of some chickpea cultivars*

Cultivars	Rhizobium Strains			
	CP-31	CP-36	CP-39	Control (No İnoculation)
Aydın-92	2289	2263	2712	3267
Menemen-92	2803	2576	2226	2434
İzmir-92	2844	3338	3010	2399

*Erdoğan (2002)

Conclusions

There is a good potential for winter chickpea production in the Mediterranean climate conditions of Turkey. But *Asoschyta bligt* damage can occurs in rainy and warm conditions. Therefore it is necessary to use cultivars with resistant to *Asoschyta blight,* if suitable growing techniques of chickpea can be applied sowing areas and production will highly increase in comparison with today's in Mediterranean climate conditions.

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МОЖНОСТИ ЗА ПРОИЗВОДСТВО НА ЗИМСКИ НАУТ (*CICER ARIETINIM* L.) ВО УСЛОВИ НА МЕДИТЕРАНСКА КЛИМА ВО ТУРЦИЈА

Тон Ајбиган, Јуцел Дерија, Анласлар Емин

Апстракт
Наутот (*Cicer arietinim* L.) е многу важна мешункаста култура во Турција, и може да се одгледува во ротација со пченица во полупустински предели, во медитерански климатски услови. Традиционално, во овој регион се сее во пролет, а може да се добие принос на семе околу 800-900 кг ха$^{-1}$. Неодамна, производството на зимски наут се рашири и во крајбрежните региони на Турција и според добиените резултати од некои истражувања, родот е околу 2000-3000 кг ха$^{-1}$ при есенска сеидба во услови на медитеранска клима. Еден од главните проблеми се штетите предизвикани од *Ascochyta blight,* која во оваа средина се јавува при зимското производство. Затоа од страна на земјоделците треба да се користат сорти кои се отпорни на болести. Постојат некои сорти кои покажуваат отпорност на оваа болест во овој регион. За да се избегне оваа болест во услови на медитеранска клима во Турција, се препорачува доцна есенска или рана зимска сеидба (од средината на ноември до средината на декември). Во вакви еколошки услови, наутот треба да се сее во склоп од 30-40 растенија/м^2.
Клучни зборови: зимски наут, пораст, принос, *Ascochyta blight*, медитерански услови.

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Original scientific paper

DETERMINING THE YIELD AND YIELD COMPONENTS IN SOME WINTER CHICKPEA GENOTYPES IN MEDITERRANEAN CLIMATE CONDITIONS

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Abstract
This study was carried out to aim to determine the performance of some promising chickpea genotypes. The research was conducted during winter season of 2009/2010 and 2011/2012 in Mediterranean climate conditions in Turkey. The experiment was arranged randomized blocks with three replications with four promising lines and two registered varieties. In this research, according to combined years chickpea genotypes were statistically different from each other for all of the characteristics. Plant height, main branch number, pod number per plant, seed number per plant, 100-seed weight, seed yield changed from 67.2 to 75.1cm, from 5.9 to 8.4 number, from 33.2 to 58.9 number, from 35.4 to 60.1 number, from 35.3 to 38.2 g, from 1876.3 to 2770.2 kg ha^{-1} respectively. As a result FLIP 00-39 and FLIP 01-54 lines should be suggested for winter chickpea grown in Mediterranean environmental conditions.
Keywords: chickpea, varieties, grain yield, yield component.

Introduction

Chickpea (*Cicer arietinum* L.) with low production cost, wide climate adaptation, use in crop rotation and atmospheric nitrogen fixation ability is one of the most important legume plants in sustainable agriculture system. The importance of the crop in human food stem from the fact that protein content of its seeds is about % 23, and this rate is rather low in comparison with other pulses, however, chickpea seeds are rich source of minerals and vitamins (Singh and Saxena, 1999). Also, it is being used increasingly as a substitute for animal protein in the diet of poor peoples.

Chickpeas are produced in over 45 different countries. World chickpea production is 9.685.967 ton and India is the world leader in chickpea production in 2007. Turkey is the third most important chickpea production followed by India and Pakistan, accounting for about five percent of total world production in 2007 (Anonymous, 2007). Chickpea is Turkey's most important pulses. Chickpea sowing area is 446.000 ha and average yield 1090 kg ha^{1} (Anonymous,2011).Chickpea is sown at spring in Middle Anatolia and parade regions, but because of the increasing the yield, instead of spring sowing, winter sowing of the chickpea enable to well results in Aegean and Southeast regions with warmer climate in winter. However, cultivars which can be grown at wintry weather and have tolerant to ascochyta blight and cold should be used in sowing. With developed new cultivars, it was reported that about 1437 to 2213 kg ha^{-1} seed yield can be obtained from winter sowing of chickpea in Mediterranean environments (Yucel and Anlarsal, 2008).On the other hand Mart.,et al.(2011) found that seed yield of winter chickpea changed 1985.2-3680.5kg ha^{-1}.

The objectives of this study were:
- to determine the most suitable chickpea genotype which can be grown under rain fed condition of the Mediterranean,
- to investigate association between yield and other agronomical characters of different chickpea genotypes in the Mediterranean-type conditions of Turkey.

Material and methods

Experiments were carried out at the Research Area of Department of Field Crops of Cukurova University in Adana (35° 18' E, 37° 01' N; 23 m above sea level) during the winter seasons of 2009/2010 and 2011/2012 . The four cultivars named FLIP 00-39 C, FLIP 01-1 C, FLIP 01-34 **C** and FLIP 01-54 C, received from ICARDA along with 2 cultivars (as check, AYDIN and INCI) originated in Turkey were used as material. A randomised complete block design (RCBD) with four replicates was used to conduct treatments. Each plot consisted of four rows of 5 m length that were 45 cm apart. Prior to sowing, plants were fertilised with equivalent to 40 kg ha^{-1} N, and 40 kg ha^{-1} P_2O_5 in both growing seasons. Sowings were done on November 24 2009, and November 28 2011. Sowing of 2010 could not be done because of extreme rain. Emergence, flowering and podding dates were recorded when 50% of plants had emerged (January 2 2010, and January 2 2012), flowered (April 1-8 2010, and April 1-12 1 2012) and podded (May 7 2010, and April 29-May 1 2012) in each sub-plot. All plants were harvested at the end of June during both growing seasons. In the experiment, agronomical traits were measured considering the methods used in international pulses experiments of ICARDA. Five plats were chosen at random from the central row of each plot for data recording on plant height (PH: cm), branch number (BN: number per plant), pod number (PN: number per plant), and seed number (SN: number per plant). After harvest, 100-SW (100-SW: g) was determined by mixing the whole sample, and then 100 seeds were randomly counted and weighted. For seed yields (SY: kg ha^{-1}), all rows were harvested, threshed, cleaned, weighed and converted into kg ha^{-1}.

The research region has a Mediterranean climate with wet winters and hot dry summers. According to the long-term average from four decades of records, there is early total precipitation of 625 mm and mean temperature 18.7 ^{o}C. Mean temperature and total precipitation of the growing seasons during 2009-2010 and 2011-2012 are shown in Figure 1 and Figure 2.

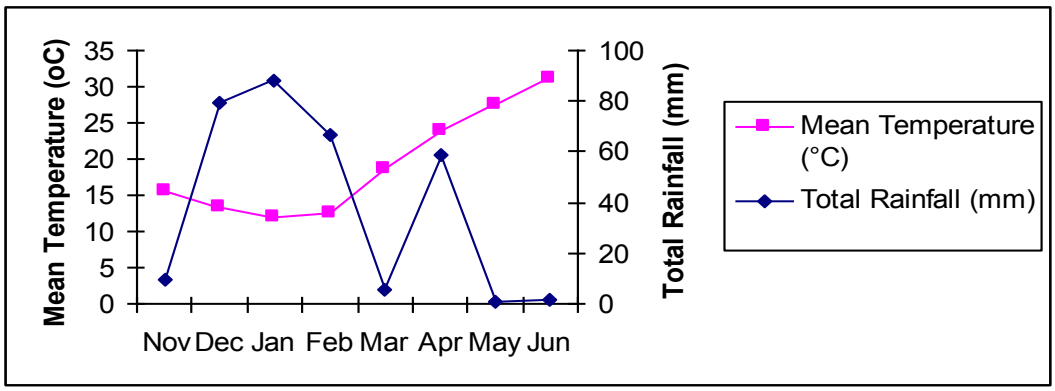


Figure 1. Mean temperature (^{o}C) and total rainfall (mm) in 2009-2010 growing seasons

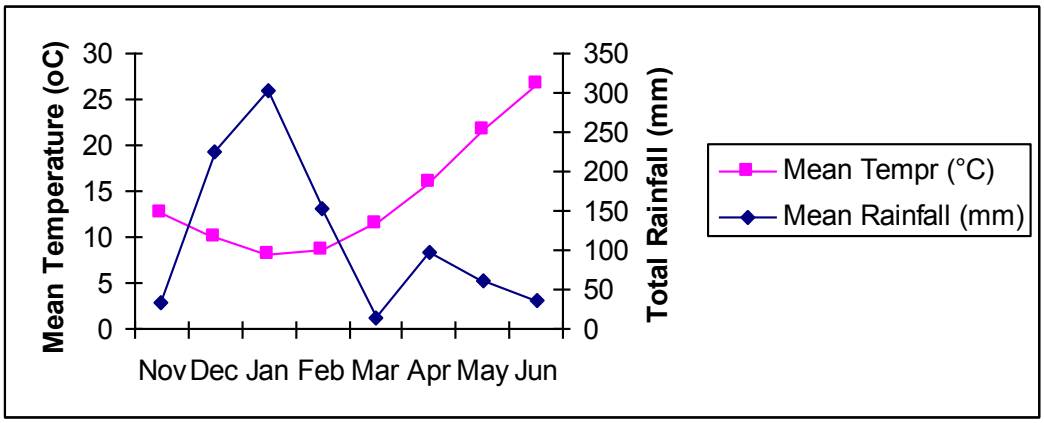


Figure 2. Mean temperature (^{o}C) and total rainfall (mm) in 2011-2012 growing season

The soil of the research area is clay that has a pH of 6.7, 1.2% organic matter, 23.6% $CaCO_3$ and 0.09% salt content. All data for each trait were statistically analysed separately the experimental years, and comparisons between means were made using least significant differences (LSD) at 0.05 probability level. All statistical analyses were performed using the SAS program (SAS Institute, 1999).

Results and discussion

Mean values and groups of 2009-10, 2011-12 and combined year about plant height, branch number and pod number obtained from chickpea genotypes were given in Table 1.

According to Table 1, the first growing season resulted in taller plant heights than the second growing season, in which average plant heights were 86.0 cm and 57.5 cm, respectively. Vegetative development of the plants continues until the initiation of the flowering. The longer time between emergences to flowering of chickpea resulted taller plant in the first growing season. Similar results are in agreement with those obtained by Yucel and Anlarsal (2008). There were significantly differences among the genotypes in both year and combined year. Plant height values were ranged between 89.5-78.5 cm, 61.2-51.5 cm and 75.1-67.2 cm, in 2009-10, 2011-12 and combined year respectively. FLIP 00-39, FLIP 01-34 and FLIP 01-54 genotypes recorded the highest value with significant differences in comparison to other cultivars at both growing seasons.

Branch number (number per plant) was higher in the second growing season compared with the first growing season (average 9.1 and 4.9 numbers per plant, respectively). This reduction in branch number could be attributed to the negative and significant correlation between plant height and branch number (Table 3). On the other hand, Ozveren Yucel and Anlarsal (2010), Farshadfar and Farshadfar (2008) and Malik *et al*. (2010) reported that branch number positively correlated with plant height. Branch number was affected by genotypes in 2011-12 and combined year. However, differences among the genotypes were not found significant in 2009-10. In terms of branch number, INCI cultivars produced significantly higher branch numbers compared with the other cultivars (Table 1).

Table 1. Mean values and groups of plant height (cm), branch number (number per plant) and, pod number (number per plant) of chickpea (*Cicer arietinum* L.) genotypes

	Plant Height (cm)			Main Branch Number (number per plant)			Pod Number (number per plant)		
Cultivars	2009-10	2011-12	Comb. Year	2009-10	2011-12	Comb. Year	2009-10	2011-12	Comb. Year
FLIP 00-39	89.5 a	59.9 a	74.7 a	4.7	10.7 ab	7.7 ab	80.1 a	37.7	58.9 a
FLIP 01-34	89.1 ab	61.2 a	74.9 a	4.7	7.1 cd	7.1 abc	35.3 d	34.1	33.2 c
FLIP 01-54	89.1 ab	60.7 a	75.1 a	5.6	9.5 abc	6.4 bc	61.2 c	39.9	47.6 b
FLIP 01-1C	88.3 ab	51.5 b	69.9 b	5.2	6.7 d	5.9 c	65.9 bc	31.3	48.6 b
AYDIN-	81.8 bc	55.9 ab	68.8 b	4.5	8.9 bcd	6.7 bc	62.4 c	33.4	47.9 b
INCI-	78.5 c	55.9 ab	67.2 b	5.1	11.7 a	8.4 a	79.2 ab	36.2	57.7 a
MEAN	86.0 A	57.5 B		4.9 B	9.1 A		64.0 A	34.0 B	
LSD (5%)	1.63	1.31	1.12	NS	0.58	0.35	3.01	NS	2.02

Pod number (number per plant) was higher in the first growing season compared with the second growing season (average 64.0, and 34.0 numbers per plant, respectively). This may be attributed to many factors such as water and temperature stress. As seen in Figure 1, during the podding and after the podding stage, total rainfall was higher but mean temperature was lower in 2011-12 comparison with 2009-2010. These results indicate that pod number is greatly influenced by temperature and precipitation. The effect of these factors during critical stages such as flowering and podding has previously been described in different crops (Al-Rifaee *et al*. 2004; Bakry *et al*. 2011; Anlarsal *et al* 2001, Bilgili *et al* 2010). Pod number values were ranged between 80.1-35.3, 39.9-31.3 number per plant in 2009-10 and 2011-12 growing seasons; combined values of two years were also changed between 57.7 and 33.2 number per plant. There were significant differences among genotypes in 2009-10 and combined year, and the highest value was recorded on FLIP 00-39 and INCI cultivars.

Mean values and groups of 2009-10, 2011-12 and combined year about seed number, 100 seed weight and seed yield obtained from chickpea genotypes were given in Table 2.

Seed number (number per plant) was higher in the first growing season compared with the second growing season (average 69.4, and 32.3 numbers per plant, respectively). The podding stage is a highly critical stage for production of chickpea and is affected by environmental factors. Any climatic fluctuation in this critical stage may cause serious losses in production. As seen Table 3, seed number was significantly and positively correlated with pod number. Differences between the two years in terms of seed number may be due to the higher pod number in the first growing season. Seed number values were ranged between 86.1-38.0, 34.8-29.9 and 60.1-35.4 number per plant in 2009-10, 2011-12 and combined years. There were significant differences among genotypes, and the lowest value was recorded on FLIP 01-34 in 2009-10 and combined year. According to Table 2, values of 100 SW were ranged between 38.28-35.9, 38.3-32.75g in 2009-10 and 2011-12 growing seasons; combined values of two years were also changed between 38.2-35.3g.

Seed yield (kg ha^{-1}) was influenced by growing season (Table 2). It was higher in the first growing season compared with the second growing season (average 2598.6, and 2269.9kg ha^{-1}, respectively). With regard to seed yield, there were significantly differences among genotypes and ranged between 2913.9-2280.6 and 2632.8-1472.0 kg ha^{-1}, between in 2009-10 and 2011-12 growing seasons; combined values of two years were also changed between 2770.2-1876.3 kg ha^{-1}.

Table 2. Mean Values and Groups of Seed Number (number per plant), 100-Seed Weight (g) and, Seed yields (kg ha^{-1}) of Chickpea (*Cicer arietinum* L.) Genotypes

	Seed Number (number per plant)			100-SW (g)			Seed Yield (kg ha^{-1})		
Cultivars	2009-10	2011-12	Comb.Year	2009-10	2011-12	Comb. Year	2009-10	2011-12	Comb. Year
FLIP 00-39	86.1 a	34.1	60.1 a	36.9 ab	38.3 a	37.6 ab	2472.2 bc	2356.4 a	2414.3 ab
FLIP 01-34	38.0 b	29.9	35.4 b	38.28 a	32.75 b	38.2 a	2508.3 bc	1472.0 b	2295.0 b
FLIP 01-1C	72.2 a	32.85	51.1 a	36.68 b	37.43 a	35.3 c	2280.6 c	2081.7 ab	1876.3 c
FLIP 01-54	72.75 a	30.95	51.9 a	36.5 b	36.88 a	36.7 b	2788.9 ab	2450.1 a	2619.5 ab
AYDIN	72.3 a	30.93	51.6 a	36.65 b	38.13 a	37.4 ab	2627.8 ab	2632.8 a	2630.3 ab
INCI	75.0 a	34.8	54.9 a	35.9 b	37.30 a	36.6 bc	2913.9 a	2626.6 a	2770.2 a
MEAN	69.4 A	32.3 B		36.8	37.1		2598.6 A	2269.9 B	
LSD (5%)	4.24	NS	2.67	0.32	0.65	0.31	7.12	15.07	10.17

The rainy conditions and lower of temperature during growth, flowering, podding and filling of pods stages adversely affected vegetative growth in 2011-12, therefore these situation resulted in the reduce of several agronomical characters contributing to seed yield such as plant height, pod number, seed number, and 100-seed weight. These results are in agreement with those obtained by Kayan and Adak (2012), who reported that rainfall affected grain yield, plant height, pod number per plant. Furthermore, in terms of seed yield, data given in Table 3 showed that positive and significant correlation between seed yield and plant height, pod number, seed number and 100 seed weight functioned as major contributors to seed yield of chickpea. These results represented that selection based on pod number, seed number and 100 seed weight increase seed yield.

Table 3. Correlations among characters in chickpea (*Cicer arietinum* L.) Genotypes (n=48)

Variable[1]	by Variable	Correlation	Signif Prob	Plot Corr
BN	PH	-0.6826	0.0000	
PN	PH	0.6619	0.0000	
PN	BN	-0.4662	0.0008	
SN	PH	0.7237	0.0000	
SN	BN	-0.5155	0.0002	
SN	PN	0.9440	0.0000	
100 SW	PH	-0.0722	0.6255	
100 SW	BN	0.3214	0.0259	
100 SW	PN	-0.2139	0.1443	
100 SW	SN	-0.1670	0.2566	
SY	PH	0.1992	0.1748	
SY	BN	0.0853	0.5645	
SY	PN	0.3594	0.0121	
SY	SN	0.3213	0.0260	
SY	100 SW	0.3390	0.0184	

[1] BN: branch number (number per plant), PH: plant height (cm), PN: pod number (number per plant), SN: seed number (number per plant), SY: seed yield (kg ha^{-1})

Conclusions

From the above results and discussion, the used cultivars have different seed's characters which can significantly affect their performance and the FLIP 00-39 and FLIP 01-54 genotypes were determined to be adaptable to Mediterranean-type conditions. These genotypes may be suggested for wintry weather chickpea grown.

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ОДРЕДУВАЊЕ НА ПРИНОСОТ И КОМПОНЕНТИТЕ НА ПРИНОС КАЈ НЕКОИ ГЕНОТИПОВИ ЗИМСКИ НАУТ ВО УСЛОВИ НА МЕДИТЕРАНСКА КЛИМА

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Апстракт

Студијата беше спроведена со цел утврдување на ефикасноста на некои потенцијални генотипови зимски наут. Истражувањето беше спроведено во текот на зимскиот период 2009/2010 и 2011/2012 во услови на медитеранска клима во Турција. Експериментот беше поставен во рандомизиран блок систем, во три повторувања со четирите потенцијални линии и две регистрирани сорти. Во ова истражување, според комбинираните години, генотиповите наут беа меѓусебно статистички различни во однос на сите карактеристики. Испитуваните карактеристики беа променливи и тоа за: висината на растенијата од 67,2 cm до 75,1 cm, бројот на главни гранки од 5,9 до 8,4 гранки, бројот на мешунки по растение од 33,2 до 58,9 мешунки, бројот на семки по растение од 35,4 до 60,1 семки, тежина на 100 семки од 35,3 до 38,2 g, и приносот на семе од 1876,3 до 2770,2 кг $ха^{-1}$. Од добиените резултати, линиите FLIP 00-39 и FLIP 01-54 може да бидат предложени за одгледување на зимски наут во услови на медитеранска клима.

Клучни зборови: наут, сорти, принос, компоненти на принос.

SECTION 2: VITICULTURE AND WINE PRODUCTION

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Original scientific paper

CLONAL SELECTION AND ESTABLISHMENT OF MOTHER PLANTATIONS OF VRANAC VARIETY

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Abstract
Bearing in mind the importance of vranac variety for the Montenegrin viticulture, work on clonal selection of this variety has started in 2004 year. After conducting mass positive selection, genotypes with the best characteristics were chosen. Selected mother vines that have passed sanitary control (ELISA, PCR and indexing) are propagated and included in the further process of selection. In the period of 2008/2009 year prebased mother plantation of potential clones was planted. Paper presents ampelographic and economic-technological characteristics of clonal candidates. In specific features potential clones have surpassed population of variety and by its structure, fullness and fruity wine character, clone candidate NC V 15-13 was stood out. Mother plantation of based category is planted in 2010. Mother plantation of high genetic potential and sanitary controlled will serve as repromaterial for the production of certified grapevine grafts-clones of vranac variety.
Key words: vranac, clonal selection, sanitary status, mother plantation.

Introduction

Viticulture production and winemaking of Montenegro is mostly based on breeding of autochthonous grapevine varieties (vranac, kratosija, krstac and zizak). Vranac is the main autochthonous grapevine variety in Montenegro. The most famous vineyard area in Montenegro is Crmnica, which is considered as a homeland of *Vranac* variety. On this area, autochthonous *Vranac* variety was cultivated for centuries and was used for producing the wine of superior quality. From Crmnica, variety *Vranac* was spread throughout Montenegro. Today, the company „13. Jul Plantaze” owns 2310 hectares of vineyards in one complex and 70% of vineyards have been planted with *Vranac* variety. Many authors, Stojanovic (1929), Bulic (1949), Ulicevic (1959, 1966) state about Vranac variety only as Montenegrin variety from Crmnica, and recently, Buric (1995), Bozinovik (1996), Cindric (2000), Avramov (2001) state that Vranac is autochthonous grapevine variety in Montenegro. Nastev (1967) points out that ‘Vranac’ is Montenegrin variety spread in Crmnica and in Montenegrin seacoast. In Macedonia ‘Vranac’ was transferred and planted 1950 on experimental field (Butel) and later it spread out in Macedonia throughout the former Yugoslavia. Bearing in mind the importance of autochthonous assortment for Montenegrin viticulture and wine making sector, it is intensively working on clonal selection of autochthonous grapevine varieties in Montenegro, primarily variety vranac. As a previous result of work on clonal selection of vranac variety, within the population of variety, certain vines which passed complete sanitary control were selected, propagated and planted. After the first crop of planted clone candidates, their ampelographic, technological and economic characteristic were comparing successively for several years with the population of the variety. Clone candidates with some positive characteristics clearly

expressed and transmitted to the vegetative offspring by which they surpass the population of variety will be included in the process of recognition.

Appreciating the importance of conservation of varietals purity and quality of the grafts, in planting new vineyards at the same time work on improving the production of grapevine grafts is performed. Quality vine grafts are the main base of a successful and economic viticulture. By planting mother plantations with selected material, the base for the production of certified grafts of vranac variety will be created. In this way, beside improvement of agribiological, economic and technological characteristics of vranac variety, clonal selection will contribute to the preservation of varietal purity, spread of sanitary and healthy grapevine grafts, and therefore prevention of the variety degradation and quality of wines characteristic for this variety.

Material and methods

The research was conducted at Cemovsko field, on the vineyards of the company "13. jul Plantaze". By visual observation during the growing season from population of variety, vines that have stood out by their characteristics were selected. Sanitary status of population is analysed by ELISA, PCR and indexing. Testing on the viruses was conducted on 145 vines of vranac variety. From vranac population, 5 vines have passed complete sanitary control. Selected vines that have passed sanitary control are propagated and planted on the soil free from nematodes. Planted vineyard serves for the research of the potential clones and at the same time represents mother plantation of pre-based category. Vineyard is planted on object Nikolj crkva, on base rootstock 1103P.

The distance of planting in the vineyard is 2.6 x 1.2m. Vines were formed in the shape of double horizontal cordon, height 70 cm from the ground. Back was constructed by a combination of concrete posts and wire. The mixed pruning was applied.

After the first crop, during 2009-2012 all potential clones and population of variety were observed and their ampelographic and technological characteristics were compared. Ampelographic data were collected as specified by the Organisation Internationale da la Vigne et du Vin (OIV 2001).

Quality of wines of potential clones is examined with standard methods and wine is produced in cellar of microvinification of company "13. jul Plantaze".

Mother plantation of based category of vranac variety population (potential clones) was formed 2010. on the object Kuce Rakica, using vine grafts obtained from the reproduction material from mother plantation of prebased category and based rootstock 1103P.

Results and discussion

Selection of mother vines and their sanitary control

After multi-years of visual observation during vegetation, in 2004. within the population of vranac variety vines with the certain positive phenotip characteritics (uniformity of varietal characteristics and the absence of symptoms of major diseases transmitted by vegetative propagation) were marked, what represents a start of work on clonal selection. Paralely with ampelographic characterisation and confirmation of varietal identity as vranac variety (by SSR markers), their sanitary control was done.

Marked vines of the population of vranac variety were tested on the presence of viruses by ELISA, PCR and indexing. Testing on the viruses was conducted on 145 vines of vranac variety. Most samples – 55 vines (37.93%) were infected by virus LR3 and 45 vines (31.03%) by GVA+LR3. There were not infected vines by AR3 virus. Using ELISA test, the presence of viruses was not

identified in 17 vines (11.72%). Vines which passed sanitary control by ELISA test were also tested by PCR. Out of 17 tested vines, 5 vines (29.41%) were infected with RSP and the same (29.41%) with RSP+NN. From the total number of tested vines by PCR and indexing, presence of virus was not identified in 5 vines (29.41%). Vines that are negative represent very useful material which entered in procedure of individual clone selection. Selected vines in population of vranac that passed complete sanitary control – mother vines were grafted on based rootstock Paulsen 1103, propagated and planted, in order to continue with their examination and selection. Plantation which serves for examination of potential clones (mother plantation of prebased category) is planted in 2008 on the locality Nikolj Crkva.

Ampelographic characteristic

Beside regular sanitary control, after first crop of propagated mother vines (2009), it was started with ampelographic observations. Ampelographic descriptions of potential clones relative to top of young shoot, mature leaf, inflorescence, bunch and berry, according to the OIV descriptors are presented in Figure 1. Within the population of vranac variety and most of potential clones, top of young shoot is medium anthocyanin colorated on prostrate hairs (Code 003 – notation 5), exept potential clone NC V 62-7, which has low anthocyanin coloration on prostrate hairs (notation 3). Density of prostrate hairs on the top of young shoot (Code 004) is lower (notation 3) of potential clones NC V 62-7 and NC V 62-8, compared with population of variety and the rest of potential clones (notation 5). For visual assessment of mature leaf 6 OIV descriptors are presented. Differences are observed in the shape of the leaf (Code 067) of potential clones NC V 62-7 and NC V 62-8 (notation 2), while all the others leaf descriptors were identical in the population of variety and potential clones.

GROUP	Top of young shoot		Shoot	Mature leaves						Inflor.	Bunch				Berry						
OIV CODE	003	004	016	067	068	076	079	084	085	151	201	202	204	206	220	223	225	231	235	236	241
Potential clones																					
NC V 62-7	3	3	1	2	3	2	5	1-3	3	3	2	3	7	1	3-5	2	6	1-3	2	5	3
NC V 62-8	5	5	1	2	3	2	5	1-3	3	3	2	5	5	1	3-5	2	6	1-3	2	5	3
NC V 62-13	5	3	1	3	3	2	5	1-3	3	3	3	5	5	1	3-5	2	6	1-3	2	5	3
NC V 14-39	5	5	1	3	3	2	5	1-3	3	3	2	5	5	1	3-5	2	6	1-3	2	5	3
NC V 15-13	5	5	1	3	3	2	5	1-3	3	3	3	5	5	1	3-5	2	6	1-3	2	5	3
POPULATION	5	5	1	3	3	2	5	1-3	3	3	2	5	5	1	3-5	2	6	1-3	2	5	3

Figure 1. Ampelographic characteristics of potential clones and population of vranac variety

Number of bunches per vine (Code 202) was the highest in NC V 62-13 and NC V 15-13 (2.1-3 bunches – notation 3). In term of based bunch characteristics, potential clone NC V 62-7, was stood out with short and dense bunch (Code 202 – 3 and Code 204 - 7), in comparison with population and other clones, which have medium lenght and medium dense bunch (notation 5). In all examinated potential clones and population of vranac variety, berry is short to medium long (Code 220), globose (Code 223), blue black colored (Code 225).

Quality of grapes, must and wine of potential clones and population of vranac variety

In figure 2. are presented four-years results of number of bunches per vine, ampelometric examination of bunch and berry (weight, lenght and width) as well as the quality of grapes and

wine. Quality of grapes is expressed as content of sugar, toatal acids and pH values in must. Chemical analysis of wine are done by standard method.

PARAMETERS 2009/2012							Must			Wine				
POTENTIAL CLONES	Num. of bunches per vine	Weight of bunch (g)	Length of bunch (cm)	Width of bunch (cm)	Length of berry (mm)	Width of berry (mm)	Sugar (%)	pH	Total acids (g/l)	Alcohol (vol%)	Total extract (g/l)	Total acids (g/l)	Anthocy-anins (mg/l)	Total polyphe-nols (g/l)
	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$
NC V 62-7	14	254.27	13.15	8.65	15.75	14.13	23.45	3.75	5.22	13.81	31.00	5.88	781	3.39
NC V 62-8	16	326.52	16.89	9.43	15.77	14.46	21.95	3.66	4.81	13.08	28.40	5.45	750	2.63
NC V 62-13	19	323.97	16.35	9.18	15.41	14.34	21.35	3.66	5.35	12.83	29.00	5.66	686	3.03
NC V 14-39	20	302.26	16.59	9.53	15.31	13.70	24.60	3.75	4.29	14.50	35.75	5.92	793	2.73
NC V 15-13	18	310.94	15.92	9.23	15.19	13.52	24.90	3.73	4.54	14.79	38.60	5.75	963	3.14
POPULATION	20	232.30	17.05	9.55	16.21	14.75	22.25	3.55	4.74	13.44	29.45	6.23	704	2.96
MAX.	20	326.55	17.05	9.55	16.21	14.75	24.9	3.75	5.35	14.79	38.60	6.23	963	3.39
MIN.	14	232.30	13.15	8.65	15.19	13.52	21.35	3.55	4.29	12.83	28.40	5.45	686	2.63

Figure 2. Quality of grapes, must and wine of potential clones and population of vranac variety

The biggest morphological differences compared with other potential clones and population of vranac variety, are noticed in potential clone NC V 62-7. The highest sugar content is measured in clone candidate NC V 15-13, following by potential clone NC V 14-39, while the highest content acids has potential clone NC V 62-13. According to these chemical parameters of must, mentioned potential clones surpass population of vranac variety. By quality of wine potential clone NC V 15-13 stand out in which the highest content of alcohol, total extract and anthocyanins are measured. The highest content of total polyphenols has potential clone NC V 62-7.

Establishment of mother plantation of potential clones

Mother plantation of prebased category of population of vranac variety, at the same time, represents plantation for examination and recognition of clones candidates of vranac variety. Vineyard was planted with grafts obtained from propagated vines which were selected and passed complete sanitary control within population of vranac variety (mother vines) on the based rootstock Paulsen 1103. As early mentioned, vineyard is situated on Nikolj Crkva. First grafts were planted in 2008 and in the next years, addition of plantation is continued. Currently, the plantation consists of 489 vines of vranac variety. Mother plantation of based category of vranac variety population was planted with reproduction material originated from prebased mother plantation of vranac variety and base rootstock Paulsen 1103. Plantation was formed in 2010. on Kuca Rakica, on the soil previously tested on the presence of nematodes. In the first year, 1872 grafts were planted, and in the next years that number is increased. In table 3. number of planted grafts in based mother plantation of variety vranac is presented. By planting of this vineyard, base for the production of certified gratfs of vranac variety was created. By planting of this vineyard, base for the production of certified grafts of vranac variety was created.

Conclusions

Within population of vranac variety from 145 tested vines, 5 vines have passed complete sanitary control. These vines entered in process of clonal selection. After propagation of selected vines, plantation of prebased category was formed by potential clones and in it their ampelographic, technological and economic characteristics were observed. By quality of wine potential clone NC V

15-13 stand out in which the highest content of alcohol, total extract and anthocyanins are measured. The highest content of total polyphenols has potential clone NC V 62-7. From the all potential clones and population of vranac variety, potential clone NC V 15-13 was stood. By planting of mother plantation of prebased and based category it is created base for production the highest quality category of vine grafts - certified gratfs of vranac variety.

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КЛОНСКА СЕЛЕКЦИЈА И ФОРМИРАЊЕ НА МАТИЧНИ ЛОЗЈА ОД СОРТАТА ВРАНЕЦ

Весна Мараш, Милена Томиќ, Весна Коџуловиќ, Јована Раичевиќ, Сања Шучур

Апстракт

Имајќи ја во предвид важноста на сортата вранец за лозарството на Црна Гора, клонската селекција на оваа сорта започна во 2004 година. Откако се изврши масовна позитивна селекција, генотиповите со најдобри карактеристики беа употребени. Селектираните матични лози кои ја поминаа санитарната контрола (ELISA, PCR и индексирање) се размножени и вклучени во натамошниот процес на селекција. Во периодот 2008/2009 година предбазниот материјал на потенцијалните клонови беа уматичени. Овој труд ги презентира ампелографските и економско технолошките карактеристики на кандидатите за клонови. Во одредени карактеристики потенцијалните клонови ја надминуваат популацијата на сортата во однос на структурата, полноста и овошниот карактер на виното, клонскиот кандидат NC V 15-13 се истакна. Матични лозја од базна категорија се подигнати во 2010. Матични лозја со висок генетски потенцијал и санитарно контролирани ќе послужи како репорматеријал за производство на сертифицирани калемени садници од сортата вранец.

Клучни зборови: вранец, клонска селекција, санитарна состојба, матични лозја.

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TECHNOLOGICAL CHARACTERISTICS OF THE AUTOCHTHONOUS TABLE VARIETY MONASTERY WHITE, SIGNIFICANT FOR HER REPRESENTATION OF THE MACEDONIAN MARKET

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Abstract
With respect to the use and preservation of domestic genetic fund of the vine, in newly discovered variety monastery white (klis izjum) made ampelographic identification, collection and propagation. Domestic, autochthonous grape varieties have a range of positive attributes that can be used for further selection. For this purpose, in the variety monastery white performed a number of tests, of which the most significant are the tests of technological features. In their examination can get a realistic picture quality, economic and use value of this variety and the possibility of its entry into assortments, and therefore greater representation in the market in the Republic of Macedonia. Technological characteristics were examined; mechanical composition of the bunch of grape and grain, mechanical properties of the bunch of grape and grain (transportability and reaction strength), chemical composition of grapes, during storage in the refrigerator and organoleptic evaluation. From the obtained results it can be seen that the variety monastery white has a high percentage of packaged grapes, characterized by good transportability and successfully kept in the refrigerator for several months. It also has favorable chemical composition and high general organoleptic evaluation. It meets the criteria for quality table variety. Negative in this variety is that sometimes occurs unequally (unevenly) fertilization.
Key words: monastery white, klis izjum, genetic fund, identification, technological features, autochthonous varieties, transportability.

Introduction

Variety white monastery is found in a limited place in Valandovo site, that it is found as individual lineages in monastery near Valandovo of it taken coil branches propagated planting in individual manufacturer. Then he plant variety is breed and introduced in the Collection plantation of Agricultural Institute, where made a number of tests on a number of parameters to prove its autochthony. White variety monastery tests were carried out in the period 2003 - 2006. The main task of the tests in this variety was ampelografical and genetically to identify and prove its origin (whether indigenous or autochthonous our area) with a common goal to further enter into assortments Republic of Macedonia. Also, one of the objectives of the test is a collection of the variety and use of its positive properties for further positive selection planned. Technological features are most valid features that prove the suitability of a variety into assortments, to be further distributed market and crowds out other varieties. Therefore in this paper examined the technological features with several parameters to prove the quality of the white variety monastery.

Material and methods

In the period from 2003 to 2006 and beyond in the variety monastery white investigated following technological properties; mechanical composition of grapes and grain, the mechanical properties of the cluster and grain (transportability and reaction strength), chemical composition of grapes, during storage the refrigerator and organoleptic evaluation. The mechanical composition of grapes and grain, mechanical properties of grapes and grain (transportability and reaction strength) and the structure of the cluster and grain are determined according to the standards of the OIV (International Bureau of grapes and wine). Chemical composition of the grapes was analyzed by HPLC methods. Examining the length of time for storage of grapes used ordinary refrigerator temperature 2°C to 3°C in special containers without the addition of some chemicals. Organoleptic assessment is carried out by tasting commission standards for table grapes and examined the following characteristics; taste, appearance, consistency, specifics of grapes and eventually gets an overall score.

Results and discussion

Studies of the mechanical composition of the bunch showed that the weight of the cluster in the white variety monastery averages 367,16 grams, length is averages 17,80 cm, width is approximately 12,17 cm, ratio length / width is 1,46 and the number of fertilized grains in the cluster averages 99,07. According to the tests of the mechanical composition of the grain showed that the weight of the grain averages 5,00 grams, length is approximately 21,1 mm, width is 20,5 mm and average ratio length / width is 1,03.

Table 1. Mechanical composition of the bunch of grape (weight, length, width)

Variety	Weight of the cluster (g)	Length (cm)	Width (cm)	L/W	Number of fertilized grains in the cluster
Monastery white	367,16	17,80	12,17	1,46	99,07

Percent of grapes and grain structure are shown in Table 3, where it can be seen that this variety has a high percentage of structural indicator of 9,93% which suggests that the variety with a high percentage of usable (the consumer) structure. Mechanical properties of grapes and grain represented by transportability and reaction strength of the grapes. Research show that white variety monastery is characterized by favorable mechanical parameters; reaction strength (resistance to pressure) of grain is 2047 (g) and resistance to splitting of grain (g) is 711. Chemical composition of the grapes is represented by the amount of sugar and total acids in grape juice analyzed as appropriate fractions of the HPLC detector. Average sugar is 188 g/dm3 and total acids 5,1 g/dm3. In Table 6 we can see the time the variety store in months, the loss of water and the dynamics of maintaining fresh consumption. The variety has a loss of water (3,9%, 4,8%, 6,7% and 8,9%), but is in good condition, not a waste and is suitable for medium term storage. In Table 7 we can see the individual scores for appearance, consistency, taste, specifics, overall impression and overall score (15,8). White variety monastery as a table variety is highly appraised of tasting commission.

Table 2. Mechanical composition of the grain of grape

Percentage of bunch stem	2,55	2,56	2,38	2,52	2,50
Percentage of skin	3,80	5,23	4,25	5,68	4,74
Percentage of seeds	1,82	2,35	1,65	2,28	2,03
Percentage of meat	91,83	89,86	91,71	89,52	90,73
Skeleton	6,34	7,79	6,63	8,20	7,24
Solid residue	8,17	10,14	8,29	10,48	9,27
Structural indicator	11,24	8,86	11,07	8,54	9,93

Table 3. Grapes and grain structure

Variety	Weight of the grain (g)	Length (cm)	Width (cm)	L/W
Monastery white	5,00	21,1	20,5	1,03

Table 4. Mechanical properties of the bunch of grape and grain (transportability and reaction strength)

Variety	Reaction strength (resistance to pressure) (g)	Resistance to splitting of grain (g)
Monastery white	2047	711

Table 5. Chemical composition of grapes

Variety	Sugar g/dm^3	Total acids g/dm^3
Monastery white	188	5,1

According to the first tests made in this paper and according to the reference data of the authors examined other autochthonous varieties (Aradhya MK and col., 2003), (Galet P. 1998), autochthonous feast breed white monastery is a variety that meets the standards for quality and has high organoleptic evaluation (grade). The only negative feature of this variety is unbalanced fertilization because it is a hermaphrodite. This indigenous variety is suitable for warm places in our country and is recommended for Macedonian assortments and Macedonian market.

Table 6. During storage in the refrigerator

Variety	Beginning in December (about 40-50 days from harvest)	Beginning in January (about 70-90 days from harvest)	Beginning in February (about 100-120 days from harvest)	Beginning in March (about 130-150 days from harvest)	Note
Monastery white	3,9%	4,8%	6,7%	8,9%	The variety has a loss of water, but is in good condition (not a waste) suitable storage medium

Table 7. Organoleptic evaluation

Variety	Outdoor. appearance 1 - 3	Consistency 1 - 3	Taste 1 - 3	Specifics 0.1 - 1	A general impression to 10	TOTAL
Monastery white	2,5	2,5	2,4	0,5	7,9	15,8



Figure 1. Variety monastery white



Figure 2. Organoleptic evaluation

Conclusions

In the white variety monastery bunch is a nice, large, medium dense, with a high percentage of packed grapes but often with more unfertilized grain table average 367,16 g and percentage of meat from 89,52 to 91,83%.

White variety monastery also features large grain (average 5,00 g), good transportabilityt and successfully kept in the cooler months.

This variety has an average of 188 g/dm3 sugar and 5,1 g/dm3 total acids. According degustation assessment, which is obtained by multi-tasting varieties by tasting commission, the highest overall assessment monastery white is 15,8 points.

With this assessment, newly discovered, indigenous, white table variety monastery, found in the Republic of Macedonia is an attractive way ahead to become part of assortments and it is with its further research and dissemination fully reveal its quality and to break into the market.

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ТЕХНОЛОШКИ КАРАКТЕРИСТИКИ НА АВТОХТОНАТА ТРПЕЗНА СОРТА МАНАСТИРСКО БЕЛО, ЗНАЧАЈНИ ЗА НЕЈЗИНА ЗАСТАПЕНОСТ НА МАКЕДОНСКИОТ ПАЗАР

Биљана Коруноска, Звонимир Божиновиќ, Елизабета Ангелова, Сребра Илиќ-Попова

Апстракт

Цел на истражување. Од аспект на искористување и зачувување на домашниот генетски фонд од винова лоза, кај новооткриената сорта манастирско бело (клис изјум) направени се ампелографска идентификација, колекционирање и размножување. Домашните, автохтони сорти винова лоза имаат низа позитивни својства кои можат да се искористат во понатамошната селекција. За таа цел кај сортата манастирско бело извршени се голем број на испитувања, од кои позначајни се испитувањата на технолошките карактеристики. Со нивно испитување може да се добие реална слика за квалитетот, стопанската и употребната вредност на оваа сорта и можноста за нејзино влегување во сортиментот, а со тоа и поголема застапеност на пазарот во Р. Македонија. Применети методи. Од технолошките карактеристики беа испитани; механичкиот состав на гроздот и зрното, механичките својства на гроздот и зрното (транспортабилност и реакциона цврстина), хемискиот состав на грозјето, време на чување во ладилник и органолептичка оценка. Резултати. Од добиените резултати може да се види дека сортата манастирско бело има висок процент на пакувано грозје, се карактеризира со добра транспортабилност и успешно се чува во ладилник и по неколку месеци. Исто така има поволен хемиски состав и висока општа органолептичка оценка. Со тоа ги задоволува критериумите за квалитетна трпезна сорта. Негативно кај оваа сорта е што понекогаш се јавува реулавост (неизедначеност) во оплодувањето.

Клучни зборови: манастирско бело, клис изјум, генетски фонд, идентификација, технолошки карактеристики, автохтони сорти, транспортабилност.

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AGROBIOLOGICAL AND TECHNOLOGICAL INVESTIGATION OF ELITE HYBRID VINE FORMS FROM CROSSES OF THE CULTIVAR GAMZA

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Abstract
An agrobiological and technological investigation of elite hybrid vine forms obtained from crosses of the cultivar Gamza has been conducted. It has been established that according to the time of maturation, these forms ripen late and very late – their grapes reach technological maturity during the second half of September and in the middle of October. There are no significant differences in the duration of the separate phenophases during the vegetation period. The hybrid forms have a distinct wine character, with medium-sized clusters and berries, high actual fertility and yield. In their growing region, the amount of sugars and acids in the must does not meet the standards for the production of quality red dry wines.
Key words: elite hybrid vine forms of the cultivar Gamza, agrobiological and technological investigation.

Introduction

Gamza is one of the well-known old vine cultivars, which has been grown since ancient times in North Bulgaria. In spite of its excellent adaptation to the local soil-climatic conditions, it is also characterized by certain agrobiological disadvantages related to the later ripening of grape, insufficient resistance to low winter temperatures and the disease grey rot (Botrytis cinerea), etc. (Donchev, Stoev 1982, Boshkov et al., 1996, Vladimirova 2009, Bozinovik, 2010). The improving of the commercial qualities of this cultivar has been performed by means of the selection methods sex hybridization and clone selection, aiming at the development of analogous cultivars possessing its positive characteristics, but not its technological drawbacks. Evaluation of the selected elite vine forms includes their ampelographic characterization, which is especially important for their recognition in practical viticulture (Valchev 1990, Magriso et al., 1979). The purpose of this investigation is to determine the phenotypic values of the most commercially-important agrobiological and technological indices of selected elite hybrid forms from crosses of the cultivar Gamza.

Material and methods

The experiment included 25 plants from each of the three selected elite hybrid forms from crosses of the cultivar Gamza, developed in the Institute of Viticulture and Wine Production – Pleven by Yordan Ivanov, PhD, and grown since 1990 in the selection field and ampelographic assortment of the Educational and Experimental Centre of the Department of Viticulture, Agricultural University – Plovdiv: Gamza x Malbek XII-13, Gamza x Pinot Noir XXII-23, Gamza x Game Noir XXII-71.

After the initiation of complete productivity of the vines from the three hybrid forms and the cultivar Gamza, grafted on the rootstock Berlandieri x Riparia SO 4, phenological observations, determination of the actual fertility and mechanical analysis of cluster and berry were conducted for a period of three years – 2008-2010, using methods described in Bulgarian Ampelography (1990). The fertility indices were established at an equal quantity of winter buds per vine – 8-10 nodes with 2 buds and one arrow with 6 buds. The statistical processing of the obtained results was carried out through dispersion analysis and multi-direction comparing test (Mokreva, Murgova 1997). All necessary agrotechnological care for the normal development of the experimental vines was provided throughout the entire growing period on Moser training system. No extreme climatic conditions were reported in that region for the period of the study.

Results and discussion

The data derived from phenological observations performed throughout the duration of the investigation of the hybrid forms, shows that the budding phenophase starts at the beginning of April – 05.04 – 09.04., the mass manifestation of this phenophase – 09.04. – 13.04., and its end – in the middle of the same month – 13.04. – 16.04. (Table 1). The appearance of the first leaf on young shoots takes place in the period 15.04. – 20.04., and the first inflorescence emerges from 18.04. to 23.04. One of the most important phenophases – flowering of vines – starts at the beginning of June – 02.06. – 04.06., its mass manifestation is observed 3-4 days later, and the end is from 10.06. to 14.06. The analyzed phenophases have almost identical duration in the three hybrid forms. The beginning of berry colouring is reported in the last days of July – 28.07. – 30.07., and the end of this essential for grape ripening phenophase is found to take place at the beginning of August – 04.08. – 07.08. Technological maturity in the hybrid form Gamza x Malbek XII-13 occurs about 21.09, in Gamza x Pinot Noir XXII-23 – 25.09., and in Gamza x Game Noir XXII-71 – approximately on 16.10. According to the time of ripening, the first two forms ripen late, and the third one ripens very late. In the mother cultivar Gamza budding and appearance of the first leaf and inflorescence begin later, flowering takes place almost simultaneously, berry colouring is during the second half of August, and technological maturity is reached at the end of September. Only the hybrid form Gamza x Game Noir XXII-71 ripens later than the cultivar Gamza. The actual fertility indices show certain differences through the years of the study, Gamza having the lowest phenotypic values. The percentage of developed buds is high in all three hybrid forms – from 77,83 % for Gamza x Game Noir XXII-71 to 84,24 % for Gamza x Pinot Noir XXII-23 (Table 2). The same refers to the percentage of fruiting shoots, which varies from 81,63 % to 97,16%. The actual fertility coefficient is a very important trait from the agrobiological characterization of each cultivar. All studied hybrid forms are characterized by comparatively high values of this index within the range 1,41 – 1,64. The fertility of substitute buds is from 0,44 to 0,65. The comparative mathematical analysis of the data shows that in all reported indices of actual fertility, three groups of reliability of differences form – a, b and c. It has been mathematically proven that the cultivar Gamza differs from the hybrid forms in most of the studied indices, with the exception of fertility coefficient of fruiting shoot and substitute shoot. Two groups – a and b – are more commonly observed in them, and the main differences exist between Gamza x Malbek XII-13 and the other two forms, which demonstrates the role of the father parent cultivar in the inheritance of these traits. The data obtained from the mechanical analysis of cluster shows that the percentage of stems in the three hybrid forms is from 3,24 % to 4,24 %, and the percentage of berries is from 95,76 % to 96,76 % (Table 3). The amount

of millerandage berries is the lowest in Gamza x Game Noir XXII-71 – 0,42 %. Within berry structure skins are 6,05 % - 9,02 %, seeds – 3,60 % - 5,35 %, and mesocarp – 85,63 % - 90,35 %. The analysis confirms that no considerable differences exist between the researched hybrid forms in relation to these indices. The average yield per vine is the highest in Gamza x Game Noir XXII-71 – 7,07 kg, and the lowest in Gamza x Pinot Noir XXII-23 – 3,97 kg. The hybrid forms are characterized by predominantly middle-sized clusters and berries. The weight of cluster and berry is comparatively greater in Gamza x Game Noir XXII-71 – 244 g and 3,97 g respectively. The sugar content is insufficient for the production of quality red wines – from 19,1 % to 21,5 %. Its values vary in separate years, which suggests its heavy dependence on external factors. In Gamza x Malbek XII-13 23,8 % sugars were accumulated in 2008. The average amount of acids is comparatively high – from 6,3 g/dm^3 to 7,5 g/dm^3. The theoretical output of must is within the limits 75,49 % - 84,11 %. The results from the mechanical and chemical analyses of cluster and berry form two groups of reliability (a and b) – for percentage of stems, berries, seeds and mesocarp, and in the remaining indices three groups are observed – a, b and c. Proven differences in the separate indices are present both between hybrid forms, and between them and the cultivar Gamza, but no steady trends are developed. The latest-ripening hybrid form - Gamza x Game Noir XXII-71 – is characterized by comparatively larger cluster and berry, high yield, percentage of berries, mesocarp and amount of acids, but it contains less sugars. Gamza x Malbek XII-13 possesses relatively better technological indices, and it surpasses the cultivar Gamza in the amount of sugars and acids and cluster sizes, but it has smaller berries.

Table 1. Phenological observations of the studied hybrid forms – average for the period 2008-2010

Hybrid combination	BUDDING			Appearance of the first leaf	Appearance of the first inflorescence	FLOWERING			BERRY SOFTENING			Technological maturity
	beginning	mass	end			beginning	mass	end	beginning	mass	end	
Gamza	13.04	15.04.	18.04	21.04	25.04	04.06	08.06	13.06	12.08	15.08.	23.08	29.09
Gamza x Malbek XII-13	06.04	09.04.	13.04	16.04	19.04	02.06	05.06	11.06	29.07	02.08.	06.08	21.09
Gamza x Pinot Noir XXII-23	05.04	10.04.	12.04	15.04	18.04	02.06	04.06	10.06	28.07	31.07.	04.08	25.09
Gamza x Game Noir XXII-71	09.04	13.04.	16.04	20.04	23.04	04.06	07.06	14.06	30.07	3.08	07.08	16.10

Table 2. Actual fertility of the studied hybrid forms – average for the period 2008-2010

Hybrid combination	Developed buds %	Fruiting shoots %	Shoot fertility coefficient	Main shoot fertility coefficient	Fruiting shoot fertility coefficient	Substitute shoot fertility coefficient
Gamza	67,40 c	75,00 c	1,30 c	1,43 c	1,57 c	0,40 c
Gamza x Malbek XII-13	79,85 b	97,16 a	1,64 a	1,75 a	2,17 a	0,65 a
Gamza x Pinot Noir XXII-23	84,24 a	88,97 b	1,47 b	1,57 b	1,91 b	0,51 b
Gamza x Game Noir XXII-71	77,83 b	81,63 b	1,41 b	1,52 b	1,64 c	0,44 c

Table 3. Mechanical and chemical analysis of cluster and berry in the studied hybrid forms – average for the period 2008-2010

Hybrid combinations	Mechanical analysis						Chemical analysis		Yield per vine kg	Average cluster weight, g	Cluster sizes		Average weight of 100 berries, g	Berry sizes	
	Cluster			Berry											
	Stems %	Berries %	Milleranda e berries %	Skins %	Seeds %	Mesocarp %	Sugars %	Acids g/dm^3			Length cm	Width cm		Length mm	Width mm
Gamza	a 4,20	ab 95,80	b 1,88	c 6,70	b 3,20	a 90,10	a 21,0	c 5,9	b 4,500	b 200,0	c 15,4	c 8,2	b 255	b 16,2	b 15,6
Gamza x Malbek XII-13	b 3,65	a 96,35	a 5,74	b 7,31	b 3,72	b 88,97	a 21,5	a 7,5	b 4,850	b 215,5	a 18,1	b 9,9	c 205	c 14,5	c 14,3
Gamza x Pinot Noir XXII-23	a 4,24	ab 95,76	a 5,21	a 9,02	a 5,35	b 85,63	b 20,2	b 6,3	c 3,970	c 173,0	b 16,7	b 9,3	c 200	c 14,5	c 14,8
Gamza x Game Noir XXII-71	b 3,24	a 96,76	c 0,42	c 6,05	b 3,60	a 90,35	c 19,1	b 6,5	a 7,070	a 244,0	a 17,5	a 10,5	a 397	a 17,9	a 17,8

Conclusions

The studied elite hybrid forms from crosses of the cultivar Gamza ripen late and very late. Their grapes ripen during the second half of September and in the middle of October. There are no significant differences in the duration of the separate phenophases during the vegetation period.

The hybrid forms have a distinct wine character, with a high percentage of stems and skins and high theoretical output. They are characterized by high actual fertility and yield, medium-sized clusters and berries. In their growing region the amount of sugars and acids in the must does not meet the standards for the production of quality red dry wines.

There is comparatively high mathematically proven specificity in terms of the observed agrobiological and technological indices in the studied cultivar Gamza and the elite hybrid forms, which can be used for selection purposes. The agrobiological and technological investigations of the hybrid forms, which ripen earlier than the cultivar Gamza - Gamza x Malbek XII-13 and Gamza x Pinot Noir XXII-23, should be continued in other micro-regions where the production of grapes of a higher quality is possible.

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АГРОБИОЛОШКИ И ТЕХНОЛОШКИ ИСПИТУВАЊА НА ЕЛИТНИТЕ ХИБРИДИ ВИНОВА ЛОЗА ДОБИЕНИ СО ВКРСТУВАЊЕ НА СОРТАТА ГАМЗА

Венелин Рojчев

Апстракт

Агробиолошки и технолошки испитувања на елитните хибриди добиени со вкрстување на сортата гмза беа изведени. Времето на созревање кај овие единки е касен и многу касен период, од средината на септември до средината на октомври. Непостојат разлики во фенофазите. Хибридните форми имаат јасен вински карактер, со средна големина на гроздот и зрното, висока фертилност и принос.

Клучни зборови: елитни хибридни форми од сортата Гамза, агробиолошки и технолошки испитувања.

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TABLE GRAPE VARIETIES FOR COOL CLIMATES

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Abstract
In order to expand the land areas for table grape growing and to introduce new varieties a research was conducted on the production and biological characteristics of large number of table grape varieties with different mature phases in the wine growing region of Fruška Gora. The objective was to develop a technology for growing table grape in cold weather conditions and to select the most appropriate varieties. Phenological investigations have shown that over the last twenty years there has been a trend of early beginning of all phenophases and earlier maturity of all varieties. Karmen and Serbia varieties reach their maturity phase at the same time as Cardinal variety, while Ljana, Muscat plevenski, Viktoria and Black magic mature at the same time as Chasselas. Lasta, Terez, Belgrade seedless and Kišmiš moldavski have medium maturity phase. All investigated varieties are characterized as highly productive, particularly Karmen and Viktoria varieties, while Ljana, Lasta, Muscat plevenski and Kišmiš moldavski have excellent organoleptic characteristics. The problem of frost sensitivity for most table grape varieties can be overcome by selection of proper training system, while quality improvement of table grape can be achieved with the introduction of additional ampelotechnical measures and development of different agro-techniques. It can be concluded that besides the standard table grape varieties some new domestic and introduced table grape varieties can also be grown in Serbia.
Key words: Table grape, phenology, frost sensitivity, yield, quality.

Introduction

Agroecological conditions in most of the wine growing regions in Serbia are favorable. Still, production of table grapes is unreasonably neglected and the assortment is old and inadequate. Table grapes are typically grown in small private estates and gardens. Out of a total area covered in grapevine around 2.000 ha (5%) is used for growing table grapes. Muscat Hamburg is the predominant variety, around 90%, while other table grape varieties are underrepresented (Kardinal, Chasselas, Afuz-ali, Italia, Karmen, Lasta, Srbija and others). Production of table grape varieties is the same as for wine grape varieties, but without the application of additional ampelotechnical measures and irrigation. Some wine grape varieties are still used as table grapes (Slankamenka, Smederevka, Portugizac and other). Demand for table grapes is met through import and consumption is low in comparison to other countries (3-4 kg per capita) (Žunić, Todić, 2002; Žunić, Matijašević, 2003). In Serbia, there is a large number of new domestic and foreign table grape varieties, as well as the grapevine clones. Modern technology and integral concept of growing grapes offer possibilities to increase table grape production so that at least local demands could be

met. Climate changes have made some wine growing regions suitable for table grape production, that is, the regions with colder climate where until recently wine grapes only have been traditionally grown (Jones *et al* 2005; Orduna 2010; Petrovic *et al* 2006).

The aim of this research was to select the best quality table grape varieties with different epochs of maturation, based on their biological and production characteristics in the conditions of moderate continental climate. This would enable greater coverage of land with table grapes in Serbia and production of high quality table grapes for domestic market.

Material and methods

Material -Twenty table grape varieties of different epochs of maturation were chosen for the purpose of this research. Most of the varieties had very early and early maturation stage: Super ran Bolgar, Beogradska rana, Kardinal, Favorit, Panonia kincse, Srbija, Karmen, Viktoria, Black magic, Muscat plevenski, Chasselas rouge and Ljana. Varieties with medium maturation epochs were: Lasta, Muscat Hamburg, Kišmiš moldavski, Terez and Beogradska seedless. The selected grape varieties with late maturation were: Afuz-ali, Italia and Moldova.

Object and conditions - All the tests were performed in the period from 1986 to 2011 in experimental and production vineyards located on the experimental field which is in the property of the Faculty of Agriculture in Novi Sad. The experimental field is located in Sremski Karlovci which is 12 km away from Novi Sad (Vojvodina region, wine growing region of Srem, wine growing region of Fruška Gora).Table 1 shows the basic data on the experimental field and conditions during research.

Methods - Phenological investigations were performed for 25 years continuously and the dates of the most important phenophase beginnings were recorded (budding, flowering, veraison and the date of the first partial harvest). Frost sensitivity of winter buds of table grape varieties was tested under the conditions of artificial freezing in cold chamber at a critical temperature of - 20.0 ºC and with the exposure of 10 hours. The tests were performed in the middle of December, middle of January and at the end of February with the aim of determining level and type of sensitivity of varieties. The percentage of survived, partially frozen and frozen buds was calculated and the results were presented in the graph (Cindrić *et al*, 2000).

The application of standard methods showed following production characteristics: total grape yield, quantity of classified grapes, sugar and acid content in must, cluster and berry masses and level of infection with grey mold.

The data are shown in tables and graphs and the correlation between the indicators of the quality of table grapes was calculated by Statistical 10 software program.

Table 1. Experimental field of the Faculty of Agriculture in Novi Sad (Sremski Karlovci)

Indicator	Description
Longitude	20º 10´ E
Latitude	45º 10´ N
Altitude	110 - 130 m/m
Mean annual temperature (on average:1954-2011)	11.7ºC
Mean temperature during vegetation	17.3ºC
Annual sum of warm temperatures	4.225 ºC
Sum of warm temperatures during vegetation	3.720 ºC
Annual amount of precipitation	578 mm
Amount of precipitation during vegetation	353 mm
Absolute minimum of temperatures in the period 1981-2012:	1987 = - 19.5°C 2005 = - 18.2 ºC 2012 = - 22.7 ºC
Soil type	Eutric cambisol on loess
Grapevine training system	Single Guyot
Pruning	12+2 bud/grapevine
Planting distance	3.0 x 1.2 m
Number of grapevines in the experiment	Minimum 20

Results and discussion

Phenological investigations

All tested varieties started budding in the period from April 3 to April 19, and the flowering started from May 24 to June 6. Significant differences between the varieties were observed in the beginning date of veraison (starting from July 7 to August 14) and even greater differences were observed in the harvesting date. Super ran Bolgar grape variety was picked first – August 2, and Moldova variety was the last to be picked (October 3). With the selection of the mentioned assortment table grapes could be consumed for over two months. The period from the beginning of budding to the harvesting date for the tested varieties lasted from 116 to 169 days (Table 2).

Analysis of phenological results for a longer period of time showed that over the last twenty years there has been a tendency of varieties to enter certain phenophases earlier than expected. This rarely occurred with budding and flowering phases, but veraison and ripening phases started particularly early with all varieties. Commonly grown varieties, such as Chasselas rouge and Afuz ali, show descending trendline (figures 1. and 2.). These changes were directly related to extremely high temperatures during July and August which caused faster grape ripening.

Table 2. Phenology (Sremski Karlovci. Period: 1986-2012)

Varieties	Beginning of the phenophases			4. Grape harvest dates	Number of days: 1-4
	1.Bud burst	2. Flowering	3. Veraison		
Super ran Bolgar	April 08	May 31	July 08	August 02	116
Muscat plevenski	April 05	June 03	July 12	August 12	120
Beogradska rana	April 11	June 01	July 11	August 10	121
Cardinal	April 16	June 04	July 19	August 20	126
Favorit	April 07	May 31	July 12	August 13	128
Panonia kincse	April 11	June 02	July 17	August 25	136
Karmen	April 13	May 30	July 14	August 23	132
Srbija*	April 03	May 24	July 07	August 21	140
Chasselas rouge	April 11	June 01	July 24	Sept. 02	144
Viktoria*	April 07	May 26	July 15	August 26	141
Black magic*	April 13	June 03	July 14	Sept. 02	142
Ljana	April 11	June 01	July 26	Sept. 06	148
Kišmiš moldavski *	April 03	May 27	July 18	Sept. 08	158
Lasta	April 14	May 31	July 27	Sept. 19	158
Beogradska seedless	April 13	June 06	July 30	Sept. 13	153
Terez	April 13	May 30	July 31	Sept. 20	160
Muscat Hamburg	April 17	June 02	July 29	Sept. 20	156
Afuz-ali	April 17	June 06	August 01	Sept. 28	164
Moldova	April 17	June 04	August 05	October 03	169
Italia	April 19	June 06	August 14	October 01	165

*Serbia – data for the period: 1999-2011

* Viktoria – data for the period: 2009-2011.

* Black magic – data for the period: 2009-2011.

* Kišmiš moldavski – data for the period: 1999-2011.

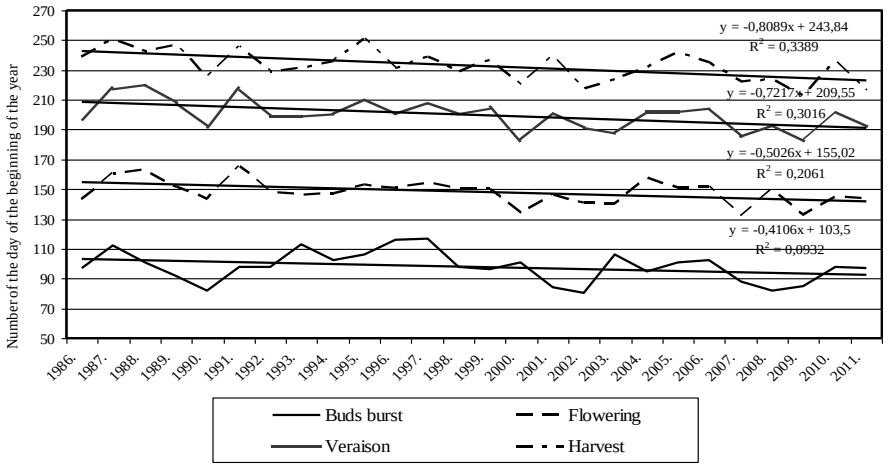


Figure 1. Chasselasrouge - Phenophases

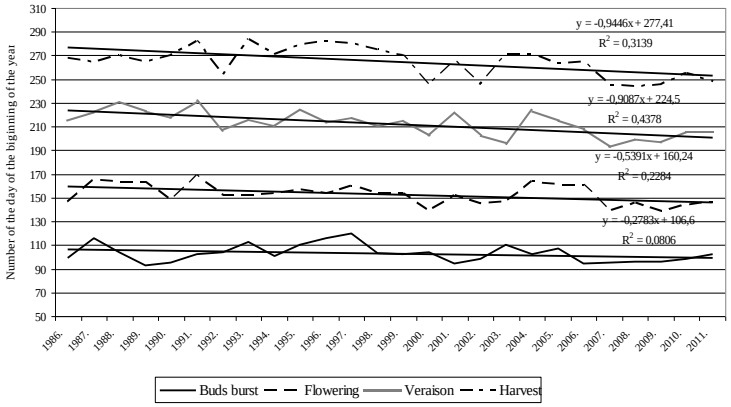


Figure 2. Afus - ali - Phenophases

Low temperature susceptibility

Figures 3 and 4 show the results obtained from testing the susceptibility of winter buds of table grape varieties to low temperatures.

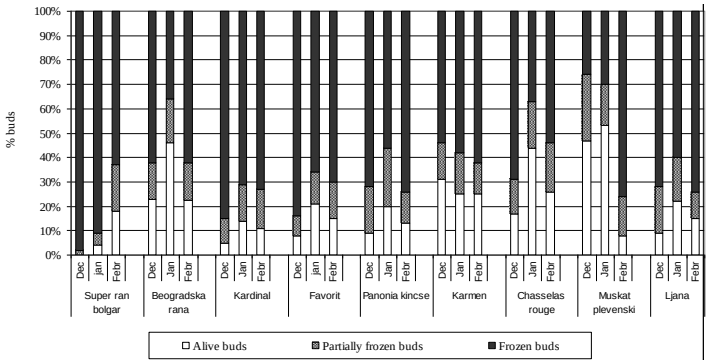


Figure 3. Susceptibility to low temperatures. Very erly and ripening varieties (Sremski Karlovci –mean for 10 years

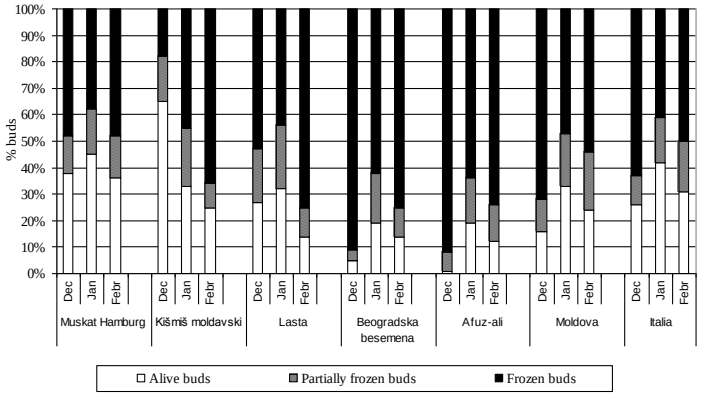


Figure 4. Susceptibility to low temperatures. MIdle late and late varieties (Sremski Karlovci –mean for 10 years

Most tested varieties showed high sensitivity to low winter temperatures. The varieties with medium sensitivity were: Muscat Hamburg, Kišmiš moldavski and Muscat plevenski. In the conditions of moderate continental climate, where extremely low temperatures occur every ten years, it is of utmost importance to adjust the growing of table grape varieties to the environmental conditions (Cindrić, Korać, 1990). Better production can be ensured by selecting the shoot positions, retaining an extra spur near the bottom of the trunk, balanced nutrition of the grapevine and by applying other measures (Korać *et al* 1991).

Production characteristics

The selected table grape varieties grown in conventional, simple trellis training system without irrigation and additional ampelotechnical measures gave good production results (Table 3). Highly productive varieties (> 2 kg/m^2) were: Karmen, Moldova, Viktoria, Chasselas rouge and Panonia kincse, but nothing less productive were the following varieties: Kišmiš moldavski, Beogradska seedless, Italia, Cardinal and Afuz-ali. The variety with lowest yield was Super ran Bolgar. Similar results were obtained by the authors: Korać et al. (1991), Korać, Cindrić (2003), Dimovska et al (2012), Mijatović et al. (2010), Žunić, Todić (2002), Žunić, Matijašević (2003).

Varieties that gave over 80% of (commercially) valuable table grapes were: Lasta, Ljana, Karmen, Kardinal, Muscat plevenski, Black magic and Kišmiš moldavski. Application of additional measures (inflorescence attenuation, removal of excess shoots, irrigation, etc.) could increase the quantity and quality of other table grape varieties as well.

The highest sugar content in the must was found in the following varieties: Kišmiš moldavski, Lasta, Black magic and Afuz ali (> 18%) and Super ran Bolgar had the lowest sugar content. However, subjective feeling of sweetness greatly depends on the sugar-acid ratio in the must, thus it could be said that all the tested varieties had sufficiently sweet and juicy grapes.

Judging by the taste, Muscat Hamburg is still the leading variety, although Muscat plevenski, Italija, Lasta and Ljana varieties are also characterized by excellent sensory properties. All varieties had large, loose or medium dense clusters. The largest berries were observed in Viktoria variety and the smallest ones in Beogradska rana variety. The following varieties had similar size and color of berries: Lasta, Ljana, Muscat plevenski, Favorit, Italija and Super ran Bolgar, while Muscat Hamburg, Viktoria and Panonia kincse varieties had berries that greatly varied in their size and color.

Medium sensitivity to Botritys was observed with Favorit, Muscat Hamburg, Afuz ali, Italia and Viktoria varieties in the conditions of regular application of chemical protection against fungal diseases. Positive, medium, correlation was determined between the size of clusters and yield, sugar and acid contents in must and harvesting date, and between berries and cluster masses. Strong negative correlation was observed between Botritys infected grapes and the amount of commercial table grape (Tab. 4). Figure 5 shows the relation between quality indicators for table grape varieties and their comparison to Cardinal variety which was taken as a standard.

Table 3. Grape yield and quality (Sremski Karlovci, period: 1986-2012)

Variety	Total grape yield (kg/m^2)	Commercial table grape (%)	Sugar in must (%)	Acid in mus (g/l)	Cluster weight (g)	Weight of 100 berries (g)	Botritys (%)
Super ran Bolgar	1.07	76	10.6	4.3	340	335	7
Beogradska rana	1.41	72	13.5	7.6	366	275	5
Cardinal	1.65	84	12.7	6.3	485	690	2
Favorit	1.52	70	14.4	6.7	348	390	12
Panonia kincse	2.07	63	13.3	6.6	495	480	4
Karmen	2.74	86	12.2	6.8	520	524	3
Srbija*	1.46	74	16.4	5.6	356	568	2
Chasselas rouge	2.04	76	14.5	6.2	258	246	4
Muscat plevenski	1.67	83	13.8	6.8	490	434	2
Viktoria**	2.26	82	13.6	4.2	660	927	8
Black magic**	1.52	82	18.4	3.8	385	535	0
Ljana	1.38	87	16.2	6.7	338	437	0
Kišmiš moldavski **	1.78	76	20.6	7.5	740	433	4
Lasta	1.25	87	19.2	8.6	345	490	1
Beogradska seedless	1.78	56	15.2	7.4	438	336	9
Terez*	1.58	66	12.9	5.9	628	558	2
Muscat Hamburg	1.37	42	17.6	7.6	344	427	12
Afuz-ali	1.65	67	18.2	7.3	498	542	11
Moldova	2.29	74	15.7	8.2	470	478	5
Italia	1.78	65	14.1	9.4	520	645	9

*Srbija – Data for the period: 1999-2011.

* Viktoria – Data for the period: 2009-2011.

* Black magic – Data for the period: 2009-2011.

* Kišmiš moldavski – Data for the period: 1999-2011.

Table 4. Table grape - Correlation. Marked correlations are significant at p< .05000

Variable	Total grape yield	Commercial grape yield	Sugar in must	Acids in must	Cluster weight	Weight of 100 berries	Botritys on grape	Harvest data
Total grape yield	1.0000	0.1266	-0.2375	0.0541	0.5009	0.3126	-0.0180	0.1020
Commercial grape yield	0.1266	1.0000	-0.1125	-0.2949	0.1072	0.2457	-0.7281	-0.3860
Sugar in must	-0.2375	-0.1125	1.0000	0.2570	0.1116	-0.0234	-0.0894	0.5959
Acids in must	0.0541	-0.2949	0.2570	1.0000	0.0707	-0.2101	0.2115	0.6414
Cluster weight	0.5009	0.1072	0.1116	0.0707	1.0000	0.5624	0.0700	0.1691
Weight of 100 berries	0.3126	0.2457	-0.0234	-0.2101	0.5624	1.0000	-0.0158	0.1209
Botritys on grape	-0.0180	-0.7281	-0.0894	0.2115	0.0700	-0.0158	1.0000	0.2884
Harvest data	0.1020	-0.3860	0.5959	0.6414	0.1691	0.1209	0.2884	1.0000

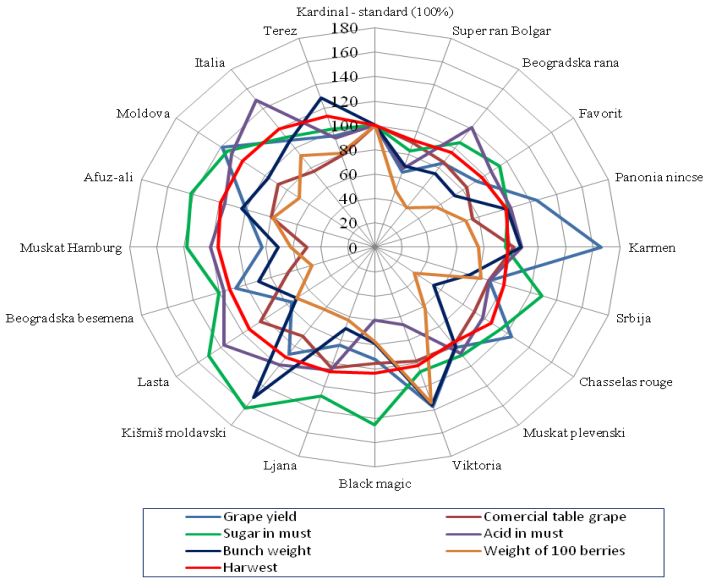


Figure 5. Producion characteristics of the table grae varieties in relation to the Cardinal

Conclusions

Table grape varieties with different maturation epochs can be successfully grown in the conditions of moderate continental climate where extremely low temperatures occur every ten years. Proper variety selection is very important. Besides Muscat Hamburg, the leading table grape variety in Serbia, all other tested varieties, with very early, early and medium maturation epochs are also recommended to be grown. Varieties with late maturation should be grown with greater attention, on smaller land areas and best positions. Development of appropriate agrotechnical measures, implementation of additional ampelotechnical measures and irrigation are necessary for cultivation of all table grape varieties.

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ТРПЕЗНИ СОРТИ ГРОЗЈЕ ЗА ЛАДНИ КЛИМАТСКИ УСЛОВИ

Корач Нада, Иванишевиќ Драгослав, Медиќ Мира, Куљанчиќ Иван, Румл Мирјана, Славица Тодиќ, Попов Милена

Апстракт

Заради ширење на површините со винова лоза и воведување на нови сорти, изедени се испитувања на производните и биолошки карактеристики на поголем број на трпезни сорти грозје со различни фази на созревање во виногорјето Фрушка Гора. Целта е да се развие технологија за одгледување на трпезното грозје во ладни климатски услови и да се селектираат соодветни сорти. Фенолошките испитувања покажуваат дека во последните дваесет години има тренд на порнао започнување на сите фенофази и порано созревање на на сите сорти. Кармен и Србија созреваат во исто време со Кардиналот, додека Љана, Мускат плевенски, Викториа и Блек меџик созреваат во истов реме со Шасла. Ласта, Терез, Белградска бессемена и Кишмиш молдавски имаат среден период на созревање. Сите испитувани вариетети се карактеризираат со висока продуктивност посебно сортите Кармен и Викторија, додека Љана, Ласта, Мускат плевенски и Кишмиш молдавски имаат извонредни органолептички карактеристики. Проблемот со чуствителоност кон мразевите кај повеќето трпезни сорти грозје може да се надмине со одбирање на соодветен систем на одгледување, додека подобрувањето на квалитетот може да се изведе со воведување на дополнителни ампелотехнички мерки и развој на различни агротехнички мерки. Може да се заклучи дека покрај стандардните трпезни сорти грозје некои домашни и интродуцирани трпезни сорти можат исто така да бидат одгледувани во Република Србија.

Клучни зборови: трпезни сорти грозје, фенологија, чуствителност на мразеви, принос, квалитет.

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WINE GRAPE CULTIVARS SUITABLE FOR ORGANIC PRODUCTION

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Abstract
Organic grape production has been increasing considerably in Serbia and all over the world. Besides this, there are number of unresolved issues relating to the organic grape production. The primary aim of this research was to determine the suitability of domestic white grape cultivars such as Bačka, Petka, Panonia and Morava for organic grape and wine production in the wine growing region of Fruška Gora by testing their biological properties and production characteristics. Petka wine grape cultivar showed high resistance to fungus diseases when grown without chemical protection against these diseases, which is why it is recommended to be grown without application of chemical protection. Other cultivars can be grown with greatly reduced protection. Bačka wine grape cultivar had the highest yield in the observed period. Similarly, high yield was also achieved with Petka cultivar. In the observed period Panonia grape wine cultivar had the highest content of sugar and acid in grape juice and its wine was evaluated as high quality wine. Panonia wine grape cultivar can give the top quality wine under favorable conditions, while other grape cultivars can give quality wines. Even though a period of three years is not enough for identification of cultivar characteristics, it could be said that white wine grape cultivars Bačka, Petka, Panonia and Morava, developed at the Faculty of Agriculture in Novi Sad, are suitable for organic grape and wine production under the agro-ecological conditions of Fruška Gora.
Key words: Wine grape, organic production, varieties, biological characteristics, production characteristics.

Introduction

Organic grape production has been increasing considerably in Serbia and all over the world. Still there are a number of unresolved issues related to the organic grape production. In organic production cultivar is of crucial importance (Korać et al., 2011). For several decades now breeders from all over the world have been working on the creation of cultivars which would be resistant to fungal diseases and which would be suitable for organic production of grapes and wines (Kozma and Hajdu, 1984; Pouget, 1998; Alleweldt 2000; Cindrić et al., 2000; Motoc et al., 2010; Topfer et al., 2011). In the mid 1970s of the XX century, the breeding, which focused on the creation of cultivars resistant to stress factors, was started on the experimental field which is in the property of Faculty of Agriculture from Novi Sad, and which is located in Sremski Karlovci. Up to now several wine grape cultivars suitable for organic production have been created (Cindrić and Korać, 1990; Korać et al., 2005). Cultivars tolerant to fungal diseases are becoming increasingly important for organic grape production in some countries (Germany, Switzerland, Austria, Eastern Europe and

eastern parts of the USA), while in other parts of the world those cultivars are less present (Geier et al., 2005; Dufour, 2006).

By testing biological and production properties of domestic white wine grape cultivars, such as Bačka, Petka, Panonia and Morava, this research focused on determining their suitability for organic production of grape and wine in the wine growing region of Fruška gora.

Material and methods

Objective - All tests were performed during a three year period (2008, 2009 and 2010) in the experimental vineyard located on the experimental field in Sremski Karlovci which is in the property of the Faculty of Agriculture in Novi Sad, Department of Fruit Growing, Viticulture, Horticulture and Landscape Architecture. The vineyard is located at longitude 45º 10´ North, at latitude 20º 10´ East and at the altitude of 120 m. The vineyard was developed in 2000. Interrow planting distance was 2.7 m and the distance between the grapevines was 1.6 m. The grapevines were planted in pairs which means that there were two grapevines planted at the same place. The nutrient area of one grapevine was 2.16 m². There were 160 to 300 grapevines of each cultivar. The training system of grapevine was single Guyot. After pruning one cane with 12 buds and one spur with 2 buds were left per grapevine. Plant protection chemicals and mineral fertilizers were not applied in the experimental vineyard during the research.

Tested cultivars - All tests were performed on Bačka, Petka, Panonia and Morava cultivars that were created at the Faculty of Agriculture in Novi Sad.

Bačka cultivar was obtained by cross-breeding Petra and Bjanka cultivars. The creators of this cultivar are P. Cindrić, N. Korać and V. Kovač. The grapevine of this cultivar is quite strong with long erect shoots. Cluster is of medium size and density, about 200g, cone-shaped, on a long peduncle. Berries are round, small with thick greenish skin and partially rose in color on the sun-facing side. It is characterized by high and regular yield. Its property of sugar accumulation is satisfactory. It can give wine of pure, neutral aroma and harmonious taste. This cultivar is not susceptible to gray mold, and it is highly resistant to powdery mildew and downy mildew. It is also resistant to low winter temperatures, especially at the beginning of winter.

Petka cultivar originates from the same cross-breeding combination as Bačka cultivar. Its creators are P. Cindrić, N. Korać, V. Kovač and M. Medić. Grapevine is very dense with long semi-erect shoots. Cylindrical-shaped cluster is of medium size, dense, with round yellow-greenish juicy berries. Grape ripens in the second epoch and gives high yield. It accumulates a lot of sugar in its must and has medium acidity. Its wine is highly qualitative and harmonious. It is gray mold resistant and fairly tolerant to downy mildew and powdery mildew. It can be grown with little protection.

Panonia cultivar was also created by cross-breeding of Rhine Riesling and domestic high quality genotype SK 86-2/293 (SK 77-7/4 x Bjanka). It was created by P. Cindrić, N. Korać and V. Kovač. Cluster is loose, widely cone and wing-shaped. Berries are round, small (around 1.6 g), green-yellow, very juicy and of pleasant flavor. A small number of erect shoots are developed. Distinguishing characteristic of this cultivar is that its laterals stop growing after several leaves are formed. The rows are always of low density and neat. It ripens in the first epoch. Panonia cultivar is highly resistant to powdery mildew and downy mildew, and it has low sensitivity to gray mold if harvest is performed on time. Most of the years, it can be grown successfully without pesticide application. It is resistant to low winter temperatures.

Morava cultivar was created by the same cross-breeding as Panonia cultivar. Its shoots are erect and numerous on the grapevine. It has strong laterals which often carry small grape clusters with few berries. The cluster is loose, wide and cone-shaped with 1−3 wings. The peduncle is short. Berries are oblong, medium (2, 3 g), green with juicy pulp and of characteristic flavor. Morava cultivar ripens in the third epoch. It is highly resistant to downy mildew and gray mold on grapes. It shows medium resistant to powdery mildew. It should be mentioned that powdery mildew is less common on fruit than on the leaves. It is highly resistant to low temperatures. This cultivar is characterized by high acid content which is even higher than in Rhine Riesling. It gives high quality wine with sharp flavor resembling the one of Sauvignon.

Climatic conditions - Meteorological data given in Table 2 were collected from local weather station located on the experimental field in Sremski Karlovci. The weather conditions in 2008 were extremely dry and hot. Vegetation period was characterized by high average vegetation temperature and small amount of precipitation. The weather in 2009 was very hot and dry because of high mean annual and vegetation temperature which exceeded average values of the same parameters in the period from 1952−2010.

Year of 2010 was characterized by high humidity and slightly lower average vegetation temperature. There was around 200 mm more precipitation than during the vegetation period, and almost 300 mm more precipitation during the entire year with respect to multi-annual average values. Considerable amount of precipitation created favorable conditions for the development of fungal diseases in 2010.

Tolerance to fungal diseases - Evaluation of resistance to fungal diseases was performed in the fields, on leaves and grapes twice during the vegetation period (in June and July). IPGRI descriptors were used for determining the level of infection (1997). Descriptor 9.2.3 was used for determining the susceptibility to downy mildew on leaf and the scale ranged from 1 to 9, where 1 represents high resistance and 9 represents high sensitivity. Descriptor 9.2.4 was used for assessing fruit infection with downy mildew and the scale ranged from1 to 9 (1,3,5,7 and 9).

Table 1. Meteorological data for period from 2007 to 2010 (Sremski Karlovci)

	Year	2007	2008	2009	2010	Multi-annual average 1952-2010
Air temperature (°C)	Annual average	13.2	13.7	13.6	12.0	11.9
	Average vegetation	19.8	18.6	19.7	17.4	17.8
Precipitation (mm)	Annual sum	867.1	515.1	521.5	912.6	622.7
	Vegetation sum	343.4	310.2	217.5	598.4	389.3

Descriptor 9.2.5 was used for assessing the leaf infection with powdery mildew and the scale also ranged from 1 to 9, and descriptor 9.2.6 was used for assessing fruit infection with powdery mildew with the same scale (1 – 9). Descriptor 9.2.2 with the scale from 1 to 9 was used for assesing the fruit infection with gray mold.

Phenological observations - Phenological observations determined the beginning of budding, flowering and veraison: the time of bud burst was the date when first buds on a grapevine started opening; the beginning of flowering was the date when 5 % of flowers was open; time of berry

ripening (veraison) was the date when the first berries were changed in this phenophase (Avramov, 1991). The date when grapes reached full maturity was the date of harvetsing.

Production-technological characteristics - The grape yield was determined by measuring the mass of harvested and full mature grape. Grapes were harvested from 24 grapevines of every cultivar. The grapevines were grouped in 3 repetitions. There were 8 grapevines per each repeptition. Oechsle scale was used for determining sugar content of the must. Salleron table served for transferring Oechsle levels into percentages of sugar in the must. Average values were determined based on weighted mean, and weight represented the yield.Acid content in the must was determined by neutralization method of all acids and their salts with n/10 NaOH solution. Acid content was expressed in g/l of tartaric acid.

Average mass of a cluster was determined during harvesting by dividing the mass of harvested grapes with the number of harvested clusters. This was repeated for every cultivar. Microvinification procedure in 10 litre glass vessels was used in the production of wine from these cultivars. The wine had free-run (without the use of press). Two thirds of sulphur were used in the wine production, as regulated by *Wine Law* (Mirošević and Karoglan-Kontić, 2008). In that way organic wine production procedure was followed.

Analysis of chemical composition of wine was performed in the accredited laboratory for enology at he Faculty of Technology in Novi Sad. The wine analysis was performed in accordance with the International methods of wine and must analysis (OIV, 1990). The following parameters were analyzed: alcohol content (% vol) – determined by the picnometry method , OIV (A 2); extract without sugar (g/l) – determined by picnometry method, OIV (A 3); total acids (such as tartaric acid, in g/l) – determined by method of titration with base solution in the presence of bromothymol blue as the indicator, OIV (A 31); pH value – determined by potentiometer, OIV (A 31); phenolic compunds (gallic acid, in g/l).Sensory evaluation was done by the experts. The wine was evaluated by using maximum 20 point scoring scale: maximum 2 points for color, maximum 2 points for clarity, maximum 4 points for aroma and maximum 12 points for taste. Based on the taste evaluation the wines were categorized as: Table wine – at least 15.00 points; Quality wine – at least 16.50 points; Top quality wine – at least 18.51 points.

Statistical results

The obtained data were statistically processed by STATISTICA 10 (StatSoft Inc., Tulsa, USA) and average values were compared by using Fisher's LSD test ($P<0.05$).

Results and discussion

Resistance to fungal diseases

Based on the results obtained from the evaluation of cultivar resistance to fungal diseases (Table 2, it was determined that in dry and warm season, which was during 2008 and 2009, Bačka, Petka and Panonia cultivars were highly tolerant to downy mildew (caused by *Plasmopara viticola),* powdery mildew (caused by *Oidium Tuckeri)* and gray mold on fruit (caused by *Botrytis cinerea)*, while Morava cultivar was quite resistant to downy mildew and gray mold on fruit and it showed high tolerance towards powdery mildew. During the rainy season which was in 2010, Bačka cultivar showed medium to high tolerance to downy mildew, high tolerance to powdery mildew and very good tolerance to gray mold on fruit; Petka cultivar showed high tolerance to powdery and downy mildew on fruits and very good tolerance to powdery mildew on leaves and gray mold on fruits; Panonia cultivar showed medium tolerance to powdery and downy mildew on leaves and high

tolerance to downy mildew on fruit and gray mold on grapes; Morava cultivar was highly tolerant to gray mold on grapes and downy mildew on leaves, it showed medium tolerance to downy mildew and powdery mildew on fruit, and low tolerance to powdery mildew on leaf. The obtained results confirmed the previous research (Cindrić et al., 2002, 2004; Korać et al., 2005b; Balaž et al., 2006). In the observed period, Bačka cultivar had the highest yield and the largest cluster (Table 4); Petka cultivar also had relatively high yield. Yields of both cultivars were statistically significantly higher than those of Panonia and Morava cultivars. In the observed period Panonia cultivar had the highest sugar and acid content in must which affected the alcohol and acid content in wine made from this cultivar (Table 5). Wine made from Panonia cultivar had the highest level of extracts without sugar. Gourmets noticed that this wine had high and balanced content of acid, similar to Rhine Riesling cultivar, which gave the wine pleasant and refreshing taste. This wine was evaluated as the best quality wine and during some years it was even evaluated as the top quality wine (in 2010). All the previously mentioned confirmed the results obtained by Cindrić et al. (2003). In comparison to Panonia, Petka and Bačka cultivars had somewhat lower content of sugar and considerably lower content of acid in must which affected the wine quality. Wine made from Petka cultivar was evaluated as the wine of the poorest quality, but it could still fall into the category of qualitative wines. On average, wine made from Panonia cultivar was, by quality, somewhat better than the wine made from Bačka cultivar which was in 2009 evaluated as the best quality wine. Morava cultivar, in the observed period, had the lowest sugar content and high acid content in must which affected the total content of alcohol and acid in wine. Wine made from this cultivar maintained the similar quality to the wine made from Panonia cultivar. The obtained results proved some authors right who claimed that wine made from some interspecies cultivars was of similar quality to the wines made from *Vitis Vinifera* cultivars (Dufoura, 2006; Kopfer and Willer, 2001; Pavlousek, 2010a).

Table 2. Resistance to fungal diseases (Sremski Karlovci)

Cultivar	Year	Disease causing agents				
		Plasmopara viticola		*Oidium Tuckeri*		*Botrytis cinerea*
		leaf	fruit	leaf	fruit	fruit
		9.2.3[1]	9.2.4[1]	9.2.5[1]	9.2.6[1]	9.2.2[1]
Bačka	2008	1	1	1	1	1
	2009	1	1	1	1	1
	2010	3	15	3	3	1
	Average	1,7 a	2,3 a	1,7 ab	1,7 a	1 a
Petka	2008	1	1	1	1	1
	2009	1	1	1	1	1
	2010	2	3	1	3	1
	Average	1,3 a	1,7 a	1 a	1,7 a	1 a
Panonia	2008	1	1	1	1	1
	2009	1	1	1	1	1
	2010	4	3	4	4	3
	Average	2 a	1,7 a	2 ab	2 ab	1,7 a
Morava	2008	1	1	3	3	1
	2009	1	1	3	5	1
	2010	3	5	6	5	3
	Average	1,7 a	2,3 a	4 b	4,3 b	1,7 a
	LSD	2,3	3,4	2,5	2,5	1,5

Note: Values marked with different letters are statistically significantly different at the significance threshold of **0.05** (LSD test).

[1] IPGRI descriptors.

Phenological observations

During the research, Panonia cultivar had the earliest beginning of budding, flowering, veraison and harvesting time, while these phenophases occurred later with Morava cultivar which was harvested the last (Table 3).

Table 3. Date of phenophase beginning (Sremski Karlovci)

Cultivar	Year	Beginning of budding	Beginning of flowering	Beginning of veraison	Harvesting date
Bačka	2008	22.03.	23.05.	12.07.	27.08.
	2009	06.04.	17.05.	11.07.	07.09.
	2010	08.04.	28.05.	23.07.	14.09.
	Average	02.04.	23.05.	15.07.	06.09.
Petka	2008	24.03.	23.05.	16.07.	03.09.
	2009	03.04.	17.05.	09.07.	07.09.
	2010	09.04.	25.05.	13.07.	14.09.
	Average	02.04.	22.05.	13.07.	08.09.
Panonia	2008	16.03.	23.05.	16.07.	26.08.
	2009	03.04.	17.05.	06.07.	20.08.
	2010	08.04.	24.05.	08.07.	14.09.
	Average	30.03.	21.05.	10.07.	31.08.
Morava	2008	30.03.	26.05.	23.07.	24.09.
	2009	06.04.	19.05.	30.07.	14.09.
	2010	11.04.	29.05.	05.08.	05.10.
	Average	05.04.	25.05.	30.07.	25.09.

Production-technological characteristics

Table 4. Production characteristics for 2008, 2009 and 2010 (Sremski Karlovci).

Cultivar	Year	Grape yield (kg/m²)	Average cluster mass (g)	Sugar content in must (%)	Acid content in must (g/l)
Bačka	2008	2.25	242	20.5	7.2
	2009	1.87	278	25.2	5.0
	2010	1.65	203	18.8	6.5
	Average	1.92 a	241 b	21.6 ab	6.3 a
Petka	2008	2.07	211	22.1	6.4
	2009	1.69	179	26.2	4.2
	2010	1.76	130	20.4	6.6
	Average	1.84 a	173 b	22.8 a	5.8 a
Panonia	2008	1.13	131	25.4	8.2
	2009	1.20	158	22.2	9.7
	2010	0.80	93	20.9	6.3
	Average	1.04 b	127 c	23.1 a	8.3 b
Morava	2008	1.32	135	20.0	7.2
	2009	1.25	149	20.7	9.1
	2010	1.10	90	18.1	8.3
	Average	1.22 b	125 c	19.7 b	8.2 b
	LSD	0.28	32.1	2.25	1.12

Note: Values marked with different letters are statistically significantly different at the significance threshold of **0.05** (LSD test).

Table 5. Sensory and chemical analysis of wines 2008−2010 (Sremski Karlovci).

Cultivar	Year	Wine tasting evaluation	Alcohol (% v/v)	Extract without sugar (g/l)	Total acids (g/l)	pH	Phenol (g/l)
Bačka	2008	16.7	11.70	17.2	6.4	3.3	0.26
	2009	18.1	15.23	17.8	5.5	3.5	0.24
	2010	17.6	12.87	16.2	5.4	3.2	0.25
	Average	17.5 ab	13.27 a	17.1 a	5.8 a	3.3 a	0.25 a
Petka	2008	17.2	13.05	18.5	6.2	3.3	0.25
	2009	16.6	15.97	17.1	5.5	3.5	0.23
	2010	17.8	12.51	14.0	5.7	3.2	0.21
	Average	17.2 a	13.84 a	16.5 a	5.8 a	3.3 a	0.23 a
Panonia	2008	18.4	14.77	20.3	9.4	3.2	0.47
	2009	18.0	11.57	22.0	8.5	3.1	0.38
	2010	18.6	13.31	16.0	6.3	3.2	0.32
	Average	18.3 b	13.22 a	19.4 a	8.1 b	3.2 a	0.39 b
Morava	2008	17.9	12.00	18.8	6.7	3.5	0.32
	2009	17.4	12.42	19.1	8.1	3.1	0.38
	2010	18.3	11.65	19.5	7.4	3.2	0.22
	Average	17.9 ab	12.02 a	19.1 a	7.4 ab	3.3 a	0.31 ab
	LSD	1.0	2.89	3.7	1.7	0.3	0.11

Note: Values marked with different letters are statistically significantly different at the significance threshold of **0.05** (LSD test).

Conclusions

Growing wine grapes without any application of chemicals against common fungal diseases showed that the wine grape cultivar Petka had the highest level of tolerance and could be recommended for growing without the application of any chemicals. In dry season Bačka cultivar can be successfully grown without the application of chemicals against fungal diseases, while in rainy season it can be grown by applying the reduced protection against downy mildew only. Panonia cultivar can also be successfully grown in dry season without using the chemicals against fungal diseases while in rainy season it can be grown by applying the reduced protection against powdery mildew and downy mildew. During warm period Morava cultivar can be grown without additional chemicals for protection against downy mildew and gray mold on fruit, while the reduced protection should be used against powdery mildew. In rainy season Morava cultivar can be grown with moderate protection against powdery mildew and reduced protection against downy mildew.

In comparison to other tested cultivars, Panonia cultivar entered first the phenophases of budding, flowering and veraison and its grapes were the first to reach the full maturity. Morava cultivar was the last to enter the budding phenophase as well as the other phenophases and its grapes were the last to reach the full maturity. Apart from genetic potential, annual climatic conditions also significantly affected the starting date of certain phenophase.

During the observed period, Bačka cultivar had the highest yield and cluster mass; Panonia cultivar had the highest content of sugar and acids in must and its wine was evaluated as the best quality wine. Panonia cultivar can give a top quality wine under more favorable conditions. This wine is characterized by pleasant taste which is similar to Rhine Riesling wines. In comparison to Panonia, Bačka and Petka cultivars had somewhat lower content of sugar and considerably lower content of acids in the must. Wine made from Petka cultivar was evaluated as the wine of poorest quality but it falls into the category of qualitative wines. During the period of observation, Morava cultivar had the lowest content of sugar and high content of acids in must, and its wine maintained the similar quality to the wine made from Panonia cultivar. Although a three year period is short for determining all the properties of cultivars, it can be concluded that white wine grape cultivars such as Bačka, Petka, Panonia and Morava, which were created at the Faculty of Agriculture in Novi Sad, are suitable for organic grape and wine production in agro-ecological conditions of Fruška Gora.

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СОРТИ ВИНОВА ЛОЗА ПОГОДНИ ЗА ОРГАНСКО ЛОЗАРСТВО

Иванишевиќ Драгослав, Корач Нада, Чабиловски Ранко, Манојловиќ Маја, Паприќ Џорџе, Куљанчиќ Иван, Медиќ Маја

Апстракт

Производството на органско грозје се зголемува значајно во Србија и во целиот свет. Покрај тоа постојат нерешени прашања во однос на органското лозарство. Примарната цел на ова испитување беше да се опрелат можностите на автохтоните сорти како Бачка, Петка, Панониа и Морава за органско производство во Фрушкогорското виногорје со испитување на нивните биолошки и производни карактеристики. Петка е винска сорта која покажува висока отпорност на габни заболувања кога се одгледува без хемиска заштита поради што и препораката е да се одгледува без хемиска заштита. Другите сорти можат да бидат одгледувани со големо намалување на заштитата. Бачка е винска сорта покажа највисок принос за испитуваниот период, висок принос беше утврден и кај сортата Петка. Во испитуваниот период, сортата Панониа покажа највисока содржина на шеќер во ширата додека нејзиното вино беше оценето со највисок квалитет. Панониа е винска сорта која може да висок квалитет во поволни услови, додека другите сорти даваат квалитетни вина. И покрај ова периодот од 3 години е недоволен за идентификација на карактеристиките на сортите, но може да се каже дека сортите Бачка, Петка, Панониа и морава, добиени на Факултетот за земјоделство во нови Сад се погодни за производство на органско грозје и вино во агроеколошките услови на Фрушка Гора.

Клучни зборови: винско грозје, органско производство, сорти, биолошки карактеристики, производни карактеристики.

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Originial scientific paper

SOME AMPELOGRAPHICAL RESEARCH ON THE INDIGENOUS VARIETY PROKUPAC

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Abstract
Prokupac is indigenous variety originating from Serbia with long history in growing the variety in the country and wider. The research was conducted from 2009 to 2011 on 6 variants of Prokupac varieties with different shapes of cluster. Cluster density (Codes N°204) was different depending from the variant and it was from: very loose (grade 1) at variant K-1, loose (grade 3) at variant K-3, medium compact (grade 5) at variant K-5, compact (grade 7) at variant 7, very tight cluster (grade 9) at variant K-9, while the standard variant had compact to very tight cluster (grade 8-9). The numbers of clusters per vine was variable from average 11,5 at variant K-1 untill 15,5 at variant K-5.The rest of the variants also had higher than the average clusters that the standard variant had (12,5). The cluster weight was also variable and it was from 110g at variant K-1 until 150g at variant K-5, while the standard variant was 140g. Yield per hectare was also variable, varying from 10.453 kg at variant K-1 to 19.216 kg at variant K-5. The yield at the rest variants was higher than the standard one which was 14.463 kg. For the period the research was conducted the highest sugar content had variant K-5 (21,6%), or 1% more than the standard variant which had 20,65%. The lowest sugar content had variant K-9 (20,35%). Lowest total acid had variant K-1 (6,6 g/l), lower from the standard by 0,20 g/l. The highest total acid was recorded at variant K-9 (7,05 g/l) or by 0,25g/l more than the average standard variant.The best result from the research gave the variant K-5 because of the earlier ripening by 8-10 days comparing to the average standard variant.
Key words: variant, cluster, yield, sugar content, total acids, time of ripening.

Introduction

Prokupac is indigenous variety originating from Serbia with long history in cultivating this variety in the country and wider. The cultivation of indigenous varieties brought a lot of attention in the region and wider. These varieties are protected in the countries where they are grown by the O.I.V standards, but in Serbia the protection has yet to be made. In this region there are vines that are more than a 100 year old, which enables us to make a quality selection. Dr. D. Zirojević in his PhD thesis in 1965 has selected several types that he considerate Prokupac variety. He did not work on exact selection of Prokupac, but he worked on separation on Prokupac as a sole variety. A lot of authors both foreign and domestic had mention in their published works this variety (Avramov L., Briza K., Bozinović Z., Žunić D., Zirojević D., Nastev D., Stojanović M., Toskić V., Cvetković D., Cindrić P.). Ampelographical researches for this variety are yet to be made.

The intention of the work is to conduct ampelographical researches on the chosen types of the indigenous variety Prokupac with purpose to select the potential clone which will be better than the standard type.

Material and methods

The research has been conducted from 2009 to 2011 in vineyard that has been planted in 1930. The location on the vineyard is in „Biljeska Čuka", in Toplica wine subregion which belongs to the Prokupje wine region, a place which is considerated to be with optimal conditions for vine growing.

The vineyard of the Prokupac variety is planted on a area of 20 are, on Kober rootstock with a distance of 1.1 x 1.1 m, i.e.8.265 vines/ ha. The rows are located north – south, with head (gobelet) vine training system with typical Župa type of pruning (low spur). The vines were pruned on 5 kondirs with 2 buds (kondir-last year vine pruned), which is total 10 buds. The research was conducted on 6 variant types that included 15 vines by variant. The variants were marked as: K-1, K-3, K-5, K-7, K-9 and standard S. Standard climate elements are processed such as: air temperature, length od sunshine radiation, precipitations, relative humidity and winds in selected areas. The physical and chemical characteristics on the soil were conducted by using standard methods of research.Phenological research and the characteristics of the variants of the Prokupac variety were followed by phenophases of development (weeping, budbreak,early flowering, end of flowering ,begin of ripening, full ripe, vine shoots maturing and leaf fall). The description od the chosen vines of Prokupac is conducted by the methods of the International office for grape and wine (O.I.V - Code Des Caracteres Des Vitis Anonimus 1983). The fully developed leaf is described before the grape ripening with the use of 10 leafs from vine that are taken from the 10 th or 11 th node of the vine shoot. The grade, shape, colour, hairyness, separation, shape of the sinus and tooth is conducted visual, but the size of the leaf, angle of the nervature and the length of the petiole are measured.

The cluster (bunch) is described in the time of harvest which 10 clusters are taken from 10 vines. The size of the cluster is determined with must measurement and the length of the clusters taken from each variety separately. The cluster weight is determined as average from sample of 30 clusters. The tightness of the clusters is visually determined and the length of the petiole is found by measuring of 10 cluster from all variants.

The chemical compound of the must is determined by measuring the sugar content with Oechsle mustmeter and Saleron's table, which is used in O.I.V – e Cod 505 (Anonymous 1983.

Important climate and land characteristics

Meteo data for Prokuplje was used for the climate characteristics. Period from 2009 until 2011 is considerated. On base of this period, basic climate elements are made that show heat conditions, sun conditions, humidity and winds in selected areas.

Air temperature - middle vegetation temperature in the researched period was 16,8ºC.

Temperature sum in the researched period was 3610ºC.

The warmest month is July with average midday temperature from 22,9 ºC to 23,4 ºC and January as the coldest with average midday temperature from -1 ºC to -1,4 ºC.

Extreme low temperatures were recorded in January and February with – 22,1 ºC.

Absolutely maximum temperatures were recorded in July and August with 42,1 ºC.

Length of sunshine radiation had optimal value for all the conducted locations and was 1682 h.

Precipitations were varying about 627mm.

On the location, the soil type is ganjaca. It has shallow humus horizon and light mechanical compound. Chemical characteristics of the soil is low acid (pH 6,4 - 6,6) and percentage of humus is 2,1 -2,7 %. The missing macro and micro elements from the soil is compensated with fertilizing.

Results and discussion

The leaf description is shown in Table. 1. Mature leaf (Codes N˚065) is oval, medium size (grade 5). Picture 1. Number of lobes (Codes N˚068) was mostly 3 part (grade 2) as in the standard, with the exception of the variant K-9 which had 5 part lobe (grade 3). Picture.1. K-1, K-3, K-5, K-7, K-9 and standard.

Table 1. Botanical description of the leaf by variants

Variant	K-1	K-3	K-5	K-7	K-9	Standard
Codes	grade					
Codes N˚o65	5	5	5	5	5	5
Codes N˚068	2	2	2	2	3	2
Codes N˚076	2	2	2	2	2	2
Codes N˚079	3	3	3	4	5	3
Codes N˚084	7	7	7	7	7	7
Codes N˚085	1	1	1	1	1	

Shape of teeth (Codes N^0 076) was the same in all variants as in the standard (grade 2) – straight. The degree of opening of petiole sinus (Codes N^0 079) was different from the standard. Variants K-1,3,5 were open (grade 3) as the standard. Variants K-7 had slightly opened (grade 4), but variant K-9 had closed form of petiole sinus (grade 5).

Density of prostrate hairs between the main veins on lower side of blade (Codes N^0 84) was high and equal as the Standard.

Density of erect hairs between the main veins on lower side of blade (Codes N^0 085) in all variants and the standard was very low (grade 1), but on the nervature of the leaf was medium (grade 5).



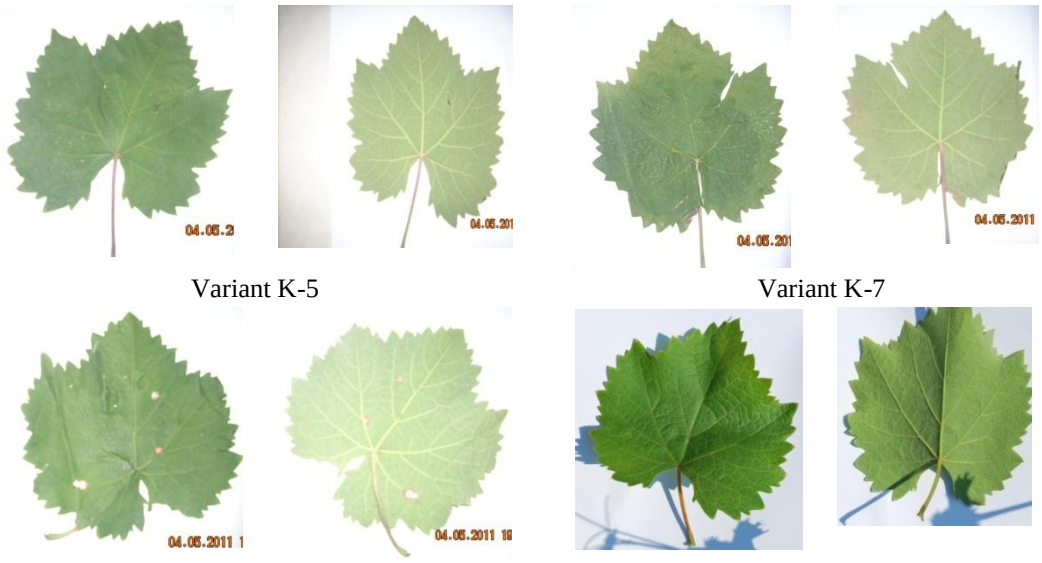


Variant K-1





Variant K-3



Variant K-5 Variant K-7

Variant K-9 Standard

Picture 1. Face and back of leafs in variants

Cluster (bunch) description

Cluster description in ampelography gives solid evidence in determination of the variety. In table 2 are given the following description of the cluster.

Table 2. Botanical Bunch (cluster) description by variants

Variants	Codes N˚202	Codes N˚203	Codes N˚204	Codes N˚206
K-1	3	3	1	3
K-3	3	3	3	3
K-5	5	5	5	3
K-7	5	5	7	3
K-9	5	5	9	3
Standard	5	5	8	3

Cluster (bunch) size (Codes N^0 202) was different (pic.2). The small bunch (grade 3) was in variant K-1 and K-3, medium (grade 5) in variant K-5, K-7, K-9 and also in the standard.



K -1



K-3



K-5



K-7



K-9



Standard

Picture 2. Size and Cluster (bunch) density by variants

Bunch legth (Codes N˚203) was different. The smallest length (grade 3) had variants K-1 and K-3 (13 and 14 cm), the other variants K-5, K-7, K-9 and the Standard had length with grade 5 (18,18,17,18 cm). Bunch density (Codes N^0 204) was different from: very loose (grade 1) at variant K-1, loose (grade 3) at variant K-3, medium (grade 5) at variant K-5, dense (grade 7) at variant K-7, The Standard had dense or very dense bunch (grade 8-9), Picture 2. The length of peduncle of primary bunch (Codes N˚206) was at all variants short (grade 3) 5-7 cm. Phenophase development was given in Table 3.

Table 3. Phenophase development of variants - average (2009 – 2011)

Variants/Phenophase	K-1	K-3	K-5	K-7	K-9	Standard
Weeping	14-3	13-3	15-3	13-3	16-3	15-3
Bud break	5-4	7-4	5-4	6-4	7-4	7-4
Early flowering	26-5	26-5	27-5	23-5	25-5	24-5
End of flowering	4-6	3-6	6-6	3-6	4-6	4-6
Begin of ripening	7-8	7-8	4-8	3-8	7-8	7-8
Full ripe	10-10	11-10	1-10	4-10	11-10	10-10
Vine shoots maturing and leaf fall	4-11	5-11	30-10	3-11	3-11	3-11

Juice movement was variable as per year and variants. The latest juice movement was recorded at variants K-9 (16-3), earliest at variants K-3 and K-7 (13-3). The difference between variants was just 1 day. The earliest bud break and vine shoot growth was recorded at variant K-1 and K-5 (5-4), which was 2 days earlier that the Standard. The difference between variants was 2 days.
The earliest flowering had variant K-7 (23-5), but latest variant K-5 (27-5).
The shortest flowering had variant K-3 (8 days), the longest had variants K-7 and the Standard. Flowering recorded after the Standard had variants: K-1, K-3, K-5 and K-9, but before the Standard just K-7.
Begin of ripening was almost same at all variants in August. Nearly all variants had begun ripening as the Standard (7-8), just variant K-7 was exception which had earliest ripening (3-8), followed by variant K-5(4-8).
The full ripe was earliest recorded at variant K-5 (1-10), which was 10 days before the Standard (10-10), at variant K-3 and K-9 (11-10) was recorded the latest, 1 day after the Standard.
The most early leaf fall and vine shoot maturing had variant K-5 (30-10), three days before the Standard, variant K-3 (5-11) had the latest, 2 days after the Standard.
The elements of yield are shown in Table 4 as averages.

Table 4. Elements of yield – averages (2009- 2011)

Variant/ elements	Cluster weight in *g*	Number of clusters/ vine	Yield/ vine in *g*.	Yield/vine shoot in *g*.	Yield / Bud in *g*.	Yield /hectare in кg.
K-1	110,0	11,5	1.265	148,8	126,5	10.453
K-3	135,0	13,5	1.822	214,3	182,2	15.058
K-5	150,5	15,5	2.325	244,7	232,5	19.216
K-7	145,0	14,5	2.102	247,2	210,2	17.373
K-9	130,0	13,5	1.755	195,0	175,5	14.505
Standard	140,0	12,5	1.750	194,4	175,0	14.463

The grape yield was variable which confirms that some variants had good fertility. The grape cluster mass was also variable from 110g. in variant K-1 to 150 g. in variant K-5, the Standard had 140g. The number of cluster per vine was variable per variants, K-1 had the lowest number (11,5), the highest had variant K-5 (15,5), also the others variants had higher numbers than the Standard. On the grape yield per vine, several factors had impact such as the grape cluster mass and the number of clusters per vine varying from 1.265 g. at variant K-1 to 2.325 g. at variant K-5. Also the others variants had higher yield than the Standard (1.750g.). The grape yield pre vine shoot was variable depending on the grape yield per vine and the number of vine shoots. The lowest grape yield per vine shoot had variant K-1 (148,8 g.), the highest (247,2) variant K-7, also the others had higher numbers than the Standard (194,4 g.).
The yield per bud was variable from 126,5 g at variant K-1 to 232,5 g. at variant K-5. Also in the other variants the yield was higher than the Standard (175,0 g), with exception from the K-9 which was almost the same as the Standard (175,5 g.). The yield per hectare was from 10.453 kg at variant K-1 to 19.216 at variant K-5. Also the yield at the other variants was higher than the Standard, which was 14.463 kg. Sugar content and total acids is given in Table 5.

Table 5. Sugar content % and total acids /l – average (2009-2011)

Variant	K-1		K3		K5		K7		K9		Standard	
Year 209/2011	Sugar content %	Total acid g/l	Sugar content %	Total acid g/l	Sugar content %	Total acid g/l	Sugar content %	Total acid g/l	Sugar content %	Total acid g/l	Sugar content %	Total acid g/l
Average	20,95	6,6	20,5	6,7	21,6	6,65	21,25	6,7	20,35	7,05	20,65	6,8

In the researched period the highest sugar content had variant K-5 (21,6%) which is 1,0 % more than the Standard (20,65), but lowest had K-9 (20,35%).Total acids were also variable per variants. The lowest total acids had variant K-1 (6,6 g/l), lower than the Standard per 0,20 g/l, but the variant K-9 had the highest (7,05 g/l) or 0,25 g/l more than the Standard. The other variants had total acids between these measured numbers.

Conslusions

The climate conditions in Toplica vine sub region are favorable for all the researched variants.

The soil conditions are suitable for cultivating vine, especially on south exposition where the physical and chemical properties are favorable in cultivating.

The phenological research gave us a possibility to separate the most productive variant.

The number of days in vegetation from bud break to full maturing was shortest in variant K-5 (175 days – 5 days shorter than Standard), K-7 (178 days – 3 days shorter than Standard) and Standard (180 days).

The grape yield was variable per variants and years. The smallest cluster mass had variant K-1 (110 g.) and the largest mass had K-5 (150g.), greater than the Standard for 10 g.

The most yield per vine and hectare had variant K-5 (2.325 g), which is more than 575 grams than the Standard (1.750g.), after that is K-7. Grape yield per vine shoot was highest in variant K-7 (247,2 g.), then variant K-5 (244,7 g.), which is higher than the Standard (194,4 g.). Yield per hectare was highest in variant K-5 (19.216 kg) which is 4.753 kg more than the Standard.

The highest sugar content in the researched period had variant K-5 (21,6%), more than the Standard per 1 %, then variant K-7 (21,25%). The rest of the variants had similar sugar content like the Standard.

There were no high oscillations in measuring total acids in the rest of the variants and they were from 6,6 g/l in variant K-1 until 7,05 g/l in variant K-9. The Standard and the rest of the variants had similar content of total acids.

The best results has given variant K-5 , then variant K-7. On the base of the information of the research, we should continue monitoring the variant K-5 in purpose for clone selection.

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НЕКОИ АМПЕЛОГРАФСКИ ИСПИТУВАЊА НА ДОМАШНАТА СОРТА ВИНОВА ЛОЗА ПРОКУПЕЦ

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Апстракт

Прокупец е домашна, автохтона сорта со потекло од Србија со долга историја на одгледување во земјата и пошироко. Испитувањата се изведени од 2009 до 2011 во шест варијанти од вариететите на Прокупец со различни форми на гроздот. Збиеност на грозд (Codes N˚204) е различна во зависност од варијантата: многу растресит кај варијантата К-1, растресит кај варијантата К-3, средно збиен кај варијантата К-5, збиен кај варијантата К-7 и многу збиен грозд кај варијантата К-9, додека стандардната варијанта има збиен до многу збиен грозд. Бројот на гроздови на една лоза варира од просечно 11,5 кај варијантата К-1 до 15,5 кај варијантата К-5. Останатите варијанти исто така имаат повисок коефициент во однос на стандардната варијаната. Тежината на гроздот е истот така варијабилна, од 110 g кај варијантата К-1 до 150 г кај варијантата К-5, додека стандардната варијанта има тежина од 140 г. Приносот по хектар исто така варира од 10,453 kg кај варијантата К-1 до 19,216 kg кај варијантата К-5. Приносот кај останатите варијанти е повисок во однос на стандардот кој изнесуваше 14,463 kg. За приодот на испитување утврдивме највисока содржина на шеќер кај кај варијантата К-5 (21,6%) или за 1% помалку во однос на стандардната варијанта која има 20,65%. Најниска содржина на шеќер има варијантата К-9 (20,35%), Најниска содржина на вкупни киселини има варијантата К-1 (6,6 g/l), пониска од стандардната варијанта за 0,20 g/l. Повисока содржина на вкупни киселини се забележани кај варијантата К-9 (7,05 g/l) или за 0,25 g/l повисоки во однос на просечната стандардна варијанта. Најдобри резултати во испитувањата даде варијаната К-5 поради пораното созревање за 8-10 дена во споредба со просечната стандардна варијанта.

Клучни зборови: варијанта, грозд, принос, содржина на шеќер, вкупни кислеини, време на созревање.

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AGROBIOLOGICAL CHARACTERISTICS OF MERLOT VARIETY POPULATION IN GROCKA VINEYARDS

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Abstract
In the period from 2006 to 2011, the research of agrobiological characteristics of Merlot variety population was done on Radmilovac locality in Grocka vineyard district. The research covered several agrobiological indicators and this paper will analyse the following: cluster mass, yield of grapes, sugar content in the must and the total acid content in the must.
Key words: cluster mass, yield of grapes, must, sugar, total acid, clone, population.

Introduction

The results showed that Merlot variety population is very homogeneous. This especially applies to indicators such as yield components, cluster mass, yield of grape, sugar content in the must and total acid content in the must. In order to obtain more accurate data on the population diversity, according to the methodology applied in the clonal selection of grapevine, the research of Merlot variety population was done in Grocka vineyard district and the results are presented in this paper.

Material and methods

Radmilovac locality is located in the territory of Experimental school farm Radmilovac – Vinca of the Faculty of Agriculture in Zemun. Experimental vineyard was planted in 1991. It was arranged in the form of a double horizontal cordon with 80-cm high seedlings spaced at 3 x 1 m. Grapevines were grafted on rootstock Kober - 5BB. The mixed pruning was applied leaving a total load of 24 buds per vine.

The materials used for the research were Merlot variety clones and populations. The experiment was set up according to a block plan. For the purpose of description each clone and population was represented by 10 vines, each vine being a separate experimental unit. Grapevines in the experimental vineyard were of consistent vigour, productivity and health. Data collection was done using standard methods. The analysis of the collected data was performed using descriptive and analytical statistical tools available in the statistical package STATISTICA for Windows 8.

First, indicators of descriptive statistics were calculated for all characteristics of tested genotypes: average value, standard error of the average value ($S\bar{x}$) and standard deviation. In order to reach objective conclusions about the effects of analysed factors on the changes of the characteristics of grapes and wine, and the potential application of parametric tests (ANOVA and LSD test), the homogeneity of variances was tested using Hartley's, Cochran's, Bartlett's and Levene's test (Hadživuković, 1977). Given that in all cases the assumption of homogeneity of variance was met, the further application of parametric tests was possible. The size of the effect of each factor, as well

as their interaction, was measured by a partial eta squared coefficient which was then classified according to Cohen's system (Cohen, 1988).

Major climatic and soil conditions- The vineyard is located in the zone of moderate continental climate. The sum of active temperatures during the growing season is 3422 degrees C. Winter frosts have not damaged buds and shoots. The average annual total precipitation is 642 mm. The maximum precipitation is in the spring and early summer. The growing season takes about 2/3 of the total annual precipitation. The land is eroded forest soil. Hydro-ameliorative interventions have been done before raising a vineyard. The soil is suitable for growing Merlot variety populations and clones.

Results and discussion

The research results concerning the characteristics of grapes have been statistically analysed and presented in Tables and Figures 1-4.

Variation in cluster mass

Table 1 shows a distribution of the cluster masses between the analysed Merlot variety populations and clones over the years of research. The largest values are measured for clone 022 (average mass of 98.71 g), and the smallest for clone 029 (average mass of 94.44 g). Data are consistent with the results of Cindrić (2000). Differences in cluster masses of clones and populations were statistically significant. Thus, the Merlot variety population had a mass significantly different from the clone 022 and clone 029, while clone 029 had significantly smaller cluster mass compared to other clones and a standard Merlot variety.

Weather conditions in these years had a profound effect on the change in the cluster mass of clones. Thus, the highest average cluster mass was measured in 2009 (104.04 g), which is statistically significant compared to the masses in all other years. The last experimental year (2011) was least favourable in terms of the formation of the cluster mass. The average cluster mass was 91.35 g and it was significantly smaller than the mass achieved in previously analysed years ($p < 0.05$). Interaction between the analysed factors (variety x year) was also statistically significant ($p < 0.01$). It is interesting to measure not only a statistical significance but also the size of the effect of the analysed factors on the cluster mass using eta squared coefficient which in this case is $\eta 2 = 0.2597$ for A factor (variety and cultivar), $\eta 2 = 0.6880$ for the years, and $\eta 2 = 0.6187$ for the factor of interaction. According to Cohen's system, the obtained eta squared values indicate that the effect of the analysed factors and their interactions on the mass of the cluster is extremely high. Moreover, climatic conditions over the years have stronger effect on the cluster mass than the analysed clones.

Table 1. Significant differences in cluster masses between standard Merlot and clones over the years of research

Cultivar (A)	Cluster mass						$\bar{x} \pm S\bar{x}$
	Year (B)						
	2006	2007	2008	2009	2010	2011	
Merlot standard	95.972	98.412	91.840	104.660	92.836	93.664	96.23^{a} ±0.952
Clone 022	94.748	104.300	95.696	107.296	95.564	94.668	98.71^{b}±1.088
Clone 025	99.408	94.540	106.632	106.632	90.108	89.012	97.63^{ab} ±1.410
Clone 029	93.360	99.424	90.344	97.564	97.872	88.068	94.44^{c} ±0.881
$\bar{x} \pm S\bar{x}$	95.87^{c}± 0.820	99.17^{b}± 1.036	95.99^{c}± 1.605	104.04^{a}± 1.042	94.10^{c}± 0.861	91.35^{d}± 0.836	

a, b, c –Values without same letter in superscript are significantly different ($p<0.05$)

Effect	F-test	p-level	LSD		Partial eta-square η^2
			0.05	0.01	
A	11.200	0.000002	1.518	1.998	0.2597
B	42.300	0.000000	1.859	2.448	0.6880
A x B	10.400	0.000000	3.719	4.895	0.6187

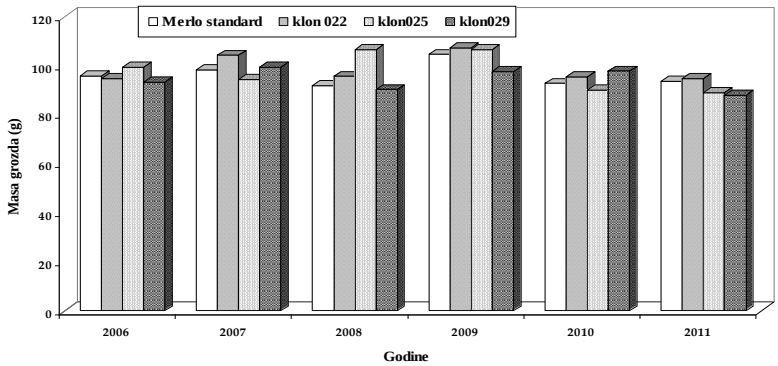


Figure 1. Variations in cluster mass - standard Merlot and clones by years

Variation in grape yield

The average yield of grapes per vine in analysed clones was not significantly different (Table 2). The smallest yield per vine was measured in clone 029 (the average of 1.99 kg / vine), and the highest in clone 025 (the average of 2.06 kg / vine). The data are consistent with the data of Žunić (2010). However, the difference in average yields based on LSD test was not statistically significant, Table 2 ($p>0.05$). Weather conditions have not influenced higher variability in grape yield of s per vine. Significantly higher yield was recorded in 2008 compared to all other years (p

<0.05). In other years, there was not a significant difference in measured yield of grapes per vine (p>0.05). Interaction between the analysed factors was not statistically significant (p>0.05).

Table 2. Significant difference in the yield between standard Merlot and clones over the years of research

Cultivar (A)	Yield						$\bar{x} \pm S\bar{x}$
	Year (B)						
	2006	2007	2008	2009	2010	2011	
Merlot standard	1.916	2.036	2.296	1.976	1.928	2.016	$2.03^{a}\pm0.034$
Clone 022	2.064	2.072	2.032	2.028	2.012	2.000	$2.03^{a}\pm0.025$
Clone 025	2.004	2.020	2.232	2.160	1.996	1.960	$2.06^{a}\pm0.031$
Clone 029	2.016	1.984	2.080	1.892	1.980	1.980	$1.99^{a}\pm0.026$
$\bar{x} \pm S\bar{x}$	$2.00^{b}\pm0.030$	$2.03^{b}\pm0.034$	$2.16^{a}\pm0.043$	$2.01^{b}\pm0.037$	$1.98^{b}\pm0.026$	$1.99^{b}\pm0.029$	

a, b –Values without same letter in superscript are significantly different (p<0.05)

Effect	F-test	p-level	LSD		Partial eta-square η^2
			0.05	0.01	
A	1.270	0.2887	0.074	0.098	0.0382
B	4.130	0.0019	0.091	0.120	0.1771
A x B	1.370	0.1766	0.182	0.240	0.1766

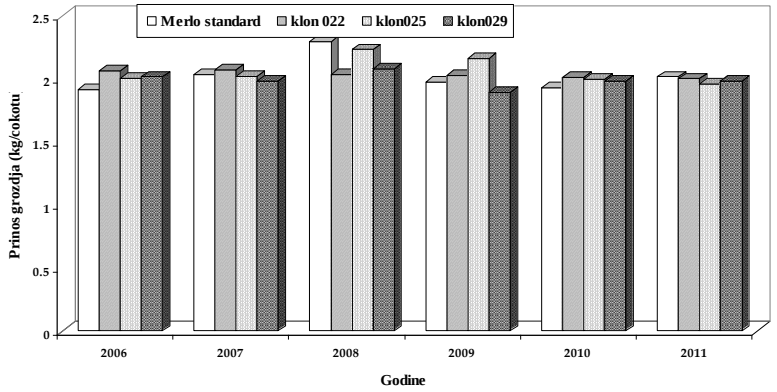


Figure 2. Variations in the yield of grapes - standard Merlot and clones by years

The partial eta squared coefficient for the analysed factor B (year) has a high value (Table 2) and clearly shows that the years characteristics determine the yield of grapes per vine, by over 17%.

Variation in sugar content in the must

The results showing the sugar content in the must are given in the following table (Table 3). The sugar content in all clones and standard Merlot is uniform, so when being tested using LSD test of individual parameters their differences are not statistically significant (p>0.05). These results are in line with Božinović (1996). The year of research as a factor showed a significant effect on the change in the concentration of sugar in the must. The lowest sugar content was found in 2007

compared to the highest content in 2008 and 2011. Thus, these yields show a statistically significant difference, $p < 0.05$ (Table 3). The interaction between the analysed factors in terms of changes in the analysed characteristic was not statistically significant ($p > 0.05$).

Table 3. Significant differences in the sugar content between Merlot standard and clones over the years of research

Cultivar (A)	Sugar						$\bar{x} \pm S\bar{x}$
	Year (B)						
	2006	2007	2008	2009	2010	2011	
Merlot standard	20.876	20.784	21.152	20.832	20.996	21.172	$20.97^{a} \pm 0.067$
Clone 022	20.884	20.912	20.964	20.900	20.716	20.848	$20.87^{a} \pm 0.055$
Clone 025	20.848	20.812	21.112	21.116	20.868	20.944	$20.95^{a} \pm 0.054$
Clone 029	20.888	20.596	20.980	20.800	20.972	21.048	$20.88^{a} \pm 0.067$
$\bar{x} \pm S\bar{x}$	$20.87^{ab} \pm 0.072$	$20.78^{b} \pm 0.074$	$21.05^{a} \pm 0.068$	$20.91^{ab} \pm 0.071$	$20.89^{ab} \pm 0.072$	21.00a±0.082	

a, b –Values without same letter in superscript are significantly different ($p < 0.05$)

Effect	F-test	p-level	LSD		Partial eta-squared
			0.05	0.01	η^2
A	0.600	0.5988	0.175	0.231	0.0192
B	1.700	0.1477	0.215	0.283	0.0808
A x B	0.600	0.8756	0.429	0.565	0.0845

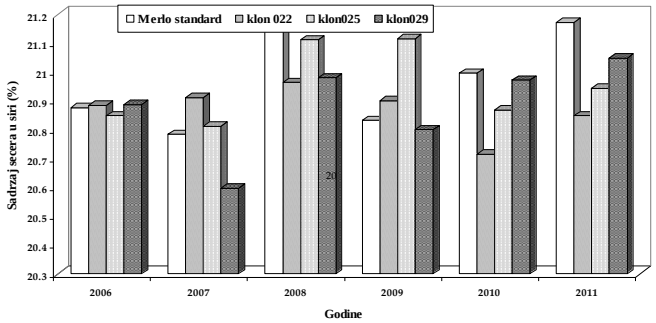


Figure 3. Variations in the sugar content in the must - standard Merlot and clones by years

Variation in total acid content

The total acid content did not significantly vary between the years. The average content was about 6.9 g / l. The results are similar to those found in Cindrić (2000). Therefore, their differences were not statistically significant ($p > 0.05$). Analysed clones gave different total acid content. Thus, clone 022 had the highest concentration of acid (6.98 g/l) and it was significantly higher than the concentration of the acid in the clone 029, as well as in the standard Merlot ($p < 0.05$). Clone x year interaction was not statistically significant for the change in the total acid content ($p > 0.05$).

Table 4. Significant differences in the total acid content between Merlot standard and clones over the years of research

Cultivar (A)	Acids						$\bar{x} \pm S\bar{x}$
	Year (B)						
	2006	2007	2008	2009	2010	2011	
Merlot standard	6.916	6.868	6.860	6.856	6.940	6.924	6.89^{b}±0.029
Clone 022	7.044	6.984	6.952	6.940	6.960	7.004	6.98^{a}±0.022
Clone 025	6.916	6.912	6.928	6.856	6.940	6.880	6.90^{ab}±0.029
Clone 029	6.872	6.780	6.872	6.844	6.904	6.892	6.86^{b}±0.028
$\bar{x} \pm S\bar{x}$	6.94^{a}±0.037	6.89^{a}±0.045	6.90^{a}±0.031	6.87^{a}±0.032	6.94^{a}±0.030	6.92^{a}±0.032	

a, b–Values without same letter in superscript are significantly different ($p<0.05$)

Effect	F-test	p-level	LSD		Partial eta-squared η^2
			0.05	0.01	
A	3.000	0.0349	0.082	0.107	0.0854
B	0.600	0.7373	0.100	0.132	0.0279
A x B	0.200	0.9996	0.200	0.263	0.0292

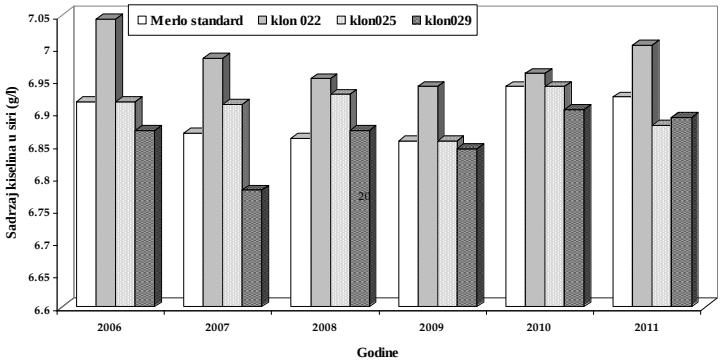


Figure 4.Variation in the total acid content in the must - standard Merlot and clones by years

Conclusions

Based on the research of the Merlot variety population in Grocka vineyard, the following can be concluded:

Climate and soil in this wine-growing region are ideal for growing Merlot variety populations.

The average cluster mass varied from 94.44 to 98.71 g. There were statistically significant differences between the clones. The average yield of grapes varied from 1.99 to 2.06 kg / vine. There were no statistically significant differences between the clones. The average sugar content in the must varied from 20.87 to 20.97%. There were no statistically significant differences between the clones. The total acid content varied depending on clones and ranged from 6.86 to 6.98 g / l. There were statistically significant differences between the clones.

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АГРОБИОЛОШКИ КАРАКТЕРИСТИКИ НА ВАРИЕТЕТИТЕ ОД ПОПУЛАЦИЈАТА ОД СОРТАТА МЕРЛОТ ВО ВИНОГОРЈЕТО ГРОЦКА

Вујовиќ Драган, Малетиќ Радојка, Дана Буцало

Апстракт
Во периодот од 2006 до 2011, изведени се испитувања на агробиолочките карактеристики на вариететите од популацијата на сортата мерлот во локалитет Радмиловац, виногорје Гроцка. Испитувани се неколку агробиолошки индикатори, во овој труд се анализирани следните, маса на гроздот, принос на грозје, содржина на шеќер во ширата и вкупни киселини во ширата.
Клучни зборови: маса на грозд, принос на грозје, шира, шеќер, вкупни кислеини, клон, популација.

UDC: 634.8-152.76 (497.11)
Original scientific paper

UVOMETRIC AND TECNOLOGICAL CHARACTERISTICS OF PROKUPAC CLONES 42/1, 43/2 AND 43/6

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Abstract
Research were carried out in the vineyard of Experimental field "Radmilovac" at Faculty of Agriculture in Belgrade and included 3 Prokupac clones-42/1,43/2 and 43/6. For the purpose of research the mechanical composition of grape and berries by Prostoserdov method are selected five vines of each clone from which it picked five representative bunches for analysis. Grape quality expressed through sugar content was determined with Oechsle mostwaage while the total acid content was determined by titration method with n/4 NaOH. The maximum bunch length was recorded for clone 43/2, and the lowest for clone 42/1. Clone 42/1 is characterized by the largest bunch width (7,54 cm), while clone 43/6 had the lowest (6,4 cm). Clone 42/1 had the highest % of bunch stem (3,36%) but the lowest % of berries in bunch (96,64%), compare to clone 43/2, which had the lowest % of bunch stem (3,05%) but the highest % of berries in bunch (96,95%) and seed number (3,28). Clone 43/2 characterized with the highest level of accumulated sugar (22,05%), while the highest total acid content was noted for clone 43/6 (6,79 g/l). The highest levels of variation were found for seed number in berry (CV= 21.30%), whereas % of berry in bunch (CV= 0.62%) and % of berry meet (CV= 1.04%) indicate the lowest difference between clones. Wine analysis showed that lowest content of free SO_2 and volatile acids was recorded from clone 42/1. With each of three clones longer fermentation affected increased content of extract, ash and potassium in wine.
Key words: Prokupac, clone, mechanical composition, wine analysis, fermentation.

Introduction

By definition clones are population of vines all derived by vegetative propagation from cutting or buds from a single mother by deliberate clonal selection (Creasy et al., 2009). In clonal selection the most important parameters are: vigor, shape and bunch size, bunch and berry mechanical composition, grape and wine quality as well as disease resistance (Rühl et al. 2004). Clonal selection could be positive or negative. Positive selection is more spread, effective and useful method to determine new plant with specific morphological characteristics (Nakalamić and Marković, 2009). With science developing except clonal selection by selecting based on morphological indicators, it is possible to talk about selection on level of DNA where is commonly used DNA screening (Cervera et al., 1998, Scott et al., 2000 a, b) or polymorphic DNA markers (Hancock, 2008; Konrad et al., 2003; Jackson, 2008; Schmid et al. 2009). Prokupac is autochthonous black wine Serbian variety with an undetermined the exact origin, but is assumed to be spread in the area surrounding Prokuplje and Aleksandrovac (Župa). It is often found under the

synonyms: Kameničarka, Rekovačka crnka, Nikodimka, Rskavac, Prokupka and Niševka. It is characterized with strong vigor and yielding capacity, which manifests as a well provided or low fertility soil. Prokupac shoots are developed and strong with standing growth. Prokupac bunch is medium large, with cylindrical or conical form and medium compact. Berries are medium large, round or slightly snippy with a thick and dark blue epidermis. Prokupac can be grown at lower training systems without post system. Yielding varieties whereat should be emphasized that the lowest buds on a shoot are with good fertility. For Prokupac is appropriate short pruning on which provides excellent yield. Some Prokupac varieties is characterized by the increased resistance to *Botrytis cinerea*. Prokupac wine is refreshing and well red colored (Avramov et al. 2001; Žunić and Garić, 2010). According to Zirojević (1964) exist: Prokupac with basic characteristics, Prokupac with smaller leaves and less yielding, Prokupac with leaves and flowers anomalies and Prokupac with bad pollination . Zirojević also established the existence of so-called "White Prokupac" which mutations occur in the direction of anthocyanin degradation and loss of typical black skin color. Research by Marković (2001,2012a) showed that some of these characteristics varied under influence of different rootstocks on which is Prokupac grafted, also mechanical composition of grapes and berries in the highest level was influenced by the rootstocks K 5BB compared to the rootstock 41B and SO4.

Marković et al. (2007, 2008, 2012b,2012c) has allocated 42 Prokupac clones which are in testing process on experimental field Faculty of Agriculture-Radmilovac. During examining years the morphological and technological characteristics of 25 clones, 11 were recognized by the Ministry of Agriculture as a technologically better clones compared to the standard variety and they are expanding into further production. Following clones from paper are recognize (indices in brackets are designation of Ministry of agriculture): 40/5 (ПР 1), 40/8 (ПР 14), 41/1 (ПР 3), 41/3 (ПР 9), 41/4 (ПР 10), 41/6 (ПР 15), 42/1 (ПР 4), 42/2 (ПР 11), 43/2 (ПР 6), 43/6 (ПР 7), 43/7 (ПР 12). From this group in paper sre present clones: 42/1 (ПР 4), 43/2 (ПР 6) and 43/6 (ПР 7). The objective of this study was (1) to examine the variability of morphological traits within the clone collection and (2) to identify the most useful variables for discrimination among clones and (3) to recommended clones suitable for further exploitation based of numerous desirable characteristics.

Material and methods

Research was carried out in the vineyard of Experimental field “Radmilovac” at Faculty of Agriculture in Belgrade and included 3 Prokupac clones-42/1, 43/2 and 43/6. For the purpose of research mechanical composition of grape and berries are selected five vines of each clone from which it picked five representatives bunches for analysis. After bunches selecting was measured their individual weight, length and width, subsequently rachis (pedicel) is separate on each berries with scissors carefully in order to the brush left with less possible mesocarp. Also is determined berries number per bunch, berry mass per bunch and mass of stems measuring on analytical balance. For the purpose of mechanical analysis were selected 100 berries from each clone and after the measured berries masses were separated berry skin and seeds. The mass of seeds and skin of 100 berries was measured on the analytical balance, while seed number of 100 berries were determined by counting. Other parameters shown in Table 1 were obtained by computation. Grape quality expressed through sugar content was determined with Oechsle mostwaage and values were determined using Dujardin-Salleron table, while the total acid content was determined by titration method with n/4 NaOH. Glicoacidometric index is determined as ratio of sugar content and total

acid content. Statistical analysis was performed using average values from three-year measurements. Vine analysis it is done using standard laboratory procedure. Data analysis was conducted using the 'Statistica' (StatSoft, Inc., Tulsa, Oklahoma, USA).

Results and discussion

Mechanical analysis results of grape and berry for 3 Prokupac clones is showed in table 1. The maximum bunch length was recorded for clone 43/2 (14.36 cm), and the lowest for clone 42/1 (12.56 cm). Clone 42/1 is characterized by the largest bunch width (7.54 cm), while clone 43/6 had the lowest (6.4 cm). Observing berries number per bunch and bunch mass from table 1, it can be concluded that the clone 42/1 had the highest value of this morphological characteristics (99.09 and 232.93 g, respectively). The bunch structure is expressed trough % bunch stem (rachis) and % berries in bunch. Clone 42/1 had the highest % of bunch stem (3.36%) but the lowest % of berries in bunch (96.64%), compare to clone 43/2, which had the lowest % of bunch stem (3.05%) but the highest % of berries in bunch (96.95%). The biggest seed number was recorded for clone 43/2 (3.28) also for same clone is recorded the smallest seed mass (0.035 g). Berry weight variation during three-year test period were no significant except that clone 42/1 figure with maximum berries mass (2.6 g). According to the values of berry structural composition of the expressed through % berry skin, % berry meet and % seeds, dissociate clones 42/1 (% berry skin-5.77%, and % seed-2.92%) and 43/2 (% of berry meat-94.27%). Clone 43/2 characterized with the highest level of accumulated sugar (22.05%), while the highest total acid content was noted for clone 43/6 (6.79 g/l). Glikoacidometric index varied from 3.38 (clone 43/6) to 3.95 (clone 42/1).

The overall mean values of all traits showed high differences between the clones indicating a high level of morphological variation. This is also confirmed by relatively high values of coefficients of variation established for the majority of examined traits (table 1). In general, the highest levels of variation were found for seed number in berry (CV= 21.30%), whereas % of berry in bunch (CV= 0.62%) and % of berry meet (CV= 1.04%) indicate the lowest difference between clones.

After microvinifikacion proces, produced wine of investigated clones were analyzed by standard laboratory methods. Observing the obtained values (table 2) is noticed clearly differences in qualitative wine composition. The lowest content of free SO_2 and total SO_2 in wine was recorded at clone 42/1. The total acid content expressed as tartaric acid minimum values had for clone 43/2, while the other two clones had approximately the same, but a higher total acid content.

Fermentation length among all three clones resulted in an increased extract content in wine which is shown at fig 1, 2 and 3. With increasing number of days in the fermentation there was a better wine coloration. After fermentation finishing were still obvious differences in the colors intensity and colors nuances between clone 43/2, which had higher values of these characteristics and clones 42/1, 43/6, which had the wine, somewhat less color intensity and nuances (fig. 4,5 and 6).

Observing fig. 7, 8 and 9, it can be concluded that the increased length of fermentation (in days) resulted in sudden increase of ash content in wine at clone 42/1, while clones 43/2 and 43/6 had a higher ash content in wine, except that values for ash content had not so drastic growth at clone 42/1. The potassium content was slightly higher in wine for clones 42/1 and 43/6, while the potassium content in wine at clone 43/2 is dramatically increased with longer fermentation.

Table 1. Mechanical analysis results

Parameter	Clones			CV
	42/1	43/2	43/6	
Bunch length	12,56	14,36	13,24	6,69
Bunch width	7,54	6,84	6,40	12,44
Berry number per bunch	99,09	88,76	98,44	12,38
Bunch mass	232,93	188,50	217,70	12,67
Bunch structure				
% of bunch stem	3,36	3,05	3,24	16,16
% of berry	96,64	96,95	96,76	0,62
Seed number in berry	1,70	3,28	1,60	21,30
Seed mass	0,047	0,035	0,036	7,83
Berry mass	2,6	2,17	2,5	8,28
Berry structure				
% of berry skin	5,77	3,50	3,84	14,27
% of seed	2,92	2,23	2,40	16,91
% of berry meet	93,31	94,27	93,76	1,04
Sugar content	20,10	22,05	21,38	7,29
Total acid content	5,34	6,22	6,79	12,37
Glicoacidometric index	3,95	3,81	3,38	17,77

Table 2. Chemical content of vine

Clon	Free SO_2 (mg/l)	Total SO_2 (mg/l)	Total acid like tartaric acid (g/l)	Tartaric acid (g/l)	Volatile acid like acetic acid (g/l)	Ash (g/l)	Potasium (g/l)	Potasium (%)	Color intensity	Color nuance
42/1	15,36	79,36	9,31	2,10	0,22	2,24	0,86	38,4	0,44	1,23
	10,24	58,88	9,25	0,60	0,26	2,53	0,90	35,6	1,65	0,70
	23,04	76,80	10,14	1,30	0,30	2,62	1,06	40,5	3,08	0,59
43/2	48,64	135,68	7,24	0,90	0,30	1,94	0,63	32,5	0,29	1,23
	10,24	53,76	8,14	0,70	0,26	2,16	0,82	28,0	1,91	0,70
	12,80	76,80	10,97	1,90	0,31	2,44	0,84	34,4	2,86	0,59
43/6	23,04	135,68	9,31	2,00	0,28	1,83	0,57	31,1	0,33	0,93
	5,12	81,92	8,97	3,10	0,26	2,08	0,75	36,1	2,00	0,43
	20,48	110,08	10,14	1,50	0,29	2,26	0,84	37,2	2,30	0,57

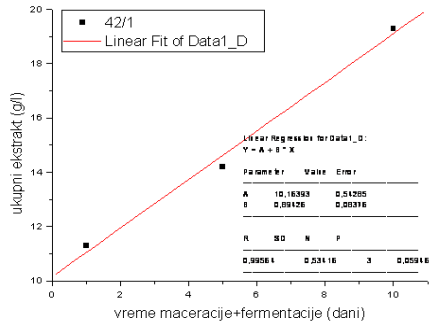


Figure 1. Extract content at clone 42/1

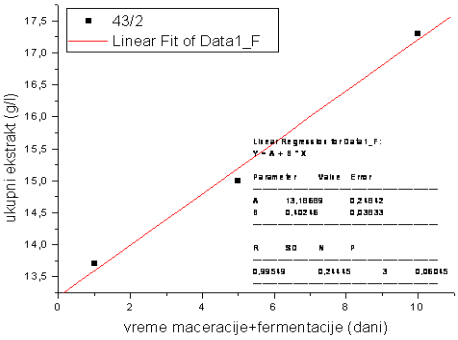


Figure 2. Extract content at clone 43/2

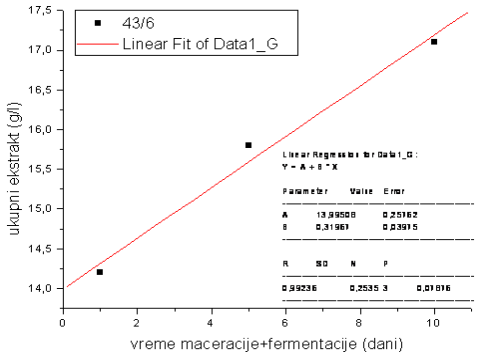


Figure 3. Extract content at clone 43/6

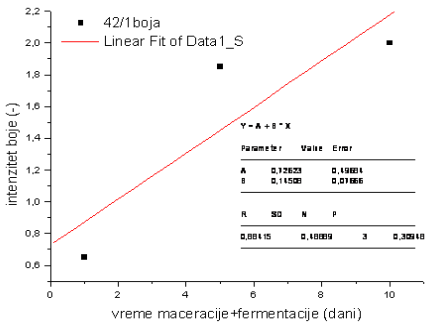


Figure 4. Vine color intensity at clone 42/1

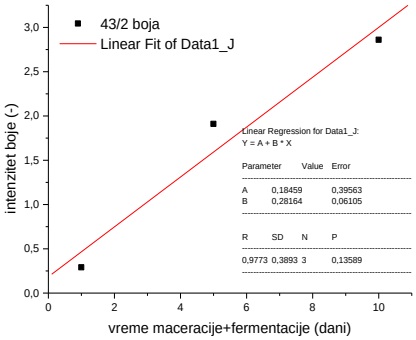


Figure 5. Vine color intensity at clone 43/2

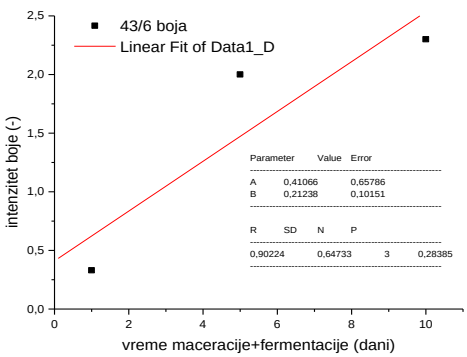


Figure 6. Vine color intensity at clone 43/6

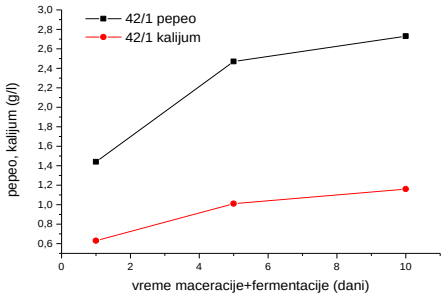


Figure 7. Ash and potassium content in wine at clone 42/1

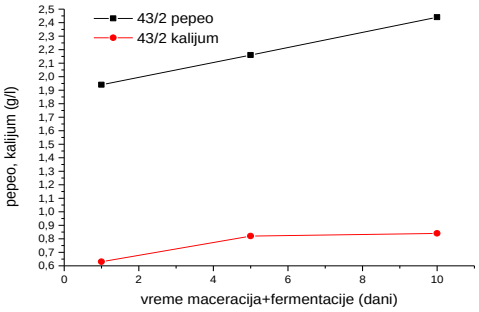


Figure 8. Ash and potassium content in wine at clone 43/2

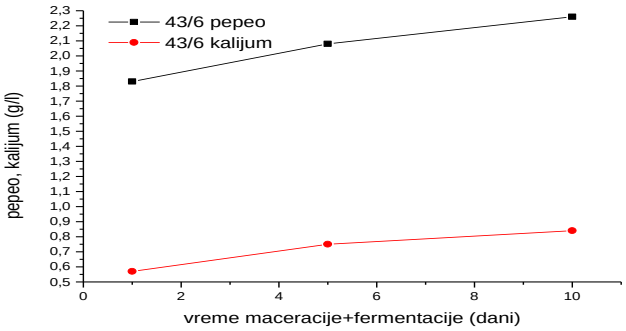


Figure 9. Ash and potassium content in wine at clone 43/6

Conclusions

After research can be done the following conclusions:

The results of this study considerable morphological and biological diversity among 3 selected Prokupac clones.

Morphological characteristics of berries and grapes showed great variation which is present by CV whose values ranged from 0.62-21.30%. The highest variation was observed in the seeds number per berry, % of berry in the cluster and berry meat.

Length fermentation process has satisfactory affect the color of the obtained wine and the ash content of the wine.

In wine of the clone 42/1 was recorded a lower content of free and total SO_2 and lower content of volatile acids expressed as acetic acid, while the wine of clones 43/2 and 43/6 was characterized with higher content of extract, tartaric acid, ash and color nuance.

The potassium content in wine has steadily increased with longer fermentation process.

Acknowledgement

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УВОМЕТРИСКИ И ТЕХНОЛОШКИ КАРАКТЕРИСТИКИ НА КЛОНОВИТЕ 42/1, 43/2 И 43/6 ОД СОРТАТА ПРОКУПЕЦ

Н. Марковиќ, З. Атанацковиќ, З. Ранковиќ-Васиќ

Апстракт

Испитувањата беа изведени на експерименталните лозја во „Радмиловац“ на Факултетот за земјоделство во Белград, вклучувајќи три клона 42/1, 43/2 и 43/6. За целта на истражувањето механичкиот состав на гроздот и зрното се анализирани со методот на Простосердов, избрани се 5 репрезентативни лози од кои се издвоени 5 репрезентативни грозда. Квалитетот на гроздот е прикажан преку содржината на шеќер, утврдена со Екслов широмер додека вкупните киселини беа определени преку титрациски метод со n/4 NaOH. Максималната должина на гроздот е забележана кај клонот 43/2 додека најмала кај клонот 42/1. Клонот 42/1 се карактеризира со најголема ширина (7,54 см) додека клонот 43/6 има најмала ширина (6,4 см). Клонот 42/1 има најголем % од гроздинка (3,36%) но најмал процент на зрна во гроздот (96,64%), во споредба со клонот 43/2 кој има најнизок процент на гроздинка (3,05%) но најголем процент на зрна во гроздот (96,95%) и број на семки (3,28). Клонот 43/2 се карактеризира со највисоко ниво на акумулиран шеќер (22,05%) додека највисока содржинха на вкупни киселини е забележана кај клонот 43/6 (6,79 g/l). Највисоко ниво на варирање е најдено во бројот на семки (CV= 21.30%), додека % на зрна и каде процентот на зрна во гроздот (CV= 0.62%) и процентот на месо (CV= 1.04%) покажува најмалите разлики помеѓу клоновите. Анализата на виното покажува најниска содржина на слободен SO2 кај клонот 42/1. Кај сите три клона долгата ферментација предизвика зголемена содржина на екстракт, пепел и калиум во виното.

Клучни зборови: Прокупец, клон, механички состав, анализа на вино, ферментација.

UDC:634.8-152.61 (497.16) 2004/2009
Original scientific paper

RESEARCH ON ORIGIN AND GENETIC SANITARY EVALUATION OF AUTOCHTHONOUS GRAPEVINE VARIETIES IN MONTENEGRO

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Abstract
Viticulture and wine production in Montenegro are mainly based on production of grapes and wine from autochtonous grapevine varieties (vranac, kratošija, krstač and žižak). Paper presents multi-years results of research on origin of those varieties which indicate their long presence and growing on affirmed vineyard localities in Montenegro. Beside that, paper shows the genetic evaluation (DNA analysis) of autochthonous grapevine varieties where it was found the originality of vranac, krstač and žižak varieties and that kratošija has the same genetic profile as zinfadel. Sanitary evaluation included testing of selected vines within the population of autochtonous grapevine varieties on the presence of viruses (GFLV, ArMV, GLRaV-1, GLRaV-3, GVA, GFkV) by serological assay ELISA, molecular assay PCR and indexing. In period of 2004-2009, it has been tested 145 interesting vines within the population of vranac variety from which 5 vines have passed complete sanitary control and 2 are still in testing. Out of 45 tested vines of kratošija, only one is still in testing and all the others have had a significant presence of the virus. Testing results of selected vines within the population of krstac and zizak varieties showed that all 15 tested vines of krstac variety and all 15 tested vines of zizak variety were infected with viruses therefore they did not passed sanitary control. Further, through the projects SEEDNET (2009-2010) and SEERA NET 91/01 (2010-2012), sanitary evaluation of new samples of our autochtonous grapevine varieties was done. Sanitary control was conducted on additional 19 samples of vranac, 26 samples of kratosija, 15 samples of krstac and 2 samples of zizak variety.
Key words: origin of variety, population, vine, genetic and sanitary evaluation.

Introduction

It is well known that the breeding of grapevine is related with territory, history and tradition. All this contributes to emphasis of its origins and importance of terroir in the expression of its best features. Autochthonous grapevine varieties that are grown for centuries in Montenegro define and to the greatest extent create the viticulture and winemaking of this country and participate in its promotion as a "small country of great wines." From the distant past to the nowadays as support of that there are numerous awards of Montenegrin wines from autochthonous varieties.

Vranac and kratosija are now economically the most important grapevine varieties for red wines in Montenegro. A big part in the production of white wine in Montenegro takes a wine produced from autochthonous variety krstac. Variety zizak is grown on a small area in Montenegro and in its

coastal region. Given the importance of autochthonous grapevine varieties for viticulture and wine making sector in Montenegro, research towards a better understanding of our autochthonous varieties, in the first place of their origin, was done. Research was done in order to collect all available literature data about origin and tradition of breeding autochthonous grapevine varieties in Montenegro. In collaboration with international partners, a genetic evaluation of our varieties as a indicator of their autochthonous character was done. Sanitary evaluation of selected vines within population of variety, aiming in determination of species and level of the viral infections as an indicator of the long growing of these varieties on viticulture localities in Montenegro, was done. These activities have created the conditions to begin the work on clonal selection of these varieties in order to enhance their agrobiological, economic and technological properties.

Material and methods

After visiting the renowned vine-growing areas in Montenegro and marking materials, its characterization and evaluation, collected material from different parts of Montenegro has been identified in the period of 2004-2011 (cooperation between ”13. jul Plantaže” and Istituto Sperimentale per la Viticoltura-Conegliano, Italy).

Firstly, identification of the material of varieties which are indicated in the literature as Montenegrin autochthonous varieties (vranac, kratošija, krstač, žižak) was done. Then, it was proceeded with the identification of 17 biotypes of kratošija variety that have been collected and planted in vineyards in the collection of the Biotechnical Institute (kratošija velja, kratošija mala, kratošija, kratošija srednja, crni krstač, ljutica, vrančina, vran, vranac, vrančić, kratošija sa dubokim urezom, velji vranac, srednji vranac, kratošija ili vran, bikača, čestozglavica and rehuljača).

In order to identify the accessions of autochthonous varieties from different viticulture areas in Montenegro, genotyping was performed with 11 SSR loci routinely employed at CRA-VIT for cultivar identification (VVS2, Thomas and Scott 1993); VVMD5, VVMD7, VVMD27 and VVMD28 (Bowers *et al*. 1996 and 1999); VrZAG62 and VrZAG79, (Sefc *et al.* 1999); ISV2, ISV3 and ISV4 (Crespan 2003) and VMCNG4b9 (Welter *et al*. 2007) as described in Crespan *et al.* (2006).

By visual observation during the growing season from population of variety, vines that have stood out by their characteristics were selected. Sanitary status of population is analysed by ELISA, PCR and indexing. During 2004-2009, testing on the viruses was conducted on 145 vines of vranac variety and 45 vines of kratosija variety. Beside these, 15 vines of both, krstač and žižak varieties, were tested. Selected vines that have passed sanitary control are propagated. In period of 2009-2012, as a result of work on projects SEEDNET and SEERA NET 91/01, sanitary status of more samples of autochthonous varieties (19 samples of vranac, 26 samples of kratosija, 15 samples of krstac and 2 samples of zizak variety) was done.

Results and discussion

Origin research of Montenegrin autochthonous grapevine varieties

As early as in 1891. M. Plamenac points out that Crmnica's wine is the best wine in Montenegro and that can be compared with the wines from Bordeaux. Particularly inspired Jergovic, (1892) writes about quality of wine. He states that this wine is produced from grapes of vranac variety and somewhere kratosija variety. The first remarkable description of the Kratošija variety was made by Petar Plamenac in the Ampelography Viale and Vermonela (1910). More detailed descriptions of

Montenegrin varieties was made by Vujović (1956) and Vojvodić (1956). Vujović described two types of Kratošija, marked them as type 1 and type 2, and Vojvodić described kratošija in the context of a few most remarkable varieties of Montenegro. Plamenac and Vujović (1956) indicate the winged bunches in the shape of the cross which is characteristic for krstac variety how it probably gets its name. For žižak variety it is written that it is grown in Bay of Kotor and it can be found under synonym žižak bijeli (Bulić, 1949). Ulićević (1959) describes žižak variety as important variety from which in some places in Boka, desert wine type Prošek is produced. Burić (1995) states that this variety gives quality refreshing wines.

According to Ulićević (1966), what is characteristic for Montenegrin varieties is that vranac, kratosija and bijeli krstac have been grown on a relatively very narrow strip. Fifty-sixty years ago, the growing area of vranac was not wider than 30 km, 40-50 km of bijeli krstac and 100-150 km of kratosija variety.

In recent years, thanks to its quality, vranac has undergone expansion and become the main variety for the production of red wines, not only in Montenegro, but in the neighborhing countries (Macedonia, Herzegovina, Dalmatia). Today, because of its heterogeneous population kratošija is rarely represented in pure varietal plantings and it is mostly found in the combination with vranac variety which dominates in the assortment of red grapevine varieties. Heterogeneity of kratosija has been writen by many authors (Bulić, 1949; Jelaska, 1954; Stojanović, 1954; Ulićević 1966, Pejović, 1988, Avramov, 1980, 1988; Burić, 1995; Božinovik, 1998; Maraš, 2000, 2004).

Unlike kratošija, krstač is considered as homogenous variety. By Ulićević (1959) it is the most represented in Podgorica subregion in the locality of Doljani, Beri and in lesser extend in Lješanska nahija. Ulićević (1966) states that in Doljani it is called as krstača bijela, while in Vražegrmcima as bijela krsta and in Beri as bijela vinogradarska. Author points out that in Crmnica where is less frequent, it is known under the name bijela loza, bioka and some other synonyms.

Taking into account the importance of vranac and kratosija for Montenegrin viticulture and wine making including as well the neighbour contries, in studied literature many authors state out autochthonous of vranac and kratosija as well as their growing areas.

Stojanović (1929), Bulić (1949), Ulićević (1959, 1966), Nastev (1967), Ćetković (1978), Zirojević (1979), Avramov (1988), Pejović (1988), Cindrić (1994, 2000), Burić (1995), Božinoviќ (1996), Maraš (2000, 2004), Milosavljević (2008), Žunić and Garić (2010) state that vranac and kratosija are autochthonous grapevine varieties originated from Montenegro. These two varieties in the production of wine complement excellent, kratosija mostly has more total acides in grapes (sometimes sugar also) and vranac is richer in coloured substances.

Bulić (1949) gives descriptions of kratosija from nine municipalities of Montenegrin cost, with synonyms (gartošija, grakošija i kratkošija). He states that “something” of this variety is represented in Dalmatia and nowadays it has been planted in Herzegovina. Moreover, he states that the variety is most likely from Montenegro came to Dalmatia.

Surely, the most important researh of origin, description and importance for Montenegro of vranac variety and kratosija variety is given by academician Ulićević (1959, 1966). He states that vranac is characteristic variety of Montenegrin viticulture area which covers about 40 % of assortment. According to author this is the only viticultural area where it dominates and the only one where it is represented to a greater extent. It is in a proper sense Crmnica's variety. Until First World War, author reports that vranac was mostly represented in Crmnica and later it has been spread to Montenegrin cost.

Another variety almost equally important in Crmnica vineyards is kratošija. Due to the fact that it is very dominant in all plantations older than 60-70 years, that often represents 90% in grapevine assortment in the other viticultural areas of Skadar subregion and that is in the coast and older plantations even more prevalent, Ulićević (1959) considering that it is the main and probably the oldest Montenegrin variety.

Author states that in that period vranac and kratosija have not been grown outside of Montenegro, exept perhapas in the experimental plantations, and that they represent our autochthonous and original material for the production of high quality red wine. Ulićevic (1956) states that „the oldest and the most represented Californian variety zinfandel is identical with our kratošija and that probably originates from this regions from where it was been spread out by our immigrants".

Confirmation that Ulićević (1959) was right is the result of recent research of Callo *et. all* (2008), in which it is confirmed by DNA analysis, that Kratošija has the same genetic profile as Zinfandel.

Genetic identification of of Montenegrin autochthonous grapevine varieties

As a result of cooperation between the company "13. jul Plantaze" and Italian partners (Instituto sperimentale per la viticulture Susegana-Conegliano TV) it has been done genetic identification of Montenegrin autochthonous grapevine varieties. Originality has been confirmed with vranac, krstač and žižak. SSR profiles for 11 markers for three autochthonous Montenegrin varieties are presented (Table 1). The samples of krstac and zizak show original SSR profiles, not present in CRA-VIT database.

Table 1. SSR profiles of autochthonous Montenegrin varieties

VARIETY	VVS2		VVMD5		VVMD7		VVMD27		VrZAG 62		VrZAG 79		VVMD28		ISV2 (VMC6E1)		ISV3 (VMC6F1)		ISV4 (VMC6G1)		VMCNG4B9		
VRANAC	133	133	226	226	247	249	181	181	193	199	258	258	239	251	151	165	133	139	177	177	164	172	Autochthonous
KRATOŠIJA	133	143	226	236	247	249	179	181	199	203	236	258	251	261	141	165	139	139	177	177	150	164	Zinfadel/Primitivo
KRSTAČ	133	139	232	240	239	239	185	185	187	195	250	258	247	261	145	151	133	139	169	177	158	166	Autochthonous
ŽIŽAK	143	145	240	240	239	263	179	191	187	193	250	250	251	261	141	159	139	139	183	187	150	152	Autochthonous

DNA analyses have showed that Montenegrin autochthonous variety kratosija has identical genetic profile as zinfandel from California, primitivo from Italy and crljenak kastelanski from Croatia (Callo *et al.* 2008). After confirming the genetic profile of kratošija as zinfandel, based on a sample sent from Montenegro, five more samples of kratošija variety from different viticulture locations of Montenegro were sent. All these samples showed identical genetic profile as zinfandel-primitivo. In the same study, DNA analysis showed close relationship between vranac and kratosija (zinfandel) and that there is the first level of relation (the closest relation parent-offspring). The population of kratosija variety is very heterogeneous which indicate its long growing in Montenegro. Ampelographic research (Maras, 2000) were done on kratosija´s biotypes which are known under different names-synonyms in viticulture areas in Montenegro: velja kratošija, velji vran, crni krstač, vrančina, bikača, vran, srednja kratošija, kratošija or vran, srednji vranac, vranac, vrančic, ljutica, kratošija, cestozglavica, kratošija mala, kratošija with deep notches and rehuljača. All 17 analyzed biotypes of kratošija have the same molecular profile like zinfandel/primitivo (unpublished results).

Sanitary status of Montenegrin autochthonous grapevine varieties

Evaluation of sanitary status of autochthonous grapevine varieties in Montenegro was done to assess the presence and the incidence of virus diseases with regard to occurrence of economically important viruses. The sanitary assessment was done by ELISA, PCR and indexing. In period of 2004-2009., it was tested 145 samples (vines) of vranac variety. Most samples of the population of vranac variety -55 vines (37.93%) were infected by LR3 virus and 45 vines (31.03%) by inf. mix GVA+LR3. There were not infected vines by ArV. Using ELISA test, the presence of viruses was not identified in 17 vines (11.72%). During 2009-2012., through the international projects SEEDNET (2009-2010) and SEERA NET 91/01 (2010-2012), 19 more samples of vranac variety were sent on ELISA testing. Presence of virus was identified in 14 (73.7%) samples, while 5 samples (26.3%) were virus-free. Results showed the prevalence of FLV (21.1%) and inf. mix of GFV+LR3 (15.8%). The significant presence was of LR1 (10.5%), LR3 (10.5%) and inf. mix of AMV+GFV (10.5%). The presence of ArV and KV was not identified. Table 2. represents ELISA results the tested vines within the population of vranac variety for total observed period.

Table 2. Sanitary status of vranac variety (ELISA test) - incidence of different viruses (2004-2012)

Number of vines	Ar	Ar+FL	FL	FL+LR3	FL+GVA +LR3	K	GVA+LR3	LR1	LR3	LR1+LR3	Negativ
0	-	-	-	-	-	-	-	-	-	-	-
2	-	+	-	-	-	-	-	-	-	-	-
15	-	-	+	-	-	-	-	-	-	-	-
3	-	-	-	+	-	-	-	-	-	-	-
5	-	-	-	-	+	-	-	-	-	-	-
5	-	-	-	-	-	+	-	-	-	-	-
45	-	-	-	-	-	-	+	-	-	-	-
5	-	-	-	-	-	-	-	+	-	-	-
57	-	-	-	-	-	-	-	-	+	-	-
5	-	-	-	-	-	-	-	-	-	+	-
22	-	-	-	-	-	-	-	-	-	-	+
164	0.00%	1.21%	9.14%	1.82%	3.04%	3.04%	27.43%	3.04%	34.75%	3.04%	13.41%

Vines which passed sanitary control by ELISA test in the first testing period were also tested by PCR and indexing. Out of 17 tested vines, 5 vines (29.41%) were infected by RSP and the same (29.41%) by RSP+NN. From the total number of tested samples (17), 5 samples have passed PCR and indexing (29.41%) - there were no viruses. They represent very useful material which entered in procedure of individual clone selection. Five samples which were included later and turned out to be virus free (by ELISA), need to be subjected to further testing (PCR). In period of 2004-2009, samples of the population of kratosija variety were also tested on the presence of viruses by ELISA and PCR. It was tested 45 samples (vines). Most samples -14 vines (32%) were infected by inf. mix GVA+LR3. The presence of inf. mix GVA+LR1 was also very significant (24%). There were no infected vines by Ar, K and FL viruses. In last four years, through the mentioned projects, more samples of kratosija variety were subjected to virus testing. From 26 ELISA samples tested, the absence of virus was in 12 samples (negative). Virus incidence was: LR1 (8 samples -46.15%), ArV (4 samples -15.38%) and FL (2 samples -7.69%), respectively.

Vines which passed sanitary control by ELISA test (4 vines -9%) in the first testing period, were also tested by PCR and indexing. PCR showed that 2 of these samples were infected with RSP+GVA and 1 did not pass indexing. One sample is still in indexing. For 12 negative samples from the second period of testing, further sanitary control need be done.

Total of 15 samples of krstac variety were subjected on virus testing during 2004-2009. All these samples were positive on some of the tested viruses. The most significant was the presence of inf. mix GVA+LR3 (10 samples -67%). During the projects, 15 new samples of krstac variety were included in the virus testing. Most samples were positive (11 samples -73.33%), while 4 samples were negative (by ELISA).

Table 3. Sanitary status of kratosija variety (ELISA test) -incidence of different viruses (2004-2012)

Number of vines	Ar	Ar+LR3	FL	FL+GVA+ LR3	K	GVA+LR3	LR1	GVA+LR1	LR3	LR1+LR3	K+LR1+ LR3	K+GVA+LR1 +LR3	Negativ
0	-	-	-	-	-	-	-	-	-	-	-	-	-
4	+	-	-	-	-	-	-	-	-	-	-	-	-
1	-	+	-	-	-	-	-	-	-	-	-	-	-
2	-	-	+	-	-	-	-	-	-	-	-	-	-
4	-	-	-	+	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	+	-	-	-	-	-	-	-
8	-	-	-	-	-	-	+	-	-	-	-	-	-
3	-	-	-	-	-	-	-	+	-	-	-	-	-
6	-	-	-	-	-	-	-	-	+	-	-	-	-
11	-	-	-	-	-	-	-	-	-	+	-	-	-
1	-	-	-	-	-	-	-	-	-	-	+	-	-
1	-	-	-	-	-	-	-	-	-	-	-	+	-
16	-	-	-	-	-	-	-	-	-	-	-	-	+
71	**5.63%**	**1.40%**	**2.81%**	**5.63%**	**0.00%**	**19.71%**	**11.26%**	**4.22%**	**8.45%**	**15.49%**	**1.40%**	**1.40%**	**22.53%**

Table 4. Sanitary status of krstac variety (ELISA test) - incidence of different viruses (2004-2012)

Number of vines	Ar	FL	GVA+LR3	K	K+GVA+ LR3	LR1	LR3	FL+LR3	LR1+LR3	Ar+LR1+ LR3	Ar+LR3	Ar+FL+ LR3	Ar+FL+LR 1+LR3	Negativ
0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	+	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	+	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	+	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	+	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	+	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	+	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	+	-	-	-	-
1	-	-	-	-	-	-	-	-	-	-	+	-	-	-
1	-	-	-	-	-	-	-	-	-	-	-	+	-	-
1	-	-	-	-	-	-	-	-	-	-	-	-	+	-
4	-	-	-	-	-	-	-	-	-	-	-	-	-	+
30	**0.00%**	**0.00%**	**33.33%**	**0.00%**	**6.66%**	**6.66%**	**10,00%**	**6.66%**	**6.66%**	**6.66%**	**3.33%**	**3.33%**	**3.33%**	**13.33%**

From 15 tested samples of zizak variety (in period of 2004-2009), ELISA results showed the highest deegre of viral infections by inf. mix GVA+LR3 (12 samples -80%). Two samples were infected by inf. mix K+GVA+LR3 (13.3%), while one sample showed infections by inf. mix GVA+LR3 (6.7%). There were no negative samples from zizak variety. As a result of SEERA NET 91/01 project, 2 more samples of zizak variety were tested, resulting in one positive (infected by LR1 virus) and one negative sample (Table 4).

Results of virus testing in different vine-growing regions of Montenegro disclosed a widespread presence of viruses and a low occurrence of non-infected vines. High presence and incidence of the different viruses is an indicator of long cultivation of these varieties in the wine-growing regions of Montenegro. Detection of multiple infections by two or even three viruses was observed. The most widespread was the presence of inf. mix GVA+LR3 (28.72%), following by single infection of LR3 (23.40%) (Table 6).

Table 5. Sanitary status of žižak variety (ELISA test) - incidence of different viruses (2004-2012)

Number of vines	Ar	FL	GVA+LR3	K	GVA+LR1 +LR3	LR1	LR3	K+GVA+ LR3	Negativ
0	-	-	-	-	-	-	-	-	-
12	-	-	+	-	-	-	-	-	-
1	-	-	-	-	+	-	-	-	-
1	-	-	-	-	-	+	-	-	-
2	-	-	-	-	-	-	-	+	-
1	-	-	-	-	-	-	-	-	+
17	0.00%	0.00%	70.58%	0.00%	5.88%	5.88%	0.00%	11.76%	5.88%

Table 6. Sanitary evaluation of autochthonous grapevine varieties - percentage of different virus incidence

Number ofvines	Ar	FL	GVA+LR1	K	GVA+LR3	LR1	LR3	LR1+LR3	Ar+LR3	Ar+FL	FL+LR3	K+LR1+ LR3	GVA+ LR1+LR3	K+GVA+L R1+LR3	FL+GVA+ LR3	K+GVA+ LR3	Ar+LR1+ LR3	Ar+FL+ LR3	Ar+FL+ LR1+LR3	Negativ
4	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
81	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
66	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
282	1.41%	6.02%	1.06%	1.77%	28.72%	5.67%	23.40%	6.38%	0.70%	0.70%	1.77%	0.35%	0.35%	0.35%	3.19%	1.41%	0.70%	0.35%	0.35%	15.24%

Conclusions

Numerous literature data verily indicate long tradition of viticulture in Montenegro and the dominant place in the assortiment belongs to the autochthonous grapevine varieties vranac, kratošija, krstač and žižak. Genetic identification has confirmed the authenticity of Montenegrin varieties cv Vranac, cv Krstac, cv Zizak and for cv Kratosija is confirmed to have identical DNA profile as cv Zinfadel, cv Primitivo and cv Crljenak kastelanski. Also, all 17 biotypes of kratosija variety are shown the same molecular profile like zinfandel/primitive/crljenak kastelanski. Evaluation of sanitary status of autochthonous grapevine varieties in Montenegro was done to assess the presence and the incidence of virus diseases with regard to occurrence of economically important viruses. The most widespread was the presence of inf. mix GVA+LR3 (28.72%), following by single infection of LR3 (23.40%). Very heterogeneous population of kratosija variety in Montenegro as well as a complete summary of the sanitary status representing a high degree of infections of selected vines within the population of varieties vranac, kratošija, krstač and žižka, confirms their growing for centuries on the territory of Montenegro.

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ИСПИТУВАЊЕ НА ПОТЕКЛОТО И ГЕНЕТСКО САНИТАРНА ПРОЦЕНКА НА АВТОХТОНИТЕ СОРТИ ВИНОВИ ЛОЗИ НА ЦРНА ГОРА

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Апстракт
Лозарството и винарството на Црна Гора главно се базира на производство на грозје и вино од домашни сорти винова лоза (вранец, кратошија, крстач и жижак). Трудот ги прикажува повеќегодишните резултати од испитувањето на потеклото на овие вариетети што покажува нивно долго присуство во афирмираните локалитети во Црна Гора. Покрај ова во трудот е прикажана генетската евалуцаија преку анализа на ДНК на автохотните сорти, каде е пронајдена оригиналност на сортите вранец, крстач и жижак , како и тоа дека сортата кратошија има исти генетски профил како зинфандел. Санитарната евалуцаија ги вклучува испитувањата на селектирани лози во популацијата на автохтоните сорти во однос на присуство на вируси (GFLV, ArMV, GLRaV-1, GLRaV-3, GVA, GFkV) со серолошки метод на ELISA, молекуларни методи PCR и индексирање. Во период 2004-2009 тестиравме 145 интересни лози во популацијата на сортата вранец од кои 5 лози целосно ја поминаа санитарната контрола а 2 се сеуште во тестирање. Кај сортата кратошија од 45 единствено една е сеуште во фаза на тестирање, кај другите е пронајдено присуство на вируси. Сите 15 тестирани лози кај крстач и сите 15 лози кај сортата жижак се инфицирани со вируси и не ја поминаа санитарната контрола. Понатаму преку проектот SEEDNET (2009-2010) и SEERA NET 91/01 (2010-2012), санитарната евалуација на нови примероци од автохтоните сорти е извршена. Санитарната контрола беше спроведена на дополнителни примероци, 19 од сортата вранец, 26 од сортата кратошија, 15 од сортата крстач и 2 од сортата жижак.
Клучни зборови: потекло на сортите, популација, лоза, генетска и санитарна евалуација.

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TECHNOLOGICAL CHARACTERISTICS OF MERLOT VARIETY CLONES IN GROCKA VINEYARDS

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Abstract
In the period from 2006 to 2011, several clones of Merlot grape variety (022, 025 and 029) were tested in Grocka vineyards. The tests included several indicators: ethyl alcohol content, content of polyphenolic substances, anthocyanin content, content of tannin substances and wine tasting grades. The results showed no statistically significant differences among the tested clones concerning the ethyl alcohol content, content of polyphenolic substances, tannin content and wine tasting grades.
Key words: clone, Merlot, alcohol, polyphenols, anthocyanins, tannins, wine.

Introduction

Merlot grape variety is quite widespread in Serbia. It is grown as a pure grape variety or in combination with Cabernet Sauvignon and Cabernet Franc. Merlot provides quality - high quality grapes and wine, alone or blended with the above mentioned varieties. Merlot is characterized by a cluster mass of 120 - 180 g, where skin accounts for 84% - 88% of the cluster structure. Sugar content in the must is 21% - 23.5% and total acidity 7g / l - 8 g / l. The wine contains 11, 5% - 13% alcohol and is well coloured.

Material and methods

Radmilovac locality is located in the territory of Experimental school estate Radmilovac – Vinča of the Faculty of Agriculture in Zemun. Experimental vineyard was planted in 1991. It was arranged in the form of a double horizontal cordon with 80-cm high seedlings spaced at 3 x 1 m. Grapevines were grafted on rootstock Kober - 5BB. The mixed pruning was applied leaving a total load of 24 buds per vine. The following wine indicators were tested: ethyl alcohol content, content of polyphenolic substances, anthocyanin content, content of tannin substances and wine tasting grades.
The analysis of the experimental data was performed using analytical tools available in statistical package SPSS version 17. The indicators of descriptive statistics were calculated for all characteristics of tested genotypes (average value, standard error of the average value ($S\bar{x}$) and standard deviation). In order to reach objective conclusions about the effects of analysed factors on the changes in the technological characteristics of grapes and wine, and apply parametric tests (ANOVA and LSD test), the homogeneity of variances was tested using Hartley's, Cochran's, Bartlett's and Levene's test (*Hadživuković, 1977*). Test results indicate that variances of tested characteristics are homogenous and do not need a detailed analyses. The effect size of each factor, as well as their interaction, was measured by the partial eta squared coefficient which was then classified according to Cohen's system (*Cohen, 1988*).

Results and discussion

The research results concerning the technological properties of grapes are presented in Tables and Figures 1-5.

Variations in the content of ethyl alcohol

Variations in the content of ethyl alcohol in analysed clones of the Merlot grape variety are given in Table 1. The content of ethyl alcohol in wine was not significantly different among the analysed clones. Variations ranged from 12.63 vol% (clone 029) to 12.65 vol% (standard Merlot and clone 025). Similar results were obtained by Singleton et all (1992). Therefore, the differences were not statistically significant ($p>0.05$). The year of production, as a factor, significantly influenced the content of ethyl alcohol in wine. The highest content of ethyl alcohol was found in the wine produced in 2010 (12.90 vol%) and the lowest in the wine produced in 2007 (12.34 vol%). The concentration of ethyl alcohol also varied in other experimental years, so the application of ANOVA test showed that these differences were statistically highly significant ($p <0.01$).

Table 1. Significant differences in ethyl alcohol (vol%) between standard Merlot variety and its clones over the years of research

Cultivar (A)	Ethyl alcohol -vol% year (B)						$\bar{x} \pm S\bar{x}$
	2006	2007	2008	2009	2010	2011	
Merlot standard	12.772	12.268	12.540	12.596	12.884	12.832	12.65^{a}±0.072
Clone 022	12.892	12.576	12.716	12.536	12.912	12.828	12.64^{a}±0.067
Clone 025	12.764	12.256	12.592	12.544	12.916	12.848	12.65^{a}±0.067
Clone 029	12.760	12.276	12.516	12.528	12.868	12.844	12.63^{a}±0.066
$\bar{x} \pm S\bar{x}$	12.65^{a} ±0.07	12.34^{a} ±0.10	12.59^{a} ±0.09	12.55^{a} ±0.08	12.90^{a} ±0.04	12.84^{a} ±0.032	

A – Values without same letter in superscript are significantly different ($p<0.05$)

Effect	F-test	p-level	LSD		Partial eta-square η^2
			0.05	0.01	
A	0.009	0.9954	0.1678	0.2209	0.0007
B	7.100	0.0000	0.2056	0.2706	0.2713
A x B	0.800	0.6885	0.4111	0.5412	0.1095

Interaction between the analysed factors did not significantly affect the content of ethyl alcohol in wine.

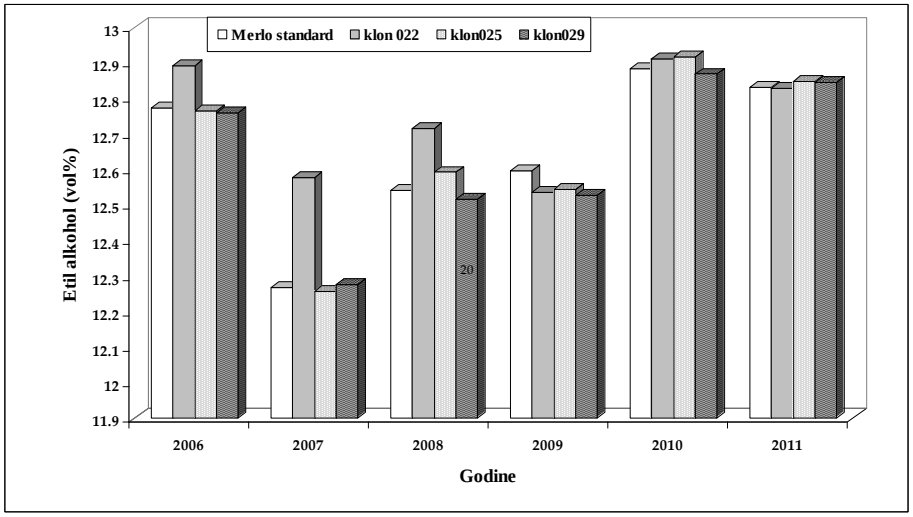


Figure 1. Variations in the content of ethyl alcohol in wine – Merlot standard and clones by experimental years

Considering the results of ANOVA test, it was interesting to calculate the value of partial eta squared coefficient for a year as a factor, since it was statistically significant for the changes in the content of ethyl alcohol. The value obtained ($\eta 2 = 0.2713$) indicates that years with their weather conditions influence the content of ethyl alcohol in wine of Merlot variety clones by more than 27%.

Variations in the content of polyphenolic substances

The total content of polyphenolic substances did not show significant variations by any factor (either by clones or by years). The content of polyphenolic substances ranged from 1.87 g / l to 1.91 g / l over years. Similar results can be found in Piljac et all. (2005). Therefore, their differences were not statistically significant - Table 2 ($p > 0.05$) by any factor, and neither was the interaction of the same factors. Given the fact that the factors had no statistically significant effect on the content of polyphenolic substances, it is needless to observe the values of partial eta squared coefficients and analyse them. since they do not have a significant effect in changing the content of polyphenolic substances.

Variations in the content of anthocyanins enidol

Table 3 presents the variations in the content of anthocyanins in wine. The largest concentration was recorded in standard Merlot variety (142.83 mg / l) and the lowest in clone 029 (142.14mg / l). Similar results can be found in Puškaš et all. (2005). However, the differences between the varieties were not statistically significant, Table 3 ($p>0.05$). The year of production, as a factor, influenced variations in the content of anthocyanins much more.

The largest concentration of anthocyanins was measured in the wine produced in 2007, and the lowest in the vine produced in 2011. The LSD test showed a statistically significant difference between the content of anthocyanins in wine produced in 2007 and all the other experimental years. Also, the content of anthocyanins in wine produced in 2008, 2009 and 2010 is significantly different than its content in 2006, 2007 and 2011. Wine produced in 2006 and 2011 has the content of

anthocyanins which is not statistically significant. The interaction between the analysed factors (variety x year) did not significantly affect the content of anthocyanins.

Table 2. Significant differences in the content of total polyphenolic substances between standard Merlot variety and its clones over the years of research

Cultivar (A)	Total polyphenolic substances						$\bar{x} \pm S\bar{x}$
	Years (B)						
	2006	2007	2008	2009	2010	2011	
Merlot standard	1.912	1.920	1.940	1.916	1.876	1.912	$1.91^{a}\pm0.023$
Clone 022	1.852	1.880	1.856	1.896	1.848	1.868	$1.87^{a}\pm0.023$
Clone 025	1.888	1.916	1.876	1.896	1.928	1.876	$1.90^{a}\pm0.022$
Clone 029	1.876	1.908	1.872	1.832	1.860	1.866	$1.87^{a}\pm0.019$
$\bar{x} \pm S\bar{x}$	$1.88^{a}\pm$ 0.029	$1.91^{a}\pm$ 0.024	1.89 $^{a}\pm0.028$	$1.88^{a}\pm$ 0.028	$1.88^{a}\pm$ 0.025	$1.88^{a}\pm$ 0.029	

a –Values without same letter in superscript are significantly different ($p<0.05$)

Effect	F-test	p-level	LSD		Partial eta-square η^2
			0.05	0.01	
A	0.890	0.4511	0.2074	0.2730	0.0270
B	0.120	0.9872	0.2540	0.3344	0.0063
A x B	0.140	0.9999	0.5081	0.6688	0.0217

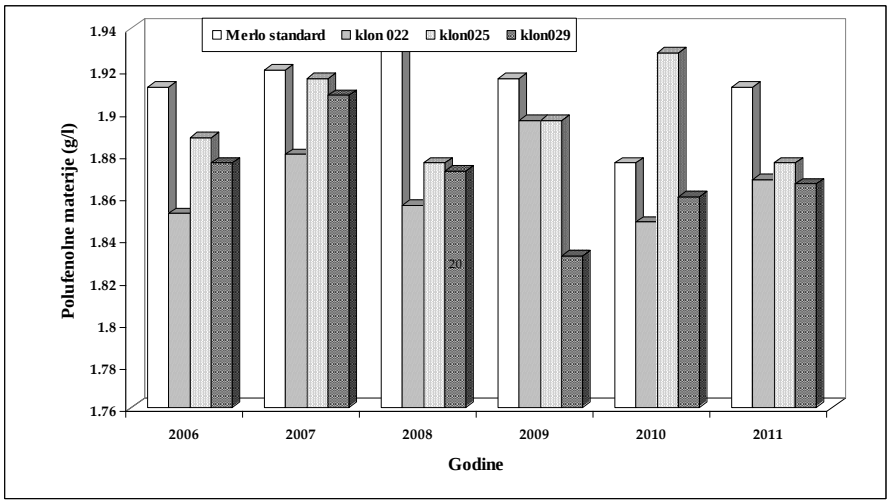


Figure 2. Variations in the content of polyphenolic substances in wine - Merlot standard and clones by experimental years

Table 3. Significant differences in the content of anthocyanins enidol between standard Merlot variety and its clones over the years of research

Cultivar (A)	content of anthocyanins enidol						$\bar{x} \pm S\bar{x}$
	Year (B)						
	2006	2007	2008	2009	2010	2011	
Merlo standard	141.204	146.660	144.424	142.672	142.324	139.708	142.83^{a}±0.695
Clone 022	136.884	146.000	142.748	140.880	141.416	139.432	141.23^{b}±0.722
Clone 025	140.608	146.260	143.000	141.588	141.96	140.812	142.29^{ab} ±0.613
Clone 029	140.448	146.140	142.232	142.868	142.536	138.636	142.14^{ab} ±0.597
$\bar{x} \pm S\bar{x}$	139.79^{c}± 0.556	146.27^{a}± 0.0338	143.10^{b}± 0.730	142.00^{b}± 0.0636	141.94^{b}± 0.770	139.65^{c}± 0.578	

a, b, c –Values without same letter in superscript are significantly different ($p<0.05$)

Effect	F-test	p-level	LSD		Partial eta-square η^2
			0.05	0.01	
A	1.500	0.2191	1.5182	1.9984	0.0448
B	13.400	0.0000	1.9584	2.4476	0.4106
A x B	0.500	0.9518	3.7188	4.8950	0.0679

Bearing in mind the fact that the year of production had a statistically significant effect on the variations in the content of anthocyanins in wine, it would be good to calculate the value of partial eta squared coefficient ($\eta 2 = 0.4106$) for this factor. It clearly indicates that the years with their specificities significantly affect the changes in the content of anthocyanins by more than 41%, which is a very high effect size by Cohen's gradation. *Variations in the content of tannin substances*

In the period from 2006 to 2011 the content of tannin substances in wine of Merlot variety clones was analysed. Table 4 shows the results.

Wine produced from Merlot variety clones had the same average content of tannin substance (mean 1.12 g / l). Similar results can be found in Revilla et all. (1997). Their differences were not statistically significant.

The changes in content of tannins in wine were much more affected by the second analysed factor (year of production). The highest content of these substances was measured in the wine produced in 2007 and 2008 and their content was significantly higher compared to other experimental years ($p <0.05$). The content of tannins in wine produced in other years was not statistically significant.

The interaction between the analysed factors did not show statistical significance ($p>0.05$).

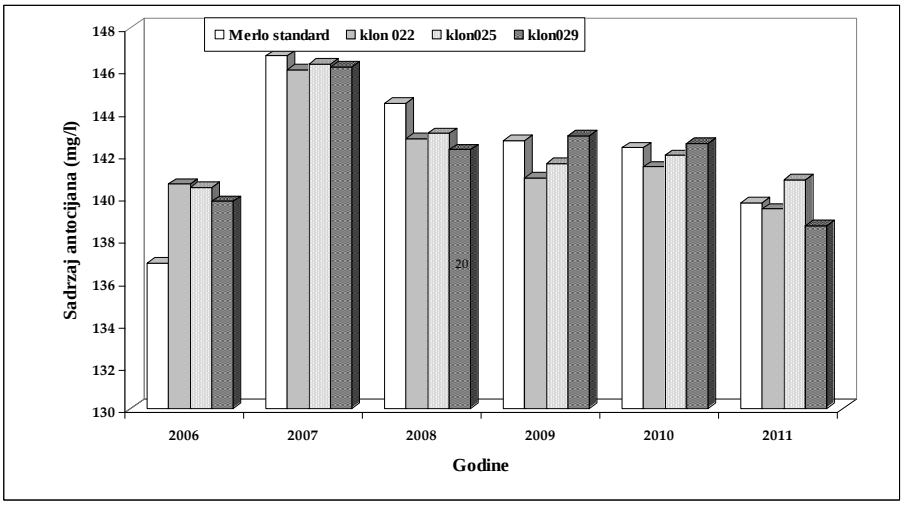


Figure 3. Variations in the content of anthocyanins enidol in vine - Merlot standard and clones by experimental years

Table 4. Significant differences in the content of tannins (g/l) between the standard Merlot variety and its clones over the years of research

Cultivar (A)	Content of tannins g/l						$\bar{x} \pm S\bar{x}$
	Year (B)						
	2006	2007	2008	2009	2010	2011	
Merlo standard	1.086	1.144	1.159	1.092	1.102	1.113	$1.12^{a}\pm0.008$
Clone 022	1.096	1.138	1.166	1.133	1.095	1.112	$1.12^{a}\pm0.008$
Clone 025	1.112	1.158	1.166	1.100	1.104	1.113	$1.12^{a}\pm0.007$
Clone 029	1.094	1.149	1.168	1.130	1.100	1.107	$1.12^{a}\pm0.008$
$\bar{x} \pm S\bar{x}$	$1.10^{a}\pm$ 0.006	$1.15^{a}\pm$ 0.010	$1.16^{a}\pm$ 0.007	$1.11^{a}\pm$ 0.009	$1.10^{a}\pm$ 0.006	$1.11^{a}\pm$ 0.006	

a –Values without same letter in superscript are significantly different ($p<0.05$)

Effect	F-test	p-level	LSD		Partial eta-square η^2
			0.05	0.01	
A	0.400	0.4270	0.0182	0.0240	0.0135
B	11.500	0.0000	0.0023	0.0765	0.3740
A x B	0.400	0.9692	0.0447	0.0588	0.0620

Partial eta squared coefficient for the year factor is very high (η^2=0,3740) which clearly shows that weather conditions affect the content of tannins by more than 37%.

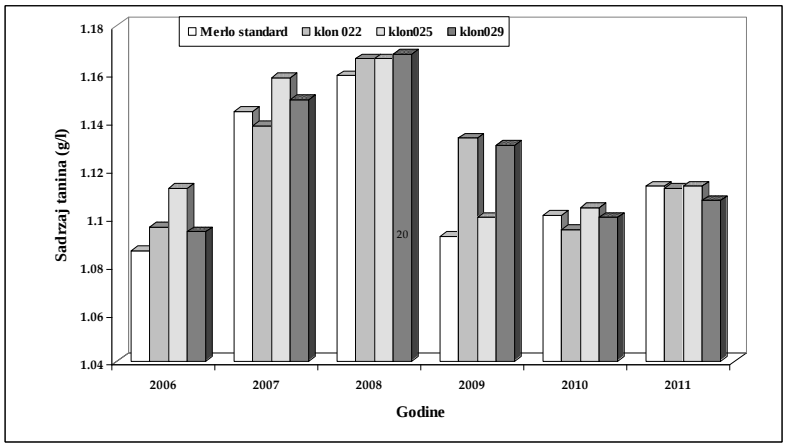


Figure 4. Variations in the content of tannins in wine - Merlot standard and clones by experimental years

Variations in the wine tasting scores

Wine tasting scores were not significantly different either by clones or by years. The average scores among the clones of Merlot variety ranged from 18.01 (clone 022) to 18.06 (clone 025). These differences were not statistically significant. Observed by experimental years, the biggest wine tasting score was in 2008 and 2009 (18.059), compared to the lowest in 2011 (17.97). Neither of these wine tasting scores was statistically significantly different. Also, the interaction clone x year showed no statistical significance ($p>0.05$). Given that the factors and their interactions did not show a statistically significant effect on the variations in the wine tasting scores, the analysis of partial eta squared coefficients made no sense.

Table 5. Significant differences in wine tasting scores between the standard Merlot variety and its clones over the years of research

Cultivar (A)	Wine tasting score						$\bar{x} \pm S\bar{x}$
	Year (B)						
	2006	2007	2008	2009	2010	2011	
Merlo standard	18.016	18.084	18.024	18.032	18.024	17.984	$18.03^{a}\pm0.037$
Clone 022	18.092	17.932	18.004	18.100	17.968	17.964	$18.01^{a}\pm0.036$
Clone 025	18.004	18.148	18.112	18.056	18.036	17.976	$18.06^{a}\pm0.035$
Clone 029	18.032	18.016	18.076	18.028	18.024	17.972	$18.02^{a}\pm0.030$
$\bar{x} \pm S\bar{x}$	$18.04^{a}\pm$ 0.048	$18.04^{a}\pm$ 0.036	$18.05^{a}\pm$ 0.045	$18.05^{a}\pm$ 0.053	$18.01^{a}\pm$ 0.032	$17.97^{a}\pm$ 0.038	

a–Values without same letter in superscript are significantly different ($p<0.05$)

Effect	F-test	p-level	LSD		Partial eta-square η^2
			0.05	0.01	
A	0.300	0.8530	0.1012	0.1332	0.0081
B	0.500	0.7977	0.1240	0.1632	0.0239
A x B	0.300	0.9941	0.2479	0.3263	0.0452

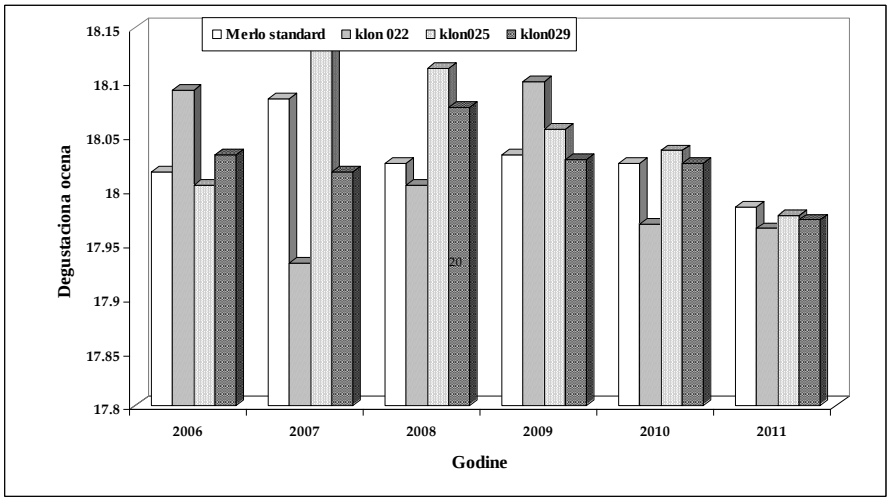


Figure 5. Variations in the wine tasting scores - Merlot standard and clones by experimental years

Conclusions

Based on the analysis of technological characteristics of the Merlot variety population in Grocka vineyards, the following can be concluded:

The average content of ethyl alcohol in clonal wine ranged from 12.63 to 12.65%.

The average content of polyphenolic substances in clonal wine ranged from 1.87to 1.91g/l.

The average content of anthocyanins in wine in clonal wine ranged from 141.23 to 142.83 mg/l.

The average content of tannins in clonal wine was 1.12 g / l.

The average clonal wine tasting scores ranged from 18.01 to 18.06.

Merlot grape variety is of special interest to the grape - wine production because it belongs to the group of varieties for the production of top-quality colour wines.

Merlot variety population was tested for the presence of 7 major viruses; the material is free from them.

The best clones of Merlot variety were planted at 2 locations (Radmilovac and Sremski Karlovci) for further monitoring and possible placement to the list of varieties of the Republic of Serbia.

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ТЕХНОЛОШКИ КАРАКТЕРИСТИКИ НА КЛОНОВИТЕ ОД СОРТАТА МЕРЛОТ ВО ВИНОГОРЈЕТО ГРОЦКА

Вујовиќ Драган, Малетиќ Радојка, Буцало Дана

Апстракт
Во периодот од 2006 до 2011, неколку клонови од сортата мерлот (022, 025 и 029) беа тестирани во виногорјето Гроцка. Тестовите вклучуваат неколку показатели: етил алкохол, полифенолни соединенија, антоцијани, танини и сензорна оценка. Резултатите покажуваат статистички значајна разлика помеѓу тестираните клонови во однос на содржината на алкохол, полифенолните соединенија, танините, и сензорните карактеристики.
Клучни зборови: клон, мерлот, алкохол, полифеноли, антоцијани, танини, вино.

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Original scientific paper

INFLUENCE OF SOIL MAINTENANCE IN THE VINEYARD ON CERTAIN BIOLOGICAL AND TECHNOLOGICAL CHARACTERISTICS OF THE VRANAC VARIETY

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Abstract
In this paper, three methods of soil maintenance have been presented (permanent grassing by sowing a meadow grass mixture, bare untilled soil with herbicide applied and tilled soil), that is, their influence on agrobiological and commercial and technological characteristics of this variety. The research was conducted on a Trial Plot of the Biotechnical Faculty in Podgorica, Lješkopolje locality. The trial vineyard was set up in 2005. Based on the research work conducted so far, there are grounds to conclude that permanent grassing over results in a good wine quality, with no significant difference in either vigour or fruitfulness of grapevine among bare, tilled and untilled plots.
Key words: grape vine, Vranac, grassing over, tillage, herbicides.

Introduction

Grape vine is one of the oldest plant cultures grown. It represents an important Christian symbol, particularly as it used for winemaking. The gape vine cluster is an attribute of deity, crop production and fertility and it represents the wine of life. The grape vine growing culture dates back to a long time ago. There are many theories about its origins, as well as about where the first steps in viticulture had been made. According to majority of these theories, the domesticated grapevine occurred first in the Middle East. According to Milosavljević (1990) traces of grape vine cultivation date back to more than 9000 years ago, in the South Caucasus and Mesopotamia, 6000 years ago in Egypt and in the Balkans, the grape vine cultivation dates back to between 4,000 to 5,000 years ago. According to Pejović et al. (2004) the grape vine distribution area is broad and it may be grown from latitude 52° north and latitude 45° south. Montenegro's viticulture was developed further by ancient masters – Romans, who made numerous records of varieties and methods of grape vine growing. According to Marco Aurelio, the Roma Emperor, wine from the area around the Lake of Skadar prevents aging, it extends life. A part of Montenegro where grape vine has been grown since the old times is the zone with modified Mediterranean climate. Today, „13. jul Plantaže" a.d. is the major producer of wine and table grapes in the region. About 70% of the vineyard set up is the Vranac variety, and wine made of it has become the national brand name and also the best-known and the best product of the company „13. jul Plantaže" a.d. which has promoted Montenegro as an important wine destination. There are about 4,000 ha under vineyards in Montenegro, situated in the

Podgorica and Coastal vineyard areas. Of that area, 2,200 ha under vineyards are the property of „13. jul Plantaže“ a.d. producing more than 20 million kg of grapes, processing of which results in about 15 million wine units at the national and foreign markets. For that reason, „13. jul Plantaže“ a.d. is the backbone of Montenegro's viticulture and winemaking and it spreads the glory of Montenegro's wines.

The objective and the significance of the research

The main objective of the research is to analyse and establish what soil maintenance method (permanent grassing by sowing a meadow grass mixture, bare untilled soil with herbicide application and tilled) in a vineyard produces the best effect on agrobiological and commercial and technological characteristics of the Vranac variety. Grassing over of soil in a vineyards is as old as the grape vine culture, but in various forms. Only as of lately has the grassing over been recommended for soil maintenance in a vineyard. Namely, the scientific community is divided when it comes to grassing over the soil in a vineyard, since soil composition has not been sufficiently studied. For that reason, intensive research activities on this topic have been in place in the past few years and significant advantages of grassing over the soil in a vineyard have been proved. The results of many studies show that permanent grassing may double the organic matters content in soil. Furthermore, it has been established that under irrigation and fertilization, grape vine's vigour is lower than that of grape vine in bare, tilled and untilled soil, but the yield is about the same. Consequently, the motive of the work behind the Master's Thesis on this topic was to get a better insight into the effect of grassing over in a vineyard. The objective of this research, in addition to the abovementioned, has been also to study and present some agrobiological and commercial and technological characteristics of the Vranac grape vine variety. The results obtained will show what is the most favourable method of soil maintenance for this specific variety, that is how the permanent grassing by sowing a meadow grass mixture, bare untilled with herbicide application and tilled influences the fruitfulness and vigour of the Vranac variety, as well as its quality. Also, one of main objectives of this work was to establish whether different soil maintenance methods in plantations of the Vranac variety reduce or increase the yield compared to the normal soil maintenance method (in the form of fallow or clean cultivation). The Vranac variety, which is the object of the research in this paper, in the Podgorica vineyard area gives supreme quality with a very balanced proportion of sugar and acids, and for that reason it is widespread and in high demand at the market.

Facilities, materials and method of work

The research on influence of the soil maintenance methods in a vineyard certain biological and technological characteristics of the Vranac variety was done on the Trial Plot of the Biotechnical Faculty – Lješkopolje locality, in the vicinity of Podgorica. The research work, which began in March 2011, covers the Vranac variety. Among numerous well-known authors who wrote about this variety, academician Marko Ulićević stands out, as he dedicated most of his work on research of this variety. The vineyard in which the trial was conducted was set up in 2005. The vine plant spacing in the vineyard is 2.4 x 1.2 m, while the spacing from one post to the other is 7 m. In the interstice, the Vranac variety was represented with 6 vine plants each. The training system is the Guyot two-folded cordon. The trellis in the vineyard is the espalier, constructed by a combination of concrete posts with galvanized wire, and mixed pruning is applied. The research and measuring conducted on the Vranac variety in the period concerned included the following:

- Agrobiological characteristics of the variety

- Commercial – technological characteristics of the variety

Results and discussion

The phenophases observed in the trial vineyard were as follows: sap flow phenophase, budbreak phenophase, flowering phenophase and ripening phenophase.

Sap flow phenophase

The overview of the beginning and the end of the sap flow in the Vranac variety is given in the Table 1 below. The research trial was divided into 3 equal parts (grass, herbicides, tillage) so the sap flow phenophase of the Vranac variety was observed in each part separately. The Table 1 shows that no significant difference was noted among the soil treatment methods specified. The onset of the sap flow phenophase was in the period 19 March 19 – 21 March, that is, in the third and the fourth decade of March.

Table 1. Beginning and the end of the sap flow phenophase in the Vranac variety under research

Vranac variety	Sap flow phenophase	
	Sap flow beginning	Sap flow end
Grass	19/03	15/04
Herbicides	21/03.	13/04
Tillage	21/03.	14/04

Based on the data given in the table above (Table 1) it can be stated that the phenophase in this trial period lasted from 24 to 28 days. Pejović and Mijović (2004) state that this phase lasts 13-24 days on average, while in extreme cases it lasts from 8 to 45 days. The same authors state that this phase is short in case of high soil and air temperatures, as high temperatures enable budding within a short time.

Budbreak phenophase

The second phenophase in the annual development cycle during the vegetation period is the budbreak phenophase, that is, the beginning of the growth of shoots and other organs. The Table 2 below gives an overview of the beginning and the full budbreak of the Vranac variety observed in the year of the research work (2011).

Table 2. Beginning and the full budbreak of the Vranac variety observed

Vranac variety	Budbreak phenophase	
	Budbreak beginning	Full budbreak
Grass	29/03	06/04 – 50 % 11/04 - 100 %
Herbicides	31/03	06/04 – 80 % 10/04 - 100%
Tillage	30/03	06/04 – 90 % 10/04 - 100 %

It can be noted in the table above (Table 2) that in the fourth decade of March, i.e. at the end of March, budbreak began in the area where the Vranac variety was treated by different soil methods. The full budbreak in all 3 soil methods began on the same day, i.e. on April 6, which is seen from the results presented in the Table 2. Differences in budbreak (in %) were noted among permanent grassing by sowing meadow grass mixture, tilled soil and bare untilled soil with herbicide

application. In this trial period, the budbreak phenophase lasted from 50 – 52 days, depending on the soil treatment method, which correspond with the assertions of Pejović and Mijović (2004), who stated that this phenophase lasts from 30 – 60 days, depending on the climatic conditions.

Flowering phenophase

Flowering phenophase begins once the flowerhoods fall off under the pressure from anthers. The beginning of the flowering of the Vranac variety observed, full flowering and the end of flowering is presented in the Table 3.

Table.3. Beginning, full flowering and the end of flowering of the variety observed

Vranac variety	Flowering phenophase		
	Beginning of flowering	Full flowering	End of flowering
Grass	19/05	23/05	28/05
Herbicides	17/05	22/05	27/05
Tillage	16/05	21/05	26/05

In all three soil maintenance methods, the Vranac variety flowered in the period 16/05 to 19/05, that is, in the third decade of May. Earlier beginning of the flowering was caused by high temperatures in May recorded in the year of research. Such effect on temperatures on flowering was also pointed out by authors Fazinić (1971) and Burić (1972). Based on the results obtained in the table above (Table 3) we note that the difference between the earliest and the latest flowering was 1- 3 days, while the flowering phenophase in the soil methods concerned lasted from 9 to 12 days.

Grape ripening phenophase

Ripening and grape harvesting phenophase of the Vranac variety observed is presented in the Table 4. For the research, the day of harvesting is taken as the day of ripe grape. In the year of the research, the grape ripening phenophase lasted from 66 to 68 days. The assertions of Merzanian (1951) and Negrulj (1959) who state that this phenophase lasts from 1.5 to 2 months match to a certain extent with the results obtained in the year of the research.

Table 4. Ripening phase and the grape harvesting for the Vranac variety observed

Vranac variety	Grape ripening phenophase	
	Veraison	Grape harvesting
Grass	06/04	10/09
Herbicides	04/07	10/09
Tillage	04/07	10/09

Grape yield

The grape yield per vine plant, as an absolute indicator of fruitfulness of a variety depends on a large number of factors, more significant ones being the biological traits of the variety as well as environmental conditions in the year of research. The influence of these factors is presented in the Table 5.

The number of clusters harvested from 5 vine plants is presented in the Table 5 above, which shows also the average number of clusters per vine plant and the average grape yield per vine plant. The

table shows that the average number of clusters per vine plant ranged from 13.9 to 16.3. The average grape yield (kg) per vine plant in the soil maintenance methods stated above ranged from 2.82 kg to 3.83 kg. On the basis of ten-year research, Ulićević et al. (1983) ascertained that the average ten-year grape yield per vine plant amounted to 2.32 kg on grassed, 3.16 kg on bare untilled and 3.23 kg on tilled areas.

Table 5. Number of clusters on 5 vine plants, average number of clusters per vine plant and average grape yield per vine plant of the Vranac variety

Vranac variety observed	Number of clusters on 5 vine plants	Average number of clusters per vine plant	Average grape yield per vine plant (kg)
Grass	81	16.3	3.14
Herbicides	57	11.5	2.82
Tillage	69	13.9	3.83

Sugar content in grape juice

Sugar content in grape juice – must was determined using Oechsle must-tester, designed in 1850 by the German scientist Ferdinand OECHSLE (MERCZ 1990). Table 6. shows the data of average content of sugar in must.

Table 6. Sugar content in grape juice (%)

Vranac variety analysed	Sugar content by Oechsle must-meter
Grass	21.7
Herbicides	21.5
Tillage	21.2

The sugar content in grape juice of the Vranac variety observed, according to data presented in the Table above (Table 6) ranged from 21.2% to 21.7%. In the year of research, the climatic and edaphic conditions in the ripening period (and temperature in particular) were balanced and favourable, hence they did not cause any significant differences in sugar content in grape juice. According to assertions of Burić (1995) ripe grapes' must of the Vranac variety contains 20-24% of sugar. These assertions match to a certain extent with the results obtained in the year of the research (2011).

Total acid content in grape juice

The influence of the Vranac variety observed and environmental conditions in the year of the research (2011) to the total acid contents in grape juice is presented in the Table 7.

Table 7. Total acid content in grape juice (g/l)

Vranac variety analysed	Total acid content
Grass	4.96
Herbicides	4.93
Tillage	4.78

On the basis of the results obtained in the year of the research (2011) presented in the Table 7 above, it can be stated that the soil maintenance methods mentioned above, when it comes to the Vranac variety, have not differed much with regard to the total acid content in the grape juice – must, and they ranged from 4.78% to 4.96%, which results from the different conditions under which the research was done. Mijović (2000) states that on the basis of the results obtained in the period (1985-1989) average total acid content on shallow ploughed soil amounted to 6.15 g/l, with application of NPK fertilizer it was 6.23 g/l. The same author states that the average total acid content in grapes from the grassed soil amounted to 6.30 g/l, while with application of NPK fertilizer, it was 6.21 g/l.

Conclusions

Based on the results of the research obtained in the course of 2011 with regard to the influence of the soil maintenance method on certain biological and technological characteristics of the Vranac variety, the following conclusions may be drawn:

There were no significant differences between the observed soil maintenance methods for the Vranac variety in the annual biological cycle of grape vine development. The onset of the sap flow phenophase occurred in the period 19/03 to 21/03, that is, in the third and the fourth decade of March. The earliest sap flow onset was recorded in the area where Vranac variety soil was grassed over with meadow grass – on 19/03, while the sap flow of the Vranac variety in the part where herbicides were applied on soil began two days later compared to the grassed over area, i.e. on 21/03, the same day as with the tilled soil. The difference between the earliest and the latest onset of sap flow phenophase was 2 days, budbreak 2 days, flowering 3 days.

The earliest onset of the beginning of veraison was recorded on the same day (04/07**)** in the tilled and untilled soil maintenance method in the vineyard. Change in the colour of skin and softening of grapes (veraison) occurred two days later, that is, on 06/07, in the part where the soil under the Vranac variety was grassed over, so the difference between the earliest and the latest veraison recorded was 2 days.

Grape harvest in all 3 soil maintenance methods took place at the same time, in early September. It was induced by various circumstances, among others, the assessment that ripening was quite uniform. The harvesting of the grapes of the Vranac variety in the part which was grassed over by the meadow grass mixture, tilled soil and bare untilled soil with herbicide application was done at one go, on 10 September.

The largest average number of clusters per vine plant of the Vranac variety in the part where soil of the trial vineyard was grassed over was 16.3, in the part with bare untilled soil with herbicide applied the lowest average number of clusters per vine plant was recorded and it was 11.5, while the average number of clusters in the tilled soil under the Vranac variety was 13.9. The highest yield of the Vranac variety observed was recorded in tilled soil (3.83 kg)**,** while with the soil maintenance method of grassing over, the grape yield per vine plant amounted to 3.14 kg. The lowest yield of the Vranac variety was recorded in bare untilled soil with herbicide applied and it amounted to 2.83 kg 2.82 kg**.** The highest average sugar content determined by the Oechsle must-meter was recorded in the part where the soil under the Vranac variety was grassed over (21.7%). The lowest sugar content of the Vranac variety was in the part of the tilled soil (21.2%). The average sugar content recorded in the part of the bare untilled soil with herbicide applied amounted to 21.5%. The highest total acid content in must of the Vranac variety was recorded in the part of the soil that was grassed over (4.96

g/l). Total acid content in the must of the Vranac variety from the bare untilled soil with herbicide applied was 4.93 g/l, while in tilled soil under this variety, the total acid content in the must was the lowest, amounting to 4.78 g/l. Based on the results obtained, it can be concluded that there are no significant differences between bare untilled soil and tilled soil when it comes to phenological phases of the Vranac variety, which applies also to the elements of fruitfulness and the mechanical properties of the cluster and grapes, while by sugar content and total acid content in grape juice – must, grassed over soil stands out, as the quality of wine made from those grapes had the highest wine tasting score.

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ВЛИЈАНИЕ НА ОБРАБОТКАТА НА ПОЧВАТА ВРЗ ОДРЕДЕНИ БИОЛОШКИ И ТЕХНОЛОШКИ КАРАКТЕРИСТИКИ НА СОРТАТА ВРАНЕЦ

Ана Павичевиќ, Славко Мијовиќ, Анита Газивода

Апстракт
Во овој труд, три методи за обработка на почвата се презентирани, постојана затревеност со сеење на ливадска тревна смеса, примена на хербициди без обработка и трето со постојана обработка на почвата и нивното влијание врз биолошките и технолошките карактеристики на сортата вранец. Испитувањето е изведено во опитното поле на Биотехничкиот факултет во Подгорица, локалитет Љешко поле. Опитното лозје е подигнато во 2005 година. Врз основа на испитувањата можеме да заклучиме дека постојаната затревеност резултира со добар квалитет на виното, со незначајна разлика во бујноста или плодноста на лозата помеѓу варијантите со хербицирање, обработена и необработена почва.
Клучни зборови: винова лоза, Вранец, затревеност, обработка, хербициди**.**

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Original scientific paper

EFFECT OF ALTITUDE ON THE QUALITY AND QUANTITY OF THE INDIGENOUS VARIETY OF PROKUPAC GRAPE

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Abstract
Considering the configuration of the terrain and altitude localities, extending from 110 to 550m above sea level, and bearing in mind the quality of grapes, which will meet the market demands, the aim was to establish to what altitude we can successfully cultivate this variety. Plant vines have been erected on the ground Kober 5 BB with a distance of 1.2 x 1.0 m, i.e.8.333 vines / ha. The investigations included: number of bunches per vine, cluster weight, grape yield per vine and hectare and the quality of grapes grown at sites with different altitudes (130, 220, 320 450 and 550m). A variety of Prokupac showed good yield at all sites, cluster mass was higher for 15 grams at the sites of altitudes of 450 and 550m, but the sugar content was lower by 2.8%, and higher total acidity of 1.7 g / l . In the years when we have an early fall frost at an altitude of 550m and 450 it does not mature completely.
Key words: altitude, cluster, cluster weight, sugar content, total acidity, yield.

Introduction

Prokupac is indigenous grape vine variety mostly represented in the Toplica wine sub region. Today over 90 % of the Toplica wine sub region is planted with this grape vine variety. The indigenous grape varieties and it's products are starting to get attention in Serbia and wider in the world.A lot of authors were writing about the research of this variety, both domestic and foreign: (Avramov, L., Briza K., Bozinovic, Z., Zunic D., Zirojevic D., Nastev D., Stojanovic M., Toskic V., Cvetkovic D., Cindric P.,). Considering the configuration of the terrain and altitude localities, extending from 110 to 550m above sea level, and bearing in mind the quality of grapes, which will meet the market demands, the aim was to establish to what altitude we can successfully cultivate this variety.

Material and methods

The research was conducted from 2008 until 2011 in the Toplica wine subregion on Prokupac variety, which is often used to produce table and quality red wine. Plant vines have been erected in 1990 on the ground, on Kober 5 BB rootstock with a distance of 1.2 x 1.0 m, i.e.8.333 vines / ha. The research included: number of bunches per vine, cluster weight, grape yield per vine and hectare and the quality of grapes grown at sites with different altitudes (130, 220, 320 450 and 550m).
Important climate and land characteristics:
Meteo data for Prokuplje was used for the climate characteristics. Period from 2000 until 2011 is considerated. On base of this perios, basic climate elements are made that show heat conditions, sun

conditions, humidity and winds in selected areas. Air Temperature - middle vegetation temperature in the reasearched period was from 15,9ºC (on 550 m altitude) to 16,9 ºC (on 130 m altitude). Temperature Sum - In the researched period the sum varied from 3365ºC (on 550 m altitude) to 3610ºC (on 130 m altitude). The warmest month is July with average midday temperature from 22,9ºC to 23,4ºC and January as the coldest with average midday temperature from -1ºC to -1,4ºC. Extreme low temperatures were recorded in January and February with -21ºC. Absolutely maximum temperatures were recorded in July and August with 42,1ºC. Length of sunshine radiation had optimal value for all the conducted locations and was 1682 h. Precipitation were varying from 531 mm (on 130 m altitude location) to 590 mm (on 550 m altitude location). On the location the soil type is ganjaca. It has shallow humus horizon and light mechanical compound. Chemical characteristics of the soil is low acid (pH 6,4 - 6,6) and percentage of humus is 2,1 -2,7%. The missing macro and micro elements from the soil is compensated with fertilizing.

Results and discussion

The fertility of the researched grape variety was good on all locations.

In table 1 is shown number of bunches and cluster weight per vine on different locations.

Table 1. Number and weight of clusters/vine 2008-2011

Altitude locality m.	Number cluster/vine	Cluster weight g.
130	15,5	140,7
220	15,1	142,0
323	14,6	143,5
452	13,4	155,0
550	13,3	155,4
Cv%	-	5,2

From Table 1 we can conclude that the highest number of cluster per vine (15,5) was on location of 130 m altitude and the lowest number (13,3) on location of 550 m altitude. With the increase of the altitude there was reducing of the number of cluster per vine, but increasing the cluster weight. The cluster weight was varying from 140,7 g on location of 130m altitude to 155 g to location of 452 m. The cluster weight was higher on locations of 452 and 550 m from 13g to 15 g. Grape yield per vine and hectare was variable per vine on the location and years (Tab. 2)

From the Table 2, we can conclude that grape yield was varying very little per vine and hectare with change of altitude location. Grape yield per vine was 2.067 (550m altitude location) to 2180 (130m). Grape yield per hectare was varying per locations from 17.224 kg (550m altitude location) to 18.169 kg (130m altitude location). Sugar contents and total acids was variable dependant from altitude location (Tab.3).

Sugar content was varying depending from altitude of the location. The highest sugar content (21,1) was in grape on location of 130m altitude, but lowest (18,2) on location of 550m altitude. The difference in between the sugar content per locations was 2,8%. In 2009 in all variants the sugar content was lowest by 3% which points that on higher altitudes sugar is not enough collected

Total acids were variable as per years and per locations. On higher altitudes, the content of total acids was raising. Lowest total acids (6,3 g/l) was in grape on altitude location of 130 m, highest (8,0 g/l) in grape on location of 550 m altitude. The difference between acids was varying by 1,7 g/l.

Table 2. Grape yield per vine and hectare locations in g

Year	Altitude location				
	130	220	323	452	550
2008	2.056	2.220	2.088	2.218	2.131
2009	2.150	2.100	2.102	2.160	2.150
2010	2.205	2.300	2.230	2.260	2.210
2011	1.990	1.960	1.980	2.150	2.010
Average ƙg/vine	2.180	2.144	2.095	2.077	2.067
Grape yield in ha / kg	18.169	17.865	17.457	17.307	17.224

Table 3. Sugar contents by years

Year	Location				
	130	220	323	452	550
2008	21,20	19,8	18,9	17,9	17,3
2009	18,9	18,5	18,0	16,8	16,2
2010	21,8	21,2	20,9	20,2	19,1
2011	22,3	214	21,2	20,5	20,1
Average	21,1	20,2	19,7	18,8	18,2

Table 4. Contents of total acids g/l (average 2008 - 2011)

Total acids g/l	Location				
	130	220	323	452	550
	6,3	6,9	7,1	7,8	8,0

Conclusions

The climate conditions on selected locations are not suitable for grape growing of the researched grape vine variety (452 and 550m). Earth conditions are optimal on all locations. Number of clusters per vine varied seamlessly with increasing of altitude. Cluster weight was seamlessly higher with increasing of altitude. Grape yield per vine was optimal on all locations, with increasing of altitude it was lowering. Sugar content was variable and was dependant of the climate conditions. In certain years where rainy autumns were on location on 423 and 550m altitude, the grape cannot mature by collecting enough sugar, making difficult to make good wine. With increasing of altitude the sugar content in grape is lowering, but is satisfactory untill 323 m altitude. Total acids were varying, increasing with higher altitudes. In this grape growing region we can grow the Prokupac on location from 323 m and on location of 452 and 550 m just in selected years. The reason is that this grape variety matures in 4 th epoch, in the first decade in October.

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ЕФЕКТОТ НА НАДМОРСКАТА ВИСИНА ВРЗ КВАЛИТЕТОТ И КВАНТИТЕТОТ НА АВТОХТОНАТА СОРТА ВИНВОА ЛОЗА ПРОКУПЕЦ

Д. Цветковиќ, П. Христов, Биљана Јанковиќ, С. Милошевиќ, Ј. Трјаковиќ, Р. Христов.

Апстракт

Имајќи ја во предвид конфигурацијата на теренот и надморската висина на локалитетите, од 110 до 550 м над морското ниво, и имајќи ги во предвид квалитетот на грозјето кое ќе ги задоволи барањата на пазарот, целта на испитувањето беше да се утврди на која надморска висина можеме успешно да ја одгледуваме оваа сорта. Сортата е калемена на подлога Кобер 5 ВВ, растојание меѓу лозите од 1,2 х 1,0 м, со 8,333 лози/ха. Испитувањето ги опфати: бројот на гроздови на лоза, тежина на гроздот, принос на грозје на лоза и хектар и квалитетот на грозјето одгледувано локации со различна надморска висина (130, 220, 320 450 и 550m). Сортата Прокупец покажа добар квалитет на сите локации, поголема тежина од 15 грама на локациите со 450 и 550м, но содржина на шеќер пониска од 2,8% и повисока содржина на вкупни кислеини од 1, g / l. Во годините кога се појавија рани есенски мразеви на надморска висина од 550 и 450 м, грозјето не созреа целосно.

Клучни зборови: надморска висина, грозд, тежина на грозд, содржина на шеќер, содржина на киселини, принос.

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INFLUENCE OF DRIP IRRIGATION IN YIELDS ON TABLE GRAPES

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Abstract
With the growth of the world population increased demands for agricultural products. While on the other hand last year's our country as well as the entire region is facing with high temperatures as a result of climate change, and with the distribution of irregular rainfall and often facing with the lack of rain during vegetation periods.The main purpose of this paper is to highlight the impact of drip irrigation in table grape on yields to respectively varieties Afus-ali and Hamburg in agro-ecological conditions of Kosovo (Dukagjini valley). The experiment was situated in the vineyard with regular fruitiness at the age of 15 in Suva Reka. They have been divided into irrigation plots (experimental) and without irrigation (control). Research were followed during 2008-2009. Grape yield is expressed in kg/vine and kg/ha. It has been verified that the differences between experimental plots (with water) and non-experimental plots without water were with high significances. Yield to variety Afus-ali has increased to 47.3% in 2008 and 20.6% in 2009, which were dependent on the amount of annual rainfall and their distribution within the year. Hamburg variety yield increased by 69.9% in 2008, by 74% in 2009. Finally we conclude that drip irrigation has shown a positive impact on increase of productivity. The results date has been calculated and processing, using SPS package. Acquired research results are statistically analyzed with variance analysis.
Keywords: productivity, table grapes, irrigation, varieties.

Introduction

Pedo-climatic conditions which characterize the region of the territory of Orahovac & Suhareka enabled cultivation, intensification and increasing viticulture areas for different purposes. Since antiquity Kosovo has been known for grape cultivation. Archaeological discoveries proved this fact. Ancient tradition, experience and cheap labor power in the cultivation of the vine, which characterize Dukagjini area, have enabled great success to cultivate large areas when in 1990 they reached 8300 ha, of which in the social ownership were 5277 ha, which for political reasons known almost entirely destroyed by the end of 1999, while the rest were under private sector. The importance of the cultivation of the vine is of particular benefit. Is of great interest for the country. Affects in comprehensive income nationally. Has impact on social problem of employment, increases consumption of grapes, affects the development of grape processing technology with the production of quality wines, activate land with vineyards etc.

The importance and role of research

To increase the productivity of grape vine, irrigation may have special importance, especially "Drip irrigation". From the Sixties of the last century comes to new ways of irrigation so-called "Drip irrigation". This form of irrigation was first used in Israel, then California, Australia etc. In the

Balkans appear in the seventieth century 20, when it starts to apply in Kosovo, mainly in fruit growing, vegetarian, etc. Within H. S. The "Radoniqi" on surfaces within the social sector were involved 720 ha of the land under irrigation system. However, irrigation is not applied to any vineyard because of lack of experience for the role and impact of this agro measure. Thus, in the vineyards of Kosovo, this is the first time and at use in experimental form. Irrigation of vineyards in our country is applied in rare cases and in limited area. For this reason "Drip-irrigation", the newest and most rational way was of interest to investigate its effect on specific conditions of Dukagjini after lacking the necessary experience for this type of irrigation. Therefore, the results obtained in this direction present special contribution to Kosovo vineyards and for the region of Balkan Peninsula.

The purpose of the research

The purpose of the study was the observation of the impact of "Drip irrigation" in yield, grape quality, growth and development intensity of (two varieties) of grapes, the formation and maturation of the berries, but also gaining new scientific knowledge about relationship between irrigation and the elements mentioned in the varieties of inquiry. With the aim of linking the soil and climatic conditions and the effect of irrigation, were followed and analyzed climatic conditions for 2008 and 2009 such as: temperature, humidity (precipitation), sun shine etc, which are compared with the average of many years, in this region. With the issue of "Drip-irrigation" are taken not so many authors in the region because it is a relatively new irrigation method. Dates from the '70's in our country. Avramov, L. (1988), states that the method of irrigation with drip (Drip Irrigation) has great efficiency in the production of grapes. This irrigation is done automatically, which ensures the optimal level of moisture in the ground. Larry E. Williams. (2001). the author has researched "Drip irrigation" in condition of California, USA. Are explored vineyards with table grapes and wine, main regions of California, the country which is characterized by high temperatures during the day and low at night. The author states that the amount of water needed for irrigation depends on: vine development phase, planting distances, evapotranspiration, the intensity of vegetation and soil moisture (rainfall during the vegetation). Researches are made in the vineyard which has been at the age of four years, in the period from budding until October. During the vegetation used 1550 gallon or 5859 liters per vine, or the daily amount ranges 11 gallons per day or 39.46 liters per vine.

The author states that the amount of water that needs to be given to irrigation depends on the size and growth of leaves (surface of transpires), a fact which shows the correlation between the amount of irrigation and vine leaf growth. Kabashi, B. (1994) noted that water has the effect of increasing the yield and the amount of sugar in the grapes. And as a suitable form for irrigation of vineyards prefers "Drip irrigation". In this way the irrigation, in addition will be provided optimum moisture in the ground but also may be used for relevant fertilization with (macro-and microelements). Koronica, B. (1996), states that the irrigation of table grape varieties is preferable but can be used also to those of wine varieties, but special care should be taken to the water regime in the stage of maturity of the grapes in order to avoid the reduction of the quality of grapes.

Kabashi, B. (2005) points out that in the region of vineyards in (Dukagjini region) falls in the year about 780 mm rainfall, but which are not properly distributed. Namely, during the vegetative stage, when the need is greater for plants we have lack of rainfall. This deficit in the moderately dry vegetation period is 329 mm and that during the months of June, July, August. Therefore for high yield and quality, have used regular irrigation of the vineyard which enables increased productivity and the amount of sugar in the grapes. Kabashi, B. Dula, Sh. (2005), suggests that the only limiting

factor for high and stable production of grapes is the lack of moisture in the ground (lack of rainfall in the summer).

Agro – ecological condition

Climate-Vine grape (Vitis vinifera) is characterized by great adaptability to diverse climatic conditions. The Dukagjini valley characterized by Mediterranean and continental climate, with warm currents permeability from white Drini river valley. This makes this area very suitable for the cultivation of the vine and achieve higher yields per unit and area.

Table 1. Temperatures in territory of Suva reka, for 2008 – 2009

Temperature (2008)													
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yearly
T. average °C	0.2	5.2	9.2	13.8	19.6	23.6	25.1	26.2	18.3	14.4	12.8	5	14.4
Absolute Max.°C	12.4	22.5	21.9	28.2	35.8	37	38.1	40.6	38.2	24.8	23.6	0	40.6
Absolute min °C	-16.8	-10.4	3.1	7.3	10.2	9.1	16.1	16.1	11.1	7.8	6.9	-4	-16.8
Temperature (2009)													
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yearly
T. average °C	0.3	3.2	7.3	14.1	19.3	21.4	24.5	25.3	21	10.2	8.3	5.5	13.4
Absolute Max.°C	16.2	17.5	25.1	25.1	33.4	35.7	38.5	36.5	0	20.8	19.9	20.3	38.5
Absolute Min °C	-17.9	-7.2	-3.6	2.4	4.3	9.5	11.3	13.3	0	-2.1	-2.9	-13.3	-17.9
Long term T. 1951 – 1980	-0.2	2.7	6.2	11.0	16.0	19.4	21.5	21.5	17.5	12.0	7.0	2.0	11.4

Table 2. The amount of long-term temperatures and years of experimentation by months vegetation season in Suva Reka

Months	IV	V	VI	VII	VIII	IX	Total
2008	414	607.6	708	778.2	812.2	549	3869 °C
2009	421	598.3	642.0	759.5	784.3	630	3835 °C
1951 -1980	330	496	582	668.2	666.5	525	3268 °C

From the analysis of dynamic of the temperatures during vegetative period, we find that the sum of the temperature in 2008 was 3869 ° C, which is about 601 ° C higher than the average perennial. While, in 2009, it was 567 ° C higher than the perennial average. This means that two years of the research have been characterized as the years with very hot and very high temperatures during the vegetation, which has had a positive impact on productivity and quality of irrigated grapes.

Rain fall-In Dukagjini valley or territory of Prizren, in the average amount fall sufficient rainfall. However, they characterized by their poor ranking through the months of the year. They lacking in the vegetative period, in which only 40% of the annual precipitation fall precisely when the need for vine are greater. Therefore appear deficit of rainfalls, which can be met only with irrigation.

From meteorological data taken from meteorological station of KFOR in Suharekë respectively Topliqan, it appears in the year of 2008 there was high rainfall deficit. During this year have dropped a total of 521 mm, while during the vegetation period a total of 193.7 mm and during the three summer months (June, July, August) have fallen a total of 88.6 mm, which represent

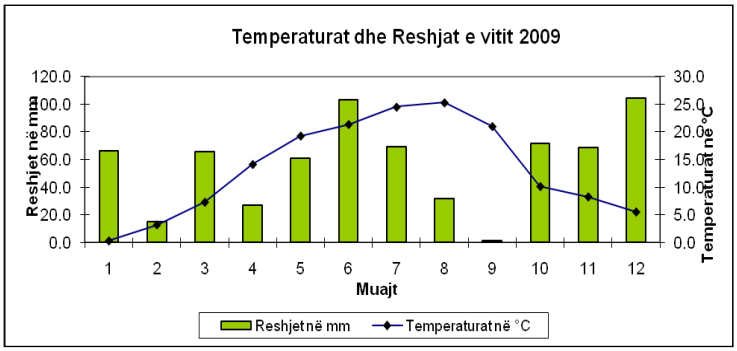
extremely high rainfall deficit. In 2009 have fallen more rainfall, 684.8 mm, of which vegetation months (April - September) 293.3 mm, while during the three summer months (June, July, August) 204.3 mm, which compared to 2008 have better ranking during the vegetation and low rainfall deficit.

Table 3. The amount of annual rainfall in Suva Reka (2008 - 2009)

Sasia e reshjeve													
Muajt	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	∑ Vjetore (mm)
2008	34.3	14.7	132.0	11.1	16.7	42.6	39.2	6.8	77.3	38.7	42.5	65.1	521.0
2009	66.0	14.8	65.6	26.8	60.6	103.4	69.3	31.6	1.6	71.6	68.9	104.6	684.8
Aver. perennial	57.1	46.5	46.6	53.6	76.1	62.0	42.8	25.1	58.2	61.4	73.0	68.1	695

Table 4. Rainfall during the vegetation (2008 - 2009)

	IV	V	VI	VII	VIII	IX	∑ during the vegetatin (mm)
2008	11.1	16.7	42.6	39.2	6.8	77.3	193.7
2009	26.8	60.6	103	69.3	31.6	1.6	293.3
Aver. perennial	13.6	76.1	62	42.8	25.1	58.2	277.8



Soil conditions - Soil represents the place where plants are reinforced, where water is supplied with nutrients and mineral substances. It introduces basic ecological factor for growth and development. Location where the research was is the type of mountain red soil, pedological profile ABC. Data from mechanical and chemical composition of soil are presented in the tables below. During the experiment were made soil analysis (in Peja Biotechnology Institute).

This year is characterized by low rainfall deficit (soil moisture) compared to 2008, which amounted to 372.4mm. If removed May months (due to very small deficit (9.1mm), and September (month which should not be involved with irrigation due to the maturation process), it appears that irrigation should be provided 275 mm, for meet the needs of grapes. Irrigation - The irrigation was done with the system of "Drip irrigation". Where dropper distances were as the distance between the plants in the sequence (1.20 m) for each plant by a dropper, with a capacity of 4 ℓ / hr.

Table 5. Physical composition (mechanical) of soil

Depth cm	Mechanical soil structure					
	2.0-0.2	0.2-0.02	0.2-0.002	<0.002	Sand	Clay
0-20 cm	12.0	33.0	28.0	27.0	45.0	55.0
20-40 cm	10.5	37.5	26.0	26.0	48.0	52.0
40-60 cm	19.0	32.5	21.5	27.0	51.5	48.5

Table 6. Chemical Composition

Depth (cm)	Sample nr	Humidity %	Ph-water	CaCO%	Humus %	Elements			
						$P_2 0_5$ mg/ 100g	$K_2 0$ mg/100g	Ca mg/100g	Mg mg/100 g
0-20	1	15.9	6.9	-	2.6	9.0	38	380	48
20-40	2	20.7	6.9	-	1.0	< 1	19.0	240	45
40-60	3	22.5	6.8	-	0.8	< 1	19.2	235	50
0-60	0	18.4	6.9	-	1.5	< 3	34	320	47

Table 7. Tabular presentation of calculating soil humidity deficit for 2008, (calculation methodology given by Professor Dr. B. Kabashi). (ETP - is calculated according to the method Penmani-t.)

Months	Amount of moisture from winter reserves used by plants (mm)		Rainfall (mm)		Potential Evotranspirations (ETP) (mm)	State of the moisture in the ground (mm)		Soil moisture deficit (mm)	
			Real	Effectives		Based on real rainfall	Based on effective rainfall	Based on real rainfall	Based on effective rainfall
April	120	120	11.1	8.9	84	+47.1	+45.0	0.0	0.0
May	47.1	45.0	16.7	13.4	115	-50.3	-56.6	50.3	56.6
June	0.0	0.0	42.6	34.1	141	-98.4	-106.9	98.4	106.9
July	0.0	0.0	39.2	31.4	161	-121.9	-129.2	121.9	129.6
August	0.0	0.0	6.8	5.4	136	-129.2	-130.6	129.2	130.6
September	0.0	0.0	77.3	61.8	90	-12.7	-28.2	12.7	28.2
Moisture deficit								412.5	448.9

In experimental plots were irrigated four rows with 30 vines/rows, or a total of 120 vines. In 2008, which were characterized by very low rainfall, especially during the vegetation season (April - September) with a total of 155 mm effective rainfall, or only 70 mm, during the three summer months (June, July, August), and with a very high deficit (soil moisture).

- Irrigation was made during the first two days, with 5 to 6 July 2008, with the amount of 4000 ℓ water or with 33 ℓ / vine (plant).
- Second Irrigation was done over two days, July 26 to 27 2008, with 3000 ℓ water or with 25 ℓ / vine.
- Third Irrigation was done with 13 to 14 August 2008, with the amount of 4000 ℓ water or 33 ℓ / vine and
- Fourth Irrigation was done with 28 to 29 August 2008, with the total amount of 4000 ℓ water or 33 ℓ / vine.

Calculated as irrigation rate expressed in m^3 / ha, it appears that the first irrigation were given 238 m^3/ ha, with second irrigation 179 m^3/ ha, third irrigation 238 m^3/ ha and fourth irrigation 238 m^3/ ha. Or in total.

$\Sigma = I + II + III + IV = 238 + 179 + 238 + 238 = 893\ m^3$ / ha.

Were attempted to do irrigation only during the dry vegetation and be more rational. However, as a relatively deficient irrigation it has shown very convincingly that has been evident impact on average productivity growth for two varieties of nearly 58%,) grape cluster length, its size, growth and weight grains, the amount of sugar etc.

Year 2009 has been a year with more rainfall than in 2008, with 684.8 mm or 104 mm longer and better ranking during the vegetation period. For this reason, the rainfall deficit, calculated. There has been much lower than in 2008.

This year has been a total of 3 irrigation, mainly in August - beginning of September where:

- Irrigation was made during the first two days, on 12 to 13 August 2009, with the amount of 3000 ℓ water or with 25 ℓ / vine (plant).- Second Irrigation was done over two days, August 24 to 25 2009, 3000 ℓ water or with 25 ℓ / vine.
- Irrigation third is made of 06-07 September 2008, with a quantity of 3000 ℓ water or 25 ℓ / vine and
- $\Sigma = I + II + III = 179 + 179 + 179 = 537\ m^3$/ ha.

However this year the rains of June and July have been nearly enough to cover the requirements of the plants. Rainfall shortages occur during the month of August (total dropped 25.3 mm) and subsequently in September (have dropped a total of 1.3 mm). Watering made during these two months, have given very good results which increases the yield to 40% (tab 8), as well as all other parameters.

It should be noted that according to the analysis, if irrigation were higher rates or approximately calculated ones, grape yields would be even higher.

Material and methods

Investigations were carried out in the vineyard owner Mr. Muhamet Kryeziu Suharekë respectively location called "Street of Peqan".

The vineyard has an area of 0.20 ha, table grapes, which is planted alone, surrounded by meadows, and with vineyards on the eastern and western. The altitude of vineyard is 420 m.Planting distance is 2 X 1.15 m, or 4348 trees per 1 ha, with row direction north-south. The vineyard is in regular fructification at age 13.Betony sticks with wires.Type of establishment (Crown) is simple giot.

During 2008 and 2009, all agro and pomo technic measures were the same for both options, as the irrigation as well without irrigation, for both research varieties.

- Spring plowing 35 cm soil depth, between orders and plow in raw.
- Additional Delivery prior to flowering, between bulky and heavy plow.
- Soil cultivation in order to improve the air regime termination of capillarity, holding moisture in ground, eliminating weeds.

Pomo technical measures

- Regular winter and summer pruning same time for both versions.
- Disease control has been the under the same program for vineyard protection by applying same treatment for both varieties in both years and in both variants with irrigation and without irrigation.

The area of vineyard where conducted the research is 0,20 Ha, from which to experiment samples were taken by "block method" and the random choice, as follows: 20 vine trunk of variety Muscat

hamburg, 20 vine trunk of variety the variety Afus – ali, 20 vine trunk of variety control (no irrigation), 20 vine trunk of variety control (no irrigation).

The data obtained from the research were processed statistically with factorial variance analysis. Studies included the following parameters: budding of buds, lossom (beginning, its duration and finish, visual concrete sight), marking grain color (followed by visual methods), technological maturity, grape yield (Measured 20 vine / varieties and 20/control), the weight of grape cluster (60 cluster), the number of berry / cluster (20 clusters), the number of seeds on 20 clusters / variety and variation, the amount of sugar as measured by 5 kg / variety (Refractometer), the amount of acid measured by 5 kg / variety (measured by the method of nitrimit with NaHO).

During the research material have served as a table grape varieties: Afus - ali and Muscat, Hamburg, the grafted rootstock Kober 5 BB, the network of irrigation system.

For irrigation were installed special network of pipelines with dropper and other accompanying material for these purposes. During the installation of the irrigation network are mounted:

- Tank (drum) - plastic tanks with a capacity of 1000 liters, with its location height of 3.5 m above the plantation.

In this system were used these elements:

1. Main pipeline with a diameter of ¾ "
2. Distribution pipeline
3. Valve for Closing –open
4. Reducing 6/4 "
5. Reducing 5/4 "
6. Duple nipple etc.
7. Dropper pipes (3/4, ½ European model).
8. Dropper (European Model. Capacity 4 ℓ / h).

As work tools for different measurements were used: measurement (to measure the performance), meter, plastic labels (resistant to weather conditions, digital camera (photographing), refractometer, mushtometer etc.

Characteristics of investigated varieties

Muscat hamburg

Botanical characteristics-Large grains round-oval shape in which characterize with dark blue grain. His cluster characterized by a cylindrical shape and large enough that its weight ranges 150 – 400 g.Agro biological characteristics: overall yield ranging from 12000 - 18000 kg/ha, while irrigation achieve even higher yields. Technological characteristics-Wine contains 18-22% sugar. Characterized by a pleasant aroma. Transported well and is very attractive on the market.

Afus – ali

The most common synonyms: Regina, Razaki, amber etc. Botanical characteristics - its grains are extended in the form of the ovary or similar to those of palma. The grape cluster is large enough with weight of 200 - 500 g. Agro biological characteristics - is a variety with high fructification where yields range from 15,000 - 20,000 kg / ha, while with irrigation can reaches well over 30,000 kg/ha. Technological features- Wine contains 18 - 20% sugar. With grape clusters very attractive and very pleasant and refreshing taste. It is resistant to transport and can be exported easily and stored up to 60 days in the refrigerator.

Results and discussion

Budding of buds

From surveys carried out on the time of budding buds shows that Hamburg variety in the level of 5% has been flourishing between the dates 19 - 22.03.2009, and 90% level, between the dates 24 - 28.03.2009. But variety Afus - ali at 5%, has started budding between the dates 23 - 27. 03. 2009, and 90% level between the dates 27.03 - 03.04.2009. So the comparison between the two varieties shows that variety Hamburg started budding earlier than variety Afus - ali that is the result of relevant genetic base of the variety.

Grape blossom

From surveys conducted, resulting that the flourishing of variety Afus - ali at level of 5%, were flourished between the dates 21 - 26.05. 2009, and 90% level, between the dates 27.05 - 08.06.2009. But, variety Hamburg, at 5%, were flourished between the dates 19 - 22.05.2009, whereas the 90% level, between the dates 24 - 30.05.2009. From the comparison between the two varieties is seen that variety Hamburg started flowered earlier than variety Afus - ali that is, as a result of genetic base of the variety.

Marking of grape grain (initial colority)

Surveys have shown that the differences between the two varieties based on marking time of the grains were significant difference. Variety, Muscat Hamburg has started marking at 5%, on 29.08.2008, and lasted until 03.09.2008. While 90% level marking, and in comparison with the control plots (without irrigation) is observed delay of 4 days in 2008, or delay in the control plot (without irrigation) was observed in 2009 by 3 days.

Variety Afus - ali at 90%, marking the difference between the control plots (without irrigation) and the experimental (with irrigation) is for 3 days in 2008 and earlier application of irrigation. But in 2009 this difference was 4 days earlier with irrigation plots.

The weight of grape cluster

From measure conducted it was concluded that irrigation variant had significant difference compare with variant without irrigation. They have been quite significant (tab 8).

This year is characterized by low rainfall deficit (soil moisture) compared to 2008, which amounted to 372.4mm. If removed May months (due to very small deficit (9.1mm), and September (month which should not be involved with irrigation due to the maturation process), it appears that irrigation should be provided 275 mm, for meet the needs of grapes.

Irrigation - The irrigation was done with the system of "Drip irrigation". Where dropper distances were as the distance between the plants in the sequence (1.20 m) for each plant by a dropper, with a capacity of 4 ℓ / hr.

From the results in tab 8, it appears that the impact of “Drip irrigation” is high (significant) between the control plots (without irrigation) and the experimental (with irrigation). But, of cluster measured differences between varieties surveyed were not significant (NS) (tab).

Table 8. The weight of the grape cluster (gr)

Variety (A)	Year (B)		Forms of treatment (C)		Average AB	Average A		
			No irrigation	With irrigation				
	2008	300	468	384				
Afus – ali	2009	296.2	440	368		376 NS		
	Aver. AC	298.1	454**					
Hamburg	2008	250	418	334		339		
	2009	273	415	344				
	Aver. AC	261.5	416.5		Avarage B			
Year x Forms of treatment	2008	275	443 **			359 NS		
BC	2009	284	427.5			356.1		
Forms of treatment (C)		279.5	435.25**					
Differences singnificants		Faktors		Intereakcionet between factors				
		A	B	C	AB	AC	BC	ABC
LSD	0.01	91.85	44.38	57	69.91	89.15	89.15	160.42
	0.05	67.34	32.54	42	46.15	62.68	62.68	102.29

The lengths of grape cluster

The observed significant differences between varieties surveyed. Positive in favor of those with irrigation. Length of clusters is functionally related to the size and extent. But also the differences between the investigated varieties are the result of their genetic base. Differences between varieties are manifested by 28.1%. Greater length is manifested to variety Afus - ali than Muscat Hamburg.

The comparison between years there has been no significant differences (NS). Seen that irrigation also has high impact and significant cluster length. Irrigation variant average is about 32.1%, in comparison with that without irrigation.

The number of seeds in the grape grain

Seed as generative organ formed at the end of the flowering stage. Grains of grape contain 1 to 4 seeds, usually 1 - 2 seeds. We counted grape seeds to ascertain what has been the effect of irrigation and analyzed if the irrigation has impact in this regard. It was found that in the version in which was applied irrigation, there was high significant difference in the number of seeds compare with variant without irrigation.Where the grape is not used irrigation, the average number was 1.58 and seeds to irrigation plots, the average has been around 2.62 seeds, respectively about 62.4% higher. Meanwhile, even among varieties were observed significant changes also higher. To variety Afus - ali in both years, the average was 3.04 while the Hamburg variety seeds 2 seeds for grain grapes. While significant differences between the years of research has not been (NS) (tab 9).

Table 9. The number of seeds in grape

Varieties (A)		Year (B)	Treatment (C)		Average AB	Average A
			No irrigation	With irrigation		
Afus – ali		2008	2.14	3.04	2.59	2.7 **
		2009	2.06	3.04	2.55	
		Avg. AC	2.1	3.04 **		
Hamburg		2008	1.06	2.02	1.54	1.54
		2009	1.06	2	1.53	
		Avg. AC	1.06	2.01 **	Average B	
Year x Forms of treatment		2008	1.6	2.53		2.07 NS
BC		2009	1.56	2.52		2.04 NS
Forms of treatment (C)			1.58	2.53 **		
Significance		Factors		Interaction between factors				
		A	B	C	AB	AC	BC	ABC
LSD	0.01	0.126	0.073	0.08	0.116	0.126	0.126	0.226
	0.05	0.093	0.054	0.06	0.082	0.088	0.088	0.144

Number of grains grapes

From graph 1, seen that variant with irrigation grape clusters had on average 11.3% higher number than the grains without irrigation option. For both varieties controls (without irrigation) has been 101.4 grains, while 113.2 irrigation respectively. Between varieties were found low significant differences. Once the number of grains/cluster is around 100 in total. This number is taken as the average of the samples. But, in terms of comparison between years, in 2009 there were minor significant differences.While the comparison between the investigated varieties are not observed significant difference (NS).

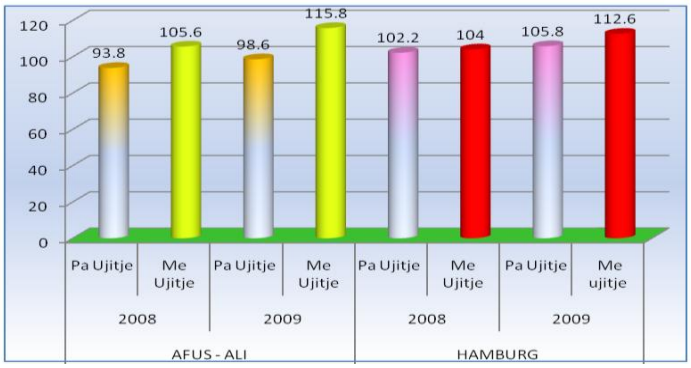


Figure 1. Number of grain in grape clusters

Technological maturity of the grape

Effect of 'Drip irrigation'' clearly manifested in the time of technological maturity of grapes. Differences are evident between the control plots (without irrigation) and the experimental (with irrigation), especially in 2008, which has been at the level of 90%, from 5 days in Hamburg variety.

But in 2009 this difference was observed varying from 2 days. Even to variety Afus - ali is the observed difference of 2 days during 2008 and 2009. These timing differences in technological maturity have always been in favor of the variant with irrigation.

Yield per vine

Comparing the results measured between control plot (without irrigation) and the experimental (with irrigation) shows clearly the positive effect of irrigation. From measurement it is concluded that: varieties Muscat Hamburg showed higher significance between control plots (without irrigation) and the experimental (with irrigation) with differences of 69.9% in 2008 and 74% in 2009, while varieties Afus-ali, experimental plots (irrigation), showed significance changes to the control plots (without irrigation) with difference of 47.3% in 2008 and 20.6% in 2009.

Table 10. The yield per vine

	Muskat Hamburg (kg/Vine)		Afus – ali	(kg/Vine)
Tretman	2008	2009	2008	2009
No irrigate	3.900	3.675	4.800	6.052
With irrigate	6.627	6.400	7.070	7.300
Increase in % .	69.9	74.1	47.3	20.7

Data of author Kabashi.B (2005), on grape irrigation especially of table varieties, proving the fact that this agro-technical measure, regularly increase the yield of grapes. This fact is proven by the annual results achieved in the Republic of Macedonia. From the calculation of the yield per vine obtained the results of yield per hectare.

From the results listed in tab 12, it can be concluded that: where the plots is made irrigation in 2008, both noted that the grape varieties has won the highest percentage of sugar and lower amounts of acids. In 2009 it was concluded the same thing. This has made possible the withdrawal of the larger quantities of mineral nutrient by water, thus enabling higher synthesis of sugar while smaller amounts of acids. In the control plot (without irrigation) the amount of absorption of water and mineral substances was lower, due to the lack of moisture in the soil, resulting in the synthesis smallest carbon hydrates. Results from tab 12. show that yield has correlation with the amount of sugar. This report comes from the supply of large quantities of water that enable supply good nutritional mineral matter which turn into more sugar acids. This conclusion may be related to adverse balance between sugar and acid. Samples that have given more sugar in cider manifest less acidic.

Table 11. The yield per ha

	Muskat Hamburg (kg/ha)		Afus – ali (kg/ha)	
Tretman	2008	2009	2008	2009
No irrigation	15.310	16.247	20.000	25.213
With irrigation	26.662	27.608	29.454	30.412
Increase on % with irrigation	69.9	74.1	47.3	20.7

Total sugar and acids in the grape juice

Based on the analysis, it is observed that the grape varieties which are irrigated characterized by high significant differences as to the amount of sugar as well as the amount of acid. These data are presented in tab 12.

Table 12. Sugar and acids

Afus – ali								Hamburgu							
2008				2009				2008				2009			
Sugar (%)		Acids (g /l)		Sugar (%)		Acids(g /l)		Sugar (%)		Acids (g /l)		Sugar (%)		Acids (g/l)	
No irrigation	With irrigation	No irrigation	With irrigation	No irrigation	With irrigation	No irrigation	With irrigation	No irrigation	With irrigation	No irrigation	With irrigation	No irrigation	With irrigation	No irrigation	With irrigation
16.1	17.2	7.7	4.5	14.8	15.1	5.4	5.2	18.5	20.4	4.7	4.1	18.6	19.1	5.7	4.9

Conclusions

Based on two-year research on the effect of "Drip irrigation" in productivity of table grape, in condition of Dukagjini region in Rep. of Kosovo, we come to these conclusions. The impact of “Drip irrigation” on increase of productivity and improve the quality to the table grape varieties Muscat Hamburg and Afus-ali is very high. Effect of positive impact is manifested in overall productivity, growth to 47.7%, ragman in 7.4% and 0.95% sugar. While irrigation has reduced the amount of acid, because it has increased the amount of sugar. Irrigation has contributed significantly to the growth of grape cluster and their length in the two varieties with 51.2%. This has impacted in the increase in the number and size of grains. While increase of the number of seeds is the result of increase of overall yield. Irrigation form "Drip irrigation" influenced early maturity of grapes that enabled the earliest exit in the market and realization of higher price. Irrigation has greatly influenced to increase in the value of table grapes, until the market has shown higher profitability. From the Two-year research results it can be concluded that irrigation of vineyards is almost necessary measure in the area of territory of Dukagjini valley in Kosovo This agro technical measure is necessary, especially in the first four years of the establishment of the vineyard, and should not be overlooked. The amount of water used for irrigation depends on the climatic conditions of the concerned year such as insolation, temperature, precipitation and soil conditions.

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ВЛИЈАНИЕ НА НАВОДНУВАЊЕТО СО КАПКА ВРЗ ПРИНОСОТ НА ТРПЕЗНИТЕ СОРТИ ГРОЗЈЕ

Сами Криезиу

Апстракт

Со порастот на хуманата популација се зголемува и потребата од земјоделски производи. Од друга страна, нашата земја и целиот регион беше зафатен од високи температури со несоодветна распределба на дождот односно често недостаток на дожд во вегетациониот период. Главната цел на истражувањето е влијанието на наводнувањето на трпезните сорти врз нинвиот принос, кај сортите афус али и мускат хамбург, во агроеколошките услови на Косово, долината на Дукаџини. Староста на насадот е 15 години, поделен на два дела, со наводнување и без наводнување. Испитувањата беа изведени во 2008 и 2009 година. Приносот е изразен како кг/лоза и kg/ha. Утврдени се рзлики меѓу варијантите. Приносот кај сортата афус али е зголемен за 47,3% во 2008 и 20,6% во 2009 година, зависно од големината на годишните колчини на врнежи и нивната распореденост во текот на годината. Приносот кај сортата мускат хамбург се зголеми за 69,9% во 2008 и за 74% во 2009 година. Можеме да заклучиме дека наводнувањето со капка покажува позитивно влијание на зголемување на продуктивноста. Резултатите се пресметани со SPS package и статистички обработени со анализа на варијанса.

Клучни зборови: продуктивност, трпезно грозје, наводнување, сорти.

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Original scientific paper

CLIMATE CHARACTERISTICS OF WINE GROWING IN MOSTAR WINE AREA

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Abstract
The purpose of the paper is to study climatic characteristics, indexes and coefficients in the Mostar area of vineyards in order to evaluate area suitability for vine growing. In this paper, climatic parameters have been analyzed for the period 1961/1990 and 2000/2010 year. In the region under study, the average annual air temperature was 15.6ºC, and the vegetative air temperature had a value of 21.0ºC. The annual temperature sum was 5701.1ºC, the vegetative sum had a value of 4492.2ºC. The elements studied showed higher values when compared to the average (1961/1990). The annual rain sum was 1498.1mm, the vegetative rain sum had a value of 663.3 mm, yielding lower values compared with the period (1961/1990). On the basis of the values of effective temperature sum, it can be concluded that the Mostar area of vineyards (Winkler, 1974) belongs to the climatic zone C. The values of the hydrothermal coefficient indicated that there was an irregular pattern of humidity in the vineyard area where the research was conducted. The helio-thermal coefficient had a value of 6,89, and the bio-climatic index had a value of 5,61. The results of this research indicate that the Mostar area of vineyards is favorable for production of table and wine grape varieties that ripen from I to IV epoch.
Key words: climatic characteristics, indexes, coefficients, grapevine.

Introduction

Certain environmental conditions are needed for normal development of vines, fruiting and in order to regularly obtain high yields of high quality grapes. Different grape vines species and varieties have different requirements to the external environment and react to it unevenly. These demands by environmental conditions, especially the climate, the plants have acquired during their phylogenetic development (Buric, 1972). The requirements of the grapevine for certain climatic conditions refer to a characteristic it gained during its growing culture. Plans to grow certain varieties of grapevine should be in close relation with the climatic and microclimatic elements of the environment (Ilic-Popov, 2003). Almost the entire production of grapes in BiH is located in Herzegovina, where, for many years, a ratio of approximately 80% of the land under vine and 20% of the area under table grapes has been retained. Mostar vineyards in the wine-growing region of Herzegovina are under the direct influence of the Adriatic Sea and have all the characteristics of the modified Mediterranean or Adriatic-highland climate (Vuksanovic and Mijatovic, 1982., Mijatovic and Šećerov, 1990). Limestone cascading from the mountain tops to the sea has important impact on the climate conditions of this area. Bare limestone in certain periods of the year has a special effect on the temperature regime. The most prominent form of fluvial region is the valley of the Neretva

River and its tributaries, which is more extended in the Mostar valley to the delta. Authochthonal cultivars Žilavaka and Blatina have the most significant factors in the production of wine in Herzegovina region (Vuksanovic, 1977).

Material and methods

For the analysis of the climatic conditions in the Mostar area of vineyards and their suitability from the climatic aspect and for successful raising of certain varieties of grapevines, we used meteorological data of the meteorological Stations in Mostar for the period of 1961/1990 and 2000/2010. We made estimations of the coefficients and the indexes in accordance with the accepted methodologies in the world grapevine circles. On the basis of the sum of effective temperatures and the established viticulture zones A, B1, C1, C2 and C3 (Winkler, 1974), we also established division of the areas of vineyards in climatic zones where the research was conducted. The international grapevine circles accepted the division according to Winkler.

Results and discussion

Since the grapevine requires certain conditions in the sense of climatic conditions, it is indispensable, prior to the introduction of every variety in the production, to study the climatic conditions in the production region in terms of the production potential of the culture to be exploited, so that good crop and high quality grape can be obtained. In our research, we have carried out an analysis of some climatic elements. In Table 1, data of the warmth and rainy conditions in the areas of vineyards where the research has been conducted are shown.

Table 1. Warmth and rainy conditions in Mostar areas of vineyards

	Year	T_{year}	$T_{iv\text{-}x}$	ΣT	Σ $T_{iv\text{-}x}$	ΣH	Σ$H_{iv\text{-}x}$	ΣEffect.T	ΣEffect.$T_{iv\text{-}x}$
Mostar	61/91	15,6	21,0	5701,10	4492,2	1498,1	663,3	2382,50	2352,2
	00/10	14,6	19,6	5333,70	4204,2	1523,0	676,0	2086,30	2064,2

In the Mostar area of vineyards, for the period of 2000/2010, the average annual air temperature is 15.6ºC and ranged from 14,6ºC (2005) to 16.1ºC (2003, 2007 and 2008). In the period of 1961/1991, the average annual air temperature ranged from 13,6ºC (1976) and 13,7ºC (1980) up to 16,1ºC in 1961. The vegetative air temperature had a value of 21,0ºC, and ranged from 19,9C (2003) to 21,5ºC (2007). In the period of 1961/1991, the vegetative air temperature ranged from 18,4ºC (1974, 1976) up to 21,1ºC in 1961. The annual temperature sum had a value of 5701,10ºC, and the vegetative sum was 4492,2ºC. Compared with the perennial average, the examined elements have higher values. The average annual sum of rain had a value of 1498,1 mm, and ranged from 1043,8 mm (2006) to 2544,7 mm (2010). The vegetative sum of rain was 663,3 mm, and ranged from 408,60 mm (2007) to 1047,8 mm (2010). In some years (2004, 2009 and 2010), the annual sum of rain deviated widely from the average. The heaviest rains were during the winter period, then in autumn, and the least during summer. Numerous researches about the influence of climate upon the grapevine contributed to the formation of bio-climatic data for the culture. With their application, the zones for growing the grapevine varieties can be differentiated and defined. On the basis of the value of the effective temperature sum, it can be concluded that the Mostar area of vineyards belongs to the climatic zone C_2. For establishing the supply of the vine with the necessary quantities of water, a hydrothermal coefficient is determined (HiTK). The values of the

hydrothermal coefficient are also determined (HeTK), being a safe indicator of the warmth conditions and sunshine. To determine potential conditions for growing the culture, we have defined bio-climatic index (BKI), which represents a complex indicator because at the same time it connects warmth, light and rain conditions with a biological characteristic of the grapevine and the duration of the vegetation period. In Table 2, the values of the climatic coefficients and indexes for the period of 2000/2010 are shown.

Table 2. Climatic coefficients and indexes in Mostar area of vineyards, 2000/2010

	Year	TK	HiTK	HeTK	BKI
Mostar	61/91	5,26	1,48	6,89	5,61
	00/10	10,05	1,61	6,05	4,90

Thermal coefficients for the period 2000-2010 amounted to 5.26 and are significantly lower than the mean values of thermal coefficient for the period (61/91) with a value of 10.05. The value of the thermal coefficient indicates favorable temperature conditions during the growing season. The values of the hydrothermal coefficient indicate that, in the study areas of vineyards, there is an irregular distribution of humidity. The values of the helio-thermal coefficient 2,8 -4,5 indicate that the viticulture unit is favorable for raising vines. In the Mostar area of vineyards, the helio-thermal coefficient had a value of 6,89. The value of the bio-climatic index is used for evaluating the climatic conditions of the viticulture unit for growing grapevines, and also for correct selection of varieties. Its optimal value is 10, and is considered good enough, increased or reduced by 5. In the study area of vineyards, the bio-climatic index had a value of 5,61.

Conclusions

The analysis of climate indicators for Mostar vineyard was done through comparative review of relevant parameters from the current zoning of Bosnia and Herzegovina and the parameters collected and analyzed for the periods 1961/1991 and 2000/2010. Temperature conditions in the Mostar area are favorable for vine growing. High air temperatures during the growing season are suitable for grape ripening and successful shoot ripening. Rainfall is quite frequent throughout the year, but it is quite low during the growing season and unevenly distributed. It is particularly low in the seventh month when grape has intensive shoot growth and development of young berries in most of varieties. Precipitation is abundant in September. The duration of sunshine is very favorable for the cultivation of almost all varieties of grape.The results of this research indicate that the Mostar area of vineyards is favorable for production of table and wine grape varieties that ripen from I to IV epoch.

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КЛИМАТСКИ КАРАКТЕРИСТИКИ НА МОСТАРСКОТО ВИНОГОРЈЕ

Јовановиќ Цветковиќ Татјана, Мијатовиќ Драгутин, Радојевиќ Ивана

Апстракт

Целта на испитувањето се климатските карактеристики, индекси и коефициенти во подрачјето на мостарското виногорје заради проценка на погодноста за одгледување на винова лоза. Во овој труд климатските карактеристики се анализирани за периодот 1961/1990 и 2000/2001 година. Просечната годишна температура изнесува 15.6ºC, додека просечната вегетациона температура изнесува 21.0 ºC. Годишната сума на температури изнесува 5701.1ºC, а вегетационата сума на темпратури 4492.2ºC. Вредностите на проучуваните елементи се повисоки во однос на просекот (1961/1990). Годишната сума на врнежи изнесува 1498.1mm и вегетативната сума која изнесува 663.3 mm, се пониски во однос на периодот (1961/1990). Врз основа на вредностите на ефективните температурни суми, може да се заклужи дека подрачјето на мостарските лозја (Winkler, 1974) припаѓаат на зона Ц. Вредноста на хидротермичкиот коефициент покажува дека постои мала неправилност. Хелиотермичкиот коефициент има вредност од 6,89 а биоклиматскиот индекс 5,61. Резултатите од ова испитување покажуваат дека подрачјето на Мостар е поволно за производство на трпезни иински сорти на грозје кои созреваат од I до IV епоха.

Клучни зборови: климатски карактеристики, индкеси, коефициенти, винова лоза.

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Original scientific paper

ECONOMIC-TEHNOLOGICAL CHARACTERISTICS OF GRAPES "VRANAC" DEPENDING ON THE FERTILIZATION AND IRRIGATION

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Abstract
The paper presents three-year results of the research the effect of different types of fertilizers and irrigation on the growth quantity, quality of yield and vegetative potential varieties Vranac. Investigations were carried out at the site of Podgorica's vineyards "Ljeskopolje".It was applied eight different fertilization variants, which are also subject to irrigation, as well as in conditions without irrigation. (Control, NPK 8:16:24, cow manure, poultry manure,peat and manure Combination of the above). All investigated variants of fertilization achieved in the three-year average yield higher than unfertilized variants. The highest yield had a variation where as cattle manure fertilizer used. Irrigation has had a positive impact on this indicator yields. Most varieties of fertilizers have yielded positive results in terms of sugar content in must. The highest sugar content in must of the three-year average was the variant with peat. Different types of fertilizers did not show a significant impact on the total content of acids in must. Both indicators of the quality of grapes had higher values reflected in the irrigated area compared to the part of the experiments, which are not irrigated. The greatest potential for vegetative had a variant where the fertilizer was used as a combination of cattle manure and peat. In all variants of fertilization discarded vine pruning weight was higher in irrigated than in no irrigated conditions.
Key words: fertilization, irrigation, yield, sugar, acid, vegetative potential.

Introduction

The viticulture of Montenegro is mainly represented in Podgorica, where the cultivation of vine, and the production of grapes and wine are an integral part of the economy of this region. In the structure of wine varieties the leading place has the autochthonous, high quality Vranac variety grapes that produce premium quality grapes. Most vineyards perched on skeletal, mostly infertile soils of the southern part of Montenegro vegetate and bearing fruit in terms of lack of basic elements of nutrition. In such conditions, the application of mineral and organic fertilizers is a very important factor in increasing yield and improving its quality, but also a very important factor for improving the physical and chemical properties of soil (Popović, 2008). Podgorica's vineyards are characterized by a Mediterranean climate with high annual precipitation, which are unevenly distributed. The land is saturated with water during resting period, and insufficiently supplied with water in times of greatest plants' activity. Under such conditions, irrigation is necessary agro-technical measure. The aim of this study was to examine how different types of mineral and organic fertilizers and combinations, as well as irrigation, affect the amount, quality and vegetative yield potential of the cultivar Vranac.

Material and methods

Studies were performed in the period 2003/2005 on the experimental farm of the Biotechnical Institute in Podgorica. The experimental vineyard was planted in 1986. The spacing between rows was 2.50 m and the distance between the vines in the row was 1.20 m. Growing form is a double cordon about 80 cm high. Studies were performed on the Vranac variety of grapes which was grafted on a rootstock Kober 5BB.

The experiment included the following combinations and variants:

Combinations: A – Irrigated, B – Unwatered. Variants: 1. Control – without fertilization, 2. NPK (8:16:24) – 500 kg/ha, 3. Cow manure – 20 t/ha, 4. Poultry manure – 10 t/ha, 5. Peat – 10 t/ha, 6. Cow + poultry manure – 10 + 5 t/ha, 7. Cow manure + peat – 10 + 5 t/ha, 8. Poultry manure + peat – 5 + 5 t/ha.

Basic fertilizer entered the soil during the period of rest by plowing a furrow in the middle of the space between the rows in 25-30 cm deep. The furrows were filled with a calculated amount of fertilizer for a corresponding variant, half the amount on one side and the other half on the other side of the row. The irrigation was carried out over the surface – not flowing through the furrows. In the space between the rows a single furrow was ploughed.

The irrigation was carried out as soon as the soil moisture dropped 17% below. It was carried out by pumping the water from the canals near the experimental location.

Each variant had 18 vines arranged in three replicates with six rows of vines. Selected vines in each year of the research were pruned by the same criteria, using the mixed pruning with two canes with 10 buds and two 1-yr-old-canes with two buds each. This made a total burdening of 24 buds per vine which was in accordance with the usual way of pruning of the Vranac variety in the plantation growing of Montenegro. Yield was obtained by measuring the harvested grapes and by the conversion of yield per m^2.

The content of sugar in the grape juice was determined areometrically (by Oechsle Scale), while the content of total acids in grape juice was determined by neutralization of all acids and their salts n/10 solution NaOH with indicator Bromothymol blue. The pruning weight was determined during winter pruning, weighing all the pruned canes on decimal scale. The data were analysed by using the variant of a completely random block system. The significance of differences was determined by using the LSD test.

Results and discussion

The yield of grapes -The highest yield of grapes, on average for all three years of research (table 1.), was measured in the variant with cow manure – 1.49 kg/m^2 . In the combination with poultry manure and peat and the variant with poultry manure alone the yield was a little lower – 1.43 and 1.42 kg/m^2 . The area that was fertilized with mineral fertilizer the yield was 1.41 kg/ m^2 . The variants 7, 5 and 6 had the yield lower than 1.40 kg/ m^2 (1.38; 1.33; 1.23 kg/ m^2). The variant 6 had the yield that was only for 0.6 kg/ m^2 higher than the control.

All the tested variants of feeding in the three-year average had a higher yield than the variant without fertilisation where the yield was only 1.16 kg/ m^2 . Despite demonstrated differences in the yield of grapes there was no statistically significant difference between the different variants of feeding. The results are in contrast with those given by Lazic (1954) who achieved the best results in the yield of grapes in areas fertilized with mineral fertilizers and then in the areas fertilized with

manure and green manure. Besides variations in yield according to the variants of feeding, Table 1. shows the variation of yield depending on the application of irrigation as well.

Table 1. The yield of grapes (kg/ m^2)

Combination	Irrigation (N_1)			Average (N_1)	Without irrigation (N_2)			Average (N_2)	Average (A)
	2003	2004	2005		2003	2004	2005		
A_1	0,91	1,23	1,44	1,19	0.97	1,25	1,21	1,14	1,16
A_2	0.98	1,45	1,87	1,43	1,12	1,56	1,50	1,39	1,41
A_3	1,52	1,60	1,73	1,62	1,31	1,27	1,50	1,36	1,49
A_4	1,39	1,33	1,63	1,45	1,20	1,53	1,47	1,40	1,42
A_5	1,34	1,68	1,50	1,51	0,91	1,07	1,47	1,15	1,33
A_6	1,19	1,44	1,37	1,33	1,06	0.99	1,33	1,13	1,23
A_7	1,29	1,68	1,74	1,57	0,93	1,35	1,27	1,18	1,38
A_8	1,11	1,72	1,54	1,46	1,39	1,32	1,45	1,40	1,43
Average B	1,22	1,52	1,60	1,44	1,11	1,29	1,40	1,26	1,35

LSD	A	B
0.05	0.814	0.407
0,01	1.096	0.548

Comparative results of the two combinations of experiment (unwatered and irrigated) reveal interesting details that lead to the conclusion that the application of fertilizers have a completely different character in the conditions of dry viticulture in comparison to the viticulture in the conditions of irrigation. In fact, under the dry viticulture the variants of fertilization like 5, 6 and 7, which gave a very low yield of grapes, proved to be very good under the irrigation, which further means that the conclusion obtained on the basis of yield under the dry viticulture would have no adequate value in the terms of viticulture with irrigation. In the three-year average the yield of grapes in irrigated area was 1.44 kg/ m^2 , while in the unwatered experimental area it was 1.26 kg/ m^2 . Despite the clear positive tendency of the influence of irrigation on the yield of grapes there was no statistically significant difference in the three-year average compared to the yield obtained under the dry viticulture. The yield of grapes in all the variants of feeding was within the results that various authors emphasize for the Vranac variety of grapes: Pejovic (1982), Ulicevic (1966, 1991), Buric (1995), Cindric (2000), Popovic (2003).

Sugar content of must - Based on the results (Table 2) it can be seen that the sugar content of the must was quite satisfactory and characteristic of the tested variety in the field. Most varieties with fertilizers had positive results, except for variant no. 7 in which the sugar content amounted 22.35%, which is 0.25% less sugar content than in the unfertilized area, where the sugar content was 22.60%. The highest sugar content of the three-year average was at variant with peat 25.90%. Variant with poultry manure had also high sugar content: 24.85%, as well as variants 3 and 6 with 24.65 and 24.45% sugar in the must. Despite the demonstrated differences in the contents of the sugar in the must according to the nutritive variations, in the three-year average, only variant 5 achieved statistically significant difference in relation to variants 7, 1 and 8. The variant with poultry manure compared with a variant no.7 and no. 1 had significantly higher sugar content in must, while variant

where beef manure was combined with peat showed statistically significant difference only in relation to variant no.7.

Table 2. Sugar content in the grape juice (%)

Combination	Irrigation (N_1)			Average (N_1)	Without irrigation (N_2)			Average (N_2)	Average (A)
	2003	2004	2005		2003	2004	2005		
A_1	23.90	22.00	23.00	22.95	22.60	22.30	21.90	22.30	22.60
A_2	26.50	23.50	24.25	24.75	24.00	21.90	23.20	23.00	23.90
A_3	23.95	25.40	26.55	25.30	23.45	23.40	25.10	24.00	24.65
A_4	24.50	28.10	24.50	25.70	24.50	24.00	23.40	24.00	24.85
A_5	28.00	26.90	25.10	26.70	23.30	25.45	26.60	25.10	25.90
A_6	24.40	24.80	24.50	24.60	23.60	25.20	24.30	24.40	24.45
A_7	22.95	23.45	23.20	23.20	21.90	20.40	22.00	21.45	22.35
A_8	25.70	24.70	22.80	24.40	20.50	21.30	22.60	21.50	22.95
Average B	25.00	24.85	24.25	24.70	23.00	23.00	23.60	23.20	23.95

LSD	A	B
0.05	2.083	1.042
0,01	2.805	1.403

In all tested variants the sugar content was in the range of values that were stated as characteristic of the cultivar *Vranac*, by Ulićević (1966.1991), Avramov (1991), Burić (1995), Pejović (1982), Popović (2003). Lazić (1954) noted that the sweetest must was obtained in variants with mineral fertilizer, and then variants with organic fertilizer and green fertilizer, which is in contrast with the results of these investigations. The sugar content in the irrigated area for all variations in the three-year average was 24.70% and was significantly higher than in non-irrigated part of investigation where it amounted 23.20%.

The content of total acids in the must - The data presented in table 3. showed that different variants of nutrition showed no significant effect on the total acid content in must.

The amount of total acids in the general three-year average was the highest in the variant that is fertilized with peat - 6.36 g / l and then at the varieties with beef manure -6.35 g / l.

In other investigated variants acid content in must was lower compared to control, where the total acid content was 6.23 g / l. The lowest content of acids in the three-year average had variant no. 6 (5.95 g / l). In the irrigated conditions the total acid content in the general average and in all the variants of nutrition was significantly higher compared to the part of the test which was not irrigated. The difference is highly significant so that it can confirm that the use of irrigation increases the total acid content in must.The total content of acids in the average of all variations on the irrigated part of the experiment was 6.40 g/l and was significantly higher compared to the part that was not irrigated and amounted 5.93 g/l.

Table 3. Acidity in the grape juice (g/l)

Combination	Irrigation (N_1)			Average (N_1)	Without irrigation (N_2)			Average (N_2)	Average (A)
	2003	2004	2005		2003	2004	2005		
A_1	8.10	5..40	5.90	6.46	7.70	5.10	5.20	6.00	6.23
A_2	8.50	5.50	5.40	6.46	7.30	5.00	5.10	5.80	6.13
A_3	7.90	6.70	5.30	6.63	7.40	5.70	5.10	6.06	6.35
A_4	8.00	5.60	5.10	6.23	7..30	5.10	5.50	5.97	6.10
A_5	8.30	6.20	5.20	6.56	7.10	6.10	5.30	6.17	6.36
A_6	7.00	5.70	5.70	6.13	6.90	5.40	5.00	5.76	5.95
A_7	7.10	5.60	5.40	6.00	7.10	5.10	5.80	6.00	6.00
A_8	8.40	6.00	5.80	6.73	6.60	5.20	5.40	5.73	6.23
Average B	7.91	5.83	5.47	6.40	7.18	5.32	5.29	5.93	6.16

LSD	A	B
0.05	0.601	0.300
0,01	0.809	0.405

Vegetative power of vines - Through the mass of vine-leaves we find out about the exuberance of vines as an indirect indicator of vegetative power of the plant. Exuberance of vines, which is the resultant of number of sprouts and their development length and thickness, depends on the biological characteristics of the variety, soil moisture, air temperature, availability of nutrients, pruning, the position of sprouts, etc. Based on the results (table 4.) it can be concluded that that variants of nutrition and use of irrigation in years of research have had significant influence on exuberance of vines, or the pruning weight. All fertilized areas had significantly more vine-leaves from unfertilized areas where the average pruning weight amounted 0.20 kg / m². At variant that was fertilized with mineral fertilizer NPK 8:16:24 and variants 6, difference in pruning weight, compared to the control, was the smallest and amounted only 0.01 kg / m².On land fertilized with organic fertilizer the pruning weight was higher and ranged from 0.22 kg / m² in the variant with peat up to 0.26 kg / m² in variant where a combination of cattle manure and peat was used as fertilizer. Accomplished difference in pruning weight between variant 7 in relation to variant without fertilization and the variant with mineral fertilizer, as well as in relation to the variants 6 and 5 is statistically very significant, while the difference between variant 7 and variants with poultry manure is statistically significant. The difference between variant 7 and 8 amounted 0.02 kg/m² and has not reached the limit of statistical significance.

Variant without fertilization had significantly very smaller pruning weight in relation to variations 8 and 3 and significantly lower in relation to the variant with poultry manure. Besides variant 7, variant 8 also had significantly higher pruning weight in relation to the variant with mineral fertilizer and variant 6.On the irrigated area the average pruning weight for all tested variants was 0.24 kg/m2, while at the non-irrigated part it amounted 0.21 kg/m2. The irrigation obviously had significant effect on the vegetative potential of vine which has been proved by analysis of variance.

Table 4. Pruning weight (kg/m2)

Combination	Irrigation (N_1)			Average (N_1)	Without irrigation (N_2)			Average (N_2)	Average (A)
	2003	2004	2005		2003	2004	2005		
A_1	0,20	0,21	0,22	0,21	0,16	0,21	0,21	0,19	0,20
A_2	0,22	0,22	0,22	0,22	0,18	0,21	0,20	0,20	0,21
A_3	0,25	0,25	0,24	0,25	0,20	0,24	0,25	0,23	0,24
A_4	0,24	0,26	0,23	0,24	0,21	0,20	0,21	0,21	0,23
A_5	0,23	0,24	0,23	0,23	0,20	0,20	0,19	0,20	0,22
A_6	0,22	0,22	0,21	0,22	0,15	0,21	0,20	0,19	0,21
A_7	0,28	0,29	0,25	0,27	0,26	0,27	0,20	0,24	0,26
A_8	0,26	0,27	0,25	0,26	0,20	0,21	0,22	0,21	0,24
Average B	0.24	0.24	0.23	0.24	0.19	0.22	0.21	0.21	0.22

LSD	A	B
0.05	0.024	0.012
0,01	0.032	0,016

Conclusions

Based on the obtained results, the following conclusions can be drawn:

The highest yield had the variant with beef manure, while the lowest yield was recorded at unfertilized surface. Irrigation had a positive influence on this indicator of fruitfulness of the cultivar.

The highest level of sugar in the must had the variant where the peat was used as the fertilizer. Sugar content in the irrigated area for all tested variants in the three-year average was very significantly higher than in non-irrigated part of the experiment. Different type of nutrition showed no significant effect on the total acid content. In the irrigated conditions the total acid content in all variants of nutrition was significantly higher compared to the part of the experiment that was not irrigated. The application of organic fertilizer had positive effect on the vegetative potential of variety *Vranac*. In all the variants of nutrition the average pruning weight was higher in relation to the unfertilized surface and surface fertilized with mineral fertilizer.The greatest pruning weight, during the three year average and under the conditions of irrigation and non-irrigation, had a variant where a combination of cattle manure and peat was used as fertilizer. Irrigation has a positive effect on the vegetative potential of the plant. In all variants of fertilization discarded vine pruning weight was higher in irrigated than in no irrigated conditions.

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СТОПАНСКО ТЕХНОЛОШКИ КАРАКТЕРИСТИКИ НА СОРТАТА ВРАНЕЦ ВО ЗАВИСНОСТ ОД ЃУБРЕЊЕТО И НАВОДНУВАЊЕТО

Поповиќ Т., Мијовиќ С., Раичевиќ Д., Пајовиќ Р.

Апстракт
Во трудот се прикажани трогодишните резултати од испитувањето на ефектот на различни типови на ѓубриво и наводнување врз порастот, квалитетот на приносот и вегетативниот потенцијал на сортата вранец. Испитвањата се изведени во опитното поле во Подгорица, Љешко поље. Аплицирани се 8 варијанти со ѓубрење, комбинирани со наводнувањеи без наводнување. Контролната варијанта, NPK 8:16:24, говетско арско ѓубриво, арско жубриво од живина, тресет и комбинации од ѓубривата. Кај сите испитувани варијанти забележан е поголем принос во однос на неѓубрените варијанти. Највисок принос е забележан во варијантите со говетско арско жубриво. Наводнувањето има позитивно влијание на приносот. Поголемиот број на варијантите со ѓубрење имаат позитивни резултати во однос на содржината на шеќер, највисока содржина е забележана кај варијантата со тресет. Различните варијанти не покажуваат значајно влијание врз содржината на киселини во ширата. Двата инидкатори за квалитет имаат поголеми вредности во варијантите каде е употребено наводнувањето. Најголемиот влијание врз вегетативниот потенцијал има варијантата каде е направена комбинација од говедско ѓубриво и тресет. Во сите варијанти со ѓубрење, забележан е поголем принос на зрели ластари со наводнување во однос на варијантите со ненаводнување.
Клучни зборови: ѓубрење, наводнување, принос, шеќер, киселини, вегетативен потенцијал.

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Original scientific paper

EFFECT OF DIFFERENT BUDS LOAD PER VINE ON GRAPES AND WINE QUALITY OF KRATOSIJA VARIETY

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Abstract
This paper presents the results of the effect of five different buds loads of vine on the quality of grapes and wine of autochthonous Montenegrin grapevine variety kratosija, in subregion Podgorica. On experimental field, different number of buds per vine (5 buds/vine, 6 buds/vine, 8 buds/vine, 9 buds/vine and 11 buds/vine) were left by winter pruning. During vegetation, yield parameters and quality of grape and wine produced by process of microvinification were monitored. Based on obtained results it was concluded that at load of 9 buds/vine, high yield with satisfactory quality of grapes and wine was achieved. At load of 6 buds/vine, lower yield per unit area and high quality wine were achieved but differences in quality are not too significant compared with quantity
Key words: load of buds, yield, quality of grapes, quality of wine.

Introduction

Load of vine with fertile buds, beside other factors, greatly influence on variation of fertility, yield and quality of grape. It is generally believed that heavy crop loads inhibit the development of quality wine grapes and many winemakers are showing a preference for fruit sourced from low yielding vineyards. However, other research has shown that there was little response to variations in yield. It is clear that the yield/quality relationship is not a straightforward one and wine grape growers should investigate certain agro-ecological conditions optimum yields that will still produce quality wine grapes. Based on indicators of potential fertility, yield, as well as, on results of chemical analysis of must and wine, the aim of this work was to determine the impact of different load of vine with buds of kratošija variety, in conditions of sub region Podgorica. According to many literature data (Ulićević, 1966; Pejović, 1988; Maraš, 2000), kratošija is Montenegrin autochthonous grapevine variety, appeared and introduced in culture of breeding quite before vranac was. Regarding the characteristics and attributes, it belongs to eco-geographical group of varieties (*Convarietas Pontica Negr.*), a subgroup *balcanica*. It is grown for centuries in Montenegro and belongs into the category of recommended varieties for quality and top quality wine. Nowadays, because of its heterogeneity kratošija is underrepresented and it mostly can be found in combination with vranac variety. Heterogeneity of kratošija in term of expressing its features led to the degradation of this variety and to the appearance of series varieties-biotypes with obviously differences, what caused its lower representation in Montenegrin vineyards. Differences occurred as consequences of long vegetative propagation and various levels of used agro-techniques in divers agro-ecological conditions of Montenegrin viticulture regions.

Material and methods

Experimental vineyard with kratošija variety/1103P, was planted in 2003 at Ćemovsko field-locality – Dinoš. The distance of planting in the vineyard is 2,60m x 0,70m (5495 vinesa/ha), each vine receives food area of 1,82m^2. Vines were formed in the shape of single Guyot with trunk height of 70cm. In order to plan load of vine with buds, data about average productivity of one bud (potential bud fertility coefficient), average bunch weight and desired yield per vine were used. Used value of bud fertility coefficients (1,0) and average bunch weight (252g), were reached as average value of examination results done by Burić (1995), Ulićević (1966), Maraš (2000), Savić (2003) and of internal data reached in company „13. Jul Plantaže" a.d. for grapevine variety – kratošija. Based on planning results, winter pruning was done and planned load was correctly staggered on fertile elements (spurs and canes). In order to realize tasks, we have followed the most important agro-bilogical, economics and technological characteristics of five examined load of vine with buds (5, 6, 8, 9 and 11buds per vine). Examination of potential and real fertility were done on 15 vines (three repeating with 5 vine) for every combination of vine load. Potential fertility as one of the most important characteristics of variety was determined in May, in the time when it is easy to notice flowers, and based on reached data, fertility coefficients (*potential buds fertility coefficient, shoot fertility coefficient and absolute shoot coefficient*) were calculated. Yield was determined by measuring ienof picked grapes weight in phase of technological maturity. Weight of picked grapes was measured separately per every vine, and its average value is shown at results. In order to complete evaluation of grape quality and its wine, grape processing of all load combinations was done in cellar for microvinification, in microvinficators of Ganimede brand. Sensory analysis was done in accordance with recommendations of OIV – *International Organisation of Vine and Wine,* where the system of evaluation up to 100 points is applied.

Results and discussion

Fertility coefficients of buds at different load

Number of left buds by pruning at grape variety kratošija, ranged from 5 buds per vine at combination A to 11 buds per vine at combination E. Degree of load vine with buds and its disposition on fertile elements, beside other factors, influenced on number of activated buds, the number of fertile shoots, yield and grape quality. On the basis of the data on potential fertility, recorded in experimental vineyard during months May, fertility coefficients were calculated for all combination, average values are shown in Graph 1.

Average number of flowers per bud that was left by pruning or potential buds fertility coefficient was the highest at combination D (1,18). Regarding to other combinations, values of these coefficients was quite lower than 1,0, and the lowest value was noticed at combination A, i.e. at combination with the lowest load. Values of this coefficient for all combinations were quite lower than those cited in literature (1,2 – 1.6) Ulićević (1966) and Avramov et al. (2001). The highest value of relative fertility coefficient was noticed at combination D (1,09), what means that on average every shoot had more than one bunch, while the lowest value of this indicator was at combination A. Also, Graph 1 shows that highest number of bunches that one fertile shoot had was noticed at combination D (1,28), and combination B had the lowest value of this coefficient (1,07).

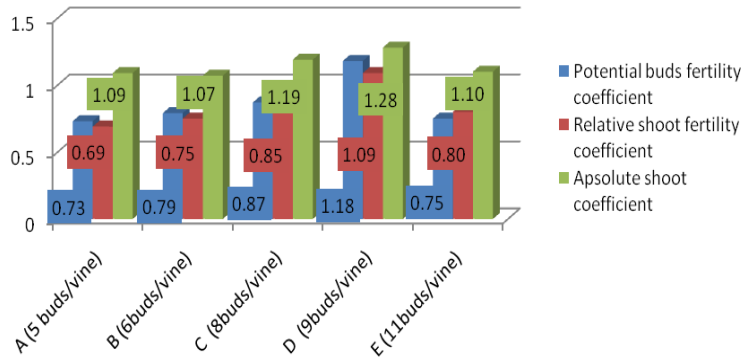


Figure 1. Fertility coefficients of grape variety kratošija at different combination of load vine with buds (2009).

Grape yield per vine at different combination of load vine with buds

By analysing of reached data (Table 1) can be concluded that the lowest average bunch weight (183,18 g) was at combination D. Average bunch weight at combination D is for 68,82 g less than average bunch weight used in planning of load vine (252.0 g). Grape variety kratošija is known as variety with big bunches (about 250 g) (Ulićević, 1966; Cindrić et al., 2000), and on the basis of the results can say that in concrete conditions, at all examined load combinations except at combination C is reached significantly lower bunch weight. Unfavourable weather conditions at the end of May and during June in 2008 caused poorly formation of crop and largeness of flowers for next year. Extremely high rainfall in month June of 2009 – 234.9 mm (even 280% more comparing to multiyear average for this month), when flowering and fertilization were still running on, caused to the lower fertilization, primary infection and later development of botrytis (*Botrytis cinarea)*, what for sure influenced on average bunch weight and reached yield. Kuljančić et al. (2007) stated that cold weather with high rainfall in May and June (in previous year), during the time of crop formation for next year, in buds that were left by pruning on shoot, cause decline of coefficient fertility value in next year. Differences in achieved values of average bunch weight and fertility coefficients to values values used during load planning, caused reaching quite lower yields, as per vine and so per unit of surface (Table 2). Increase of vine load with fertile buds and increase ol fertile elements lenght is not followed with proportionate enhancement of yield.

Table 1. Achieved grape yield per vine and per unit of surface at different combination of load vine with buds of grape variety kratošija (2009)

	Combinations of load	Number of bunches per vine (X)	Average bunch weight (g)	Yield per vine (X) (kg/vine)	Average yield per ha (t/ha)
KRATOŠIJA	A (5 buds/vine)	6.10	204.89	1.24	6.81
	B (6 buds/vine)	5.50	190.42	1.04	5.75
	C (8 buds/vine)	5.30	268.69	1.43	7.88
	D (9 buds/vine)	10.00	183.18	1.78	9.78
	E (11 buds/vine)	7.90	213.79	1.68	9.23

Quality of grapes and wine

Grape quality expressed through the sugar content, total acids and pH value in must (Table 2) was on approximately the same level at all examined combinations, suggesting that vine load with fertile buds like this did not lead to the significant reduction in grape quality. Stoev (1973) stated that all varieties don't react in the same way on change of load, e.g. Cabernet sauvignon belongs to varieties that stand up high load with no noticeable reduction of sugar content in grape must. Chemical analyses results of wine (Table 2) indicate that the highest alcohol content had the sample of B combination – 15,2vol %, and the lowest alcohol content was in the sample A, D i E - 14,7vol %. Generally can be ascertain that in all wine samples of grape variety kratošija alcohol values are high, what is, beside high total acid content, one more expressive feature of this variety. Wine quality largely depends on extract content. Wines with low extract content are inharmonious and empty, while wines with too much extract are too heavy and dense. Desirable fullness and harmoniousness are characteristics of wine with good extract content. Extract content without sugar range between 18 – 40g/l in red wines (Blesić, 2006). Chemical analyses results indicate that these wines are very extractive and that value of this parameter ranged from 30,2g/l (E combination) to 32,3g/l (combination B). Phenolic compounds accumulate with development of berry, as secondary product of sugar catabolism. Healthy and mature grapes give wine with high phenolic compounds content. In analysing wines polyphenolic content ranged from 2,07g/l (E combination) to 2,33g/l (D combination). Values of anthocyanin content in examined wines ranged from 241 mg/l (E combination) to 374 mg/l (B combination). Low values of anthocyanins are primarily features of grape variety, and then the other factors. By sensory analysis, wine of B combination (load of 6 buds/vine) received the most points (94,5), and it is characterized as balanced wine, with good relation of acids and alcohol, good structure and body. Wine with highest load (11 buds/vine) received the lowest mark and it is assessed as wine with no expressed odour, covered aromas of variety, weak body and inharmonious.

Table 2. Results of must and wine chemical and sensory analyses of grape variety kratošija (2009).

Combinations of load	Chemical analysis							Sensory analysis	
	Must		Wine						
	Sugar (%)	Total acids (g/l)	Ph	Alcohol (vol%)	Total acids (g/l)	Total extract (g/l)	Total polyphe-nols (g/l)	Anthocyanins (mg/l)	Total mark
A	24.2	7.05	3.39	14.70	6.50	32.00	2.10	299	83.20
B	24.4	6.96	3.40	15.20	6.52	32.3	2.08	374	94.50
C	24.4	6.87	3.46	15.00	6.6	31.00	2.29	341	87.30
D	23.6	6.97	3.42	14.70	6.46	31.00	2.33	288	80.50
E	24.2	6.96	3.42	14.70	6.22	30.20	2.07	241	66.80

Conclusions

Analysing all previosly stated results, D combination (load 9 buds/vine), separated as combination which achieved high yield and satisfying quality of grape and wine. B combination, with quite lower grape yield (load of 6 buds/vine), distiguinshed with wine quality, but because of economic

justification of production, this load could be recommended only for production of grape on small surfaces and production of high quality wine. Although achieved results are positive, it should be noted that data collected during one year are not sufficient to make a judgment about optimal load of grape variety kratošija. It is neccesery to do this examination for many years contaniously. Even though, one year results can serve us as significant source of information in term of solving this and similar problems of grape variety kratošija.

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ЕФЕКТ ОД РАЗЛИЧНОТО ОПТЕРЕТУВАЊЕ СО ОКЦА ВРЗ ГРОЗЈЕТО И КВАЛИТЕТОТ НА ВИНОТО ОД СОРТАТА КРАТОШИЈА

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Апстракт

Во овој труд се презентирани резултатите од ефектот на пет различни оптеретувања со родни окца на лозата врз квалитетот на грозјето и виното на автохтоните црногорски сорти винова лоза кратошија во подреонот Подгорица. На експерименталното поле, различен број на окца по лоза (5 окца/лоза, 6 окца/лоза, 8 окца/лоза, 9 окца/лоза и 11 окца/лоза) беа оставени со зимска резидба. За време на вегетацијата, приносот и квалитетот на грозјето и виното произведени со методот на микровинификација беа разгледувани. Врз основа на добиените податоци заклучивме дека оптеретувањето од 9 окца на лоза дава висок принос со задоволителен квалитет на грозје и вино. На оптеретување од 6 окца/лоза понизок квалитет на единица површина и висок квалитет на вино беа добиени но разликите во квалитетот не се толку значајни споредени со квантитетот.

Клучни зборови: оптеретување со окца, принос, квалитет на грозје, квалитет на вино.

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Original scientific paper

APPLICATION OF CLUSTER ANALYSIS IN AN INVESTIGATION OF THE VARIABILITY OF QUANTITATIVE TRAITS IN THE HYBRID COMBINATION SUPER EARLY BOLGAR X RUSSALKA

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Abstract
The variability of commercially significant quantitative traits and the possibilities for selection of elite seedless and seeded forms in F_1 progeny of the cross Super Early Bolgar x Russalka have been studied by means of Cluster Analysis and Principal Component Analysis (PCA). It has been found that only seven of the principal components are enough to explain 85,186 % of the total variation in the entire plant population, six principal components – 88,462 % of the total variation in the seeded seedlings and 90,663 % – in the seedless. The most significant are the traits total number of shoots – fruiting shoots – clusters, yield, shoot fertility coefficient, cluster length and width, average weight of 100 berries, berry length and width. Seeded forms № 1, 6, 8, 13, 17, 21 and seedless form № 2 have the greatest potential for selection purposes, and for the development of new crosses forms № 17, 1 and 8 should be used.
Key words: F_1 progeny, commercially significant traits, Cluster Analysis and Principal Component Analysis, selection.

Introduction

Polymorphism and polygenetic determination of commercially-valuable traits in vine require the utilization of methods, which provide high precision in the process of their investigation. The cluster method has obtained wide application for evaluation and grouping of vine cultivars according to their genetic remoteness (Moreno-Arribas et al., 1999, Labra et al., 2002, Grassi et al., 2003, Fanizza et al., 2003, Hvarleva et al., 2004, Varga et al., 2006, Fujita et al., 2009). This method decreases the influence of the subjective factor, facilitates the selection of elite hybrid forms and assists in the correct determination of parent pairs in accordance with the concrete selection purpose (Dimova, Bojinov, 2001). The relative significance of separate traits, which influence to the greatest extent the division of genotypes into groups is presented by means of Principal Component Analysis (PCA). The application of these two analyses makes it possible to reduce the number of researched traits as soon as the first stages of the selection procedure, and to explain the reasons for their clustering. The purpose of this study is to establish the variability of important ampelographic traits and the possibilities for selection of elite seedless and seeded forms in F_1 progeny of the cross Super Early Bolgar x Russalka, through cluster analysis and principal component analysis.

Material and methods

The experiment included 30 plants from F_1 progeny of the hybrid combination Super Early Bolgar x Russalka. For a period of four consecutive years 22 ampelographic traits determining the

commercial value of each vine cultivar, were observed: 1. Yield, kg; 2. Coefficient of shoot fertility; 3. Coefficient of main shoot fertility; 4. Coefficient of fruiting shoot fertility; 5. Millerandage berries, %; 6. Average cluster weight, g; 7. Cluster length, cm; 8. Cluster width, cm; 9. Average weight of 100 berries, g; 10. Berry length, mm; 11. Berry width, mm; 12. Index of berry shape; 13. Budding-flowering (days); 14. Flowering-softening (days); 15. Softening-technological maturity (days); 16. Budding - technological maturity (days); 17. Sugars, %; 18. Acids, g/dm^3; 19. Total bud number; 20. Total shoot number; 21. Total fruiting shoot number; 22. Total cluster number (Bulgarian Ampelography 1990). Seedlings were grouped by means of cluster analysis, and the significance of the traits for the division of genotypes was established by the application of principal component analysis (Everitt 1979, Preigel et al., 1986, Philippeau 1990). The two analyses were carried out in the entire population of F_1 progeny and in the seedless and seeded seedlings separately.

Results and discussion

All plants from F_1 progeny of the hybrid combination Super Early Bolgar x Russalka are divided into two large groups and four subgroups (Figure 1). The first subgroup includes seedlings № 8, 12, 15, 11, 13, 6 and 14; the second subgroup – seedlings № 2, 9, 3, 10, 7, 4, 29, 26 and 23; the third - № 1, 17, 24, 30, 20, 16, 27, 18, 19 and 21; the fourth – № 28, 25, 5 and 22. The relative distance between them varies from 0,000 to 301,549. Only seven principal components are enough to explain 85,186 % of the total variation (Table 1). The traits with the greatest influence on the division of genotypes into groups, are total number of fruiting shoots, yield, total shoot number, shoot fertility coefficient, berry length, average weight of 100 berries, cluster width, millerandage berries and cluster length. Their relative variation degree is the highest in the first principal component, which explains 27,608 % of the total variation. The second principal component explains 15,034 % of the variation through fewer traits, which are almost completely identical with the mentioned ones – total number of clusters, millerandage berries, cluster length, average weight of 100 berries, berry length. The third principal component explains 12,980 % of the total variation through the traits sugars, acids, main shoot fertility coefficient, average cluster weight, berry shape index, berry softening - technological maturity and budding – technological maturity. The remaining components explain respectively: 10,371% of the total variation - fourth component, 8,675 % - fifth component, 5,619 % -sixth component and 4,899 % - seventh component. According to the values of the traits from the first and second principal component, the greatest attention in the course of selection should be paid to seedlings № 1, 2, 6, 17 and 21 (Table 2). These seedlings are not included in the first or fourth subgroup and therefore they are not suitable for future crosses. The seeded plants in this hybrid combination are divided into two large groups, the second one comprised of three subgroups (Figure 2). The first group encompasses seedlings № 17, 24, 30 and 22; the first subgroup of the second group - № 26, 10 and 25; the second subgroup of the second group - № 5, 19, 6, 21, 13 and 7, and the third subgroup of the second group - № 1 and 8. The relative distance between the variants is from 0,481 to 155,837. The principal component analysis shows that only six of them are enough to explain 88,462 % of the total variation (Table 3). The first principal component explains 33,156 % of the variation and these are half of the studied traits – yield, shoot and main shoot fertility coefficient, total number of shoots – fruiting shoots and clusters, cluster width, berry length and width, budding – technological maturity and average weight of 100 berries. The traits total bud number, millerandage berries, cluster length, total cluster number, acids and sugars are

characterized by the highest variability in the second principal component, which explains 17,945 % of the total variation.

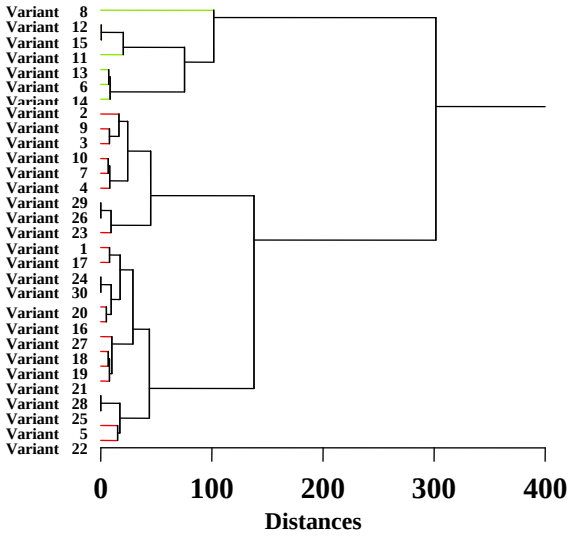


Figure 1. Dendrogram of cluster analysis of the genotypes of F_1 progeny of the hybrid combination Super Early Bolgar x Russalka

Table 1. Results from Principal Component Analysis of F_1 progeny of the hybrid combination Super Early Bolgar x Russalka

Traits	Principal Components						
	1	2	3	4	5	6	7
1	0,842	0,216	0,222	0,032	0,334	-0,129	0,085
2	0,830	0,254	0,200	0,043	0,343	-0,161	0,095
3	0,396	0,028	0,591	0,188	0,053	-0,224	-0,358
4	0,362	-0,020	0,206	-0,152	-0,641	-0,367	0,145
5	-0,595	0,675	-0,116	0,092	0,041	0,109	-0,011
6	0,302	0,106	0,526	-0,166	-0,157	0,139	-0,479
7	-0,569	0,615	-0,139	-0,019	-0,045	0,129	-0,262
8	-0,677	0,450	0,226	-0,225	0,126	-0,061	0,270
9	-0,699	0,530	0,078	-0,022	-0,066	-0,426	0,017
10	-0,706	0,495	0,224	-0,277	0,013	0,004	0,167
11	-0,163	0,224	-0,170	0,395	-0,136	-0,764	-0,173
12	-0,051	0,233	0,585	0,459	0,059	0,175	-0,258
13	0,267	0,218	0,093	-0,846	0,172	-0,099	0,060
14	-0,345	-0,222	-0,042	0,833	-0,076	0,079	0,184
15	-0,230	0,170	0,563	0,404	0,223	0,100	0,312
16	-0,047	-0,165	-0,511	0,145	0,681	-0,199	0,052
17	0,115	-0,107	0,627	0,021	-0,469	0,056	0,433
18	0,354	0,328	-0,586	0,036	-0,495	0,165	-0,118
19	0,391	0,484	-0,455	0,213	-0,388	0,085	0,112
20	0,841	0,372	-0,228	0,077	0,080	0,058	0,218
21	0,869	0,421	-0,045	0,155	-0,016	-0,065	0,121
22	0,384	0,833	0,021	0,137	0,155	0,224	-0,050
Explained % of the total variation	27,608	15,034	12,980	10,371	8,675	5,619	4,899

Table 2. Values of the studied traits for the seedlings from F_1 progeny of the hybrid combination Super Early Bolgar x Russalka

.. Plants	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	5,580	1,25	1,30	1,45	22,21	124,0	17,67	8,81	195	15,40	12,7	1,21	59	44	26	129	14,44	6,22	42	36	31	45
2	6,840	1,09	1,12	1,46	18,13	180,0	14,50	10,30	282	16,38	15,3	1,07	60	49	21	130	15,00	5,96	48	35	26	38
3	1,240	0,34	0,34	1,00	20,44	124,0	13,50	8,40	300	17,53	16,0	1,09	59	48	24	131	16,80	5,12	32	28	10	10
4	2,109	1,13	1,13	1,30	16,27	111,0	16,15	8,10	238	14,96	13,5	1,10	58	53	24	134	19,30	5,38	25	17	15	13
5	1,500	0,93	0,93	1,47	57,47	60,0	16,35	7,45	170	14,50	13,1	1,11	59	48	21	128	15,20	4,64	44	27	17	25
6	5,424	0,69	0,75	1,50	14,28	226,0	16,90	11,20	322	19,56	15,6	1,25	68	41	26	135	16,70	3,88	41	34	16	24
7	1,760	0,96	1,00	1,53	4,26	110,0	12,40	8,50	265	18,38	13,8	1,32	62	46	25	133	14,45	7,66	20	17	10	16
8	2,379	0,56	0,56	1,18	14,27	183,0	13,50	8,50	690	20,25	18,6	1,08	62	50	28	140	17,86	6,03	29	23	11	13
9	1,628	0,42	0,44	1,22	44,44	148,0	12,90	8,90	312	19,41	15,1	1,28	61	45	26	132	15,00	7,19	33	26	9	11
10	2,750	0,72	0,87	1,22	13,05	125,0	9,80	8,50	269	17,92	15,4	1,16	58	53	23	134	20,17	4,56	35	31	18	22
11	1,302	0,50	0,55	1,22	18,42	93,0	16,13	7,40	383	21,52	15,6	1,37	64	41	27	132	16,80	6,36	39	27	11	14
12	2,080	0,68	0,68	1,36	22,22	130,0	17,68	10,22	443	22,40	17,0	1,32	59	50	22	131	15,83	5,13	35	24	12	16
13	1,491	0,23	0,26	1,00	19,32	213,0	11,25	10,30	326	21,20	15,2	1,39	54	51	20	125	20,14	4,71	40	30	7	7
14	1,491	0,23	0,26	1,00	19,32	213,0	11,25	10,30	326	21,20	15,2	1,39	60	27	48	135	20,14	4,71	40	30	7	7
15	1,820	0,59	0,59	1,33	22,22	130,0	17,68	10,22	443	22,40	17,0	1,32	59	50	22	131	15,83	5,13	35	24	11	14
16	1,869	0,58	0,58	1,50	14,28	89,0	12,56	8,31	172	15,98	12,4	1,29	61	41	26	128	17,65	3,83	45	36	14	21
17	4,032	1,21	1,31	1,50	10,61	144,0	14,53	9,31	193	17,31	12,7	1,36	61	51	22	134	21,67	4,07	35	23	19	28
18	1,188	0,39	0,39	1,10	14,86	108,0	18,86	8,28	147	14,50	12,2	1,19	61	50	22	133	15,10	5,11	40	28	10	11
19	2,250	1,09	1,09	1,39	28,00	90,0	16,39	8,06	147	14,43	12,5	1,15	61	42	29	132	15,90	6,27	32	23	18	25
20	1,919	0,59	0,59	1,27	16,28	101,0	16,38	8,19	188	14,42	13,5	1,07	61	45	28	134	15,40	6,11	41	32	15	19
21	3,360	1,07	1,07	1,43	28,01	112,0	15,46	5,95	125	15,09	11,5	1,31	62	50	23	135	18,40	5,97	37	28	21	30
22	2,496	1,30	1,41	1,79	56,04	52,0	15,45	5,95	105	15,69	11,1	1,41	60	51	23	134	16,81	5,81	44	37	27	48
23	0,896	0,86	0,88	1,25	17,31	56,0	15,38	6,38	235	13,16	12,1	1,09	61	43	24	128	24,45	5,59	25	19	13	16
24	1,344	0,57	0,60	1,00	19,31	112,0	13,70	8,86	177	14,41	12,5	1,16	58	50	22	130	15,95	3,69	45	21	12	12
25	1,856	0,89	0,89	1,14	15,25	58,0	13,50	6,60	145	13,72	11,7	1,18	58	44	27	129	24,17	4,66	45	36	28	32
26	0,913	0,57	0,57	1,10	21,15	83,0	15,80	7,30	223	15,96	14,4	1,11	61	45	26	132	16,80	5,16	29	20	10	11
27	1,030	0,50	0,50	1,00	13,04	103,0	13,00	8,60	133	15,40	11,7	1,32	60	27	48	135	16,27	7,65	31	20	10	10
28	1,900	0,94	0,98	1,14	16,02	68,0	14,27	6,84	151	14,32	10,6	1,35	57	46	25	128	20,07	4,12	47	35	29	33
29	1,122	0,52	0,59	1,10	20,85	95,0	16,34	7,46	231	15,86	14,7	1,08	60	46	28	134	16,58	5,31	30	21	10	11
30	1,386	0,59	0,62	1,00	18,11	122,0	14,29	8,96	183	15,01	12,4	1,21	56	52	23	131	15,65	4,66	44	22	13	13

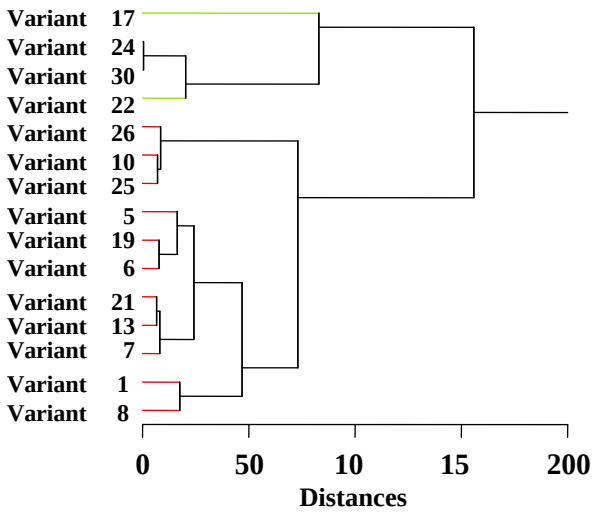


Figure 2. Dendrogram of cluster analysis of the genotypes of F_1 progeny of the hybrid combination Super Early Bolgar x Russalka - seeded plants

Table 3. Results from Principal Component Analysis of F_1 progeny of the hybrid combination Super Early Bolgar x Russalka - seeded plants

Traits	Principal Components					
	1	2	3	4	5	6
1	0,900	-0,038	0,312	-0,008	-0,203	-0,150
2	0,896	0,001	0,308	-0,009	-0,255	-0,136
3	0,745	0,074	0,370	-0,107	0,171	-0,403
4	0,251	-0,252	-0,587	-0,158	0,499	0,096
5	-0,469	0,734	0,093	0,109	-0,093	0,190
6	0,446	0,078	0,211	0,018	0,482	-0,482
7	-0,270	0,780	0,031	0,277	0,065	-0,221
8	-0,591	0,007	0,559	0,217	0,387	0,164
9	-0,815	0,209	0,103	0,141	0,298	-0,329
10	-0,629	0,110	0,435	0,343	0,441	0,228
11	-0,555	0,204	-0,275	-0,147	-0,011	-0,674
12	0,008	0,264	0,548	-0,559	0,360	-0,096
13	0,321	-0,438	0,180	0,803	0,004	0,078
14	-0,481	0,292	-0,014	-0,709	-0,242	0,121
15	-0,318	-0,004	0,786	-0,352	-0,094	0,299
16	-0,514	0,156	0,145	0,140	-0,616	-0,128
17	0,340	-0,621	-0,004	-0,336	0,371	0,244
18	0,271	0,657	-0,495	0,019	0,320	0,144
19	0,239	0,793	-0,365	0,019	0,107	0,299
20	0,877	0,369	0,077	0,059	-0,084	0,131
21	0,872	0,413	0,070	-0,005	0,036	0,060
22	0,614	0,710	0,259	0,085	-0,003	0,128
Explained % of the total variation	33,156	17,945	12,471	9,358	8,630	6,880

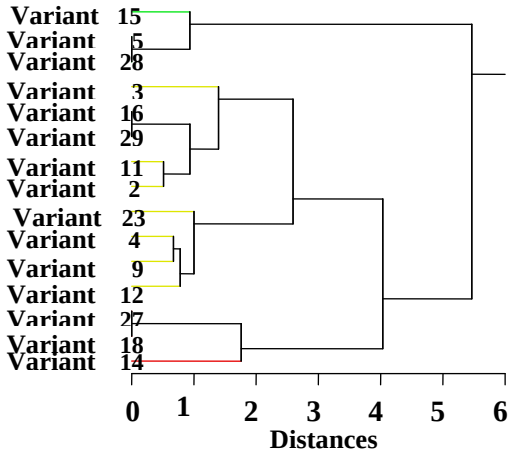


Figure 3. Dendrogram of cluster analysis of the genotypes of F_1 progeny of the hybrid combination Super Early Bolgar x Russalka - seedless plants

The third principal component explains 12,471 % of the total variation, predominantly through the traits berry softening – technological maturity, berry shape index, cluster width

and fruiting shoot fertility coefficient. The fourth, fifth and sixth principal component explain respectively 9,358 %, 8,630 % and 6,880 % of the entire variation, the greatest share belonging to the traits budding – flowering, flowering – berry softening, berry shape index, budding – technological maturity and berry width. The most considerable potential for selection purposes is reported for seedlings № 1, 6, 8, 13, 17 and 21, and for crosses – seedlings № 17, 1 and 8, since they are included in the first and third group. Seedless seedlings are divided into four groups according to their degree of similarity (Figure 3). The first group of the dendrogram includes plants № 15, 5 and 28, the second group - № 3, 16, 29, 11 and 2; the third - № 23, 4, 9 and 12; the fourth - № 27, 18 and 14.

Table 4. Results from Principal Component Analysis of F_1 progeny of the hybrid combination Super Early Bolgar x Russalka - seedless plants

Traits	Principal Components					
	1	2	3	4	5	6
1	0,841	0,194	0,147	0,210	0,275	0,245
2	0,840	0,211	0,185	0,198	0,258	0,216
3	0,025	0,732	-0,109	0,251	0,373	-0,485
4	0,612	0,372	-0,298	0,240	-0,162	-0,282
5	-0,294	0,355	0,694	-0,420	-0,221	0,254
6	-0,123	0,579	-0,224	0,432	-0,512	0,269
7	0,519	0,050	0,521	-0,512	-0,208	0,033
8	-0,691	-0,044	0,272	0,553	0,262	0,001
9	0,015	0,652	0,511	-0,186	0,279	-0,435
10	-0,704	0,267	0,214	0,389	0,027	-0,268
11	0,639	0,322	0,209	-0,499	0,205	-0,169
12	-0,115	0,796	-0,035	0,209	0,151	0,133
13	0,339	0,056	0,525	0,524	-0,538	-0,022
14	-0,247	0,095	-0,503	-0,671	0,432	0,052
15	0,128	0,831	-0,029	-0,332	-0,120	0,154
16	0,125	-0,580	0,202	0,199	0,649	0,210
17	0,095	0,577	-0,674	-0,156	-0,291	0,221
18	0,452	-0,490	0,197	-0,302	-0,542	-0,338
19	0,688	-0,243	-0,179	-0,087	-0,216	-0,337
20	0,913	-0,308	-0,012	0,052	0,015	0,104
21	0,978	0,022	-0,041	0,089	0,076	-0,062
22	0,699	0,304	0,533	-0,113	0,063	0,237
Explained % of the total variation	30,568	19,606	12,575	11,972	10,099	5,843

The relative distance between them is small – from 0,000 to 54,641. Six of the principal components determine 90,663 % of the total variation (Table 4). The first principal component explains 30,568 % of the variation, mainly through the traits total number of

fruiting shoots – shoots – clusters, yield, shoot and fruiting shoot fertility coefficient, cluster length and width, berry length and width, total bud number. The second principal component explains 19,606 % of the variation, predominantly through the traits main shoot fertility coefficient, average cluster weight and average weight of 100 berries, berry shape index, berry softening – technological maturity, budding – technological maturity and sugars. Some of the traits from the second component repeat in the third one - millerandage berries, average weight of 100 berries, cluster length, budding – flowering, flowering – berry softening, sugars and total number of clusters. The third component explains 12,575 % of the total variation. The fourth, fifth and sixth principal component explain 11,972 %; 10,099 % and 5,843 % respectively of the total variation. Seedling № 2 is found to be an elite form, possessing the best selection indices, and seedlings № 12, 14 and 15 should be investigated further.

Conclusions

In the hybrid combination Super Early Bolgar x Russalka only seven of the principal components are enough to explain 85,186 % of the total variation in the entire plant population, six principal components – 88,462 % in seeded seedlings and 90,663 % in seedless ones. The most significant are the traits total number of shoots – fruiting shoots – clusters, yield, shoot fertility coefficient, cluster length and width, average weight of 100 berries, berry length and width. Seeded forms № 1, 6, 8, 13, 17, 21 and seedless form № 2 have the greatest potential for selection purposes, while forms № 17, 1 and 8 can be used for the development of new crosses.

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ПРИМЕНА НА КЛАСТЕР АНАЛИЗАТА ВО ИСПИТУВАЊЕ НА ВАРИЈАБИЛНОСТА НА КВАНТИТАТИВНИТЕ КАРАКТЕРИСТИКИ НА ХИБРИДИТЕ ОД SUPER EARLY BOLGAR X RUSSALKA

Венелин Ројчев

Апстракт

Варијабилноста на комерцијално значајните квантитативни карактеристики и можноста за селекција на елитни бессемени и семени форми од Ф1 генерацијата добиена од вкрстување на Super Early Bolgar x Russalka се проучувани преку примена на Cluster Analysis и Principal Component Analysis (PCA). Утврдивме дека само седум од основните компоненети се доволни за објансување на 85,186 % од вкупните варијации кај семените и 90,663 % – кај бессемените. Најзначајни се карактеристиките на бројот на ластари, родни ластари , гроздови, принос, коефициентите на родност на ластарите, должина и ширина на гроздот, просечна тежина на 100 зрна, должина и ширина на зрно. Семените форми № 1, 6, 8, 13, 17, 21 и бессемената форма № 2 имаат значаен потенцијал за целите на селекцијата и за развој на нови вкрстени форми № 17, 1 и 8 можат да бидат употребени.

Клучни зборови: Ф1 генерација, комерцијално значајни карактеристики, кластер анализа (PCA) анализа, селекција.

UDC:663.252.4
Original scientific paper

INFLUENCE OF THE YIELD AND TYPE OF VINIFICATION ON THE QUALITY OF WINE VRANAC

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Abstract
The results of testing the influence of yield and type of fermentors on the quality of the wine Vranac are presented in this work. The research was done on 4 types for yield: 8 t/ha, 10 t/ha, 12 t/ha and 15 t/ha. The fermentors made by SIFA, GANIMEDE and GIMAR were used and the control sample was taken from the classic vinification in PVC vat. The results showed that the best quality grapes for obtaining high quality wines have been achieved with yield of 8t/ha. All three types of fermentors gave better phenolic compounds of wine and better sensory characteristics than the classic vinification in the barrel. The yield of 10 t/ha gives grapes for producing quality wines for fast consumption.
Key words: Vranac, yield, red wine, fermentors, polyphenols, anthocyans, sensory characteristics.

Introduction

Vranac is an autochtonous Montenegrin grape variety and the leading vine variety in the red wine production. The red wine Vranac, made of autochtonous grape variety has become national brand and the most famous and the best brand of the company ‘13 jul –Plantaze’, which has promoted Montenegro as a significant wine destination in previous years.Therefore, there is a will for improving and researching the enological potentials, new and greater possibilities of the grape variety Vranac itself as well as the quality of the Vranac wine itself. The goal of the research was to determine the influence of the yield and type of vinification on the quality of the grape and wine of Vranac.The goal of the research is to determine the influence of the yield and methods of vinification on the grape quality, polyphenols and sensory quality of wine. The idea was to determine the optimal yield and vinification method by which the wine with high polyphenol contents and sensory potential is made.

Material and methods

Experimental plantings with Vranac grapevine variety are situated on Nikolj Crkva locality on the Cemovsko field. This locality is a part of the Podgorica’s subregion of the

Montenegrin basin of Lake Skadar. Microvinifications were performed in the microvinification section of the company "13 jul-Plantaze" ad. For the research and monitoring of the data, 4 types of yield were set (8, 10, 12, 15 t/ha) and the grapes were vinified in four types of fermentors (Sifa, Ganimede, Gimar and classical pvc vat).

Table 1. Schematic review of the experiment.

	Types of fermentors		MARK
Examined factors	Yield 8t/ha	Classiicalvinificationpvc vat	B-1
		Fermentor“sifa”	S-1
		Fermentor“ganimede”	Ga-1
		Fermentor“gimar”	G1-
	Yield 10t/ha	Classiicalvinificationpvc vat	B-2
		Fermentor“sifa”	S-2
		Fermentor“ganimede”	Ga-2
		Fermentor“gimar”	G-2
	Yield 12t/ha	Classiicalvinificationpvc vat	B-3
		Fermentor“sifa”	S-3
		Fermentor“ganimede”	Ga-3
		Fermentor“gimar”	G-3
	Yield 15/ha	Classiicalvinificationpvc vat	B-4
		Fermentor“sifa”	S-4
		Fermentor“ganimede”	Ga-4
		Fermentor“gimar”	G-4

The grape quality parameters were monitored, based on its mechanical and chemical properties, chemical and polyphenol contents and sensorial quality of wines, made of Vranac grape variety. For the determination of the mechanical contents of grape, modified method by Negrul is applied. The sensory wine analysis is done, complied with the OIV principles by the application of 20 points evaluation system

Results and discussion

Yield

For each type, number of bunches per vine, yield per vine and yield per ha were measured (Table 2). From the results of the research we could conclude that the grape mass varies from 200,7 g to 224,9 g, which means that bunch of Vranac variety belongs to the category of medium big bunches (PhD Z Božinovik, 2010).

Table 2. Mechanical analysis and grape yields

Elements	Types			
	8 t/ha	10 t/ha	12 t/ha	15 t/ha
Number of bunches per vine	12.3	13.7	16.4	20.2
Yield per vine (kg)	2.45	2.95	3.44	4.51
Yield per ha (kg)	8.909	9.995	11.825	14.586

Number of bunches is in proportion with yield per vine and ranges from 12,3 for the yield 8 t/ha to 20,2 bunches for 15t /ha, with grape mass per vine from 2,45 kg to 4,5 kg..

Mechanical properties of bunches and berries

The analysis of the mechanical properties of the grapes has been performed, by testing the mass of grape bunches and berries, properties of berries, number of berries in the bunch, mass of stems, based on which the theoretical ratio between the quantity of grapes and the quantity of wine produced of it, plays a very important indicator of the quality of the grapes and wine (Table 3).

Table 3. Mechanical properties of grapes and berries

Elements	8 t/ha	10 t/ha	12 t/ha	15 t/ha
Bunch mass (g)	224,9	215,2	209,6	200,7
Berries mass without stems(g)	218,8	208,9	203,2	195,2
Berry mass(g)	2,35	2,33	2,69	2,63
Stems%	11,3	20,0	10,8	10,64
R %	86,3	85,4	86,5	86,9

Theoretical ratio of the quantity of the grapes and quantity of wine made (R %), ranges from 85,4 % to 86,9 % for 15 t/ha yield. Based on this data we could conlude that the grape vine yield has great influence on grape quality, with higher yields there is a higher number of bunches, bigger berries, theoretical ratio of the quantity of the grapes and quantity of wine made, as well as the negative ration between the solid-liquid phase, which is the indicator of the lower grape quality for winemaking. Based on this data, we could conclude that the bunch of Vranac grape variety is medium big,cone shaped, of medium density, of grey black colour. By comparing these data with the data from literature (Ulićević, 1966; Avramov, 1991, Burić 1995, Božinovik 2010) a great similarity is noticeable.

Chemical and polifenolic properties of grape

Chemical properties of grapes, sugar contents, total acids and pH values were measured (Table 4), so we could notice that there are no great differences related to the chemical composition of the grapes in relation to the projected yield. By measuring chemical properties of wine we could also conclude that there are no big differences related to the total acids, pH values, but it is obvious that sugar contents declines with the increasing of the yield.

Polyphenol properties, polyphenol and anthocyanins content of Vranac grape wine variety is shown in table 5. from which we could concluded that Vranc is grapevine variety with high polyphenol and anthocyanins content.

Table 4. Chemical analysis of grape must

Compounds	Types			
	8 t/ha	10 t/ha	12 t/ha	15 t/ha
Sugar g/dm^2	257	247	231	221
Total acids g/dm^2	5.27	5.19	5.08	5.00
pH	3.47	3.46	3.48	3.4

Table 5. Polyphenol compounds of skins, seeds and berry pulps

Indicator	total polyphenols mg/kg	anthocyanins mg/kg
skin	1.940	3.860
seed	5.210	-
pulp	21	53
total	7.171	3.913

Chemical properties of wine

According to the testings of wine and by analysis of chemical compounds, it can be concluded that regarding the tested chemical compounds for all types of yields as well as for all four types of fermentation, there are no significant differences (Table 6). Measuring the alcohol content, total acids, residual sugars, pH it is obvious that there is a slight difference in the alcohol contents for the types with classical vinifications, where some more non fermented sugars remained. All other parameters are at expected levels. For the yields of 12 t/ha and 15 t/ha there is a higher content of malic acid in the wine which shows slightly lower tehnological ripeness of the grapes at the moment of harvest.

Table 6. Chemical properties of wine in relation to yeald and type of vinifications

	Type of vinification							
	Classical (vat)		Fermentor“sifa“		Fermentor Ganimede		Fermentor Gimar	
	8 t/ha	10 t/ha	8 t/ha	10 t/ha	8 t/ha	10 t/ha	8 t/ha	10 t/ha
Alcohol%v/v	15,48	15,58	15,4	15,82	15,64	15,8	15,58	15,88
Total extract g/lit	31,3	31,9	33,7	32,5	33,5	32,8	33,5	32,3
Total acids g/lit	6,72	6,86	6,71	6,9	6,76	6,72	7,1	6,88
pH-value	3,46	3,45	3,47	3,41	3,33	3,41	3,36	3,43
malic acid g/l	-	-	-	-	-	-	--	-
lactic acid g/lit	0,85	0,79	0,83	0,78	0,86	0,88	0,81	0,85
Non fermented sugar gr/l	2,28	3,36	4,38	2,78	2,02	2,4	2,24	2,02

Table 7. Type of vinification

	Type of vinification							
	Classical		Fermentor“sifa“		Fermentor		Fermentor	
	12	15	12 t/ha	15 t/ha	12	15	12	15
Alcohol%v/v	13,9	13,6	13,5	13,37	13,45	13,35	13,42	13,5
Total extract g/lit	30,01	30,5	30,5	30,28	30,9	30,6	30,4	30,05
Total acidsgr/lit	7,07	7,38	7,15	7,04	6,56	6,8	6,51	6,85
pH-value	3,45	3,25	3,41	3,42	3,40	3,44	3,42	3,45
malic acid g/l	0,5	0,8	0,7	0,35	-	-	-	-
lactic acid g/lit	0,75	0,7	0,81	0,74	0,85	0,85	0,8	0,89
Non fermented	1,44	2,08	2,11	3,48	1,92	3,45	2,11	2,68

By testing chemical and polyphenol parameters of wine in relation to the yield and type of vinifications, we can see from the table that polyphenols and anthocyanins are divided in two levels.Polyphenol and anthocyanin for the tested variants are shown at Figures 1, 2, 3, 4. For wines with yields of 8t/ha (Fig 1.) and 10t/ha (Fig. 2) polyphenol contents are rather high ranging from 2,95 – 3,23 g/l as well as for the anthocyanins, between 620-780 mg/l which means that for these types we can expect a good wine aging potential, especially for vinifications with Gimar and Ganimede fermentors.

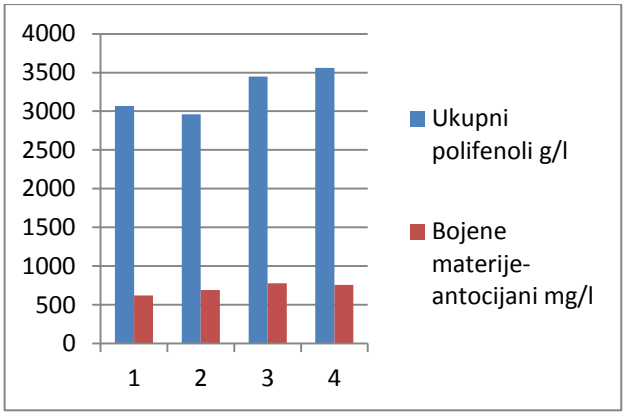


Figure 1. Relation of polyphenols and anthocyanins 8 t/ha

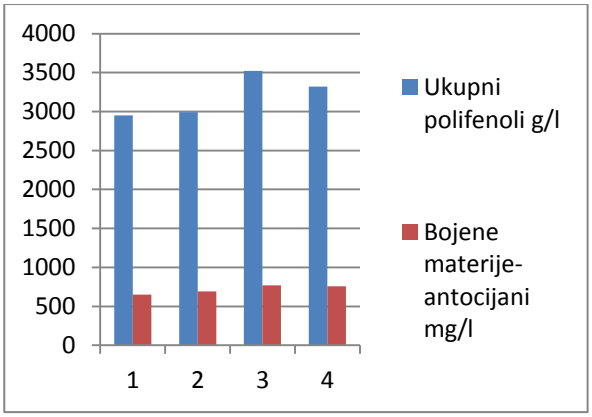


Figure 2. Relation of polyphenols and anthocyanin 10 t/ha

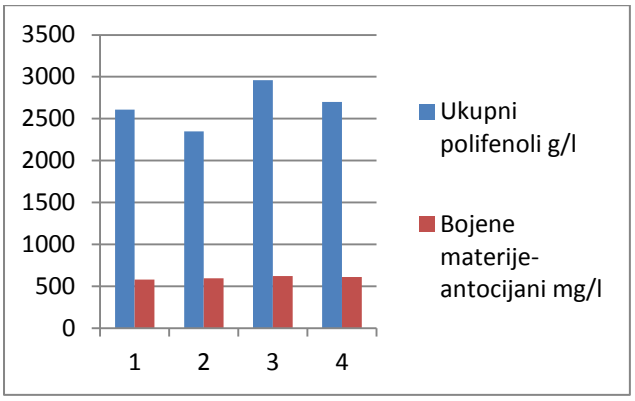


Figure 3. Relation of polyphenols and anthocyanins 12 t/ha

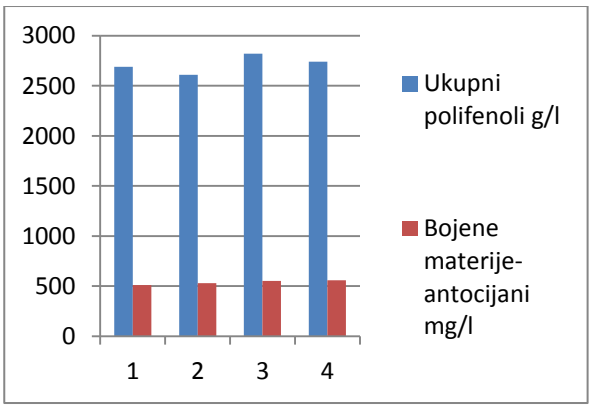


Figure 4. Relation of polyphenols and anthocyanins 15 t/ha

In diagrams No. 3 and 4 is shown polyphenol contents of wine with yields of 12 and 15t/ha from which it can be seen that polyphenol contents is 2,6 - 2,82 g/l, and anthocyanin contents is also rather low, 580 - 620 g/l from which can be concluded that those wines are

the wines with good polyphenol contents, but not the ones which have a good wine aging potential.

Organoleptic evaluation

It has been performed by 20 points evaluation method. The highest points of 19,4 and 19,1, had wines Gi 8 and G 8. Those wines are very rich on structure, strong, rounded, with good balance and fine,soft tannins, wine with great aging potential. The type B -8 on nose had cooked aromas as a consequence of classical vinification. If we assume sensorial characteristics of wine with yield of 8 t/ha on Sifa fermentor and classical fermentor, it can be concluded that those fermentors do not give high quality wines regardless the low yield.

Yields of 12 and 15 t/ha also gives good wines, with satisfying quality for lower wine category, with recognizable varietal characteristics, but not wines with longer aging potential regardless the method and type of vinifications.

Conclusions

Based on this evaluation and results, conlusions can be made, as follows:

1. In regards of the mechanical properties, the differences between types are expressed on the bunch mass, berries mass, and theoretical ratio between the quantity of grapes and the quantity of wine produced of it. The biggest bunch mass has yield type 8t/ha – 224,9 g and the lowest yield type 15 t/ha – 200,7 g. Theoretical ratio between the quantity of grapes and the quantity of wine produced of it is 85,4 for 10 t and 86,9 for yield type 15 t.
2. The chemical composition of the must is characterized by high sugar contents for all types, low acids and moderate pH. Sugar contents is 221 g/l for the type 15 t/ha and 246 g/l for the type 8 t/ha. It is noticeable that yield has a low influence on total sugar and acids.
3. Types of 12 t/ha and 15 t/ha gave wine with slightly lower alcohol contents. The amount of the malic acid is higher, so the malolactic fermentation has not finished. Polyphenols for the all types of vinifications are low, so these wines do not possess aging potential.
4. Yields per ha and types of fermentation have the biggest influence on sensorial characteristics of wines. For all types of classical type of fermentation, the wines are with low aromatic complex. The types of 12 and 15 t/ha, regardless the type of vinification , give wines with a bad, aromatic potential and a very poor structure.
5. Based on chemical, polyphenols and sensorial evaluations of wines, it can be stated that there is a great influence of the yields and types of vinifications on the quality of the obtained wines and their longevity. Types of 8 and 10 t/ha can be recommended for making wines of good potential, rich structure and suitable for long aging. On the other hand, high yields of 12 and 15 t/ha,regardless the manner and type of the applied vinification, give wines with poor structure, which have not a long aging potential, wines of lower quality category and for fast consumption.

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ВЛИЈАНИЕ НА ПРИНОСОТ И ТИПОТ НА ВИНИФИКАЦИЈА ВРЗ КВАЛИТЕТОТ НА ВИНОТО ВРАНЕЦ

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Апстракт
Резултатите од тестирањето на влијанието на приносот и тиопот на ферментаторите врз квалитетот на виното Вранец се презентирани во овој труд. Испитувањето го извршивме на 4 типа на принос: 8 t/ha, 10 t/ha, 12 t/ha и 15 t/ha. Ферментатори од типот на SIFA, GANIMEDE и GIMAR беа споредени во однос на стандардната враијанта со класична винификација во пластични буриња. Резултатите покажуваат дека најдобар квалитет на вино се добива со принос од 8t/ha. Сите три ферментатори даваат подобар состав на фенолните компоненети на виното и подобри сензорни карактеристики во однос на класичната винификација во буре. Приносот од 10 t/ha дава горзје за производство на вино за брза консумација.
Клучни зборови: Вранец**,** принос, црвено вино, ферментатори, антоцијани, сензорни карактеристики.

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THE IMPACT OF VINIFICATION METHODS ON CHEMICAL COMPOSITION AND SENSORY PROPERTIES OF THE VRANAC WINE VARIETY

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Abstract
The goal of testing was to establish the impact of the vinification method on the chemical composition and sensory properties of the red wine variety Vranac. To achieve that goal an experimental apparatus was set up in the microvinification plant of the company "13. jul Plantaze" in Podgorica. The grape raw material from Cemovsko field, which belongs to the Podgorica sub-region, was used. The research entailed four processing ways (methods): processing in the Sifa, Ganymede and Gimar fermentation tanks and the classic-traditional method. The obtained results showed that the vinification method has no significant influence on the chemical composition of wine, and the impact on the sensory properties of wine is evident. The highest tasting score received the wine produced by the Ganymede method, because of its good structure and the potential for long-term maturation and high quality.
Keywords*:* Vranac, chemical composition, sensory properties, Sifa, Ganimede, Gimar.

Introduction

Knowledge of chemical composition of must is of great importance in the technology of wine making, since the quality of wine for the most part directly depends on it. The sensory properties of a wine are the main indicators of the wine quality. Based on the sense of sight, the sense of smell (olfactory assessment) and taste (gustatory assessment) we assess the clarity and color, the smell and the taste of a wine, that is, we determine the sensory profile of a wine. In producing red wines, in order to achieve better chemical composition and sensory characteristics of a wine, that is, in order to obtain better quality wines, different technologies and methods of vinification are applied. During this research, the processing of the Vranac grape variety, i.e., vinification, was done in 4 ways or methods of vinification: the classic method and three modern technologies in the Sifa, Ganymede and Gimar fermentation tank using the standard oenological tools. The objective of this research was to determine whether, and to what extent the vinification method affected the chemical composition and the sensory properties of a wine, thus, obtaining a justification for the application of modern methods of making the Vranac wine.

Material and methods

The research was conducted on an autochthonous Montenegrin wine variety - Vranac. The analysis of the chemical composition of a wine, depending on the way, that is, the method of vinification was carried out in the period from 2008 to 2011. In order to determine the chemical composition of a wine and the sensory properties of a wine, the same conditions of vinification were provided for all the variants of winemaking within the research (the classic method and three modern technologies in the Sifa, Ganimede and Gimar fermentation tanks).

The classic-traditional method of winemaking – the vinification was carried out in the traditional manner using the standard procedure. After the grape was harvested at full maturity and crushed, whereby the stems were removed, the pomace was placed into a PVC fermentation tank. The pomace immersion was performed manually. After completion of the fermentation, decantation into vessels for wine aging was carried out.

The SIFA fermentation tank – is a modified form of the Gimar fermentation tank. It consists of two parts, which are not fixed and can be separated. The first part of the fermentation tank is filled with the pomace to a certain level, and the second part is filled with the liquid part, through the pump and a side pipe. During remontage (after the cap has been formed), the pump draws liquid from the lower part and transports it through the side of the tube to the upper part of the fermentation tank. The bottom of the upper part is funnel-shaped with a mobile plate that closes the vessel during filling, and after the vessel is filled the cap is opened and rinsed.

The GANIMEDE fermentation tank - consists of two parts that are connected, with the funnel-shaped upper part. The fermentation tank has two bypasses (shortcuts), which allow the liquid part to reach the cap by a shorter way, break it and, therefore, wet it, and possibly turn it, depending on the amount of CO_2 released during fermentation.

The GIMAR fermentation tank - within its container it includes a small vessel attached to the cover, which is filled with liquid through the pump and a side pipe. At the bottom of the vessel is a fixed plate, and between the walls of the vessel and the plate is an open space through which the liquid part flows out, while at the same time an aeration of the liquid part and sprinkling of the cap is performed . Processing-vinification was performed in a microvinification plant, which is part of the company, "13.jul -Plantaze " in Podgorica. Grapes are harvested at full maturity which is determined on the basis of sugar content, pH and total acidity in the grapes. After crushers where the grapes were destemmed, the pomace was placed into fermentation tanks. The standard oenological tools were used. The pomace was treated with 5g/100l of sulphur dioxide, the selective yeast was added (BDX, Lallemand) in the quantity 10/100l and the fermaid E yeast nutrient (Lallemand) in the the amount of 20 gr/100l of must (10 gr/100l of must in the pomace and 10 gr/100l of must at 1/3 of fermentation), for all the methods applied. The immersion of pomace was performed manually in the traditional manufacturing vessels, while automatic remontages were performed in the fermentation tanks. After completion of the fermentation, decantation was carried out in the vessels for wine aging.The analysis of the chemical composition of must and wine was performed 3 months after the end of fermentation. The chemical analyzes were performed at the oenological laboratory of the Biotechnical faculty and the laboratory

of the company "13.jul Plantaze", in Podgorica. They were performed under the Rules on quality and other requirements for wine (Sluzbeni list SRJ br.no. 54/99 and 39/2002).
Sensory properties of the wine were determined by tasting with the pointing-scoring method according to Buxbaum (max.20 points). The properties evaluated were: *clarity* (0-2), *colour* (0-2), *smell* (0-4) and *taste* (max.12). The organoleptic evaluation was carried by a tasting committee consisting of 6 members. The statistical processing of the obtained data was performed by calculating the average value, a variable expressed as a percentage and ANOVA (Student Newman Klaus test) in order to determine possible significant differences between all the analyzed wines.

Results and discussion

Chemical composition of the must and wine of the examined Vranac wine variety

The chemical composition of must is of great importance for the quality of a wine, and not only the amounts of certain ingredients, but their volume ratio. As one of the main indicators of the quality of must and the future wine is the concentration of sugar and the total acidity in grapes. The chemical composition of the must of the examined Vranac wine variety is shown in Table 1.

Table 1. Chemical composition of must

Vintage year	Sugar (%)	Total acidity (g/l)	pH	Sweetness index
2008	23.7	4.8	3.4	49.38
2009	23.9	4.7	3.5	50.84
2010	23.6	4.47	3.49	52.8
x	23.73	4.66	3.46	51.47
CV	0.64	3.63	1.59	3.33

x – average value, CV % - coefficient of variation

The average sugar content in the must during the three-year research was 23.73%, and the total acidity was 4.66 g/l, which is characteristic of the Vranac variety (Ulićević, 1966). The Student Newman-Klaus test showed that there is no statistically significant differences ($p<0.05$) between the values of the examined must parameters in the three different vintage years. The table shows that the sugar content in the must was rather high, and that the total acid content was in the range typical for this variety. The pH value of the must examined was relatively high, which is consistent with the total acid content of the must.

In order to obtain a better picture of the quality and degree of ripeness of the grapes, in addition to sugar and acid content, the sweetness or the glucoacidomeric index was determined which is the sugar acid ratio in grapes. The high sugar content and low acidity caused the sweetness index of the variety examined to be very high: 51.47.

After examination of the chemical composition of the Vranac wine variety must, we can conclude that the Vranac variety grapes were of excellent quality and that there were no significant variations in its quality over the years of research. The chemical composition of the wines made by the 4 vinification methodis is presented in Table 2. The specific gravity of the wine ranged from 0.9934 to 0.9944 on average. The value of this parameter depends

on the amount of extract and the concentration of alcohol in a wine. Based on the tabulation of the chemical components of the examined wines it can be concluded that all the wines, on average, have a high content of alcohol in accordance with the content of sugar in must. It ranges from 14.0 to 14:33 vol%.

Analogous to the high content of sugar in the must, the total extract content in the tested wines is also high. The extract of wine is an important component of its quality and by this term we mean the set of all volatile substances in a wine. The obtained average values range from 29.37 to 31.50 g / l. In the wines obtained a high content of total acids in wine is evident ranging from 6:03 to 6:33 g / l. In terms of reducing sugars, all the wines were dry and there was no difference among the variants. Based on the above mentioned parameters of the examined wines chemical composition, it can be concluded that all the wines have excellent characteristics, typical of the Podgorica area, which are characterized by a high content of alcohol and extract. A higher total acid content is evident, which is not typical for the wines produced from the Vranac variety, since they could be distinguished by a lower content of total acids. The higher content of total acids is caused by addition of tartaric acid in order to raise the low acid content in the must. Based on the results obtained on the chemical composition of wine, it can be concluded that the wines were of approximately the same chemical composition and that the vinification method has no statistically significant effect ($p > 0.05$) on the chemical composition of wine.

Sensory properties of wine in the wines tested

Based on the average tasting score for the 3 years of research, we have obtained results for all the vinification methods, which are shown in Table 3. After obtaining the average sensory scores, it can be concluded that the sensory properties of wine to a large extent depend on the vinification methods. Based on the data in Table 3 we can conclude that there is a significant impact of the modern vinification methods on sensory properties of a wine (control wine) compared to the classic one. The wines produced using modern vinification methods have a higher tasting score ranging from 0.4 to 0.9 points compared to the control wine, that is the wine made by a conventional method of vinification. Modern vinification methods differ slightly in the overall sensory evaluation

The highest average sensory evaluation of 18.2 points during the 3-year research period received the wine made using the Gimar method (G), while the lowest of 17.3 points received the wine produced by the classical method of vinification (K).

Table 2. Chemical composition of Vranac wines

Vintage year	Relative density	Alcohol (vol%)	Total extract (g/l)	Total acidity (g/l)	Volatile acids (g/l)	pH	Tartaric acid (g/l)	Potassium (mg/l)	Reducing sugar (g/l)
	The classic method								
2008	0.993	14	29.2	6.5	0.42	3.3	3.4	861	1.9
2009	0.9932	14.1	29.6	5.7	0.28	3.4	3.06	851	2.1
2010	0.994	13.9	29.3	5.9	0.52	3.45	3.2	850	2.3
X	0.9934	14.0	29.37	6.03	0.41	3.38	3.22	854	2.10
CV%	0.05	0.71	0.71	6.90	29.64	2.26	5.31	0.71	9.52
	The Sifa method								
2008	0.9939	14.3	29	6.4	0.37	3.31	3.31	920	1.8
2009	0.9941	14.5	30.4	6	0.29	3.39	3.33	884	2
2010	0.9942	13.8	30.2	5.95	0.45	3.45	3.28	899	2.2
x	0.9941	14.2	29.87	6.12	0.37	3.38	3.31	901	2.00
CV%	0.02	2.54	2.54	4.03	21.62	2.08	0.76	2.01	10.00
The Ganimede method									
2008	0.9935	14.4	31.9	6.3	0.28	3.4	3.6	855	2.2
2009	0.9941	14.6	32.7	7.1	0.22	3.26	3.48	827	2.4
2010	0.994	14	29	5.6	0.39	3.43	3.4	840	2.7
x	0.9939	14.33	31.2	6.33	0.30	3.36	3.49	841	2.43
CV%	0.03	2.13	6.24	11.85	29.06	2.70	2.88	1.67	10.34
The Gimar method									
2008	0.9937	14.46	33	6.8	0.3	3.29	3.8	860	2.7
2009	0.9951	14.54	32	6.6	0.28	3.31	3.7	830	3.1
2010	0.9945	13.9	29.5	5.55	0.41	3.4	3.62	840	2.7
x	0.9944	14.30	31.5	6.32	0.33	3.33	3.71	843	2.83
CV%	0.07	2.44	5.72	10.63	21.21	1.76	2.43	1.81	8.15

x – averaga velue, CV % - coeficient of variation

Table 3. Sensory characteristics of tested wines (2008-2010)

Vinification	2008	2009	2010	Average
K	17.4	17	17.5	17.3
S	17.7	17.7	18.3	17.9
Ga	17.7	17.9	18.6	18.1
G	/	18.0	18.4	18.2

However, since during the first year of research, processing in the Gimar fermentation tanks was not performed and having observed the last two years of the research when all the methods of vinification were present, a higher average score was obtained by the wines produced using the Ganimede (18.3) than using the Gimar method (18.2). There is a small difference in sensory evaluation, which is not to statistical significance.

Conclusions

Based on the results obtained during the three-year research, it can be concluded that:

The vinification method did not affect significantly the chemical composition of the tested wines, i.e., all the wines are of approximately the same chemical composition.

On the basis of the average sensory scores it can be noted that there is a significant influence of modern winemaking methods on the sensory properties of a wine compared to the traditional method (control wines). The wines produced by modern vinification methods have better sensory properties, better tannin structures necessary for high quality, more harmonious wines with the potential for medium and longer storage. The wines produced by the Ganimede and Gimar mehod due to its good structure have the potential for long-term maturation and high quality. With a proper selection of the vinification method a positive impact on the extraction of components from grapes is achieved, that is, from must into wine, as well as the possibility to control the maceration process, and to manage this process means to get the desired type of wine and the maximum quality out of the raw material at disposal.

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ВЛИЈАНИЕ НА МЕТОДОТ НА ВИНИФИКАЦИЈА ВРЗ ХЕМИСКИОТ СОСТАВ И СЕНЗОРНИ КАРАКТЕРИСТИКИ НА ВИНОТО ОД СОРТАТА ВРАНЕЦ

Данијела Раичевиќ, Звонимир Божиновиќ, Михаил Петков, Биљана Кнежевиќ, Весна Коџуловиќ, Сања Сучур, Весна Мараш

Апстракт
Целта на испитувањето беше да влијанието на методот на винификација врз хемискиот состав и сензорните карактеристики на црвеното вино од сортата Вранец. За добивање на овие резултати експериментален апарат за микровинификација беше оспособен во компанијата "13. jul Plantaze" во Подгорица. Грозјето е добиено од лозовите насади во Чемовско поле кое припаѓа на подреонот Подгорица. Испитувани се 4 начини на процесирање, со Sifa, Ganymede и Gimar ферментациони цистерни и класичниот традиционален метод. Добиените резултати покажуваат дека винификациониот метод нема значајно влијание врз хемискиот состав на виното но евидентно е влијнаието врз сензорните карактеристики. Највисоки оценки се добиени кај варијантите со добиени со методот на Ganymede поради добрата структура и потенцијалот за долго созревање и високиот квалитет.
Клучни зборови: Вранец, хемиски состав, сензорни карактеристики, Сифа, Ганимеде, Џимар.

UDC:663.531:634.21 (497.16)
Original scientific paper

THE EFFECT OF THE LENGTH OF MACERATION ON THE PHENOLIC CONTENT IN WINE VRANAC IN PODGORICA SUBREGION

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Abstract
This paper presents the results which have been obtained by examining the effect of the duration of maceration on the phenolic content in wine Vranac in Podgorica subregion. The study was carried out in 2005 by vinifying grapes of the Vranac variety for 14 days. During the maceration, the content of anthocyanins, total phenolic compounds, catechins, as well as the intensity and hue of the colour were monitored daily. Using an OIV descriptor, a sensory evaluation was performed for the wines which were produced after 7 and 14 days of maceration. The analysis of the phenolic content was carried out by means of spectrophotometric methods. The results showed that the length of maceration had influence to the content of all phenolic compounds especially catechins in wines. The content of anthocyanins had rapidly grown since the first day, reaching a maximum on day seven and slightly decreasing with the passage of time. The content of total polyphenols and catechins recorded an upward trend from the first to the last day of maceration. The sensory evaluation rated the wines as premium quality. On the basis of the obtained results, we have concluded that the duration of maceration must be adapted to the type and style of the wine we want to produce. If we want fresh, fruity and aromatic wine, a shorter maceration of up to 7 days is needed. For wines that are to be aged for a longer period of time, requiring a stronger tannic structure, a longer maceration of 14 days is necessary. The degree of grape maturity and the maceration conditions could have a decisive role in this regard.
Key words: length of maceration, the wine Vranac and phenolic compounds.

Introduction

The maceration is an essential stage for transferring phenolic compounds from grape into wine. These compounds play a very important role in achiving wine quality - sensory properties, in particular color and astringency. They have influence in wine stability and aging. The initial color of red wine is mainly due to anthocyanins extracted from the skins, whereas their astringency and bitterness are largely due to flavan-3-ols (catechin and proanthocyanidins) extracted from solid parts of grape (skins and seeds). During maceration, the release of phenolic compounds from solid parts of grapes depends on various factors, including grape varieties, maceration time, cap punching programme, temperature, alcohol content, $S0_2$ level (Dallas and Laureano, 1994).

It was found that under normal red winemaking conditions, the color intensity and total anthocyanin content increased significantly at early stage of maceration, reached in few days their maximum and then decreased during the latter stage (Scudamore-Smith et al., 1990). Concerning total phenolics, similar profile was observed at early stage of maceration, nevertheless the content of total phenolics went on increasing until the end of fermentation (Watson et al., 1994, Sprangler et al., 2000, Gomez-Plaza et al., 2000). However, the effects of extended maceration on total and polymeric phenol concentration in wines were considerably differents among cultivars (Mazza et al., 1999).

To high level of tanins (condensed proanthocyanidins) may contribute to excessive astringency and bitternes. Therefore, the optimal length of maceration should be matched with desired style of wine. If we want to produce lighter, fruity wine it is preferable shorter maceration, while producing wine taninic style, suitable for longer storage, requires a longer period of maceration (Schmidt and Noble, 1990). Grape variety Vranac has a high content of coloring compounds – anhtocyanins (Pajovic et al., 2009). It is noted that this variety easily released coloring compounds mostly in the first days of maceration. However, the process of extracting polyphenolic substances during maceration for this variety is not well examined. The aim of this paper is to determinate dynamics of transfer polyphenolic substances from the solid parts of the grape of the wine during maceration, for a period of 14 days. We also determinated optimal length maceration for wine Vranac.

Material and methods

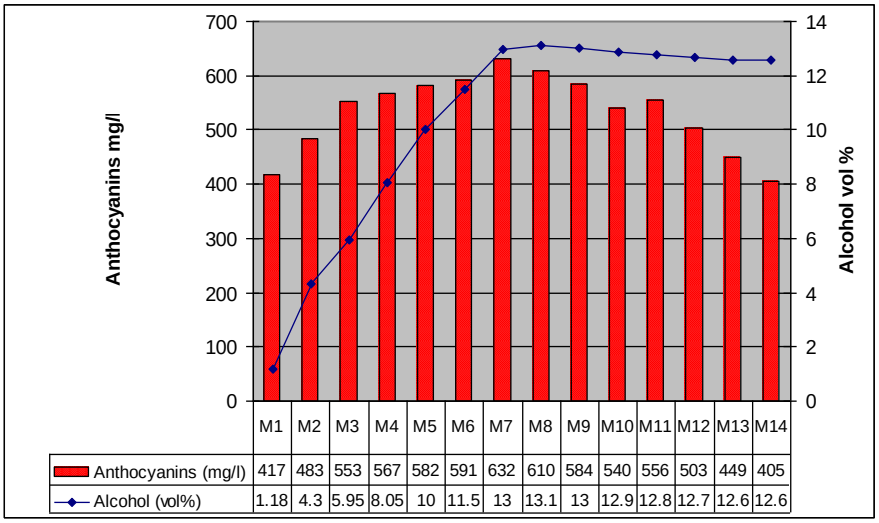
Experiment was carried out at the winery of Biotechnical faculty during vintage 2005. Grape variety was harvested in the period of technological maturity from experimental vineyard of Biotechnical Faculty, which is located on the Podgorica - Lješkopolje within the Podgorica subregion.

Procedure of wine preparation was done with following procedures: crushing grape, sulphuring, addition of yeast, vinification. Experiment was conducted in three groups (2 types of vinification 7 and 14 days). During the maceration, the content of anthocyanins, total phenolic compounds, catechins, as well as the intensity and hue of the colour were monitored daily. After that period the wines were racked without pressing. One month later the wine were racked again. After the spontaneous malolactic fermentation has occurred, the wines were racked again and sulphur dioxid was added. The wines for each length of maceration (7 and 14 days) were sensory evaluated four months after finishing fermentation using an OIV descriptor (OIV, 2009). Phenolic substances were analyzed using spectrophotometric methods with a spectrophotometer Jenwey 6405. Total phenols were analyzed by the Folin-Ciocalteu method (Singleton et al., 1999), with gallic acid standard, and results were expressed as gallic acid equivalent (GAE). Chromatic characteristics of wine were determined by measuring absorbance at 420, 520, 620 nm in a 1 mm cell in regard to double distilled water (Glories, 1984). Total anthocyanins were determined by spectrophotometry at 520 nm (Ough, 1984). Total flavan-3-ols content was analyzed by the vanillic method (Revilla et al., 1990) by use of (+)-catechin as a standard. In this paper we present the average results of three measurements of phenolic compounds.

Results and discussion

Dinamic of extraction phenolic compound in wine Vranac for 14 day of maceration

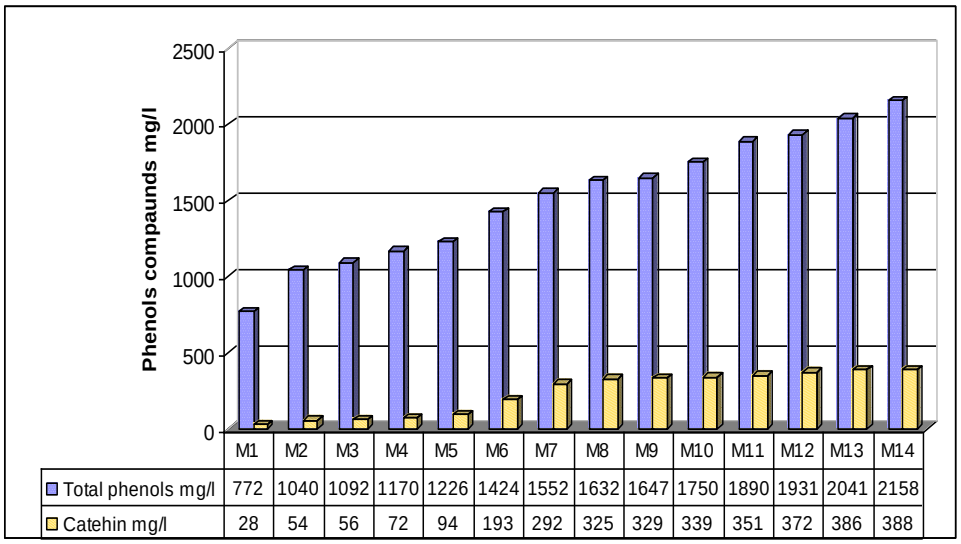
The knowledge about evolution of phenolic compounds in red wines during fermentation may help in determining the ideal wine-making process to control wine phenolic composition or to produce the wine style expected. The evolution of extraction anthocyanins, total phenols and catechins in wine Vranac during maceration for 14 days is presented in graphs in Figure 1 and Figure 2.



	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14
Anthocyanins (mg/l)	417	483	553	567	582	591	632	610	584	540	556	503	449	405
Alcohol (vol%)	1.18	4.3	5.95	8.05	10	11.5	13	13.1	13	12.9	12.8	12.7	12.6	12.6

Figure 1. Content of anthocyanins (malvidin mg/l) and alcohol (vol %) during 14 days of maceration

As shown in graph, Figure 1, a great content of the anthocyanins was found already on the first day and the most intense extraction of the anthocyanins occurred during the first three days of the maceration. The alcohol contents in the wine during these three days ranged from 1,18 to 5,9 vol%. That is the alcohol contents in the wine during which the maximum extraction of the anthocyanins has been made (Mazza et al., 1999). During next four days of the maceration, a considerably slower growth of the anthocyanin contents was expressed, until the maximum contents of the anthocyanins was reached on the seventh day. The obtained results correspond to the results of the authors Scudamore-Smith et al. (1990) and Sprangler et al. (2000) who stated that maximum contents of the anthocyanins was reached in the period from the 4th-6th day. Later reaching of the maximum extraction of the anthocyanins in our experiment (only one day) may be explained by a lower temperature of the maceration during fermentation.

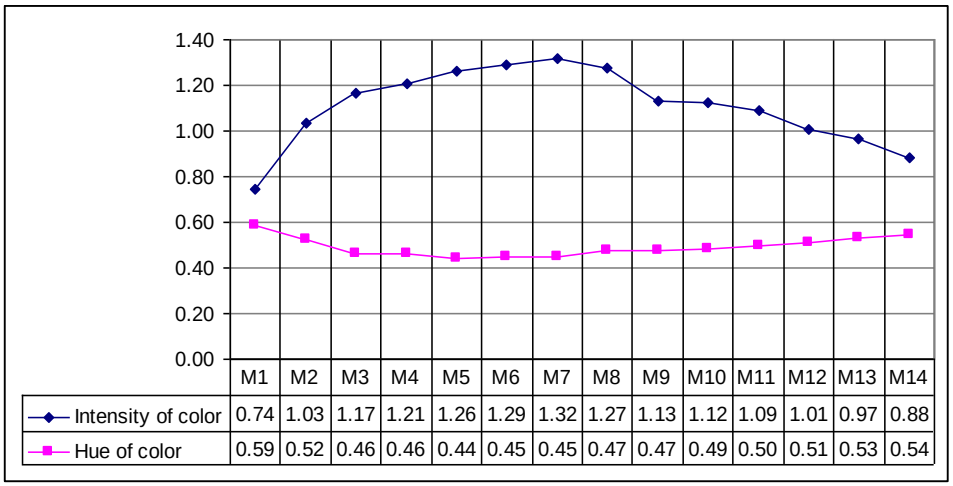


	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14
Total phenols mg/l	772	1040	1092	1170	1226	1424	1552	1632	1647	1750	1890	1931	2041	2158
Catehin mg/l	28	54	56	72	94	193	292	325	329	339	351	372	386	388

Figure 2. Content of total phenols and catechins in wine during 14 days of maceration

As shown in Figure 2, the contents of the total polyphenols increased successively with the increase of the length of the maceration. On the first day of the maceration, the contents of the total polyphenols amounted to 772, and on the last, i.e. on the fourteenth day 2158 mg/l. Such results correspond to the research of Gracin et al., (2000) who proved that with the prolonged contact of wine with the pomace, the contents of the total polyphenols and tannins has been increased.

The contents of the catechins in the wine increased with the prolongation of the length of maceration. A slower increase was expressed from the first to the fifth day of maceration and then, it was more intense from the sixth to the eighth day. After that, the increase in the contents of the catechins was slow and successive with the maximum, reached on the 14th day of maceration. The obtained results related to the increasing values of the total polyphenols and catechins (potential procyanidins) correspond to the results of Gomez-Plaza et al. (2000) who stated that the examined phenolic components had greater concentration in wine after 10 days of maceration and that prolonged maceration time increased the contents of the catechins and proanthocyanids in the wine. The review of the intensity and hues of the wine colour, kept on the pomace for 14 days, is shown in Fig. 3.



	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14
Intensity of color	0.74	1.03	1.17	1.21	1.26	1.29	1.32	1.27	1.13	1.12	1.09	1.01	0.97	0.88
Hue of color	0.59	0.52	0.46	0.46	0.44	0.45	0.45	0.47	0.47	0.49	0.50	0.51	0.53	0.54

Figure 3. Intensity and hue of color during 14 days of maceration

The graph in Fig 3, shows the increase in the colour intensity by the seventh day of maceration and later it decreased which was in accordance with the range of the contents of the anthocyanins in the wine. Hue values moved in the opposite direction to color density. The results of our research corresponded to the research of Yokatsuka et al., (1999) who proved, by monitoring the parameters of the pigment absorbance at 420 and 520 nm and colour intensity, that these parameters grow with the length of maceration, reach the maximum on the fourth or eighth day and then, decrease.

Phenolic composition of examined wine during maceration

During the maceration, phenolic components from the grape skin pass into the wine. The length of maceration is the factor which influences considerably on the dynamics of the transition of the phenolic components. The shorter maceration the greater concentration of the anthocyanins, but they are then, less stable and they sediment more easily. Longer contact of the wine with the pomace leads to greater polymerization of the pigments and better stability of the colour in later stages of wine keeping, which always depends on the grape variety (Mazza et al., 1999). In the table 1, the review of the polyphenolic composition of the researched wines Vranac, by maceration days, is given.

As we consider the polyphenolic composition of wine in the table 1, we may conclude that length of maceration has affected the content of catechin in wine where the coefficient of variation was 61%. The contents of anthocyanins and phenolics were also changing under the influence of the length of maceration, but lower (13 and 27%).

Polyphenolic composition of wine in all of the samples and particularly in the wine on the seventh day of maceration was very favorable. Thus, the anthocyanins reached the maximum, the contents of total phenols and catechin is very high. After the seventh day, also, the examined wines had a very high content of anthocyanins and very high contents of the total polyphenols which had a considerable impact on the colour stability. In the wines from the eighth to the fourteenth day of maceration, there is also, a high content of the catechins, which is according to Kovač (1992) a positive characteristic for the colour

stability which has a positive effect on the sensory properties of wine. The data on the polyphenolic composition of wine correspond to the results of Pajović et al., (2001), obtained during the research of the length of maceration of the wine, made of the variety Vranac.

Table 1. Phenolic content of wine during maceration long 14 days

	Alcohol vol%	Anthocyanins mg/l	Total polyphenols mg/l	Catchins mg/l	Intensity of color	Hue of color
M_1	1.2	417	772	28	0.74	0.59
M_2	4.3	483	1040	54	1.03	0.52
M_3	6.0	553	1092	56	1.17	0.46
M_4	8.1	567	1170	72	1.21	0.46
M_5	10.0	582	1226	94	1.26	0.44
M_6	11.5	591	1424	193	1.29	0.45
M_7	13.0	632	1552	292	1.32	0.45
M_8	13.1	610	1632	325	1.27	0.47
M_9	13.0	584	1647	329	1.13	0.47
M_{10}	12.9	540	1750	339	1.12	0.49
M_{11}	12.8	556	1890	351	1.09	0.50
M_{12}	12.7	503	1931	372	1.01	0.51
M_{13}	12.6	449	2041	386	0.97	0.53
M_{14}	12.6	405	2158	388	0.88	0.54
CV	38	13	27	61	15	9

CV- Coefficient of variation (%)

The analysis of the sensory properties of the obtained wines were also performed. The wines were described by OIV Descriptor (OIV, 2009). *Wine* M_7 (macerated 7 days) is limpid, intense red colour, open, medium aromatic, luxurious aroma with predominant fruit aroma, with pronounced blackberry aroma. On palate it is rich with good structure, balanced, very harmonious and with good aging potential. *Wine* M_{14} (maceration 14 days) was very limpid with intense red colour, it has open aromatic complexity with the spectrum of odours of generally ripe fruit aroma. The taste is intense, fine structure, long and pleasant.

Conclusions

The results showed that the length of maceration had influence to the content of all phenolic compounds especially catechins in wines. The content of anthocyanins had rapidly grown since the first day, reaching a maximum on day seven and slightly decreasing with the passage of time. The content of total polyphenols and catechins recorded an upward trend from the first to the last day of maceration. The color intensity grew up to the seventh day, declining slightly afterwards. The sensory evaluation rated the wines as very good.

On the basis of the obtained results, we have concluded that the duration of maceration must be matched with type and style of the wine we want to produce. If we want fresh, fruity and

less tanninc type of wine, a shorter maceration of up to 7 days is needed. For wines that are to be aged for a longer period of time, requiring a stronger tannic structure, a longer maceration of 14 days is necessary. Both produced types of wine Vranac (M7 and M14) were the premium red wines with sensory differences that make them specific.

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ЕФЕКТ НА ДОЛЖИНАТА НА МАЦЕРАЦИЈА ВРЗ СОДРЖИНАТА НА ФЕНОЛНИ МАТЕРИИ ВО ВИНОТО ВРАНЕЦ ВО ПОДРЕОНОТ ПОДГОРИЦА

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Апстракт
Во овој труд се презентирани резултатите кои се добиени со проучување на ефектот на должина на мацерацијата врз содржината на феноли во виното вранец во подреонот Подгорица. Испитувањето е изведено во 2005 година со винификација на сортата вранец во должина од 14 дена. За време на мацерацијата, секој вршени се анализи на антоцијаните, тоталните феноли, кетехини и интензитет на боја. Со дескрипторот на ОИВ извршена е сензорна анализа на вино добиено после 7 дена и после 14 дена мацерација. Содржината на фенолните материи се анализирани со спектрофотометар. Резултатите покажуваат зависност на содржината на фенолните материи од должината на мацерација, посебно врз содржината на катехините, антоцијаните рапидно се зголемуваат од првиот до седмиот ден а потоа благо опаѓаат со текот на времето. Вкупните полифеоноли и катехините покажуваат постојан пораст од првиот до последниот ден на мацерација. Должината на мацерација влијае на квалитетот на виното, за добивање на свежи, овошни вина, потребна е кратка мацерација до 7 дена, додека за вина предвидени за созревање, за кои се бара поголема количина на танински материи потребна е долга мацерација од 14 дена. Степенот на зрелост на грозјето и условите на мацерација би можеле да влијаат пресудно во оваа смисла.
Клучни зборови: должина на мацерација, вино вранец, фенолни материи.

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THE INFLUENCE OF pH ON COLOUR PARAMETERS OF RED WINE MERLOT AND PINOT NOIR

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Abstract
Results of pH influence (2.80, 3.20 and 3.80) on colour characteristics of red wine Merlot and Pinot Noir (after fermentation, and after 12 month period aging in a bottle) are shown in this paper. The colour intensity decreased and the hue increased along with the increase of pH value. The share of the red component in colour intensity was decreasing along with increase of pH of the wine, while the share of blue and yellow components increased, in the case of blue component with lower intensity. After a 12 month aging period in a bottle, the share of yellow colour increased in intensity in all investigation variants, but considerably more with higher pH values. With the increase of pH wine value, the ionisation anthocyanin content decreased, while the colourless anthocyanin content increased, because of witch the colour of wine became „brighter", especially after 12 month aging period in the Pinot Noir wine.
Key words: red wine, Merlot, Pinot Noir, colour parameters, pH.

Introduction

Phenol compounds and the products of their reaction with other compounds affect the sensory characteristics of wine. Anthocyanins are simple compounds that give wine its red color, whose intensity, hue and durability depend on the type and quantity of anthocyanins, but also on other phenolic compounds which are transferred from grapes to wine. The color manifested in the solution of anthocyanins is the manifestation of the pH value of the medium. In an acid medium, the anthocyanins are red, in a neutral or alkaline ones they are blue, and in the intensively alkaline medium they are yellow. The change of color takes place because in various media, the molecule structures are modified. The maximum intensity of red colour is encountered in very acid medium where pH value is lower than 3 and it is a result of the presence of double flavylium cations, whereas at pH value slightly higher than 3 (as in most wines) the red color becomes less intensive, since there emerge a lot of anthocyanin molecules called pseudo basa which are colorless as they lack certain double bonds and they are in equilibrium with red forms (Buccelli et al. 1991). As the pH value increases, this balance, shifts to the colorless carbinol pseudo base, which is related to the decrease in color intensity (Dallas and Laureano,1994).

The research of Sims and Morris (1984) showed that pH has a significant influence on the wine color. When pH value increases from 3.0 to 4.0 the content of colorless pseudo base

increases in respect to the red carbonium ion. If pH is near neutral reaction, the blue base of anthocyanin becomes dominant. Higher pH results in an increase of brown color, reduction of red color during nine months of wine storage. According to Ribereau-Gayon et al. (1998) in an acid medium, a certain equilibrium between the red form of flavylium and colorless products is established. The balance status depends on pH value. In the experiment with the model solution the colour of anthocyanins was 36 units on pH=1,6 and 1 unit on pH=3,9. The aim of this paper is to examine the influence of three pH values on colour parameters of Merlot and Pinot Noir during the period of their storage.

Material and methods

Vinifications has been carried out using the usual methods under laboratory conditions in Centre for Viticulture and Winemaking in Nis, Serbia. The grapes were crushed with a laboratory crusher, the stems was removed, the pomace was placed in 5-litre glass recipients, followed by addition of sulphur dioxide (10g/hl) in the form of potassium metabisulphite. After 6 hours, 2% of basic culture of wine yeasts (*Saccharomyces cerevisiae,* MO), was inoculated into the fermentation recipients. The fermentation was performed under the temperature of 25 to 28˚C. The cap was punched down twice a day. After 15 days, the wine was pressed. After that, the wine was kept at the temperature between 15 and 18˚C. The procedure and treatment was as follows: three pH values and two wine storage periods. The starting pH was 3,20 (B variant). Lower pH value (A variant) was obtained by adding 10% HCl solution to the wine, and the higher pH value (C variant) by adding $CaCO_3$ ($CaCO_3$ affects on titratable acidity and increases pH by the precipitation tartarates and somewhat less malates). $CaCO_3$ was added to the wine and left to settle down for seven days. The wine was analysed immediately after being treated, then again after six months, and once again after one year. The following analyses were performed: antocyanins at wine pH, after adding the rest of the SO_2, and at pH=1, polymers, as well as the Somers and Evans (1977) "chemical age" index, colour intensity as the sum of absorbencies at 420, 520 and 620 nm, then the share of yellow, red and blue colour in the intensity, as well as the Glories (1984) spectrum shape, Sudraud (1958) hue, and the real acidity (pH) was determined with the pH-meter, which is standardised up to pH 4,00 and 7,00 with buffer solutions.

Results and discussion

The values of colour intensity, hue, share of colours and dA% on different pH values are presented in Table 1. The biggest value for colour intensity was for investigation variant on pH=2,80 (0,756) in the case of Merlot wine and 0,546 in Pinot Noir wine, and the lowest value for colour intensity was 0,555 (Merlot), and 0,422 (Pinot Noir) on pH=3,80. Hue of the colour increased along with increasing of pH values from 0,403 to 0,558 in Merlot wine, and from 0,416 to 0,640 in Pinot Noir wine.

The share of red component in the colour intensity decreased with the increasing of pH value of the wine in both cases, while the share of yellow component increased. High pH value increased the share of blue component in colour intensity. This indicates that the blue form of anhydro base appears on higher pH values.

Values for spectral shape (dA%) decreased with increasing of pH values of the wine (with increasing share of yellow and blue colour and decreasing of red colour) from 75,0% (Merlot) and 73,9% (Pinot Noir) respectively on pH=2,80 to 65,7% (Merlot) and 57,5% (Pinot Noir) respectively on pH=3,80.

Table 1. Investigation results of pH influence on the colour of red wine (instantly after treatment)

Parameter	Variant					
	A (pH = 2,80)		B (pH = 3,20)		C (pH = 3,80)	
	Merlot	Pinot Noir	Merlot	Pinot Noir	Merlot	Pinot Noir
Colour intensity	0,756	0,546	0,685	0,502	0,550	0,422
Hue	0,403	0,406	0,449	0.527	0,558	0,640
A_{420}%	26,9	27,3	28,9	31,8	32,9	34,6
A_{520}%	66,7	65,7	64,2	60,3	58,9	54,0
A_{620}%	6,4	7,0	6,9	7,9	8,2	11,4
dA%	75,0	73,9	72,1	67,1	65,7	57,5

Table 2. Investigation results of pH influence on phenolic compounds in red wine (instantly after treatment)

Parameter	Variant					
	A (ph = 2,80)		B (ph = 3,20)		C (ph = 3,80)	
	Merlot	Pinot noir	Merlot	Pinot noir	Merlot	Pinot noir
Free antocyanins (mg/l)	455,0	230,0	452,8	228,6	450,0	229,6
Ionisation antocyanins(mg/l)	81,6	51,2	67,1	39,1	44,8	21,2
Colourless antocyanins (mg/l)	373,4	178,8	385,7	189,5	405,2	208,4
Polymers, mg/	19,2	20,8	19,5	21,5	20,0	21,2
„chemical age“ index	0,040	0,083	0,041	0,086	0,043	0.087

The influence of pH on content of free, ionisation and colorless anthocyanins, as well as Index of chemical age of wine are shown in Table 2. The content of total free anthocyanins didn't varies between investigation variants. The bigger variation were shown for ionisation and free anthocyanins. With the increase of pH value, the content of ionisation anthocyanins decreased, while the content of colourless anthocyanins increased, witch affected on decrease of colour intensity.

High pH leads to a brighter wine color (Table 3). This effect was there at the beginning of the test, but it was especially prominent after 12 months period of storage. This color reduction is both the result of the increase of dominance of colorless pseudo form of anthocyanins over the carbonium ion form and the result of the loss of free anthocyanins (Table 4 and Figure 1). Wine becomes brown during keeping, and in 12 months, the share of yellow color increases in all variants, but significantly more at higher pH values, as in the wine Pinot Noir.

Table 3. Investigation results of pH influence on colour of red wine (after period of 12 months)

Parameter	Variant					
	A		B		C	
	Merlot	Pinot noir	Merlot	Pinot noir	Merlot	Pinot noir
Colour intensity	0,620	0,466	0,549	0,396	0,410	0,303
Hue	0,446	0,582	0,508	0.736	0,626	0,963
A_{420}%	28,8	34,0	31,2	38,1	35,2	43,2
A_{520}%	64,5	58,4	61,4	53,3,3	56,3	45,0
A_{620}%	6,7	7,6	7,4	8,6	8,5	11,8
Da%	72,5	64,3	68,6	54,9	61,2	38,6

Age index is the way of describing the colour of the wine; greater chemical aging have the wines with lower values of monomeric anthocyanins, and higher concentration of polymers. After the fermentation, the wines had low values of this quotient, which started to rise as the wine started to age (Figure 3). The lowest value when the testing started had the variant with the lowest pH value, and the highest the variant with the highest pH value. After one year aging period of the wine, chemical age index increased, but the same trend persisted among the variants. Its value is affected by the variety. At the beginning, as well as at the end of the testing, the lowest value had variety Merlot, and the highest Pinot Noir.

Table 4. Investigation results of ph influence on phenolic compounds in red wine (after period of 12 months)

Parameter	Variant					
	A		B		C	
	Merlot	Pinot noir	Merlot	Pinot noir	Merlot	Pinot noir
Free antocyanins (mg/l)	309,5	153,6	260,1	122,8	206,4	90,4
Ionisation antocyanins (mg/l)	68,2	30,0	40,1	19,8	21,3	1,6
Colourless antocyanins (mg/l)	241,3	123,6	220,0	101,6	185,1	88,8
Polymers, mg/l	29,2	24,4	27,3	21,5	25,0	25,6
„chemical age“ index	0,086	0,137	0,095	0,147	0,108	0,221

The influence of pH on the share of polymers and ionisation antocyanins on the colour of Merlot and Pinot Noir wine after 12 month period are shown in Figure 2. Results presents that the increase of pH value lead to lower content of ionisation anthocyanins and bigger content of polymers in wine colour.

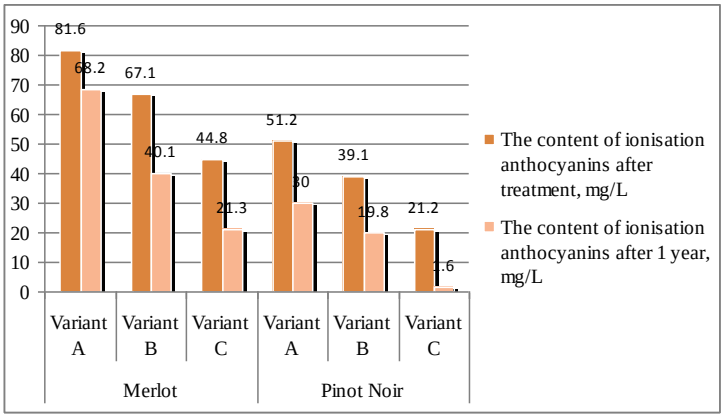


Figure 1. Influence of pH value on the content of ionisation anthocyanins in wines (Merlot and Pinot Noir)

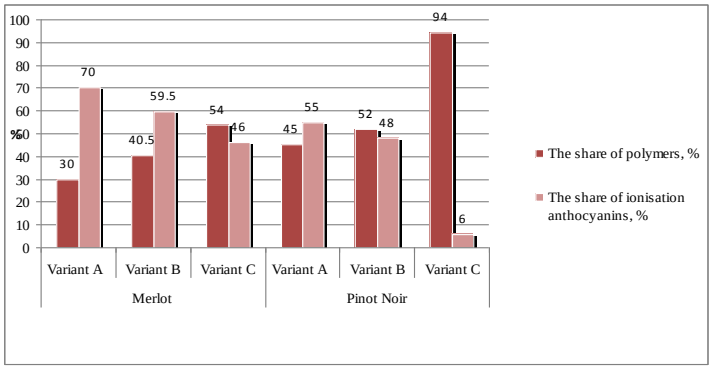


Figure 2. Influence of pH value on the share of polymers and content of ionisation anthocyanins in the colour of wines Merlot and Pinot Noir after 12 mounth period

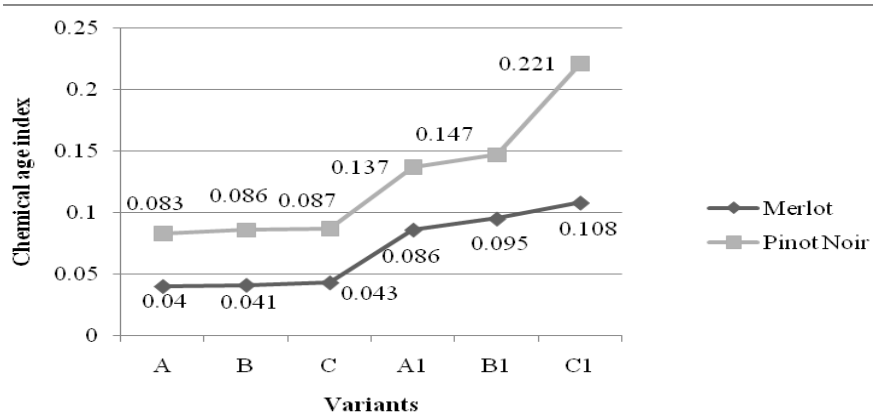


Figure 3. Influence of pH on „chemical age“ index of the wine on the beginning (A,B and C) and after investigation period of 12 month (A1, B1 and C1)

Conclusions

According to the results presented in this paper the following conclusions can be made:

- The content of ionisation anthocyanins decreased while the content of colourless anthocyanins increased with increase of pH value.
- High pH value lead to „brighter“ wine colour. This effect was detected from the beginning of investigation, but especially after 12 month period of wine aging. Reduction of colour was influenced by increase of colourless pseudo form anthocyanins under the carbonium form, as well as by the greater loss of total free anthocyanins.
- The share of the red component in colour intensity decreased with ageing of wine, while the share of blue and yellow components increased, in the case of yellow component with bigger intensity.
- Higher pH value of wine decrease the content of ionisation anthocyanins, and increase the content of colourless anthocyanins, because of witch the colour of wine became „brighter“, especially after 12 month aging period in the Pinot Noir wine.
- Spectrum (dA%) had sharp absorption maximum for wine with lower pH value, where the red colour is dominant, while in the case of higher pH values spectrum had stretched maximum, where yellow and blue colour are dominant.

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ВЛИЈАНИЕ НА pH ВРЗ ПОКАЗАТЕЛИТЕ ЗА БОЈА ВО ЦРВЕНИТЕ ВИНА НА МЕРЛО И ПИНО НОАР

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Апстракт

Резултатите од влијанието на pH (2.80, 3.20 и 3.80) врз показателите за боја на црвените вина од сортите мерлот и пино ноар (после ферментација и 12 месеци после зреење во шише се прикажани во овој труд. Интензитетот на боја се намалува а нијансата се зголемува со порастот на вредноста на pH. Учеството на црвените компоненти во интензитетот на бојата се намалува со зголемување на pH на виното, додека учеството на сината компонента и жолтата компонента се зголемуваат, во случајот со сината компонента со помал интензитет. После 12 месеци на созревање во шише, учеството на жолтата компонента се зголемува во интензитет кај сите испитувани варијанти но значајно при повисоки pH. Со зголемување на pH, содржината на јонизирани антоцијани се намалува, додека безбојните антоцијани се зголемуваат поради што бојата на виното станува по сјајна посебно кај виното Пино ноар после 12 месеци созревање.

Клучни зборови: црвено вино, Пино ноар, показатели за боја, pH.

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EFFECT OF REDISTILLATION CUTS ON QUALITY OF 'CRVENA RANKA' PLUM BRANDY

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Abstract
"Crvena ranka" (Red ranka) is among in the plum producing superior quality. The aim of this study was to determine the influence of the moment of separation and patoka fraction of the heart during the redistillation of the quality - the chemical composition and sensory characteristics of red plum rank. Different moments of separation medium fractions of fractions at patoka redistilling have influenced the plum brandy produced significant differences in the content of total acids, total esters, 1-hexanol, and other ingredients that exceed the allocations at the end of distillate fractions or medium at the beginning and during the extraction fraction patoka. There were no significant differences in sensory scores obtained plum.
Keywords: Plum, Red Ranka, redistillation, chemical composition, sensory characteristics.

Introduction

Ranka is a red old native plum brandy, is widespread in Serbia, especially in Šumadija (Misic, 1996). It belongs to the plum plum to produce high-quality (and Nikićević, Tešević, 2010). In order to unify the quality in the last decade have dramatically improved technological process of brandy made from this variety, especially in terms of primary production of plums and control of alcoholic fermentation (Nenadović-Mratinić et al., 2007). Traditional processing of this sort of brandy includes double distillation Alambic. During the first distillation (distillation of fermented plum mash) no separation of fractions, and the content of ethanol in the distillate obtained (raw soft plum brandy) ranges from 20 to 25% v / v, often up to 30% v / v. During the second distillation (crude redistillation soft plum brandy) are separated fractions firstborn heart and patoka, with only the middle fraction (heart) used to produce the final brandy. The traditional production of ethanol content in middle distillate fraction is about 50% v / v. Dynamics of the most important ingredients in the distillation process of redistillation traditional crude brandy soft red varieties rank studied by Radovanovic et al. (1963). In contemporary ways redistillation recommended earlier separation fractions of fractions of heart patoka, where the ethanol content in the medium fraction obtained more than 50% v / v and can range up to 65% v / v (Daničić Paunovic, 1967; Nikićević and Tešević , 2010). In the production of other renowned spirit drinks, fruit and grapes need to be at the right moment redistilling perform

separation of fractions of fractions patoka heart, in order to achieve the highest quality final strong alcoholic beverages (Leaute, 1990, Guan and Pieper, 1999; Malcata and Silva, 1999; Cortes et al., 2002; Nikićević and Tešević, 2010).

Given that some manufacturers still apply traditional redistillation, while others separate the medium fraction with ethanol content greater than 50%, even 60% v / v, the objective of this study was to determine the influence of the moment of separation and patoka fraction of the heart during redistillation of the quality - the chemical composition and sensory characteristics of red plum rank.

Material and methods

For this experiment we used raw soft brandy obtained directly from a commercial producer of Scotch. Crude soft brandy is produced by fermentation and distillation of pomace plum seeds of red rank on alambiku 100 liter, without separating factions. Ethanol content in raw soft brandy was 25.8% v / v. Its chemical composition is shown in Tables 1 and 2.

Redistillation soft raw brandy was carried out in the pilot batch distillation device made of copper - alambiku, volume 25 liter cauldron. The tank is heated by direct flame (gas burner). During all experimental redistillation separated fractions firstborn same amount (1% of the volume of crude soft plum brandy that is filled cauldron). Depending on the time of separation fraction of the heart and patoka medium fractions were obtained which contained 50.0%, 52.5%, 55.0%, 57.5%, 60.0% and 62.5% v / v ethanol. The content of ethanol in the distillate fractions obtained secondary deionized water was reduced to 45% v/v. For the analysis of the content of ethanol, higher alcohols, acids, esters, aldehydes, furfural, methanol, benzaldehyde and HCN in the middle fractions obtained by the redistillation, using standard methods prescribed by legislation Serbia (Official Gazette 70/87). Gas chromatographic analysis of the content of acetaldehyde, ethyl acetate, methanol, 1-propanol, 2-methyl-1-propanol, 1-butanol, and 2/3-metil-1-butanola 1-hexanol was used 4-methyl-1-pentanol as internal standard. Used a gas chromatograph HP 5890 chromatographic column and CHROMPACK CP-WAX 52 CB (capillary column, length 50 m, polyethylene glycol stationary phase, internal diameter 0.32 mm and film thickness 1.2 μm). Injector temperature was 233° C, was injected into 2 mL of sample in split mode (1:1). Temperature program: from 40° C to 222°C to 4.3°C / min and 20 min to 222°C. Carrier gas: hydrogen (H2) at a flow rate 1.2 ml / min. Detector: plamenojonizujući (FID), T = 300°C. Sensory analysis was conducted by an expert committee modified the method by Buxbaum-in.Statistical data analysis was performed using the Statistica 7 (StatSoft, Inc.., Tulsa, OK, USA).

Results and discussion

According to the legislation of Serbia and EU quality plum brandy is considered in terms of the effect of the individual components of the safety (methanol, HCN) and sensory characteristics (other volatile components) brandy. Tables 1 and 2 shows the chemical composition of the raw soft plum (containing ethanol 25.8% v / v) and medium fractions obtained by the redistillation of her (with an ethanol content of 50.0 to 62.5% v / v). Table 3 presents the results of the sensory analysis of final plum brandy containing ethanol 45.0%

v/v, which are obtained by reducing the ethanol content in produced high fractions of deionized water.

Table 1. The influence of the time of separation medium fractions (rate) fraction of patoka redistillation of the raw soft plum brandy (ethanol content of 25.8% v / v) on the chemical composition of the medium fractions – heart

ethanol content (% v/v)	(% V / v) Higher alcohols	(mg / L AA) Acids	(mg / L AA) Esters	(mg / L AA) Aldehydes	(mg / L AA) Furfural	(mg / L AA) Evaporative ingredients	(mg / L AA) Evaporative ingredients without acid	(mg / L AA) Methanol	(g / L AA) benzaldehyde	(mg / L AA) HCN
Crude soft plum										
25,8	2469	2842	1985	42	8	7346	4504	5,40	85	13,41
Intermediate fraction (heart) obtained by the redistillation										
50,0	2419	691	1496	33	8	4647	3956	4,83	85	3,88
52,5	2360	685	1492	31	8	4576	3891	4,83	84	3,87
55,0	2512	696	1353	33	8	4602	3906	4,83	84	3,84
57,5	2335	555	1306	29	7	4232	3677	4,96	84	2,88
60,0	2500	506	1292	31	8	4337	3831	4,12	83	3,36
62,5	2490	421	1328	44	8	4291	3870	4,96	85	2,88
CV (%)	5,82	16,05	5,47	19,81	5,67	4,06	2,50	6,28	0,75	18,53
r	0,42	- 0,94	- 0,86	0,50	0,20	- 0,85	- 0,46	- 0,23	0,01	- 0,83

Irrespective of the time of separation fraction of the heart and patoka, all middle distillate fractions, obtained during the redistillation, meet the requirements of the legislation of Serbia and the EU which state that the presence of methanol is up to 12 g / l AA, HCN content of up to 50 mg / l AA (Serbia), or 70 mg / l AA (EU), the content of benzaldehyde to 100 mg / l AA and volatile matter content of at least 2000 mg / l AA The content of volatile matter is the sum of the concentration of higher alcohols, acids, esters, aldehydes, and furfural.

The use of different modes redistillation we found that, compared with the raw soft brandies that are placed on a binding constraint, the obtained mean frakcijame to contain 76-85% less total acid, less than 25-35% of total esters and 5-37% less than 1 - hexanol. The dynamics of the distillation components investigated variants in the traditional way that suits redistillation (ethanol content in the heart was 50.0% v / v) is in agreement with the results obtained by examining the dynamics of distillation of these components get Radovanovic et al. (1963) and Nikićević Paunovic (1989).

By selecting different moments of separation and patoka heart were obtained by the redistillation of the middle fractions were differing by the content of those components that the distillate generally exceed appropriations at the end or middle fractions during the extraction fraction patoka. As we have emphasized, the greatest differences were observed

in the content of total acids, total ester and 1-hexanol. Therefore, the highest values are correlation coefficients between ethanol content and the contents of the above ingredients in the middle distillate fraction: the total acid ($r = -0.94$, $p = 0.006$), for a total esters ($r = -0.86$, $p = 0.028$) for 1-hexanol ($r = -0.99$, $p = 0.000$). Also, the highest values of coefficients of variation were found for total acid content (CV = 16.05%) and 1-hexanol (CV = 15.59%).

Table 2. The influence of the time of separation medium fractions (rate) fraction of patoka redistillation of the raw soft plum brandy (ethanol content of 25.8% v / v) the content of acetaldehyde, ethyl acetate, methanol and higher alcohols in some medium fraction - the heart

ethanol content (% v/v)	(% V / v) acetaldehyde	(mg / L AA) Ethyl acetate	(mg / L AA) Methanol	(g / L AA) 1-propanol	(mg / L AA) 2-methyl-1-propanol	(mg / L AA) 1-butanol	(mg / L AA) 2/3-metil-1-butanol	(mg / L AA) 1-hexanol	(mg / L AA) Total higher alcohols	(mg / L AA) Total higher alcohols - 1-propanol
Crude soft plum										
25,8	122	720	6,29	1857	773	123	1952	747	5452	3595
Intermediate fraction (heart) obtained by the redistillation										
50,0	71	364	5,69	1727	709	113	1822	713	5084	3357
52,5	77	380	5,99	1836	748	118	1923	699	5325	3489
55,0	73	364	5,83	1804	731	117	1885	638	5177	3372
57,5	76	372	5,64	1770	720	116	1854	593	5053	3283
60,0	84	388	5,56	1772	720	114	1850	528	4986	3214
62,5	81	386	5,35	1752	720	119	1852	473	4917	3168
CV (%)	6,44	2,84	3,86	2,17	1,81	2,06	1,89	15,59	2,85	3,55
r	0,82	0,70	- 0,78	- 0,14	- 0,16	0,39	- 0,15	- 0,99	- 0,73	- 0,85

Earlier fractions separating the heart from the fractions obtained Patoka medium fractions with lower total acid content, especially if the content of ethanol in the heart of greater than 55.0% v / v. This is understandable, given that Radovanovic et al. (1963) and Guan and Pieper (1999) emphasize that acetic acid, the acid as the most common brandy, exceeds the maximum distillate fractions during separation patoka. Similar behavior and have more fatty acids with 6-12 C atoms (hexanoic, octanoic, dodecanoic acid and decanal) and, to a lesser extent, present, fatty acids with 3-5 carbon atoms.

Content of total ester also decreases with increasing ethanol content in the medium fraction, especially if it contains more than 55.0% v / v. Given that contain significant amounts of plum and etillaktata dietilsukcinata (Crowell and Guymon, 1973, Popovic et al., 2009), which distils mostly at the end of the middle fractions and fractions at the beginning of patoka (Leaute, 1990, Guan and Pieper, 1999), before separation heart leads to a reduction

in the content of these ingredients, and thus a decrease in the total content of esters in the final brandy. The content of 1-hexanol decreased significantly with increasing ethanol content in the medium fraction obtained by the redistillation.

According to Cortes et al. (2002) this higher alcohol distilled mostly at the end of the extraction fraction of the heart and the beginning of the extraction fraction patoka. Higher alcohols from similar behavior in a distillation and 2-phenylethanol (Leaute, 1990, Guan and Pieper, 1999), which, unfortunately, is not included in the analysis of gas chromatographie.

No significant changes in the concentration of the other analyzed constituents in produced high fractions depending on how redistillation. It is primarily concerned with substances that pass into the distillate as the firstborn of impurities (acetaldehyde, ethyl acetate), or as an admixture to pass into the distillate mainly in fractions firstborn and heart (methanol, 1-propanol, 2-methyl-1-propanol, 1-butanol , 2-methyl-1-butanol, 3-methyl-1-butanol). This is evident by the very low values of the coefficient of variation (CV).

Table 3. The influence of the time of separation medium fractions (rate) fraction of patoka redistillation of the raw soft plum brandy (ethanol content of 25.8% v / v) on the sensory characteristics of the middle fractions - rate reduced to 45% v / v

ethanol content (% v/v)	(% V / v) Color	(0-1) The clarity	(0-1) typicality	(0-2) Odor	(0-6) The taste	(0-20) Total
	Crude soft plum					
25,8	1	1	2	5,43	8,40	17,83
	Intermediate fraction (heart) obtained by the redistillation reduced to 45% v / v					
50,0	1,00	1,00	2,00	5,50	8,53	18,03
52,5	1,00	1,00	2,00	5,53	8,47	18,00
55,0	1,00	1,00	2,00	5,45	8,47	17,92
57,5	1,00	1,00	2,00	5,43	8,47	17,90
60,0	1,00	1,00	2,00	5,45	8,45	17,90
62,5	1,00	1,00	2,00	5,43	8,52	17,95
CV (%)	0,00	0,00	0,00	0,75	0,38	0,30
r	-	-	-	- 0,80	- 0,18	- 0,71

Furfural can be considered a component that goes into most of the middle distillate fraction (Radovanovic et al., 1963), which explains the inability to reduce its content in relation to the initial soft brandy in the middle fractions obtained in the course of our experiments, in which the highest content of ethanol was 62.5% v / v. Leaute (1990) states that furfural is a partial fraction of the cross and if patoka start with separation much earlier, as is the case for the redistillation in the production of cognac, such that the average fraction of more than 62.5% v / v ethanol.

According Nikićević Paunovic (1989), benzaldehyde passes into the distillate distillation of all time, and using a simple redistillation can not reduce its content in the medium fraction obtained, compared to the initial soft brandy. Also, how can the redistillation influence its

content in the medium fractions obtained. HCN content is reduced in comparison to the initial soft brandy for 71 to 79%, solely due to the binding of copper parts of the distillation unit, with a moment of separation fractions of fractions of heart patoka no importance for the reduction of this compound in the middle fractions obtained by the redistillation. The approximate content of HCN in the middle fractions obtained indicating very uniform binding of this compound to the copper parts of the distillation unit. Different moments of separation fraction heart of the patoka redistillation of fraction did not significantly impact on the sensory evaluation of the final plum. Scope of smell score ranged from 5.43 to 5.53, for a taste of 8.45 to 8.53, and the sum of 17.90 to 18.03. Top rated plum were those produced from medium fractions containing ethanol 50.0% (from 18.03), 52.5% (from 18.00) and 62.5% v / v (from 17.95). Generally, the earlier the separation of fractions of fractions patoka heart with one hand can improve the sensory characteristics of the final brandy due to the reduction of acetic acid content and certain fatty acids. On the other hand, in this way reducing the content of components that contribute to the fullness of flavor, distinctive aroma and fruity plum (etillaktat and dietilsukcinat), freshness (1-hexanol) and smell the roses (2-phenylethanol). Cortes et al. (2002) point out that excessive elimination of certain components (such as 2-feniletanola, 1-hexanol, etc.). Premature separation of patoka during redistillation may lead to loss of structure and brandy adversely affect the flavor. Normally, these considerations make sense when you put on redestilaciju flawless soft brandy (brandy and soft without excessive production of acids and other ingredients that remain high even after redistillation and can negatively affect the sensory quality of the finished product).

Conclusions

Based on chemical analysis of secondary fractions obtained by various methods and sensory analysis redistillation final plum was found that the separation of momentum fractions of fractions patoka heart affects the appearance of differences in the content of individual components are important for the quality of Scotch. It is therefore essential that redistillation be conducted so as to maximize remove components that could adversely affect the health and sensory characteristics of the final value of brandy, and at the same time preserve the components of the optimal degree of importance for the fine aroma of top plum. This depends largely on the skill and knowledge and technology-destilatera, making the distillation of fruit brandy is both science and art.

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ЕФЕКТ ОД МОМЕНТОТ НА ИЗДВОЈУВАЊЕ НА ФРАКЦИИ СО РЕДЕСТИЛАЦИЈА ВРЗ КВАЛИТЕТОТ НА БРЕНДИ ОД СЛИВАТА ЦРВЕНА РАНКА

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Апстракт

Црвена ранка е меѓу сортите сливи кои даваат супериорен квалитет. Целта на ова испитување беше да се определи влијанието на моментот на оделување на фракцијата патока од срцето за време на дестилација врз квалитетот, хемиски состав и сензорни карактеристики. Различните моменти на одделување на фракцијата влијае значајно на разликите во составот на вкупните киселини, вкупни естри, 1-hexanol, и други состојки. Не е утврдена значајна разлика во сензорните карактеристики на ракиите од слива.

Клучни зборови: слива, Црвена Ранка, редестилација, хемиски состав, сензорни карактеристики.

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LANDSCAPE ECOLOGY IN THE WINE CENTER

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Abstract
The criteria on location of the wine celler on the north slope of Vrshats hill have been defined based on analysis of the natural conditions and the climate, the erosion of the slope and the pedological types. A vineyard complex along with a production wine cellar has been regulated.
Key words: climate, erosion, vineyard.

Introduction

Malo Sredishte is situated in the territory of Vrshats municipality, 7.5 km east from Vrshats and 10.7 km from the border on Romania. The Malo Sredishte brook basin drains the northern slopes of Vrshats bank (at an altitude 463 m) and Gudrichki top (at an altitude of 641 m). Three morphological units are distinguished on the terrain: hilly-mountaneous part at an altitude of over 200 m, a prolluvial – dilluvium fan at an altitude of 200 – 120 m and the third geomorphological unit is the alluvial plain of the Malo Sredishte brook and Mali Rt (small cape) as a local erosion base (Dimiskovska, 2012).

Material and methods

For the purpose of arrangement of the production-tourist centre, the climatic, geomorphological, geological and pedological conditions of the environment have been analyzed. The extent of erosion has been defined by the analytical method developed by S. Gavrilovic (Spalevic, 1997). The insight into all the natural characteristics of the area has enabled application of bioengineering as well as maximum utilization of the genetic potentials regarding wine and table types of grapes for the given agroclimatic region and ecological production of grape.

Results and discussion

The main elements of the basin that are important for the occurrence of land erosion are area F, length L, perimeter O and its shape. The basin has an area of F=5.17 km^2, length L=2.87 km and perimeter O=11.25 km. The parameters of the basin are: the lowest level of 120 m, the highest level of the brook of 300 m, the watershed level of 641 m, the average grade of the brook bed of 7.5%, the average height of the basin of 210 m, the average difference in height of 90 m, the average grade of the basement 15%, and the coefficient of average

erosion energy of the relief of 62 $mkm^{-1/2}$. In the upper part of the basin area, there are shales, different varieties of gneisses susceptible to physical-chemical disintegration and pronounced erosion. In the lower and the middle part of the basin, i.e., in the zone of the prolluvial-dilluvial fan, the valley of the brook is carved into neogene and quaternary sedimentary rocks undergoing intensive processes of ravining. These are slight to moderately water impermeable rocks which contribute to the non-resistance of the land against erosion (Sekularac et. al., 2008).

In the basin area, under the effect of pedogenetic factors, the following types of land are present: skeleton and skeletoid land on gneisses, loessized podzol soil on gneisses as well as clay soil and podzolized clay soil on neogene clays (Zivkovic at al., 1972).

The climatic elements contributing to the processes of land erosion are precipitations and temperature. For MS Vrshats, the period between 1966 – 2009 has been taken for analysis. The meteorological station covers the agroklimatic area of southeast Banat. The multiannual average precipitation amounts to 661,7 mm. The distribution of precipitation per seasnos is as follows: winter 127.2 mm, spring 177.7 mm, summer 228.4 mm, autumn 148.3 mm and 407.2 in the vegetation period. The primary annual maximum precipitation takes place in June with an average precipitation of 89.3 mm, which is higher than the Vojvodina average value for 7.5 mm. The primary minimum is expressed in this agroclimatic area only in March, with an amount of precipitation of 36.1 mm and is lower than the average value for Vojvidina for 0.1 mm. The relative variation of precipitation is R = 8%. The average annual temperature amounts to 11.6^{o}C. The average temperatures vary with the seasons: the maximum is always in July, with air temperature of 21.5^{o}C. In the analyzed period of 18 years, August is warmer than July for 0.3 – 4.8^{o}C on the average. The minimal monthly temperatures are observed in January, amounting to 0.4 ^{o}C (Stojiljkovic et al., 2011).

Based on analysis of the natural characteristics of the basin, measures against erosion have been proposed as follows: terracing of the terrain along with grassing trackways and placement of retaining walls constructed of gneisses from place to place, as well as placement of watteles and doubs in the area of terrain ravining. As to the flow itself, it is anticipated to strengthen and arrange the banks by stone lining and cascading of the brook bottom for the purpose of decelleration of the torrential flows. At the compound itself, a retention reservoir has been designed. At all parts of the terrain with skeletoid land and big inclination, bioengineering has been designed - the same as the measures against erosion.

Preliminary Solution of the Production-Tourist Compoun

The location of the production-tourist compound is in an area of orchards and vineyards. The lot is situated beteen 11 m and 146 m and covers the right and the left slope of Malo Sredishte brook. In the vicinity of the compound, there are the natural forests of the Vrshats mountains as a hunting potential, the vicinity of the town of Vrshats and the good connection with the road network. Functional zones have been distinguished with the preliminary solution Fig.1 as follows: 1. Representative zone, 2. Camping zone, 3. Protective zone, 4. Production and processing of grapes zone, 5. Recreation zone and 6. Economic zone.

1. Representative zone: it is situated in the highest part of the terrain. In this zone, the guests are accepted and the vehicles are parked. It is anticipated for holding manifestations,

meetings and cellebrations. Situated in this zone is the hunting house as a catering facility along with a restaurant at the ground floor and rooms for guests in the attic. In front of the hunting house, above the wine cellar is the summer terrace oriented to the south, with a line of sight over the small ridge of Vrshats. Beside the hunting house, there is a canopy for processing of wine and entrance into the cellar. The possibility of involving the guests in each part of the work related to the vineyard, through the harvesting of the grapes up to making wine gives an authenticity and charm to the entire compound. At the highest level of the lot, there is a gazebo with a capacity of up to 100 guests.

2. Camping zone: it is situated between the previous zone and the east boundary of the lot. This part of the compound is in a valley with a natural forest. In this part, there are seven camp houses consisting of a room, a small kitchen, a bathroom and a terrace. In this zone, there are retaining walls – dry walls constructed of gneiss with a height and width of 0,5 m designed as a counter erosion measure.

3. Protective zone: In this zone, the inclination of the terrain is the greatest, around 50%. Complete afforestation and placement of a gabion in three rows along the contours and then terracing of the terrain and construction of a retaining – decorative wall as a dry wall made of gneiss with a height and width of 0,5 m, is anticipated for this zone.

4. Production zone: the total area of 2,83ha covered with vineyards is divided into two units – the first on the rift and the second on the banks of the brook. Out of the total area, 1,05 ha is planned on the rift and 1,78 ha is planned on the banks. Planting is designed to be carried out along the contours along with terracing of the terrain and grassing between the vine rows (Kis, 2011). This measure is aimed at avoiding frequent cultivation of the land and disturbance of the land structure and enabling treatment of vineyards by machinery immediately after rain. Cultivation of grape vines is planned on lanes with acacia sticks and galvanized steel wires placed in four rows.

5. Recreation zone: this zone covers the central, i.e., the lowest part of the compound. Planned for this zone is construction of a dam and creation of a retention lake. The lake has three functions: to reduce the speed of flow of the Malo Sredishte brook and prevent erosion; to provide sufficient quantity of water for irrigation in the dry periods of the year and to serve for recreational purposes (bathing, paddling, fishing). The area covered by the lake is 2233 m2. Its has an average depth of about 2 m, a length of 150 m and an average width of 18 m. The capacity of the lake is between 4000 – 4500 m3 water.

6. Economic zone: it is located in the northeast, the highest part, along the boundary of the compound. It is mainly on podzolized clay soil. The justification of selecting this place is the low productivity of this type of land in the vicinity of the main road. Situated in this zone are economic structures where the stable for the horses, the storehouse, the shed for the pasturage and the shed for the mechanization are located. In front of the structures, there is an area for training horses which is in a good line of sight from the terrace of the hunting house.

Conclusions

The effects on the environment have been evaluated as follows: the measures for repair of the Malo Sredishte brook contribute to improvement of the environmental conditions and

does not pose any threat for the environment, while the structures, according to their contents and function, are to function safely and contribute to the reduction of the extent of erosion within the basin. The preliminary solution well fits in the space and does not disturb the neighbouring contents but contributes to the repair of the existing erosion processes and the landscape in the zone of the compound, improving the microclimate, as well.

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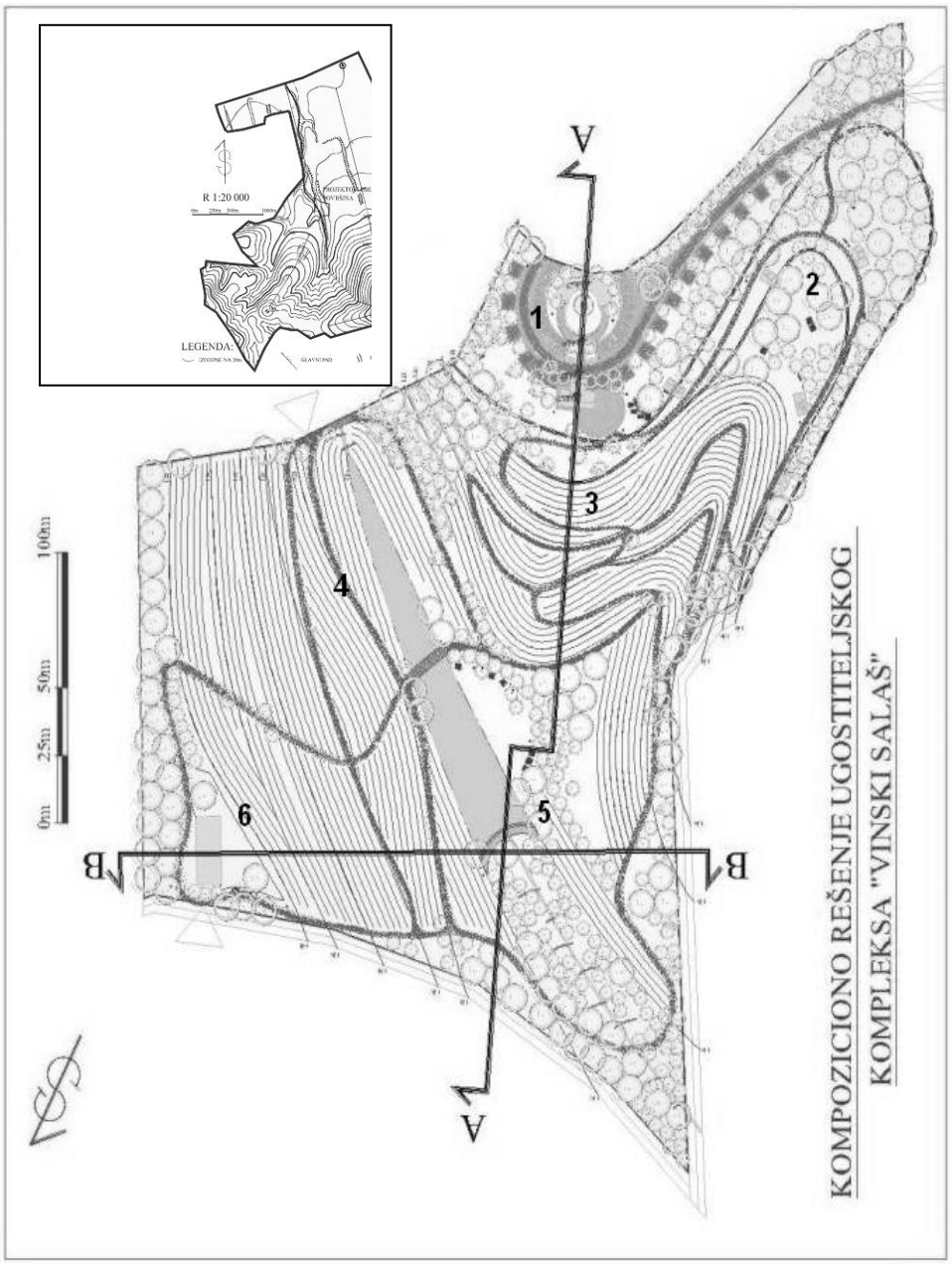


Figure. 1. Preliminary solution of „Vinski Salash“ compound with distinguished functional zones.

Legend: 1. Representative zone, 2. Camping zone, 3. Protective zone, 4. Production and processing of grapes zone, 5. Recreation zone, 6. Economic zone. COMPOSITION SOLUTION OF THE „VINSKI SALASH“CATERING COMPOUND

ЕКОЛОГИЈА НА ПЕЈСАЖОТ ВО ВИНСКИ ЦЕНТАР

Драгица Стоињковиќ, Тибор Кис, Бисерка Димишковска

Апстракт
Критериумите на локацијата на внарскито продрум на северната падина на ридот Вршац се дефинирани врз основа на анализа на природните услови и климата, ерозијата на наклонот и педолошките типови. Лоарскиот комплекс заедно со производството на винарската визба е предходно регулирано.
Клучни зборови: клима, ерозија, лозјето.

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ECONOMIC POTENTIALS OF WASTE PROCESSING OF GRAPES

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Abstract
The volume of the grape waste produced directly relates to the volume of grapes pressed and in turn depends on the specific climatic conditions of the relevant vintage. The grape waste in EU-27 during 2008 was estimated for a wine production of 159.3 Miohl (International Organization of Vine and Wine - OIV, 2010) in, approximately 1138 x 10^3 tons/year of grape stalk, 3186 x 10^3 tons/year of grape marc, 1365 x 10^3 tons/year of wine lees and 95 x 10^6 m3 of winery wastewater. Serbia constitutes one of the middle grape and wine producers, with a grape production during 2010 was 330 070 tonnes of which remains about 7 000 tons of grape by-products, which is only used for the production of alcohol, and most of ending up in landfills as organic waste (Statistical Serbian Office –RZS, 2012). Our results of analysis of grape by-products show high content of polyphenols reflecting their high antioxidant activity. The grape waste, constitute a very cheap source for the extraction of phenolic antioxidants, which can be an alternative source for obtaining nutritional antioxidants (dietary supplements), thus providing an important economic advantages.
Keywords: Grape waste, economic potential, nutritional antioxidants.

Introduction

According to the Food and Agriculture Organization (FAO), 75 866 square kilometers of the world are dedicated to grapes. Grapes are the world`s largest fruit crop with more than 60 million metric tons (67.5 x 106 tons during 2009) produced annually. Europe represents 44% of this worldwide production (International Organization of Vine and Wine - OIV, 2010). Approximately 71% of world grape production is used for wine, 27% as fresh fruit, and 2% as dried fruit (www.oiv.int).

The European Union (EU-27) has an important presence in the world wide market of wine, with approximately 49% of the vine growing area of the world and 60% of the wine production. The world production of the wine during 2008 was about 267.4 Miohl in the EU-27, about 159.3 Miohl, the Mediterranean countries (Italy, France and Spain) being the main producers. Spain constitutes one of the main wine producers, with the highest vineyard area of the world (1165 mha, equivalent to 15.1 % of the world total vineyard area) and with a wine production during 2008 of 35.9 Miohl (13.4% of the world wine production) (OIV, 2010).

However wine making leads to the generation of large quantities of waste (around 5-9 million tonnes per year, worldwide), which considerably increase the chemical oxygen

demand (COD) and the biochemical oxygen demand (BOD) due to a high pollution load (high content of organic substance such as sugars, tannins, polyphenols, polyalcohols, pectins and lipids) with detrimental effects on the flora and fauna of dischanged zones (Oreopoulou et al. 2007). According to the European Council Regulation (EC) No. 479/2008 on the common organization of the market in wine (EC, 2008), grape marc and wile lees are considered by-products and must be sent to alcohol distilleries to extract alcohol and tartarates, producing a solid waste, exhausted grape marc and a liquid waste, vinasse. Grape stalk is obtained after the esteeming process and contains the stems of the grape, while grape marc, obtained after the pressing process, consists of processed skins and seeds.

Wine lees are produced throughout the fermentation and clarification steps in the wine producing processed. On the other hand, the aerobic depuration of the winery effluents, vinasse and winery wastewater, generates another solid waste, winery sludge (Moure et al., 2001; Scola et al., 2010). The composition of grape waste varies considerably, depending on grape variety, vintage and technology of winemaking. Thus, the waste generation of the winery industry during 2008 was estimated for a wine production of 159.3 Miohl in, approximately 1138 x 10^3 tons/year of grape stalk, 3186 x 10^3 tons/year of grape marc, 1365 x 10^3 tons/year of wine lees and 95 x 10^6 m3 of winery wastewater (OIV, 2010). Serbia constitutes one of the middle grape and wine producers, with a grape production during 2010 was 330 070 tonnes of which remains about 7 000 tons of grape by-products, which is only used for the production of alcohol, and most of ending up in landfills as organic waste (Statistical Serbian Office –RZS, 2012, www.stat.gov.rs). Therefore, the treatment and disposal of winery waste must is a serious environmental problem and winery waste must find another use other than as animal feed or as fertilizers.

The problem of all these waste materials is their disposal and treatment due to their seasonal character (during September - November) and some characteristics which difficult their management. The cost of waste disposal and the penalties imposed on companies have therefore increased significantly, often reaching 30,000 – 40,000 Euros in EU. In recent years, the growing concern about the environment has led authorities to look for economically viable solutions for recycling and /or valorising grape waste.

The grape waste is characterized by high-phenol content because of poor extraction during winemaking, so that its use supports sustainable agricultural production. (Arvanitoyannis et al. 2006). Polyphenols that might protect against human diseases related to oxidative stress. The active ingredients contained in this value-added are proanthocyanidins (Da Silva et al. 1991). Recent studies in animals, as well as some human studies, have shown that grape proanthocyanidin possess a broad spectrum of biological, pharmacological and chemoprotective properties against free radicals and oxidative stress (Baydar et al. 2004; Gorduza et al. 2000; Kennedy 2008; Radovanović et al. 2010). Together with tannins and polyunsaturated fatty acids, these grape constituents display inhibitory activities against several experimental disease models, including cancer, heart failure and other disorders of oxidative stress. The aim of this work is to evaluate grape stalk as a sources antioxidant polyphenols for their possible use as food antioxidants. To this purpose antioxidant capacity and total polyphenolic content of four grape stalk samples of different grape varieties, grown in Serbia was investigated.

Material and methods

Chemicals and samples

All chemicals used for analysis were of analytical degree of purity from Merck (Darmstadt, Germany). There was used the following chemicals: 2,2`-diphenyl-1-picrylhydrazyl free radical (DPPH), methanol, ethanol, acetone, hydrochloric acid, trifluoroacetic acid (TFA), gallic acid. The used reagents were of analytical quality.

The grape stalk samples of four grape varieties: Vranac, Merlot, Gamay and Italic Riesling which was used for analysis, were grown at the vineyards of Serbia (vintage September, 2011). Samples were collected at physiological ripeness phase.

Preparation of grape stalk extracts

0.5 g of stalk was extracted with 10 ml of solvent mixtures (methanol /acetone/water/TFA). The samples were stirred for 30 min on a magnetic stirrer, and then centrifugated at room temperature (Tehnica LC-320, Železniki, Slovenia) at 4000 rpm for 10 min the supernatants from three extraction procedures.

Determination of total polyphenols

Total phenol contents in the grape stalk extracts were determined spectrophotometrically, as already reported (Mazza et al. 1999). After about 15 min, the absorbances (A) at 280 nm were recorded using an Agilent 8453 UV-visible spectrophotometer (Agilent Technologies, Santa Clara, CA, USA). Absorbance at 280 nm was used to estimate total phenols content, by using gallic as the standard compound.

Determination of antioxidant activity

Antioxidant activity of test grape stalk samples was determined by using free radical scavenging (DPPH) assay. This antioxidant assay is based on the measurement of DPPH· colour loss due to the changes in absorbance at 517 nm, caused by the reaction of DPPH· with the test sample. After 20 min at room temperature, $A_{517\ nm}$ was measured against the blank. The DPPH-scavenging activity of each wine sample was calculated from the decrease in absorbance according to the following relationship: Antioxidant activity (%) = [1 – (A_{sample} - A_{blank})/$A_{control}$] x 100, where: $A_{control}$ is the absorbance of control (8.0 x 10^{-5} M methanol solution of DPPH·), A_{blank} is the absorbance of diluted wine sample and A_{sample} is the absorbance of the diluted wine sample with the same concentration of DPPH-radical as in control. The radical scavenging activity (%) was plotted against the leaves extract concentration (mg g^{-1}) to determine the concentration of extract that reduces activity by 50% (EC_{50}).

Statistical analysis

Three analytical replicates were carried out on each grape sample. Measurements were averaged and results are given as mean ± standard deviation (SD). The standard deviation was calculated by ANOVA using the Minitab statistical package (Minitab Inc., State College, PA, USA).

Results and discussion

The phenolic composition in grape varies widely and is usually determined by several factors, such as: the variety of grape and conditions under which they was grown: soil,

geographical location, light exposure, temperature, sun exposure of the clusters and weather (Gil-Munoz et al. 2010; Mazza et al. 1999; Xu et al. 2011).

Also, the amount and types of phenol compounds present in a particular grape waste can vary and is greatly influenced by the extraction process, as well as the source, variety and storage of the used waste. Polyphenols in grape waste are mainly flavonoids, including the monomeric flavan-3-ols and procyanidin dimers, trimers and more highly polymerized procyanidins (Kennedy 2008; Lachman et al. 2009). The content of total polyphenols of four grape stalk extracts obtained from the international grape varieties: Merlot, Gamay and Italic Riesling, as well as the autochthonic grape variety Vranac has been determined by spectrophotometric assays.The antioxidant activity of the tested grape stalk extracts was estimated by their ability to scavenge the stable free radical, DPPH· method. The EC_{50} values used in this work, which reflect the equivalent concentration of antioxidant sample able to scavenge 50% of the DPPH-radical. It should be noted that as higher antioxidant activity of the sample is, the lower EC_{50} value is (Tab 1. and Figure 1).

Table 1. Content of total polyphenols of Vranac, Merlot, Gamay and Italic Riesling grape stalk samples, expressed as mg g^{-1} fresh weight and their antioxidant activity, expressed as EC50 (mg g^{-1} ± SD)

Variety of grape stalks	Total polyphenols (mg g^{-1})	Antioxidant activity (EC50)
Vranac	82.06 ± 0.45	1.92 ± 0.06
Merlot	58.18 ± 0.46	2.23 ± 0.08
Gamay	48.78 ± 0.23	2.31 ± 0.03
Italic Riesling	79.11 ± 0.61	1.95 ± 0.02

*p > 0.05

In the appropriate environmental conditions, these grape varieties have great economic importance because that their quality wines are very appreciated in the domestic and foreign markets.

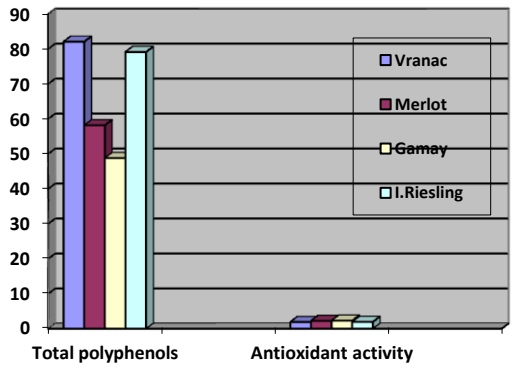


Figure 1.Content of total polyphenols of grape stalk samples, expressed as mg g^{-1} fresh weight and their antioxidant activity, expressed as EC50 (mg g^{-1} ± SD)

Investigated grape stalk extracts had antioxidant capacity which is in excellent correlation ($R^2 = 0.9946 \pm 0.0178$) with their total polyphenolic content (Figure 2):

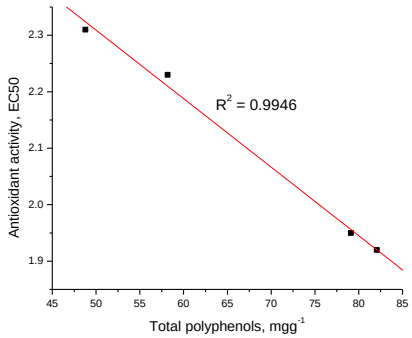


Figure 2. Correlation between content of total polyphenols and antioxidant activity of tested grape stalk samples ($p < 0.01$)

Conclusions

Based on results of this research we can conclude that investigated grape stalk samples have significant antioxidant activity, which is in excellent correlation with their total polyphenolic content. For this reason, extraction of polyphenols from grape waste has emerged as an opportune and vital business for the wine, food and pharmaceutical industry.

Acknowledgment

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ЕКОНОМСКИОТ ПОТЕНЦИЈАЛ НА ОТПАДОТ ОД ПРЕРАБОТКАТА НА ГРОЗЈЕТО

Владимир Радовановиќ, Снежана Џекиќ, Блага Радовановиќ

Апстракт
Волуменот на отпадот добиен во преработката на грозјето директоно е во релација со волуменот на пресуваното грозје зависи од специфиќните климатски услови на едно виногорје. Отпадот од грозје, во ЕУ-27 за време на 2008 е преоценет на 159.3 Miohl (International Organization of Vine and Wine - OIV, 2010) во, приближно 1138 x 10^3 ton/year од гроздинка, 3186 x 10^3 tons/year комиње, 1365 x 10^3 tons/year од вински талогоf 95 x 10^6 m3 искористена вода во винариите. Србија претставува среден производител на грозје и вино, со производство од 330 070 ton во 2010 година од кои остануваат околу 7 000 тони грозје за нуспроизводи, најмногу алкохол или како органско ѓубриво. (Statistical Serbian Office –RZS, 2012). Нашите резултати од анализите покажуваат висока содржина на полифеонеоли во нуспроизводите од грозје, тие претставуваат многу ефтина суровина од која со екстракција се добиваат антиоксиданти употребливи во исхраната на човекот.
Клучни зборови: отпадок од грозје, економски потенцијал, хранливи антиоксиданти.

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Original scientific paper

HERBONIZATION – METHOD FOR PRODUCING SPECIFIC WINES

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Abstract
Herbonizacion is a specific amphelotechnical method which allows production of wines with bigger content of alcohol, total acids, extract, polyphenols and aromatic compounds. The aim of the investigation was to produce wines with specific compound of chemical and polyphenol compound, and sensory properties. Research was done on varietes Vranec, Merlot and Cabernet sauvignon, grown in Tikves wine region. Wines were produced in winery Stobi Gradsko. By the results we conclude that the method herbozinization allows production of specific wines with bigger content of alcohol, total acids, extract and color compounds. Wines are characterized with emphasized fruit aroma.
Key words: herboniziation, polyphenolic compound, extract, aromatic metters, sensory characteristics.

Introduction

More wine regions are affirmed and developed the production of special and specific wines. The production of grapes and wine apply specific amphelotechnical measures and technological procedures. There are several methods that are used to increase the concentration of sugar in the must. In wine production, also apply technological methods for obtaining special or specific wines. Special or specific wines are characterized with a specific chemical composition and sensory properties. Based on the environmental conditions, varietes and equipment we applied an amphelotechnical measure called herbozinizacija. The purpose of the application was to provide raw material for the production of a specific wine. By applying herbozhinizacija started in 2004 in the "Bovin" - Negotino. Then in 2005 ”Winery Valandovo" produce wine "Alexander" which won several international awards. Due to the high quality of wine it comes into regular production program in "Winery Valanovo". In 2011 herbonization is applay in the winery "Stobi" from Vranec and Merlot. Herbozinizacija as a method to produce specific wines, allows bigger contents of sugar, acids, collor materials and flavors in the grapes. Wines obtained by applying herbozinizacija are characterized by increased alcohol content, total acid, extract, anthocyanins, and aromatic substances.

Object and method of operation

Herbozinizacion is applied in production vineyards of the "Crveni Bregovi" - Negotino and processed grapes and produced wine in the winery "Stobi" - Gradsko. The survey included Vranec and Merlot varieties grown on training system using double Guyot method of pruning. The vines were left with two arches with 8 buds and two parts with two buds.

During regular production applied agro-technical measures. At the time of technological maturity grapes contain 200-210 g/l sugar is made shorter bows with removal of the final two tendrils. They were left to hang on the supporting structure. After 10-12 days became drying of leaves and rying of grape on cutting branches. Dynamics of maturing was analyzing by the content of sugars in the standard grape production, and in the grape producing by herbozation with dynamics of sugars in the grapes from cutting bunches and remaining bunches. Determination of specific gravity and glucose in the must is done by Oechle and content of sugar in the must is calculated by using Saleronov form. The total acids were determined by potentiometric titration using an indicator bromtimolsino. Chemical analysis of the wine is made according to the methods of the Law on Wine (Official Gazette of RM br.69/2004). Total polyphenols were determined using FOLIN-CHIOCALTES method. The content of anthocyanins was determined by the method STONESTREET. The intensity of the hue of the color is determined by spectrophotometric measurement absorbence of 420 and 520 nm. Sensory properties of wine tasting and determined by applying positive twenty point system.

Results and discussion

The results of the chemical composition of the must Vranec are presented in Table 1, and the variety Merlot in Table 2. Based on the results, shown in Table 1 and Table 2 we can conclude herbozhinizacijata impact on the content of sugar and acid. The content of sugars is enhanced in terms of standard 4,1 - 4,2 g/dm^3 in potsushenoto herbozhinizirano grapes and the grapes for all herbozhiniziranoto 12-14 g/dm^3. The total acids in grapes dried-herbonizated increased compared to the standard of 0,75 to 0,91 g / l. The results of the chemical composition of wine is presented in Table 3. There are significant differences in the chemical composition of wines obtained by the standard method and the method of herbozinization. Wines derived ampelotechnical measure herbozinizacija contain more alcohol than 1,1 to 1,4 vol% of the standard and more total acids from 1,19 to 0,42 g / l. Wine produced by the method of herbozation contains more dry extract standard 3,4 - 4,0 g /l. Table 4 shows the figures for poliphenolic composition of wines obtained by standard methods and application of herbozinizacion. Based on the obtained results we found a significant influence on the herbozinization on poliphenolic composition of wines. Wines obtained herbozinizacion contain more total phenols from 519-881 mg/l standard of guilt. Wine Vranec obtained by herbozinizacion containing 895 mg/l anthocyanins, and standard 640 mg/l. The wine of Merlot variety have an anthocyanins content ranges from 417 mg/l in the standard, and 551 mg/l in wine made with herbozinizacion. Herbozinizacion has a positive impact on the hue and intensity of color. The results of the sensory properties of the tested wines are presented in Table 5. Based on the results obtained we concluded that herbozinizacion has a great influence on olfactory characteristics and taste qualities of wines. Wines obtained herbozinizacion are features with pronounced fruit flavors and tastes better qualities.Sensory total score obtained by the guilt herbozhinizacion is higher by 1.1 to 1.2 points by default fault.

Table 1. Chemical composition of the must Vranec

Standard	223	6,35
Herbonizated – total	234	6,30
Herbonizated - dried	265	7,10

Table 2. Chemical composition of grape must from grape Merlot

Variation	Total sugars g/l	Total acids g/l
Standard	221	5,61
Herbonizated – total	235	5,58
Herbonizated - dried	262	6,52

Table 3. Chemical composition of wine

Parameter	Vranec		Merlot	
	Standard	Herbonizated	Standard	Herbonizated
Alcohol vol %	13,2	14,6	13,3	14,4
Total acids g/l	5,95	6,14	5,12	5,54
Total extract g/l	32,3	38,5	32,8	36,5
Dry extract g/l	28,8	32,8	28,3	31,7

Table 4. Polipphenolic composition of wine

Parameter	Vranec		Merlot	
	Standard	Herbonizated	Standard	Herbonizated
Total phenols mg/l	1.653	2.534	1.488	1.907
Anthocyanins mg/l	640	895	417	551
Intensity	0,77	0,8	0,91	0,93
Hue	2,05	3,58	1,31	1,61

Table 5. Sensory properties of wine

Parameter	Vranec		Merlot	
	Standard	Herbonizated	Standard	Herbonizated
Color	2,0	2,0	1,8	2,0
Clarity	2,0	2,0	2,0	2,0
Smell	3,1	3,6	3,0	3,5
Taste	10,5	11,1	10,5	11,0
Total	17,6	18,7	17,3	18,5

Conclusions

Based on the results obtained can be drawn the following conclusions:

By applying ampelotecal measure herbozinizacion getting raw material enriched with grape-sugar content, total acid, polyphenols and primary aromatic substances..Wines obtained

herbozinizacion contain more alcohol, total acid, extract and polyphenols. They have improved taste and olfactory qualities.
With herbozinizacion it is possible to produce specific wines suitable for aging. It can be successfully applied to varieties Vranec, Merlot, Cabernet Sauvignon, Syrah and other varieties.
Research should continue to more locations and determine specifics arising due to climate conditions, variety, creativity applied vinification and human resources.

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ХЕРБОЖИНИЗАЦИЈА – МЕТОД ЗА ДОБИВАЊЕ СПЕЦИФИЧНИ ВИНА

Божиновиќ, З., Петков, М., Јованов, Ѓ., Јованов, Д.

Апстракт
Хербожинизацијата е специфичен ампелотехнички метод со кој се овозможува добивање вина со зголемена соджина на алкохол, вкупни киселини, екстракт, полифеноли и ароматични материи. Цел на испитувањето беше да се добијат специфични вина по хемиски и полифенолен состав и сензорни својства. Испитувањата се вршени кај сортите вранец и мерло, одгледувани на шпалирен систем во Тиквешкото виногорје. Виното е произведено во Винарија Стоби – Градско. Врз основа на добиените резултати констатиравме дека методот хербожинизација овозможува добивање на специфични вина со зголемена содржина на алкохол, вкупни киселини, екстракт и боени материи. Винатa се карактеризираат со нагласени овошни ароми.
Клучни зборови: хербожинизација, полифенолен состав, екстракт, ароматични материи, сензорни својства.

UDC:663.252-486.4(497.714)
Original scientific paper:

THE INFLUENCE OF DIFFERENT SELECTED YEAST STRAINS ON YOUNG WINE VRANEC FROM TIKVES WINE REGION

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Abstract
In this study we have presented the examination results of the influence of different selected yeast strains on young wine Vranec from the tikves wine region. The analysis were done on wines from the cultivar Vranec, which is the leading variety in the tikves wine region. During the research the following selected yeast strains were used: *Saccharomyces cerevisiae ph.r. cerevisiae* PB2031, and *Saccharomyces cerevisiae ph.r. cerevisiae* PB2590 which are commercial yeast strains. In order to determine the influence of these selected yeast strains on the young wine, the study was focused on determination of the fermentation kinetics of the yeasts which is in tight correlation with the kinetics of the alcoholic fermentation. The study was also focused on the determination of the total number of selected yeast strains, including the number of the viable and dead yeast cells in certain stages. Finally, the quality of the young wines was observed through microbiological, chemical and sensorial analysis, and the differences originated from the different wine treatments were commented. The obtained results should provide theoretical and practical knowledge and to improve the future work with selected yeast strains.
Key words: selected yeast strains, Vranec, kinetics, viable cells.

Introduction

Our goal was to investigate the influence of different selected yeast strains on young wine Vranec derived from tikvesh wine region in Macedonia. For that purpose the following yeast strains were seleceted:*Saccharomyces cerevisiae ph.r. cerevisiae* PB2031,*Saccharomyces cerevisiae ph.r. cerevisiae* PB2590, which are commercial yeast strains, and we have decided to make this research with grapes from the cultivar Vranec, since is leading cultivar in our winegrowing areas. Aims of our research were: Establishing the dynamics of the selected yeast strains, which is in tight correlation with the dynamics of the alchocolic fermentation, Determination of total yeast cell number in certain phases, Determination of viable and dead yeast cells, Determination of percentage of activity of the yeast strains during fermentation, Determination of the quality obtained, through microbiological, chemical and sensory evaluation of the young wines.

Our examination included microbiological analyses and collection of sterile samples through all the phases of the production process, where as the counting of the viable cells was done

through the method of Howard (hemocythomer), than monitoring of the yeast activity and with that monitoring of the inhibitory conditions was concluded as well. The obtained results were compared with the declaration of the producer. The producer of the selected yeast strains had declared that the yeast strains were produced in March 2007, with expiry date within 24 months if the strains are kept below 20C, and below 4C the expiry date is within 36 months. According the producer, in 1g dry yeast there is cca. 2×10^{10} active cells, and after the biological rehydration there is 4×10^{6} active cells in one mL. On the second day of the fermentation the yeast cells number rises up to 6×10^{7} cells and this number may vary according the ecological conditions in the environment, but minimum is 4×10^{7} cells, and maximum $1{,}1 \times 10^{8}$ cells in mL. In these phase if the cell number drops to 4×10^{7}, the fermentation can be stucked or sluggish. At the end of the alchocolic fermentation the total cell number drops to 3×10^{7} cells in mL.

Method of work

Scheme of the method applied is displayed in Table 1.

Table 1. Scheme of the research

Trials						
No	Cultivar	Qty	Strain	Qty aplied	Antioxidant	Qty aplied
1	Vranec	1hL	PB2031	25g/hL	Galovit C	30g/hL
2	Vranec	1hL	PB2031	25g/hL	H_2SO_3	50mg/L
3	Vranec	1hL	PB2590	25g/hL	GalovitC	30g/hL
4	Vranec	1hL	PB2590	25g/hL	H_2SO_3	50mg/L
5	Control Vranec	1hL	No strain	0	Galovit C	30g/hL
6	Control Vranec	1hL	No strain	0	H_2SO_3	50mg/L

As displayed in Table 1 we had six different trials. At each trial we used selected yeast strain and antioxidant, except for the controls were we didn't used any strains, and only antioxidant was used. As antioxidants were used H_2SO_3 and commercial additive by the name of Gallovit C. Gallovit C is a combination of 30% ascorbic acid and 70% gallo tanins. Microbiological research was done with the use of both methods - direct method and the culturelle method. Total cell number was monitored directly with Spencer chamber, as well as with petry dish (indirect method), while the counting of the number of viable cells was done only with the direct method.Sterile sampling was done at the grape crusher, after the addition of SO_2, and ascorbic acid, and after the biological activation of the both selected yeast strains. The dilution of the samples was10^{1}, only we had dilution of 10^{10} at the samples taken after the biological activation. The monitoring of the yeast population grow, the determination of viable and dead yeast cells in fermentation was done from the first to the seventh day of the trials.

Results and discussion

Microbiological research in grape must

In our trials the following yeast strains were used: *Saccharomyces cerevisiae ph.r. cerevisiae* PB2031, *Saccharomyces cerevisiae ph.r. cerevisiae* PB2590 ,which are commercial strains. Before fermentation in the grape must we had total number of cells of 1.5×10^7, where as in the samples were gallo tannins, ascorbic acid and SO_2 was added, the total number of cells was lower and was at the rate of 1.4×10^7, and at the trial were SO_2 was added, total yeast number decreased significantly due to the effect that it has, and the total cell number was 9×10^6. At the samples from the crusher and the gallo tannins there were no dead yeast cells, while at the sample taken after the addition of SO_2, the mortality rate was 5.26%. After the bilolgical activation of *Saccharomyces cerevisie ph.r. cerevisiae* PB2031, the total cell number was 1.5×10^{10} , with mortality rate of 6.66%. Obtained results were different than what was declared by the producer, but several factors may influence on this high mortality rate such as for example the inadequate storing temperature before delivery or the loss of vacuum in the package, etc.. After the bilolgical activation of *Saccharomyces cerevisie ph.r. cerevisiae* PB2590, the total cell number was 1.95×10^{10} , with mortality rate of 2.56%. Obtained results were in correlation with what was declared by the producer for this yeast strain that in 1g dry yeast there are 2×10^{10} cells. *S.cerevisiae ph.r.cerevisiae* PB2590 in comparison with *S.cerevisiae ph.r.cerevisiae* PB2031 had higher number of viable cells and also, *S.cerevisiae ph.r.cerevisiae* PB2590 had lower mortality rate.

Table 2. Total yeast cell number before fermentation in grape must

	After crusher	After gallo tannins and ascorbic acid	after SO_2	After activation of *S.cerevisiae* PB2031	After activation of *S.cerevisiae* PB2590
Live cells	1.5×10^7	1.4×10^7	9×10^6	1.4×10^{10}	1.9×10^{10}
Dead cells	0	0	5×10^5	1×10^9	5×10^8
Total cell number	1.5×10^7	1.4×10^7	9×10^6	1.5×10^{10}	1.95×10^{10}
% of dead cells	0	0	5.26%	6.66%	2.56%
% of activity	100%	100%	94.7%	93.33%	97.4%

The results from the counting of cell colonies are shown in Table 3:

	After crusher	After gallo tannins and ascorbic acid	after SO_2	After activation of *S.cerevisiae* PB2031	After activation of *S.cerevisiae* PB2590
Total yeast number	1.4×10^7	1.2×10^7	7×10^6	1.2×10^{10}	1.5×10^{10}

Table 4. Obtained differences between direct and indirect method

Total yeast number	After crusher	After gallo tannins and ascorbic acid	after SO_2	After activation of *S.cerevisiae* PB2031	After activation of *S.cerevisiae* PB2590
Direct method	1.5×10^7	1.4×10^7	9×10^6	1.5×10^{10}	1.95×10^{10}
Indirect method	1.4×10^7	1.2×10^7	7×10^6	1.2×10^{10}	1.5×10^{10}

Chemical and microbiolocal analysis of young wine Vranec. Detailed results of the chemical analysis is shown in Table 5.

	Vranec Sample 1 *S.cerevisiae* PB2031, Gal.C	Vranec sample 2 *S.cerevisiae* PB2031, $H2SO_3$	Vranec sample 3 *S.cerevisiae* PB2590, Gal.C	Vranec sample 4 *S.cerevisiae* PB2590, $H2SO_3$	Vranec sample 5 Control, Gal.C	Vranec sample 6 Control $H2S0_3$
Relative density	0,9955	0,9953	0,9954	0,9954	0,9957	0,9959
Alcohol Vol%	13,27	13,3	13,8	14	13	12,95
Total extract g/dm^3	31,2	31,9	31,3	31,3	30,8	31,9
Total acidity g/dm^3	6,1	6,2	6	6,1	6,3	6,4
Volatile acidity g/dm^3	0,28	0,26	0,26	0,27	0,32	0,52
Glycerol g/dm^3	8,1	8,1	8,9	8,7	7,6	7,4
Free SO_2 mg/L	23,04	25,6	24,02	27,5	20,48	33,02
Total SO_2 mg/L	39,4	43,24	45,5	39,8	35,84	48,19
Residual sugar g/dm^3	3,7	4	4	3,5	6	6,4

Table 6. Total number of cells and percentage of viable and dead yeast cells at sample 1

Vranec *S.cerevisiae* PB2031+Gal.C	Total cell number	Viable yeast cells	Dead yeast cells	%of dead yeast cells	% of viable cells
1 day	1×10^7	$9{,}5 \times 10^6$	5×10^5	5%	95%
4 day	$1{,}05 \times 10^8$	$1{,}02 \times 10^8$	$2{,}5 \times 10^6$	2,38%	97,61%
7 day	$4{,}05 \times 10^7$	$3{,}8 \times 10^7$	$2{,}5 \times 10^6$	6,17%	93,83%

Table 7. Total number of cells and percentage of viable and dead yeast cells at sample 2

Vranec *S.cerevisiae* PB2031+H_2SO_3	Total cell number	Viable yeast cells	Dead yeast cells	%of dead yeast cells	% of viable cells
1 day	$9,5 \times 10^6$	9×10^6	5×10^5	5,26%	94,73%
4 day	1×10^8	$9,85 \times 10^7$	$1,5 \times 10^6$	1,5%	98,5%
7 day	4×10^7	$3,65 \times 10^7$	$3,5 \times 10^6$	8,75%	91,25%

Table 8. Total number of cells and percentage of viable and dead yeast cells at sample 3

Vranec *S.cerevisiae* PB2590+Gal.C	Total cell number	Viable yeast cells	Dead yeast cells	%of dead yeast cells	% of viable cells
1 day	$9,5 \times 10^6$	9×10^6	5×10^5	5,26%	94,73%
4 day	$1,07 \times 10^8$	$1,02 \times 10^8$	5×10^6	4,65%	95,35%
7 day	$4,15 \times 10^7$	$3,9 \times 10^7$	$2,5 \times 10^6$	6,02%	93,97%

Table 9. Total number of cells and percentage of viable and dead yeast cells at sample 4

Vranec *S.cerevisiae* PB2590+H_2SO_3	Total cell number	Viable yeast cells	Dead yeast cells	%of dead yeast cells	% of viable cells
1 day	$1,05 \times 10^7$	1×10^7	5×10^5	4,76%	95,24%
4 day	$1,09 \times 10^8$	$1,04 \times 10^8$	$4,5 \times 10^6$	4,18%	95,87%
7 day	$4,3 \times 10^7$	$4,05 \times 10^7$	$2,5 \times 10^6$	5,81%	94,18%

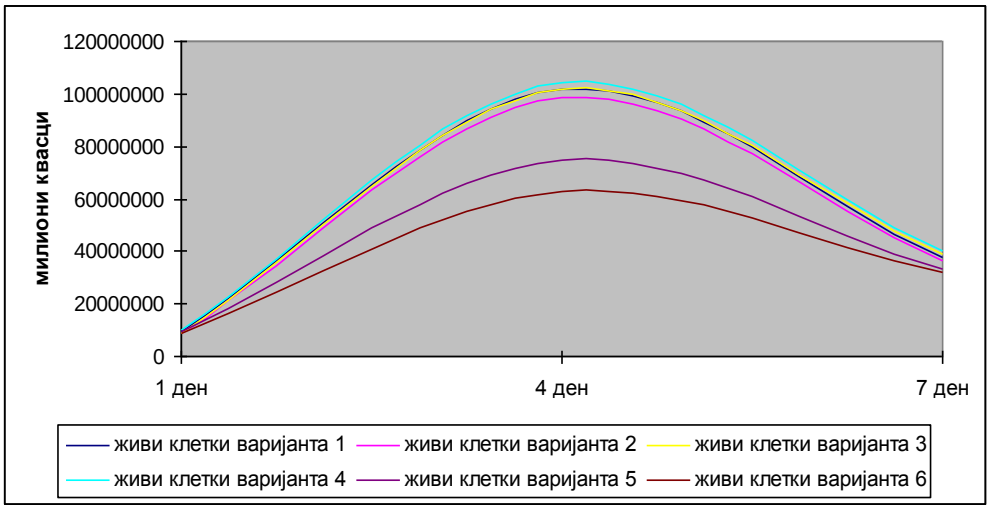
Table 10. Total number of cells and percentage of viable and dead yeast cells at sample 5

Vranec Control Gal.C	Total cell number	Viable yeast cells	Dead yeast cells	%of dead yeast cells	% of viable cells
1 day	1×10^7	$9,5 \times 10^6$	5×10^5	5%	95%
4 day	$8,2 \times 10^7$	$7,45 \times 10^7$	8×10^6	9,75%	90,85%
7 day	$3,85 \times 10^7$	$3,35 \times 10^7$	5×10^6	12,98%	87,01%

Table 11. Total number of cells and percentage of viable and dead yeast cells at sample 6

Vranec Control H_2SO_3	Total cell number	Viable yeast cells	Dead yeast cells	%of dead yeast cells	% of viable cells
1 day	$1,05 \times 10^7$	$8,5 \times 10^6$	2×10^6	19,04%	80,95%
4 day	$7,3 \times 10^7$	$6,3 \times 10^7$	1×10^7	13,70%	86,30%
7 day	$3,7 \times 10^7$	$3,2 \times 10^7$	5×10^6	13,51%	86,49%

Graph 1 is showing the viable cells at all six trials



From the graph is easy to see that in the samples were the inoculation with seleceted yeast strain was conducted, they all had similar nuber of viable yeast cells, where as in the last two samples were no inoculation was done, they had significantly lower number of viable cells, which can later resukt with stuck or sluggish fermentation.

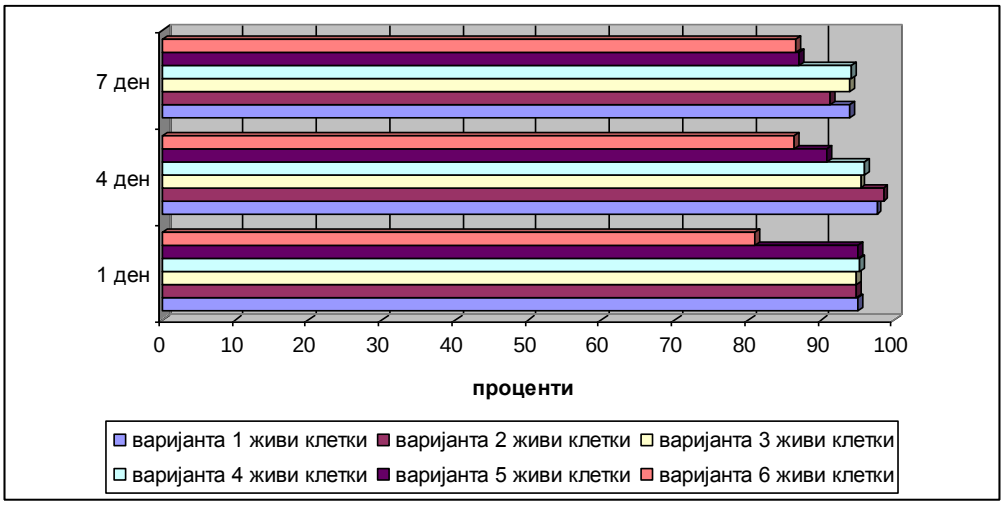


Figure 2. Acitvity percent of the selected yeast strains at all trials

As we can see from the graph, samples 1-4 have higher percent of viable yeast cells than samples 5 and 6, and the maximum is reached at the sevnth day. This difference can be caused due to several inhibitory factors, such as alcohol, vitamins and sterol insufficiency, etc..

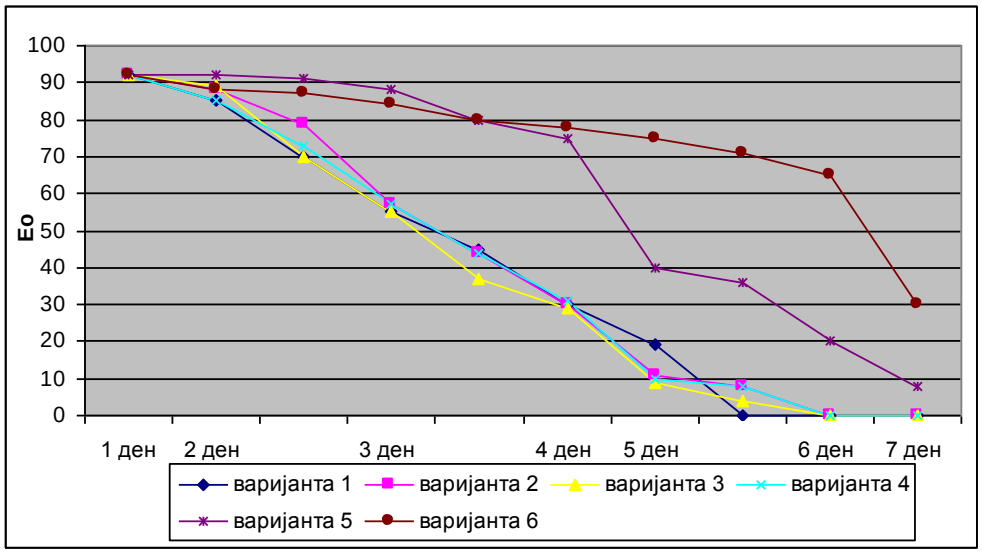


Figure 3. Fermentation kinetics at samples 1 - 6

From the graph we can conclude that the obtained results for the number of viable yeast cells at all samples are in correlation with the fermentation kinetics and due to the lower nuber of viable yeast cells at samples 5 and 6 has caused to have slower fermentation kinetics, which later on can caused stuck and sluggish fermentation and producing of off flavours and attracting high volatile acids. From chemical point of view the young produced wine Vranec has clearly shown its tipicity – wine with higher alcohol, high extract and amount of glycerol which gives longevity of the wine. From microbiological point of view, we can conclude that we were able to confirm the declaration of the producer of the selected yeast strains for the number of viable and total cell number in different stages of the fermentation process. The obtained results from the microbiological research of the young wine Vranec has clearly shown that for normal start of the fermentation it is necessary to inoculate with minimum 4 x 10^6 cells in 1mL in grape must. The resuts obtained are in correlation with results which were earlier obtained from Bubalov (1998) who has studied the dynamics and composition of the yeast microflora in grape must of vranec from the valandovo vine growing region. Oragnoleptics characteristics of young wine Vranec in the tikvesh wine region

One of the aims of this research was to establish the quality of the produced wine through their sensory evaluation. Analysis results obtained from the microbiological and chemical analysis of the wine clearly speak that the produced wine meets the criteria to be classified as quality wine. What is very important in order to establish the overall report on the quality of the wines is the sensory evaluation of the wine. Therefore, we did the sensory evaluation with the code of description OIV – panel tasting and the maximum points is 100.

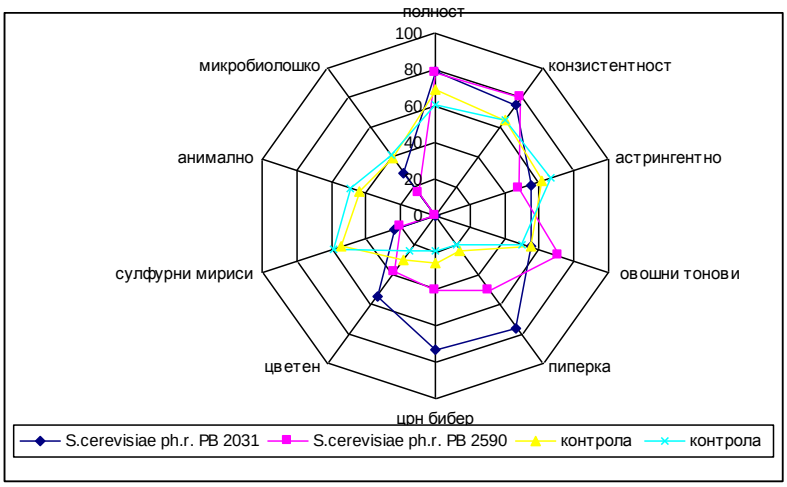


Figure 4. Differences in aromatic profile at all samples 1-6

From the graph we can see that the use of selected yeast strains is strong tool in the production of wines which are characterized as typical for the cultivar, with high concentration of fruity aromas, while on the palate the wines are smooth, consistent and long lasting. At the control trials were no selected yeast strain was used, we established that these wines are with olfactory defects caused by high volatile acidity and microbiological off flavours. Therefore it is strongly recommended to use selected yeast strains in the winemaking process in order to obtain correct start and finish of the alcoholic fermentation.

Conclusions

Based on the research and on the analysis report we have come to the final conclusions:

Leading variety for production of quality red wine in the tikvesh vine area is Vranec, which symbolized the type of Macedonian red wines. After the activation of the strain *S.cerevisiae phr. cerevisiae* PB2031 total cell number in 1mL pomace was 1,5 x 10^{10}, viable cells in 1mL pomace was 1,4 x 10^{10}, which enabled 93,33% viability of the cells. These findings confirmed the declaration of the producer for the strain *S.cerevisiae phr. cerevisiae* PB2031 who had declared that in 1g dry yeast there are 2 x 10^{10} cells. After the activation of *S.cerevisiae phr. cerevisiae* PB2590 total yeast number in 1mL pomace was 1,95 x 10^{10}, viable cells in 1mL pomace was 1,9 x 10^{10}, with 97,4% activity. These findings confirmed the declaration of the producer for the strain *S.cerevisiae phr. cerevisiae* PB2590 who had declared that in 1g dry yeast there are 2 x 10^{10} cells. The grape must of Vranec prior to fermentation had 1,5 x 10^{7} total cells. This total number of cells is sufficient for spontaneous start of the alcoholic fermentation.

Rapid start of the alcoholic fermentation is in correlation with the inoculation rate and minimum is 4 x 10^{6} cells in 1mL. Fermentation kintetics is strongly depended from the supply with yeast nutrients, aeration and correct biological activation of the strains. The samples which were inoculated with the strain *S.cerevisiae phr. cerevisiae* PB2031 had total

cell number of 1 x 10^7 on the first day, on the fourth day had 1,05 x 10^8, and on the seventh day 4,05 x 10^7. The samples which were inoculated with the strain *S.cerevisiae phr. cerevisiae* PB2590 had total cell number of 1,05 x 10^7 on the first day, on the fourth day had 1,09 x 10^8, and on the seventh day 4,3 x 10^7. The samples which were not inoculated had total cell number of 1,05 x 10^7 on the first day, on the fourth day had 8,2 x 10^7, and on the seventh day 3,7 x 10^7. These samples had high mortality rate which on the seventh day was at the rate of 13,51%.

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ВЛИЈАНИЕ НА РАЗЛИЧНИТЕ СТАРТЕР КУЛТУРИ КВАСЦИ ВРЗ МЛАДО ВИНО ВРАНЕЦ ОД ТИКВЕШКОТО ВИНОГОРЈЕ

Дане Јованов, Михаил Петков, Звонимир Божиновиќ

Апстракт

Во овој научен труд прикажани се резултатите од проучувањата на влијанието на различните стартер култури квасци врз младо вино Вранец од тиквешкото виногорје. Испитувањата се вршени кај вината од сортата Вранец која е водечка сорта во тиквешкото виногорје. При испитувањата беа користени следните стартер - култури квасци: *Saccharomyces cerevisiae ph.r. cerevisiae* PB2031 и *Saccharomyces cerevisiae ph.r. cerevisiae* PB2590 кои се лабораториски комерцијални изолати. Со цел да се утврди влијанието на овие стартер култури врз младите вина беше одредена и утврдена динамиката, т.е. кинетиката на селекционираните стартер култури квасци, која пак е во тесна корелација со динамиката на алкохолната ферментација. При истражувањата се утврди и вкупниот број на стартер - култури квасци во поодделни фази, и утврдување на живи и мртви клетки како и одредување процент на активност на квасците при алкохолната ферментација. Испитуван беше и квалитетот на добиените млади вина преку нивна микробиолошка, хемиска и сензорна евалуација, а испитувани беа и добиените разлики како резултат на различните третмани (со или без стартер култури).

Клучни зборови: селекционирани стартер - култури, Вранец, динамика, кинетика на ферментација.

SECTION 3: VEGETABLE, FLOWER AND DECORATIVE PLANTS PRODUCTION

UDC:725.892.011:502.17 (497.113)
Original scientific paper

APPLICATION OF LANDSCAPE ARCHITECTURE IN RECULTIVATION OF OPEN PIT MINING IN BUKOVAC

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Abstract
The main purpose of elaboration of the General Design is getting an insight into the existing conditions of the unlicensed landfill, i.e., the open cut for excavation of clay within the former brick plant in Bukovats and through recultivation – adaptation of the available area to construction of a hippodrome with accompanying contents. The available documentation and the lack of results from surveys have conditioned a level of elaboration in accordance with the „Law on Planning and Constriction“ („Official Gazette of RS“ no. 47/2003). In further phases of elaboration of the design documentation, the necessary scope of research works will be conceived and done along with the creation of all the necessary conditions and obtaining of consents. Recultivation of the brick plant is basically a measure for preservation and protection of the environment as well as enhancement of the living conditions of the gravitating population of the urban media of Sremski Karlovats, Petrovaradin and Novi Sad. The anticipated construction of structures will enable opening of new jobs and a possibility of placement of organic food produced by individual farmers as are the bermet, the blackberry wine, the kugloff and other prducts of the surrounding population.
Key words: landscape architecture, recultivation, bukovac.

Introduction

The main purpose of elaboration of the General Design is getting an insight into the existing conditions of the unlicensed landfill, i.e., the open cut for excavation of clay within the former brick plant in Bukovats and through recultivation – adaptation of the available area to construction of a hippodrome with accompanying contents.

The available documentation and the lack of results from surveys have conditioned a level of elaboration in accordance with the „Law on Planning and Constriction („Official Gazette of RS“ no. 47/2003). In further phases of elaboration of the design documentation, the necessary scope of research works will be conceived and done along with the creation of all the necessary conditions and obtaining of consents. Recultivation of the brick plant is basically a measure for preservation and protection of the environment as well as enhancement of the living conditions of the gravitating population of the urban media of Sremski Karlovats, Petrovaradin and Novi Sad (Vitruvije, 1998). The anticipated construction of structures will enable opening of new jobs and a possibility of

placement of organic food produced by individual farmers as are the bermet, the blackberry wine, the kugloff and other prducts of the surrounding population.

Material and methods

Recultivation is aimed at creation of an interesting area accessible to people of all age and social groups or creation of space for special purposes (Stojcevsja at al, 2010). The preliminary solutions could be different:

- Retroffiting and return of the nationalized land to previous owners;
- Establishment of new ecologucally friendly habitations for the protection of authochtonous species;
- Spotanenous development of vegetation after closure of the open cut;
- Establishment of ecologically friendly areas for different purposes depending on potential users and their interests and hobbies if an urban environment is at stake;
- Establishment of food production plants if the area is in a protected zone.

In the case of application of landscape architecture in recultivation of degraded areas, it is necessary to analyze the main limitations and directions of the given space in accordance with the natural characteristics of the environment and the extent of physical chemical degradation of the area which is arranged (Sekularac at al, 2008). Then, the development of the existing infrastructure, the extent of isolation in respect to the environment, the closeness and the age structure as well as the hobbies of potential users are analyzed from the aspect of selection of the area purpose.Taking the old brick plant in Bukovats as an example, detailed analysis of natural conditions, urban environment, size of degraded area and needs of the city environment have been investigatied (Stoiljkovic, 2011). Due to the considerable length of the work, only description of the existing conditions and preliminary solution of the arrangement of the space is given in the results.

Results and discussion

The brick plant covers about 1.525 ha. On all sides, it is surrounded by residential structures. Existing conditions: the open cut has been used for uncontrolled disposal of communal and other waste by the population of Bukovats and Petrovaradin as well as the population of other inhabited places in the surrounding. Such uncontrolled refuse disposal has been going on for a number of years and has resulted in a considerable amount of waste on the considered location. The open cut is accessed by a road on the west side, from Bukovats direction, at a level of 90 m. The level of the open cut bottom varies from 87 to 90 m. The open cut has the form of an amphitheatre with a steep cut having a heigth of several tens of meters and an upper edge level of 102-110 m in south and east direction. On the Petrovaradin side, the edge of the excavation can be reached by Toma Maretic street. The street continues with the local road leading to the vineyards. At the entry on the left side, from the lower road from the direction of Bukovats, there is a porter's desk. On the left side, when entering the brick plant location, there are the abandoned production plants and the storehouses. The area covered with the structures and the access areas are asphalted. From the entry, in a straight direction, there is a hill which is with a height of 10 m in respect to the level of the excavation bottom. To the left from the entrance, when the part under vegetation and the structure on that side are passed, there is a smaller canal with a depth of about 1,5 m which is also overgrown with high grass and bushes. After that, there continues the open cut in the form of an amphitheatre covering

and area of about 47.65 ha. The area of about 0.825ha on the right side of the Bukovats road, from the Petrovaradin direction, also belongs to the brick plant. The general disposition of the structures is given on the site plan with presentation of the open cut and the production plants (Fig.1, Fig. 2a).



Figure 1. Geographic Position of the open cut of the brick plant in Bukovats covering an area of 50 ha



Figure 2. Prelimiary solution of disposition of the brick plant in Bukovats
2a) Existing production plants

Plant material: mainly self-seeding weed plants with individual dendrological species as are: in the production plant - *Platanus X acerifolia*, birch *Betula alba*, blue spruce *Picea pungens*, spruce *Picea alba*, arbor vitar *Thuja occidentalis*, willow *Salix alba*, cherry plum *Prunus cerasifer*, lilac *Syringa vulgaris*, cherry tree *Prunus avium*, while along the fence, a few specimens of *Juglans regia* (wallnut tree) are found. On the hill, in-between the production plant and the open cut, there are *Populus alba* (silver leaf poplars), *Salix alba* (willows), *Amorpha fructicosa* (false indigo), *Robinia pseudoacacia* (locusts), while the open cut is a non-arranged landfill with self-seeding bush species and grass.

Preliminary solution: From the analyses of the old brick plant area in Bukovats, construction of a hippodrome has been proposed by a preliminary solution (Vujkovic at al, 2003). The entire project

is divided into separate entities as given in Fig. 3. The hotel compound covers an area of 0.8 ha at the location of the former production plant. It is designed in the style of constrution and by selection of construction materials as those of the Petrovaradin fortress and the old core of Petrovaradin (stone, brick, wood, wrought-iron , and plain tiles for the roof). In the northwernmost part, in front of the main entrance into the hotel, there is a paved plateau with a diameter of 10 m from which there extend a number of paths toward the parking lot for the hotel guests. The hotel is in the form of cyrillic letter P, facing south. In the middle, there is a ground floor with carrefours of seasonal flowers and a grass area covering 0.18 ha (Fig. 3, position 1).In continuation of the ground floor, to the south, there is an open restaurant with a line of sight toward the race trackways and the lake (Fig. 3, position 4). The lake covers an area of 2400 m². It is of an irregualr shape and has a depth of 3 m. Below the lake is the underground room for accommodation of the system for water drive, physical, chemical and biological purification of the water. The circulation of water is realized with the smaller lake on the east edge of the open cut. The lakes and the waterfalls are decorated by stones of different forms and dimensions as well as water vegetation (Fig. 3, position 2 and 3). The east edge of the open cut is terraced, i.e., the terrain descends in cascades to the summer restaurant levelling level. The cascades are defined by retaining walls constructed of red brick and are adorned with corresponding plant material. The slope of the terrain is solved by footways and staircases. The cascades are used also in the creation of the river flow. Formed at the upper edge of the terrain is a smaller lake – a reservoir covering 100 m^2, with irregular shape and with a depth of 2 m. From this lake, there starts a water fall with a width of 1,5 and length of 70 m of meandering flow with cascades emptying into the large lake in front of the open restaurant at the lower plateau. At places where the cascade flow cuts the footways, small timber bridges are constructed.

The playground is situated west from the large lake, in the park spread over 3.7 ha. It covers an area of 250 m^2 and is enclosed by a timber fence. The playground constis of swings, seesaws, toboggan and climbers of different dimensions and shapes (Fig. 2b, 2e, Fig. 3, position 5). The gadgets are made of cast plastic and wood. The playground is adapted to children of different age. Within it, there is vegetation as a protection against the sun rays, while the area is covered with well maintained grass.



Figure 2b) Children's playground

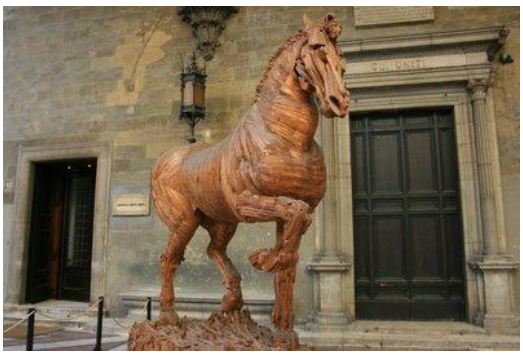


Figure 2e) Art gallery

The main entrance into the hippodrome is from the Petrovaradin direction, from the upper road. It represents a high gate of solid wood with wrought iron ornaments, door knockers and indivual safetydoor – net made of wrought iron that is kept down when the hippodrome does not work, i.e.,

when horse races are not held. Its width is 10 m, with a small pedestrian entrance on one wing of the gate, with a width of 3 m. The path with the width of the gate is bifurcated to the right up to the parking place and to the left, toward the ticket hall, the entrances into the stands and the betting house. The difference in height of the terrain is solved by stands for spectators constructed in a cascade manner under which there are business and production premises for different purposes. The line of sight of the stands is toward Frushka Gora mountain. The parking lot is further extended by an outdoor art gallery. The outdoor gallery – is the area between the main entrance on the Petrovaradin side and the small lake that falls into cascades into the lower lake, in front of the open door restaurant. This part covers an area of 0.10 ha consisting of pathways with cobbled pavement, multiannual vegetation, grassy areas and diamond shaped pavement beside the footways – the exhibiting area (Fig. 2c, 2d, Fig. 3, position 6).



Figure 2c) Children's playground



Figure 2d) Exhibition area

The race tracks are intended for galloping races without harnesses, races with jumps and harness races. The longer track is 1400 m, while the shorter one is 900 m long, which is designed according to the main parameters of length of racing tracks. The width of the tracks is 15 m. The space within the track is covered with grass. It is a gras cover made of fine grass resistant to stamping. Such area covers 9 ha. Here, there is also a system for automatic watering of the grassed area. The track itself is designed according to the standards referring to horse racing. (Fig. 3, position 8).

Underground stables and premises with equipment -These cover an area of 1000 m². There are 40 separate boxes for horses proportioned 3 x 5 serving for temporary accommodation of horses prior to the races. These premises serve for keeping equipment and machines necessary for the maintenance of the compound. Air is introduced by means of a built-in installation, while light is obtained through the glass roofs. From these premises, the horses exit, through a tunnel, onto the central part of the shorter trackway, where the horses are presented prior to the races and are warmed up. Opendoor stables and trackways for rushing out and training, horce racing club– serves for permanent accommodation of the horses. This area covers 1900 m^2. The stables are within the facilities and also have access to the fenced open area of a semicircular form. Beside the stables, theres is a smaller trackway of 300 m length that serves for training and exercising of horses. The precedure of construction 0f the trackway is the same as that for the big racing trackways (Fig. 3, position 10). Solar energy -The old brick plant in Bukovats is situated in a good location from the



Figure 3. Preliminary solution of arrangement of the brick plant in Bukovats
Legend: 1. Hotel compound; 2. Water areas – upper lake with a cascade flow; 3. Lower lake with the park area; Opendoor restaurant; 5. Children's playground; 6. Gallery; 7. Stands and business premises; 8. Racing track; 9. Production of branded food; 10. School for riding.

aspect of exposure to the Sun which is a great advantage as to utilization of the solar enegy. From that reason, active and passive solar energy has been used in the design. According to the preliminary solution, the solar collectors are placed on the roofs of the hotel compound and the business premises of the upper plateau. Passsive solar enegy has been used in the maximum orientation of the facades toward south (the longest daily insolation) with underground parts of the bussiness premises to the south and east.

Conclusions

The measures for repair of unlicensed landfills contribute to improvement of protection of the eneivonment. The anticipated purpose (compound for holding horse races, riding school and use of stable muck for production of mushrooms in the re-designed brick plant, then production of humus and biogas, construction of wine cellars) enriches the offer of branded products of Frushka Gora and

the tourist offer of Novi Sad. The energy supply of the hippodrome is done through production of biogas and solar cells as an ecologial energy for maintenance of the hippodrome and the business premises throughout the entire year. There is no danger of pollution of underground waters since there are no springs neither underground waters on the present location.

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ПРИМЕНА НА ПЕЈСАЖНА АРХИТЕКТУРА ВО РЕКУЛТИВАЦИЈА НА ОТВОРЕН КОП ВО БУКОВАЦ

Драгица Стојилковиќ, Јована Стојчевска, Милица Рајиќ, Бисерка Димишковска

Апстракт

Главна цел на изработката на Главниот проект е да се добие увид во постојните услови на нелиценцирана депонија, односно површински коп за глина во рамките на бивша циглана во Буковац и преку рекултивација – адаптација на расположивата површина, да се изгради хиподром со придружни содржини. Достапната документација и недостигот на резултати од истражувања условија ниво на изработка во согласност со Законот за планирање и градење (Службен весник на РС бр. 47/2003). Во понатамошните фази на изработка на проектната документација, ќе биде замислен и извршен неопходниот обем на истражувачки работи заедно со создавање на сите неопходни услови и добивање на дозволи. Рекултивацијата на цигланата во основа претставува мерка за сочувување и заштита на природната средина како и подобрување на условите за живеење на гравитирачкото население од урбаните средини на Сремски Карловац, Петроварадин и Нови Сад. Предвидените градби ќе овозможат отворање на нови работни места и можност за пласман на органска храна произведена од индивидуални фармери како што е бермет, вино од капини, куглоф и други производи на околното население.

Клучни зборови: пејсажна архитектура, рекултивација, буковац.

UDC:712.025.4(497.6)
Review Article

THE IDENTIFICATION, VALORIZATION AND PROTECTION OF HISTORICAL PARK SURFACES OF THE GREAT PARK IN SARAJEVO

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Abstract
The park heritage of Bosnia and Herzegovina is not recorded nor evaluated, and its historic gardens and parks are not categorized, and a very few of them are protected as monuments of landscape architecture or cultural monuments. The Great Park, located in one of the most frequent parts of Sarajevo, has the outstanding horticultural and historical significance. It has partially lost their functional and aesthetic value, because of the devastation during the war of the 1992- 1995, but also because of poor maintenance and unorganized planting of trees and shrubs after the war. Given the fact that the Great Park is the first public park in Sarajevo, formed in 1885, its value can also be observed from the culturally-historical aspect. It is therefore necessary to perform the evaluation of this green area, and determine the actual state of plants and architectural elements, and suggest methods of reconstruction that would restore or emphasize their functional, biological and ecological value. The choice of plant species in the reconstruction of the Great Park must fulfill all the functions that are required of this green area: decorative-aesthetic, sanitary-hygienic and culturally-educational.
Key words: Great Park Sarajevo, historical green areas, identification, valorization, protection.

Introduction

Based on its size and location, the Great Park in Sarajevo is classified as a city park, and its primary function is to bring the nature closer to the urban people and provide the peaceful place for active and passive relaxation. It is located in the Center municipality of the city, bordered by the streets Titova, Džidžikovac and Tina Ujevića.

One of the first schemes of the Great Park was made in 1885. by Hugo Krvarić, and it is believed to be the first park project in Bosnia and Herzegovina - until then, there were no public green areas, but a small private garden around each house, where trees and shrubs were planted randomly. The park was created during 1890-1895, and it has a very interesting concept, mostly informal landscape style, and several classical-style elements in the central part. The park was damaged during the World War II, and renewed in 1952, keeping its original appearance (Kulenović, 1960).

The Great Park has the area of 29,2 ha, and is divided to 22 surfaces by concrete paths (Figure 1). This green area is the valuable monument of cultural, historical and biological heritage of the city of Sarajevo, and has the following functions (Ljujić-Mijatović & Mrdović, 1998):

- Sanitary-hygienic: since it is located in a central part of the city, where there is a large traffic frequency, it has the important role in reducing air pollution by intercepting particulate matter and

absorbing gaseous pollutants, thus improving the air quality, the urban climate, and also reducing the noise levels;

- Decorative-aesthetical: the Great Park has a beautifully designed layout that is neatly combined with the architectural solution of the Austro-Hungarian period part of the city of Sarajevo. The main part of the park is formed in informal landscape style, with several classical-style elements in the central part, which gives this green area an exceptional visual effect;
- Culturally-educational: since the Great Park is the first public green area in Sarajevo, built according the plan during the Austro-Hungarian monarchy, it represents the part of cultural and historical heritage. Also, because of a large number of plant species, the surface of this park can be used as a "outdoor classroom" for education of school children and natural sciences students.



Figure 1. The copy of the cadastre plan of the Great Park Sarajevo (Institute of Planning and Development of the Sarajevo Canton)

The primary vegetation of Sarajevo was mostly destroyed or changed due to urbanization. In the past, the location of today's Great Park was covered with the forests of common oak and hornbeam (*Carpino betuli – Quercetum roboris*) on pseudogley. Those woodlands are characterized by *Quercus robur* L. and *Carpinus betulus* L., along with *Ulmus laevis* Pal., *Acer campestre* L., *Tilia platyphyllos* Scop., *Corylus avellana* L., *Euonymus europaeus* L., *Cornus mas* L., *Prunus spinosa* L. and *Cornus sanguinea* L. (Lakušić, 1988). The area where the Great Park is located has the moderate continental climate, influenced by the middle-European climate from the north and Mediterranean climate from the south, characterized by warm summers and snowy winters (Drešković, 2003). Parks can be defined as architectural objects made of organic material (Obad Šćitaroci, 1992), and they are the documents of the culture and the time that they were created in. The parks are very prone to degradation, either by the influence of nature (strong winds, snows, plant diseases) or human factors, mostly bad maintenance or bad choice of plan material.

Material and methods

The research work of this paper was conducted on the green area of the Great Park in Sarajevo, during the summer of 2011. The plants were identified using the determination key (Domac, 2002) and the available literature regarding ornamental shrubby and woody plants (Janjić, 1966, 1984, 1998; Russe & Cutler, 2004; and Šilić, 1990, 1973). The percentage of evergreen and deciduous species and cultivars was calculated, and the suggestions for introducing new plant species were given according to ecological characteristics of the Great Park location.

Results and discussion

During this research, 74 species and cultivars (44 trees and 30 shrubs) were identified. The results are presented in tables 1 and 2.

The shrubs are planted in large, irregular, mixed groups, so it was not possible to provide the exact number of plants. The analysis of dendrological composition of the Great Park in Sarajevo shows that there is a large deficiency of evergreen plant species, which gives this green area insufficient decorative effect during the late autumn and winter. Of total 44 tree species and cultivars, 40 (90,9%) are deciduous and only 4 (9,1%) evergreen, and of 30 shrub species 23 (76,6%) are deciduous and 7 (23,4%) are evergreen (Figure 2). Of total 44 tree species and cultivars, 30 (68,18%) are autochthonous, and 14 (31,82%) allochthonous, which is a very good ratio, in accordance with Obad Šćitaroci (1992) - the base of the green area is formed using autochthonous plants, that are already adapted to the ecological conditions of the given space, and the composition is later filled with the exceptionally ornamental species, that can be allochthonous, but resistant to climatic factors in the urban conditions. Of 30 shrubs, there are 14 (46,6%) autochthonous and 16 (53,4%) allochthonous species and cultivars (Figure 3). When choosing the trees for the public green areas, the most important characteristics that must be taken into consideration are the height, size and shape of the crown, shape and color of leaves, flowers and fruits. It is also important to combine trees with interesting fall colors and evergreens, so that the green area would have decorative effect in every time of the year.

Table 1. Trees in the Great Park in Sarajevo

Scientific/latin name	Type	Origin	Quantity
Acer campestre L.	deciduous	autochthonous	29
Acer heldreichii Orph. ex Boiss	deciduous	autochthonous	2
Acer obtusatum Waldst. & Kit. ex Willd	deciduous	autochthonous	1
Acer platanoides L.	deciduous	autochthonous	29
Acer platanoides 'Drummondii'	deciduous	autochthonous	4
Acer pseudoplatanus L.	deciduous	autochthonous	31
Acer tataricum L.	deciduous	autochthonous	1
Aesculus carnea Hayne	deciduous	allochthonous	1
Aesculus hippocastanum L.	deciduous	allochthonous	32
Ailamthus altissima (Mill.) Swingle	deciduous	allochthonous	10
Betula pendula Roth.	deciduous	autochthonous	3
Carpinus betulus L.	deciduous	autochthonous	5
Catalpa bignonioides Walt.	deciduous	allochthonous	1
Chamaecyparis lawsoniana (Murr.) Parl.	evergreen	allochthonous	1
Cornus mas L.	deciduous	autochthonous	1
Fagus silvatica L.	deciduous	autochthonous	4
Fraxinus angustifolia Vahl.	deciduous	autochthonous	1
Fraxinus excelsior L.	deciduous	autochthonous	24
Fraxinus ornus L.	deciduous	autochthonous	4
Fraxinus pennsylvanica Marshall	deciduous	allochthonous	1
Ginkgo biloba L.	deciduous	allochthonous	3
Gleditschia triacanthos L.	deciduous	allochthonous	6
Juglans regia L.	deciduous	autochthonous	1
Larix decidua Mill.	deciduous	autochthonous	1
Morus alba L.	deciduous	allochthonous	1
Picea abies (L.) Karsten	evergreen	autochthonous	11
Picea pungens 'Glauca'	evergreen	allochthonous	3
Pinus nigra Arnold	evergreen	autochthonous	9
Platanus × *acerifolia* (Aiton) Willd.	deciduous	allochthonous	8
Prunus avium L.	deciduous	autochthonous	11
Prunus cerasifera Ehrh.	deciduous	autochthonous	4
Prunus cerasifera 'Atropurpurea'	deciduous	autochthonous	3
Prunus padus L.	deciduous	autochthonous	4
Quercus robur L.	deciduous	autochthonous	9
Quercus rubra L.	deciduous	allochthonous	1
Robinia pseudoacacia L.	deciduous	allochthonous	16
Sophora japonica L.	deciduous	allochthonous	5
Sorbus torminalis (L.) Crantz	deciduous	autochthonous	6
Tilia cordata Mill.	deciduous	autochthonous	15
Tilia platyphyllos Scop.	deciduous	autochthonous	37
Tilia tomentosa Moench	deciduous	autochthonous	21
Ulmus glabra Huds.	deciduous	autochthonous	3
Ulmus laevis Pallas	deciduous	autochthonous	3
Ulmus minor Mill.	deciduous	autochthonous	12
Total			378

Table 2. Shrubs in the Great Park in Sarajevo

Scientific/latin name	Type	Origin
Berberis thunbergii 'Atropurpurea'	deciduous	allochthonous
Chaenomeles japonica (Thunb.) Lindl.	deciduous	allochthonous
Cornus alba 'Sibirica'	deciduous	allochthonous
Cornus sanguinea L.	deciduous	autochthonous
Corylus avellana L.	deciduous	autochthonous
Cotoneaster horizontalis Dcne.	deciduous	allochthonous
Crataegus monogyna Jacq.	deciduous	autochthonous
Euonymus europaeus L.	deciduous	autochthonous
Forsythia × *intermedia* Zab.	deciduous	allochthonous
Ilex aquifolium L.	evergreen	autochthonous
Juniperus × *media* Melle	evergreen	allochthonous
Juniperus virginiana 'Gray Owl'	evergreen	autochthonous
Ligustrum vulgare L.	deciduous	autochthonous
Lonicera nitida L.	evergreen	allochthonous
Lonicera pileata Oliver	deciduous	allochthonous
Lonicera tatarica L.	deciduous	allochthonous
Mahonia aquifolium (Pursh) Nutt.	evergreen	autochthonous
Philadelphus coronarius L.	deciduous	allochthonous
Physocarpus opulifolius (L.) Maxim.	deciduous	allochthonous
Rosa canina L.	deciduous	autochthonous
Rosa × *hybrida* Vill.	deciduous	allochthonous
Sambucus nigra L.	deciduous	autochthonous
Spiraea × *billardi* Meehan	deciduous	allochthonous
Spiraea × *vanhouttei* (Briot.) Zbl.	deciduous	allochthonous
Symphoricarpos albus (L.) Blake	deciduous	allochthonous
Syringa vulgaris L.	deciduous	autochthonous
Taxus baccata L.	evergreen	autochthonous
Thuja occidentalis L.	evergreen	allochthonous
Viburnum lantana L.	deciduous	autochthonous
Viburnum opulus L.	deciduous	autochthonous

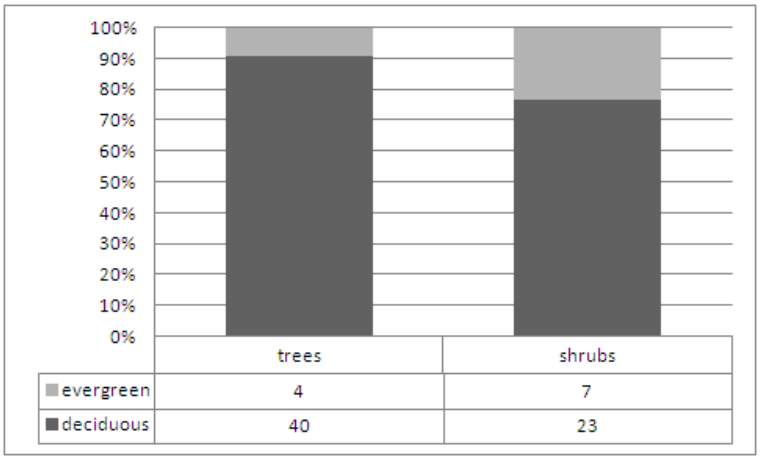


Figure 2. The total number and the ratio between deciduous and evergreen plants in the Great Park in Sarajevo

It is necessary to plant more evergreen plants, that are resistant to climatic factors in Sarajevo: *Pinus sylvestris* L., *Prunus laurocerasus* L., and to increase the number of *Picea abies* (L.) Karsten, *Pinus nigra* Arnold and *Mahonia aquifolium* (Pursh) Nutt. When choosing shrub species, it is recommended to plant more flowering shrubs, in order to improve the colour of the park during spring and summer: *Potentilla fruticosa* L., *Spiraea* × *bumalda* 'Elegans', *S. media* F. Schmidt, *S. ulmifolia* Scop., and *Hibiscus syriacus* L.

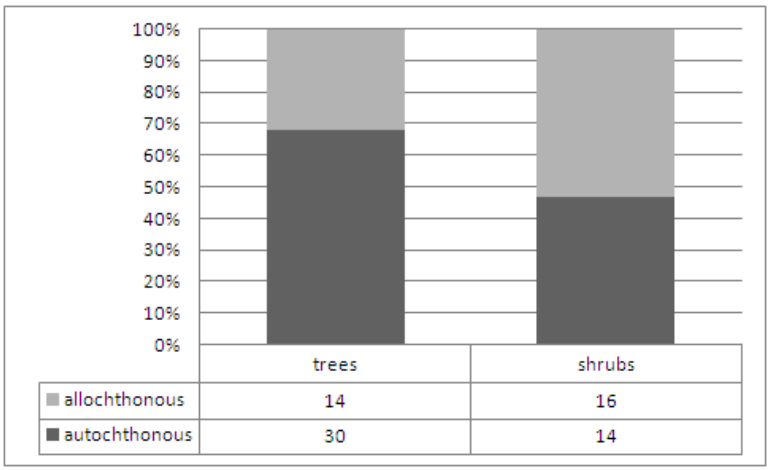


Figure 3. The total number and the ratio between autochthonous and allochthonous plants in the Great Park in Sarajevo

Although the ratio between autochthouous and allochthonous plants in the Great Park is satisfactory, it is recommended to plant more *Picea omorika* (Pančić) Purk and *Buxus sempervirens* L. – autochthonous evergreen plants that have very high ornamental properties and are highly resistant to climatic factors in Sarajevo. The choice of plant species and cultivars for should fulfill

all functions that are expected from this type of green area, and the plants should be able to endure drought and low winter temperatures.

Conclusions

After the identification and valorization of green area of the Great Park in Sarajevo, the following conclusions can be made:

- The Great Park, located in the Center municipality of the city of Sarajevo, is the first public green area in Bosnia and Herzegovina created during the rule of Austro-Hungarian monarchy, and is the valuable monument of cultural, historical and biological heritage.
- During this research, 74 species and cultivars (44 trees and 30 shrubs) were identified.
- Of total 44 tree species and cultivars, 30 (68,18%) are autochthonous, and 14 (31,82%) allochthonous.
- Of 30 shrubs, there are 14 (46,6%) autochthonous and 16 (53,4%) allochthonous species and cultivars.
- There is a large deficiency of evergreen plant species, which gives this green area insufficient decorative effect during the late autumn and winter. Of total 44 tree species and cultivars, 40 (90,9%) are deciduous and only 4 (9,1%) evergreen, and of 30 shrub species 23 (76,6%) are deciduous and 7 (23,4%) are evergreen.
- It is necessary to plant more evergreen plants, that are resistant to climatic factors in Sarajevo.
- When choosing shrub species, it is recommended to plant more flowering shrubs, in order to improve the colour of the park during spring and summer.

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ИДЕНТИФИКАЦИЈА, ВАЛОРИЗАЦИЈА И ЗАШТИТА НА ИСТОРИСКИТЕ ПАРКОВИ ПОВРШИНИ ВО ГОЛЕМИОТ ПАРК ВО САРАЕВО

Авдиќ Јасна, Сарајлиќ Нермина, Бечиќ Берина

Апстракт

Наследството на паркот во Босна и Херцеговина не е запишано или евалуирано, неговите историски градини и паркови не се категоризирани, а многу мал дел од нив се заштитени како споменици на пејзажната архитектура или како културно-историски споменици. Големиот Парк, лоциран во еден од најфрекфентните делови на Сараево, има исклучително хортикултурно и историско значење. Делумно ја има изгубено својата функционална и естетска вредност заради уништувањата во текот на војната од 1992 до 1995 година, но исто така и поради слабото одржување и неорганизираното садење на дрвја и грмушки. Со оглед на фактот дека Големиот Парк е прв јавен парк во Сараево, основан во 1885 година, неговата вредност може да се набљудува и од културно-историски аспект. Затоа е потребно да се изврши проценка на оваа зелена површина, да се утврди фактичката состојба на растенија и да се предложат методи за реконструкција со што ќе се обнови или нагласи нивната функционална, биолошка и еколошка вредност. Избор на растителни видови за реконструкција на Големиот Парк мора да ги исполни сите функции кои што треба да ги има една зелена површина: декоративни-естетски, санитарно-хигиенски и културно-образовни.

Клучни зборови: големиот парк во Сараево, историски зелени површини, идентификација, валоризација, заштита.

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Original scientific paper

DYNAMICS OF NO_3-N IN THE SOIL UNDER PEPPER AS DEPENDENT ON FERTILIZATION SYSTEMS AND MULCHING

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Abstract
In a field trial set up on the research field of Agricultural station in Sombor, the effect of different fertilization systems and mulching on yield of pepper (varieties) and mineral nitrogen (N) dynamics in soil were studied. Trial was conducted during 2010 and 2011 cropping seasons. Pepper was grown with and without plastic foil as a ground cover, and on both mulching systems it was applied 240 kg N ha^{-1} in total, through different fertilization systems. Four organic fertilizers were applied: mature cattle manure (MCM); composted pig manure (CPM); vermicompost (G) and organic fertilizer *Fertor* (F). Each organic fertilizer was applied in two different amounts which contained 120 and 240 kg N ha^{-1}. On the same plots, mineral N fertilizers were added to fulfill target value for N application (240 kg N ha^{-1}). The monitoring of NO_3-N in soil during the pepper growing season has shown that the mineralization of organic fertilizers was most intense in the first half of vegetation, while in the second, during the yield formation, concentration of mineral nitrogen in soil was significantly reduced. Concentration of mineral N in soil under plastic mulch was significantly higher compared to plots without mulch. Yield of pepper in first and second term of harvest were positively correlated with concentration of mineral N in soil.
Key words: soil, NO_3-N, fertilization systems, pepper, yield.

Introduction

Vegetable cultures produce high yields during a short vegetation period so they have greater demands for nutrients, primarily nitrogen, which is an essential factor affecting yield. In order to achieve high and stable good-quality yields in a short vegetation period of vegetable crops, not only mineral but also organic fertilizers need to be applied. Mineral fertilizers are fast-acting sources of nutrients. Organic fertilizers have a twofold effect on crops as they not only provide nutrients for the crops but they also positively affect the physical and biological properties of the soil. Organic fertilizers contain higher proportions of nutrients in an organic form, which is only after mineralization transformed into plant-available forms. It is therefore necessary to access the mineralization potential of organic matter in the fertilizer by following its nitrate dynamics so that the choice of an appropriate fertilizer and the time of its application can be coordinated with the demands of the crops (Čabilovski, 2009). Nitrate dynamics in the soil is affected by numerous factors, the most important of which are temperature and humidity. Soil humidity directly affects the mineralization process and thus the mineral nitrogen content in the soil.

Low or excessive humidity can be stressful for microorganisms in the soil and it can inhibit their growth (Stanford and Epstein, 1974; Myers *et al*., 1982; Bogdanović *et al*., 2001; Ubavić *et al*.,

2005), while alternating high and low levels of humidity increase the amount of fast-mineralizing material. Temperature directly affects the decomposition of organic matter, while the microorganisms that are involved in the process have different temperature oscillations. Vegetable production in an open field occurs in the period of constant increase of soil temperature (10-15-25-30ºC) and, as intensive vegetable production is not possible without irrigation, this means that there are favourable conditions for the mineralization of applied organic fertilizers and organic matter in the soil. The rate of organic fertilizer mineralization is determined by the type of fertilizers, the degree of decomposition of organic matter, temperature, humidity and microbiological activity (Pansu and Truries, 2003). Due to intensive mineralization, an excessive application of organic fertilizers can lead to an increased accumulation of NO_3-N in the soil, harmful accumulation in the plants and pollution of the environment. The objective of this research is to assess the effect of different systems of fertilizing pepper grown under polyethilene (PE) foil and without PE foil on NO_3-N dynamics in the soil and their effect on the yield.

Material and methods

The dynamics of NO_3-N in pepper production was observed in field experiments set up using a split plot design with and without PE foil. The experiments are two-factorial, where factor A is the fertilization systems and B is the use of PE foil as mulch (Table 1).

Table 1. Treatments of fertilization and mulching

Number of treatments	Treatments of fertilization systems
1	Control–no fertilizer
2	100% of N dose applied through NPK[1] mineral fertilizers
3	50% of N dose applied through mature catle manure (MCM) and 50% N through NPK mineral fertilizers
4	100% of N dose applied through MCM
5	50% of N dose applied through vermicompost (V) + 50% applied through NPK mineral fertilizers
6	100% of N dose applied through V
7	50% of N dose applied through composter organic fertilizer *FERTOR* (F) + 50% applied through NPK mineral fertilizers
8	100% of N dose applied through F
9	50% of N dose applied through composted pig manure (CPM) + 50% applied through NPK mineral fertilizers
10	100% of N dose applied through CMP
	Mulch treatments
1	Use of black polyethilene foil as ground cover
2	Without use of black polyethilene foil

Table 2 gives the initial results of agrochemical analyses of the soil before planting. The soil in the experiments is hydromorphic, of semigley type (meadow black soil) with the following properties:

Table 2. Agrochemical properties of soil in exspperiments before pepper planting

Year	Depth	pH		$CaCO_3$ (%)	humus (%)	total N (%)	mg $100g^{-1}$		mg NO_3-N kg^{-1}	
		H_2O	KCl				P_2O_5	K_2O	before planting	after planting
2010	0-30	7.60	7.0	4.59	3.12	0.16	21.9	22.1	36.0	27.0
	30-60	7.80	7.0	5.42	2.96	0.15	14.3	21.0	41.6	38.0
2011	0-30	8.01	6.85	3.82	2.48	0.12	17.8	21.3	46.4	30.0
	30-60	8.11	6.98	13.58	1.99	0.10	6.7	16.5	22.1	23.0

Neutral reactions, weak to medium carbonate, medium to poor in humus for vegetable production, medium supplied in total and mineral nitrogen, medium to poor in easily available phosphorus and medium supplied in easily available potassium.

- For the analysis of soil fertility standard methods were used.

-NO_3-N in the soil was measured in the 0-30 and 30-60cm layers four times during vegetation: before planting the seedlings, during intensive growth, before the first and second harvest. Analysis of mineral nitrogen in soil was done by Nmin method of Scharpft and Wehrmann (1978). The chemical composition of the applied fertilizers is given in Table 3 and Table 4.

Table 3. Chemical compozition of applied organic fertilizers at the exsperiment

Organic fertilizers	% N		% P_2O_5		% K_2O	
	2010	2011	2010	2011	2010	2011
Composted pig manure (CPM)	1.30	3.07	3.58	4.90	1.68	1.32
Mature catle manure (MCM)	1.20	2.20	1.82	3.17	0.33	0.91
Vermicompost (V)	1.50	1.38	1.75	2.15	1.83	0.96
Organic fertilizer *Fertor* (F)	4.50	4.25	2.70	2.90	2.30	2.30

On the basis of nitrogen content in the organic fertilizers, the amounts were calculated depending on the treatment applied in the pepper fertilization experiment (Table 1).

Table 4. Concentration of micronutrients and heavy metals in organic fertilizers

Organic fertilizers	Mn (mg kg^{-1})	Fe (mg kg^{-1})	Zn (mg kg^{-1})	Cu (mg kg^{-1})	Cd (mg kg^{-1})	Ni (mg kg^{-1})	Pb (mg kg^{-1})
Mature catle manure (MCM)	177	1087	35.8	5.54	1.56	78.86	7.12
Composted pig manure (CPM)	123	792	170.1	31.69	1.52	88.62	3.63
Vermicompost (V)	171	1054	45.2	8.9	1.59	59.34	7.78

Pepper seedlings of the Amfora variety were obtained from Grow rasad company from Irig. The pepper was planted towards the end of May in both years, with 25cm within-row and 50cm between-row distance, which gave 8 plants per m^2. The first and the second harvests were

performed during optimum technological maturity. The research results were processed by variance analysis for a two-factorial experiment.

Results and discussion

NO_3-N dynamics in the soil under pepper with and without foil, dependent on applied fertilization systems, and fertilization treatments in 2010 and 2011 is given in Figure 1 and Figure 2. In both years a higher amount of NO_3-N was detected at all sampling times, with all systems and fertilization treatments in pepper under foil than in pepper without foil.

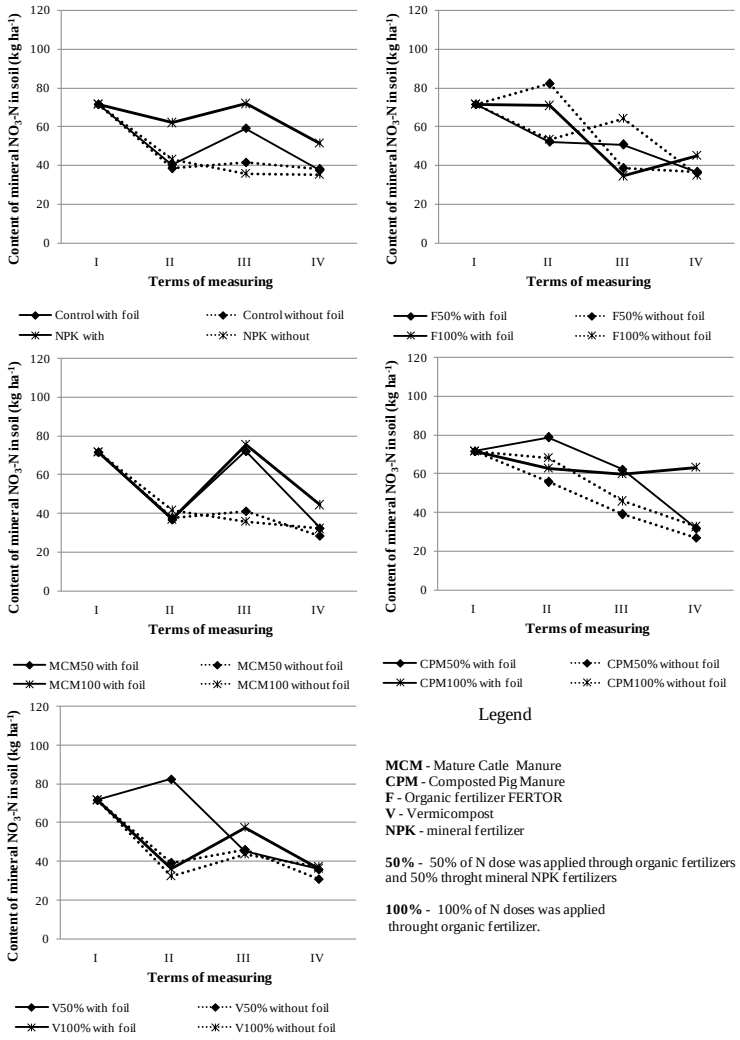


Figure 1. NO_3-N dynamics in the soil under pepper with and without foil, dependent on applied fertilization systems, and fertilization treatments in 2010

Significantly higher amounts of NO_3-N were found in the soil under foil than in the soil without foil because of better mineralization conditions. The basic prerequisite for a better mineralization of

organic fertilizers is a 2-3°C higher temperature and 1.5%-2.5% higher soil humidity in the experiment under foil when compared to the experiment without foil.

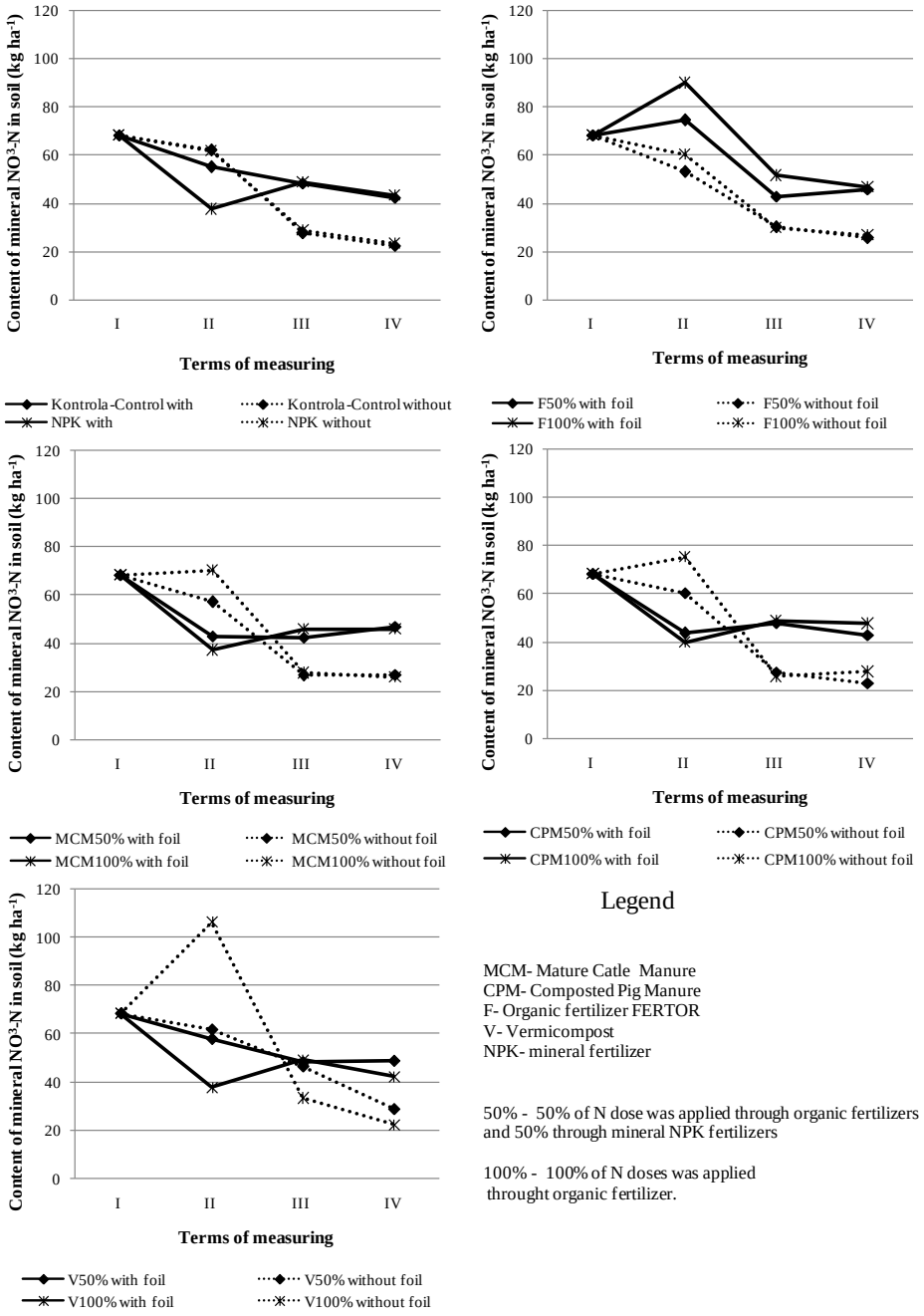


Figure 2. NO_3-N dynamics in the soil under pepper with and without foil, dependent on applied fertilization systems, and fertilization treatments in 2011

The exception is the sampling made during intensive growth in 2011, in which the sample taken from the plot with pepper without foil had a significantly higher amount of NO_3-N with all fertilization treatments.

The highest amount of NO_3-N in the soil under foil was recorded in the experiment in 2011 with 100% Fertor fertilization systems, and on the plots without foil with the application of N from vermicompost.

In the first harvest, the highest value of NO_3-N in the soil in 2010 was recorded with the treatment N from 100% MCM, and in the second harvest with the treatment N from 100% CPM under foil.

The recorded values of NO_3-N under pepper with and without foil at different sampling times indicate that organic fertilizer N mineralization was more intensive in the first period of vegetation, during intensive growth, as compared to the second period of vegetation, when lowest values were recorded at the end of the second harvest.

The recorded amounts of NO_3-N at different sampling times represent a state of equilibrium between the mineralization of applied organic fertilizers and soil organic matter on one hand, and the immobilization of mineral nitrogen by pepper crops and microorganisms on the other (Bogdanović and Čabilovski, 2007; Bogdanović and Ubavić, 2008; Čabilovski *et al*. 2010).

NO_3-N dynamics in soil under pepper in the experiments with and without foil correlates positively with obtained yields in both years. The yields in the experiments with foil were significantly higher with all fertilization systems and treatments than those produced in the experiments without foil Figure 3 and Figure 4. Higher yields in the experiments without foil are directly dependent on the amounts of NO_3-N measured in the soil, which are a result of better conditions for organic fertilizer mineralization (humidity and temperature).

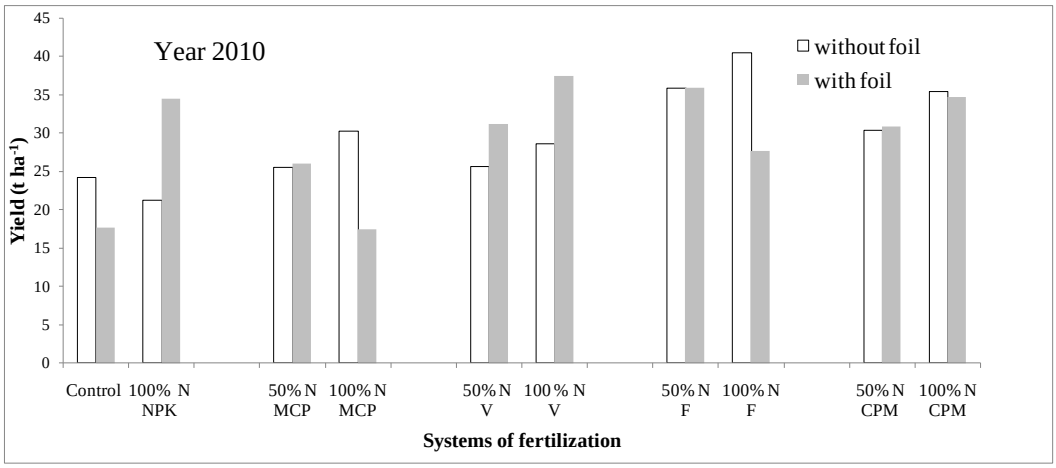


Figure 3. Pepper yield as dependent on fertilization systems and mulching in 2010

Of all the applied organic fertilizers, the highest yields with and without foil were obtained with fertor (F) treatment, followed by composted pig manure (CPM), vermicompost (V), mature cattle manure (MCM), and the lowest with mineral fertilizers (NPK) (Figure 3 and 4). The stronger effect that fertilizing with fertor had on pepper yields when compared to the other applied organic fertilizers stems from the production technology of this fertilizer and its content.

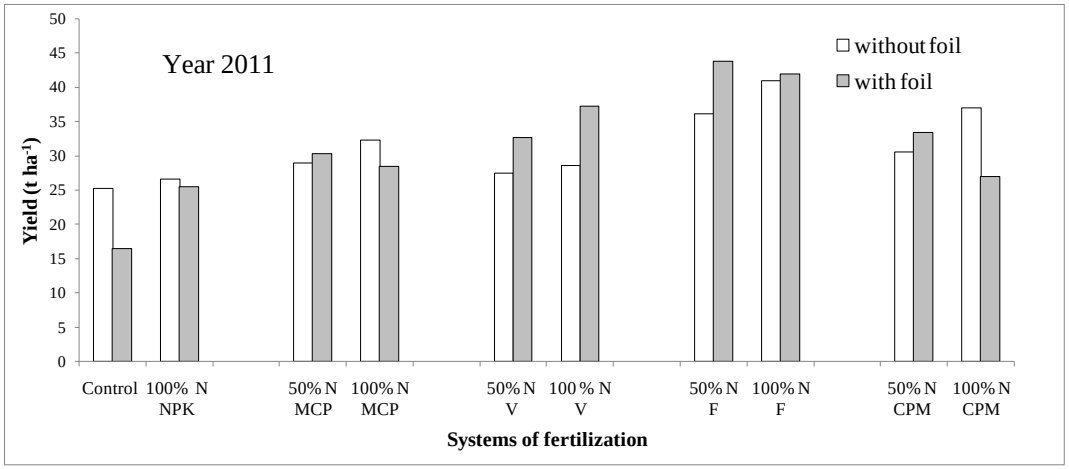


Figure 4. Pepper yield as dependent on fertilization systems and mulching in 2011

Fertor is a pelleted organic poultry manure to which other organic plant materials are added and it contains all biogenic elements. Furthermore, with CPM treatments higher yields were obtained with and without foil than with V, MCM and NPK treatments, which can be explained with significantly higher solubility and the presence of biogenic elements, primarily nitrogen from CPM, when it is compared to other fertilization systems. Research by Denić (2010) on maize and Bogdanović *et al*. (1995) on wheat shows that NO_3-N from liquid pig manure in the year of application had an effect on yield, identical to that of mineral fertilizers.

Conclusions

Based on the observed dynamics of NO_3-N in the soil under pepper with and without foil, depending on the fertilization method and its effect on yield, the following conclusions can be drawn:

- Mineralization of NO_3-N from organic fertilizers was more intensive in the first period of vegetation, during intensive growth, and considerably slower in the second period of vegetation at the times of the first and second harvest.
- The highest amount of NO_3-N was recorded in the soil under pepper with foil in 2010, at the first harvest with N from 100% MCM treatment, and at the second harvest with N from 100% CPM treatment.
- In both years higher amounts of NO_3-N were found with foil than without it, at all sampling times, with all fertilization systems and treatments.
- Pepper yields under foil with all fertilization systems and treatments are significantly higher than those without foil.
- Of all applied organic fertilizers the most favourable effect on the yield both with and without foil was achieved with fertor fertilizer with all treatments, followed by composted pig manure, vermicompost, mature cattle manure, whereas the poorest effect was obtained with a mineral fertilizer.

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ДВИЖЕЊЕ НА NO_3-N ВО ПОЧВАТА ПОД НАСАД ОД ПИПЕРКИ ВО ЗАВИСНОСТ ОД СИСТЕМОТ НА ФЕРТИРИГАЦИЈА И МУЛЧИРАЊЕ

Богдановиќ Даринка, Илин Жарко, Чабиловски Ранко

Апстракт

Во полскиот опит поставен на истражувачките полиња на земјоделска станица во Сомбор, било испитувано влијанието на различни системи за фертиригација и мулчирање врз приносот од пиперки и движењето на минералниот азот (N) во почвата. Опитот бил спроведен за време на вегетационите сезони во текот на 2010 и 2011 година. Пиперките биле одгледувани со и без примена на пластична фолија за мулчирање каде што кај двата начина било аплицирано 240 kg N ha^{-1} преку различни системи за фертиригација. Четири видови на органски ѓубрива биле аплицирани и тоа: зрело арско ѓубриво (MCM), компостирано ѓубриво од свињи (CPM), вермикомпост (G) и органско ѓубриво *Fertor* (F). Секое од огранските ѓубрива било аплицирано во две различни количини кои содржеле по 120 и 240 kg N ha^{-1}. На истите парцели биле додадени минерални азотни ѓубрива за да се достигне целната вредност за апликација на азот (240 kg N ha^{-1}). Следењето на NO_3- N во почвата за време на вегетационата сезона на пиперката покажа дека минерализацијата на органските ѓубрива била најинтензивна во првата половина од вегетацијата, додека во втората половина, за време на формирањето на плодовите, концентрацијата на минерален азот во почвата била значително намалена. Концентрацијата на минерален азот во почвата под пластичната мулч фолија била значително повисока споредено со парцелите кои не биле покриени со фолија.

Клучни зборови: почва, NO_3- N, систем за фертиригација, пиперки, принос.

UDC:634.23:635.9(497.113)
Original scientific paper

MORPHOMETRIC CHARACTERISTICS OF DECORATIVE SOUR CHERRY AND SWEET CHERRY FORMS SHAPED BY PRUNING MEASURES

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Abstract
Collection plot of sour cherry and sweet cherry cultivars at the nursery of Faculty of Agriculture in Novi Sad was established in 2009 year. The aim of the research is to shape the forms of sour cherries and sweet cherries with pruning technique, for use in horticulture and landscape architecture. The study involved one cultivar of sweet cherry and two varieties of sour cherries on two rootstocks. This paper investigated the characteristics of two decorative forms, dwarf and columnar. Natural crown form was translate with pruning measures into dwarf and columnar form as the two most attractive decorative forms. The pruning is done in the period from 2009-2012 year while, morphological measurements were performed in 2012 year. This paper presents the results of morphometric measurements of sour cherry varieties 'Erdi Botermo' and 'Maynard' and sweet cherry cultivar 'Summit' on two rootstocks, 'Oblačinska' sour cherry and magriva. The measured properties included tree height, crown diameter and height, the angle of branching, rooting and crown volume. The largest crown volume (0.8 m^3) and (0.6 m^3) was in the form of dwarf variety 'Summit' and 'Erdi Botermo' on mahaleb as a rootstock. The lowest crown volume had columnar forms of cultivar 'Summit' (0.001 m^3) and cultivar 'Maynard' (0.001 m^3) on 'Oblačinska' sour cherry as a rootstock. The intensity of rooting for all varieties on both rootstocks was satisfactory. Obtained unique dwarf and columnar forms of sour cherries and sweet cherries, combine specific genetic potential of variety, their interaction with the rootstocks and traditional horticultural skills. These forms have a double potential, decorative application and use of fruits as quality table fruits.
Key words: sour cherry, sweet cherry, decoratve forms, characterization.

Introduction

The Balkan Peninsula is one of the most valuable secondary centers of genetic diversity and gene pool sour cherries and sweet cherry (Ljubojević *et al.*, 2011; Ljubojević *et al.*, 2012; Ognjanov *et al.*, 2012). Sweet and sour cherry fruits occupy an important place in the diet, as a natural source of antioxidants, polyphenols and anthocyanins (Stoecklein, 2001a). According to research conducted by Pooler (2007), their decorative use is equally important. In private, amateur orchards and gardens, where fruit species provide fresh produce that meets family needs throughout the year, cherryes are of high value (Stoecklein, 2001b). According to Freeman (2010), sour and sweet cherries are grown in gardens together with other fruity, floral and woody species; thus, due to the limited space available, their vigor and form are important. Growing cherry fruit and ornamental species in the garden is popular because of the reduced need for protection against pests and

deseases, which is highly beneficial, as it implies that the produce is healthy and safe for human consumption. Various crown forms are most often found in sour cherries populations (Schuster, 2009). Biodiversity of natural populations, introduced cultivars and selections, is a source of genetic variability of sour and sweet cherries. In addition to the natural habitus, with a proper choice of rootstock and pruning measures, both sour and sweet cherry can be grown in dwarf, columnar and other decorative forms. According to findings Khadivi-Khub *et al.* (2011), morphological characterization is the first step in the description and classification of germplasm, as well as a good starting point for statistical analysis. As Hrotkó (2004) stated, for the intensive growing of sour and sweet cherry, dwarfing rootstocks compatible with the grafting varieties are necessary. According to research conducted by Keserović *et al*. (2011) on alkaline soils of Vojvodina province, Mahaleb is the best rootstock for the both sour and sweet cherry. Moreover, Long and Kaiser (2010) claim that Mahaleb is the most drought resistant rootstock. 'Oblačinska' sour cherry was traditionally used as a rootstock for both sour and sweet cherry and showed a high degree of adaptability to climate and edaphic conditions in Serbia (Ljubojević *et al.*, 2011). A detailed analysis of dwarfing rootstock anatomy of sour cherry and sweet cherry was reported by Zoric *et al*. (2012).

The subject of this paper is to describe the characteristics of two varieties of sour cherry and one variety of sweet cherry grafted on 'Oblačinska' sour cherry and Mahaleb rootstocks. The aim is to determine the combination of varieties and rootstocks that are most suitable for the development of dwarf or columnar form.

Material and methods

Our collection of decorative sour cherry and sweet cherry was established in the fall of 2009, in the experimental field at the plant nursery of the Department of Fruit Science, Viticulture, Horticulture and Landscape Architecture, in the temperate-continental climatic conditions and černozem soil type. As a part of this project, 1400 grafted seedlings were planted, applying 4 and 2 m spacing between adjacent rows and plants, respectively. Height reduction to 80 cm, in order to enhance uptake of seedlings, was carried out after the plants were repositioned to their permanent location. Pruning of the tree shape was performed in order to achieve dwarf and columnar forms.

This study included two varieties of sour cherry ('Maynard' and 'Erdi Botermo') and one sweet cherry variety ('Summit'). Variety 'Maynard' is characterized by its pyramidal habit, very short internodes, small leaves and small fruits. In contrast, variety 'Erdi Botermo' is characterized by long shoots, large leaves, sparse crown and bent branches. Finally, sweet cherry variety 'Summit' is of lower height, compared to the older, standard varieties of sweet cherry, such as 'Burlat'.

The quantitative characteristics measured using a micrometer of 0.01 mm precision reveal that, in the vegetation period of 2012, the diameter both above and below the graft union was 5 cm. Plant height, crown width, branch length, volume and diameter of branches were measured using tape measure of 1 mm precision. The angle of branching was measured by protractors. The evaluated characteristics were tree shape, as well as crown branching and overgrowth, and rooting intensity. In order to monitor the development of the crown size and shape, the growth of shoots was measured in 30-day interval.Statistically significant differences were analyzed by Dunckan test.

Statistically significant differences were analyzed by applying Duncan test, using STATISTICA 10 (StatSoft Inc., Tulsa, USA) software.

Results and discussion

Many research groups around the world have carried out detailed investigations of sour cherry and sweet cherry low vigor rootstocks. According to Janes and Pae (2004), as low vigor rootstocks are increasingly used, it is important to examine the interaction between the rootstocks and scions and its dependence on environmental conditions. This is of particular importance, given that these interactive mechanisms influence the formation of plant vegetative and reproductive characteristics. The importance of pruning measures as an established technique of garden design has, however, not been investigated in Serbia. Thus, in order to bridge this knowledge gap, we have monitored the development of the grafted seedlings of sour cherry and sweet cherry on rootstocks of different vigor in our collection orchards that provide environmental conditions typical of this region.

Monitoring of indicators of growth in the rootstocks 'Oblačinska' sour cherry and Mahaleb, was conducted at the beginning of the growing season, when the rootstocks started to run juices. The increase in the number of annual shoots was monitored through the observations of the development of the rootstocks. The development of graft diameter was also measured. The obtained results pertaining to dwarf varieties 'Maynard' and 'Erdi Botermo' indicate that we had achieved the appropriate value for height (92.5 cm; 90 cm) and crown diameter (57.5 cm; 57.5 cm), on 'Oblačinska' sour cherry as a rootstock. Columnar form of cultivar 'Maynard' on 'Oblačinska' sour cherry as a rootstock achieved a greater height (165 cm) and smaller crown diameter (9 cm) in relation to the columnar form on Mahaleb as the rootstock, with the height of 140 cm and the crown diameter of 27 cm. Because of the great vigor of Mahaleb rootstock, branching intensity and fouling exhibited higher values than the sour cherry rootstock.

Sweet cherry variety 'Summit' was tested on sour cherry rootstock (*Prunus cerasus* L.) and Mahaleb (*Prunus mahaleb* L.). Considering the vigor of Mahaleb rootstock, dwarf form achieved significant height (137 cm), crown diameter (110 cm) and crown volume (0.8 m^3). Ljubojević *et al.* (2011) reported similar results for Mahaleb, indicating that its use as a rootstock had a significant effect on the vigor of sweet and sour cherry varieties. Columnar form of variety 'Summit' on the rootstock Mahaleb had a high value of crown diameter (45 cm) and vigor (4), which is not a desirable trait in this form. However, better form of this variety was achieved when grafted on the sour cherry rootstock, with height of 120 cm, 10 cm crown diameter and 0.001 m^3 crown volume.

The key characteristics of the two sour cherry and one sweet cherry variety on the two rootstock types are given in Table 1 and 2.

Duncan multiple test revealed statistically significant differences within the varieties grafted on different rootstocks. Dwarf forms of varieties 'Maynard', 'Erdi Botermo' and 'Summit' on the 'Oblačinska' sour cherry showed significant differences in the crown height and diameter in relation to the same features on the Mahaleb rootstock. Considering that Mahaleb is vigorous rootstock, this result was expected and is in accordance with the previously published data. High values of crown diameter (45 cm) of columnar forms in cultivar 'Summit' on rootstock Mahaleb are not desirable and differ significantly from the diameter achieved in other columnar forms. In the dwarf form, the diameter of the graft union in rootstock Mahaleb ranged from 43.8 to 61.1 cm, while in the rootstock 'Oblačinska' sour cherry, it was only 32.6 to 40 cm. The same relation was noted for stem diameter in columnar forms, which was 49.2 to 58.1 cm, when Mahaleb was used as a rootstock. In contrast, with 'Oblačinska' sour cherry as a rootstock, it ranged from 33.1 to 46.6 cm. Thickening at the site of the graft union is the result of production of secondary wood tissue. Thus, its optimal value is approximately equal to the rootstock or scion diameter.

Table 1. Morphometric characteristics of tested varieties sour cherries and sweet cherry on two different rootstock

Rootstock	Genotype	Tree height (cm)	Diameter of the crown (cm)	Crown volume (m^3)	Diameter of 5 cm above the graft union (mm)	Diameter of graft union (mm)	Diameter of 5 cm below the graft union (mm)
		Sour cherry					
		Df/Cf*	Df/Cf	Df/Cf	Df/Cf	Df/Cf	Df/Cf
'Oblačinska' sour cherry	Mejnard	$92.5^{a}/165^{d}$	$57.5^{a}/9^{a}$	$0.01^{a}/0.001^{a}$	$28.2^{a}/24.2^{b}$	$32.6^{a}/33.1^{b}$	$25.5^{a}/30^{a}$
	Erdi Botermo	$90^{a}/-$	$57.5^{a}/-$	$0.043^{a}/-$	$18.3^{c}/-$	$33.2^{a}/-$	$16.5^{c}/-$
Mahaleb	Mejnard	$110^{b}/140^{b}$	$75^{d}/27^{b}$	$0.3^{b}/0.02^{b}$	$43.3^{b}/30.5^{a}$	$61.1^{d}/49.2^{a}$	$51.3^{b}/39.6^{b}$
	Erdi Botermo	$150^{d}/-$	$107.5^{b}/-$	$0.6^{c}/-$	$30.1^{a}/-$	$43.8^{b}/-$	$36.8^{d}/-$
		Sweet cherry					
		Df/Cf	Df/Cf	Df/Cf	Df/Cf	Df/Cf	Df/Cf
'Oblačinska' sour cherry	Summit	$90^{a}/120^{a}$	$37.5^{c}/10^{a}$	$0.03^{a}/0.001^{a}$	$29.8^{a}/29.7^{a}$	$40^{b}/46.6^{a}$	$23.9^{a}/24.4^{a}$
Mahaleb	Summit	$137^{c}/150^{c}$	$110^{b}/45^{c}$	$0.8^{d}/0.02^{b}$	$40.2^{b}/37.2^{c}$	$52.5^{c}/58.1^{c}$	$49.3^{b}/44.8^{b}$

*Df-dwarf form; Cf-columnar form

Differences in values within columns that are not followed by the same letter are statistically significant at a 0.05 significance level by ANOVA Duncan test.

Table 2. Values of qualitative traits

Rootstock	Genotype	Crown branching	Overgrowth intensity	Branching angle (°)	Rooting intensity
		Sour cherry			
		Df/Cf*	Df/Cf	Df/Cf	Df/Cf
'Oblačinska' sour cherry	Mejnard	5/4	5/4	45/45	5/5
	Erdi Botermo	4/-	4/-	50/-	4/-
Mahaleb	Mejnard	5/5	5/5	40/40	5/5
	Erdi Botermo	4/-	5/-	40/-	5/-
		Sweet cherry			
		Df/Cf	Df/Cf	Df/Cf	Df/Cf
'Oblačinska' sour cherry	Summit	3/3	3/3	35/35	4/4
Mahaleb	Summit	4/4	4/4	30/40	4/5

Based on the evaluated characteristics, the crown branching and overgrowth intensity is most pronounced on Mahaleb rootstock. Variety 'Maynard' had good rooting on both rootstocks, while the dwarf form of the variety 'Erdi Botermo' showed better rooting when Mahaleb was used as the rootstock. High values of the crown branching and overgrowth intensity, as well as rooting, were

noted for variety 'Summit' grafted on Mahaleb rootstock, which proved to be the most suitable choice in the first vegetation period, with respect to the examined parameters, such as the crown branching and overgrowth intensity, as well as rooting, for all studied varieties. 'Oblačinska' sour cherry, as low vigor rootstock, proved suitable for dwarf varieties of 'Mejnard', 'Erdi Botermo' and 'Summit' form. The results reported here indicate that, for the purposes of horticulture and landscape architecture, the dwarf tree forms should not be shaped, while seedlings grafted on rootstock Mahaleb require use of pruning measures for most optimal results.

Conclusions

Although dwarf and columnar forms in natural populations are caused by spontaneous mutation, sour and sweet cherry are rarely found in nature in this form. Therefore, it is important to examine the genetic potential of varieties grafted on dwarfing and vigorous rootstocks, in relation to the interactions with the environmental conditions. For commercial production of seedlings of dwarf and columnar form, unless the environmental conditions are optimal, it is necessary to apply extensive gardening skills.

The results of our investigations carried out in ecological conditions provided by the plant nursery in Rimski Šančevi indicate that, in the first vegetation season, 'Oblačinska' sour cherry, as low vigor rootstock, proved suitable for dwarf form of 'Maynard' and 'Erdi Botermo' varieties. In the formation of columnar forms, varieties 'Maynard' and 'Summit' grafted on the 'Oblačinska' sour cherry rootstock had desirable height and crown width values. Considering the great decorative value of these forms, their application in horticulture and landscape architecture, especially in the front gardens and terraces, is possible. In addition to decorative applications, due to the reduced need for protection against diseases and pests, fruits of sweet and sour cherry can also be used as safe and nutritious food.

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МОРФОЛОШКИ КАРАКТЕРИСТИКИ НА ФОРМИ НА ДЕКОРАТИВНА ВИШНА И ЦРЕША ОБЛИКУВАНИ СО МЕРКИ НА КРОЕЊЕ

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Апстракт

Парцелата за колекционирање на сорти на вишна и цреша во расадникот на Земјоделскиот Факултет во Нови Сад беше основана во 2009 година. Целта на истражувањето е да се обликуваат форми на вишна и цреша со техники на кроење, заради нивна употреба во хортикултурата и пејзажната архитектура. Во истражувањето се вклучени два вариетета на вишна и една сорта на слатка на две подлоги. Во овој труд се истражувани карактеристиките на две декоративни форми, џуџеста и столбеста. Природните форми на круните со мерки на кроење беа обликувани во џуџести и столбести форми, кои што се сметаат за едни од најатрактивните декоративни форми. Кроењето се вршеше во периодот од 2009 до 2012 година, додека морфолошките мерења беа извршени во 2012 година. Во трудот се презентирани резултати од морфолошките мерења кај вариететите на вишна 'Erdi Botermo' и 'Maynard' и кај сортата на цреша 'Summit', на две подлоги, 'Oblačinska' вишна и магрива. Измерените својства вклучија висина на дрвото, дијаметар и висина на круната, аголот на разгранување, волумен на коренот и круната. Најголем волумен на круната ($0.8m^3$) и ($0,6m^3$) имаа џуџестите формите на вариетот 'Summit' и 'Erdi Botermo' калемени на вишна. Најмал волумен на круната имаа столбестите формите на култиварите 'Summit' ($0.001\ m^3$) и 'Maynard' ($0.001\ m^3$) со 'Oblačinska' вишна како подлога. Интензитетот на ожилување кај сите вариетети на двете подлоги беше задоволителен. Одржувањето на уникатен облик на џуџести и столбести форми кај вишната и црешата, е комбинација од специфичниот генетски потенцијал на вариететот, неговата интеракција со подлогата и традиционалните хортикултурни вештини. Овие форми имаат двојна примена, како декоративни, а нивните плодови се користат и како трпезно овошје.

Клучни зборови: вишна, цреша, декоративни форми, карактеристики.

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KONJICA'S ONION–A NEW VARIETY FROM BOSNIA AND HERZEGOVINA

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Abstract
Onions are one of the most versatile vegetables, used year round, either fresh (green onions, mature bulbs), or processed (dehydrated, pickled, canned). Choice of cultivar and proper cultural practices are important facets in the production process. Choosing the right cultivars is one way of ensuring high yields and good quality of onions. In Bosnia and Herzegovina, production of the crop from sets predominates. The Federal Institute for Agriculture in Sarajevo has developed a new line, Konjica's onion (Konjički). This paper evaluates production characteristics (yield of bulbs, bulb weight and shape, bulb skin tightness and colour, plant height and length of growing season) and characteristics of quality (dry matter, acid content and total sugar content) of this new line of red onion, tested in Sarajevo-Butmir over three consecutive years (2009, 2010, 2011) with the Stuttgarter cultivar used as a standard. The trials were conducted in a randomised block design with five replicates. The new line is medium late (114 d) and characterised by yellow-brown flattened bulbs (bulb index of 0.68), an average bulb weight of 108.88 g, a well closed neck, very good quality of bulbs (high dry matter (15%) and sugar content (9.51%)) and mildly pungent flavour. Over three years, the variety yielded 33.15 t ha^{-1} on average, 38% more than the standard cultivar.
Key words: red onion, new line, production characteristic.

Introduction

Onions are grown for a variety of purposes, namely as fresh shoots for green 'salad' onions and as bulbs for: (i) consumption uncooked; (ii) consumption cooked; (iii) pickling; (iv) in factory-made food; (v) dehydration; (vi) seed production; and (vii) sets (Brewster, 2008). The purpose of an onion production determines the choice of variety and growing technology. Hence the goal of an onion breeding program varies (Gvozdanović-Varga *et al.*, 1996). Onions may be grown from seed, transplants or seed-grown sets (sets started from seed the previous year). Cultural system is determined by the cultivar`s biology, conditions of the environment and food preferences in the locality (Lazić *et al.*, 2000). Yields are highest where the crop is grown directly from seed and modern growing technologies are fully utilised, whereas yields are low where onions are grown from sets (Gvozdenović *et al.*, 2005). In Bosnia and Herzegovina, onion is extensively cultivated and production of the crop from sets is predominant. In this paper, the Federal Institute for Agriculture in Sarajevo introduces a new variety of red onion-Konjica's onion, specially developed for

production from onion sets to suit the environmental conditions of Bosnia and Herzegovina. The paper evaluates the variety's agronomic performances and characteristics of quality, tested in Sarajevo (Butmir) over three consecutive years with the Stuttgarter cultivar used as a standard.

Material and methods

Variety evaluation trials were conducted in Butmir (43°49′N 18°20′E) in the Sarajevo Canton of Bosna and Herzegovina in 2009, 2010 and 2011. Cultivar Stuttgarter, commonly grown and cultivated from sets in Bosnia and Herzegovina was used as the standard.

Before the trials were set up, average soil samples were taken and chemical analyses were carried out. The soil was of the brown valley type, poorly supplied with phosphorus and moderately supplied with potassium across all three years (data not shown). In accordance with soil tests and commercial recommendations, 56, 112, and 294 kg ha^{-1} of Nitrogen, Phosphorus and Potassium was applied respectively every year. The trials were conducted in a randomised block design with five replicates. Plot size was 6 square meters. March 30th 2009 and 2010 and March 16th 2011 were the sowing dates. Seeds were planted manually in triple rows spaced 30 cm apart and within-row spacing 10 cm resulting in population density of 150 plants per plot. Soil management, pest and disease control was carried out according to standard procedures. The date of technological maturity was recorded. After the onions were lifted and dried, main agronomic traits (yield of bulbs, bulb weight and shape, bulb skin tightness and colour, plant height and length of growing season) and characteristics of quality (dry matter and total sugar content) were measured. Dry matter content was determined after drying 5g of fresh matter at 104°C for two hours. Total sugar content was determined according to the Luf-Šurl method.

Data (mean monthly temperatures and monthly precipitation sums) from the weather station at Butmir were used to obtain weather data for the growing seasons studied. Yield data were analysed for the differences between the standard (Stuttgarter) and the tested variety (Konjički) using analysis of variance. Mean separation was based on a LSD test. Differences were considered to be significant at P=0.05 and P=0.01.

Results and discussion

Growing conditions during variety evaluation trials

Seed-grown sets make a more robust plant at emergence than seeds, have a shorter growing season and the whole plant growth is less dependent on conditions of environment (Brewster, 2008; Đurovka, 2008). If higher temperatures prevail in germination stage, rooting may be shortened and above-ground grow hastened (Đurovka, 2008). During trial years, mean monthly air temperatures in Butmir were within the long-term average range (Figure 1A.). After planting and April temperatures in 2009-2011 were within range of optimal 5-10 ºC and 10-15 ºC for growing stages rooting and germination, respectively. Therefore, well developed above-ground plant parts and a strong rooting system secured good bulb formation. According to Jones and Mann (1963), under conditions of extremely high temperatures, bulbs will mature early and yields may be reduced; at low temperatures, maturity is usually delayed, curing becomes difficult, and storage quality is often impaired. In 2009-2011 trials in Butmir during the stage of bulb formation (late April and early May), mean monthly air temperatures though lower than the optimal for the stage (22 ºC) (Lazić *et. al*., 2001) were higher than nine-year average so both varieties obtained good yields. Irrigation during leaf and early bulb growth ensures that onion crop reaches a high LAI (Leaf Area Index) as

quickly as possible. This will tend to promote rapid ripening and good bulb quality for storage (Brewster, 1990). In Butmir wetter-than-average conditions were observed in January, March and June in 2009 and 2010 (Figure 1B). April in all three seasons was unusually dry. Compared to the multiyear average (74.5 mm) July of 2010 was extremely dry (19.2 mm). Irrigation late in bulbing may delay maturity and reduce bulb quality by virtue of skin splitting and rotting, particularly if they follow a period in which growth has been restricted by lack of water or Nitrogen nutrition (Brewster, 1990). Although July 2011 summed 134 mm of precipitations, nearly twice than was recorded in the 1996-2005 period (74.5 mm), all rain fell late in the month when the crop had already been lifted. That was the reason why the bulb yield remained good in 2011 (Table 2.).

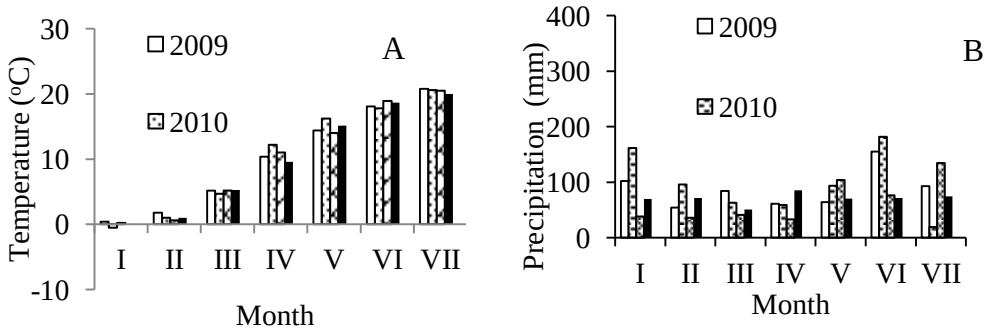


Figure 1. Weather conditions in onion growing season. Panel A, mean monthly air temperatures. Panel B, monthly precipitation sums

Agronomic and quality attributesof Konjica's onion

In onion, bulbing will not start until the temperature-day-length combination exceeds the minimum requirement. Thus from year to year a considerable spread may occur in the maturity date of a given cultivar (Jones and Mann, 1963). The new variety, Konjički, is medium late (in 2009 and 2010 technical maturity reached in 114 days, while in 2011 in 129 days), just as the standard is (data not shown). The plants are well developed and have erect leaves that are dark green in color and have a pronounced waxy coating. The height of the above ground portion of the plant is 58.96 cm, making the new line 1.8 cm taller than the standard (Table 1.). The number of hearts in the bulb is positively correlated with the number of germs (Gvozdanović-Varga *et al*., 1996) but negatively correlated with bulb shape, so flattened varieties most often have 1-2 hearts with a larger number of germs. Konjica`s onion is characterised by a flattened bulb (bulb index of 0.68) that is yellow-brown in color and has a well closed neck. Its leaves are juicy and white-yellow in color, while the bulb has 1-2 hearts. The average weight of the bulb over the three study years was 106.88 g, which is 17.25 g more than the standard. The bulb is well enveloped and there are no cracks in the bulb skin.

Table 1. Characteristics of the above-ground plant parts and the bulb

Variety	Plant height (cm)	Average bulb weight (g)	Bulb index	Bulb skin tightness (1-9)	Colour	Pungency
Konjički	58.96	106.88	0.68	8	Yellow-brown	Mildly pungent
Stuttgarter	57.15	89.63	0.68	9	Yellow-brown	Mildly pungent

The average dry matter content over the three years was 15.41%, which is typical of onion populations from former Yugoslavia grown from sets (Gvozdanović-Varga *et al.* 2005). Sugar content as a quality indicator of onion, affects bulb storage life (Fenvick and Hanley 1990). New variety had high level of total sugars (9.51%), but still lower levels than the standard (10.61%) (Table 2).

Table 2. Quality attributes of Konjički and Stuttgarter variety in 2009-2011

Variety	Konjički			Mean	Stuttgarter			Mean
Trait	2009	2010	2011		2009	2010	2011	
Dry matter (%)	14.00	18.78	13.45	15.41	13.31	15.09	13.42	13.94
Total sugars (%)	9.50	8.60	10.43	9.51	9.80	10.20	10.50	10.16

In all trial years, the new variety significantly out-yielded the standard variety (Table 3.). Tested varieties yielded the lowest in 2010 (21.00 t ha^{-1}), 12.26 t ha^{-1} and 13.72 t ha^{-1} less than in 2009 and 2011, respectively. Maximal yield varieties were obtained in 2011 (Table 4). Temperature and rainfall conditions, in contrast to day-lengths, are never exactly alike, year after year, in the same district; consequently, onion cultivars cannot be expected to perform consistently, even though cultural practices are similar (Jones and Mann, 1963). Over the three years, the new tested variety- Konjički obtained an average yield of 33.15 t ha^{-1}, or 27% more than standard variety- Stuttgarter (26.17 t ha^{-1}) (Table 5).

Table 3. Yield of Konjički and Stuttgarter variety in 2009-2011. Asterix indicates significant differences at *P*=0.05 and *P*=0.01 by LSD test

Variety	Year					
	2009		2010		2011	
	Yield (t ha^{-1})	%	Yield (t ha^{-1})	%	Yield (t ha^{-}	%
Stuttgrater	29.16	100	18.00	100	31.35	100
Konjički	37.36**	163	24.00**	133	38.10**	121
LSD $_{P=5\%}$	1.51		1.08		0.63	
LSD $_{P=1\%}$	2.17		1.57		1.058	

Onion is one of the important vegetable crops grown in Bosnia and Herzegovina. It is extensively cultivated (mainly for domestic production) by small holdings with no irrigation possibilities, thus production of the crop from sets is predominant. Culture system (production from seed-grown sets), high quality and good agronomic characteristics make the new variety, Konjica's onion (Konjički), highly suitable for production conditions in our country.

Table 4. Effect of year on onion yield

Year	Yield in t ha^{-1} (average for both varieties)	%
2009	33.26	158
2010	21.00	100
2011	34.72	165
$LSD_{P=5\%}$	17.68	
$LSD_{P=1\%}$	40.81	

Table 5. Effect of variety on average yield (2009-2011)

Variety	Average yield (t ha^{-1})	%
Stuttgrater	26.17	100
Konjički	33.15	127
$LSD_{P=5\%}$	10.21	
$LSD_{P=1\%}$	23.56	

Conclusions

In Bosnia and Herzegovina, expansion of domestic varieties, development of varietal technology and controlled onion set production should result in an increase of domestic production of the crop and reduction of its import from abroad.

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КОЊИЧКИ КРОМИД - НОВА СОРТА ОД БОСНА И ХЕРЦЕГОВИНА

Јосип Чота, Јелица Гвоздановиќ- Варга, Мирјана Васиќ, Анамарија Петровиќ, Јелена Чота, Вида Тодоровиќ, Александра Савиќ

Апстракт

Кромидот е зеленчук кој наоѓа примена во текот на целата година, било да е во свежа состојба (зелен кромид, зрели луковици) или преработен (сушен, кисел, конзервиран). Изборот на сорта и соодветни земјоделски практики се значајни аспекти во процесот на производство. Изборот на правилна сорта е еден од начините со кој се обезбедува висок принос и добар квалитет на кромидот. Федеративниот институт за земјоделство во Сараево создаде нова сорта на кромид- Коњички кромид. Во овој труд се оценети производните карактеристики (принос од луковици, тежина и форма на луковиците, дебелина и боја на лушпата на луковицата, висина на растенијата и должина на вегетациониот период) и квалитативните карактеристики (сува материја, содржина на киселини и вкупна содржина на шеќери) на оваа нова сорта на црвен кромид, испитувана во Сараево-Бутмир, во текот на три последователни години (2009, 2010, 2011), при што сортата Stuttgarter се користеше како стандард. Опитите беа спроведени во рандомизиран блок систем со пет повторувања. Новата сорта е средно доцна (114 дена), карактеристична по жолто-кафените сплескани луковици (индекс 0,68), просечна маса на луковиците од 108,88 g, добро затворен врат, многу добар квалитет на луковиците (висок процент на сува материја-15% и содржина на шеќер- 9,51% и малку лут вкус). Во текот на трите години просечниот принос на сортата беше 33.15 t ha^{-1}, што е за 38% повисок од приносот на стандардните сорти.

Клучни зборови: црвен кромид, нова сорта, производни карактеристики.

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INFLUENCE OF COMPOUND MINERAL FERTILIZERS PRODUCED BY DIFFERENT TECHNOLOGIES ON YIELD AND QUALITY OF LETTUCE

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Abstract
Overabundant and unbalanced input of nutritional elements to soil has a negative effect to the yield and quality of lettuce. Accumulation of nitrates and harmful effects of the chloride ion are the reasons why there is a need to establish an optimal quantity and relation of nutrients in lettuce nourishment. In the experiment which was carried out during years 2010 and 2011 on the farm of Secondary Agricultural Boarding School in Futog, nitrate content in a fresh mass of lettuce (mgNO3 kg^{-1}) was obesrved, in dependence on applied compound fertilizers. produced by different technologies at different quantities of nitrate and potassium fertilizers. The results of the research show that in a technological ripeness, the highest average lettuce yield has been obtained in the treatment where the highest dosage of nitrate fertilizers was used in spring, in a combination with complex fertilizers in autumn. The lowest average yield has been obtained on the control plot. The highest average nitrate concentration in a fresh lettuce mass has been recorded in using technology of applying mixed fertilizers and the smallest in using a technology of complex fertilizers. At the moment of harvest, the highest nitrogen content in a dry mass of a plant has been recorded when complex fertilizers of phosphorus and potassium were used by the technology of mixed fertilizers.
Key words: soil, nutritional elements, nitrates, lettuce, yield.

Introduction

The research results made by several scientists have shown that the yield and chemical content of lettuce depend on:variety, prodouction conditions, mineral nutrition, termines of sowing and harversting (Brunsgaard *et al.*, 1994; Sady *et al*., 1995; Bronzeti, 1997).

Among all the factors that influence total yield, 30-70% belong to a correct nutrition or fertilizing (Богдановић and Убавић, 2008). The influence of fertilizes can be positive and negative (Кастори, 1995; Чувардић *et al*., 1999, 2004; Богдановић *et al*., 1999).

A positive influence of fertilizing results in fertility increasing and biological soil activity.(Богдановић *et al.*, 1997; 1998). It has also been noticed that genetic productivity potential can be fully expressed only under the condition of an optimal and balanced nutrition (Богдановић and Убавић, 2008). Fertilizes can also have negative influence on quality of vegetables and living environment. For example, overabundant and untimely usage of nitrogen can lead to enormous increasing of nitrate in lettuce leaves, as well as increasing of nitrate concentration in ground waters (Brumm and Schenk, 1993). Lettuce belongs to the group of nitrophilic plants so it is apt to harmful nitrate accumulation in leaves. High nitrate content in an organism of human being can cause

methemoglobinemia and forming of carcinogenic nitrosamines and nitrosamides (Кастори *et al*., 2005). It should not neglect lettuce sensibility to chloride ion (Cl^-).

All these facts lead to a conclusion that lettuce fertilizing needs special care in choosing a corresponding type of fertilizer and its dosage. The aim of this research was to find out and confirm the effect of compound mineral fertilizers produced by different technologies, to lettuce yield and quality.

Material and methods

In 2010 and 2011 a field experiment was set up on the farm of Agricultural Boarding School in Futog, in a split- plot design in four repetitions. The influence of compound mineral fertilizers produced by different technologies, on lettuce yield and quality, was explored by different technologies:

a) by a simple blending of particular fertilizers

b) by a chemical reaction between the components

c) by compacting (under pressure) without chemical reactions between the components

In nutrition of lettuce, different dosage of nitrogen and potassium fertilizers was applied. (Table 1.)

Table 1. Fertilizing treatment schedule in the lettuce experiment

	Fertilization	Treatments		Total of introduced nutrients		
	Autumn		Spring	N (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)
1		Ø		/	/	/
2	400kg/ha NPK (8:16:24)	Mixed		90	64	96
		Compact	58 kg/ha N			
		Complex				
3	400kg/ha NPK (8:16:24)	Mixed		70	64	96
		Compact	38 kg/ha N			
		Complex				
4	400kg/ha NPK (8:16:24)	Mixed		90	64	120
		Compact	58 kg/ha N +			
		Complex	24 kg/ha K2O			

In the autumn, before spreading mineral fertilizers, soil samples were taken for basic chemical properties analysis. The results of soil agrochemical analysis are shown in table number 2.

Table 2. Agrochemical soil properties before an application of fertilizers

Depth	pH		$CaCO_3$	Humus	N	mg P_2O_5	mg K_2O	NO_3-N
	H_2O	Cl	(%)	(%)	(%)	$100g^{-1}$	$100g^{-1}$	kg/ha
0-30	7,74	7,04	8,4	1,38	0,09	63,87	32,8	13,18
30-60	8,07	7,17	15,96	0,84	0,05	15,45	18,16	17,05

The analyzed soil belongs to carbonated chernozem on alluvial depositions have following chemical properties:

The analyzed soil has neutral reaction, it belongs to the carbonated, weak humus soil class, and it is poor in total nitrogen. The content of easily reached phosphorus is very high in the soil layer of 0-30cm, while it is middle secured in the layer of 30-60 cm. Easily reached potassium is between optimal boundaries for vegetable production. Standard methods were used for soil fertility analysis.
The mineral nitrogen content in the field conditions was determined in samples of natural soil moisture by Scharpf and Wehrmann method (1978).
The lettuce was planted into an open field on 29th March 2011 at 30 cm space between the rows and 25 cm between the plants which supplied the group of 11 plants per m2. In the second half of April in the phase of developing of leaf rosette, nitrogen sulfate (urea) and potassium (potassium sulfate) fertilizers were spread. Lettuce harvesting was on 17th May 2011 in the phase of technological ripeness.
The following parameters were observed during the period of vegetation:

- The yield of fresh leaf mass (the plant mass in its technological ripeness).
- Nitrate concentration in a fresh leaf lettuce mass (mg NO_3 kg^{-1}) in phase of leaf rosette developing at harvesting time.
- The content of the total N, P, K (%) in the shoot when developing leaf rosette and in technological ripeness.
- Content of the total phosphorus was determined destruction of plant material with H_2O_2 and $HClO_4$.
- The content of total phosphorus in the plant material was determined from parental solution from which the phosphorus concentration was determined (JANWAY), (Арсенијевић-Максимовић and Пајевић, 2002).
- The nitrate content in lettuce after extraction by distilled water and applying of phenol disulphonic acid and ammonium hydroxide, was determined by spectrophotometry (λ, 420) (Арсенијевић-Максимовић and Пајевић, 2002).

Statistic data processing was made by method of variance analysis by the program STATISTICS 7. Statistical importance of differences was tested by LSD test.

Results and discussion

Statistically important difference between the treatments in which mineral fertilizers that have been applied and those where mineral fertilizers haven't been applied, has been established. The highest average lettuce yield (796,1 g plant^{-1} or 87,6 t ha^{-1}) was recorded at the second treatment where the higher dosage of nitrogen fertilizers was applied with the usage of complex fertilizers technology. The average yield values per fertilizers treatments, depending on applied dosage of nitrogen and potassium fertilizers, show that the highest yield was realized at the second treatment (85,0 t ha^{-1}), while the lowest yield (78,5 t ha^{-1}) was recorded at the treatment number three.
Higher dosage of nitrogen fertilizers as well as the combination of nitrogen with potassium fertilizers had a good influence on the height of lettuce yield. If we compare the average lettuce yields depending on applied technologies of compound mineral fertilizers, we find out that the highest average yield of lettuce was when fertilizing by the compact fertilizer (751,5 g plant^{-1} or 82,7 t ha^{-1}) and the lowest was when applying the complex fertilizer (716,0 g plant^{-1} or 78,8 t ha^{-1}).
Lettuce belongs to the group of nitrophilic vegetables, which means that it is apt to nitrate accumulating. According to the vegetable classification of nitrate content in a fresh leaf mass (Correand, Breimer, 1979; Terbe *et, al.*, 1986), lettuce belongs to the vegetable group with the

highest nitrate content (over 2500 mg NO3 kg⁻¹ of a fresh mass), together with red beet, celery, radish, spinach etc. Nitrate content in a fresh lettuce mass in dependence of used compound fertilizers produced by different technologies at the usage in nutrition of different quantities of nitrogen and potassium fertilizers were shown in table number 4.

Table 3. Average yield of lettuce at the end of vegetation depending on the treatment of fertilizing and of production technology of compound fertilizers

Fertilization		Yield of lettuce (g plant ⁻¹)	Average	Yield of lettuce (t ha⁻¹)	Average
Treatments					
In autumn N32P64K96	In spring - a phase of leaf rosette developins				
Ø	Control	485,1 б	485,1 б	53,4 б	53,4 б
Mixed	58 kg/ha N	758,1 a	738,3 a	83,4 a	81,3 a
	38 kg/ha N	698,9 a		76,9 a	
	58 kg/ha N + 24 kg/ha K_2O	757,8 a		83,5 a	
Compact	58 kg/ha N	765,4a	751,5 a	84,2 a	82,7 a
	38 kg/ha N	712,5 a		78,4 a	
	58 kg/ha N + 24 kg/ha K_2O	776,6 a		85,4 a	
Complex	58 kg/ha N	796,1 a	716,0 a	87,6 a	78,8 a
	38 kg/ha N	728,7 a		80,2 a	
	58 kg/ha N + 24 kg/ha K_2O	623,2 a		68,5 a	
Average		710,2 a		78,2 a	

The values signified by different bold letters within a column are statically of great difference on the level n<0,05.

Table 4. Average nitrate concentrations in fresh lettuce mass (mg NO3 kg⁻¹ of a fresh mass)

Fertilization treatments		A phase of leaf rosette developins	A phase of technological ripenes	Average in treatmetns	Average
In autumn N32P64K96	In spring	27.april	17. may		
Ø Control		1022 b	667 б	844 b	844 b
Mixed	58 kg/ha N	5676 a	2418 a	4047 a	2894 ab
	38 kg/ha N	3918 a	1412 ab	2665 ab	
	58 kg/ha N + 24 kg/ha K2O	2252 ab	1691 ab	1971 б	
Compact	58 kg/ha N	6165 a	2293 a	4229 a	2426 ab
	38 kg/ha N	2136 ab	1531 ab	1833 ab	
	58 kg/ha N + 24 kg/ha K2O	1428 ab	1007 аб	1217 b	
Complex	58 kg/ha N	3967 a	1904 ab	2935 ab	2038 ab
	38 kg/ha N	1906 ab	1472 ab	1689 ab	
	58 kg/ha N + 24 kg/ha K2O	2211 ab	772 b	1491 b	
Average		3068 A	1517 B		

The values signified by different bold letters within a column are statically of great difference on the level n<0,05.

Average nitrate content in fresh lettuce leaf content in a technological peak was reduced nearly to a half according to the measured nitrate values in phase of leaf rosette developing. The lowest nitrate concentration in fresh leaf mass was measured in control plot in both examined phases of lettuce development. In the phase of leaf rosette development, the highest nitrate concentration was in the second treatment at the usage compact fertilizers technology (6165 mg NO_3 kg^{-1} of a fresh mass) and in technological peak, also in the second treatment but at the usage of mixed fertilizers (2418 mg NO_3 kg^{-1} of fresh mass). The highest nitrate accumulation in a fresh lettuce mass was at the usage of mixed fertilizers technology (2894 mg NO_3 kg^{-1} of fresh mass), and the lowest nitrate content was recorded in lettuce plants which were fertilized by the complex fertilizers (2038 mg NO_3 kg^{-1} of a fresh mass). The results like that show that the best nitrate assimilation was at the usage of complex fertilizers. If we look at the the average nitrate content per treatments in the phase of technological ripeness, the highest nitrate quantities in a fresh lettuce mass were recorded at the second treatment (2205 mg NO_3 kg^{-1} of a fresh mass) on which the nitrogen fertilizer was used in quantities of 58 kg ha^{-1}, while the lowest average nitrate content in fresh mass of the plant recorded at the fourth treatment (1157 mg NO_3 kg^{-1} of a fresh mass). The fourth treatment was treated with nitrogen and potassium fertilizer with the quantities of 58 kg ha^{-1} K_2O). The potassium fertilizer which was used for the nutrition at the fourth treatment influenced the reduced accumulation NO_3 ion in a leaf lettuce mass in technological ripeness. It is known that potassium stimulates nitrogen metabolism and participate in protein synthesis. The role of potassium in forming of enzymes in nitrogen reduction reaction and transport systems responsible for nitrogen taking (Kastori and Petrović, 2003). From this, we can conclude that the fourth treatment fertilizing was the best for lettuce production. The content of total nitrogen (N), phosphorus (P) and potassium (K) in a dry mass of lettuce shoot in the period of intensive growing (27th April) and in the technological ripeness was shown in the table number 5.

If we look average values of the nutritive elements in a dry lettuce mass, we can conclude that the nitrogen content decreased in technological ripeness according to the recorded values of this element in the period of developing of leaf rosette. Phosphorus and potassium contents have been constantly increasing during the vegetation period. The results of a two-year research of the organic fertilizers influence on lettuce chemical compositions (Чабиловски, master's thesis, 2009) show that in the both years of research the highest nitrogen content in a dry plant substance recorded in the middle of the period of vegetation, and in opposite to nitrogen, phosphorus and potassium contents have been constantly increasing till the end of the vegetation. During the period of leaf rosette development, the highest nitrogen content (4,57%) in a dry mass of the plant was recorded on the second treatment when mixed fertilizers were used. The highest content of potassium (6,60%) in a dry lettuce mass was recorded also on the second treatment but when complex fertilizers were used, while in this phase of the lettuce development the applied fertilizers didn't influence phosphorus increase in a dry mass of the lettuce shoot. In the period of the technological ripeness, the highest nitrogen content (3,67%) in a dry lettuce mass was recorded on the second treatment when complex fertilizers technology was used. On the third treatment, when mixed fertilizers were used, the highest phosphorus content (0,52%) was recorded in a dry lettuce mass and potassium on the second treatment when mixed fertilizers were used. At the harvest time, when the complex fertilizers technology was used, the highest nitrogen content was reached (3,53%) in a dry

lettuce mass. When the mixed fertilizers technology was used, the highest phosphorus percentage (0,49%) and potassium (6,63%) was reached.

Table 5. Content of nutritive elements in a dry mass of the plant in the phase of leaf rosette and in technological ripeness

Fertilization treatments		Content of nutritive elements in a of the plant				Dry mass	
		N (%)		P (%)		K(%)	
In autumn N32P64K96	In spring	A phase of leaf rosette developing	A phase of technological ripeness	A phase of leaf rosette developing	A phase of technological ripeness	A phase of leaf rosette developing	A phase of technological ripeness
Ø	Control	3,79 б	2,95 б	0,42 a	0,47 a	5,30 б	5,84 б
Mixed	58 kg/ha N	4,57 a	3,66 a	0,40 a	0,49 a	6,19 a	6,81 a
	38 kg/ha N	4,11 аб	3,41 a	0,42 a	0,52 a	6,00 a	6,44 a
	38 kg/ha N + 24 kg/ha K_2O	4,25 a	3,43 a	0,41 a	0,47 a	6,33 a	6,64 a
Averages		4,30	3,50	0,41	0,49	6,17	6,63
Compact	58 kg/ha N	4,38 a	3,61 a	0,44 a	0,47 a	6,53 a	6,59 a
	38 kg/ha N	4,17 аб	3,23 аб	0,44 a	0,48 a	6,22 a	6,42 a
	38 kg/ha N + 24 kg/ha K_2O	3,89 б	3,29 аб	0,41 a	0,47 a	6,33 a	6,64 a
Average		4,15	3,38	0,43	0,47	6,36	6,47 a
Complex	58 kg/ha N	4,30 a	3,67 a	0,39 a	0,46 a	6,60 a	6,47 a
	38 kg/ha N	4,25 a	3,37 a	0,43 a	0,50 a	5,97 a	6,47 a
	38 kg/ha N + 24 kg/ha K_2O	4,13 аб	3,66 a	0,42 a	0,46 a	6,22 a	6,61 a
Average		4,32	3,53	0,41	0,47	6,26	6,51
Average		4,18	3,43	0,42	0,48	6,17	6,47

The values signified by different bold letters within a column are statically of great difference on the level n<0,05.

Conclusions

The highest average lettuce yield was recorded on the second treatment where the technology of complex fertilizers was used.

The average nitrate content in fresh lettuce mass in its technological ripeness decreased approximately to a half according to measured nitrate values in the phase of the leaf rosette development.

Depending of applied technology of complex fertilizers, the highest average nitrate concentration in a fresh mass was at the usage of mixed fertilizers and the lowest ath usage of complex fertilizers.

On the treatments where nitrogen and potassium fertilizers were used in nutrition, less nitrate concentration was recorded in a fresh lettuce mass. It shows the positive potassium influence to nitrate implement into nitrogen organic compounds.

The nitrogen content was reduced in the technological ripeness according to the recorded values of this element in the period of leaf rosette development. Phosphorus and potassium contents were

constantly increasing till the end of the vegetation.

At the time of harvest, when complex fertilizers technology was used the highest nitrogen content was reached in a dry lettuce mass. When mixed fertilizers technology was used, the highest phosphorus and potassium percentage in a dry mass was achieved.

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ВЛИЈАНИЕТО НА СЛОЖЕНИТЕ МИНЕРАЛНИ ЃУБРИВА ПРОИЗВЕДЕНИ ПО РАЗЛИЧНИ ТЕХНОЛОГИИ ВРЗ ПРИНОСОТ И КВАЛИТЕТОТ НА САЛАТАТА

Станка Продановиќ, Даринка Богдановиќ, Жарко Илин, Маја Манојловиќ

Апстракт

Изобилното и неизбалансираното внесување на хранливи елементи во почвата има негативен ефект на приносот и квалитетот на салатата. Акумулацијата на нитрати и штетните ефекти на хлоридни јони се причините зошто е потребно да се воспостави оптимална количина и однос на хранливите материи во исхраната на салатата. Во експериментот кој беше спроведен во текот на 2010 и 2011 година на фармата на средното земјоделско училиште во Футог, беше утврдена содржината на нитрати во свежа маса на салата (mgNO3 кг$^{-1}$), во зависност од употребата на сложени вештачки ѓубрива произведени со различни технологии во различни количини на нитрати и калиумски ѓубрива. Резултатите од истражувањето покажуваат дека во технолошка зрелост, највисок просешен принос на салата е добиен во третманот каде што беше употребена највисока доза на нитратни ѓубрива во пролет, во комбинација со сложени ѓубрива во есен. Најнизок просечен принос е добиен кај контролната парцелка. Највисока просечна концентрација на нитрати во свежа маса на салата е утврдена со користење на технологија со примена на мешани ѓубрива и најмала со користење на технологија на комплексни ѓубрива. Во моментот на берба, највисока содржина на азот во сувата маса на растенијата е забележан со примена на сложени ѓубрива на фосфор и калиум со примена на технологија на мешани ѓубрива.

Клучни зборови: почва, хранливи елементи, нитрати, салата, принос.

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DETERMINATION OF LYCOPEN CONTENT IN '*LAGUNA*' VARIETY PRODUCED IN SKOPJE REGION

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Abstract
Food products that contain antioxidants are an important part of everyday diet. As a natural antioxidant lycopene is essential in the nutrition for preservation and improvement of human health. The samples were taken from the Banjani village in Skopje region. The experiment was done in four replications and four harvests were carried out. The analyses of lycopene were performed by VARIAN CARY 50 Scan UV / Vis Spectrophotometer. Results show that the average content of lycopene in *Laguna* variety is 83,131 mg/kg, variation width is 66.5, standard deviation 17.28, coefficient of variation 20.79 and with mean error of 4.46.
Key words: lycopen, tomato, Laguna, UV/Vis.

Introduction

The presence of red color in tomatoes, pepper, watermelon, papaya and other fruits and vegetables is because of lycopene in their content (2, 3). Tomato (Lycopersicon esculentum L) is consumed worldwide (1). Tomatoes have highest lycopene content in comparison to any fruit or vegetable (4). Lycopene is a found in tomatoes (5). Tomatoes and its products are main sources from where an individual human being can introduce enough lycopene content in the body (7, 8). Bioavailability of lycopene in tomatoes depends of capability of human body to process tomatoes. Tomatoes that are thermically processed allow lycopene to be extracted from bonding cells which means easier absorption of lycopene by the human body (6). There is some evidence that first tomatoes brought in Europe were yellow by color. Red tomatoes appeared in the 19th century (9, 10).
Lycopene is the strongest antioxidant (11). The structure of lycopene is determined in 1930 by Karrer. Lycopene, $C_{40}H_{56}$, has high molecule mass 536 g/mol and intensive red color (13, 15). Open structure contains 11 double bonds and 2048 isomers theoretical possible although few of them determined in plants (14). Twenty five percent of lycopene is trans isomer so called (all-E)-Lycopene and the rest is in cis configuration.

Material and methods

Samples were taken from village Banjani, Skopska Crna Gora, Skopje. The examined variety is Laguna. Four harvests and four repetitions were made. The samples were collected during summer period. Repetitions were made from different clusters. Laguna plants are 1 -1.2 m high (12). Leaves are dark green, medium size, resistant to most diseases. Flowers are medium size with flower formula 6. The yield is oval with green colour during maturation and dark red after maturation. The

mass of the yield is 250 – 350 g. When matured the tomatoes can be stored in ambient temperature for 5 – 7 days. The yield can be consumed or processed. The tomatoes contain 5.5 % dry matter.
Sample preparation was made by the following steps: Samples were cut and homogenized. Five grams dried sample is taken as representative sample. A portion of 5 ml, 0.05 % BHT in acetone is added, 5 ml ethanol and 10 ml hexane. The sample is taken on ice bath for several minutes and then stirred for 15 minutes. A portion of 3 ml water is added and then the sample is again placed on ice bath for additional 5 minutes. After 5 minutes the sample is leaved remaining in ambient temperature for 5 minutes. The sample is dried by low temperature and then stored in polyethylene containers on temperature -200C. Analysis was performed on Varian Cary 50 Scan UV/Vis Spectrophotometer. Wavelength is adapted for the method and calibration curve is constructed before analyzing the sample.

Results and discussion

Table 1. Statistical data gained from determination of lycopene content (mg / kg) from Laguna variety

Variety		Laguna
Flowers - plants	First	74,1
	Second	77,2
	Third	71,1
	Forth	61,9
	First	94,8
	Second	86,3
	Third	88,4
	Forth	87,7
	First	78,5
	Second	81,6
	Third	111,9
	Forth	128,4
	First	64,4
	Second	66,3
	Third	79,2
	Forth	78,3
Average		83,131
Variation width (RV)		66,5
Standard deviation (σ)		17,28
Coefficient of variation (CV)		20,79
Error in average $S_{\bar{x}}$		4,46

Table 1 show that lycopene average lycopene content in Laguna is 83.131 mg/kg. This average content is satisfactory for lycopene content in tomatoes. According to amount of lycopene in tomatoes it can be concluded that tomatoes from this variety are suitable and healthy for consummation and processing as well. Variation width is 66.5. Standard deviation is 17.28. Coefficient of variation is 20.79 and error in average is 4.46.

Table 2. Individual average by flowers

Variety Laguna		mg/kg	Average
Flowers - plants	First	74,1	77,95
	First	94,8	
	First	78,5	
	First	64,4	
	Second	77,2	77,85
	Second	86,3	
	Second	81,6	
	Second	66,3	
	Third	71,1	87,65
	Third	88,4	
	Third	111,9	
	Third	79,2	
	Forth	61,9	89,075
	Forth	87,7	
	Forth	128,4	
	Forth	78,3	

Table 2 shows that average by flowers is 77.95 mg/kg in first flower, 77.85 mg/kg in second flower, 87.65 mg/kg in third flower and 89.075 in forth flower.

Conclusions

Laguna variety has in its content significant amounts of lycopene. The average of lycopene content in the variety is 83.131 mg/kg. The average is 83.131 mg/kg which is an amount that is satisfactory. According to the amount of lycopene it can be concluded that tomatoes from variety Laguna can be used for fresh consummation and processing as well. Variation width is 66.5. Standard deviation is 17.28. Coefficient of variation is 20.79 and error in average is 4.46. The average by flowers is 77.95 mg/kg in first flower, 77.85 mg/kg in second flower, 87.65 mg/kg in third flower and 89.075 in forth flower.

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ОПРЕДЕЛУВАЊЕ НА ЛИКОПЕН КАЈ СОРТАТА *ЛАГУНА* ОДГЛЕДУВАНА ВО СКОПСКО

Илиќ Попов Станко, Ангелова Елизабета, Иљовски Игор

Апстракт
Прехрамбените продукти кои во својот состав содржат антиоксиданси се важен дел од секојдневната исхрана на човекот. Ликопенот како природен антиоксиданс претставува есенцијален додаток во исхраната со цел зачувување и подобрување на човечкото здравје. Примероците се земени од с. Бањани, скопско. Направени се четири берби и четири повторувања. Анализите на испитуваниот ликопен се вршени со VARIAN CARY 50 Scan UV/Vis Spectrophotometer. Добиените резултати покажаа дека просекот на содржината на ликопен во сортата *Лагуна* изнесува 83,131 mg/kg, вариационата ширина изнесува 66,5, стандардната девијација 17,28, коефициентот на варијација 20,79 и грешката на средната вредност 4,46.
Клучни зборови: ликопен, домат, Лагуна, UV/Vis.

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SHADING EFFECTS ON SOME GROWN PARAMETERS OF GREENHOUSE AND OPEN FIELD TOMATO

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Abstract
The photoselective netting concept was studied in a tomato 'Vedeta' cultivation in the south part of Serbia (Aleksinac) under high solar radiation (950 Wm^{-2} and PAR around 1600 μmol $m^{-2}s^{-1}$ on sunny days), using four different colored shade-nets (pearl, red, blue and black) with relative shading (40% PAR). It is either applied by itself over net-house constructions, or combined with plastic-house technologies. Exposure to full sunlight was used as a control. Significantly higher leaf area index (LAI) was observed in plastic-house tomato integrated with shade netting technologies (6.1-7.9) than in control plants (plastic house) 5.7. Similarly, obtained value for LAI in net-house (4.8-8.2) were significantly higher at comparison with control (open field) 4.6. Lower light intensity increased stem elongation, leaf blade area and leaf area index. Changing the light intensity by color shade nets affected the biosynthesis of plant pigments (chlorophylls and carotenoides) in tomatoes. Thus, significantly higher total chlorophyll content was observed in plastic-house tomato integrated with shade netting (2.32 -2.85) or net-grown tomatoes (1.76-2.47 $mg \cdot g^{-1}$ f.w.) than in control plants from plastic-house (2.08) or open field (1.44 $mg \cdot g^{-1}$ f.w.). Tomato leaves in open field (control) and under pearl net had significantly less carotenoids than leaves grown under black or blue nets. Chlorophyll a+b /carotenoids ratio increased in shade leaves at comparison with control plants (open field or plastic house). The photo-selective, light-dispersive shade nets appear as interesting tools that can be further implemented within protected cultivation practices.
Key words: tomato, shade, LAI, chlorophyll, carotenoids.

Introduction

The use of shading nets has become very popular in Serbia due to the very high temperatures (35~40 °C) in the summer season. Netting is frequently used to protect tomato crops from excessive solar radiation, improving the thermal climate sheltering from wind and hail and exclusion of bird and insect-transmitted virus diseases. Many factors influence tomato yield (Heuvelink, 2005b), of which radiation is the most important one, as it supplies the energy for photosynthesis, the basic production process in plants. Only radiation that is intercepted by the crop can contribute to photosynthesis. Light interception shows a saturating response to LAI, with about 90% of the incident light intercepted at an LAI of 3.0 (Heuvelink, 1996a). LAI in tomato is influenced by stem density, number of leaves on a stem and individual leaf size (Heuvelink, 2005a). The LAI of vegetation depends on species composition, development stage, and seasonality. Furthermore the LAI is strongly dependent on the prevailing site conditions and the management practices.

In greenhouse tomato production, using the high wire system, plants are allowed to grow vertically up to a 3.5-4.0 m high horizontal wire. Plants produce about 3 leaves and 1 truss every week (De Koning, 1994). All side shoots are removed except for a few (e.g. one or two on each four plants) to increase stem density towards summer (Heuvelink, 2005b). Armitage, 1991 found that shaded plants grew taller than unshaded plants. El-Aidy *et al.* (1994) found that shading led to lower number of leaves and total leaf area under the Egyptian climate conditions. This result was attributed to the light intensity reduction under full shading treatment. Dry matter was decreased linearly with shade increasing (Smith *et al.*,1984). Black net greenhouse gave significantly the highest early yield, while white net greenhouse gave significantly the highest plant height, number of leaves per pepper plant, leaf area index and total yield compared to the other greenhouses (Medany *et al.*, 2009). Shading induced a LAI increase of about 40% (4.66) compared to open field (3.26), Kittas *et al.* (2009). Reducing the leaf area index (LAI) from 5.2 to 2.6, by removing old leaves, did not affect yield (Valdes *et al.*, 2010). Differences in leaf area index (LAI) between control and shaded plants increased at successive harvests. Final values were 4.70 $m^2 \cdot m^{-2}$ and 3.94 $m^2 \cdot m^{-2}$, respectively, which differed significantly (Sandri *et al.*, 2003). As the degree of shading was increased, leaves developed greater area per leaf, but less dry weight per unit area and per leaf. Chlorophyll content and photosynthetic capacity increased as the degree of shading was increased. Leaf chlorophyll content provides valuable information about the physiological status of plants (Gitelson *et al.*, 2003). In this study, less than optimum light was simulated, to observe that even with a one environment parameter, would there be a variation in the content of chlorophyll. The photoselective, light-dispersive shade nets provide a unique tool that can be further implemented within protected cultivation practices. Shading reduced the appearance of tomato cracking and eliminated sun scalds on tomato fruits and accordingly, increased the marketable tomato production by about 35% compared to non-shading conditions (Ilić *et al.*, 2012). The aim of this work was to study the effects on some grown parameters of greenhouse tomato under different shading nets (shading intensity and color) in south Serbia.

Material and methods

Tomatoes (*Solanum lycopersicon*, cv.'*Vedeta'*) were tested in greenhouse production (plastic tunnels - 2.5 m high, covered by termolux 150 μ) during 2008-2009. The experiments were performed in an experimental garden located in the village of Moravac near Aleksinac, (Longitude: 21°42' E, Latitude: 43°30' N, altitude 159 m) in the central area of south Serbia. The shade nets were applied at the start of warm weather in early June. The houses were shaded for the rest of the summer and vegetables were harvested until late August. A completely randomized block design was used, with four blocks assigned to each of four treatments (black, pearl, blue and red net) plus control. Each treatment and block consisted of four rows of 20 plants.

Plant material

The plants were grown following the technique that is usually implemented by the local producers. Seedlings were transplanted on April 30 (plant density was 2.6 plants m^{-2}) As the plants grew, all lateral shoots were manually removed except lateral branches below the first inflorescence, which serve a secondly stem plants.The shading nets were subsequently installed above the crop on June 10 (40 days after transplanting) and the measurements were carried out until September 5. All plants were irrigated using drip irrigation. The tomatoes leaf used in the study were take 90 DAT (day after transplanting) at intensive harvest period (end of July).

Net characteristics

In order to test the effect of shading nets (color and shading intensity), four different shading nets were used: the photoselective nets including 'colored-ColorNets' (red, blue and black) as well as 'neutral-ColorNets' (pearl) with shading intensity of 40% relative shading, photosynthetically active radiation (PAR) were compared to the open field microclimate and production. The color shade nets were obtained from Polysack Plastics Industries (Nir-Yitzhak, Israel) under the trade mark ChromatiNet. These nets are unique in that they both spectrally-modify, as well as scatter the transmitted light. The photoselective net products are based on the incorporation of various chromatic additives, light dispersive and reflective elements into the netting materials during manufacturing. The shading nets were mounted on a structure about 2.0 m in height over the plants (net house) or combined with plastic-house technologies.

Light interception by nets

The effect of nets on the interception of light was measured annually as a percentage of total PAR above canopy, using a Ceptometer mod. Sun Scan SS1-UM-1.05 (Delta-T Devices Ltd Cambridge, UK) with a 64 sensor photodiode linearly sorted in a 100 cm length sword. Readings are in units of PAR quantum flux (μ mol m^{-2} s^{-1}). All measurements were done on clears days at noontime. Measurements of global radiation made every second day, three times during the day.

The Solarimeter- SL 100 is an easy-to-use portable autonomous solarimeter that measures solar irrigation range from 1 W m^2 to 1300 W m^2. All spectral data were expressed as radiation intensity flux distribution in W m^{-2} nm^{-1}.

Weather measurement

Monthly meteorological data from May to September 2008. and 2009. from the meteorological stations in Aleksinac were used (Table 1).

Table 1. Temperature and solar radiation during the growing season in Aleksinac

Month	TS		TOD		TX		TM		MSR	RR		RO
	2008	2009	2008	2009	2008	2009	2008	2009		2008	2009	
May	18.4	18.7	1.8	2.1		25.	11.	11.	219.0	48.0	41.4	66.7
June	22.6	20.9	3.1	1.4		27.	15.	14.	237.2	15.8	72.4	
July	22.9	23.3	1.6	2.0		30.	15.	16.	289.0	112.	63.4	
Avgust	23.5	23.5	2.4	2.4		30.	15.	16.	276.0	55.0	23.4	
Septembe	16.6	19.0	0.6	1.8		26.	11.	12.	210.0	42.4	33.5	

TS-mean monthly air temperature (^{o}C); *TOD*-temperature deviation from 1961-1990 average (^{o}C); *TX*-mean daily temperature maximum for month (^{o}C); *TM*-mean daily temperature minimum for month (^{o}C); *MSR*, mean daily solar radiation (MJ/m^2); *RR*- precipitation amount (mm); RO-relative deviation of monthly precipitations amount from 1961-1990 average (%).

Pigments extraction from tomato leaf

Determination method of chloroplast pigments in acetone solution by Holm (1954) and Wetstein (1954). Average samples of leaves are finely cut and the analytical balance to weigh 0.5g. Measured material is placed in a mortar and pestle to homogenize with the addition of 5-10ml 100% of acetone. For better homogenization at the top adds a few tablespoons of quartz sand, and to prevent acidification of the solution adds a little $MgCO_3$. Homogenization takes about 3min. After which the content of mortar quantitatively transferred to a glass filter and the filtering is done with the help

of a vacuum pump to water spray. Mortar and pestle is rinsed several times with 2-3ml of acetone and content is quantitatively transferred to a filter, and if necessary, a filter and washed with acetone alone, until complete bleaching. The obtained filtrate was extract pigments, which are transferred from the tube measured in 25 ml of court, the court may amend acetone to the mark and well shaken. As the concentration of pigments usually large, the resulting extract is diluted, it could be done reading on the spectrophotometer. Thinning: 1ml concentrate + 9 ml of absolute acetone. The obtained extract was read on the spectrophotometer at wavelengths 644, 662, and 440 nm (absorbance) and then with reading. Chlorophyll a = 9784 · A662 - 0990 · A644, Hlorofill b = 21,426 4 · A662 – 4.650 · A662, Chlorophyll a +b = 5134 · A662 + 20. 436 · A664, Carotenoids = 4695 · A440 - 0268 (a + b) where A is the absorbance-reading spectrophotometer at the appropriate wavelength, a value of 9784, 0990; 21,426; 4650 and 0288 are the molar absorption coefficients by Holm (1954) and Wetstein (1957) in absolute acetone and the thickness of 1cm cuvette. (Holm determines absorption coefficients for chlorophyll a and b and Wetsttein for carotenoids).

When the calculated concentrations (mg/l), approaches the calculation amount of pigments in mg per g fresh or dry matter, according to the formula: $C = C1 \cdot V \cdot R / G \cdot 1000$,

C-pigments content in mg/g dry matter of fresh materije)

C1-pigment concentration was calculated according to the formula mg/l

V the original volume of extract (ml)

R-dilution (if any)

G-weighed fresh (dry) weight of plant material (g)

1000 - translation factor g mg UV / Vis spectrophotometer Agilent 8453 with the furnace length of 1 cm optical path was used to determine the content of chloroplast pigments (mg/L) on Faculty of Natural Science-Department of Chemistry, in Niš. Chlorophyll "a"/"b" and chlorophyll/carotenoid ratios were estimated.

Direct methods for leaf area determination

Method of contours on the paper. Method for the determination of the method used ordinary printer paper, regular rectangular shape. First, measure the length and width of paper and calculate the surface area (P), and then determine its mass on the analytical balance. Then remove the leaves from the plant, put it on paper and pencil outline on the edge of its contours. Contours leaf area on the paper is cut with scissors and set to its mass (G_1). Since the value of P, G and G_1 known, then one can calculate the unknown leaf area (P_1) using the formula: P/P_1 G/G_1, where $P1 = G_1 \cdot P/G$.

After the values obtained by this method started with the calculation of leaf area index. For tomato and pepper were measured three categories sheets: old, middle and upper (youngest). With plants, which were used as samples, the measured size of the three groups of leaves, then the area is multiplied by the total number of sheets in each group. For the obtained surface is taken into account and the number of stem per plant (2 stem).Total leaf surface in all three categories are added together and the value obtained is divided by the plant density. The resulting value is the leaf area index (LAI).

Statistical analysis

The data were analyzed by analysis of variance (ANOVA) followed by Tukey's HSD test, using the Statistica 6.1 software (Statsoft, Tulsa, OK, USA). All analyses were performed at a 95 % level of confidence ($p<0.05$).

Results and discussion

Leaf area index (LAI)

For tomato plastic house production in Serbia the use of containerized transplants is common. Transplants are typically 6 week old, having 3 to 5 leaf-bearing nodes an initial leaf area of 15 to 40 cm^2, and a dry weight of 0.20 to 0.30 g/plant. The LAI values at transplanting ranged from 0.002 to 0.004 (data not show). The light effect on biomass production occurs through its effects on leaf development rate, leaf expansion, stem elongation and flower and fruit development. Increase in biomass result from action related to increases in leaf area and chlorophyll content. Leaf area index - LAI is a dimensionless variable and was first defined as the maximal projected leaf area per unit ground surface area (Myneni *et al.* 1997).

It was founded here that red and pearl shade nets significantly increased the total leaf area, in comparison with LAI obtained from blue or black shade nets. Generally, tomato under plastic house integrated with color shade nets had lowest LAI in comparison with LAI obtained from screen house (only color nets). The black shade nets where LAI were lowest than other color nets.

Table. 2. Influence of different color shade nets on leaf area index (LAI) in tomato plants from plastichouse integrated with color shade nets and from sreen-house (only color shade nets)

Year (A)	Color nets (B)									
	Red		Black		Pearl		Blue		Control	
	PH+CN	CN	PH+CN	CN	PH+CN	CN	PH+CN	CN	PH	OF
2009.	8.1a	8.3a	6.5a	5.5a	7.2a	7.7a	7.2a	7.1a	6.2a	5.2a
2010.	7.9a	8.2a	6.3a	5.2a	7.1a	7.9a	6.9a	7.4a	5.9a	4.9b
2011.	7.8a	8.2a	6.3a	4.6b	6.9a	7.5a	7.1a	7.1a	5.2b	3.8b

LSD 0.05 1.268 0.983 1.117 0.665 1.094 1.046 1.242 1.167 0.393 1.217

LSD 0.01 2.103 0.188 1.853 1.102 1.815 1.735 2.059 2.290 0.651 2.017

A·B 0.963 1.029 0.988 0.947 0.922 0.988 0.863 0.908

PH+CN – Plastic house+Color Nets; CN- Color Nets

PH-Plastic House OF-Open Field

Plants grown under black color nets had similarly LAI with control plants (grown in plastic house or without nets in open field). Higher LAI values are generally indicative of excessive vegetative growth which may delay the onset of fruit production. Lower light intensity increased stem elongation, leaf blade area and leaf area index.

A shade leaves generally have a larger surface area and are thinner than sun leaves. As water is a main component in plant development, the surface area of a sun leaf is smaller to reduce water loss. As a result, less water is lost to heat and evaporation so a plant can grow. Leaf area index ranged from 3.8 - 5.2 from open field plants (control) to maximum LAI values of 8.2 - 8.3 in screen-house with red color nets (40% shade). Differences in leaf area index (LAI) between control and shaded plants increased at successive harvests.

Similarly, Smith *et al*. (1984) presented that cucumber (*Cucumis sativus* L.) grown in a greenhouse under 0.3 shade density produced less dry matter and had more biomass in leaves and stems and less in root and fruits than plants without shade. Plants acclimate to shade, in part, by increasing specific leaf area. Tomato plants grown under 0.52 shade density compared with no shade had a greater LAI, 4.7 and 3.9, and a greater specific leaf area, 320 and 230 $cm^2 \cdot g^{-1}$, respectively (Sandri *et al.*, 2003).

Previously development for drip-irrigated and subirrigated culture, reported LAI values for subirrigated field tomato and drip-irrigated greenhouse tomato were 5.5 to 6.5 and 7 to 8, respectively (Jones *et al.*, 1989; Marlowe *et al.*, 1983).

Chlorophyll content

Shades leaves harvest lower levels of light and thus contain more chlorophyll than sun leaves do. Because they're not directly exposed to sunlight, they need the extra chlorophyll to attract and absorb the sun's energy in order to produce the food needed for a plant to grow. Although sun leaves contain less chlorophyll than shade leaves do, they have a greater light saturation point and therefore can handle full exposure to the sun. Shade leaves are not predisposed to handle the extra saturation of light and can burn if exposed to the direct rays of the sun.

It could be observed that the highest average spad value was concentrated in the middle layer followed by the second highest reading within the upper layer and the lowest reading being recorded in the lower layer of the plant (data not shown). This according to Buchanan-Wollaston (1997) is a natural phenomenon in a plant's development, whereby leaf chlorophyll content is known to be lower in both the newly developed leaves and older leaves of the plant.

Table 3. Influence of different color shade nets at leaf pigments (mg/g) in tomato plants from plastic house integrated with color shade nets

	Chl a			*Chl b*			*Carotenoides*		
	2009.	2010.	2011.	2009.	2010.	2011.	2009.	2010.	2011.
Red	1.813c	1.839bc	1.252a	0.761a	0.880bc	0.425c	0.459bc	0.354d	0.329c
Black	1.799c	2.457a	1.690a	0.738a	1.069a	0.691a	0.462bc	0.527ab	0.437ab
Pearl	2.060b	1.888b	1.451a	0.852a	0.842c	0.478c	0.541ab	0.549a	0.373bc
Blue	2.228a	2.240a	1.672a	0.850a	0.938b	0.625b	0.586a	0.461bc	0.436ab
Control	1.605d	1.587c	1.338a	0.595b	0.585d	0.551d	0.435c	0.412cd	0.463a

LSD 0.05 0.152 0.277 0.920 0.124 0.087 0.087 0.087 0.087 0.087
0.01 0.252 0.460 1.527 0.209 0.145 0.145 0.145 0.145 0.145
A·B 0.214 0.096 0.067 0.297 0.133 0.094

A shade leaves generally have larger total chlorophyll (chlorophyll *a* and chlorophyll *b*) content than control leaves (from plastic house or open field). Plants from black shade nets obtained maximum leaves chlorophyll content in comparison with another color shade nets. Carotenoids content ranged from 0.416 (mg/g) from open field plants (control) to maximum carotenoids values of 0.508 (mg/g) in net-house with black nets or 0.500 (mg/g) in blue nets. A similar trend was observed in plastic house integrated with color shade nets where the lowest carotenoid content (0.426mg/g) was recorded in plastichouses (control). The highest content of carotenoids was observed in plastic house integrated with blue (494mg/g) or pearl nets (487mg/g). Similar results were found by Bergquist *et al*. (2007) who showed that the concentrations of total carotenoids and total chlorophylls in baby spinach leaves were significantly higher under the nettings, especially under the spectrum-altering and low transmittance nettings. Other authors have found an increase in chlorophyll "a" content in lemon stressed plants with high temperatures (Martin *et al.*, 1995). Thus, the shade-grown leaves had a conformation somewhat the opposite to that of leaves grown in high light intensity. Shade-grown leaves were of a softer texture and had a darker green coloration. The

increase in chlorophyll "a/b" ratio might be associated with the protection of photosynthetic system under stress conditions, due to a lesser radiation absorption at shorter wave length (Garcidueña, 1993). As the degree of shading was increased, leaves developed greater area per leaf, but less dry weight per unit area and per leaf (Woltz, 1968). Thus, with 50% shade tomato leaf area index increased with 55% in comparison with unshaded (control plants).

Table 4. Influence of different color shade nets at leaf pigments (mg/g) on tomato plants in net-house (only color shade nets)

	Chl a			Chl b			Carotenoides		
	2009	2010	2011	2009	2010	2011	2009	2010	2011
Red	1.433b	1.634ab	1.161bc	0.566b	0.884a	0.450ab	0.369b	0.441ab	0.517a
Black	1.968a	1.791a	1.469a	0.754b	0.908a	0.523a	0.535a	0.367b	0.623a
Pearl	1.412bc	1.090c	1.281ab	0.499bc	0.559c	0.447ab	0.381b	0.227c	0.544a
Blue	1.902a	1.370b	1.180b	0.771a	0.707b	0.424ab	0.510a	0.519a	0.471a
Control	1.097c	1.002c	1.041bc	0.377c	0.492c	0.325b	0.485a	0.207c	0.556a

LSD 0.05 0.3166 0.2776 0.3620 0.1242 0.124 0.2483 0.0832 0.0878 0.1242
0.01 0.2522 0.4604 0.6003 0.2059 0.2059 0.4118 0.1381 0.1456 0.2059
A·B 0.2145 0.9592 0.06782 0.2977 0.1331 0.09414

Chlorophyll content and photosynthetic capacity increased as the degree of shading was increased. Thus, with 50% shade tomato leaves increased chlorophyll level with 50% (Woltz, 1968). It should be pointed out that the shading procedure as a method of varying light intensity causes other variations, namely in the soil (temperature and moisture) and micro-climate of the plant (data not show). These variations are doubtless of considerable significance at some physiological parameters.

Table 5. Effect of different color shade nets on total chlorophyll content, carotenoid content (mg/g), chlorophyll “a/b” ratio and total chlorophyll/carotenoid ratio

	Chl a + b		Car		Chl a / b		Chl a+b /Car	
	Plastichouse + color nets	Color nets	Plastichouse + color nets	Color nets	Plastichouse + color nets	Color nets	Plastichouse + color nets	Color nets
Red	2.322	2.042	0.380	0.442	2.37	2.12	6.11	4.62
Black	2.814	2.470	0.475	0.508	2.38	2.39	5.92	4.86
Pearl	2.523	1.762	0.487	0.384	2.48	2.52	5.18	4.58
Blue	2.854	2.118	0.494	0.500	2.55	2.34	5.78	4.23
Plastic house Open field	2.087	1.444	0.426	0.416	2.61	2.63	4.90	3.47

Tomato leaves grown under black, blue or red nets had significantly more total chlorophyll content than leaves from open field (control) and under pearl net. Similarly, tomato plants grown under black, pearl and blue nets had significantly more chlorophyll level than leaves grown in a plastic house (control) and under integrated plastic house with red net. Tomato leaves in open field

(control) and under pearl net had significantly less carotenoids than leaves grown under black or blue nets. Tomato plants grown in a plastic house (control) and under integrated plastic house with red net had significantly less carotenoid level than leaves grown under black, pearl and blue net (Tab. 5). Similar results were found by Camejo and Torres (2001) who showed that the total chlorophyll content per unit leaf area remained relatively constant, although the chlorophyll a/chlorophyll b ratio declined in shade plants. Chlorophyll a+b /carotenoids ratio increased in shade leaves at comparison with control plants (open field or plastic house). The differences in total pigment content and Chl/carotenoids between sun and shade leaves, as detected also in other plants (Lichtenthaler *et al.*, 1981), are due to the high irradiance adaptation response of the photosynthetic pigment apparatus of sun leaves with a much lower quantity of light-harvesting Chl a/b proteins (LHCII) and a greater number of reaction centers on a total Chl basis as compared to shade leaves (Lichtenthaler *et al*., 1982). The lower level of LHCII proteins, with their low Chl a/b ratio of 1.1–1.3, in sun leaves results in higher values for the ratio Chl a/b of ca. 3.1–3.3 found here in ginkgo and beech sun leaves. In contrast, shade leaves possess lower Chl a/b ratios as observed here for ginkgo and beech (ca. 2.6–2.8). Photo-selective nets were designed to selectively filter different spectral bands of solar radiation, and/or transform direct light into scattered light. The spectral manipulation intends to specifically promote desired physiological responses, while the scattering improves the penetration of the spectrally modified light into the inner plant canopy. Since the nets are composed of holes, in addition to the translucent photo-selective plastic threads, shade nets actually create mixtures of natural, unmodified light, which is passing through the holes, together with the diffused, spectrally modified light, which is emitted by the photo-selective threads (Shahak *et al*., 2008).

Conclusions

Lower light intensity in shade plats increased stem elongation, leaf blade area and leaf area index. Total chlorophyll and carotenid content increased in shade leaves in comparison with leaves grown under sun. The results of the present study provide useful data for detecting differences among environment variation in leaf area index and pigment leaf content and color shade nets. However, the data are preliminary and more research is required for understanding the physiological mechanisms behind the plant responses and for testing results with other crops and other environmental conditions.

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ЕФЕКТИ ОД ЗАСЕНЧУВАЊЕ ВРЗ НЕКОИ ПАРАМЕТРИ ЗА ПОРАСТ НА ДОМАТОТ ОД ОРАНЖЕРИИ И ОД ОТВОРЕНО

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Апстракт

Концептот на фотоселективни мрежи бил изучуван во одгледувањето на 'Vedeta' домати во јужниот дел на Србија (Алексинац) под високо сончево зрачење (950 Wm-2 и PAR околу 1600 μmol $m^{-2}s^{-1}$ на сончеви денови), со помош на четири различни бои на мрежи за засенчување (бисерна, црвена, сина и црна), со релативно засенчување (40% PAR). Се применуваат над конструкции, или во комбинација со пластенички технологии. Изложеност на полна сончева светлина се користи како контрола. Значително повисоки индекс на лисна површина (LAI) е забележана кај пластениците со домати со интегрирани технологии на засенчување (6,1-7,9) отколку кај контролните растенија (пластеници) 5,7. Слично на ова, добиените вредности за LAI во пластениците од мрежа (4,8-8,2) биле значително повисоки во споредба со контролата (отворено поле) 4.6. Понискиот интензитет на светлина ги зголемува издолжувањето на стеблото, лисната површина и индексот на лисната површина. Менувањето на интензитетот на светлината со примена на обоени мрежи влијае врз биосинтезата на растителни пигменти (хлорофил и каротеноиди) во доматите. Така, значително повисока содржина на вкупен хлорофил е забележан во пластеници со домати и интегрирана мрежа за засенчување (2,32 -2,85) или нето пораст на доматите (1.76-2.47 mg•g−1 f.w.) отколку кај контролните растенија од пластеници (2,08) или отворено поле (1.44 mg•g−1 f.w). Листовите домат од отворено и под бисерна мрежа имале значително помалку каротеноиди од лисјата под црни или сини мрежи. Соодносот хлорофил а + б / каротеноиди се зголемил со засенчување во споредба со контролата (отворено поле или од пластеници). Фотоселективни, светло-дисперзивни мрежи за засенчување се интересни алатки кои можат понатаму да се спроведува при одгледување во заштитени простори.

Клучни зборови: домати, засенчување, ЛАИ, хлорофил, каротеноиди.

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Original scientific paper

EFFECT OF POSTHARVEST TREATMENTS ON MASS, β-CAROTENE AND VITAMIN C LOSSES IN CARROT ROOT DURING PROLONGED STORAGE

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Abstract
Carrots are the most popular and wide-spread of all root vegetables, and are the principal source of carotenoids in human diet. The purpose of this study was to examine differences between postharvest washed treatments (hot water, H_2O_2 and Na_2OCl) and non-washed (control) root and the effect of different storage condition S_1 (0°C and 95-99% RH) or S_2 (0-2°C and <90% RH) regarding the mass, β-carotene and vitamin C changes in carrots 'Maestro F_1'. Storing carrots at either 0 ^{o}C to simulate long-term storage (180 days) or 20 ^{o}C to simulate marketing practices (3 weeks) resulted in a significant reduction of micronutrient of carrot taproot. At the end of 180 days of storage the percentage mass losses ranged from 3.1 to 33.2% depending on the storage condition and disinfection treatment. Initial concentrations of β-carotene in freshly harvested carrots was 39.74 μg/g f.w. Loss of β-carotene during storage was observed higher in the S_2 (28.2- 46.9%) than in the S_1 cold storage (7.8-20.7%). Initial concentrations of vitamin C in freshly harvested carrots (5.05mg·100g^{-1}), confirming that carrots are not a rich source of this vitamin. After 180 days storage vitamin C concentration in carrots decreased depend of storage conditions. Thus, the vitamin C losses of carrot root inside the S_1 sophisticated cooling room ranged from 2.0% to 18.2%, while under simple refrigerated storage, was recorded significant higher vitamin C losses (20.7% - 52.3%).
Key words: carrot, storage condition, postharvest treatment, mass loss, β-carotene, vitamin C.

Introduction

Carrots (*Daucus carota L.)* in general are one of the best sources of β-carotene in our diet, and provide 17% of the total β-carotene intake in human nutrition (Alasalvar *et al.,* 2001). β-carotene is the principal precursor of vitamin A, which is involved in vision, cell differentiation, synthesis of glycoproteins, mucus secretion from the epithelial cells, and overall growth and development of bones. The harvested carrot root is an underground organ that has been dug out of the soil while it was in full metabolic activity. The principal factors which can be used to establish the length of postharvest life of carrots include the time of harvest of the products, stage of maturity at harvest and the handling and storage conditions (Ilić *et al.,* 2009). Carrot has good physiological storability. Provided that carrots are not infected by microbes causing storage diseases, they can be stored for 6-8 months without loss of quality under optimal storage conditions (temperature 0°C and relative

humidity 98%), Balvoll (1985). Carrot has low metabolic activity at low temperatures, as shown by the low respiration rate (Stoll and Weichmann 1987). A low storage temperature also prevents the onset of new growth. However, carrot is sensitive to wilting if not protected from water loss. In commercial refrigerated stores, storage diseases, mainly caused by pathogenic fungi, pose the greatest risk. Ethylene in the air may impair the sensory quality by inducing the synthesis of phenolic compounds, which give rise to a bitter taste (Lafuente *et al.,* 1989).

The most significant changes in postharvest quality are weight loss, bitterness, bacterial deterioration, rooting and sprouting. This can be prevented by different methods including cold storage, postharvest treatment and chemical applications. The two basic conditions, as recommended by previous researchers and confirmed by our results, are a temperature of 1°C and a relative humidity of 98% (Ilić *et al.,* 2009). Typical procedure as carrot handling involves washing, tapping, chemical treatment and packaging. Disinfection is part of an overall sanitation and safety management program. The chemical fungicide iprodione is usually applied before storage to reduce the development of postharvest diseases. A technology for the precise application of steam and combined application with stabilized hydrogen peroxide (Tsunami® 100) or a yeast commercial product (Shemer™) were applied (Eshel *et al.,* 2009). Chlorination of process water is one of the primary elements of a property management postharvest sanitation program. Washing carrots with cold chlorinated water (4°C) and warm tap water (50 °C), respectively, provided good microbiological safety paired with improved sensorial properties (Klaiber *et al.,* 2005). In the last few years, carrot growers in Israel have begun to brush carrots before storage to remove the outer peel of the root (Eshel *et al.,* 2009).

Singh *et al*. (2001) mentioned vitamin C and carotenoid losses after storage, with higher losses for vitamin C. Loss of beta-carotene during carrot storage was observed higher in the cellar than in the cold storage. Mean loss of beta-carotene in dry matter for cold storage was 13.57-14.28%, compared to cellar 20-27.3% (Fikselova *et al*., 2010). Vitamin C content in different cultivars ranged from 54 mg·kg^{-1} to 132 mg·kg^{-1}. Significantly higher contents of vitamin C were also found in the late cultivars and moderately late cultivars in comparison to early ones. 30-day storage resulted in a significant reduction in vitamin C content, on average of 47%. There was also a reduction in the carotenoids content, but to a lesser extent, on average of 11% (Matejkova and Petrikova, 2010).

The aim of this study was to determine the contents of β-carotene and vitamin C in carrot and to study the effect of different postharvest treatment during 6 month storage period on the contents of these compounds.

Material and methods

Field production

Carrot (*Daucus carota L.*) cv. 'Maestro F_1' a commercial hybrid for open field during the fall, autumn and winter. Taproot of uniform size, about 150 g, were picked directly from a field in the south part of Banat (village Debeljača) at the full maturity stages. The soil condition was well drained and sandy, and drip irrigation was used. Cultural practices, such as land preparation, planting and plant protection for the crop, were as is the standard in this area. Mature carrots were harvested in the fall and went into storage immediately after harvest. Taproot without defects or diseases, at same size, shape and injury free were selected for the experiment. The carrots went into storage on November 10, 2011 and the study was terminated on April 20, 2012.

Postharvest treatment

The purpose of this study was to examine differences between postharvest washed treatments: 1) hot water washing and brushing (50 ^{o}C for 1 minut); 2) H_2O_2 (1%); 3) Na_2OCl (175 ppm) and non-washed roots (with soil) were used as a control.

Storage condition

After treatments taproot were stored for 160 d at different storage condition. The taproot were stored at 0 $\pm$ 0.5 ^{o}C, in a sophisticated requirements cooling-room (S_1) with constant relative humidity (RH 95%) in the dark or second cooling room with temperature 0-2 ^{o}C and uncontrolled conditions of relative humidity ~ 90% (S_2). For each postharvest treatment and storage regime, 25 root per replicate (4) were sampled for analysis. After 160 d storage at either temperature taproot were transferred at 20 ^{o}C to study their shelf life. Analyses were performed after 3 weeks at 20 ^{o}C (simulate marketing practices).

Samples and analysis

Ten grams of scraped carrot have been extracted with 100 ml 95% hot ethanol in 400 ml erlenmeyer flask for 30 minutes. Yellow extract has been diluted by water up to 85% and cooled down to room temperature. This solution has been transfered in separating funnel and mixed well with 50 ml of petroleum ether. After layers separations, lower one (alcoholic) has been washed with petroleum ether in portions of 2 ml, until upper layer becomes colorless, which means that all carotenes are extracted. All petroleum ether layers have been collected and washed with 85% ethanol to remove eventually present xanthophylls. Petroleum ether layer has been concentrated under the vacuum and the temperature of water bath was maintained below 40°C. Oily residue was kept in the dark at 4°C.HPLC analysis of extracts was carried out with the Agilent 1100 Series system, Waldborn, Germany (pump, detector, software). The LC column Zorbax-Eclipse XDBC18; 4.6 mm × 250 mm, 5 μm was used, with a mobile phase consisting of a mixture of acetonitrile: methanol: ethyl acetate, 6:2:2 v/v, at a flow rate of 1 cm^3/min. The injection volume was 20 μl using the detector DAD Agilent 1200 Series at 474 nm wavelength (Cvetkovic and Markovic, 2008).

Preparation of extracts for analysis

The extracts (8 cm^3) of different concentrations were evaporated to dryness with rotary vacuum evaporators at room temperature and the residues were dissolved in *n*-hexane (2 cm^3). Extracts were filtered through a 0.45 μm Millipore filter immediately before HPLC analysis.

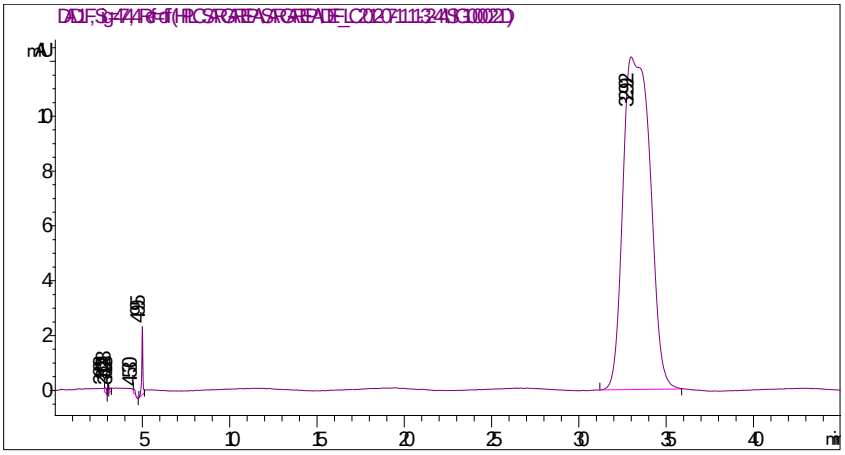


Figure 1. HPLC Chromatograms β-caroten (c = 0,00625mg/cm^3)

Calibration curve for β-carotene standard

Standard of β-carotene was dissolved in *n*-hexane just before HPLC analysis, and diluted to the appropriate concentrations (1.56-100 mg/cm^3) for calibration curve obtaining (Cvetkovic and Markovic, 2008). The external standard method was used for determination of β-carotene concentration in the extracts.

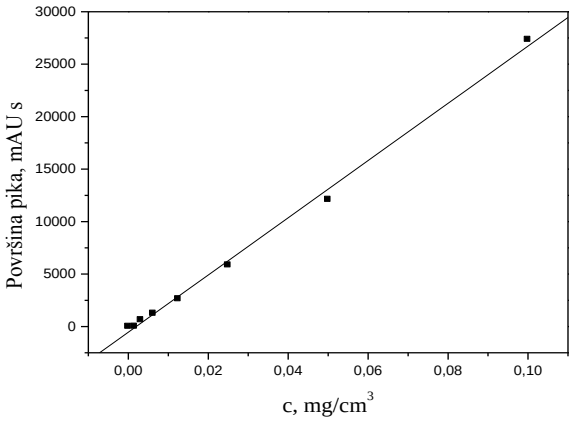


Figure 2. The calibration curve for the determination of β-carotene in carrot, based on HPLC analysis

Results and discussion

Carrot has low metabolic activity at low temperatures, as shown by the low respiration rate. A low storage temperature also prevents the onset of new growth. However, carrot is sensitive to wilting if not protected from water loss. The rate of water loss of carrot is affected by the surface area of the root, the water vapour pressure deficit and air velocity (Correa *et al.,* 2012). Water loss due to transpiration results in shriveling, loss of bright colour and increased risk of post-harvest decay. An 8% weight loss is reported to make carrots unsaleable (Robinson *et al.,* 1975).

A key goal of washing and sanitizing postharvest treatments, therefore, is removal or inactivation pathogens on fresh carrot.

Table 1. Effect of postharvest treatments and storage conditions on mass losses (%) during storage

Storage condition	S_1 - (0 ^{o}C; >95% RH)			S_2 - (0-2 ^{o}C; <90% RH)		
	days after harvest					
Treatment	60-days	120-days	180-days	60-days	120-days	180-days
Control	0.86	3.00	6.77 c	12.48	18.96	24.00 b
Hot water	3.01	4.01	4.85 b	21.80	29.76	33.24 c
H_2O_2	1.42	1.73	3.12 a	11.71	18.08	20.69 a
Na_2OCl	2.30	3.02	3.42 a	11.00	17.52	21.25 a

The moisture content of the refrigerated carrots decreased with time of storage. The relative humidity measured inside the S_1 sophisticated cooling room conditions ranged from 95% to 99%, however the relative humidity under simple refrigerated storage varied from 79% to 94%. The low

relative humidity under the refrigerated storage might have contributed to the decrease in moisture content of the carrots with time.

Mass losses (shriveling) and fungal diseases were most important cause of postharvest losses of carrot in Serbia. At the end of 180 days of storage the percentage mass losses ranged from 3.1% to 33.2% depending on the storage condition and disinfection treatment. Thus, the weight loss of carrot root inside the S_1 sophisticated cooling room conditions ranged from 3.1% with chlorinated (175ppm Na_2OCl) prestorage treatment to maximum weight loss of 6.8% in control (unwashed-control roots). A different trend was observed under simple refrigerated storage, where the lowest mass losses (20.7 %) was recorded in treatment with hydrogen-peroxide but significant the highest mass losses was observed in hot water treatment (33.2%).

Similar results were found by Sudimac *et al.* (2012) who showed that the percentage mass losses ranged from 15% to 35% depending on the cultivars and disinfection treatment. Commercial storage of carrots resulted mass losses of 15% fresh weight over the 3 months period (Ng *et at*., 1998).The effects of sanitation treatments were highly effective at reducing disease decay (*A. alternata*) in comparising with control (12%). In view of microbial reduction and maintenance of sensory properties, the use of cold chlorinated water proved to be effective for washing carrots (Sudimac *et al.*, 2012).

β-caroten and vitamin C levels in fresh carrot decreased during storage. Since carrots are important source of carotenoids and vitamin C in the human diet, it is appropriate to determine to what extent these compounds are lost during storage. Carrot root is associated with the presence of certain carotenoids, xanthophylls or anthocyanins. In orange carrots α-carotene account 15% to 40% of total carotenoid content while β-carotene acounts for 45% to 80% and γ-carotene for 2% to 10%. At the end of 180 days of storage the percentage of β-carotene loss resulted in a significant reduction particularly under simple refrigerated storage. Depending on the disinfection treatment loss of β-carotene was differ. Thus, loss of the β-carotene in carrot root inside the S_1 sophisticated cooling room conditions ranged from 4.1% with hot water prestorage washing treatment to maximum of 20.7 % in treatment with Na_2OCl (Tab.2).

Table 2. Effect of postharvest treatments and storage conditions on β-carotene changes (μg/g f.w)

Storage condition	S_1 - (0 °C; >95% RH)			S_2 - (0-2 °C; <90% RH)	
	β-carotene (μg/g f.w)				
Treatment	Time of harvest	180 days storage	% loss	180 days storage	% loss
Control	39.74	36.65b	7.8d	28.53a	28.2d
Hot water		38.12a	4.1c	23.02b	42.1b
H_2O_2		33.52c	15.6b	24.79b	37.6c
Na_2OCl		31.51c	20.7a	21.09c	46.9a

A similar trend was observed under simple refrigerated storage, where the lowest β-carotene loss (28.2%) was recorded in treatment with hot water treatment but significant the highest β-carotene was observed in Na_2OCl treatment (46.9%). Our findings that these compounds (β-carotene) are lost during storage depend of storage condition are in agreement with those of Fikselova *et al.* (2010) who found that, loss of β-carotene during carrot storage was observed higher in the cellar than in the cold storage. Mean loss of beta-carotene in dry matter for cold storage was 13.57-14.28%,

compared to cellar 20-27.3% (Fikselova *et al.*, 2010). In Nantes carrot, stored at 2°C and 90 percent relative humidity, alfa-carotene and beta-carotene levels increased slowly up through 100 to 125 days and then decreased (Lee, 1986). Some changes in the α and β-carotene contents of carrot could be discerned under dark and lighted cold storage (4 °C), but these changes were not found to be statistically significant (Kopas-Lane and Warthesen 1995). It was concluded that neither lighted nor dark cold storage affected the major carotenoids of carrot. Dily *et al.* (1994) showed the total carotenoid content of carrot roots stored in cold storage at 0 to 1°C for 209 days did not change. Phan *et al.*, (1973) suggested the change in total carotenoids in carrot roots is tissue specific in cold storage. They found a decrease in xylem carotenoid level and little changes in phloem carotenoid levels. Losses in total carotenoid content were reported in some vegetables, especially leaves. Both sweet pepper and parsley lost over 20 % of their total carotenoid content at cold room storage (7 °C) for 9 days (Takama and Saito 1974). Carotenoid losses amounted to 60 and 80 % at 15 °C and 17 °C, respectively. Leek lost about 53% of its total carotenoid content within 3days at both temperatures (Takama and Saito, 1974).The content of vitamin C in carrot can be influenced by various factors such as genotypic differences, preharvest climatic conditions and cultural practices, maturity and harvesting methods, and postharvest handling procedures. Temperature management after harvest is the most important factor to maintain vitamin C of vegetables; losses are accelerated at higher temperatures and with longer storage durations (Lee and Kader, 2000).

Table 3. Effect of postharvest treatments and storage conditions on vitamin C changes

Storage condition	S_1 - (0 °C; >95% RH)					S_2 - (0-2 °C; <90% RH)			
	Content of vitamin C mg·100g^{-1}								
Treatment	Time of harvest	60-days storage	% loss	180-days storage	% loss	60-days storage	% loss	180-days storage	% loss
Control	5.05	4.95 a	2.0c	3.28b	35.0c	4.27b	15.4c	2.97b	41.2b
Hot water		5.00 a	1.0c	4.07a	19.4d	4.95a	2.0d	3.52a	30.3c
H_2O_2		4.35 b	13.9b	3.08b	39.0b	3.41c	32.5a	2.56c	49.4a
Na_2OCl		4.18 b	18.2a	2.86c	43.4a	3.99b	21.0b	2.41c	52.3a

The losses of vitamin C that occur immediately after harvest. 60-day storage resulted in a significant higher reduction in vitamin C content under simple refrigerated storage (2 -32.5%) compared with loss in sophisticated cooling room (1-18.2%). Significant more vitamin C loss observed Matejkova and Petrikova (2010) after 30-day storage content, on average of 47%. At the end of 180 days of storage the percentage of vitamin C loss resulted in a significant reduction particularly under simple refrigerated storage. Depending on the disinfection treatment loss of vitamin C also was differ. Thus, the vitamin C losses of carrot root inside the S_1 sophisticated cooling room conditions ranged from 2.0% with hot water prestorage washing to maximum vitamin C losses of 18.2% in treatment with Na_2OCl. A similar trend was observed under simple refrigerated storage, where the lowest vitamin C loss (20.7 %) was recorded in treatment with hot water treatment but significant the highest vitamin C loss was observed with hydrogen-peroxide treatment (52.3%). Favell (1998) noted a 15% decrease of vitamin C in carrot after 14 days storage at 4°C. Fresh storage at ambient temperatures resulted in greater loss; for example, fresh peas stored at ambient temperatures lost

50% of their ascorbic acid in 1 week, while fresh spinach stored at ambient temperatures lost 100% of its ascorbic acid in less than 4 days (Hunter and Fletcher, 2002).

Conclusions

This work confirms the existence of important differences between storage condition and postharvest washing treatments during carrot storage regarding mass, vitamin C and β-carotene losses. Losses of mass, β-carotene and vitamin C during carrot storage were observed higher in the simple cooling room than in the sophisticated cold storage. After 180 days of storage the levels of both compounds were significantly lower. Higher losses were noted for vitamin C.

This research revealed that prestorage root washing (175ppm sodium hypochlorite) significantly reduced weight loss, while maintaining a good quality (β-carotene and vitamin C content) obtained with hot water treatment.

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ВЛИЈАНИЕ НА ПОСЛЕБЕРБЕНИТЕ ТРЕТМАНИ НА ЗАГУБИТЕ ВО МАСА, β-КАРОТИН И ВИТАМИН С КАЈ МОРКОВОТ ЗА ВРЕМЕ НА ПРОДОЛЖЕНО ЧУВАЊЕ

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Апстракт

Морковите, од сите коренови зеленчуци, се најпопуларни и широко распространети и претставуваат главен извор на каротеноиди во човечката исхрана. Целта на оваа студија беше да се испитаат разликите помеѓу послебербениот третман со миење (топла вода, H_2O_2 и Na_2OCl) и немиење (контрола) на корените и ефектот на различните услови на складирање S1 (0 ^oC и 95-99% RH) или S2 (0-2 ^oC и <90% RH) во однос на промените во масата, β-каротинот и витамин С кај сортата "Маестро F_1. Складирањето на морковите било на 0 ^oC да симулира долгорочно чување (180 дена) или на 20 ^oC да симулира услови на маркет (3 недели) што доведоа до значително намалување на хранливите материи на коренот. На крајот од складирањето (180 дена) процентот на загуби во маса се движи 3,1-33,2% во зависност од условите на чување и третманите за дезинфекција. Почетната концентрација на β-каротин во свежо набраните моркови беше 39,74 μg/g f.w. Загубите на β-каротин во текот на складирањето беше повисоко во услови на S2 (28,2-46,9%) отколку во услови на S1 ладилници (7,8-20,7%). Почетните концентрации на витамин С во свежо набраните моркови (5.05mg • 100g-1), потврдуваат дека морковот не е богат извор на овој витамин. По 180 дена складирање концентрацијата на витамин С во морковите се намалува во зависност од условите на чување. Така, загубите на витамин С во корените морков чувани во S1 софистициран систем за ладење се движеше од 2,0% до 18,2%, додека при едноставен ладилник за чување загубата на витамин С беше значајно повисока (20,7% - 52,3%).

Клучни зборови: морков, услови на складирање, послебербени третмани, загуба во маса, β-каротин, витамин С.

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BIOLOGICAL AND MORPHOLOGICAL CHARACTERISTICS OF SOME INTRODUCED HYBRIDS OF EGGPLANT (SOLANUM MELONGENA L.)

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Abstract
New, foreign varieties and hybrids of eggplant are often introduced in Republic of Macedonia, especially for greenhouse production. The selection of appropriate hybrids and varieties, according to their biological and morphological characteristics and their behavior in local production conditions, significantly affects the yield and the quality of production. The biological and morphological characteristics of four introduced hybrids of eggplant (Solanum melongena L.) were examined for the purpose of this study: Classic F_1, *Mileda* F_1, *Galine* F_1 and *Diva* F_1. The biological characteristics were studied by the occurrence and the duration of the following phenological phases: vegetation period, number of days from emergence to beginning of flowering, number of days from flowering to beginning of maturity and number of days from emergence to maturity (first harvest). In relation to the morphology, detailed analysis was performed on the fruit characteristics such as: fruit size, fruit weight with pedicle, fruit weight without pedicle, fruit shape, colour and gloss of fruit and the fruit structure. The domestic variety "*Domasen poludolg*" was taken as standard. The colected data were comparatively analyzed. The results show that the tested hybrids are characterized with good morphological and biological properties. Furthermore, this study reveals that for some of the analyzed characteristics of the hybrids *Diva F1, Classic F1 and Galine F1* even exceed the standard.
Key words: eggplant, hybrids, domestic variety, morphological and biological properties.

Introduction

For the vegetable production in our country of great importance are crops of the Solanaceae family in which are included the eggplants (Solanum melongena L). It covers an area of 62-65000 ha, which is equivalent to more than 10% of the total arable land. Lately in our country are introduced more varieties or hybrids of eggplant. The eggplant is not characterized with a wealth of nutrients and has a very low caloric and vitamin value and contains a large amount of water of about 93%. The remaining substances are nitrogen substances 1.1% no nitrogen extractive substances 3.9%, 1.2% cellulose and 0.5% ash. It also contains solanin from where the bitter taste comes. In this area this culture is an annual dikotiledon plant, while in tropical conditions it can be a perennial. The biological characteristics of vegetable varieties especially population represents internal characteristics that are acquired in the historical development under the influence of the center of origin and heritability. In our production more often a foreign varieties and hybrids of an eggplant are imported especially for greenhouse production. Selection of a suitable hybrid variety influences

on the yield and quality of the production. The main goal of the research is through morphological and biological characteristics to be provided relevant indicators provided for examined hybrids of eggplant.

Material and methods

In order to achieve the goal of the research, the two years trials were set up. Four hybrids of foreign origin and one domestic standard were grown and examined as follows: *Diva* F_1 and *Mileda* F_1 of Dutch origin and *Galine* F_1 and *Classic* F_1 of French origin. The domestic variety "Domasen poludolg" was taken as standard. The trials were in plastichouses (heated only by solar energy) with dimensions of 5 x 30 m, and area of 150 m^2 in the village Stajkovci-Skopje. Tested varieties were placed in six replications of 10 plants each, at 2.00 m^2 experiment small parcel, arranged in a random block system, with application of standard production technology and agro-technical measures. The morphological characteristics were detail studied as: characteristics of the fruit, such as the fruit size, the fruit weight with the pedicle, the fruit weight without the pedicle, the fruit shape, the colour and the gloss of the fruit and the fruit structure. The biological characteristics were studied: the occurrence and duration of the individual phenological phases such as: days from emergence to beginning of flowering, days from flowering to beginning of maturity, days from emergence to maturity (first harvest).

Results and discussion

Morphological characteristics of the fruit

Weight of the fruit is one of the parameters by which the size of the fruits is determined. It depends on the conditions and agrotehnical cultivation, location of the fruit of the plant and of other external conditions. The weight of the fruit is a varietal characteristic. The fruits of eggplant are classified as: very small (100 g); small (100 - 200 g); medium (200 - 400 g); large (400 - 800 g); very large (over 800 g). All hybrids according to the classification have large and very large fruits.

Table 1. Average weight of fruit

Hybrid	Fruit weight with pedicle (gr)	Fruit weight without pedicle (gr)
Diva F_1	600	588
Mileda F_1	500	490
Galine F_1	600	588
Classic F_1	700	685
Domasen poludolg Ø	350	338

From the table it can be concluded that all tested hybrids are larger compared with standard, which is medium (350gr) as follows: the hybrid *Classic* F_1 with weight of the fruit (700 g), *Diva* F_1 (600 g), *Galine* F_1 (600 g) and *Mileda* F_1 (500 g). It can be seen that pedicle takes a very small part of the weight of the fruit (10 - 15 g). The shape of the eggplant fruit is like berries. The fruit may be of different size, shape and colour, depending on the variety and age. The harvest of the eggplant is performed in its technological maturity when the fruit reaches a characteristic size, shape and colour appropriate for the variety. In the terms of length, the fruit can be: short (under 10 cm), medium long (10-25 cm), long (25-40 cm), very long (over 40 cm). The shape of the fruit is a varietal

characteristic which may be different such as: cylindrical, elongated, spherical, globular etc. The colour of the fruit is a varietal characteristic, but depends on the stage of maturity. The colour of fruits in technological maturity during harvest is mainly purple with the lighter or darker purple shades, but do not exclude the possibility to be green, white-green (now in the world there are varieties with white colour). Brightness of the fruits can be from very glossy to matte. In botanical maturity, the fruits are with brown or yellowish colour. Fruit structure can be hard or soft and gentle. The internal colour of the fruit is mainly white, white-greenish or greenish. The numbers of locules where the seeds are located are from 7 to 11. The seed is small, flat, and oval as kidney with light brown colour. It has a diameter of 2.5 mm, and a thickness of 2.5 mm. In a fruit there are up to 600 seeds with absolute weight 4-6g. The taste of the fruit may be sweet, faint bitter or strong bitter.

Characteristics of the fruit

Diva F_1: It is characterized by elongated-oval fruit. The length of the fruits is 30-35cm. The colour of the fruit is dark-purple, where fruits are smooth and glossy. The inner colour of the fruit is white, while the internal consistency of the fruit is soft and gentle.

Mileda F_1: The fruits are long and thinner with a length of 30cm. Unlike hybrid Diva F_1, Mileda F_1 is characterized by dark-purple colour even black. They are smooth, the whole plants are spineless and they are with good shine.

Galine F_1: The shape of the fruits is round with an obvious purple colour and expressive gloss. The length of the fruit is about 30cm. The internal consistency of the fruit is soft and gentle, with a relatively white colour with a darker shade of white around the seed.

Classic F_1: The fruit of this type of hybrid has an oval shape and dark purple colour. The length of the fetus is 35cm or more and it is very smooth and shiny. The inner colour of the fruit is white, while internal consistency is soft and gentle.

Table 2. Characteristics of fruits

Hybrid	Shape of the fruit	Length of the fruit	Colour of the fruit	Internal colour and consistency
Diva F_1	elongated-oval	30-35cm	dark-purple	White soft and gentle
Mileda F_1	long	30cm	purple black	creamy-white, soft and gentle
Galine F_1	round	30cm	purple	White, soft and gentle
Classic F_1	oval	35cm	dark-purple	White, soft and gentle

Biological characteristics

Regarding the reactions of the eggplant to external conditions it is more picky then tomatoes, but more similar with pepper. An external conditions specific for the particular region affect on ontogenetic development of plants, respectively on individual phenological phases and on the dynamics of their appearance. In this context particular phenophases of development have been noticed as: emergence, flowering, fertilization, fruitfulness and finally maturity.

Vegetation period is the period of time that plants spend all phenological phases during development from emergence to botanical maturity. On the length of the vegetation period affect environmental factors and genetic characteristics of the variety or hybrid which is different for plants, species, varieties, hybrids. According the length of vegetation period eggplants are: early, medium-early and late. During our study, the vegetation period of the tested hybrids *Diva F_1*,

Galine F_1 , and standard *Domasen poludolg* in the first year was 120 days, while the hybrids *Mileda* F_1 and *Classic F1* had 125 days vegetation period. In the second year of the study vegetation period of the tested hybrids *Diva* F_1, *Galine* F_1 and standard lasted 108 days, while the hybrids *Classic F1* and *Mileda F1* lasted 119 days.

An occurrence of the cotyledons on the soil surface is named as emergence. According to the many scientists' researches, the optimal temperature for germination and emergence is 22 - 25°C although it can emergence at lower temperature from 14°C where emergence is much slower. For a good germination and emergence water was added frequently, where soil moisture was 70 - 80% of SWC (soil water capacity). Because of the good conditions prevailing in the greenhouse where the seedlings were produced, plants emergenced for 13 days. Despite favourable conditions for plant emergance, also other remaining phenological phases, as blooming, require optimal amounts of water, optimum temperature, heat, light and nutrients. During this period, which many scientists consider to be a critical period in the life cycle of plants, it is essential that the preceding factors should be on optimal level. If at least one of the factors is not optimal at this phase, decreasing of flower buds occurs or the progress of this phase slows. Occurrence of the first flowers in hybrids *Diva* F_1, *Galine* F_1 and *Domasen poludolg* was after 82 days, while in hybrids *Mileda* F_1, *Classic* F_1, the time of flowering (20%) was 84 days in the first year of the examination.

In the second year of the study the number of days from emegance to the beginning of flowering (20%) was lower in all tested hybrids due to the higher temperatures that were present in this year of our study.

The number of days from emegance to the beginning of flowering (20%) in hybrids *Diva* F_1, *Galine* F_1 and in standard *Domasen poludolg* was 72 days, while the hybrids *Mileda* F_1 and *Classic* F_1 were 78 days in the second year of research.

The flower ends with the formation of the fruit which in itself carries the seeds. The fruit is formed after fertilization of the ovary, makes the fruit grow as a result of the influx of nutrients that fill the cells of the fruit (R. Grupce, 1994). In the first year of the study the period from emergence to begginig of maturing (first harvest) of tested hybrids *Diva* F_1, *Galine* F_1 and in the standard lasted 120 days, where in hybrids *Mileda* F_1 and Classic F_1 lasted 125 days. In the second year of the study, period from emergence to beginning of maturing was 108 days in hybrids *Diva* F_1, *Galine* F_1 and standard *Domasen poludolg*, while in hybrids *Mileda* F_1 and *Classic* F_1 was 119 days. This is the period of time that is required hybrids to reach harvest and is different in both studied years due to the different weather conditions. On this period from flowering to early maturing and technological maturity, beside affect of genetic traits of the examined hybrid, external factors (temperature, light, water, food, etc.) also affects. Also, in this phase, the lack of any of the above factors can lead to slower progress of this phase, and thus slower growth and development of the plants. As an example, although the eggplant belongs to the group of plants with short day with the optimal 12-14 hour lighting for normal growth and development in this phase is very important optimum lighting. In the absence of light in this phase flowers fall, and this is reflected on the yield. In this study we didn't encountered such a problem thus the plant had normal growth and development. In the first year of testing, the number of days from flowering to beginning of maturing (first harvest) in tested hybrids *Diva* F_1, *Galine* F_1 and standard *Domasen poludolg* was 38 days, while in *Mileda* F_1 and *Classic* F_1 was 41 days. The number of days from flowering to the beginning of maturing (first harvest) in the second year of the study for hybrids *Diva* F_1, *Galine* F_1 and standard Domasen poludolg was 36 days, in hybrids *Mileda* F_1 and *Classic* F_1 was 42 days.

Table 3. Observations of phenological appear in 2002

Hybrid	Date of sowing	Date of Emergence	Date of flowering (20%)	Days from emergence to start flowering (20%)	Date of maturing (first harvest)	Days from emergence to first harvest	Days of flowering (20%) to first harvest
Diva F_1	27.01.	10.02.	03.05	82	10.06.	120	38
Mileda F_1	27.01.	10.02.	05.05	84	15.06.	125	41
Galine F_1	27.01.	10.02.	03.05	82	10.06.	120	38
Classic F_1	27.01.	10.02.	05.05	84	15.06.	125	41
Domestic half long Ø	27.01	10.02	03.05	82	10.06	120	38

Table 4. Observations of phenological appear in 2003

Hybrid	Date of sowing	Date of Emergence	Date of flowering (20%)	Days from emergence to start flowering (20%)	Date of maturing (first harvest)	Days from emergence to first harvest	Days of flowering (20%) to first harvest
Diva F_1	27.01	10.02	23.04.	72	29.05.	108	36
Mileda F_1	27.01	10.02	29.04.	78	09.06.	119	42
Galine F_1	27.01	10.02	23.04.	72	29.05.	108	36
Classic F_1	27.01	10.02	29.04.	78	09.06.	119	42
Domestic half long	27.01	10.02	23.04.	72	29.05.	108	36

Conclusions

The results of two years study of morphological, biological properties of the new hybrid of eggplant, gives the following conclusions:

In terms of the weight of fruit, *with largest fruits is characterized hybrid Classic F_1*, with an average weight of 700g hybrid *Diva F_1*, then *Galine F_1* with an average weight of 600g, and finally *Mileda F_1* with an average weight of 500g. The standard *Domasen poludolg is* characterized with an average weight of 350g and is very smaller than the tested hybrids. According to the length of the vegetation period from emergence to maturity of first fruits (first harvest) in hybrids *Diva F1*, *Galine F1 and* standard Domasen poludolg this period lasted 120 days, while in hybrids *Mileda F1 and Classic F1* lasted 125 days. In the second year of the study vegetation period is shorter and in hybrids *Diva F_1, Galine F_1* and standard was 108 days, in hybrids *Mileda F_1* and *Classic F_1* was 119 days. As a result of different weather conditions there were differences in the length of the vegetation period in both years of testing hybrids and the standard. The study of the basic properties of the hybrids shows that they are characterized by good morphological and biological properties. *Diva F_1, Classic F_1, Galine F_1* for the most testing properties are on the same level with the standard, even in some cases they overcame the level of the standard *Domasen poludolg*, which give another confirmation of their successful cultivation in - plastichouses, heated only by solar energy.

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БИОЛОШКИ И МОРФОЛОШКИ КАРАКТЕРИСТИКИ НА НЕКОИ ИНТРОДУИРАНИ ХИБРИДИ ПАТЛИЏАН (SOLANUM MELONGENA L.)

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Апстракт

Странските сорти и хибриди на патлиџан се почесто се внесуваат во Република Македонија, особено за производство во заштитени простори. Изборот на соодветни хибриди и сорти, според нивните биолошки и морфолошки карактеристики и нивното однесување во локалните производни услови, значајно влијаат врз приносот и квалитетот на производството. Во ова истражување се проучени и утврдени биолошките и морфолошките својства на следните четири интродуцирани хибриди патлиџан (*Solanum melongena L.*): *Classic F_1, Mileda F_1, Galine F_1* и *Diva F_1*. Биолошките својства беа проучувани преку појавата и времетраењето на одделни фенофази како што се: вегетациски период, број на денови од никнење до почеток на цветање, број на денови од цветање до почеток на зреење и број на денови од никнење до почеток на зреење (прва берба). Од морфолошките карактеристики подетално беа анализирани својствата на плодот и тоа: големина на плод, маса на плод со дршка, маса на плод без дршка, форма на плод, боја и сјај на плод и структура на плод. Како контрола беше земена сортата „*домашен полудолг“*. Добиените податоци за својствата беа споредбено анализирани. Резултатите покажуваат дека испитуваните хибриди се одликуваат со добри морфолошки и биолошки својства. Исто така, оваа студија покажа дека некои од анализираните својства на хибридите *Diva F_1, Classic F_1* и *Galine F_1* дури и го надминуваат стандардот.

Клучни зборови: патлиџан, домашна сорта, морфолошки и биолошки карактеристики.

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PRODUCTIVE CHARACTERISTICS OF SOME INTRODUCED HYBRIDS OF EGGPLANT (SOLANUM MELONGENA L.)

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Abstract
The yield of one crop or variety is primarily genetically determined, which is characterized by the variety or hybrid, expressed through genetic. Although the yield is genetic trait, it is influenced by the complex external (production) conditions, as well as manufacturing technology. In this research some product properties of four eggplant hybrids (Solanumlo melongena L.): Classic F_1, Mileda F_1, Galine F_1 and Diva F_1 were studied and determined. The domestic variety "Domasen poludolg" was taken as standard. Some productive properties were studied, as follows: dynamic of yield achievement per harvests, total yield of fruits per hectare, index of early maturity. Total average yields of examined hybrids for two years are: *Diva F_1 104.05 t/ha, Mileda F_1 66,4 t/ha, Galine F_1 93,1 t/ha, Classic F_1 97,1 t/ha* and of standard *Domasen poludolg 70.2 t/ha*. The results show that the tested hybrids are characterized by good productive characteristic, suitable for greenhouse production, with an exception of the hybrid Classic F_1 which gave better results, with the complete removal of the foils, which means that it is a hybrid for open filed production.
Key words: eggplant, hybrids, domestic variety, productive properties.

Introduction

When we talk about plant production features we think of the productivity, which is expressed by the yield. The term productivity, more precisely general bioproductivity of plants means the sum of the circadian increase in vegetation. It actually represents the total weight of the plants with all underground and aboveground organs.

According to R. Grupce (1994) for agricultural production is especially important economic productivity, what is used in the diet and that has particular economic importance. The amount of yield of a crop or variety is primarily genetically determined capability that characterizes the variety or hybrid, expressed through genetic potential ie yield. In the literature, there are many data that show the influence of growing conditions on the yield. According Gazenbush (1958) temperature between 20-25 ° C and the length of the light day 12-14 hours are optimum conditions for growth, development and yield of peppers and eggplant.

Production technology in horticulture has a special impact on the amount of the yield, or the success of the production. The main goal of this research was to obtain relevant indicators of the examined eggplant hybrids, and to determine the productive characteristics during cultivation in greenhouse. On the basis of the results of comparative examination with the standard, the better will be recommended for production.

Material and methods

To achieve the goal of the research, trials were set up for a period of two years where four eggplant hybrids of foreign origin and a standard variety "*Domasen poludolg*" were grown and examined. The hybrids are *Diva* F_1, *Mileda* F_1 of Dutch origin, and *Galine* F_1 *and Classic* F_1 of French origin. Tested varieties were placed in six repetitions of 10 plants in repetition, with a experimental plot size of 2.00 m^2 arranged in a random block system.

For normal growth and development of the tested varieties appropriate production technology was conducted. Experiment was set up in the region of Skopje, village Stajkovci, in plastichouses with dimensions 5 x 30 meters, ie an area of 150 m^2. During the growing period were analyzed more productive properties as follows: number of fruits; percent of fertilization; dynamics of the yield per harvests; total fruit yield per unit area (ha); index of early maturity. The obtained results were statistically processed according to the method of Mudra and method of analysis of variance.

Results and discussion

Yield of market fruit

The total yield of market in eggplant is the sum of all harvests. Harvests of eggplant are successive, because of successive formation of the fruit during vegetation. The fruits are harvested in an immature state in the technological maturity. Then the fruits have typical characteristics of the variety or hybrid: shape, size, color, gloss and flavor.

The harvest in the first year of the survey began in early June (10.06), in the second year at the end of May (29.05) which is due to the higher temperatures in the second year of the examination. In these two years of research differences were identified in yield among hybrids in both studied years, and in yield among the hybrids in one studies.

Table 1. Yield in t/ha

Hybrid	Yield in t / ha		
	2002	2003	Average
Diva F_1	109.0	99.1	104.05
Mileda F_1	76.9	55.8	66.4
Galine F_1	98.4	87.8	93.1
Classic F_1	102.4	91.8	97.1
Domasen poludolg Ø	72.9	67.5	70.2

Number of fruit per plant

The arrangement of the fruit on branches in eggplant is a varietal characteristic, but depends on external conditions that are prevalent in the stages of flowering and fertilization. In unfavorable conditions, fertilization cannot be performed normally and abortion of fertilized flowers occurs. The number of fruits per branches in the tested populations is different for everyone. The number of fruits is the least in the first branch and then rises to third where the maximum number of fruits is formed. In the higher branches the number of fruits in sequence and gradually declines.

The arrangement of the fruits on branches, especially in the first three is of great importance for early maturity and affects the coefficient of early maturity.

The number of fruits per plant, among the surveyed populations in technological maturity is different. The largest variation was in hybrid *Mileda* F_1 with ten fruits, while the smallest variation was found among all remaining *hybrids Classic* F_1, *Diva F, Galine* F_1 including standard *Domasen*

*poludolg.*In our study in both tested years, the average number of fruits in examined hybrids and standard variety is presented in the Table 2.

Table 2. Number of fruits per plant

Hybrid	Number of fruits per plant		
	2002	2003	Average
Diva F_1	17	17	*17*
Mileda F_1	18	10	*14*
Galine F_1	16	16	*16*
Classic F_1	18	16	*17*
Domasen poludolg Ø	16	14	*15*

Percent of fertilization

The percent of fertilization is determined number based on recorded (emerging) flowers per plant and grown (shaped) fruits.

Table 3. Percent of fertilization

Hybrid	2002	2003	Average 2002/2003
Diva F_1	89	75	82
Mileda F_1	87	72	79.5
Galine F_1	87	73	80
Classic F_1	89	77	83
Domasen poludolg Ø	87	73	80

In the all tested hybrids, including the standard, the percent was significantly higher in the first year compared to the second year of the survey, due to the higher temperatures that prevailed in the second year, which leaded to abortion of fertilized flowers.

In the first year of the survey, the highest percent of fertilization showed hybrids *Diva F_1*, *Classic F_1* by 89%. Lower percent of fertilization was observed in hybrids *Mileda F_1*, *Galine F_1* and in standard *Domasen poludolg* whose percent of fertilization was 87%.

In the second year of the survey, the highest percent of fertilization was observed in the hybrid *Galine F_1* with 83%, and *Diva F_1* with 82%. The lowest percent of fertilization was observed in hybrid *Mileda F_1* with 79.5%. The standard *Domasen poludolg* hybrid and *Galine F_1* have a percentof fertilization of 80%.

Dynamic of yield per harvest

Hybrids Mileda F_1; Diva F_1; Galine F_1; Classic F_1, have achieved a higher yield in the first year of the examination in relation to the second year. This is due to various external conditions that prevailed in 2002/2003. Besides the external conditions that affect the dynamics of yield per harvest of tested hybrids, the yield on the dynamics affect genetic traits hybrids. The following tables indicate the yield of eggplant hybrids in t/ha per harvest in 2002 and 2003.

Table 4. Dynamic of yield per harvest t / ha in 2002

Number	Harvest	Hybrids yield in t / ha				
		Diva F_1	*Mileda F_1*	*Galine F_1*	*Classic F_1*	*Domasen*
1	10.06.2002	*10.9*	/	*6.2*	/	*4.1*
2	15.06.2002	*10.6*	*7.0*	*8.4*	*13.0*	*6.5*
3	30.06.2002	*13.4*	*12.4*	*11.2*	*17.6*	*10.9*
Total of three harvests		*34.9*	*19.4*	*25.8*	*30.6*	*21.5*
4	04.07.2002	*18.7*	*16.6*	*13.1*	*13.1*	*11.4*
5	06.07.2002	*17.1*	*12.8*	*15.5*	*14.6*	*13.5*
6	09.07.2002	*12.5*	*9.4*	*14.8*	*10.9*	*9.3*
7	12.07.2002	*9.9*	*7.8*	*10.7*	*12.0*	*5.3*
8	16.07.2002	*7.6*	*4.7*	*11.5*	*11.8*	*6.6*
9	19.07.2002	*8.3*	*6.2*	*7.0*	*9.4*	*5.3*
10	*Total*	*109.0*	*76.9*	*98.4*	*102.4*	*72.9*

Table 5. Dynamics of yield per harvest t / ha in 2003

Number	Harvest	Hybrids yield in t / ha				
		Diva F_1	*Mileda F_1*	*Galine F_1*	*Classic F_1*	*Domasen*
1	29.05.2003	*11.5*	/	*5.0*	/	*5.0*
2	09.06.2003	*15.0*	*8.5*	*8.7*	*15.3*	*7.5*
3	20.06.2003	*16.6*	*10.0*	*13.1*	*26.6*	*11.9*
Total of three harvests		*43.1*	*18.5*	*26.8*	*41.9*	*24.4*
4	28.06.2003	*15.4*	*10.6*	*14.9*	*15.4*	*9.8*
5	05.07.2003	*18.0*	*10.0*	*18.9*	*14.4*	*11.1*
6	09.07.2003	*14.4*	*9.2*	*15.6*	*9.0*	*17.2*
7	13.07.2003	*8.2*	*7.5*	*11.6*	*11.1*	*5.3*
8	*Total*	*99.1*	*55.8*	*87.8*	*91.8*	*67.5*

Hybrids *Diva F_1; Mileda F_1; Classic F_1* and standard *Domasen poludolg* in the first year of the research achieved the highest yield in 3th, 4th and 5th harvest, while hybrid *Galine F_1*, the highest yield achieved in the 4th, 5th and 6th harvest. Individually, each hybrid separately, hybrids *Diva F_1, Mileda F_1* achieved highest yield at 4th week of harvest, hybrid *Galine F_1* and standard *Domasen poludolg* highest yield achieved at 5th week of harvest, while hybrid *Classic F_1* highest yield achieved during the 3rd week of harvest.

In the second year of the examination all tested hybrids *Diva F_1, Mileda F_1, Galine F_1, Classic F_1,* as well as standard *Domasen poludolg* are characterized by a smaller number of harvests (two harvests less than the first year of the survey) or the number of harvests was seven. Hybrids *Diva F_1, Galine F_1* achieved highest yield at 5th week of harvest, hybrid *Mileda F_1* highest yield achieved at 4th week of harvest, while hybrid *Classic F_1* highest yield achieved in the 3rd week of harvest. The standard *Domasen poludolg* reached the highest yield at 6th harvest. From this it can be seen that there are not only reduces in the total yield and yield per harvest, but also reducing the yield

among the hybrids in a harvest in the second year of the examination in comparison to the first year of the examination.

Dynamic of yield per harvests is shown in the following graphs separately for tested hybrids in both years of the survey.

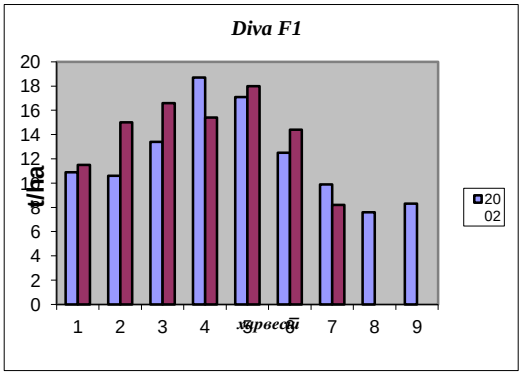


Figure 1.

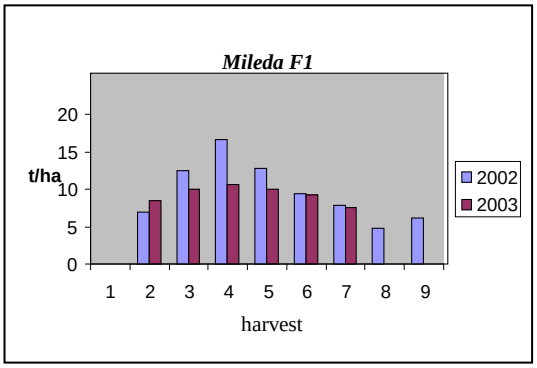


Figure 2.

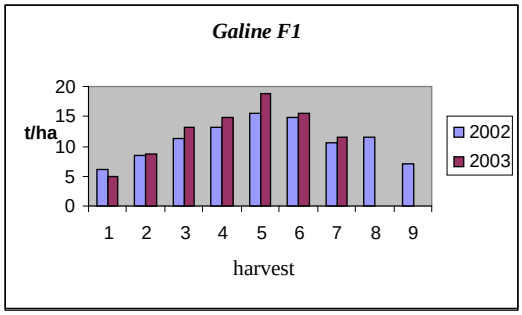


Figure 3.

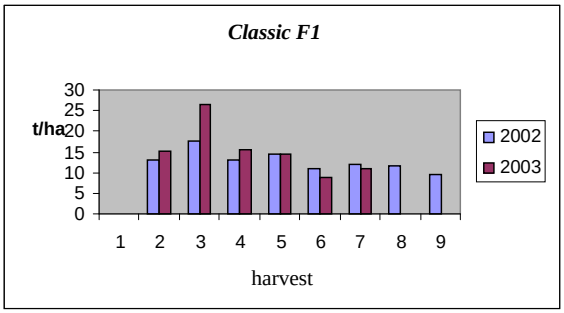


Figure 4.

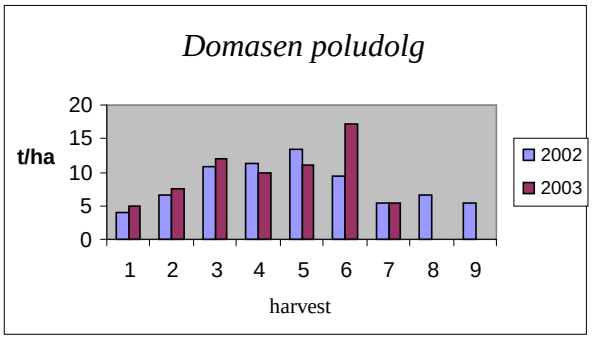


Figure 5.

Total fruit yield per hectare

Genetic properties of the hybrid, complex of external factors and production technology have a big influence in total yield or variations of total yield between individual hybrids during the survey, and

the total yield variation, during examination in a same hybrid. In addition to this, Table 6 shows the total fruit yield per hectare of tested hybrids in the both years of the survey.

Table 6. Total yield in t / ha

Hybrid	2002	2003	average	+;- од Ø in tons	percent (%)
Diva F_1	109	99.1	104.05	33.85	148.2
Mileda F_1	76.9	55.8	66.4	-3.8	94.6
Galine F_1	98.4	87.8	93.1	22.9	132.6
Classic F_1	102.4	91.8	97.1	26.9	138.3
Domasen poludolg Ø	72.9	67.5	70.2	Ø	100.0
LSD 0,05	3.07	2.56			
LSD 0,01	4.18	3.50			

From the previously stated values shown in the table can be seen that the highest yield per unit area in the first year of examination achieved hybrid *Diva* F_1 with 109,0 *t/ha*, then *Classic* F_1, *Diva* F_1 with 102,4 *t/ha*, *Galine* F_1 with 98,4 *t/ha* and *Mileda* F_1 with 76.9 *t/ha*. The standard *Domasen poludolg* in the first year of the test scored an average yield of 72.9 *t/ha* which is also the lowest yield compared to the tested hybrids. All tested hybrids, compared with the standard *Domasen poludolg* in the first year of the examination achieved significantly higher yield on the level of probability 0.05 and 0.01.

In the second year of the examination, all tested hybrids including the standard achieved lower yield compared to the first year. However, in the second year of the examination highest yield achieved the hybrid *Diva* F_1 with a yield of 99.1 *t/ha* and the lowest yield was observed in the hybrid Mileda F_1 55,8 *t/ha*. The standard *Domasen poludolg* realized yield of 67,8 *t/ha* which is subsequent to *Classic* F_1 91,8 *t/ha* and *Galine* F_1 87,8 *t/ha*, and is greater than the hybrid *Mileda* F_1.

In the second year of the examination statistically significant differences of achieved higher yield in individual hybrids on the level of probability of 0.05 and 0.01 was observed in all tested hybrids, except in *Mileda* F_1 which gave statistically significant lower yield than standard *Domasen poludolg on* probability level of 0.05 and 0.01.

Expressed as a percentage of the two years of the examination, the hybrid *Diva* F_1 had 48.2% higher yield than the standard *Domasen poludolg*. Hybrid *Mileda* F_1 had a lower yield of 5.4% from the standard, hybrid *Classic* F_1 had a higher yield of 38.3% compared with the standard, while hybrid *Galine* F_1 had 32.6% higher yield than standard.

Early maturity

Understanding and determination of the early maturity in hybrids is very important. Determining of early maturity is through two indicators:

- Coefficient of early maturity
- Index of early maturity

From the results in the Table 7 hybrid *Classic* F_1 in 2003 has the highest coefficient of early maturity 45.6 from all tested hybrids, but in average of the two tested years the highest coefficient of early maturity has hybrid *Diva* F_1 with an average 37.5.

Regarding of index of early maturity there are differences among the tested hybrids between the two years of research, as well as the differences compared with standard *Domasen poludolg*.

Table 7. Coefficient and Index of early maturity

Hybrid	Yaer	Total yield	Yield of the first three harvests	Coefficient of early maturity	Index of early maturity
Diva F_1	2002	109.0	34.9	32.0	208.8
	2003	99.1	43.1	43.5	176.6
	average	104.05	39.0	37.5	192.2
Mileda F_1	2002	76.9	19.4	25.2	90.2
	2003	55.8	18.5	33.1	75.8
	average	66.4	18.9	28.5	83.0
Galine F_1	2002	98.4	25.8	26.2	120.0
	2003	87.8	26.8	30.5	109.8
	average	93.1	26.3	28.2	114.9
Classic F_1	2002	102.4	30.6	29.9	142.3
	2003	91.8	41.9	45.6	171.7
	average	97.1	36.2	37.3	157.0
Domasen poludolg Ø	2002	72.9	21.5	29.5	100.0
	2003	67.5	24.4	36.1	100.0
	average	70.2	22.9	32.6	100.0

From the results shown in Table 7, we can see that there are differences in the index of of early maturity in tested hybrids between the two years of testing, as well as the differences compared with standard *Domasen poludolg*.

The standard *Domasen poludolg* showed the equivalent index of early maturity in two years of the examination. The standard *Domasen poludolg* during the first three harvests in the first year of the examination, achieved a yield of 21.5 *t/ha*, and in the second year 24,4 *t/ha*. In comparison to standard variety, the tested hybrids *Diva* F_1, *Galine* F_1, *Classic* F_1 have a higher index of early maturity which means that they were earlier. Hybrid *Mileda* F_1 has a lower index of early maturity compared with the standard, which means it is later hybrid.

Conclusions

From the results of two years research on the production characteristics of new eggplant hybrids in our country can be concluded:

The percent of fertilization in the tested hybrids in comparison to standard was higher in the first year then in the second year of the examination as a result of the different conditions prevailing in two years of our study.

There were no major fluctuations in terms of the number of formed fruit per plant among the tested hybrids and standard. In average of two years, least fruits formed hybrid *Mileda* F_1 - 14, while hybrids *Diva* F_1, *Classic* F_1 formed most fruits -17. *Galine* F_1 formed 16 fruits, and standard *Domasen poludolg* formed 15 fruits.

Regarding the total yield per hectare, all tested hybrids including the standard have a higher yield in the first year of the examination in relation to the second year of the examination. The highest two-year average yield is observed in hybrid *Diva* F_1 with 104,05 *t/ha*, and the lowest was observed in

the hybrid *Mileda* F_1 66,4 *t/ha*. In standard *Domasen poludolg* the average two-year yield was 70.*2 t/ha*, while in hybrid *Classic* F_1 91,1 *t/ha* and in *Galine* F_1 93,1 *t/ha*.

The highest coefficient of early maturity in 2003 had the hybrid *Classic* F_1, but in average of the two tested years the highest coefficient of early maturity had the hybrid *Diva* F_1. In average of two years examination, higher index of early maturity compared to the standard *Domasen poludolg* was observed in hybrids *Diva* F_1, *Classic* F_1, *Galine* F_1, while hybrid *Mileda* F_1 was later than the standard.

The hybrids showed excellent production properties in comparison to the standard, which give another confirmation of their successful cultivation in protectedhouses-in our case plastichouses heated only by solar energy. Hybrid *Mileda* F_1 compared to standard had relatively lower production properties, although genetically is characterized with good fertilization at relatively cold conditions. Also it should be noted that hybrid *Classic* F_1 during two years of research showed higher yield with complete removal of the foils, which means that it is a hybrid which is selected for open filed production.

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ПРОИЗВОДНИ КАРАКТЕРИСТИКИ НА НЕКОИ ИНТРОДУИРАНИ ХИБРИДИ МОДАР ПАТЛИЏАН (SOLANUM MELONGENA L.)

Стојкоска Дијана, Иљовски Игор, Ристовска Биљана, Звезда Богевска

Апстракт

Големината на приносот кај една култура или сорта пред сè е генетски определено својство што ја карактеризира сортата односно хибридот, изразено преку генетскиот потенцијал на родност односно принос. Меѓутоа, иако приносот претставува генетско својство, врз него влијае комплексот на наворешните (производните) услови, како и технологијата на производство. Во ова истражување беа проучени и утврдени одредени производни својства на четири интродуцирани хибриди патлиџан (*Solanum melongena L.*): *Classic F_1, Mileda F_1, Galine F_1* и *Diva F_1*. Како контрола беше земена сортата "*домашен полудолг"*. Од производните својства подетално беа анализирани: динамика на постигнување принос по берби, вкупен принос на плодови по единица површина (ha), индекс на раностасаност. Просекот на вкупниот принос на плодови по единица површина (хектар) остварен во двете години од истражувањето кај испитуваните хибриди е следен: *Diva F_1 104.05 t/ha, Mileda F_1 66,4 t/ha, Galine F_1 93,1 t/ha, Classic F_1 97,1 t/ha* и кај контролата *Домашен полудолг* е *70,2 t/ha*. Добиените резултатите покажуваат дека испитуваните хибриди се одликуваат со добри призводни својства, погодни за одгледување во заштитени простори, со исклучок на хибридот *Classic F_1* кој покажа подобри резултати односно повисок принос при целосно отстранување на фолиите, што значи дека тоа е хибрид што е наменет за одгледување на отворено.

Клучни зборови: патлиџан, хибрид, домашна сорта, производни својства.

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INFLUENCE OF DIFFERENT SUBSTRATES ON THE HEIGHT OF THE STALK, ROOT LENGTH, NUMBER OF LEAVES AND LEAF SURFACE ON PEPPER SEEDLINGS (CAPSICUM ANNUUM)

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Abstract
The objective of this study was to assess the growth and development of seedlings of a hybrid pepper as affected by ten growing media formulas developed from commercially available peat, inorganic media and from on-farm organic media (1st experiment: peat 100% + vermiculite 0%; peat 75% + vermiculite 25%; peat 50% + vermiculite 50%; peat 25% + vermiculite 75% and peat 25% + vermiculite 25% + organic media 50% and 2nd experiment by using perlite instead of vermiculite). The quality of seedlings is impacted by different substrates used during the seedling production. The major effect on growth parameters of pepper seedlings was obtained on substrate with on-farm organic media. This research presents data on height of stalk, height of root, leaf number per plant, leaf surface.
Key words: commercially peat, organic media, vermiculite, perlite, substrate, seedling.

Introduction

Peat, vermiculite and organic materials are the most widespread material that is used in the vegetable seedlings in greenhouse and tunnel growing in Kosovo. Vegetable production is one of the most important and at the same time the most profitable activity in crop production, (Balliu, 2004). Vegetables are grown both in the open field and in protected environments as well. In Kosovo the main vegetable crop cultivated under greenhouses are pepper, tomato, salad, onion, cucumber, etc., (Kaçiu, *et al*. 2009). From the economical point of view sweet pepper is one of the most important vegetable crops of the country. The most important limiting factor in their successful cultivation is the poor agro-technique undertaken, not adequate crop protection, and some minor factors.

Utilizing substrate on seedling growth and development is a logical alternative to the current soil-based production approach in the country. The use of different organic and inorganic substrates allows the plants the best nutrient uptake and sufficient growth and development to optimize water and oxygen holding (Verdonck et al., 1982). However, different substrates have several materials which could have direct and/or indirect effects on plant growth and development. Therefore selecting the best substrate between the various materials is imperative to plant productivity. The addition of the upper layer of coco fiber to the prelate raised the leaf water potentials (-0.74 vs. -0.84 MPa) and the rates of net assimilation (13.7 vs. 12.1 μmol CO2 m-2 s-1) and transpiration (6.01 vs. 5.19 mmol H2O m- 2 s-1) of Gerbera plants compared to the prelate alone (Paradiso and

De Pascale 2008). Fascella and Zizzo (2005) evaluated the influence of prelate and prelate mixed with coconut coir dust (coco peat) (1:1, v/v) on quantitative and qualitative parameters of cut flower (cv. Anastasia) production, they reported that the mix caused the highest amount of flowers (17.7 stems/plant) and the longest stems (65 cm). Due to diminishing supplies of peat soils for horticultural substrates, coco peat is being considered as a renewable peat substitute for use in horticulture. Tehranifar et al., 2007 reported that the vegetative growth of a number of strawberry cultivars were higher in media with peat and coco peat compared with 100% sand and prelate and in coco peat 40% + prelate 60% some cultivars produced the highest number of fruits and yield per plant. The yield in substrates with peat or coco peat was higher than in substrates with without peat or coco peat (Tehranifar et al., 2007). The selection of substratum influences not only seedlings quality, but also plant yield, the ear lines of their yielding and fruit quality (Lopez et al., 2004). Vermiculite and organic is used as the addition of other peat substratum. According to the data of Arenas and other scientists, the mixing of prelate, vermiculite, coco fibers into peat substratum influenced tomato development. Seedlings grown in peat-vermiculite and peat-prelate substratum had bigger root weight, stem diameter, leaf area (Arenas et al., 2002). The data of other scientists showed that the highest seedling quality was achieved using the mixture of substratum, peat (2/3) and enriched zeolite (1/3) (Markovic et al., 1995).The objective of this study was to evaluate the effect of different substrates on characteristics growth and seedlings development of cultivar "Bonty" of *Capsicum annuum.*

Material and methods

Bounty f1 from seminis Company

This study was carried out in the research greenhouse located at the village Godanc, municipality of Shtime in Kosovo in 2011. The plant material used in the study was F1 seeds of Capsicum annuum L., known as "Bounty F1", from "Seminis" Company. Pepper seedlings were grown in polymeric pots with prepared peat and vermiculite substratum. Sowing time – 22.04.2011. Pepper seedlings were grown in trays with different density (104,187 and 144 cell trays). The trays were disinfected with sodium hypochlorite before being filled with substrate. The seeded trays were put on 1.10 m-high tables and watered by means of micro aspersion. The duration of growing – 50 days. Seedlings were grown in different substratum. The substrates used were:

V1 – peat (potground)
V2 – peat + vermiculite (3 : 1),
V3 – peat + vermiculite (1 : 1),
V4 – peat + vermiculite (1 : 3),
V5 – peat + vermiculite +organic (1 : 1: 2).

V1 – peat (potground)
V2 – peat + perlit (3 : 1),
V3 – peat + perlit (1 : 1),
V4 – peat + perlit (1 : 3),
V5 – peat + perlit +organic (1 : 1: 2).

Each substrate was fertilized every week with NPK/MgO (18+18+18 +3) at a ratio of 100 mg·L-1. This treatment was made along with the watering during successive weeks. The samples for the characterization of the seedlings were obtained when, in most of the treatments, the transplanting size had been reached (7-8 true leaves), at 40 days. Each sample consisted on five complete plants per repetition. The fresh weights of leaves, stems and roots were determined. During the stage of seedling production, the experimental design consisted of a completely randomized arrangement, with four repetitions in a factorial combination of 5x3 factors (five substrate mixtures x three levels

of densities cell trays). The results obtained were subjected to an analysis of variance ANOVA, according to Vukadinovic (Croatia).

Results and disscusion

Pepper seedlings grown in peat substratum, enriched with 1/3 zeolite, were higher, had more leaves and dry matter (Markovic et al., 2000). The amount of zeolite also influences seedling growth and development. Stem diameter, leaf area and dry weight of seedlings increased with the increased amount of zeolite (Song et al., 2004). According to the data of Güler et al, tomato seedlings grown in peat-perlite and other substratum and grown only in peat were the same (Güler, Büyük, 2007). According to the data of Eltez and other scientists, the seedlings of aubergine and pepper grown in peat+perlit substratum didn't differ from seedlings grown in peat (Eltez et al., 1994). According to the data of Demirer and Kuzucu investigations, perlite positively influenced the growth and development of lettuce, cucumber, tomato seedlings (Demirer, Kuzucu, 2000). According to the data of our investigation, vermiculite and organic materials, mixed into peat substratum influenced biometrical parameters of seedlings. Pepper seedlings grown in peat+vermiculite and peat+vermiculite+organic materials substratum were lower and had smaller leaf area than the seedlings grown in peat. Seedlings grown in peat+vermiculite and peat+peat+vermiculite+organic materials substratum had bigger fresh weight. It is often used in order to establish as some method of growing and environmental conditions influence on characteristics of pepper seedlings. Pepper seedlings grown in peat-vermiculite and peat-vermiculite – organic materials substratum are compact, have smaller leaf area, but their above-ground and root weight is bigger than this of seedlings grown in peat. The bigger amount of vermiculite (1:1) in peat determines the fact that pepper seedlings accumulate in roots and leaves more dry matter. When the amount of vermiculite in peat is less (2:1), pepper seedlings accumulate in leaves less dry matter. The main purpose of the research work was to estimate the impact of using different types of peat mixed in the different percentage of vermiculite. By using different percentage of peat mixed we reached to get significant results in different parameters such are weight of stalks and roots, leaf area and number of leaves. Measurements which have been done and calculating them with statistical program (ANOVA) and test with LSD, it is obvious that there are significant results in different parameters, such using peat+ vermiculite (A1), with different mixtures (5) with different percentages (B1-B5) as well as using different type of trays with different holes (C1-C3). Stalk height cm: The obtained results after the data processing with ANOVA showed that there are significant statistical differences at different level with regard to substrate, mixture, modules and their interactions (Tab.1). The highest average with regard to the substrate has been recorded to A1 (11.62), whereas the lowest one with the substrate A2 (10.99) and these differences are highly significant. As for the mixture (Factor B) the highest value has been recorded with mixture B1(12.70) and the lowest one with mixture B5 (9.25). With the modules used the highest value has been recorded with module C2 (11.446), whereas the lowest one with module C3 (11.217). Statistically significant differences were recorded as well with regard to the interaction AxB, AxC, BxC and AxBxC. Root length cm: Vermikulit substrate A1 root length was B2 in module C2 with the value of 10,355 cm and smaller length has been observed to B3, module C2 worth 7,825 cm. Perlit substrate A2 length has been observed to B1, module C3 with the value of 10.60 cm, and lower length proved to mix B3, module C1 with the value of 7.49 cm (Tab.2). Leaf surface (cm^2): Vermiculite substrate A1 largest leaf surface was B1, module C1 with the value of 6.18 cm2 and less blending B3, module C3 with a value 2.63cm^2.

Perlit substrate (A2) the largest surface area was B1, module C1 with the value of 6.95 cm^2, while the lower surface is proven to mix B4, module C2 with value 1.67cm^2 (Tab.3).
Number of leaves: The majority of the leaves was found to Vermikulit substrate A1 at B1, module C1 with a value of 4.90 leaves and smaller number has been found to B4, module C1 worth of 2.25 leaves. Perlit substrate (A2) greatest number has been found to B2, module C2 with the value of 5.35 leaves, while the lowest number is verified to B3, module C1 and C3 with value 2.70 leaves (Tab.4).

Table 1. Stalk height (cm)

Substrat (A)	Mixture (B)	Modules (C)			Average (AB)	Average (A)
		C_1	C_2	C_3		
A1	B1	13.923	10.255	11.835	12.004	11.62*
	B2	10.640	10.815	15.545	12.333	
	B3	11.225	12.375	10.600	11.400	
	B4	13.033	14.275	10.945	12.751	
	B5	9.125	9.565	10.210	9.633	
	Average (AC)	11.589	11.457	11.827		
A2	B1	16.580	12.685	10.935	13.40	10.99*
	B2	9.778	14.185	11.770	11.91	
	B3	8.785	8.590	7.345	8.24	
	B4	10.550	14.005	12.970	12.50	
	B5	8.975	7.710	10.015	8.90	
	Average (AC)	10.934	11.435	10.607	Average (B)	
Dëmtuesi x Kultivari (BC)	B1	15.251	11.470	11.385	12.70**	
	B2	10.209	12.500	13.658	12.12	
	B3	10.005	10.483	8.9721	9.82	
	B4	11.791	14.140	1.958	12.63	
	B5	9.050	8.637	13.112	9.26**	
Average (C)		11.261	11.446	11.217	AxBxC	

Factors		A	B	C	AB	AC	BC	ABC
LSD	1%	0.42033	0.99837	0.63588	1.54214	0.99164	1.84900	3.58834
	5%	0.31932	0.73673	0.48308	1.09994	0.72709	1.27088	2.16361

Table 2. Root length (cm)

Substrat (A)	Mixture (B)	Modules (C)			Average (AB)	Average (A)
		C_1	C_2	C_3		
A1	B1	10.025	9.400	10.025	9.817	9.311
	B2	10.040	10.355	9.470	9.955	
	B3	10.058	7.825	9.030	8.971	
	B4	9.080	8.943	8.695	8.906	
	B5	8.330	9.165	9.220	8.905	
	Average (AC)	9.507	9.137	9.288		
A2	B1	9.880	9.875	10.600	10.118	9.020
	B2	9.192	10.000	8.250	9.148	
	B3	7.488	8.300	7.905	7.898	

	B4	9.175	9.040	9.020	9.078	
	B5	9.115	8.520	8.940	8.858	
	Average (AC)	8.970	9.147	8.943	Average (B)	
(BC)	B1	9.952	9.837	10.313	9.967	
	B2	9.613	10.177	8.860	9.551	
	B3	8.773	8.063	8.467	8.434	
	B4	9.127	8.991	8.858	8.992	
	B5	8.722	8.843	9.080	8.882	
Average (C)		9.238	9.142	9.115	AxBxC	

Factors		A	B	C	AB	AC	BC	ABC
LSD	1%	0.79754	0.71267	0.45401	1.10084	0.70801	1.32015	2.56200
	5%	0.60588	0.52591	0.34491	0.78518	0.51913	0.90728	1.54477

Table 3. Leaf surface (cm^2)

Substrat (A)	Mixture (B)	Modules (C)			Average (AB)	Average (A)
		C_1	C_2	C_3		
A1	B1	6.177	6.050	6.073	6.100	3.963
	B2	3.602	4.162	3.385	3.717	
	B3	4.438	3.810	2.673	3.640	
	B4	2.863	2.967	2.688	2.839	
	B5	3.170	4.210	3.182	3.521	
	Average (AC)	4.050	4.240	3.600		
A2	B1	6.947	3.02	5.510	5.420	3.611
	B2	5.015	2.233	5.320	4.189	
	B3	2.092	2.495	2.170	2.919	
	B4	2.282	1.670	1.775	1.909	
	B5	5.348	2.987	2.513	3.616	
	Average (AC)	4.737	2.638	3.457	Average (B)	
(BC)	B1	6.563	4.926	5.791	5.760	
	B2	4.309	3.197	4.352	3.953	
	B3	4.265	3.153	2.421	3.280	
	B4	2.572	2.319	2.231	2.374	
	B5	4.259	3.599	2.847	3.568	
Average (C)		4.394	3.439	3.529	AxBxC	

Factors		A	B	C	AB	AC	BC	ABC
LSD	1%	0.23553	0.67563	0.39693	1.04362	0.61900	1.15417	2.23990
	5%	0.17893	0.49857	0.30154	0.74437	0.45386	0.79330	1.35056

Table 4. Number of leaves

Substrat (A)	Mixture (B)	Modules (C)			Average (AB)	Average (A)
		C_1	C_2	C_3		
A1	B1	4.900	4.650	4.700	4.750	4.390
	B2	4.300	4.350	4.600	4.417	
	B3	4.000	4.200	3.900	4.033	
	B4	2.250	4.800	4.350	4.467	
	B5	4.150	4.350	4.350	4.283	
	Average (AC)	4.320	4.470	4.380		
A2	B1	4.750	4.500	4.100	4.450	3.910
	B2	3.950	5.350	4.400	4.567	
	B3	2.700	2.950	2.700	2.783	
	B4	3.550	4.650	4.150	4.117	
	B5	3.700	3.350	3.850	3.633	
	Average (AC)	4.470	4.160	3.840	Average (B)	
(BC)	B1	4.825	4.575	4.400	4.600	
Average (C)		4.025	4.315	4.110	AxBxC	

Factors		A	B	C	AB	AC	BC	ABC
LS	1%	0.52858	0.66321	0.24377	1.02444	0.38015	0.70882	1.37560
D	5%	0.40156	0.48941	0.18519	0.73069	0.27873	0.48719	0.82942

Conclusions

Pepper seedlings grown in vermiculite substratum were higher, had higher stalk, lengthen root, bigger leaf area and the biggest number of leaves than the seedlings grown in perlit.

Pepper seedlings grown in 100% peat substratum were the best mixture.

Comparing the different modules used in experiment the highest results were shown to the module type C1 (104 holes).

According to the results of this study that was conducted in order to find an alternative material to vermiculite and organic materials can be used in the production of pepper seedling together with peat.

Larger cell sizes result in larger transplants which should better withstand stresses at planting and should subsequently produce earlier peppers.

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ВЛИЈАНИЕТО НА РАЗЛИЧНИ СУПСТРАТИ ВРЗ ВИСИНАТА НА СТЕБЛОТО, ДОЛЖИНАТА НА КОРЕНОТ, БРОЈОТ НА ЛИСТОВИ И ПОВРШИНАТА НА ЛИСТОВИТЕ КАЈ РАСАД ОД ПИПЕРКА (*CAPSICUM ANNUUM)*

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Апстракт
Целта на ова истражување беше да се процени влијанието на десет различни подлоги за одгледување врз растот и развојот на расадот од хибридни пиперки. Подлогите беа добиени од комерцијално достапен тресет, неоргански материи и органски материи добиени на фарма (прв експеримент: тресет 100% + вермикулит 0 %, тресет 75% + вермикулит 25%, тресет 50% + вермикулит 50%, тресет 25% + вермикулит 75% и тресет 25% + вермикулит 25% + органски материи 50%; во вториот експеримент користено е перлит наместо вермикулит). Квалитетот на расадот зависи од видот на супстратот кои се користи за негово производство. Најголем ефект врз растот на расадот од пиперки беше забележан при примената на супстрат со огранski материи. Во ова истражување се прикажани висината на стеблото, должината на коренот, бројот на листови по растение и површината на листовите.
Клучни зборови: комерцијален тресет, органски материи, вермикулит, перлит, супстрат, расад.

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Expert paper

EFFECT OF LIGHT AND ARIFICICAL LIGHTNING IN THE PRODUCTION OF SOME FLOWER SPECIES

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Abstract
Light as one of the basic production factors, that is in deficit during the winter period, can be replaced by artificial lighting. For this purpose there are various lights with different spectrum, that affects the intensity of photosynthesis (blue, orange), vegetative growth (blue) or the flowering and fruiting (red). Here are presented results from the application of artificial lighting on two flowering species Petunia Wave Purple treated with incandescent and compact fluorescent lamps. With the treatments with fluorescent lamps after 10 weeks treatment the plants were not blossomed, while with the treatment with incandescent lamps all plants blossomed for 6 to 8 weeks. The treatment with combinations of both lamps, gave rarely blossomed plants. Campanula puncata, treated with three sources of lightness (natural and two types on lamps). Visible difference in the treatments: 1 Small growth without flowers, 2 Average growth and poor flowering, 3 Full flowering. In the third treatment with high pressure sodium lamps (HPS), its full blooming plants.
Key words: Light, arificical lightning, spectrum, lamps, Pethunia, Campanula puncata.

Introduction

The production of flower crops, as well as all crops in general, is mostly organized according to the environment conditions. According to the light there is adjustment of the species, varieties and the purpose of production in general. Unsuitably representation on some of the basic factors can limit or enable the production. Providing optimal environment conditions and agro technical measures (temperature, relative humidity, fertilization etc.), often can be costly but is easily manageable. However, the factor light is difficult to manage. Deficiency is occurring mostly in winter period and depending on degree of deficit it can reduce the flowering and decrease the yield and quality of flower crops. The lack of natural light in greenhouses can be compensated with application of artificial light with use of different lights and lightning systems that have different spectrum and different influence on the growth and development of plant organs (stem, leafs, flowers).Also in the production of flower species is used appropriate spectrum.

Subject and purpose of the research

Subject of the research is assembling information for the utilization of the artificial lighting in the production of floral species in greenhouses.

The purpose is popularization of the light as factor, in particular artificial lighting in the production of floral species, so it can be used more appropriate in practice. For this there is several factors that are important such as- the influence of different lighting installations, the color spectrum, time and duration of lighting that is different for different for different species. This is especially important because of the fact that appropriate use of light affects the number of flowers and their quality that is basic for the production of flowers. But using lamps and artificial lighting means more expensive production, because of what in addition are shown some of the factors that should be considered at the time of introducing artificial lighting.

Elements of light and their influence on the crops

When all wavelengths or all colors from the spectrum are present, the light has white color. It is considered as great success in the production to get spectrum close to the sun spectrum.

Light spectrum (color and wavelength)

Purple 380 - 440 nm (nanometers), Dark blue 440-460 nm, Blue 460-510 nm, Green 510-560 nm, Yellow 560-610 nm, Orange 610-660 nm and Red 660-760 nm.

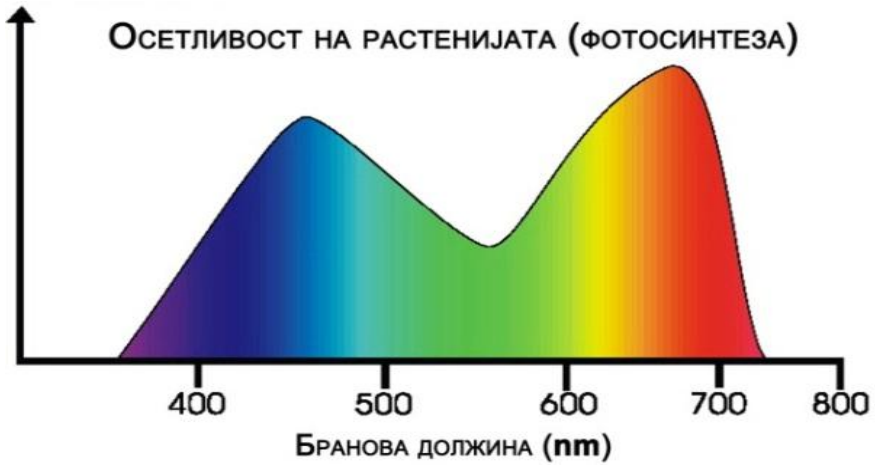


Figure 1. Photosynthetic active radiation

Different colors and wavelengths have different influence on the spectrum and intensity of photosynthesis (Picture 1). Strongest influences on the process have blue, orange and red color from the spectrum. When there is use of artificial lighting with lamps in all colors from the spectrum, it can be chosen color according to the needs of the plant, in that way blue color is used for vegetative growth and the red for flowering and fruiting.

There is a difference between the terms radiation which means general lighting and irradiation which means lighting on plant.

When artificial light from various sources is used, the light has different intensity, wavelength (color) and is present with different percentage. For artificial light sources used in greenhouse production it is very important the presence of various colors. There are several light sources that have different use and serve for different needs. The choice of lamps depends on the crop, the light installation, type and characteristics of the greenhouse, as well as other factors mutually related,

such as: level and intensity of radiation, period of irradiation (lightning on plant), photoperiod characteristics and needs, the amount of light needed for supplement or replacement of daylight and the costs for artificial light.

Basic parameters for determination of economic viability of artificial light

The decision for installation of artificial light, the growers should be making on extensive economic analysis. Additional profit with that type of installation can be achieved depending on: the quality of produced crop, the projected yield and whether there will be possibility for shortening of vegetation period and decreasing production expenses.

Detailed analysis for greenhouse production with artificial light includes: 1. Type and dimension of greenhouse, 2. Needs for artificial light of the potential crops, 3. Types of lamps and lighting bodies, 4. Light flow, 5. Period of use, 6. Intensity of daylight, 7. Height of crops to the lamps (nm), 8. Spatial index (K) and direct radiation in proportion with lighting (DR), 9. Number (n) and schedule of lamps, 10. Horizontal light uniformity (Emin/Emax), 11. Power consumption and energy costs per unit (kg, number).

Lighting on the flower species

When dealing with basic production factors, producers often are working on optimizing temperature, relative humidity, fertilization as a way to compensate the lack of light. That is feasible to certain extent, but the negative effects on yield and quality cannot be fully eliminated.

The understanding of light and its influence on the vegetative growth, flowering and fruiting is continuously growing with the development of new light technologies in plant production. The result is higher yields and regular market presence.

The achievements in genetics and plant breeding, as well as in light technology and its implementation are contributing in the extensive development of horticulture.

Whit implementation of artificial light, growers are independent from the duration of daylight in winter period. Thus, it is possible to produce transplants and cuttings for some flower crops and bushes, as well as control of vegetative period. Knowing the needs of different species, the types of lamps, type of radiation and light intensity, as well as necessary light according to the day length, in addition with the economic analysis are the foundation for successful greenhouse production.

The substitution of day light with artificial light takes place when day light is completely eliminated. In order to be economically feasible, for this technique is needed:

- production of crops that have lower needs for radiation
- crops that require higher temperature
- fast growing species
- plants with small habitus
- production of expensive crops
- plant production in greenhouses with clear time planning

From the relevant literature is known that artificial light is commonly used in the production of following species:

- tulips, narcissus, hyacinths, and other bulbs
- bushes, azaleas, chrysanthemum etc.;
- transplants for cut flowers and pot flowers (Bromelia, chrysanthemum etc.),;
- cuttings propagation of dianthus, chrysanthemum etc.;
- production of transplants for pot plants such as: begonia, chrysanthemum, bromelia;
- in vitro production.

Light treatment of flower species with different lamps

As interesting examples and results obtained during treatment with different types of lamps can be indicated the experiments in production of Petunia and Campanula punktata.

Petunia, long day plant, was treated with two types of lamps: incandescent and compact fluorescent lamps. The results show that after 10 weeks the plants did not produce flowers during the treatment with fluorescent lamps. Whereas after the treatment with incandescent lamp all plants were producing flowers in the period of 6 to 8 weeks. The combined treatment, with both types of lamps, resulted in less developed flowers.

Same flower crop was treated as a transplant, without additional light and with artificial light with HSP (High Sodium Pressure) lamps in same environment conditions. The plants treated with artificial light blossomed, and those without artificial light blossomed very poorly. Other flower crop, Campanula puncata was treated with natural light, incandescent lamps and HPS lamps. The analysis show that in natural light plants remain small and flowers are absent, the incandescent lamps gave solid results, and HPS lamps gave best results where all plants blossomed.

Conclusions

During a period when lack of light is present there are negative impacts on the flowering, yield and quality. This deficit can be substituted with artificial light in the production of many flower crops. For that purpose, different lamps with different spectrum are used, depending on the aim of production (development or stimulation of vegetative growth, flowers or fruits).

The choice of lamps depends on the crops, aim of production, type of greenhouse, the existing lack of natural light, economic parameters etc. The economic analysis for installation of artificial light in greenhouses is very important because it includes all specifics for successful implementation.

Particular problem in this area is the fact that there is not enough available information for the researches of the impact of artificial lighting in floriculture. From the minor number of popularized reports can be used the result from the treatment of Petunia and Campanula. In this research is demonstrated that various lamps have different effect on same species. In the example of petunia is demonstrated that fluorescent lamps gave no results in promotion of flowering after 10 weeks treatment, whereas the incandescent lights promoted flowering after 6-8 weeks. In other crops, such as Campanula punctata incandescent lamps gave good results, but HPS lamps gave even better results in promotion of flowering.

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ВЛИЈАНИЕ НА СВЕТЛИНАТА И ВЕШТАЧКОТО ОСВЕТЛУВАЊЕ ВО ПРОИЗВОДСТВОТО НА НЕКОИ ЦВЕТНИ ВИДОВИ

Иљовски Игор, Богевска Звезда, Давитковска Маргарита, Ристовска Биљана, Стојкоска Дијана, Илиќ Попов Станко, Ибушоска Афродита, Ибраим Јашка

Апстракт
Светлината како еден од основните фактори за производство, која во зимскиот период е во намалена, може да се надомести со вештачко осветлување. За таа цел постојат најразлични светилки со различен спектар на бои, кои влијаат на интензитетот на фотосинтезата (сина, портокалова), за вегетативниот раст (сина) или за формирање на цветот и плодот (црвена). Презентирани се резултатите од примената на вештачко осветлување на два цветни вида Petunia Wave Purple, третирано со жаречки и компакни флуросцентни светилки. При третманите со флоурецентни светилки после 10 недели растенијата не процветале, а при третманот со жаречки светилки сите растенија процветале за 6 до 8 недели. При третманот на комбинација од двете светилки, дава ретко процветани растенија.Campanula puncata, третирана со три извори на светлина - природна и два типа на светилки. Видни разлики на третманите: 1. Мал пораст без цвет, 2. Среден пораст и слабо цветање, 3. Полно цветање. Во третиот третман со натриумови светилки под видок притисок (HPS), растенијата потпоно процветале.
Клучни зборови: светлина, вештачко осветлување, спектар на бои, светилки, Pethunia, Campanula puncata.

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Original scientific paper

THE INFLUENCE OF SUBSTRATE COMPOSITION ON THE QUALITY OF ANNUAL SPECIES OF FLOWERS

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Abstract
This paper investigates the justification of the introduction of domestic raw materials for preparing substrate favourable for growing seedlings of annual flowers. The substrates prepared on the Tutin peat and perlite with zeoplant were investigated. The selected species of annual flowers Tagetes patula and Catharanthus roseus were produced in plastic containers (speedling system) and poly-propylen pots (pot system). The trial was conducted during 2009 and 2011 in the greenhouse at the Faculty of Agriculture in Belgrade. The total number of investigated substrates was 14. Research results indicate the justification of the introduction of Tutin peat (T), perlite (P) and zeoplant (Z) for preparing substrates for growing seedlings of the selected annual flowers. The results of the research show that the composition of substrates differently affects the development of investigated seedlings (plant height, above-ground mass, root mass) and accordingly their quality. The best development of plant seedlings Tagetes patula was achieved on the substrate $T_{60}+P_{20}+Z_{20}$, and of plant seedlings Catharanthus roseus on the substrate $T_{80}+P_{10}+Z_{10}$.
Key words: substrate, seedling, annual flowers, Tutin peat, perlite, zeoplant.

Introduction

In modern production of flower seedlings there are substrata of different composition. Since there is no 'ideal' substratum with respect to all grown seedlings (Samadi, 2011), special attention should be paid to the physical, chemical, and biological characteristics of a substratum during its preparation. Consequently, the selection of substrata of adequate composition plays a crucial role in the production of high quality plants (Latimer 1991; Kallo et.al., 1985; Argo, 2004). According to Landis et al. (1990), Heiskanene (1993), and Reinikainen (1993), it is desirable that the components for the preparation of substrata are easily accessible, of small specific weight, and easy for handling as well as that their use can provide the uniformity of plants. Modern substrata which are suitable for growing seedlings of flowers mostly consist of peat, sand, perlite, and vermiculite (Tinus and McDonald 1979; Landis et al., 1990). Rising peat prices worldwide call for new alternative materials which would be used for the preparation of substrata (Abad et.al., 2001; Guerin et.al., 2001; Grazia-Gomez et.al., 2002; Adalberto et al., 2006) or the application of domestic raw materials (Vujošević, 2012). Even the results of several independent authors underline the importance of finding alternative substrata for the production of flower seedlings in a glasshouse (Bayer et al., 2007; Samadi, 2011). In countries such as Serbia, apart from being ecologically viable, the use of domestic raw materials, particularly peat and mineral raw materials-zeolite, can provide an economical production of flower seedlings (Vujošević, 2012). The aim of this paper was to

investigate the justification for introducing domestic raw materials in the preparation of substrata suitable for growing seedlings of annual flowers and their effect on the quality of produced seedlings.

Material and methods

The trials on the influence substrata composition has on the quality of seedlings of annual flowers were performed from 2009 to 2011 in the greenhouse at the Faculty of Agriculture, University of Belgrade. The subject of examination were substrata of different composition, which were prepared on the basis of domestic raw materials of Tutin peat (T), perlite (P) and zeoplant (Z), and their influence on the development of seedlings of annual flowers *Tagetes patula L.* series *`Bonanza` yellow-PanAmerican seed* and *Catharanthus roseus* series *'Pacifica`-red*. The selection of species was made on the basis of the length of the seedlings vegetation. The initial seedlings were produced in plastic containers of the HP QP 144/4,5 P type according to the *speedling* system, and further growing was continued with after transplanting to plastic TEKU pots (*pot system*) of the VCC 9 cm series was done and it proceeded on substrata of different composition according to the following variants: 1. Control – imported substratum (*Floragard Medium Coarse*), 2. Control – Tutin peat 100%, 3. Tutin peat 90% with 10% of zeoplant, 4. Tutin peat 80% with 20% of zeoplant, 5. Tutin peat 70% with 30 % of zeoplant, 6. Tutin peat 90% with 10% of perlite and no zeoplant, 7. Tutin peat 80% with 10% of perlite and 10% of zeoplant, 8. Tutin peat 70% with 10% of perlite and 20% of zeoplant, 9. Tutin peat 60% with 10% of perlite and 30% of zeoplant, 10. Tutin peat 80% with 20% of perlite and no zeoplant, 11. Tutin peat 70% with 20% of perlite and 10% of zeoplant, 12. Tutin peat 60% with 20% of perlite and 20% of zeoplant, 13. Tutin peat 50% with 20% of perlite and 30% of zeoplant. Substrata were made on the basis of the volume ratio of components. For each examined substratum variant, 50 plants of the initial seedling were taken, while the selection of plants for transplanting was made randomly. At the end of the production cycle of seedlings and with a sample of 30 randomly selected plants of each substrata variant that was examined, the development of seedlings was tested using the following parameters: plant height (cm), above-ground mass (g) and root mass (g). All the data we acquired were analysed using STATISTICA 6. The results of the trial were presented through the main indicators of descriptive statistics (the range, the arithmetic mean and its standard error, the median, and the coefficient of variation). Regarding the aim of the paper, we statistically tested the claim that the average values of examined parameters of seedlings, which were obtained by applying different substrata variants, were not different from each other. Homogeneity of the treatment variances was investigated by Leven's test. Taking the results of Leven's test into consideration, the hypothesis was tested using the parameter model of the analysis of variance (ANOVA) and LSD test. By applying the I-distance (Lakić and Stevanović, 2003), the substrata were ranked in accordance with the simultaneous effect on all the investigated parameters of the development of seedlings.

Results and discussion

The results on average height, average above-ground mass and average root mass indicate that the investigated substrata were prepared using domestic raw materials, Tutin peat (T), perlite (P) and zeoplant (Z), which had a positive effect on them (Tables 1 and 2). The maximum value of height (38.3 cm) as well as the maximum average value of height of the *Tagetes patula* seedlings (26.33cm) were recorded in variant 13 ($T_{60}+P_{20}+Z_{20}$) while the minimum average height (11.367cm)

was in variant 11 ($T_{80}+P_{20}+Z_0$). The seedlings of *Catharanthus roseus* as a species with the highest vegetation of seedlings, had the maximum height value (28.1 cm) in variant 1 (commercial substratum) while they had the maximum average height value (23.95 cm) in variant 3, $T_{90}+Z_{10}$, in which, apart from peat, zeoplant accounted for 10 volume percent (Table 2). The minimum average height (8.83 cm) and the minimum singular value of height (4.9 cm) the *Catharanthus* seedlings had in variant 6, $T_{90}+P_{10}+Z_0$ (Table 2). The *Catharanthus* seedlings had the most favourable average height when grown in variants, in which, the smallest dose of zeoplant of 10 volume percent was used (3, 7, and 12). The height of the examined seedlings in all samples was homogeneous Cv ≤30% (Tables 1 and 2).

The results on the average height are in accordance with the results of Damjanović et al. (1994) who conclude that young seedlings are higher in the container production of vegetable seedlings on humus substrata with zeoplant. Marković et. al. (1994) and Pavlović (1997) had similar results by adding zeoplant in substrata for the production of tomato seedlings.

Zeoplant had an equally positive effect on the height of seedlings and the above-ground mass. Just as the above-ground mass of seedlings was dependent on the content of easily accessible nutrients, the minimum average values for the above-ground mass were recorded in the case of substrata in which zeoplant was not added (variants 2, 6, and 11). The maximum average value of the above-ground mass of the *Tagetes* seedlings (24.815 g) was recorded in variant 13, $T_{60}+P_{20}+Z_{20}$, in which the maximum average plant height was achieved (Table 1). Since the above-ground values were heterogeneous in three samples (Cv≥30%), the median was used for those samples as a more valid indicator of average (Table 1). In the case of seedlings with the longest vegetation, *Catharanthus roseus*, only in one analysed sample did the plants have heterogeneous above-ground mass (Cv≥30%), so the median was taken as a more valid indicator of average (Table 2). On the basis of average values, the above-ground mass of the *Catharanthus* seedlings ranged from 3.11 g in variant 6, $T_{90}+P_{10}+Z_0$ to 13.30 g in variant 1, the ready-made substratum. In the case of substrata based on domestic raw materials, the maximum average value of the above-ground mass was recorded in substratum 3, $T_{90}+Z_{10}$ (13.194g).

Table 1. The main indicators of descriptive statistics for the development of the *Tagetes patula Bonanza yellow* seedlings on the tested substrata

Tested characteristics	Ordinal number of the variant	Variant	Arithmetic Mean	Median	Standard deviation	Standard error	Min	Max	Coefficient of variant (%)
Height (cm)	1.	Ready-made substratum	20.163	20.000	1.972	0.360	15.900	25.800	9.780
	2.	T_{100}	12.073	12.000	1.388	0.253	9.800	15.700	11.499
	3.	$T_{90}+Z_{10}$	18.360	18.100	2.961	0.541	13.100	24.200	16.129
	4.	$T_{80}+Z_{20}$	19.667	19.550	2.563	0.468	11.800	23.900	13.033
	5.	$T_{70}+Z_{30}$	17.803	17.600	1.975	0.361	14.600	22.300	11.093
	6.	$T_{90}+P_{10}+Z_{0}$	12.210	12.100	2.567	0.469	8.100	22.100	21.027
	7.	$T_{80}+P_{10}+Z_{10}$	21.020	20.650	2.611	0.477	16.600	27.900	12.419
	8.	$T_{70}+P_{10}+Z_{20}$	22.283	23.100	3.337	0.609	11.800	27.600	14.974
	9.	$T_{60}+P_{10}+Z_{30}$	20.677	19.900	3.123	0.570	15.800	28.400	15.105
	10.	$T_{50}+P_{10}+Z_{40}$	18.307	18.000	1.629	0.297	15.800	21.100	8.901
	11.	$T_{80}+P_{20}+Z_{0}$	11.367	11.250	1.243	0.227	9.400	14.100	10.936
	12.	$T_{70}+P_{20}+Z_{10}$	21.300	21.650	3.197	0.584	15.500	28.800	15.008
	13.	$T_{60}+P_{20}+Z_{20}$	26.333	26.300	3.785	0.691	20.100	38.300	14.372
	14.	$T_{50}+P_{20}+Z_{30}$	22.737	22.950	2.484	0.454	15.900	27.600	10.925
Above-ground mass (g)	1.	Ready-made substratum	12.444	12.655	2.122	0.387	6.720	15.510	17.052
	2.	T_{100}	2.872	2.900	0.423	0.077	1.510	3.570	14.736
	3.	$T_{90}+Z_{10}$	14.083	12.800	6.456	1.179	8.590	45.800	45.847
	4.	$T_{80}+Z_{20}$	17.164	17.375	3.529	0.644	8.640	23.470	20.563
	5.	$T_{70}+Z_{30}$	18.749	18.455	2.466	0.450	14.320	25.850	13.150
	6.	$T_{90}+P_{10}+Z_{0}$	3.389	3.490	1.108	0.202	1.140	5.460	32.701
	7.	$T_{80}+P_{10}+Z_{10}$	13.200	13.480	3.134	0.572	6.740	18.050	23.741
	8.	$T_{70}+P_{10}+Z_{20}$	15.406	15.125	2.611	0.477	9.860	20.940	16.950
	9.	$T_{60}+P_{10}+Z_{30}$	15.201	15.770	2.738	0.500	7.880	20.230	18.012
	10.	$T_{50}+P_{10}+Z_{40}$	13.380	12.935	1.659	0.303	10.390	16.530	12.402
	11.	$T_{80}+P_{20}+Z_{0}$	3.486	3.515	0.763	0.139	1.150	4.470	21.894
	12.	$T_{70}+P_{20}+Z_{10}$	15.746	15.160	5.038	0.920	7.370	30.450	31.992
	13.	$T_{60}+P_{20}+Z_{20}$	24.815	23.120	6.675	1.219	13.750	41.240	26.900
	14.	$T_{50}+P_{20}+Z_{30}$	21.821	21.870	4.382	0.800	8.760	32.010	20.079
Root mass (g)	1	Ready-made substratum	5.396	5.165	1.501	0.274	2.900	8.900	27.817
	2	T_{100}	2.069	2.010	0.562	0.103	1.160	3.020	27.156
	3	$T_{90}+Z_{10}$	4.001	3.760	1.360	0.248	1.610	8.600	33.990
	4	$T_{80}+Z_{20}$	4.589	4.730	1.598	0.292	1.700	8.890	34.832
	5	$T_{70}+Z_{30}$	4.414	4.340	1.253	0.229	1.990	7.230	28.387
	6	$T_{90}+P_{10}+Z_{0}$	2.734	2.800	0.831	0.152	0.790	4.330	30.405
	7	$T_{80}+P_{10}+Z_{10}$	3.790	4.000	1.382	0.252	1.280	6.260	36.473
	8	$T_{70}+P_{10}+Z_{20}$	4.837	4.675	1.444	0.264	2.890	8.670	29.850
	9	$T_{60}+P_{10}+Z_{30}$	4.224	4.425	0.823	0.150	2.550	5.510	19.490
	10	$T_{50}+P_{10}+Z_{40}$	3.877	3.955	0.894	0.163	2.300	5.710	23.047
	11	$T_{80}+P_{20}+Z_{0}$	2.495	2.420	0.794	0.145	0.500	4.000	31.815
	12	$T_{70}+P_{20}+Z_{10}$	4.171	4.135	1.367	0.250	1.760	7.410	32.786
	13	$T_{60}+P_{20}+Z_{20}$	6.638	6.790	2.279	0.416	3.260	14.020	34.326
	14	$T_{50}+P_{20}+Z_{30}$	5.893	5.820	1.673	0.305	2.420	9.450	28.384

Table 2. The main indicators of descriptive statistics for the development of the *Catharanthus roseus Pacifica red* seedlings on the tested substrata

Tested characteristics	Ordinal number of the variant	Variants	Arithmetic mean	Median	Standard deviation	Standard error	Min	Max	Coefficient variant of (%)
Height (cm)	1.	Ready-made substratum	23.120	23.350	2.865	0.523	17.100	28.100	12.390
	2.	T_{100}	9.840	10.000	1.209	0.221	6.600	11.600	12.284
	3.	$T_{90}+Z_{10}$	23.953	24.000	2.195	0.401	19.200	27.100	9.163
	4.	$T_{80}+Z_{20}$	21.487	22.250	3.148	0.575	11.900	25.600	14.653
	5.	$T_{70}+Z_{30}$	22.356	22.650	2.138	0.390	17.600	27.100	9.563
	6.	$T_{90}+P_{10}+Z_{0}$	8.827	9.600	1.874	0.342	4.900	11.200	21.226
	7.	$T_{80}+P_{10}+Z_{10}$	23.103	23.600	2.521	0.460	15.800	27.300	10.914
	8.	$T_{70}+P_{10}+Z_{20}$	20.427	20.500	3.533	0.645	12.300	26.900	17.294
	9.	$T_{60}+P_{10}+Z_{30}$	19.113	19.250	2.300	0.420	15.400	24.200	12.036
	10.	$T_{50}+P_{10}+Z_{40}$	20.557	20.450	2.787	0.509	14.100	27,900	13.560
	11.	$T_{80}+P_{20}+Z_{0}$	11.487	11.150	1.914	0.350	7.200	15.900	16.666
	12.	$T_{70}+P_{20}+Z_{10}$	23.287	23.850	2.912	0.532	16.800	27.900	12.505
	13.	$T_{60}+P_{20}+Z_{20}$	22.740	23.150	2.605	0.476	16.400	27.400	11.455
	14.	$T_{50}+P_{20}+Z_{30}$	19.083	19.100	2.949	0.538	13.200	23.100	15.456
Above-ground mass (g)	1.	Ready-made substratum	13.302	13.185	1.634	0.298	10.110	16.630	12.283
	2.	T_{100}	3.484	3.370	0.647	0.118	2.240	5.160	18.556
	3.	$T_{90}+Z_{10}$	13.194	13.260	2.042	0.373	8.180	18.490	15.475
	4.	$T_{80}+Z_{20}$	11.695	11.585	3.826	0.699	1.980	17.900	32.718
	5.	$T_{70}+Z_{30}$	10.050	10.235	2.135	0.390	3.940	13.190	21.240
	6.	$T_{90}+P_{10}+Z_{0}$	3.106	3.105	0.870	0.159	1.080	4.640	27.995
	7.	$T_{80}+P_{10}+Z_{10}$	12.588	12.960	2.174	0.397	7.830	18.140	17.271
	8.	$T_{70}+P_{10}+Z_{20}$	9.712	9.670	2.383	0.435	4.650	14.490	24.537
	9.	$T_{60}+P_{10}+Z_{30}$	9.776	9.980	1.880	0.343	4.300	13.040	19.227
	10.	$T_{50}+P_{10}+Z_{40}$	10.766	10.555	2.668	0.487	5.370	17.280	24.782
	11.	$T_{80}+P_{20}+Z_{0}$	3.500	3.390	0.996	0.182	1.810	5.700	28.474
	12.	$T_{70}+P_{20}+Z_{10}$	11.874	11.930	2.777	0.507	0.460	16.000	23.383
	13.	$T_{60}+P_{20}+Z_{20}$	10.344	10.025	1.670	0.305	7.150	15.050	16.140
	14.	$T_{50}+P_{20}+Z_{30}$	9.202	10.190	2.560	0.467	4.720	13.210	27.824
Root mass (g)	1	Ready-made substratum	2.632	2.715	0.462	0.084	1.810	3.450	17.574
	2	T_{100}	1.962	1.875	0.458	0.084	1.050	3.070	23.342
	3	$T_{90}+Z_{10}$	1.757	1.620	0.424	0.077	1.170	2.620	24.127
	4	$T_{80}+Z_{20}$	2.030	1.995	0.580	0.106	0.880	3.300	28.574
	5	$T_{70}+Z_{30}$	1.617	1.595	0.415	0.076	0.890	2.810	25.690
	6	$T_{90}+P_{10}+Z_{0}$	2.283	2.260	0.587	0.107	0.830	3.460	25.718
	7	$T_{80}+P_{10}+Z_{10}$	2.443	2.355	0.553	0.101	1.410	3.710	22.630
	8	$T_{70}+P_{10}+Z_{20}$	2.339	2.190	0.721	0.132	1.120	4.090	30.804
	9	$T_{60}+P_{10}+Z_{30}$	2.268	2.170	0.557	0.102	0.720	3.210	24.565
	10	$T_{50}+P_{10}+Z_{40}$	2.066	1.960	0.496	0.091	1.060	3.110	24.024
	11	$T_{80}+P_{20}+Z_{0}$	1.712	1.670	0.367	0.067	1.190	2.860	21.464
	12	$T_{70}+P_{20}+Z_{10}$	2.041	1.990	0.449	0.082	1.260	3.050	22.007
	13	$T_{60}+P_{20}+Z_{20}$	1.677	1.635	0.440	0.080	0.800	2.480	26.215
	14	$T_{50}+P_{20}+Z_{30}$	2.283	2.375	0.767	0.140	0.830	3.720	33.593

The minimum and the maximum average value of the above-ground mass of the *Catharanthus* seedlings were recorded in variants in which seedlings had the minimum and the maximum average values of height (Table 2). The results of the experiment involving the root mass (Table 1) showed that the average root mass of the *Tagetes* seedlings increased when physical characteristics of tested substrata were improved when perlite was added and nutritional regime was improved when zeoplant was added. The average root mass ranged from 2.069 g in variant 2, T_{100} to 6.790 g in variant 13, $T_{60}+P_{20}+Z_{20}$. For all heterogeneous samples (Cv≥30%) the median was taken as a more valid indicator of average. In the case of seedlings with the longest vegetation, *Catharanthus roseus*, the minimum average root mass (1.617 g) was recorded in variant 5, $T_{70}+Z_{30}$, and the maximum average root mass (2.63 g) was recorded in variant 1, the ready-made commercial substratum (Table 2). The root in variant 9, $T_{60}+P_{10}+Z_{30}$ had the minimum single mass (0.72 g) while the root which was grown in variant 8, $T_{70}+P_{10}+Z_{20}$ had the maximum singular mass (4.09 g). The results of Leven's test (Table 3) showed that the variances of samples were heterogeneous for all tested characteristics of the development of seedlings. Since the tested samples were of the same height, the importance of difference in average values of examined parameters was tested using the parameter model of the analysis of variance (ANOVA). According to the results of this test (Table 3) and by using substrata variants which were tested, we got plant groups which were statistically very significantly different according to all tested parameters of the development of seedlings.

For testing the differences of average values of all examined characteristics, we used the least significant difference – LSD test (Table 4, 5, and 6). The results of these tests showed that by applying zeoplant in examined substrata, average height, average above-ground mass and average root mass of tested seedlings were statistically significantly increased when compared with average values which were recorded in the case of substrata with no zeoplant. Substrata with 20% of zeoplant (variants 8 and 13) had a statistically very significant influence on the height of the *Tagetes* seedlings compared to the ready-made commercial *Floragard medium coarse* substratum, whereas in the case of the *Catharanthus* seedlings substrata with 10% of zeoplant were statistically significant (Table 4). In substrata with the smallest dose of zeoplant (variants 3, 7, and 12), the recorded average height values of the *Catharanthus* seedlings did not differ statistically from the average height of the ready-made commercial substratum and substratum 13, $T_{60}+P_{20}+Z_{20}$ (Table 4). The test results showed that the growth of the *Catharanthus* seedlings was not only influenced by the content of zeoplant's mineral component, but also by the physical characteristics of substrata.

Table 3. The results of Leven's test on the homogeneity of variances and variance analysis for the development of seedlings

Flower species	Tested parameters	Leven's test		ANOVA	
		F	P	F	P
Tagetes patula Bonanza yellow	height	3.60	0.001**	84.4	0.001**
	above-ground mass	3.47	0.000**	266.66	0.000**
	root mass	2.88	0.000**	26.34	0.000**
Catharanthus roseus Pacifica red	height	2.50	0.003**	124.893	0.001**
	above-ground mass	3.153	0.000**	94.263	0.000**
	root mass	2.540	0.000**	10.027	0.000**

p≤ 0,05(*) the difference is significant

p≤ 0,01(*) the difference is very significant

Since the physical characteristics of substrata directly depend on the quantity of organic matter, a decrease in the organic component in substrata below 70% and an increase in the mineral one did not have a statistically favourable influence on the average height of seedlings with the longest vegetation – *Catharanthus*. The results showed that substrata in which organic matter (Tutin peat) accounted for 70-90% had the most favourable influence on the average seedling height. This can be explained by the length of the *Catharanthus* seedling vegetation, which enabled the seedlings to use easily accessible elements created by the mineralization of organic matter. This is in accordance with Stevanović and Pavlović's (1995) results, which underline the low fertilising ability of peat in the first part of vegetation due to the small mineralising ability and wider C/N ratio.

Table 4. Levels of the significance of difference in the average height of the Tagetes patula Bonanza yellow seedlings and Catharanthus roseus Pacifica red seedlings based on LSD test

Variants	1.		2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
	Average height values of Tagetes patula Bonanza yellow														
$\bar{x}$	20.163	12.073	8.360	19.667	17.803	12.210	12.210	21.020	22.283	20.667	18.307	11.367	21.300	26.333	
1.		0.566	0.007	0.459	0.000	0.000	0.202	0.002	0.444	0.006	0.000	0.091	0.000	0.000	
2.	0.000		0.000	0.000	0.000	0.838	0.000	0.000	0.000	0.000	0.292	0.000	0.000	0.000	
3.	0.209	0.000		0.052	0.407	0.000	0.000	0.000	0.001	0.937	0.000	0.000	0.000	0.000	
4.	0.014	0.000	0.000		0.006	0.000	0.044	0.000	0.132	0.043	0.000	0.015	0.000	0.000	
5.	0.249	0.000	0.016	0.189		0.000	0.000	0.000	0.000	0.453	0.000	0.000	0.000	0.000	
6.	0.000	0.127	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.209	0.000	0.000	0.000	
7.	0.980	0.000	0.200	0.015	0.260	0.000		0.060	0.609	0.000	0.000	0.676	0.000	0.011	
8.	0.000	0.000	0.000	0.110	0.004	0.000	0.000		0.017	0.000	0.000	0.143	0.000	0.499	
9.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.048		0.000	0.000	0.353	0.000	0.002	
10.	0.000	0.000	0.000	0.161	0.007	0.000	0.000	0.844	0.030		0.000	0.000	0.000	0.000	
11.	0.000	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	
12.	0.801	0.000	0.314	0.007	0.161	0.000	0.782	0.000	0.000	0.000	0.000		0.000	0.033	
13.	0.566	0.000	0.068	0.059	0.563	0.000	0.583	0.001	0.000	0.001	0.000	0.409		0.000	
14.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.043	0.964	0.027	0.000	0.000	0.000		
$\bar{x}$	23.120	9.840	23.953	21.487	22.356	8.827	23.103	20.427	19.113	20.557	11.487	23.287	22.740	19.083	
	Average height values of Catharanthus roseus pacifica red														
Variants	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	

Using LSD test to compare the average values of the above-ground mass of seedlings between two groups of plants showed that in addition to an improved nutritional regime, using zeoplant made the physical characteristics of substrata result in an increase in the above-ground mass of tested seedlings of annual flowers (Table 5). In the case of seedlings with the shortest vegetation – *Tagetes*, a change of the minimum and maximum dose of zeoplant in substrata (10 and 40 volume percent) led to an increase in the above-ground mass, which became equal to the above-ground mass of the ready-made substratum and was not statistically significantly different from it (Table 5). By using zeoplant of 20 and 30 volume percent, the above-ground mass of *Tagetes* seedlings became statistically very significantly increased compared to the above-ground mass of the ready-

made substratum. The maximum average above-ground mass of the *Catharanthus* seedlings was recorded in substrata with the highest percent of organic matter (70-90%) and the lowest percent of mineral matter (variants 3, 7 and 12). The recorded values were statistically very significantly higher compared to the average values of other substrata that were tested. The above-ground mass of the *Catharanthus* seedlings of the ready-made commercial substratum was not statistically significantly different from the above-ground mass of seedlings which were grown in variants 3 and 7. Knowledge of the length of the seedlings vegetation was highly important during the preparation phase for growing suitable substrata, which was supported by our trial. As with the recorded average height, a decrease of peat in substrata for growing plants with the longest vegetation, in this case *Catharanthus*, to 70% while using the minimal dose of zeoplant (variant 12) resulted in a statistically significantly smaller above-ground mass than the average mass achieved on the ready-made commercial substratum 3, $T_{90}+Z_{10}$. In relation to the substratum with the same percentage of peat (70%) but higher percentage of zeoplant (variant 5), the above-ground mass of the *Catharanthus* seedlings was statistically significantly increased in variant 12. This underlines the importance of the percentage of organic matter in substrata for growing flower seedlings with the longest vegetation which might have a direct influence on the price of substrata. Similarly, the percentage of perlite in substrata had an influence on an increase in the above-ground mass of seedlings. It can be noted that substrata in which perlite was present with 10 volume percent were not statistically very significant to the increase of the above-ground mass of the *Tagetes* seedlings and they even led to a decrease in case the content of zeoplant was higher with regard to substrata without perlite (Table 5). The *Tagetes* seedlings had a statistically significantly greater above-ground mass on substrata with 20 volume percent of perlite and the smallest dose of zeoplant (10 volume percent) than plants on the ready-made commercial substratum (Table 5). An increase of zeoplant of 20 and 30 volume percent (variant 13 and 14) in substrata made plants obtain a greater average above-ground mass in comparison with an average mass recorded on other substrata. Even in the case of this examined indicator of the development of obtained seedlings, it turned out that the *Tagetes* plants in variant 13, $T_{60}+P_{20}+Z_{20}$, had the maximum average above-ground mass (24.815 g) which was statistically very significantly different from the average values for the above-ground mass on other substrata that were tested.

Table 5. Levels of the significance of difference in the above-ground mass of the *Tagetes patula Bonanza yellow* and *Catharanthus roseus Pacifica red* seedlings on the basis of LSD test

Variants	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13	14
	Average above-ground mass values of Tagetes patula Bonanza yellow													
$\bar{x}$	12.444	2. 872	12.800	17.164	18.749	3.490	13.200	15.406	15.201	13.380	3.486	15.160	24.815	21.821
1.			0.181	0.000	0.000	0.000	0.471	0.001	0.001	0.192	0.000	0.001	0.000	0.000
2.	0.000		0.000	0.000	0.000	0.058	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.000
3.	0.843	0.000		0.000	0.000	0.000	0.536	0.034	0.064	0.972	0.000	0.047	0.000	0.000
4.	0.004	0.000	0.007		0.095	0.000	0.000	0.111	0.063	0.000	0.000	0.085	0.000	0.000
5.	0.000	0.000	0.000	0.029		0.000	0.000	0.001	0.000	0.000	0.000	0.001	0.000	0.029
6.	0.000	0.233	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.370	0.000	0.000	0.000
7.	0.275	0.000	0.371	0.073	0.000	0.000		0.006	0.014	0.559	0.000	0.009	0.000	0.000
8.	0.000	0.000	0.000	0.006	0.555	0.000	0.000		0.790	0.031	0.000	0.897	0.000	0.000
9.	0.000	0.000	0.000	0.010	0.685	0.000	0.000	0.853		0.059	0.000	0.890	0.000	0.000
10.	0.000	0.000	0.000	0.276	0.271	0.000	0.004	0.091	0.132		0.000	0.043	0.000	0.000
11.	0.000	0.949	0.000	0.000	0.000	0.259	0.000	0.000	0.000	0.000		0.000	0.000	0.000
12.	0.013	0.000	0.022	0.691	0.010	0.000	0.162	0.002	0.003	0.138	0.000		0.000	0.000
13.	0.000	0.000	0.000	0.110	0.556	0.000	0.001	0.239	0.320	0.608	0.000	0.046		0.059
14.	0.000	0.000	0.000	0.000	0.128	0.000	0.000	0.351	0.264	0.009	0.000	0.000	0.035	
$\bar{x}$	13.301	3.484	13.194	11.695	10.050	3.106	12.588	9.712	9.776	10.766	3.500	11.874	10.344	9.202
	Average above-ground mass values of Catharanthus roseus pacifica red													
Variants	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.

Table 6. Levels of the significance of difference in the root mass of the *Tagetes patula Bonanza yellow* and *Catharanthus roseus Pacifica red* seedlings on the basis of LSD test

Variants	1.	2.	3.	4.	5.	6.	7	8.	9.	10.	11.	12.	13	14
	Average root mass values of *Tagetes patula Bonanza yellow*													
	5.396	2.069	4.001	4.589	4.414	2.734	3.790	4.837	4.224	3.877	2.495	4.171	6,638	5.893
1		0.000	0.002	0.056	0.054	0.000	0.000	0.292	0.040	0.003	0.000	0.006	0.124	0.499
2	0.000		0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.085	0.000	0.000	0.000
3	0.000	0.117		0.232	0.238	0.000	0.319	0.040	0.291	0.917	0.000	0.714	0.000	0.000
4	0.000	0.713	0.053		0.988	0.000	0.029	0.388	0.890	0.275	0.000	0.407	0.001	0.0098
5	0.000	0.007	0.248	0.002		0.000	0.030	0.379	0.901	0.282	0.000	0.416	0.001	0.009
6	0.014	0.027	0.000	0.065	0.000		0.001	0.000	0.000	0.000	0.133	0.000	0.000	0.000
7	0.190	0.001	0.000	0.003	0.000	0.249		0.002	0.041	0.272	0.000	0.173	0.000	0.000
8	0.031	0.012	0.000	0.033	0.000	0.767	0.391		0.316	0.051	0.000	0.091	0.0098	0.084
9	0.011	0.035	0.000	0.082	0.000	0.919	0.210	0.691		0.341	0.000	0.490	0.000	0.007
10	0.000	0.460	0.021	0.711	0.001	0.140	0.009	0.077	0.170		0.000	0.792	0.000	0.000
11	0.000	0.060	0.753	0.025	0.401	0.000	0.000	0.000	0.000	0.009		0.000	0.000	0.000
12	0.000	0.551	0.031	0.820	0.001	0.106	0.006	0.056	0.130	0,887	0.014		0.000	0.001
13	0.000	0.025	0.493	0.009	0.639	0.000	0.000	0.000	0.000	0.003	0.711	0.005		0.388
14	0.008	0.046	0.000	0.102	0.000	0.833	0.173	0.613	0.913	0.206	0.000	0.160	0.000	
$\bar{x}$	2.632	1.962	1.757	2.030	1.617	2.283	2.443	2.339	2.268	2.066	1.712	2.041	1.677	2.283
	Average root mass values of *Catharanthus roseus pacifica red*													
Variants	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.

The LSD test results (Table 6) indicated that growing seedlings of *Tagetes* and *Catharanthus* on substrata without zeoplant (variants 2, 6, and 11) statistically very significantly reduced the root mass of seedlings.

Improving the nutritional regime of substrata by adding zeoplant for growing *Tagetes*, from 10 to 30 volume percent (variants 3, 4, and 5) led to a statistically significant increase in the average root mass in relation to the variant with no zeoplant (2, 6, and 11). The application of zeoplant in substrata of 20 and 30 percent resulted in an increase in the average root mass but that increase was not statistically significant compared to the average root mass achieved on the ready-made commercial substratum (Table 6). The application of perlite in substrata of 10 volume percent did not statistically very significantly affect an increase in the average root mass compared to substrata without perlite (variants 3, 4, and 5). Statistically significantly greater root mass was achieved only on the observed substratum in which zeoplant accounted for 20 volume percent (variant 8) in relation to the tested substratum 3, with 10 volume percent of zeoplant. Similarly, in the case of tested substrata (variants 7 to 10) zeoplant of 20 volume percent, statistically very significantly affected an increase in the average root mass compared to substrata with 10% of zeoplant and in relation to substrata with 30% of zeoplant. This proves that the root is better elongated, and developed in substrata when less food is available, which directly affects its mass (Bloom, 2003). The results we obtained are in accordance with the results published by Pavlović (1997), who studied the root mass of tomato seedlings grown on different substrata with the addition of 20% of zeoplant. When increasing the percentage of perlite in substrata to 20 volume percent (Table 6), the application of zeoplant of 20 and 30 volume percent (variant 13 and 14) statistically very significantly increased the average root mass of *Tagetes* seedlings in relation to the lower dose of zeoplant that was administrated (variant 12). The application of zeoplant dose of 30%, variant 14, led to a decrease or increase in the average root mass compared to substrata with perlite and 20% of zeoplant (variants 8 and 13), but those changes were not statistically significant. This underlines the positive impact and justification of the application of a greater percentage of perlite in substrata when it comes to the development of the root system of the *Tagetes patula* seedlings. The average root mass of the *Tagetes* seedlings recorded on substratum 13, $T_{60}+P_{20}+Z_{20}$, was statistically very significantly greater than the average mass obtained on the other tested substrata based on domestic raw materials (Table 6). As for the other observed characteristics of the development of the *Tagetes* seedlings (seedling height and above-ground mass) substratum 13, $T_{60}+P_{20}+Z_{20}$ proved to be optimal for the observed characteristic of the root mass. In the case of seedlings with the longest vegetation, *Catharanthus roseus* as well as in the case of *Tagetes* seedlings, the application of zeoplant of 20 volume percent in the investigated substrata based on peat and zeoplant (variant 3, 4, and 5) resulted in an increase of the average root mass (Table 6). The recorded average mass, 2.03 g, was statistically very significantly higher than the average root mass (1.617 g) obtained by using higher doses of zeoplant (variant 5), whereas compared to the average root mass obtained by using a minimum dose of 10% of zeoplant, 1.75 g, it was not statistically significantly different, variant 3 (Table 6). In comparison to the other tested substrata, the average root mass of the *Catharanthus* seedlings on substratum 4 ($T_{80}+Z_{20}$) was statistically very significant and greater than the average root mass on substrata 2, T_{100}, and 13, $T_{60}+P20+Z_{20}$, but statistically significantly lower than the average mass recorded on substratum 7, $T_{80}+P_{10}+Z_{10}$. Similarly, the achieved average root mass of the *Catharanthus* seedlings on substratum 4 was even statistically significantly higher than the average root mass on substratum 11, but also statistically significantly lower compared with the root

mass recorded on substratum 8. The results we obtained only confirmed the importance of a larger percentage of an organic component (peat) in substrata for growing plant seedlings of annual flowers with the longest vegetation. The application of perlite in substrata of 10 volume percent (variants 6, 7, 8, 9, and 10) had a positive impact on the average root mass of *Catharanthus*. The LSD test results indicated that even with the same percentage of organic matter of 90% (variants 3 and 6) the average root mass in substratum 6 with added perlite, was statistically very significantly higher than in the substratum with zeoplant, variant 3 (Table 6). This can be interpreted by the improved water-air regime of substrata using perlite, which was suitable for better adoption of nutrients. Similarly, the percentage of organic matter in the substratum with 80% (variant 7, $T_{80}+P_{10}+Z_{10}$) with the use of perlite of 10% and a minimal use of zeoplant, 10%, statistically very significantly increased the average root mass compared to the average root mass recorded on the substratum with the same percentage of organic matter and a greater percentage of mineral matter (variant 4, $T_{80}+Z_{20}$). The obtained average root mass on substratum 7, 2.44 g, although smaller than the average mass, which was achieved on the ready-made commercial substratum (2.63 g), was not statistically significantly lower. A higher percentage of zeoplant in substrata in which perlite accounted for 10 volume percent (variant 6, 8 and 9) did not lead to statistically significantly higher average root mass compared to the masses that were obtained by using a minimum dose of zeoplant (variant 7) whereas when applying the highest dose (40% of zeoplant), the masses were statistically very significantly reduced (Table 6). For the purpose of ranking substrata according to the simultaneous influence on all investigated parameters of the development of seedlings, the I-distance was used (Lakić and Stevanović, 2003) (Table 7). With regard to the I-distance values, it can be concluded that the best quality plant seedlings of the group with the shortest vegetation, *Tagetes*, were obtained when plants were grown on substratum 13, $T_{60}+P_{20}+Z_{20}$. While the best quality plant seedlings with the longest vegetation *Catharanthus* are obtained when plants were grown on the ready-made commercial substratum 1, and then on substrata with the highest percentage of organic matter and the smallest percentage of zeoplant, substratum 7, $T_{80}+P_{10}+Z_{10}$ and substratum 12, $T_{70}+P_{20}+Z_{10}$.

Table 7. The I-distance values for the parameters of the development of seedlings of annual flowers

Ordinal number of the variant	Investigated substrata	*Tagetes patula*		*Catharanthus roseus*	
		I- distance	rank	I- distance	rank
1.	Ready-madesubstrata	1.656	X	*5.277*	I
2.	Peat 100%	0.040	XIV	0.821	XIII
3.	$T_{90}+Z_{10}$	1.637	XI	3.943	V
4.	$T_{80}+Z_{20}$	2.391	IV	4.010	IV
5.	$T_{70}+Z_{30}$	2.687	III	2.797	XI
6.	$T_{90}+P_{10}+Z_{0}$	0.127	XII	1.156	XII
7.	$T_{80}+P_{10}+Z_{10}$	1.796	IX	4.489	II
8.	$T_{70}+P_{10}+Z_{20}$	2.209	VI	3.495	IX
9.	$T_{60}+P_{10}+Z_{30}$	2.134	VII	3.716	VII
10.	$T_{50}+P_{10}+Z_{40}$	1.817	VIII	3.632	VIII
11.	$T_{80}+P_{20}+Z_{0}$	0.115	XIII	0.341	XIV
12.	$T_{70}+P_{20}+Z_{10}$	2.250	V	4.054	III
13.	$T_{60}+P_{20}+Z_{20}$	3.993	I	2.873	X
14.	$T_{50}+P_{20}+Z_{30}$	3.427	II	3.728	VI

Conclusions

This paper investigates the justification of introducing domestic raw materials in the preparation of substrata suitable for growing the seedlings of annual flowers. The tested substrata were favourable for growing the seedlings of annual flowers of *Tagetes patula 'Bonanza' -yellow* and *Catharanthus roseus 'Pacifica' -red* and had different effects on their development. The highest average height of seedlings with the shortest vegetation, *Tagetes patula 'Bonanza'-yellow* (26.33 cm), the highest average above-ground mass (24.815 g) and the highest average root mass (6.79 g) were recorded on substratum 13, $T_{60}+P_{20}+Z_{20}$. In the case of seedlings with the longest vegetation, *Catharanthus roseus 'Pacifica' red*, the maximum average height of seedlings (23.95 cm) was recorded on substratum 3, $T_{90}+Z_{10}$. The maximum average above-ground masses (13.3 g and 13.19 g) were recorded in the case of the ready-made commercial substratum and substratum 3, $T_{90}+Z_{10}$, whereas the highest average root masses (2.63 g and 2.44 g) were achieved on the ready-made commercial substratum and substratum 7, $T_{80}+P_{10}+Z_{10}$.

Taking into account all tested parameters of the development of seedlings, the calculated values of the I-distance suggested that the best development of seedlings of annual flowers, *Tagetes patula 'Bonanza' -yellow* was recorded on substratum 13, $T_{60}+P_{20}+Z_{20}$ and *Catharanthus roseus 'Pacifica' -red* on substratum 7, $T_{80}+P_{10}+Z_{10}$.

These variants of substrata: $T_{60}+P_{20}+Z_{20}$, and $T_{80}+Z_{10}+Z_{10}$, were made of domestic components, and their ratio was exactly balanced according to the requirements of the seedlings of annual flowers. When producing substrata of such a composition, the substitution of the imported substratum is guaranteed. Domestic raw materials and other domestic resources are used, so it would be normal that their price as well as the price of the final product is lower.

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ВЛИЈАНИЕ НА СОСТАВОТ НА СУПСТРАТОТ ВРЗ КВАЛИТЕТОТ НА ЕДНОГОДИШНИТЕ ЦВЕТНИ ВИДОВИ

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Апстракт

Во овој труд се истражува оправданоста од примената на домашни сурови материи за подготовка на супстрати погодни за одгледување на расад од едногодишни цветни видови. Истражувани се супстрати подготвени од Тутин тресет и перлит со зеоплант.

Испитуваните едногодишни цветни видови, Tagetes patula и Catharanthus roseus беа произведувани во пластични контејнери (speedling систем) и во поли-пропиленски саксии (pot систем). Опитот беше спроведен во текот на 2009 и 2011 година во стакленик на Земјоделскиот Факултет во Белград. Вкупниот број на испитувани супстрати беше 14. Резултатите од изтражувањето ја потврдија оправданоста на воведувањето на Тутин тресетот (Т), перлитот (Р) и зеоплантот (Z) за подготовка на супстрати за одгледување на расад од испитуваните едногодишни цветни видови. Резултатите од истражувањето покажаа дека составот на супстратот различно влијае врз развојот на испитуваните видови (висина на растенијата, маса на надземниот дел, маса на коренот), а согласно со тоа и на нивниот квалитет. Најдобар развој на расадот од Tagetes patula беше постигнат при примената на супстрат од $T_{60}+P_{20}+Z_{20,}$ додека кај Catharanthus roseus најдобри резултати беа постигнати со користење на супстрат $T_{80}+P_{10}+Z_{10.}$

Клучни зборови: супстрат, расад, едногодишни цветни видови, Тутин тресет, перлит, зеоплант.

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YIELD AND YIELD COMPONENTS OF NEWLY TOMATO HYBRIDS IN REPUBLIC OF MACEDONIA

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Abstract
Tomato (*Lycopersicum esculentum*) is one of the major vegetables in Republic of Macedonia. Our National Variety List has a significant number of registered domestic varieties and introduced hybrids.Before their introduction into commercial production, all introduced hybrids and newly varieties are examined in order to determinate the yield and yield components. In this paper, we treated a total of 54 varieties / hybrids of tomato examined in the period from 2005 to 2010, of which 26 of them are grown in the open field, and 28 in the greenhouses with prescribed standard technology. Tested varieties and hybrids were compared with the standard according to the prescribed rules and procedures set by the National Variety Commission. In examined period the hybrids of tomatoes grown on open field were compared with the standard varieties: Arleta F_1, San Pier, Magnus F_1, Erato F_1 and Optima F_1, while hybrids grown in the greenhouses were compared with the following standards: Amati F_1, Monika F_1 and Balca F_1. All varieties and hybrids that have shown better results than the standards in terms of estimated parameters are recommended for introduction into commercial production.
Key words: tomato, hybrid, yield.

Introduction

Tomato is one (*Lycopersicon esculentum mill*) of the widest spread vegetable crops. It is one of the most popular and widely grown vegetable crops, ranking second in importance to potato in many countries (Hartmann et al. 1981). Tomato is nutritional crop and important source of vitamin A and C and minerals which are important ingredients for human consumption (Sekhar *et al*. 2010). Since the early 20th century, the worldwide production of tomato is growing, and per area takes the tenth place of food production. Today, it is grown in most countries around the world except in colder regions (Hannan et al.2007). It is cultivated in all parts of Macedonia due to its adaptability to a range of soil and climate. The best growing areas of tomato are southeast region in Macedonia, Ovče Pole and Povardarie with total production of 120000 - 140000 tons. Tomato (*Lycopersicon esculentum*) is the most cultivated herbaceous plant in the Republic of Macedonia leading with 66% of vegetables production (Jankulovski *et.al*). Tomato yield is a complex trait that is included in almost every selection program includes several components, the quantitative nature. According to Zdravkovic et al., (2010) studies made in relation to the inheritance of yield and yielding components in the cultivation of this crop. According to Marisici et al., (2011) the yield and fruit quality depends on the cultivar and the climate in which it is grown. In 2010, in the Republic of Macedonia tomato is represented the area of 5665 ha, and production of 168,010 t Jankulovski D. et

al., (2002). The cultivation of (*Lycopersicon esculentum mill)* is carried out on the open field and greenhouses. The objective of this study was determining the yield and yield components in tomato hybrids grown on open field and greenhouses.

Material and methods

A total of 54 tomato varieties were included in this study, out of which 26 are grown in the open field and 28 in the greenhouses. All survey was made in a period of 2005-2010. The experiments in the open field were done in Skopje, in a randomised complete block design. The unit plot size was 7.0 m², while transplantation was in rows at a distance of 70x40 cm. In 2005 there were analyzed six varieties/hybrids of tomato that carry the following names: Tamaris F1, Nemo Neta F1, Galina, V71, Agora and Valina.They were compared with two standard varieties: Arleta F1 and San Pier F1. During the 2006 there were examine a total of eight varieties/hybrids: Queen F1, Bonito, Lorena F1, T8948 F1, Charisma F1, Torpeder F1, Bobcat F1 and SLX 3749 F1.The hybrids Bobcat F1 and SLX 3749 F1 were compared with standard variety Erato F1.The other six tomato hybrids were compared with the standard named as: Magnus F1. The unit plot size of this experiment was 10.0 m², and a distance of rows was 100x15 cm. As plant material for 2007 there were used two tomato hybrids: Nemo Neta F1 which were compared with Optima F1 and Queen F1 compared with Magnus F1. Hybrids: Astraion F1, CLX 37286 F1, CLX 37147 F1, CLX 37305 F1 were analyzed during the vegetation in 2008. In these trials the standard Magnus F1, was used as a comparative variety for hybrid CLX 37147 F1, and with the standard Optima F1 were compared all the other hybrids. In 2009, five tomato varieties were analyzed as follows Staccato F1, Tourist F1, Logistica F1, Pink Paradise F1, CLX 37304 F1 which were compared with standard Optima F1. During the vegetation in 2010 hybrid assigned as Abelus F1 was compared with control variant Optima F1. Greenhouse experiments were conducted during 2005-2008, at four different locations. In 2005 the experimental fields were set up in St.Nikole with total of seven tomato hybrids: Buran F1, Newton F1, Ombelline F1, PX 01021547 F1, PS 150825 F1, Iker F1 and Merkurio F1 which were compared with two standard varieties: Amati and Monika F1. The size of the experimental plot was 4.8 $m.^2$ Tested varieties marked as: Rosaliya F1, PS6262 F1, Bonarda F1, BS 015 037 003 F1, Ballet F1 and Siluet F1, were set up on the experimental fields in Gradsko, in 2006 according to the prescribed methodology for growing tomatoes in a protected space. For comparison were used two standard varieties: Amati F1 and Balca F1. Varieties: Rosaliya F1, PS6262 F1, Bonarda F1, BS015037003 F1 are indeterminate types,which were compared with the standard variety Amaty F1. Balca F1 was ised as standard variety for comparison with the semideterminant varieties Ballet and Siluet.A group of six varieties of tomato hybrids: Teory F1, Sprinter F1, Menhir F1, Tundra F1, Mondial F1 and Trogir F1 were examinate in 2007 set up in Kumanovo. As standard variety was used Monika F1. Hybrids: Lady Rosa F1, Fantom F1, Roxana F1, Thalassa F1, Trofeo F1, Alfred F1, Mathias F1, Profilo F1, and Bonito N F1, who were compared with Monika were set up on the experimental fields in Valandovo, Anska reka. Analyzes were done during the 2008, on the experimental plot of 8m². During the production of all varieties grown in open field and protected houses data of the stages of growth, average yields and characteristics of the fruits were registerd. The yields were statistically obtained and verified with LSD test.

Results and discussion

Experiment for the study of yield and yield components have been conducted in five years. This paper reviews the five-year average values of the yield components. In tab.1 there are given stages of growth for tomato hybrids cultivated on open field. Vegetation researches made in 2005 ranged from (96days) in control variant to 104 days of examined hybrids. The greater difference compared to the control variant showed hybrids: Tamaris F1, V71, and Agora. The longest vegetation in 2006 showed the variety Bobcat F1 (108 days). In 2007 the length of the vegetation in all analyzed hybrids ranged from (88days) showen by standard Magnus F1 and (83 days) in the standard Optima F1. Tomato hybrids Nemo, Neta F1 and Queen F1 compared with the control varieties showed a longer vegetation period. In the table 1 can be noticed that the variety CLX 37147 F1 has the highest length of vegetation (100 days). Variety Astraion F1 and CLX 37286 F1 showed a longer vegetation than the standard hybrid Magnus F1. Only the hybrid CLX 37305 have showen shorter vegetation for a day. The results obtained in 2009 showed that the analyzed varieties have the same vegetation period with the standard Optima F1, except hybrid Staccato F1 in which is noticed two days longer vegetation period. Analyzed hybrid Abelus F1 in 2010 showed seven days longer vegetation period (102 days) compared with control Optima F1. In the table 2 are given the productive traits of the investigated varieties in the open filed from 2005 to 2010 expressed in average yields. From all investigated hybrids in open filed in 2005, the highest yield showed the hybrid V71 with (120.2t/ha). In 2006 all tested varieties have significant differences compared to average yield. The lower yield had given just the hybrids Queen F1 (68.3 t/ha) and Bonito (84.4t/ha). Compared to the control variant: Erato F1ø, varieties Bobcat F1 and SLX 3749 F1 also had a higher yield than the standard. The higher significant diferences in yield also gave the variety Nemo Neta F1 (71.6t/ha) in 2007, Astraion F1 (73,7t/ha) in 2008, Tourist F1 (63.6t/ha) in 2009, while in 2010 with higher yield was Abelus F1 (44.6t/ha). In Tab.3 there are given the characteristics of the fruit for tested hybrids in the period of 2005-2010.From the examined tomato hybrids in 2005, compared to standard varieties the highest average weight showed the variety V71 weight (180g). In 2006 the weight of the fruit in the tested varieties varied from 125g in control variant Magnus F1 to 189 g in the control variant Erato F1. In 2007 the highest weight of the fruit showed the standard variety Optima F1 (177.5g).

In 2008 the analyzed hybrids were compared with two standards, where the significant difference for this trait has shown the variety CLX 37147 F1 (198.7g). The hybrid CLX 37304 F1 showed the highest values for fruit weight 232,2 g and hybrid Staccato F1 had the lowest values of all other hybrids by weight of fruit (87, 2g) which were analyzed in 2009. The hybrid Abelus F1, had lower values for all tested properties Compared with the standard variant. The period of 2005-2008 analyzes were done with the tomato hybrids in greenhouses (Table 4). Length of the vegetation in 2005 ranged from 122 days (MonikaF1ø) and 124 days Amati F1ø. Longer vegetation in relation to the standards shown hybrids PX010215F1 PS150825 F1 (128 days). In 2006 the highest vegetation showed the standard variety (131 days). The others values were as follows: Tundra F1 138 days in 2007, Roxana F1, Trofeo F1 and Bonito n F1 138days in 2008. According to the results given in tab.5 and 6 best parameters for the analyzed traits showed hybrid Bonarda F1: with highest yield (171,98 t / ha) and weight of fruit (380g) analyzed in 2006.

Table 1. Stages of growth in open field production

Variety	Date of sowing	Date of suporting 50%	Date of transplanting	Date of flowering 20%	Date of first harvest	Vegetation from sprouting to first harvest
2005						
Arleta F1ø	09.04.05	17.04.05	18.05.05	5.06.05	22.07.05	96
Tamaris F1	-//-	-//-	-//-	2.06.05	22.07.05	103
NemoNetaF1	-//-	-//-	-//-	1.06.05	19.07.05	96
V 71	-//-	-//-	-//-	8.06.05	29.07.05	103
Agora	-//-	-//-	-//-	8.06.05	19.07.05	104
San Pier ø	-//-	-//-	-//-	8.06.05	22.07.05	103
Galina	-//-	-//-	-//	28.05.05	16.07.05	96
Valina	-//-	-//-	-//-	5.06.05	19.07.05	96
2006						
Magnus F1ø	12.04.06	22.04.06	25.05.06	01.06.06	24.07.06	91
Queen F1	-//-	22.04.06	-//-	02.06.06	-//-	91
Bonito	-//-	24.04.06	-//-	29.05.06	-//-	93
Lorena F1	-//-	23.04.06	-//-	03.06.06	-//-	94
T 8948 F1	-//-	22.04.06	-//-	05.06.06	-//-	91
Charisma F1	-//-	20.04.06	-//-	10.06.06	-//-	90
Torpeder F1	-//-	22.04.06	-//-	04.06.06	-//-	91
Erato F1ø	-//-	23.04.06	/	12.06.06	05.08.06	105
Bobcat F1	-//-	18.04.06	/	08.06.06	04.08.06	108
SLX3749 F1	-//-	24.04.06	/	07.06.06	28.07.06	96
2007						
Magnus F1ø	13.04.07	28.04.07	24.05.07	11.06.07	25.07.07	88
Queen F1	-//-	-//-	-//-	09.06.07	30.07.07	93
Optima F1ø	-//-	-//-	-//-	08.06.07	20.07.07	83
NemoNetaF1	-//-	-//-	-//-	09.06.07	02.08.07	96
2008						
Optima F1ø	05.04.08	13.04.08	14.05.08	30.05.08	12.07.08	92
CLX37147F1	-/-	-//-	-//-	28.05.08	20.07.08	100
Magnus F1ø	-/-	-//-	-//-	25.05.08	11.07.08	91
Astraion F1	-/-	-//-	-//-	28.05.08	12.07.08	92
CLX37286F1	-/-	-//-	-//-	25.05.08	13.07.08	93
CLX 3730	-/-	-//-	-//-	28.05.08	10.07.08	90
2009						
Optima F1ø	08.04.09	12.04.09	15.05.09	28.05.09	12.07.09	92
Staccato F1	22.04.09	01.05.09	28.05.09	10.06.09	27.07.09	94
Tourist F1	08.04.09	12.04.09	15.05.09	24.05.09	10.07.09	92
Logistica F1	-//-	12.04.09	-//-	21.05.09	13.07.09	92
PinkParadiseF1	-//-	-//-	-//-	22.05.09	02.07.09	92
CLX37304F1	-//-	-//-	-//-	22.05.09	02.07.09	92
2010						
Optima F1ø	26.04.10	10.05.10	11.06.10	21.06.10	15.08.10	93
Abelus F1	10.04.10	16.05.10	-//-	27.06.10	13.08.10	102

Table 2. Average yield t/ha in open field production

Variety	Average yield	+ – from ø*	CV%	LSD	
				0.05	0.01
2005					
Arleta F1ø	97.0	Ø	5.46	9.40	12.80
Tamaris F1	99.5	2.5	10.23		
NemoNetaF1	75.9	21.1	5.22		
V 71	120.2	23.2	4.50		
Agora	108.0	11.0	3.31		
San Pier ø	63.8	Ø	1.43		
Galina	74.7	10.9	0.94		
Valina	73.5	9.7	19.02		
2006					
Magnus F1ø	86.9	Ø	5.93	6.99	9.70
Queen F1	68.3	18.6	7.25		
Bonito	84.4	2.5	1.08		
Lorena F1	115.2	28.3	1.74		
T 8948 F1	109.2	22.3	6.63		
Charisma F1	100.4	13.5	3.99		
Torpeder F1	90.3	3.4	4.40		
Erato F1ø	45.9	Ø	1.96	4.66	7.73
Bobcat F1	57.2	11.3	5.52		
SLX 3749 F1	61.5	15.6	1.47		
2007					
Magnus F1ø	50.0	Ø	13.8	7.5	11.3
Queen F1	49.9	0.1	3.2		
Optima F1ø	66.3	Ø	6.3		
Nemo Neta F1	71.6	5.3	2.3		
2008					
Optima F1ø	65.5	Ø	4.45	5.00	7.11
CLX 37147 F1	46.6	18.9	10.76		
Magnus F1ø	54.8	Ø	3.40		
Astraion F1	73.7	18.9	4.03		
CLX 37286 F1	66.5	11.7	3.25		
CLX 37305 F1	73.4	18.8	1.32		
2009					
Optima F1ø	55.4	Ø	2.53	10,15	14.43
Staccato F1	56.4	1.0	0.94		
Tourist F1	63.6	8.2	9.31		
Logistica F1	57.9	2.5	3.82		
Pink ParadiseF1	56.3	0.9	8.01		
CLX 37304 F1	57.4	2.0	17.21		
2010					
Optima F1ø	42.5	Ø	7.1	3.52	8,11
Abelus F1	44.6	2.1	5.2		

Table 3. Characteristics of the fruit in open field production

Variety	Mass in (g)	Index of fruit	Thickness of pericarp(mm)	Number of loculess	Content of dry matters%	Green zone 0-no 1-yes	Taste	Juicy (1-3)
	2005							
Arleta F1ø	198	0.7	6.8	5.3	3.7	1	acidic	1
Tamaris F1	144	0.8	8.8	3.1	3.5	0	sweet	-//-
NemoNetaF1	106	0.8	7.9	2.8	3.7	0	sweet	-//-
V 71	180	0.7	8.2	4.0	3.4	0	sweet	-//-
Agora	167	0.8	6.8	4.1	3.3	0	acidic	-//-
San Pier ø	132	0.8	6.0	4.3	3.0	1	sweet	-//-
Galina	144	0.8	6.8	5.0	3.2	0	acidic	-//-
Valina	165	0.8	7.9	4.5	3.6	0	acidic	-//-
	2006							
Magnus F1ø	125	1.01	6.7	3.6	3.6	0	Sweet	1
Queen F1	114	0.89	6.3	4.2	3.7	0	-//-	-//-
Bonito	100	0.86	6.6	3.0	4.0	0	-//-	-//-
Lorena F1	102	0.84	6.7	2.8	4.0	1	-//-	-//-
T 8948 F1	101	0.93	6.8	3.2	3.9	0	-//-	-//-
Charisma F1	115	0.86	6.5	4.2	6.3	0	-//-	-//-
Torpeder F1	85	0.90	6.9	2.2	4.5	0	acidic	-//-
Erato F1ø	189	0.87	6.2	4.5	4.3	0	sweet	-//-
Bobcat F1	188	0.86	6.3	4.1	3.2	0	-//-	-//-
SLX3749 F1	170	0.89	6.2	4.3	4.2	0	-//-	-//-
	2007							
Magnus F1ø	99,7	0.88	3.91	3.9	3.6	0	sweet	1
Queen F1	144,2	0.82	5.70	5.5	4.1	1	sweet	-//-
Optima F1ø	177,5	0.79	5.92	5.9	4.0	1	very	-//-
NemoNetaF1	134,2	0.83	6.45	3.2	3.9	0	sweet	-//-
	2008							
Optima F1ø	196.0	0.78	6.7	5.0	3.8	1	sweet	1
CLX37147F1	198.7	0.79	6.9	5.3	3.5	0	-//-	2
Magnus F1ø	146.5	0.83	7.4	3.6	4.6	1	-//-	2
Astraion F1	148.0	0.78	7.5	4.4	4.4	1	-//-	1
CLX37286F1	148.5	0.79	8.5	4.2	3.8	0	-//-	2
CLX37305F1	126.7	0.78	6.8	4.4	4.1	0	acidic	2
	2009							
Optima F1ø	124.3	1.18	5.2	5.5	3.7	0	sweet	/
Staccato F1	87.2	0.80	4.4	3.4	3.7	0	sweet	/
Tourist F1	84.8	0.86	5.5	3.9	3.4	0	acidic	/
Logistica F1	118.0	1.39	7.0	5.0	4.0	0	acidic	/
PinkParadiseF1	144.8	1.31	5.3	7.0	4.0	0	sweet	/
CLX37304F1	232.2	1.31	7.3	6.2	3.3	0	sweet	/
	2010							
Optima F1ø	207	0.98	5.2	4.5	4.28	0	Sweet	2
Abelus F1	121	0.17	5.1	3.6	4.18	0	sweet	2

Table 4. Stages of growth in protected houses

Variety	Date of sowing	Date of sprouting 50%	Date of transplanting	Date of flowering 20%	Date of first harvest	Vegetation from sprouting to first harvest
2005 Sveti Nikole						
Amati ø	04.12.04	12.12.04	24.01.05	18.02.	15.04.05	124
MonikaF1ø	-//-	14.12.04	-//-	15.02	15.04.05	122
Buran F1	-//-	12.12.04	-//-	18.02	15.04.05	124
Newton F1	-//-	12.12.04	-//-	20.02	18.04.05	127
Ombelline	-//-	12.12.04	-//-	17.02	15.04.05	124
PX010215F1	-//-	11.12.04	-//-	20.02	15.02.05	125
PS150825 F1	-//-	11.12.04	-//-	20.02	18.04.05	128
Iker F1	-//-	11.12.04	-//-	20.02	18.04.05	128
Merkurio F1	-//-	10.12.04	-//-	20.02	15.04.05	126
2006 Gradsko						
Amati F1 ø	21.12.05	29.12.05	05.02.06	18.02.	08.05.06	131
Rosaliya F1	-//-	29.12.05	-//-	18.02.	07.05.06	130
PS6262F1	-//-	30.12.05	-//-	20.02.	08.05.06	130
Bonarda F1	-//-	31.12.05	-//-	20.02.	09.05.06	130
BS015037003F1	-//-	30.12.05	-//-	18.02.	04.05.06	125
Ballet F1	-//-	30.12.05	-//-	15.02.	04.05.06	125
SiluetF1	-//-	30.12.05	-//-	16.02.	04.05.06.	125
Balca F1ø	-//-	29.12.05	-//-	15.02.	04.05.06	126
2007 Kumanovo						
Monika F1 ø	23.12.06	28.12.06	15.02.07	05.03	10.05.07	134
Teory F1	-//-	-//-	-//-	08.03	10.06.07	131
Sprinter F1	-//-	-//-	-//-	06.03	07.05.07	134
Menhir F1	-//-	-//-	-//-	06.03	10.05.07	134
Tundra F1	-//-	-//-	-//-	08.03	10.05.07	138
Mondial F1	-//-	30.12.06	-//-	07.03	10.05.07	134
Trogir F1	-//-	-//-	-//-	07.03	11.05.07	135
2008 Valandovo- oranzerii Anska Reka						
Моника ø	03.12.07	08.12.07	25.01.08	23.02.	21.04.08	135
Lady Rosa F1	-//-	-//-	25.01.08	23.02.	18.04.08	132
Fantom F1	-//-	-//-	25.01.08	23.02.	15.04.08	129
Roxana F1	-//-	-//-	25.01.08	23.02.	21.04.08	135
Thalassa F1	-//-	-//-	25.01.08	23.02.	18.04.08	132
Trofeo F1	-//-	-//-	25.01.08	23.02.	21.04.08	135
Alfred F1	-//-	-//-	25.01.08	23.02.	15.04.08	129
Profilo F1	-//-	-//-	26.01.08	27.02.	18.04.08	132
Bonito N F1	-//-	-//-	25.01.08	23.02.	16.04.08	131
					21.04.08	135

Table 5.Average yield t/ha in protected houses

Variety	Average yield	+ and – from ø*		CV%	LSD	
					0.05	0.01
2005 Sveti Nikole						
Amati ø	92,9	Ø		2,12	4,10	5,52
MonikaF1ø	83,1	-	Ø	1,87		
Buran F1	136,2	43,3	53,1	1,76		
Newton F1	140,3	47,4	57,2	2,22		
Ombelline	110,2	17,3	27,1	3,07		
PX010215F1	110,0	17,1	26,9	1,83		
PS150825 F1	118,3	25,4	35,2	3,21		
Iker F1	150,7	57,8	67,6	3,83		
Merkurio F1	127,9	35,0	44,8	2,99		
2006 Gradsko						
Amati F1 ø	93,06	Ø		1,83	2,78	3,83
Rosaliya F1	149,3	56,24		0,92		
PS6262F1	131,64	38,58		2,14		
Bonarda F1	171,98	78,92		0,90		
BS015037003F1	143,08	50,02		2,20		
Ballet F1	109,04	6,14		0,59	5,34	7,77
SiluetF1	159,12	56,22		3,20		
Balca F1ø	102,9	Ø		2,76		
2007 Kumanovo						
Monika F1 ø	93.0	Ø		7.22	14.14	19.37
Teory F1	105.0	12.0		6.07		
Sprinter F1	104.9	11.9		7.74		
Menhir F1	106.4	13.6		14.53		
Tundra F1	119.1	26.1		9.95		
Mondial F1	120.4	27.4		4.14		
Trogir F1	120.3	27.3		6.88		
2008 Valandovo- greenhouses Anska Reka						
Моника ø	131.9	Ø		1.84	5.64	7.62
Lady Rosa F1	126.5	-5.4		3.54		
Fantom F1	146.8	14.9		3.41		
Roxana F1	146.2	14.3		3.10		
Thalassa F1	135.9	4.0		2.57		
Trofeo F1	143.7	11.8		2.50		
Alfred F1	141.8	9.9		2.26		
Profilo F1	149.7	17.8		3.73		
Bonito N F1	145.3	13.4		3.45		
	128.4	-3.6		2.89		

Table 6. Characteristics of the fruit in protected houses

Variety	Mass in (g)	Index of fruit	Thickness of pericarp (mm)	Number ofloculess	Content of drymatters %	Green zone 0-no 1-yes	Taste	Juicy of fruit (1-3)
2005 Sveti Nikole								
Amati ø	150	0,8	8	5	4,58	0	sweet	1
MonikaF1ø	120	0,8	8	5	4,46	-//-	acidic	-//-
Buran F1	200	0,7	7	5	4,82	-//-	sweet	-//-
Newton F1	180	0,6	9	5	4,09	-//-	-//-	-//-
Ombelline	150	0,7	8	5	5,35	-//-	-//-	-//-
PX010215F1	180	0,7	8	5	4,45	-//-	-//-	-//-
PS150825 F1	170	0,6	7	5	4,88	-//-	-//-	3
Iker F1	180	0,6	7	5	4,24	-//-	-//-	1
Merkurio F1	150	0,7	7	5	4,00	-//-	-//-	3
2006 Gradsko								
Amati F1 ø	200	-	0,8	2/3	-	0	sweet	1
Rosaliya F1	270	-	0,6	3/4	-	-//-	-//-	-//-
PS6262F1	300	-	0,7	3/4	-	-//-	-//-	-//-
Bonarda F1	380	-	0,8	4/5	-	-//-	-//-	-//-
BS015037003F1	280	-	0,8	4/5	-	-//-	-//-	-//-
Ballet F1	200	-	0,7	3/5	-	-//-	-//-	-//-
Silue tF1	300	-	0,7	4/5	-	-//-	-//-	-//-
Balca F1ø	180	-	0,6	4/5	-	-//-	-//-	-//-
2007 Kumanovo								
Monika F1 ø	160	0,8	5	-	-	0	Sweet	1
Teory F1	130	0,8	5	-	-	-//-	-//-	-//-
Sprinter F1	260	0,7	6	-	-	-//-	-//-	-//-
Menhir F1	170	0,8	6	-	-	-//-	-//-	-//-
Tundra F1	180	0,7	6	-	-	-//-	-//-	-//-
Mondial F1	160	1,00	7	-	-	-//-	-//-	-//-
Trogir F1	180	1,06	7	-	-	-//-	-//-	-//-
2008 Valandovo- green houses Anska Reka								
Моника ø	120	0,72	4	4	-	0	sweet	1
Lady Rosa F1	110	0,75	5	3	-	0	-//-	-//-
Fantom F1	270	0,67	4	7	-	1	-//-	-//-
Roxana F1	130	0,75	4	7	-	0	-//-	-//-
Thalassa F1	120	0,70	3	5	-	-//-	-//-	-//-
Trofeo F1	130	0,75	4	3	-	-//-	-//-	-//-
Alfred F1	165	0,80	5	5	-	-//-	-//-	-//-
Profilo F1	170	0,75	6	4	-	-//-	-//-	-//-
Bonito N F1	150	0,60	5	5	-	-//-	-//-	-//-
	90	0,70	5	6	-	-//-	-//-	-//-

"-"data not registered

Conclusions

It can be concluded that the newly tomato hybrids showed stable agronomic traits and good average yields and were introduced into commercial production. All of the investigated varieties showed the better results than standard varieties with who were comparised. Best values in relation to the examined properties in hybrids grown in the open field showed hybrid V71, while from the hybrids grown in the greenhouses will single out the hybrid Bonarda F1.

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ПРИНОС И КОМПОНЕНТИ НА ПРИНОС КАЈ ПОНОВИ ХИБРИДИ ОД ДОМАТ ВО РЕПУБЛИКА МАКЕДОНИЈА

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Апстракт

Доматот (*Lycopersicum esculentum mill)* е една од најважните зеленчукови култури во Република Македонија. Нашата Национална сортна листа изобилува со голем број на регистрирани домашни сорти и интродуирани хибриди.Пред да се воведат во комерцијалното производство, сите интродуирани хибриди и новосоздадени сорти се испитуваат со цел да се утврди приносот и компонентите на принос. Во овој труд се обработени вкупно 54 сорти/хибриди на домат испитувани во периодот од 2005 до 2010 година, од кои 26 од нив се одгледувани на отворено, а 28 во заштитен простор со пропишана стандардна технологија. Испитуваните сорти и хибриди се споредувани со стандард според пропишани правила и постапки, одредени од Националната сортна комисија. Во испитуваниот период сортите /хибридите домат одгледувани на отворено, се споредувани со стандардите: Arleta F_1, San Pier, Magnus F_1, Erato F_1, и Optima F_1, додека хибридите одгледувани во заштитен простор се споредени со следниве стандарди: Amati F_1, Monika F_1 и Balca F_1. Сите сорти и хибриди кои покажаа подобри резултати од стандардите во однос на испитуваните параметри се препорачаа за воведување во комерцијално производство.

Клучни зборови: домат, хибриди, принос.

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YIELD POTENTIAL OF SOME INTORDUCED CABBAGE HYBRIDS FOR SPRING PRODUCTION

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Abstract
The main objective of this research is description of the production capacities and adaptive values of some introduced cabbage hybrids: Parel, Kevin, Mirror, Nozomi, Pandion and Jetma RZ. To obtain this objective the biological, morphological and market characteristics of these cabbage hybrids have been evaluated trough comparative trials. The obtained results will be used as solid basis for their further implementation in the production schemes and more stable production in the region of Strumica. According to the two-year results and the statistical analyses it can be concluded that the hybrids Nozomi and Pandion mature the earliest 65 days, i.e. 9 days before the standard hybrid. From the two-years results it can be concluded that Nozomi hybrid had the highest yield, close to 70 t/ha as opposed to Jetma RZ which had the lowest yield.
Key words: cabbage, hybrids, vegetables, morphological traits, yield.

Introduction

Cabbage is an important vegetable which is vastly produced during the whole year in the Republic of Macedonia. According to data from the State Statistical Office (2012) cabbage is grown on 4630 ha with total production of 142670 t and average yield of 30 t/ha. The significance of this crop comes from the fact that in our country there are 72 recognized species, out of which 52 are foreign, 20 local (Bogevska Z et al., 2010). Keeping in mind the daily use of cabbage in nutrition and its high nutritional value, there is a need for permanent study of cabbage varieties. These studies will determine the assortments which will give the best results of production in certain conditions in order to get economically feasible cultivation. So the main objective of this research was to describe the production capacities and adaptive values of some introduced cabbage hybrids.

Material and methods

In order to achieve the goal of this research, during the two years (2009 and 2010), the following six hybrids of spring cabbage were examined: *parel*, *kevin*, *mirror*, *nozomi*, *pandion* and *jetma rz*. *parel* F_1 is the most abundant in the production, and therefore in this study it is used as a control variant. The hybrids were examined in the region of Strumica where there are favorable conditions for their cultivation. The experiment was set by a method of randomized blocks in six replications. The experimental plot was 125 m^2, by using standard technology. During the research stages of growth, the mass of the head and the total yield were observed. The results were statistically processed with an analysis of variance and verified with t-test.

Results and discussion

Sprouting is a stage of development which is characterized by the emergence of cotyledons. For a successful sprouting, it requires healthy seeds and enough heat and moisture. According to Pavlek P. (1978), the minimum temperature for the sprouting of cabbage seed ranges from 1 to 5˚C, the optimum is about 20°C and the maximum is 38˚C. Accordingly, the results (Table 1) in the first year's examined hybrids sprouted for 4 or 7 days, depending on the hybrid. *Pandion*, *mirror*, *jetma rz* and the standard *parel* sprouted for 4 days. Hybrid *kevin* sprouted one day later, while hybrid *nozomi* sprouted for 2 or 3 days later than the other hybrids. In the second year all hybrids sprouted for 5 days, except hybrid *nozomi* which sprouted two days later. Later sprouting for 2 days in all hybrids does not represent a significant difference and is mainly dependant on environmental conditions. In the two years of research, it should be mentioned that the hybrid *nozomi* sprouted later than the other hybrids. This is mainly due to the structure of the seed and the energy of germination, which is linked with the variety specificity (Cerne M., 1998).

Table 1. Length of vegetation period (days)

Hybrid	Days from sowing to sprouting		Days of vegetation (from transplanting to technological maturity)		Days of vegetation (from transplanting to technological maturity)
	Year		Year		
	2009	2010	2009	2010	Average
parel ø	4	5	73	74	73
kevin	5	5	76	76	76
mirror	4	5	76	76	76
nozomi	7	7	64	65	64
pandion	4	5	64	65	64
jetma	4	5	78	79	79

According to the data in Table 1, it can be concluded that depending on the type, vegetation period lasts differently, varying from interval 64 -78 days in the first, and 65-79 days in the second year. In the first year of the examination, the hybrids *nozomi* and *pandion* have the shortest vegetation period with 64 days, which is about 9 days shorter in comparison to the standard 73 days. The standard, *kevin* and *mirror* have the same vegetation period of 76 days. The *jetma rz* has the longest vegetation period (78 days). In the second year of research, the length of the vegetation period ranges between 65 - 79 days. *Nozomi* and *pandion* hybrids showed to have the shortest vegetation period, 65 days, 9 days earlier than the standard (74 days). The hybrid *jetma rz* (79 days) had the longest vegetation period. According to the average number of days of the vegetation period, it can be concluded that the hybrids *nozomi* and *pandion* are earlier and reach their technological maturity within 65 days. Compared with the standard variety, they have 9 days shorter vegetation period. It can be considered that the hybrid *jetma rz* was the latest and spends 79 days vegetation period, i.e. 4-5 days longer than the standard. *parel* in the both years had the same vegetation period, 73 to 74 days. It should be noted that the tested hybrids are able to stay in the field for a long time depending on external conditions. The economic value of the grown plants is characterized by their productivity, i.e. the realized yield. Cabbage is grown for its head, which is an indicator of its productive-commercial properties, determined by the mass of the head and other quantitative

characteristics, yield per unit area - hectare. The mass of the head is a varietal characteristic, but largely dependent on climate, soil and applied technology. The results obtained in terms of the average mass of a head are given in table 2.

Table 2. Average mass of the head (g)

Hybrids	$\bar{x}$	$S_{\bar{x}}$	Σ	VK	VS
parel ø					
2009	2185,82	60,72	470,31	0,22	1900,00
2010	2093,67	79,67	436,35	0,21	1600,00
Average	2139,74	70,19	453,33	0,21	1750,00
kevin					
2009	2161,50	60,80	470,96	0,22	1700,00
2010	2067,67	67,08	367,41	0,18	1500,00
Average	2114,58	63,94	419,18	0,20	1600,00
mirror					
2009	2133,83	54,72	423,83	0,20	1700,00
2010	2124,33	75,27	412,30	0,19	1500,00
Average	2129,08	65,00	418,06	0,20	1600,00
nozomi					
2009	2330,93	54,91	425,31	0,18	1850,00
2010	2300,33	60,25	330,02	0,14	1300,00
Average	2315,63	57,58	377,66	0,16	1575,00
pandion					
2009	2251,83	61,81	478,75	0,21	2100,00
2010	2074,67	84,48	462,74	0,22	1800,00
Average	2163,25	73,15	470,74	0,22	1950,00
jetma rz					
2009	1881,50	68,71	532,24	0,28	2000,00
2010	1802,80	79,83	437,26	0,24	1600,00
Average	1842,15	74,27	484,75	0,26	1800,00

By t-test at 0,05 probability, it was determined statistically that there are significant differences between *kevin* and *nozomi*, *kevi*n and *jetma rz*, while hybrid *jetma rz* has significantly less mass of the head than other hybrids, except *parel*, *mirror*, *nozomi* and *pandion* (Table 3).

Table 3. Difference between average values of the mass of the head (g)

Hybrids	*parel*	*kevin*	*mirror*	*nozomi*	*pandion*	*jetma*
parel	0,00	25,16	10,66	-175,89	-23,51	297,59
kevin		0,00	-14,50	-201,05	-48,67	272,43
mirror			0,00	-186,55	-34,17	286,93
nozomi				0,00	152,38	473,48
pandion					0,00	321,10
jetma						0,00

The economic value of the product obtained - spring cabbage, except of head mass is determined with total realized yield per unit area, or hectare. The values of the average yield per unit area (kg / hectare) of examined hybrids are given in the following table:

Table 4. Yield per unit area (kg/ha)

Hybrid	2009	2010	Average
parel ø	65574,50	62810,00	64192,25
kevin	64845,00	62030,00	63437,50
mirror	64015,00	63730,00	63872,50
nozomi	69928,00	69010,00	69469,00
pandion	67555,00	62240,00	64897,50
jetma	56445,00	54084,00	55264,50

In the first year of the examination, the highest yield was achieved by hybrid *nozomi* 69928.00 kg/ha, and right behind it is the hybrid *pandion* with 76555.00 kg/ha. The standard *parel*, in the first year of examination, achieved an average yield of 65574,50 kg/ha. From the average results of two years, it can be concluded that the highest yield was reached by the hybrid *nozomi* with a yield of 69928 kg/ha, while the hybrid *jetma rz* had a lower yield than the standard for about 10000 kg/ha.

Table 5. Difference between average values of yield in comparison to *parel* (t)

Hybrids	*parel*	*kevin*	*mirror*	*nozomi*	*pandion*	*jetma*
parel	0,00	0,73	-1,56	-4,35	-1,98	9,13
kevin		0,00	-0,83	-5,08	-2,71	8,40
mirror			0,00	-5,91	-3,54	7,57
nozomi				0,00	2,37	13,48
pandion					0,00	11,11
jetma						0,00

By t-test at 0,05 probability, statistically significant differences were determined between *kevin* and *nozomi* and *kevin* and *jetma rz*. The hybrid *jetma rz* has a significantly lower yield than other hybrids.

Conclusions

According to the research conducted on 6 hybrids of cabbage in two years, it can be concluded that:

- The hybrids *nozomi* and *pandion* are earlier and reach technological maturity within 65 days. In comparison to standard variety, they have 9 days shorter vegetation.
- In terms of head weight, there are statistically significant differences between Kevin and *nozomi*, *kevin* and *jetma rz*, while hybrid *jetma rz* has significantly less mass of head than other hybrids.
- The hybrid *nozomi* gave the most yield with 69928 kg/ha, while the hybrid *jetma rz* had a lower yield than the standard for about 10000 kg/ha.

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ПРОИЗВОДЕН ПОТЕНЦИЈАЛ НА НЕКОИ ИНТРОДУИРАНИ ХИБРИДИ ОД ЗЕЛКА ЗА ПРОЛЕТНО ПРОИЗВОДСТВО

Тимов Томе, Агич Рукие, Богевска Звезда

Апстракт
Целта на ова истржување е да се проучат вредностите и потенцијалите на неколку интродуирани хибриди пролетна зелка: Parel, Kevin, Mirror, Nozomi, Pandion и Jetma RZ, преку компаративно проучување на нивните биолошки, морфолошки и стопански својства. Добиените резултати од овие истржувања ќе послужат за одредување и препорака на овие хибриди кои ќе гарантират посигурно производство во регионот на Струмица. Според изведените двогодишни истражувања на шесте хибриди зелка и обработените резултати може да се заклучи дека хибридите Nozomi и Pandion се најрани и стасуваат до технолошка зрелост за 65 дена. Споредено со стандардот, тие имаат за 9 дена покус период на вегетација. Од просечните испитувања за двете години заклучено дека највисок принос има хибридот Nozomi со принос од блиску 70 t/ha, додека хибридот, Jetma RZ има најнизок принос.
Клучни зборови: зелка, хибриди, градинарство, морфолошки особини, принос.

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Review Article

THE USAGE OF SOME DECORATIVE REPRESENTATIVES OF PICEA MILL GENUS IN THE LANDSCAPE DESIGN IN SKOPJE (REPUBLIC OF MACEDONIA)

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Abstract
With the development of the landscape design in our region, the interest for decorative species has increased. The usage of already present ones became bigger and in the same time there were introduced numbers of new species, varieties and cultivars. So, there can be found many representatives of the Picea Mill genus which considering their physiological, ecological and specific morphological characteristics, form, texture and color, take their places on our green areas. The aim of this research is to point out the representatives of the Picea Mill genus that can be found in our region and also to determine their usage when designing the open green spaces. There are recommendations for the usage of some of them as elements or part of the elements of the landscape design. It was used the visual method for the research, which consider founding out and determination of the representatives of the Picea Mill genus in the green areas, garden centers and nurseries as well. So it was found out that the most present taxons of the Picea Mill genus are: *Picea abies, Picea abies 'Inversa Pendula', Picea abies 'Nidiformis', Picea glauca 'Conica', Picea omorica, Picea pungens, Picea pungens 'Glauca', Picea pungens 'Glauca Globosa'* and *Picea pungens 'Hoopsii'*. Their frequent and complex usage in the design of the green areas, as focal points, solitary trees, in groups or as parts of stone gardens is due to the specific morphological characteristics as well their shape and height.
Key words: Picea, landscape design, decorative species, varieties, cultivars, morphological characteristics, form, texture, color, green areas.

Introduction

There are about fifty species that belong to Pinaceae family in the Picea genus and they are spread out in the cold regions of the north hemisphere. Their resistance on low temperatures, which can even go to minus 40°C, is surely one of the many other reasons for their presence in the green areas in Skopje. Recently, there have been more varieties and cultivars there with different specific morphological characteristics, considering the color of their leaves (needles) and the form of their habitus, making them interesting and attractive when designing parks and other types of green areas. Some representatives of this genus already exist in the open green spaces in Skopje such as: *Picea abies*, *Picea omorica*, *Picea pungens* and *Picea pungens 'Glauca'*. Recently, with the development of landscape design, new interesting species have been introduced, among which are some representatives of this genus with specific morphological characteristics. They can be found on various types of green areas: public parks, boulevards, squares, private gardens, etc. as specimen

plants, in plant grouping, as focal points and in alpineums and rock gardens as well. The dwarf forms considering their small dimensions and slow growth can be found in pots and jardinières. The ones with bigger dimensions are usually situated in the green areas.

In the garden centers in Skopje, there are mostly species from the countries that are successfully dealing with the problematic of nursing and export of decorative species such as Italy, Holland and in recent time Greece and Serbia. So in the designing of the green areas here (Skopje), beside the taxons that are already used and were produced in our nurseries, other representatives from Picea genus are also present, among which are: *Picea abies 'Inversa Pendula', Picea abies 'Nidiformis', Picea glauca 'Conica', Picea pungens 'Glauca Globosa'* and *Picea pungens 'Hoopsii'*.

The present taxons in our plant-market are usually imported. Many of them are container-grown plants and there are some root balled (which are very rare) often intended as Christmas trees. They are: *Picea abies*, *Picea pungens* and *Picea pungens 'Glauca'*. The price is relatively expensive, but considering their ecological characteristics and the decorative value they have, the representatives of Picea genus are highly valued; the interest for them is big and nowadays they can often be present on smaller or bigger green areas.

Material and methods

This research is dealing with some decorative representatives of Picea Mill genus which are mostly used in the landscape design of the green areas in Skopje. The research was made in Skopje, in the green areas that are available for public use and in the bigger garden centers such as „Eko-Rast", „Foja-Ko", „Horti Ekspert" and „Green Planet" (the ones that import plant materials from abroad and from domestic producers and have big assortment of plants). The garden centers were interesting for this research because of the specific way of dealing with the plants, which means closer contact with them considering the fact that private gardens were not always available. But with special agreement from the owners, some of them were visited and researched, such as residential complex "St. Jovan", few private gardens and some balcony gardens too.

The research was made in spring and autumn, or more precisely in the period from April to June and October-November 2011 and 2012. This period was chosen because it is planting season and therefore the choice for plants in the garden centers is the biggest. The basic information for the imported species, varieties and cultivars of Picea genus are from declarations on the imported plant material, but for more details there had to be done cabinet work which would imply their determination. Further on, there had to be ascertained their morphological characteristics, resistance on low temperatures, their behavior in the places where they were located and the conditions needed for their successful growth, considering the specifics of the climate conditions in Skopje. The facts were presented in tables, from which further on concrete conclusions were made. This research determines the effects from their usage in the landscape design on the green areas, considering the specifics of the taxons as well as the type and the character of the green areas where they were planted. According to this, the relevant dates were presented with appropriate photos.

Results and discussion

The research of the decorative represents of the Picea Mill genus used in the landscape design in Skopje, shows that the most present taxons are: *Picea abies* (European spruce); *Picea abies 'Inversa Pendula'* (Weeping Norway spruce); *Picea abies 'Nidiformis'* (Birdsnest spruce); *Picea glauca 'Conica'* (Dwarf Alberta spruce); *Picea omorica* (Serbian spruce); *Picea pungens* (Blue spruce);

Picea pungens 'Glauca' (Colorado Blue spruce); *Picea pungens 'Glauca Globosa'* (Globe blue spruce) and *Picea pungens 'Hoopsii'* (Colorado spruce "Hoopsii").

Four of them, *Picea abies*, *Picea omorica*, *Picea pungens* and *Picea pungens 'Glauca'*, are already used in our green areas. The others are recently introduced, considering the development of the landscape designing nowadays, so these taxons are most present in the public green areas today. In the renewed ones and in certain new green areas, there are other registered representatives of Picea genus, but in relation with the previously mentioned ones, their number is very small. From the four taxons used in the green areas there, the presence of *Picea omorica* is the rarest. It can be found in some private gardens in the settlements Vodno, Centar, Taftalidze, which allows us to say that some of the species used many years ago are not part of the parks or other types of green areas today so we can say that they are not "in trend" nowadays. But some representatives of Picea genus are always actual and the interest for them, in spite many other varieties and cultivars on the market, is still big.

From ecological aspect, considering their growth, all researched taxons have equal or similar needs. They are sun-loving, but also shade tolerant in the same time, especially Picea *abies, Picea glauca 'Conica'* and *Picea pungens 'Glauca'*. They are resistant on low temperatures and can stand from - 30°C to - 40°C. They grow on wet to medium wet, but enough drained soils. Most of them grow well on locations with bigger moist in the air, *Picea abies, Picea abies 'Inversa Pendula', Picea abies 'Nidiformis', Picea glauca 'Conica', Picea omorica*, but the others *Picea pungens, Picea pungens 'Glauca', Picea pungens 'Glauca Globosa'* and *Picea pungens 'Hoopsii'* are resistant on dry air and dry weather periods. *Picea omorica* is considerably resistant on polluted air opposite to *Picea abies* and its varieties and cultivars. *Picea pungens* can stand the urban climate more than the others; it can tolerate high temperatures and also dry and polluted air. The same characteristics have *Picea pungens 'Glauca', Picea pungens 'Glauca Globosa'* and *Picea pungens 'Hoopsii'*, while *Picea glauca 'Conica'* cannot stand pollution, dryness and higher temperatures.The main task of this research, in spite of detection and determination of the representatives of Picea genus is to determine their role in the arranging of the green areas. It is confirmed that they can be found on various types of green areas (public and private): in the parks, boulevards, in front of the buildings, in private gardens, as parts of balcony gardens and in pots and jardinières too. Their usage on certain green areas, the functions they are fulfilling and the role they have in esthetic way (as element or part of the elements in the landscape design), depends on the dimensions they reach and the morphological characteristics of the taxons. In table 1 are given decorative representatives of Picea genus, their life forms and maximal growth as well. The life forms are determined according to the dendrology classification of the plants, trees and shrubs [16]. Maximal growth of the plants means maximal size dimensions that any of the taxons can reach both in height and width. It must be appointed that plants reach these dimensions in ideal conditions, or more specific, in their native regions. This relates to *Picea abies, Picea omorica, Picea pungens* and *Picea pungens 'Glauca'* and some of their varieties, which grow in different conditions in the urban area: altitude, humidity, air pollution, temperature amplitudes, etc. The optimal height of these plants is around 20 m.

Table 1. Life forms and maximal growth of the decorative representatives of Picea Mill genus

Ordinal number	Plant species	Life forms							Maximal growth	
		Trees				Shrubs				
		I size (very big, over 30 m)	II size big, from 20 to 30 m)	III size (from 10 to 20 m)	Low (from 5 to 10 m)	High (3–5 m)	Medium high (1,5–3 m)	Low (to 1,5 m)	Height	Width
1	*Picea abies*	√							30–50 m	4–5 m
2	*Picea abies 'Inversa Pendula'*			√					16–20 m	1–1,5 m
3	*Picea abies 'Nidiformis'*							√	0,5–0,7m	1,5 m
4	*Picea glauca 'Conica'*						√		3 m	1,0 m
5	*Picea omorica*	√							30–50 m	3 m
6	*Picea pungens*	√							30–50 m	5–6 m
7	*Picea pungens 'Glauca'*		√						26–30 m	5-6 m
8	*Picea pungens 'Glauca Globosa'*							√	1–1,5 m	1,5–2,0 m
9	*Picea pungens 'Hoopsii'*			√					10–16 m	3–5 m

Presented data in the table 1 shows that six taxons are trees, three of them *Picea abies*, *Picea omorica* and *Picea pungens* are in category of trees from I size that grow over 30 m high, one of them, *Picea pungens 'Glauca'* is in category of trees from II size that grow 20-30 m and *Picea abies 'Inversa Pendula'* and *Picea pungens 'Hoopsii'* are in category trees from III size that reach 10-20 m. height. Trees that grow 5-10 m in height are not registered here in this table. The rest three taxons are shrubs from which *Picea glauca 'Conica'* is on the list of medium-high shrubs that reach to 3 m and *Picea abies 'Nidiformis'* and *Picea pungens 'Glauca Globosa'* are in the category of small (short) shrubs that reach up to 1,5 m in height. The height as parameter is one of the main factors that define the presence of the taxons in the different types of the green areas. The big trees, although in urban conditions, can still reach up to 20 m of height and can be found in the bigger parks; those are the species such as *Picea abies 'Inversa Pendula'* and *Picea pungens 'Hoopsii'*. The ones with smaller dimensions are used in landscape design both in the bigger and smaller open green spaces (public and private). Shrubs are mainly in the private and smaller green areas. The basic morphological characteristics such as form, texture and color are factors that determine the usage of the plants in the landscape design. While their dimensions define their usage in the certain open green spaces, the morphological characteristics define their role, or more specific the usage of the concrete plant as element or as part of the composition in the landscape design.

In table 2 there are basic morphological characteristics (form, texture and color) of the registered decorative representatives of Picea genus.

Table 2. Basic morphological characteristics of the decorative representatives of Picea Mill

Ordinal number	Plant species	Basic morphological characteristics				
		Form	Texture			Color
			coarse	fine	Semi-fine	
1	*Picea abies*	Conical form	√			dark green
2	*Picea abies 'Inversa Pendula'*	Weeping (branches are directed downwards)			√	dark green
3	*Picea abies 'Nidiformis'*	Irregular round, dwarf form (top flat, compact)			√	Green
4	*Picea glauca 'Conica'*	Conical-pyramidal, compact		√		light green
5	*Picea omorica*	Conical form			√	dark green
6	*Picea pungens*	Pyramidal form	√			blue-green
7	*Picea pungens 'Glauca'*	Pyramidal form	√			silver-blue
8	*Picea pungens 'Glauca Globosa'*	Irregular round (more wide than high)	√			silver-blue
9	*Picea pungens 'Hoopsii'*	Pyramidal, compact	√			silver-blue

Data in table 2 show the morphological characteristics of the registered representatives of Picea genus. It is obvious that considering their form, high species such as *Picea abies* and *Picea omorica* have conical form, *Picea pungens, Picea pungens 'Glauca'* and *Picea pungens 'Hoopsii'* have pyramidal form and *Picea pungens 'Hoopsii'* has more compact habitus. *Picea abies 'Inversa Pendula'* has specific weeping form; it is slow-growing cultivar with branches directed downwards. Each of these cultivars of *Picea abies 'Inversa Pendula'* is unique and has high decorative value. *Picea glauca 'Conica'* has compact conical-pyramidal form and because of its small dimension it is called semi-dwarf. The smallest representatives from Picea genus, *Picea abies 'Nidiformis'* and *Picea pungens 'Glauca Globosa'* registered in the researched area have irregular round form. Related to the texture, only *Picea glauca 'Conica'* has fine texture, while *Picea abies 'Inversa Pendula', Picea abies 'Nidiformis'* and *Picea omorica* have semi-fine texture and the others, *Picea abies, Picea pungens, Picea pungens 'Glauca', Picea pungens 'Glauca Globosa'* and *Picea pungens 'Hoopsii'* have coarse texture. Considering the color of the needles, the researched representatives from Picea genus have shades of green, blue-green and silver-green color. *Picea abies 'Nidiformis'* has green color of the needles, *Picea abies, Picea abies 'Inversa Pendula'* and *Picea omorica,* have dark-green needles and *Picea glauca 'Conica'* has light green color of the needles. *Picea pungens* has various shades of blue-green color. *Picea pungens 'Glauca', Picea pungens 'Glauca Globosa'* and *Picea pungens 'Hoopsii'* have attractive silver-blue color of the needles.It is obvious that these representatives of Picea genus have various forms and colors with fine, semi-fine and coarse texture. There are high trees with green, blue-green and silver-blue color and small shrubs with irregular round forms with green and silver-blue color. In fact, the various forms and colors are the main reasons for the complex use of these taxons when designing various

categories green areas. In table 3 is shown the usage of the registered representatives of Picea genus as elements or as parts of elements in the landscape design of the green areas in Skopje.

Table 3. Representatives of Picea Mill genus as element or part of elements of landscape design

Ordinal number	Plant species	Usage in landscape design			
		Specimen plant	Plant grouping (tree groups)	Alpineum and rock garden	In pots and jardinières
1	*Picea abies*	√	√		
2	*Picea abies 'Inversa Pendula'*	√			
3	*Picea abies 'Nidiformis'*			√	√
4	*Picea glauca 'Conica'*			√	√
5	*Picea omorica*	√	√		
6	*Picea pungens*	√	√		
7	*Picea pungens 'Glauca'*	√	√		
8	*Picea pungens 'Glauca Globosa'*			√	√
9	*Picea pungens 'Hoopsii'*	√	√		

In the table 3 are shown tree representatives from Picea genus: *Picea abies, Picea abies 'Inversa Pendula', Picea omorica, Picea pungens, Picea pungens 'Glauca'* and *Picea pungens 'Hoopsii'* which are found as specimen plants. They are located in public green areas, bigger and smaller ones, in school yards, around churches, on boulevards, in the greenery of "Jane Sandanski" boulevard, Aerodrom settlement, in the green spaces in front of public objects, around blocks and in private gardens too. *Picea abies 'Inversa Pendula'* (Figure 1) can be found very rarely, often in very exclusive private gardens. *Picea pungens 'Hoopsii'* (Figure 2) is present in the private gardens and in front of some public buildings, in front of the Dentist office "Endomak" in Aerodrom settlement, in front of "Tobacco" on boulevard „ Krste Petkov Misirkov", near „University Library" etc.



Figure 1. *Picea abies 'Inversa Pendula'*



Figure 2. *Picea pungens 'Hoopsii'*



Figure 3. Tree group of *Picea pungens* and *Picea pungens 'Glauca'* – church „St. Arhangel and Michael" – Autocomanda



Figure 4. Tree group of *Picea pungens* and *Picea pungens 'Glauca'* – complex „St. Jovan" – Zlokukani

All mentioned species, except *Picea abies 'Inversa Pendula'*, form tree groups of three or more trees (plant grouping). The tree groups can be usually found on bigger green areas formed from *Picea abies, Picea pungens* and *Picea pungens 'Glauca'*, planted 2-5 m from each other. On figure 3 and 4 there is plant grouping from *Picea pungens* and *Picea pungens 'Glauca'*.

Picea abies 'Nidiformis', Picea glauca 'Conica' and *Picea pungens 'Glauca Globosa'* are very rare in the public green areas. These plants have smaller growth (shrubs) and are usually part of group, alpineum, rock garden or are simply planted in pots or jardinières. From the three of them the most present is *Picea glauca 'Conica'* that can be found in front of some public objects and small public green areas; for example, it is part of the greenery of the fountains in the beginning of Aerodrom municipality. *Picea glauca 'Conica'* and *Picea pungens 'Glauca Globosa'* are located in two balcony gardens in Karpos 2 settlement, near "Faculty of engineering "-Skopje and in boulevard „Oktomvriska revolucija" in the "Mi-Da Motors" complex.



Figure 5. *Picea glauca 'Conica'*- part of greenery in private garden –Centar municipality



Figure 6. *Picea glauca 'Conica'*- part of balcony garden in the "Mi-Da Motors" complex –Karpos 2 settlement

In the "Bonsai garden" which is part of the garden center "Horty Expert" there is a bonsai of *Picea pungens 'Glauca Globosa'* (Figure 7).

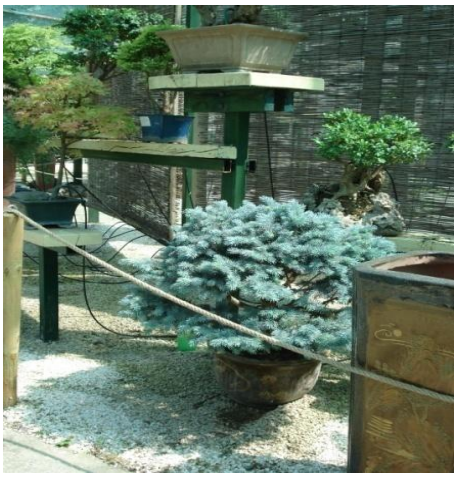


Figure 7. *Picea pungens 'Glauca Globosa'* bonsai



Figure 8. *Picea abies 'Nidiformis'*

Picea abies 'Nidiformis', Picea glauca 'Conica' and *Picea pungens 'Glauca Globosa'* are the most used in designing private gardens, usually as part of alpineums and rock gardens, for which they are most recommended.



Figure 9. *Picea pungens 'Glauca Globosa'* as part of alpineum – "Horty Expert"

All these representatives, whether they are used as different elements or as parts of elements in the landscape design are usually focal points in the areas they are located in. Some of them attract the attention with their color, for example the taxons with silver-blue color, *Picea pungens 'Glauca'*, *Picea pungens 'Glauca Globosa'* and *Picea pungens 'Hoopsii'* and others with their form, such as *Picea abies 'Inversa Pendula'* and *Picea pungens 'Hoopsii'*.

Conclusions

The research over the usage of some decorative representatives of the Picea Mill genus in the landscape design in Skopje brings out these conclusions:

- In the landscape design in Skopje the most present are these representatives from Picea genus: - *Picea abies* (European spruce), *Picea abies 'Inversa Pendula'* (Weeping Norway spruce), *Picea abies 'Nidiformis'* (Birdsnest spruce), *Picea glauca 'Conica'* (Dwarf Alberta spruce), *Picea omorica* (Serbian spruce), *Picea pungens* (Blue spruce), *Picea pungens 'Glauca'* (Colorado Blue spruce), *Picea pungens 'Glauca Globosa'* (Globe blue spruce) and *Picea pungens 'Hoopsii'* (Colorado spruce "Hoopsii").
- *Picea abies*, *Picea omorica*, *Picea pungens* and *Picea pungens 'Glauca'* are present in our green areas for many years and the other taxons are introduced later, with the development of the landscape design here (Skopje);
- The usage of the representatives of Picea genus on certain green spaces and the functions they are fulfilling or the role they have as element or part of elements in the landscape design, depends on the dimensions they reach and the basic morphological characteristics of the taxons themselves;
- Six of the registered taxons are trees, three of them *Picea abies*, *Picea omorica* and *Picea pungens* are in the category of trees over 30 m high, one, *Picea pungens 'Glauca'* in the category of trees 20-30 m high, and the rest two *Picea abies 'Inversa Pendula'* и *Picea pungens 'Hoopsii'* in the category of trees that reach 10-20 m high. The rest 3 taxons are shrubs from which *Picea glauca 'Conica'* belongs to the group of medium high shrubs that grow up to 3 m, while *Picea abies*

'Nidiformis' and *Picea pungens 'Glauca Globosa'* are in the category of small shrubs that reach 1,5 m in height;

- Considering the form, high growing species *Picea abies* and *Picea omorica* have conycal form, *Picea pungens*, *Picea pungens 'Glauca'* and *Picea pungens 'Hoopsii'* have pyramidal form and the last one (*Picea pungens 'Hoopsii'*) has even more compact habitus. *Picea abies 'Inversa Pendula'* has specific weeping form; *Picea glauca 'Conica',* compact conical-pyramidal form; and *Picea abies 'Nidiformis'* and *Picea pungens 'Glauca Globosa'* have irregular round form;
- Related to the texture, only *Picea glauca 'Conica'* has fine texture, *Picea abies 'Inversa Pendula', Picea abies 'Nidiformis'* and *Picea omorica* have semi-fine and *Picea abies, Picea pungens, Picea pungens 'Glauca', Picea pungens 'Glauca Globosa'* and *Picea pungens 'Hoopsii'* have coarse texture;
- Green is the color of the needles of *Picea abies 'Nidiformis',* dark-green are the ones of *Picea abies, Picea abies 'Inversa Pendula'* and *Picea omorica,* and light green are the needles of *Picea glauca 'Conica'*. *Picea pungens* has various shades of blue-green color. The needles of *Picea pungens 'Glauca', Picea pungens 'Glauca Globosa'* and *Picea pungens 'Hoopsii'* have attractive silver-blue color;
- The registered representatives of Picea genus in the landscape design in Skopje can be found in various categories of green areas, public and private, in balcony greening, as specimen plants, in tree groups (plant grouping), in alpineums, rock gardens and in pots and jardinières;
- *Picea abies, Picea abies 'Inversa Pendula', Picea omorica, Picea pungens, Picea pungens 'Glauca'* and *Picea pungens 'Hoopsii'*can be found as specimen plants. They are located on bigger and smaller green areas and in private gardens too;
- *Picea abies 'Inversa Pendula'* can be rarely found, usually in the exclusive private gardens, while *Picea pungens 'Hoopsii'* in the private gardens and in front of some public buildings;
- Groups of trees (plant grouping) are usually formed of *Picea abies, Picea pungens* and *Picea pungens 'Glauca'*, often in the public green areas;
- *Picea abies 'Nidiformis', Picea glauca 'Conica'* and *Picea pungens 'Glauca Globosa'* are very rare on the public green areas. They are often part of groups, alpineums, rock gardens, or are planted in pots and jardinières;
- All registered decorative representatives of Picea genus are very often used as focal points, mainly considering:
- The color of the needles of the taxons, the ones with attractive silver-blue color: *Picea pungens 'Glauca', Picea pungens 'Glauca Globosa'* and *Picea pungens 'Hoopsii'*
- and the form, exquisite example for that are *Picea abies 'Inversa Pendula'* and *Picea pungens 'Hoopsii'*.

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УПОТРЕБАТА НА НЕКОИ ДЕКОРАТИВНИ ПРЕТСТАВНИЦИ ОД РОДОТ PICEA MILL ВО ПЕЈЗАЖНОТО ДИЗАЈНИРАЊЕ ВО СКОПЈЕ (Р. МАКЕДОНИЈА)

Ризовска Атанасовска Јасминка, Брндевска Викторија

Апстракт

Со развојот на пејзажниот дизајн на нашите простори, интересот за декоративните растителни видови стана поголем. Употребата на веќе присутните е зголемена, а исто така внесени се и голем број нови видови, вариетети и култивари кои можат да успеат на нашето поднебје. Меѓу нив среќаваме поголем број претставници од родот Picea Mill кои благодарение на своите физиолошки, еколошки и специфични морфолошки карактеристик, форма, текстура, боја, завземаат сè почесто место на зелените површини кај нас. Целта на истражувањето е да се посочат претставниците од родот Picea Mill кои се среќаваат на нашите простори и притоа да се одреди нивната употреба во пејзажниот дизајн. Исто така дадени се препораки за употребата на поединечните таксони како поединечни елементи или дел од елементите во пејзажното дизајнирање. При истражувањето применет е визуелниот метод на пронаоѓање и детерминација на претставниците од родот Picea Mill на зелените површини, во поголемите градинарски центри и во расадниците. Со ова истражување констатирано е дека кај нас најчесто се среќаваат следниве претставници од родот Picea Mill: *Picea abies, Picea abies 'Inversa Pendula', Picea abies 'Nidiformis', Picea glauca 'Conica', Picea omorica, Picea pungens, Picea pungens 'Glauca', Picea pungens 'Glauca Globosa'* и *Picea pungens 'Hoopsii'*. Нивната честа и комплексна употреба во пејзажното дизајнирање на зелените површини како фокусни точки, солитери, дел од дрвни групи, алпинуми и слично, се должи на нивните специфични морфолошки карактеристики како и на различните форми и големини кои ги достигнуваат.

Клучни зборови: Picea, пејзажно дизајнирање, декоративни видови, вариетети, култивари, морфолошки карактеристики, форма, текстура, боја, зелени површини.

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Expert paper

CHARACTERIZATION OF BEEF TOMATO LANDRACES IN THE REPULBIC OF MACEDONIA

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Abstract
This research encompasses characterisation of domestic populations of tomato type known as "jabuchar". Fourteen domestic populations, that origin from several regions in Macedonia with various altitudes above sea level have been explored.Certain methodology of biological, morphological and reproductive characteristics of researched population has been used in order to meet the research aim. The results has shown differences in several parameters. According to the vegetation period (germination to aging) five populations have relatively short vegetation time of 103-105 days, unlike the other nine populations that have up to 115 days of vegetation period. When it comes to biological characteristics the fertilization percentage ranges from 46,8% at population No.2 up to 66.6% at population No.7. Significant differences amongst researched populations are registered at morphological characteristics, especially at the morphology of flower, form and size of the fruits, structure of the fruits, thickness of pericarp, crack appearance and green zone of the fruits and mass of the fruits which is 119gr at No.1 population up to 225 g at No.5 population. Also, there are significant variations at some morphological characteristics amongst populations and within them. The achieved results per plant and per hectare are considerably different amongst researched populations. Taking in mind the median, the yield of 7 populations is very small, and to other 7 the yield is higher by 24 or 27%. The final results obtained by more parameters, amongst researched domestic population of tomatoes, are divergent, which is of huge importance for selected activities.
Key words: tomato, morphological and biological characteristics, characterization, domestic populations.

Introduction

The tomato is one of the most widespread vegetable species in the world, as well as in our country. According to the FAO data, it is being grown in about 4 million hectares worldwide, and in R. Macedonia it is grown in the area of 9,000 - 10,000 ha. Tomato varieties are classified according to their biological and morphological characteristics, according to their purpose, way of growing, varieties that grow outdoors or in protected areas (indoors). In the period from 1994-1996, 112 autochthonous populations and local varieties of 11 species of garden plants have been sequenced and preliminary characterized. More recent research has been done within the frames of the Solanaceae international sequencing project in Southeastern Europe (SEED-net). The sequenced

samples have been documented with passport data. In addition, 27 local tomato populations have been characterized and stored in the Gene Bank at the Institute of Agriculture in Skopje.

Subject and Objective of the Research

Subject of the research is characterization of autochthonous populations of tomato type known as beef tomato ("*jabuchar*"). The objective of this research is studying the general biological and morphological characteristics, i.e. the occurrence and duration of particular stages of growth and development, duration of the vegetation period, percentage of fertilization, detailed description of several morphological traits. Furthermore, certain populations are to be selected from the obtained results in order to be used in selection processes for creating new genotypes in the overall production practice.

Material and methods

The experiment was placed in the location of Drachevo, where 14 autochthonous (local) populations of beef tomato ("*jabuchar*") were analyzed. The populations have been sequenced from different regions of Macedonia and stored in the Herbal Genes Bank at the Institute of Agriculture in Skopje. The sequenced populations belong to the group of indeterminate (high) varieties. The production took place outdoors with previous production of seedlings, planting them out at a distance of 80 cm between the rows and at 40 cm within the row, i.e. with proportional presence of 31,250 plants per hectare. During the vegetation, all necessary agrobiological and agrotechnical measures have been applied. Observations and registration of particular events - stages have been recorded at the research, in order to confirm the biological features of the plants, as well as biometrical measures and comparisons. For reaching the set objective, the biological, morphological and farming characteristics have been analyzed by defined methodology. Data has been analyzed and compared by accurately established methods. Regarding the biological characteristics, the following have been analyzed: days from sowing to germination, from germination to blooming, from blooming to the beginning of ripening, days from germination to the beginning of blooming (vegetation period), and percentage of fertilization.

Regarding the morphological characteristics, the following have been analyzed: leaf shape, number of leaves on the first (I) flower branch, number of flowers per plant, flower size, flower structure, fruit characteristics (size, shape, fruit surface, pericarp thickness, and number of chambers (locules) inside the fruit).

Regarding the production characteristics, the following have been analyzed: fruit number and mass per plant, yield per unit of area, coefficient of early ripening.

The characteristics have been processed according to international descriptors, and the obtained results have been processed by the variation and statistic method of Mudra. The yields have been processed by the Method of Analysis of Variance and by the LSD test on the level of 0.05 and 0.01.

Table 1. Survey of researched populations

No.	Sequenc. number (code)	Local Names	Place / Location	Height above sea level
1.	PA2-0-1	Paste Tomato	Vil. Rajkova Kukja - Kumanovo	353
2.	PA2-0-2	Beef Tomato ("*dashak*")	Vil. Drachevo - Skopje	246
3.	PA2-0-3	Pepper-shaped Tomato	Vil. Drachevo - Skopje	611
4.	PA2-0-4	Red Beef Tomato	Vil. Pagarusha - Skopje	246
5.	PA2-0-5	Red Beef Tomato	Vil. Vartekica - Skopje	544
6.	PA2-0-6	Tomato	Vil. Dolono Kolichani - Skopje	559
7.	PA2-0-7	Red Beef Tomato	Vil. Zubovo - Strumica	198
8.	PA2-0-8	Bull's Heart (flat)	Vil. Chucher - Skopje	480
9.	PA2-0-9	Beef Tomato	Vil. Chucher - Skopje	480
10.	PA2-0-10	Bull's Heart (oval)	Vil. Chucher - Skopje	480
11.	PA2-0-11	Pink Beef Tomato	Vil. Vasilevo - Strumica	235
12.	PA2-0-12	Yellow Pear Tomato	Vil. Miletino - Tetovo	382
13.	PA2-0-13	Large Tomato	Vil. Miletino - Tetovo	382
14.	PA2-0-14	Tomato	Vil. Zhelino - Tetovo	418

Results and discussion

Biological Characteristics

The dynamics of growth and development is a variety feature. However, the complex of external conditions (temperature, light, soil conditions), the production technique, way of growing, etc., have a direct influence on the occurrence of certain stages. By the length of vegetation period (days of germination up to beginning of fruit ripening) 5 populations have relatively short period of 103-105 days, while the other 9 populations, being characterized as late, have up to 115 days of vegetation period. Regarding the phenological occurrences, the most characteristic ones, according to the days from germination up to ripening, are the populations with selection code PA2-0-1 having 106 in the year 2007 and 103 in the year 2008 - with the fewest days, compared to the population with selection code PA2-0-12 having 120 in the year 2007 and 108 days in the year 2008. Regarding the vegetation period for both years, the population with code PA2-0-4 has a vegetation period of 103 days, unlike the population with code PA2-0-9 with 115 days. The fertilization percentage shows how many of the formed flowers of the plant have been pollinated and fertilized. It is predominantly a variety feature, but it also depends on the growing conditions and technique. The fertilization percentage ranges from 46.8% in the sequencing number PA2-0-2 or Beef Tomato ("*dashak*"), up to 66.6% in PA2-0-12 under the local name Yellow Pear Tomato. According to the obtained results, there is no connection (dependence) between the number of flowers and the number of fruits per plant. The average number of fruits is about 14.1 per plant. The coefficient of variation is the highest in the population 2 - PA2-0-2 under the local name Beef Tomato ("*dashak*"), and lowest in the population 3 - PA2-0-3 under the local name Pepper-shaped Tomato. Regarding the fruit mass, the population 5 - PA2-0-5 or Red Beef Tomato has the largest fruits of 255 g., while the population 1 - PA2-0-1 or Paste Tomato has the smallest fruits of 119 g. The researched populations can be observed in two groups:

a) Fruits with mass of up to 150 g (1, 3, 4, 9 and 11);

b) Fruits with mass above 150 g (2, 5, 6, 7, 8, 10, 12, 13 and 14)

The population with ordinal number 1 (CV 17.48) has the lowest level of variation. The highest variation of fruit mass can be noticed in the population with ordinal number 5 (CV 53.09). According to the obtained median values about the fruit shape, the researched autochthonous populations have a medium flat shape, with index from 0.76 to 0.90 (1, 4, 6, 8, 9, 10, 12, 13 and 14). Three of the researched populations (no. 2, 5 and 7) have fruits with distinguishing flat shape, while the population under ordinal number 3 has oblong fruits. The population with ordinal no. 12 (CV 6.57%) has the most stable shape. The population with ordinal no. 11 has the highest coefficient of variation (CV 23.88), with fruits of oval shape. In general, regarding the fruit shape, the researched populations have a low coefficient of variation which implies that it is a stable characteristic.Fruits from the population no. 6 have the thickest pericarp with median value of 6.1 mm. Fruits from the population no. 11 have the thinnest pericarp (3.2 mm). The coefficient of variation (CV) has an average range of 21.87. According to the obtained results, except for the populations no. 3, 10, 11 and 13, the other researched populations have relatively low variation in the thickness of the pericarp. Regarding the organoleptic features of the fruit, the fruit hardness is relatively small. The cracks have slight to medium appearance. The green zone appearing around the fruit stem is a frequent occurrence and is also a variety feature and genetically inherited characteristic. Catfacing-high level of fruit deformity. The populations 4, 5, 13 and 14 have occurrence of a slight level of deformity (3), while in the population number 1 the deformity is of medium appearance (5). The fruit colour is various - red, pink and rarely orange and white.

Production characteristics

Tomato yield depends mainly on the variety, morphological and biological characteristics, way of growing - outdoors or in protected areas. The total yield depends on several elements, such as: number of flower branches, number of flowers, number of fruits along the flower branch and the plant, fruit mass, and other contributing to yield formation. Based on our research, the obtained yields per plant and per hectare significantly differ among the researched populations.

Table 2. Yield *t/ha*

Population	2007	2008	Median Value	CV	+ - of Ø	
					t	%
1	42.0	33.9	37.9	34.9	-9.9	79.3
2	44.0	36.0	40.0	41.7	-7.8	83.7
3	42.6	38.4	40.5	20.1	-7.3	84.6
4	44.8	37.0	40.9	37.4	-6.9	85.4
5	44.0	38.4	41.2	30.5	-6.6	86.1
6	48.0	44.2	46.1	24.0	-1.7	96.3
7	55.1	51.0	53.0	38.6	5.2	110.7
8	52.8	49.1	50.9	30.4	3.1	106.5
9	47.5	41.6	44.5	31.5	-3.3	93.1
10	53.8	48.0	50.9	33.2	3.1	106.3
11	55.1	49.3	52.2	27.9	4.4	109.0
12	61.8	56.9	59.3	34.2	11.5	124.1
13	63.4	58.4	60.9	35.3	13.1	127.2
14	55.7	48.5	52.1	36.5	4.3	108.8
Median Value Ø	50.7	45.0	47.90	32.2		
Coefficient of Variation CV	13.88	17.20				
LSD 0.05	2.37					
0.01	3.30					

Conclusions

The vegetation period (days from germination to the beginning of ripening) is a result of the occurrence and duration of particular stages of tomato growth and development. According to the obtained results, the researched populations under the ordinal no. 1, 2, 4, 5 and 10 have a relatively short vegetation period from 103 to 105 days. The other populations have longer period of up to 115 days.

As an important biological characteristic, the highest fertilization percentage is observed in the populations no. 7 and no. 12 (66.6%). The number of formed flowers per plant (having 6 flower branches) ranges from 25 in the population no. 5 up to 43 flowers in the population no. 11. The population no. 5 has the fewest fruits with an average of 10, as well as the fewest formed flowers. The population no. 11 has the highest number of fruits (average of 18), as well as the most formed flowers. Fruit shape and mass are the parameters for usual determination of the variety, i.e. the population. According to the obtained results, 9 populations have medium flat shape; three of the researched populations have distinguishing flat shape, and the population no. 3 has oblong fruits.

During the two years of research, the highest yield of 60.9 t/ha has been realized from the population under no. 13.

From the total of the obtained research results, according to the majority of researched parameters, it can be concluded that among the researched autochthonous tomato populations there is a significant divergence in the majority of analyzed characteristics. This occurrence is especially important for certain research objectives-selection processes.

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КАРАКТЕРИЗАЦИЈА НА АВТОХТОНИ ПОПУЛАЦИИ ДОМАТ (LYCOPERSICON ESCULENTUM, MILL.) ОД ТИПОТ ЈАБУЧАР ВО РЕПУБЛИКА МАКЕДОНИЈА

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Апстракт

Со ова истражување е извршена карактеризација на автохтони популации домат од типот јабучар. Проучувани се 14 автохтони популации кои потекнуваат од повеќе реони во Македонија, со различни надморски височини. За да се постигне поставената цел, според одредена методологија, анализирани се биолошките, морфолошките и производните карактеристики на испитуваните популации. Според добиените резултати, утврдени се одредени разлики на повеќе параметри. Според должината на вегетацискиот период (денови на никнење до почеток на зреење на плодовите), 5 популации се одликуваат со релативно кус период од 103 до 105 денови, додека другите 9 популации се карактеризираат како подоцни и до 115 дена вегетациски период. Од биолошките својства е значајна појавата дека процентот на оплодување се движи од 46,8% кај Популацијата бр.2 до 66,6% кај Популацијата бр.7. Во однос на морфолошките карактеристики, значајно е дека се утврдени релативно големи разлики меѓу испитуваните популации според морфологијата на цветовите, формата и големината на плодовите, структурата на плодовите, дебелината на перикарпот, појавата на пукнатини и зелена зона на плодовите, масата на плодовите која според средните вредности се движи од 119 g кај Популацијата бр.1 до 225 g кај Популацијата со бр.5. Исто така, утврдени се релативно високи варирања на некои морфолошки својства меѓу популациите и внатре во нив. Постигнатите приноси на единица растение и на хектар, значително се разликуваат меѓу испитуваните популации. Во однос на средната вредност од сите испитувани популации кај 7 популации приносот е помал, а кај другите 7 приносите се повисоки за 24, односно 27%. Според севкупните добиени резултати по повеќе испитувани параметри и извршената карактеризација, меѓу испитуваните автохтони популации домати, утврдена е одредена дивергентност, што е од посебно значење за селекциските активности.

Клучни зборови: домат, морфолошки и биолошки својства, карактеризација, автохтони популации.

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FIRST NODE SEED QUALITY IN DIFFERENT TOMATO GENOTYPES

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Abstract
Republic of Serbia is a significant producer of tomato seed for the domestic market and for export. This paper presents the results of the experiment with seven tomato genotypes, including five varieties and two indeterminate lines. In addition to the required mass of fruit per gram of seeds and seed mass per plant on the first node, we analyzed the germination energy, germination, and the absolute mass of natural seeds (first node). There was an average germination of 90,33%, where the determinate genotypes had a slightly lower percentage compared to the energies of indeterminate genotypes. Seed germination ranged from 89,66% in cultivar Knjaz, to 93,00% in high line V14. Seed obtained from the first node fruits of all genotypes had a high average of absolute seed mass (3,35 g). The results were statistically analyzed using analysis of variance. Taking into account legal norms, the seed of all the genotypes had a very high seed quality, which guarantee a stable and successful tomato production.
Key words: absolute seed mass, germination, seed, tomato.

Introduction

Tomato (*Lycopersicon esculentum* Mill.) is the most commonly grown vegetable in the world, with a very wide distribution area of 4.338.834 ha (FAO, 2010). The world's largest tomato producers are China, USA, India, Turkey, Egypt, Russia, Italy and Mexico. In 2011. 20.229 ha in Serbia were planted under this vegetable, with an average yield of 9,82 t / ha (webrzs.stat.gov.rs). During the last 10 years, the area under this crop has not fluctuated much in the Republic of Serbia. In the structure of total vegetable consumption in Serbia, tomato has a share of 11,6% or 15,2 kg per capita per year (Vlahović and Puškarić, 2012). It is used as fresh, ripe fruit or as different processed products. Contemporary tomato production is based on the use of certified seeds of newly developed varieties and hybrids (Takač et al., 2005). In Vojvodina, and along the river valleys of central Serbia, there is a good combination of soil and plenty irrigation water as well as favourable climate. Fruit yields of 50-80 t / ha can easily be achieved in this area. Tomato growth type can be indeterminate, semideterminate and determinate. Indeterminate variety is characterized by unlimited, tall growth of the stemtrees and dense branching (Takač et al., 2007). Depending on the type of growth tomato can be produced in various ways and used for different purposes. Seed production takes place by direct seeding or from seedlings. Seed production and seed processing should be given special attention in order to improve the quality of seeds, which far exceed legal standards, ensuring safe and smooth production of seedlings sprouting in the open field (Takač et al., 2012). Substantial areas under tomato in Serbia and favourable climate for seed production are the basis of quality tomato production.

Material and methods

Seven tomato genotypes were selected for this study from the collection of the Institute of Field and Vegetable Crops in Novi Sad, Serbia. According to the type of growth, three varieties are determinate (Alparac, Bačka and Knjaz), while two cultivars (Pegaz and Novosadski jabučar) and two lines (V9 and V14) are indeterminate (Table 1). The experiment was conducted in a randomized complete block design with five replications, planting two rows of each genotype at the site was performed. Sowing for the production of seedlings was done on March 30. 2011 in greenhouse and planting on May 12. in the open field. Row spacing was 70 cm, while the distance between plants in a row was 50 cm. During the growing period, plants were watered regularly. Two interrow cultivations and hoeing were performed. Indeterminate genotypes were grown with support (peg) on a one stem. Fertilization experiment was carried out with mineral fertilizer AN in the amount of 250 kg / ha. Plant protection measures were regularly carried out.

In the experiment, the following parameters were monitored on the first node: the mass of fruit needed for one gram of seeds, Seed mass (per plant), germination energy, seed germination, absolute seed mass. Average, minimum and maximum values for these analyzed traits were calculated, while statistical significance was tested using LSD test.

Results and discussion

The mass of fruit needed for one gram of seeds

In the production of tomato seed the required amount of fruit for one gram or one kilogram of seed is a very important parameter. One kilogram of seed is obtained from 300-400 kilograms of fruit. (Gvozdenović et al., 2011). With heirloom varieties and populations of soft fruit, it takes a small amount of fruit for 1 kilogram of seed. In the newly developed determinate varieties, of firm fruit, the ratio is less favourable (Popović et al., 2012). This must be taken into account while contracting in the seed production i.e. the seed producer should not be paid the same price for one kilogram of seed. This is illustrated by the data shown in Table 1 where the greatest need of fruit mass was in the variety Bačka (552,7 g), significantly lower in V14 and Pegaz, and highly statistically significantly lower in Novosadski jabučar (287,4 g).

Seed mass

Seeds and seedlings are an important factor in high-quality production, especially in vegetable production (Ćirkova et al., 1989.). Tomato belongs to a group of plants with a high rate of multiplication, as illustrated by the fact that there are about 288 seed embryos in a tomato flower , whereas there are up to 8 in pea flower , 90 in sesame (Žučenko, 1990), and 80-100 in peppers (Gvozdenović et al., 1995). So one cannot always get a realistic picture of tomato seed production only by the sown area under this crop, especially if one takes into account that a part of tomato production comes the seedlings and another part from seeds. Seed yield of the cultivars and lines per plant at the first node ranged from 1,5 g for variety Backa up to 2,2 g in the line V9. The differences found were not statistically significant (Table 1).

Germination energy

Seed is the primary carrier of quality values and hereditary characteristics (Milosević and Ćirović, 1994). Seed is an immature dormant plant with a certain amount of food reserves and wrapped in hard pericarp. Germination energy is the percentage of germination of seeds that germinate in the first days of germination test. This time is different for different types of vegetables grown (4 days for salads, radishes, cucumbers and melons, 10 days for parsley and celery), while in the case of

tomatoes it is 5 days. As tomato seed ages, germination energy has a much sharper decline than the decline in the overall percentage of germination. The trial average germination energy was 90,33% and ranged from 86,66% in cultivar Knjaz to 93,00% in hybrid V14. On average, determinate genotypes had a lower germination energy compared to indeterminate genotypes. Highest germination was observed at tall line V14 (93,00%) (Table 2).

Table 1. The amount of seed on the first node of different tomato genotypes

Number	Genotype	The mass of fruit needed for one gram of seeds (g)	Seed mass per plant (g)
1.	V14	377,4	1,8
2.	Pegaz	334,7	2,1
3.	V9	472,0	2,2
4.	Novosadski jabučar	287,4	1,9
5.	Alparac	420,6	1,5
6.	Bačka	552,7	1,5
7.	Knjaz	439,8	2,1
	Average	412,1	1,9
	Min	287,4	1,5
	Max	552,7	2,2
	LSD(0,05)	168,5	0,9
	LSD(0,01)	227,4	1,2

Seed germination

Seed germination is the percentage of normally germinatedseeds, under certain conditions, determined by methods already established for each type of vegetable seeds. Tomato is a herbaceous plant which for some years retains high germination, even up to 5 years (Takač, 1997), unlike most other vegetable crops who rapidly lose viability. Onion and lettuce lose germination in two to three years (Lazić, 1987). According to Mladenovski and Mihajlovski (1994) seed after 20 years of storage in a hermetically sealed package with moisture percent of 5,77% had germination of 93,75%. According to the current legislation, seed that has purity of at least 97%, maximum moisture content of 12%, the presence of weeds of 0% and minimum germination of 75% can be marketed. Seed germination is one of the most important quality indicators. In order to compare the results obtained, it is necessary to standardize the method, including mediu,, germination conditions, the length of the investigation and the methods used to break dormancy. Depending on the species, seed germination lasts from 7 days (radishes, lettuce) to 28 days (parsley, parsnip), and the germination of tomato lasts for 14 days. If the soil conditions are almost ideal germination obtained in laboratory conditions is a good indicator of seed vigour, which can predict the field emergence (Durrant and Gumerson, 1990). Seed germination of the trial genotypes ranged from 89,66% in Prince to 93,00% in tall line V14. On average it amounted to 91,42% (Table 2). Here we highlight that the seed was not processed, i.e. the results given in germination energy and seed germination relate to the natural seed. Taking into account the legal norms, we see that the seeds of all genotypes had very high germination, which is the guarantee of a stable and successful seedling production,

and for determinate genotypes it is the guarantee of a rapid and uniform field emergence. Processing such seed would increase these indicators.

1000 seed weight

1000 seed weight or absolute seed mass (AM) is a very important indicator of the quality of seed. Seeds with higher AM have more reserve materials, they germinate faster and smoother, fight stress conditions easily, yield better developed plants and seeds, and are easily stored in a warehouse for longer periods. Seeds located closer to the handle of the fruit is heavier than seeds located on the opposite side. Sowing rate is determined based on germination and AM. In tomato seed production of aaverage 1000 seed weight is 2,7 to 3,3 grams (Gvozdenović et al. 2011). Year as a production factor affects this. The average absolute mass in 7 genotypes was 3,35 grams and varied in the range of 2,66 grams in Prince to 3,87 grams of indeterminate line V14 (Table 2). The data show that the tomato seeds collected from fruits of the first node had high absolute mass, which is one of the prerequisites for rapid and uniform germination. On the other hand, since larger seeds are more easily processed, seedsmen and seed processors store seeds without fear of decreased quality or seed germination.

Table 2. Seed quality on the first node of tomato

Number	Genotype	Germination energy (%)	Seed germination (%)	Absolute seed mass (g)
1.	V14	93,00	93,00	3,87
2.	Pegaz	91,33	91,66	3,44
3.	V9	91,66	92,00	2,74
4.	Novosadski jabučar	90,33	90,66	3,82
5.	Alparac	91,00	92,33	3,06
6.	Bačka	89,00	90,66	3,82
7.	Knjaz	86,33	89,00	2,66
	Average	90,33	91,42	3,35
	Min	86,33	89,00	2,66
	Max	93,00	93,00	3,87
	LSD(0,05)	3,19	1,87	0,10
	LSD(0,01)	4,43	2,60	0,15

Conclusions

Analysis of seven different tomato genotypes showed that the average weight of fruit needed for 1 gram of seeds is very different, and that this isa varietal characteristic. It ranged from 287,4 g in Novosadski jabučar up to 553,7 g in Bačka. Based on these results, determinate genotypes need more fruit for 1 g of seed (average 470 g) then indeterminate genotypes (on average 394 g). Seed yield of the first node of the analyzed varieties and lines per plant ranged from 1,5 g for variety Backa up to 2,2 g in the line V9.

Germination energy for determinate genotypes was on average slightly lower than for indeterminate genotypes, ranging from 86,66% in cultivar Knjaz, to 93,00% in tall line V14. Seed germination of all genotypes was 91,42% on average and ranged from 89,66% in cultivar Knjaz to 93,00% in tall line V14. Taking into account the legal norms, it can be concluded that the seeds of the first node

for all genotypes had very high germination, which is the guarantee of a stable and successful production.

The average absolute seed mass for all 7 genotypes was 3,35 g, in the range from 2,66 g (Knjaz) to 3,87 g (V14). The obtained results indicate that tomato seeds collected from fruits of the first node have a high absolute mass, which is one of the prerequisites for rapid and uniform emergence, as well as the possibility for seeds to be stored without worrying about the decline in the quality and seed germination.

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КВАЛИТЕТ НА СЕМЕТО ОД ПРВАТА НОДИЈА КАЈ РАЗЛИЧНИ ГЕНОТИПОВИ НА ДОМАТ

Вукашин Поповиќ, Адам Такаќ, Светлана Глоговац, Јелица Гвоздановиќ- Варга

Апстракт
Република Србија е значаен производител на семе од домати за домашниот пазар и за извоз. Во овој труд се прикажани резултати од експериметот со седум генотипови на домат, вклучувајќи пет сорти и две индетерминантни линии. Според потребната маса на плод на грам семе и маса на семе на растение од првата нодија, анализирани се енергијата на `ртење, `ртливоста и апсолутната маса на семето (прва нодија). Просечната `ртливост била 90,33%, при што детерминантните генотипови имаа незначително понизок процент споредено со индетерминантните генотипови. `Ртливоста на семето се движела од 89,66% кај сортата Књаз, до 93, 00% кај V14. Семето добиено од првата нодија од сите генотипови имало висок просек на апсолутна маса од 3,35 g. Резултатите биле статистички анализирани со примена на анализа на варијанса. Земајќи ги предвид законските норми, семето од сите генотипови имало многу висок квалитет, со што се гарантира стабилно и успешно производството на домати.
Клучни зборови: апсолутна маса на семе, `ртење, семе, домати.

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AGRONOMIC TRAITS OF SOME NEWLY PEPPER VARIETIES AND HYBRIDS IN REPUBLIC OF MACEDONIA

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Abstract
Pepper is one of the leading vegetable crops in production in open field and protected house especially plastics. In the recent years there is a tendency of introducing new varieties and hybrids. In this article 40 varieties and hybrids were examined in period 2005-2010 with the aim registration in national variety list and introducing in production. During investigation period stages of growth, average yields and main characteristics of the fruits were examined. All varieties and hybrids showed stable traits. Novosadska, Atris F_1, Silba F_1, Kaptur F_1 and Kapro F_1 gave better results in comparison with standard varieties for open field production, while Daras F_1, Donat F_1, Romatca F_1 and Ekstaza F_1 for protected houses.
Key words: pepper, hybrids, traits.

Introduction

Pepper is one of the leading vegetable crops in R. Macedonia. According state statistical office it is grown on 8475 hectares, with total production of 153.842 tones and average yield of 18,17 t / ha in open field and in protected houses for early crop production. In the review of the fresh vegetables value chain baseline screening for 2012 is stated that the production of pepper has increased 31% in 2010 in comparison with 2004 because of the use of new varieties and subsidies by the government. Still the leading variety for open field production is Kurtovska kapija generally used for processing. The production in protected area is mostly in plastics than in greenhouses. Predominant pepper varieties are: Fortese, Struma, Inferno (hot peppers) and Pinokio, Zlaten medal, Bela dolga, Sivrija (sweet peppers). Having in mind the vast diversity of the pepper and tradition of growing years ago the number of autochthonous populations for all types of pepper is 483 represented in 153 localities in the Republic of Macedonia (Bogevska Zvezda et. al, 2010). Also according the national variety list of Republic of Macedonia for 2008 there are 78 recognized species of which 53 are foreign, 23 local and two national. So far the number of new varieties is still growing so the aim of this study was to determine the value for cultivation and use of the new varieties and hybrids of pepper for open and protected production during 2005-2010.

Matherial and methods

For this study the experiments have been done on 40 varieties and hybrids of pepper for 2005-2010. The experiments in the open field were done in experimental fields at the Institute of agriculture in Skopje but for protected houses the experiments were done in glasshouses in four regions Sveti Nikole, Shtip, Kochani and Valandovo. In 2005 the research was done on 6 varieties in open field as follows: Inferno, Ringo F_1, Zlaten medal, Thoros F_1, Zlaten medal and Piran. The standard varieties were Inferno and Zlaten medal. The research was done in three replications with 12 m^2 experimental plot. They were grown from seedlings in semi hot beds and transplanted in rows 60x20cm. The technology was standard for growing pepper in open field. In 2006 the varieties Bel Kalvin, Novosadska, Sorok sari, Silba F_1, Stajkovski Kavardzik, Sweet ethem, Sweet banana, Zlaten medal and Piran were examined. Novosadska was compared with Bel Kalvin, Silba F_1 with Sorok Sari, Sweet ethem and Sweet banana with Stajkovski Kavardzik and Piran with Zlaten medal. The technology was the same as previous year and the year that follows. In 2007 Semerkand F_1 and Atris F_1 were compared with Kurtovska kapija. During the 2009 Tarsila F_1 and Rendo F_1 were compared with Bela Dolga and Galga F_1 with Kurtovska kapija. The technology was the same except the size of the experimental plot which was smaller 6 m^2 and the number of the plants per plot was 50. In 2010 five varietes were examined. BT Samsung 016, Kapija 1990 F_1 Kaptur F_1 Kapro F_1 were compared with Kurtovska kapija. The experiment procedure was the same as previous year. The varietal experiments in the protected houses were done in 2005, 2008 and 2009.

In the 2005 four varieties were examined on three different locations Sveti Nikole, Kochani, Stip - v. Karbinci. Daras F_1 was compared with the standard variety Sivrija and Donat F_1 with Zlaten medal respectively. It was used standard technology. The size of the experimental plot was 3,2 m^2 with 10 plants. The plants were transplanted in rows 80x40cm in 5 replications in Sveti Nikole and 3 in Kochani and Stip respectively. In 2008 there were two experiments in the glasshouses Anska reka, Valandovo. The diferences were in the choice of the variety of pepper. The tecnology was the same with experimental plot 6,4 m^2 and 40 plants per plot transplanted in rows 65x25 cm. The first experiment was with long pepper Ekstaza F_1 which was compeared with the standard variety Zlaten medal. The other research was on bell pepper variety Romatca F_1 compared with Blondy F_1. In the 2009 three varieties were examined in two locations Kochani and Stip. It was used common cultivation technology on experimental plot 4 m^2 with 16 plants per plot and space betweet the plants 80x30cm. The experiment was in 5 replications. Plants were regulary irrigated, fertilized and protected. During the production of all varieties grown in open field and protected houses data of the stages of growth, average yields and characteristics of the fruits were registered. The yields were statistically obtained and verified with LSD test.

Results and discussion

The date of stages of growth for the pepper varieties grown in open field are given in the table 1. All varieties in 2005 were sown and transplanted on the same date, 08.04.2005 and 06.06.2005 respectively. The differences were found in the sprouting date. Ringo F_1 sprouted one day later, Thoros F_1 8 days earlier and Piran 4 days earlier than the standard varieties. The grater difference in the date of first harvest gave the variety Thoros F_1. It was 8 days earlier than the Zlaten medal. The vegetation from sprouting to first harvest varies from 103 days in Thoros F_1 and Zlaten medal to 108 in Piran.

In 2006 the varieties Sweet ethem, Sweet banana and Piran sprout in the same time with the standards except Silba F_1 and Novosadska which were 4 days earlier than the standard varieties. There were differences in the date of the first harvest that contributed to differences in the vegetation. All tested varieties showed longer vegetation than the standards except Sweet banana which had the same days as the standard 110.

In 2007 the dates of growing stages were the same in all investigated varieties except the date of physiological maturity. The variety Semerkand F1 was 14 and Atris F1 31 days earlier than the standard variety Kurtovska kapija. In 2009 there were differences in the date of first harvest and date of technological and physiological maturity that result in differences in vegetation period which differ from 96 in Galga F_1 to 108 in Kurtovska kapija and Rendo F_1. In 2010 the variety BT Samsung 016 (95) was 20 days and Kapro F1 (102) and Kaptur F1 (102) 13 days earlier than the standard Kurtovska kapija (115). The variety Kapija 1990 F_1 (122) had 7 days more vegetation period. In the table 2 are given the productive traits of the investigated varieties in the open filed from 2005 to 2010 expressed in average yields.

All investigated varieties were more yielded than the standard varieties except the Sweet etham and Sweet banana in 2006 and Tarsila F_1 in 2009. The differences weren't significant. The higher significant differences in yield gave the variety Novosadska in 2006, Atris F_1 in 2007, Kaptur F_1 and Kapro F_1 in 2010.

In the table 3 are given the characteristics of the fruit of all examined varieties from 2005-2010.

Table 1. Stages of growth in open field production

Year	Variety	Date of sowing	Date of sprouting	Date of transplanting	Date of first harvest	Date of maturity		Vegetation from sprouting to first harvest
						Tech.*	Phys.**	
2005	Inferno ø	08.04.05	20.04.05	06.06.05	01.08.05	01.08.05	-	103
	Ringo F_1	08.04.05	21.04.05	06.06.05	03.08.05	03.08.05	-	105
	Zlaten medal ø	08.04.05	26.04.05	06.06.05	06.08.05	06.08.05	-	103
	Thoros F_1	08.04.05	18.04.05	06.06.05	29.07.05	29.07.05	-	103
	Zlaten medal ø	08.04.05	26.04.05	06.06.05	06.08.05	-	-	103
	Piran	08.04.05	22.04.05	06.06.05	04.08.05	-	-	108
2006	Bel Kalvin ø	12.04.06	01.05.06	30.05.06	12.08.06	12.08.06	01.09.06	104
	Novosadska	12.04.06	27.04.06	30.05.06	14.08.06	14.08.06	04.09.06	110
	Sorok sari ø	12.04.06	01.05.06	30.05.06	10.08.06	10.08.06	05.09.06	102
	Silba F_1	12.04.06	27.04.06	30.05.06	10.08.06	10.08.06	05.09.06	106
	Stajkovski Kavardzik ø	12.04.06	27.04.06	30.05.06	14.08.06	14.08.06	01.09.06	110
	Sweet ethem	12.04.06	27.04.06	30.05.06	15.08.06	15.08.06	01.09.06	111
	Sweet banana	12.04.06	27.04.06	30.05.06	14.08.06	14.08.06	30.08.06	110
	Zlaten medal ø	12.04.06	03.05.06	30.05.06	14.08.06	-	-	104
	Piran	12.04.06	03.05.06	30.05.06	18.08.06	-	-	108
2007	Kurtovska kapija ø	13.04.07	05.05.07	28.05.07	-	-	29.08.07	96
	Semerkand F_1	13.04.07	05.05.07	28.05.07	-	-	15.08.07	96
	Atris F_1	13.04.07	05.05.07	28.05.07	-	-	28.07.07	96
2009	Bela dolga ø	09.04.09	23.04.09	26.05.09	09.08.09	09.08.09	24.08.09	100
	Tarsila F_1	09.04.09	23.04.09	26.05.09	10.08.09	10.08.09	26.08.09	100
	Rendo F_1	09.04.09	23.04.09	26.05.09	12.08.09	12.08.09	21.08.09	108
	Kurtovska kapija ø	09.04.09	23.04.09	26.05.09	12.08.09	12.08.09	21.08.09	108
	Galga F_1	09.04.09	23.04.09	26.05.09	23.07.09	23.07.09	14.08.09	96
2010	Kurtovska kapija ø	25.04.09	15.05.09	12.06.09	22.08.09	03.09.09	15.09.09	115
	BT Samsung 016	25.04.09	15.05.09	12.06.09	18.08.09	12.08.09	01.09.09	95
	Kapija 1990 F_1	25.04.09	15.05.09	12.06.09	29.08.09	25.08.09	15.09.09	122
	Kaptur F_1	25.04.09	15.05.09	12.06.09	03.09.09	25.08.09	03.09.09	102
	Kapro F_1	25.04.09	15.05.09	12.06.09	13.09.09	03.09.09	10.09.09	102

*technological stage of maturity

**physiological stage of maturity

ø standard variety

"-"data not registered

Table 2. Average yield t/ha in open field production

Year	Variety	Average yield	+ - from ø	CV	LSD	
					0,05	0,01
2005	Inferno	44,0	ø	5,53	4,23	6,40
	Ringo F_1	50,5	6,5	4,15		
	Zlaten medal	37,7	ø	2,26		
	Thoros F_1	42,4	4,7	3,66		
	Zlaten medal	27,7	ø	3,07	3,75	4,87
	Piran	33,9	6,2	4,35		
2006	Bel Kalvin	30,3	ø	1,19	3,36	4,63
	Novosadska	43,6	13,3	9,14		
	Sorok sari	45,1	ø	5,33		
	Silba F_1	54,7	9,6	1,93		
	Stajkovski Kavardzik	42,0	ø	2,90		
	Sweet ethem	39,9	-2,1	3,90		
	Sweet banana	40,9	-1,1	4,44		
	Zlaten medal	45,8	ø	4,33	3,36	4,63
	Piran	51,2	5,4	3,67		
2007	Kurtovska kapija	41,1	ø	11,2	9,2	15,2
	Semerkand F_1	46,4	5,3	3,9		
	Atris F_1	54,7	13,6	4,2		
2009	Technological stage of maturity					
	Bela dolga	49,5	ø	7,47	7,88	11,47
	Tarsila F_1	45,1	-4,4	12,87		
	Rendo F_1	54,7	5,2	11,80		
	Kurtovska kapija	37,0	ø	4,11		
	Galga F_1	38,3	1,3	5,00		
	Physiological stage of maturity					
	Bela dolga	44,1	ø	7,71	7,88	9,41
	Tarsila F_1	45,9	1,9	7,11		
	Rendo F_1	48,0	3,9	3,63		
	Kurtovska kapija	29,8	ø	17,52		
	Galga F_1	35,0	5,2	3,77		
2010	Kurtovska kapija	22,8	ø	10,1	4,53	6,58
	BT Samsung 016	27,9	5,1	15,8		
	Kapija 1990 F_1	25,8	3,0	6,9		
	Kaptur F_1	50,7	27,9	4,2		
	Kapro F_1	39,9	17,1	5,1		

ø standard variety

Table 3. Characteristics of the fruit in open field production

Year	Variety	Mass in g	Index of fruit	Thickness of pericarp mm	Number of locules	Colour of fruit		Content of dry matters %	Fruit utilization %	Flavour of fruit
						Technological	Physiological			
2005	Inferno ø	49,2	4,7	3,0	2,1	light yellow	-	4,0	80	hot
	Ringo F_1	51,5	4,3	3,1	2,2	light yellow	-	3,9	83	hot
	Zlaten medal ø	54,7	3,2	4,0	2,1	yellowish green	-	5,1	79	mild
	Thoros F_1	83,7	3,4	4,1	2,2	light green	-	3,7	84	mild
	Zlaten medal ø	55,0	3,2	4,0	2,1	yellowish green	-	5,1	79	-
	Piran	51,0	3,8	4,2	2,0	yellowish green	-	5,0	83	-
2006	Bel Kalvin ø	43,9	0,60	6,0	3,3	light yellow	-	3,2	34,5	-
	Novosadska	44,7	0,63	8,2	2,8	light yellow	-	3,2	31,0	-
	Sorok sari ø	69,7	1,1	5,6	3,3	light yellow	-	3,4	53,2	-
	Silba F_1	87,0	1,1	6,1	3,4	light yellow	-	3,0	70,7	-
	Stajkovski Kavardzik ø	44,7	3,8	2,5	2,1	whitish yellow	-	3,9	35,7	-
	Sweet ethem	56,5	3,2	3,3	2,6	light yellow	-	3,4	45,2	-
	Sweet banana	67,5	4,0	3,1	2,6	light green	-	3,4	56,0	-
	Zlaten medal ø	67,0	3,2	3,4	2,4	yellowish green	-	3,8	73	-
	Piran	71,0	4,0	3,1	2,3	yellowish green	-	3,6	70	-
2007	Kurtovska kapija ø	97,5	2,4	4,3	2,3	-	dark red	6,9	76	mild
	Semerkand F_1	81,2	3,6	4,6	2,8	-	dark red	5,5	65	mild
	Atris F_1	103,0	3,1	4,5	3,3	-	dark red	6,4	84	mild
2009	Bela dolga ø	58,9	-	3,7	2,3	-	-	3,8	-	mild
	Tarsila F_1	53,2	-	2,8	2,5	-	-	3,8	-	mild
	Rendo F_1	112,0	-	3,1	3,1	-	-	3,8	-	mild
	Kurtovska kapija ø	113,0	-	2,2	2,2	-	-	4,5	-	mild
	Galga F_1	83,2	-	3,0	3,0	-	-	3,8	-	mild
2010	Kurtovska kapija ø	73,4	3,4	-	2,1	greenish white	dark red	7,3	56,5	-
	BT Samsung 016	66,7	2,8	-	2,5	white	light red	6,2	48,1	-
	Kapija 1990 F_1	78,4	4,4	-	2,1	green	dark red	6,3	63,0	-
	Kaptur F_1	73,9	4,5	-	3,1	green	dark red	6,4	98,0	-
	Kapro F_1	88,1	4,0	-	2,2	green	dark red	6,8	73,2	-

ø standard variety ; "-"data not registered

In 2005 the mass of the fruit ranged from 49,2 g in Inferno to 83,7 in Thoros F_1. The highest index of the fruit was obtained in the standard variety Inferno but the smallest 3,2 in Zlaten medela. The others values were as follows Thoros F_1 3,4, Piran 3,8 and Ringo F_1 4,3. The thickness of the fruit was 3,0 in Inferno and 4,2 in Piran which indicate that these varieties are medium fleshy peppers. The number of the locules was about 2. The colour in technological maturity was yellowish green in Zlaten medal and Piran, light yellow in Inferno and Ringo F_1 and light green in Thoros F_1. The content of dry matters is among 3,9 in Ringo F_1 to 5,1 in Zlaten medal. The utilization part was better in Ringo F_1 (83%), Thoros F_1 (84%) and Piran (83%) in comparison to standard varieties Zlaten medal (79%) and Inferno (80%).

In 2006 the mass of the examined varieties varied from 43,9 g in Bel Kalvin to 87,0 in Silba F_1 depending on the type of pepper. The index of the fruit was 0,60 in Bel Alvin to 4,0 in Sweet banana and Piran. The biggest thickness showed the bell pepper Silba F_1 (6,1mm). The least thickness (3,1) was obtained from the varieties Sweet banana and Piran. The colour in technological stage of maturity was whitish yellow in Stajkovski kavardzik, yellowish green in Zlaten Medal and Piran, light green in Sweet banana. The others had light yellow colour of the fruits. The content of dry matters was in the range of 3,0 % in Silba F_1 and 3,9 % in Stajkovski kavardzik. The utilization part depends on the variety and according this the biggest fruit utilization had the standard variety Zlaten medal (73%). The values of the fruit utilization in the others varieties varied from 31,0% in Novosadska to 70,7 in Silba F_1.

In 2007 the mass of the three examined varieties was 81,2 g in Semerkand F_1, 97,5 g in Kurtovska kapija and 103, 0 in Atris F_1. The index of the fruit was 3,6 in Semerkand F_1, 3,1 in Atris F_1 and 2,4 in Kurtovska kapija. The thickness of the fruit was about 4 in all three varieties. The number of the locules was 2,3 in standard variety Kurtovska kapija, 2,8 in Semerkand F_1 and 3,3 in Atris F_1. The fruits of all varieties were in physiological maturity dark red and mild. The content of dry matters was in favor of the control variant (6,9%). The best fruit utilization showed Atris F_1 (84%).

In 2009 five varieties were investigated. Tarsila F_1 and Rendo F_1 were compared with Bela dolga and Galga F_1 with Kurtovska kapija.The fruit mass varies from 53,2 in Tarsila F1 to 113,0 in Kurtovska kapija. Galga F_1 was better in the thickness of the fruit and number of the locules in comparison to standard variety. Tarsila F_1 and Rendo F_1 had the same dry matter content and more locules than the standard variety Bela dolga. All varieties had mild flavour.

In 2010, BT Samsung 016, Kapija 1990 F_1, Kaptur F_1, Kapro F_1 were compared to Kurtovska kapija.

The average mass of the fruits varied from 66,7 g in BT Samsung 016 to 88,1 g in Kapro F_1. Kapija 1990 F_1, Kaptur F_1, Kapro F_1 had bigger index of the fruits. Kapija 1990 F_1 and the standard variety Kurtovska kapija had the same number of the locules. The others showed bigger number of the locules in comparison to standard. All varieties had the lower content of dry matters. Kapija 1990 F_1 (63,0%), Kaptur F_1 (98,0%), Kapro F_1 (73,2%) showed better fruit utilization than the standard variety Kurtovska kapija (56,5%).

The varietal experiment was done in protected houses in 2005, 2008 and 2009. Eleven varieties were grown to assess the agronomic traits.

In 2005 Sivrija (standard variety), Daras F_1, Zlaten medal (standard variety) and Donat F_1 were examined in three different locations Sveti Nikole, Kochani and Shtip. Date of the sowing was the same as well as date of the transplanting depending of the location. In Sveti Nikole Daras F_1 and Donat F_1 were little bit later than the standard varieties. In Kochani these varieties had the same

vegetation period in comparison to standards 124 days. In Shtip Daras F_1 (136) was ten days later than the standard variety Sivrija (126). Donat F_1 (134) was five days later than the standard variety Zlaten medal (129).

In 2008 Zlaten medal (standard variety), Ekstaza F_1, Blondy F_1 (standard variety) and Romatca F_1 were examined in one location in glasshouses Anska reka in Valandovo. The date of the stages of growth as date of sowing, data of sprouting, date of transplanting was the same that resulted in the same number of the days from sprouting to first harvest (156).

In 2009 three hot varieties of pepper were studied in glasshouses in two locations Kochani and Shtip. HV 410 F1 and Kais had more or less the same number of days from sprouting to first harvest in the two locations. The stages of growth in the protected houses are given in the table 4. The average yields of the examined varieties are given in the table 5. The data of the yields in Stip for 2009 is not recorded. All the investigated varieties were more yielded than the standard varieties in all locations and years of research. It can be noticed that the differences are significant especially for 2005 where the varieties Daras F_1 and Donat F_1 in the three locations gave significant more yields in comparison with the standard varieties Sivrija nad Zlaten medal.

The characteristics of the fruit in the protected houses are given in the table 5. The data for the 2009 in the Shtip region are not registered. The average mass of the fruit in Daras F1 (60g) and Donat F1 (90g) was bigger than the standard varieties Sivrija (30 g) and Zlaten medal (80g) in the region Sveti Nikole for 2005. The index of the fruit was 6,5 in Daras F_1 and 5 in Donat F_1. In Kochani the characteristics of the fruit were more or less the same. In the region Shtip there were differences in the mass of the fruit. The average mass of the fruit in Daras F1 and Donat F1 was 51 g and 42 g respectively.

In 2008 for the Valandovo locations the characteristics of the fruit are given in the technological and physiological stage of maturation. The two different varieties Ekstaza F_1 (long type) and Romatca F_1 (bell pepper) were compared to standard varieties Zlaten medal and Blondy F_1.The mass of the fruits was bigger in the technological stage than in the physiological stage of maturity. The index of the fruit, thickness of the fruit and the number of the locules differ slightly in the two stages of the maturation.

Table 4. Stages of growth in protected houses

Year	Variety	Date of sowing	Date of sprouting	Date of transplanting	Date of first harvest	Vegetation from sprouting to first harvest
2005	Region of Sv. Nikole					
	Sivrija	4.12.04	19.12.04	21.02.05	21.04.05	125
	Daras F_1	4.12.04	14.12.04	21.02.05	21.04.05	128
	Zlaten medal	4.12.04	21.12.04	21.02.05	21.04.05	123
	Donat F_1	4.12.04	17.12.04	21.02.05	21.04.05	125
	Region of Kochani					
	Sivrija	6.12.04	26.12.04	17.01.05	10.04.05	124
	Daras F_1	6.12.04	12.12.04	17.01.05	15.04.05	124
	Zlaten medal	6.12.04	14.12.04	17.01.05	10.04.05	124
	Donat F_1	6.12.04	12.12.04	17.01.05	15.04.05	124
	Region of Shtip - v. Karbinci					
	Sivrija	17.01.05	04.02.05	25.04.05	10.06.05	126
	Daras F_1	17.01.05	25.01.05	25.04.05	10.06.05	136
	Zlaten medal	17.01.05	01.02.05	25.04.05	10.06.05	129
	Donat F_1	17.01.05	27.01.05	25.04.05	10.06.05	134
2008	Region of Valandovo					
	Zlaten medal	03.01.08	08.01.08	09.04.08	-	156
	Ekstaza F_1	03.01.08	08.01.08	09.04.08	-	156
	Blondy F_1	03.01.08	08.01.08	09.04.08	-	156
	Romatca F_1	03.01.08	08.01.08	09.04.08	-	156
2009	Region of Kochani					
	Inferno F_1	21.12.08	30.12.08	-	05.05.09	128
	HV 410 F_1	21.12.08	29.12.08	-	03.05.09	126
	Kais	21.12.08	30.12.08	-	05.05.09	128
	Region of Shtip					
	Inferno F_1	20.12.08	27.12.08	-	14.05.09	138
	HV 410 F_1	20.12.08	27.12.08	-	13.05.09	137
	Kais	20.12.08	26.12.08	-	09.05.09	133

"-"data not registered

In 2009 in the location of Kochani the average mass of the fruit was as follows: 111 g in the standard variety Inferno F_1, 108 g in HV 410 F_1 and 98 g in Kais. There were very small differences in the index of the fruit which was about 4. The thickness of the pericarp was 1 mm in Inferno F_1, 0,8 mm in HV 410 F_1 and 1,1 mm in Kais. The number of the locules was 3 in all varieties. The flavor of the fruit in these varieties was hot.

Table 5. Average yield t/ha in protected houses

Year	Variety	Average yield	+ - from ø	CV	LSD	
					0,05	0,01
2005	Region of Sv. Nikole					
	Sivrija	43,2	ø	4,37	5,88	8,24
	Daras F_1	64,6	21,4	4,65		
	Zlaten medal	75,1	ø	7,06		
	Donat F_1	106,7	31,6	4,29		
	Region of Kochani					
	Sivrija	58,9	ø	2,15	4,64	7,02
	Daras F_1	74,4	15,5	2,76		
	Zlaten medal	61,2	ø	1,73		
	Donat F_1	77,9	16,7	5,77		
	Region of Shtip – v. Karbinci					
	Sivrija	32,9	ø	5,33	3,37	5,11
	Daras F_1	49,3	16,4	1,33		
	Zlaten medal	46,6	ø	1,75		
	Donat F_1	53,7	7,1	6,63		
2008	Region of Valandovo					
	Zlaten medal	38,53	ø	4,48	6,81	12,50
	Ekstaza F_1	44,50	5,98	7,65		
	Blondy F_1	40,68	ø	8,31	9,37	17,19
	Romatca F_1	48,80	8,13	6,56		
2009	Region of Kochani					
	Inferno F_1	82,0	ø	1,70	1,89	2,75
	HV 410 F_1	87,7	5,7	1,30		
	Kais	88,0	6,0	2,10		
	Region of Shtip					
	Inferno F_1	-	-	-		
	HV 410 F_1	-	-	-		
	Kais	-	-	-		

ø standard variety

"-"data not registered

Table 6. Characteristics of the fruit in protected houses

Year	Variety	Mass in g	Index of fruit	Thickness of pericarp mm	Number of locules	Colour of fruit	Flavour of fruit
2005	Region of Sv. Nikole						
	Sivrija	30	5,0	-	-	light yellow	mild
	Daras F_1	60	6,5	-	-	light yellow	mild
	Zlaten medal	80	2,9	-	-	green	mild
	Donat F_1	90	5,0	-	-	light yellow	mild
	Region of Kochani						
	Sivrija	42	5,3	2,3	2-3	yellow	mild
	Daras F_1	65	6,7	2,5	2-3	light green	mild
	Zlaten medal	75	5,3	3,3	2-3	light green	mild
	Donat F_1	87	5,1	3,5	3-4	yellow	mild
	Region of Shtip - v. Karbinci						
	Sivrija	53	6,7	3,3	2	yellow	mild
	Daras F_1	51	6,2	2,5	3	light green	mild
	Zlaten medal	58	3,6	3,5	3	light green	mild
	Donat F_1	42	5,1	2,5	3	yellow	mild
2008	Region of Valandovo						
	Technological stage of maturity						
	Zlaten medal	80	2,54	3	3	light green	mild
	Ekstaza F_1	95	4,35	2	4	light green	mild
	Blondy F_1	145	1,20	6	5	light yellow	mild
	Romatca F_1	204	1,55	7	4	light yellow	mild
	Physiological stage of maturity						
	Zlaten medal	50	4,10	2	3	intensely red	mild
	Ekstaza F_1	55	5,20	1	4	intensely red	mild
	Blondy F_1	100	1,30	4	7	intensely red	mild
	Romatca F_1	140	1,28	4	4	intensely red	mild
2009	Region of Kochani						
	Inferno F_1	111	4,8	1,0	3	green	hot
	HV 410 F_1	108	4,3	0,8	3	light green	hot
	Kais	98	4,3	1,1	3	light green	hot
	Region of Shtip						
	Inferno F_1	-	-	-	-	-	-
	HV 410 F_1	-	-	-	-	-	-
	Kais	-	-	-	-	-	-

"-"data not registered

Conclusions

All newly pepper varieties which were grown in the open field and protected houses showed stable agronomic traits. It can be concluded that all of these are suitable for production in open field and

protected areas. Novosadska, Atris F_1, Silba F_1, Kaptur F_1 and Kapro F_1 gave better results in comparison with standard varieties for open field production, while Daras F_1, Donat F_1, Romatca F_1 and Ekstaza F_1 for protected houses.

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АГРОНОМСКИ КАРАКТЕРИСТИКИ НА НЕКОИ ПОНОВИ СОРТИ И ХИБРИДИ ОД ПИПЕРКА ВО РЕПУБЛИКА МАКЕДОНИЈА

Богевска Звезда, Агич Рукие, Биљана Ристовска, Афродита Ибушоска, Маргарита Давитковска, Игор Иљовски

Апстракт

Пиперката е една од водечките градинарски култури во производството на отворено и во заштитени простори посебно пластеници. Во последните години постои тенденција на воведување на нови сорти и хибриди. Во овој труд беа истражени 40 сорти и хибриди во период од 2005 до 2010 со цел регистрирање во националната сортна листа и воведување во производство. За време на истражувањата беа следени фазите на пораст, просечните приноси како и битните карактеристики на плодовите. Сите испитувани сорти и хибриди покажаа стабилни својства. Од испитуваните сорти на отворено подобри резултати во поглед на продуктивните својства во споредба со стандардот дадоа сортите Novosadska, Atris F_1, Silba F_1, Kaptur F_1 и Kapro F_1, додека за во заштитени простори сортите Daras F_1, Donat F_1, Romatca F_1 и Ekstaza F_1.

Клучни зборови: пиперка, хибриди, карактеристики.

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HORTICULTURE CROP PRODUCTION IN NORTH-WESTERN HIMALAYAS UNDER CHANGING CLIMATE SCENARIO

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Abstract
During the recent past, weather patterns all over the world have changed and Himachal Pradesh of North-Western Himalaya is no exception. The trend analysis of temperature and precipitation data was done by taking data of 1973-1990 from wet temperate and 1971-90 duration from sub temperate region as baseline which was further divided into two periods i) 1991-2000; ii) 2001-2011 and variation was analysed season wise. In the sub temperate region maximum temperature has increased in all the seasons, however highest increase of 3.11^{o}C was noticed in winter season during 2001-2011 period from the base years of 1971-90. The average minimum temperature was found to decrease over the base period of 1971-90. The maximum decrease of 1.3^{o}C over the base period was noticed in autumn season during the period of 2001-2011. In the region the period 2001-2011 experienced decrease in the rainfall during summer, spring and winter seasons, however, the maximum decrease of 115.23 mm was noticed in summer season. In wet temperate to dry temperate regions both maximum and minimum temperatures have increased and winters have become warmer. Among all fruits, apple is the main crop of the state occupying the place of pride in its economy. However, the rise in temperatures and decreased snowfall over years has adversely affected apple cultivation in the state. Earlier snowfall was a regular phenomenon in apple growing areas but since 1973-1985 (baseline) a reduction in the snow fall from 430 cm to 51.33 cm during the period of 2006-2010 was recorded. The un-conducive weather during fruit setting and development in apple has reduced the apple productivity of the region. Surprisingly, the orchards below 1500 m elevation have been rendered unproductive. In the sub- tropical climate of foothills of Himalayas the mango is an important crop and is being influenced by frequent frost events. The cold waves during winter months also found to influence the vegetable crops of the region. To adapt to changing climate farmers have shifted to cultivation of pomegranate, kiwi and off-season vegetables. In sub-tropical zone, the regular frost injury to mango plants has become common. The farmers of this zone have shifted to protected cultivation of flowers and vegetables to save their livelihoods. Therefore, accepting change and getting in tune with nature by following scientific mitigation and adaptation strategies seem to be the key to survival and prosperity of mountain farmers.

Key words: Apple, mango, vegetable crop, snowfall and frost.

Introduction

Horticulture in Himachal Pradesh consists of diverse farming activities viz. growing of fruits, vegetables and floriculture, which are cultivated in a wide range of production regions because of the diverse micro-climates. All horticultural crops are sensitive to temperature and commercial crops of the state e.g. apple in temperate and mango in sub-tropical region have specific temperature requirements for their growth and development. Based on temperature requirements, the fruit trees grown in Himachal Pradesh can be categorized into sub-tropical, sub-temperature/warm temperate and temperate.

Rising global temperature has triggered large-scale changes in the energy exchange processes affecting the atmospheric circulation and precipitation patterns (Fallot *et al*., 1997, Zhai *et al*., 1999, Beniston, 2003). The studies in Nepal Himalaya (Shreshtha *et al*., 2000) and upper Indus basin in the North Western Himalaya (Archer and Fowler, 2004) have shown minor and statistically insignificant variations in the precipitations in the last century. Air temperature is generally recognized as a good indicator of the state of climate globally because of its ability to represent the energy exchange process over the earth's surface with reasonable accuracy (Thapliyal and Kulshreshta, 1991). In the North-Western Himalayan region, very limited number of studies explaining the climate change in different mountain states e.g. Himachal Pradesh have been done for the want of adequate instrumental data. Hence, the present study was conducted to study changing climate situations and its impact on horticulture.

Material and methods

For better understanding of potential impacts of the climate change in data sparse state, trend analysis of temperature and precipitation data available from following two stations in Himachal Pradesh a true representative of North-Western Himalayas was done. Variations in temperature and precipitation was analysed season wise i.e. summer (June, July, August), autumn (September, October, November), winter (December, January, February) & spring (March, April, May). The meteorological data w.e.f. 1973-1990 for wet temperate and 1971-90 for sub temperate region was taken as baselines (Table 1). For better analysis of the climate conditions the data was divided into two periods i) 1991-2000; ii) 2001-2011 (Table 2 & 3).The snow fall data recorded in wet temperate region was grouped on five year basis and was compared with baseline period of 1973-1985. Survey was conducted in different parts of the state to identify the crops vulnerable to changing climate situations and to know the adaptation strategies being followed by the mountain farmers. During the survey impact of the climate on the major fruit and vegetable crops of the region was also recorded.

Table 1. Location of weather data stations

S. No.	Region	Altitude (m)	Latitude/Longitude	Data Period
1	Wet temperate	2300	$31^0$06'N/$77^0$10'E	1973-2011
2	Sub temperate	1275	30.02^{o}N/77.05^{o}E	1971-2011

Results and discussion

Climate change scenario of sub temperate and wet temperate zone

In sub temperate region, during the period from 2001-2011 maximum temperature has increased in all the seasons, however highest increase of 3.11^{o}C was noticed in winter months from the base years of 1971-90 which was followed by 1.57^{0}C increase in spring season (Table 2). Whereas, the

average minimum temperature was found to decrease over the base period of 1971-90. The maximum decrease of 1.3^{o}C was noticed in autumn season during the period of 2001-2011 followed by 1.24 ^{o}C in winter season in the same period over the base years of 1971-90. In the region, the decade 2001-2011 experienced decrease in the rainfall during summer, spring and winter seasons, however, the maximum decrease of 115.23 mm was noticed in summer over the base period followed by 88.31mm in spring and 25 mm in winter season. However, an increase in rainfall to the tune of 53.37mm was noticed in the autumn season of the same decade over the base period. The sub temperate region as a whole is therefore, experiencing scanty rains during winter, summer and spring months resulting water scarcity which is affecting the crops.

In wet temperate region of high hills of North-Western Himalayas, the maximum temperature during the period 1991-2000 and 2001-2011 compared over the baseline 1973-1990 has shown increase in all the seasons (Table 3). Among both the decades studied the highest increase of 3.98^{0}C in maximum temperature was recorded during the period from 2001-2011 in winter season which was followed by spring season in the same decade. The perusal of data presented in the table 3 indicated that in this part of Himalayan region winters have become warmer. In the 2001-2011 decade a rise in minimum temperature in the range of 0.88 to 1.74^{0}C was noticed, however the highest increase (1.74^{0}C) over the base period in this parameter was recorded during spring season. The total rainfall was found to decrease during summer and spring months of both the decades. The highest decrease of 97.2 mm was recorded during summer season of 2001-2011 period. Wet temperate hills of this part of Himalayas have experienced drastic reduction in snowfall since the base line period of 1973-1985 (Figure 1). In the baseline period, the region used to receive average snow fall of 430 cm beginning from November i.e. early winter season. It has now squeezed to about 51.33 cm during the period of 2006-2010 and in the months of January and February only. Non-availability of early winter snowfall in March is inducing early flowering in temperate fruit crops due to early warming effect.

Table 2. Season wise decadal changes in mean maximum, minimum temperature (^{0}C) and total rainfall (mm) with respect to baseline 1971-1990 in sub-temperate region of North-Western Himalayas.

Season	Maximum Temperature			Increase/ Decrease (+/-)		Minimum Temperature			Increase/ Decrease (+/-)		Total Rainfall			Increase/ Decrease (+/-)	
	1971-1990	1991-2000	2001-2011	1991-2000	2001-2011	1971-1990	1991-2000	2001-2011	1991-2000	2001-2011	1971-1990	1991-2000	2001-2011	1991-2000	2001-2011
Winter	17.43	18.42	20.54	+0.99	+3.11	4.25	3.5	3.01	-0.75	-1.24	156.9	171.2	131.98	+14.22	-25.00
Spring	27.23	26.97	28.8	-0.26	+1.57	12.38	12.48	12.60	+0.10	+0.22	224.8	163.8	136.52	-60.95	-88.31
Summer	29.23	28.9	29.48	-0.33	+0.25	19.89	19.81	19.47	-0.08	-0.42	687.3	674.1	572.15	-13.00	-
Autumn	25.47	25.46	26.57	-0.01	+1.10	12.16	11.75	10.86	-0.41	-1.30	141.6	175.8	195.04	+34.15	+53.37

Table 3. Season wise decadal changes in mean maximum, minimum temperature (^{0}C) and total rainfall (mm) with respect to baseline 1973-1990 in high hill wet temperate region of North -Western Himalayas

Season	Maximum Temperature			Increase/ Decrease (+/-)		Minimum Temperature			Increase/ Decrease (+/-)		Total Rainfall			Increase/ Decrease (+/-)	
	1973-1990	1991-2000	2001-2011	1991-2000	2001-2011	1973-1990	1991-2000	2001-2011	1991-2000	2001-2011	1973-1990	1991-2000	2001-2011	1991-2000	2001-2011
Winter	10.14	11.97	14.12	+1.83	+3.98	1.79	1.75	3.25	-0.04	+1.46	80.19	87.11	81.34	+6.92	+1.15
Spring	18.91	20.67	21.71	+1.76	+2.80	8.79	8.65	10.53	-0.14	+1.74	235.3	228.39	194.69	-6.98	-40.68
Summer	22.46	23.64	23.67	+1.18	+1.21	14.13	14.13	15.01	-	+0.88	777.9	767.73	680.79	-10.26	-97.2
Autumn	19.0	20.51	20.41	+1.15	+1.41	9.05	8.91	10.30	-0.14	+1.25	180.5	185.95	200.09	+5.45	+19.59

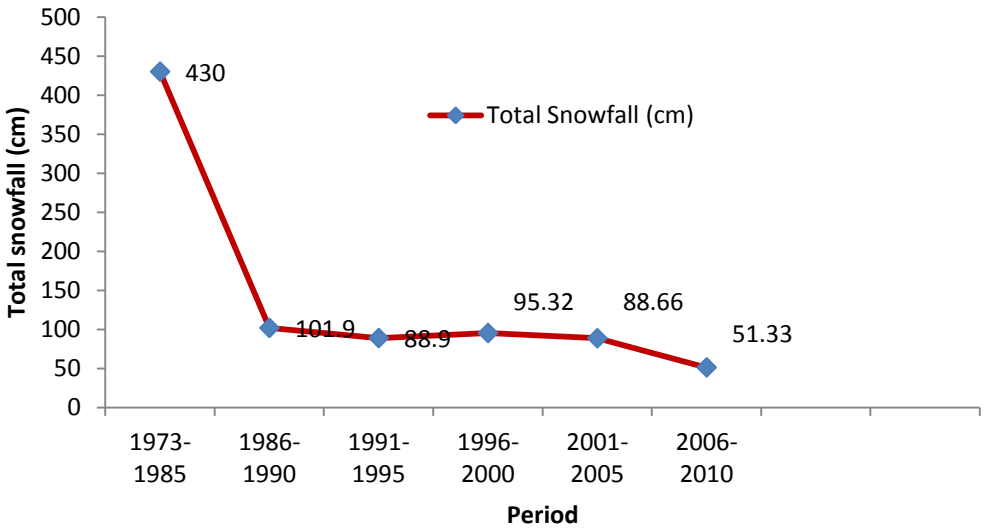


Figure 1. Snowfall pattern of wet temperate region of North-Western Himalaya

Fruit and vegetable crop production under changing climate conditions

The distribution of horticulture crops in the region is influenced mainly by climate than any other factor. Rising temperatures, reducing snowfall and rainfall events as well as changes in monsoon pattern is affecting horticulture and is a matter of serious concern for farmers of North-Western Himalayan region. Climate change is projected to affect the horticultural crops and these impacts can be at any stage of crop growth and development, thus influencing the quality and yield.

Apple is the predominant temperate fruit crop of North-West Himalayas. Winter temperatures and precipitation especially in the form of snow are very crucial for induction of dormancy, bud break and ensuring flowering in apples. Apple requires minimum of 1200 chilling hours during winters for yielding a good crop especially for standard cultivars like Royal Delicious. Short chilling hours during winters result staggered, delayed, sparse flowering and ultimately low productivity. Early winter chilling has more beneficial effect on productivity as compared to late chilling contribution. Cumulative effect of more than 1600 chilling hours, good snow and well distributed winter rains resulted in a good crop year of 1998 and 2011. In contrast during 1999 and 2009 only about 958 chilling hours were received which were supplemented by late snow and rains in January-February and almost dry and warm early winter resulted in a poor crop year.

Flowering period is the most sensitive stage of plant development in apple so far as climatic conditions are concerned. The flowering in the largely grown apple variety Royal Delicious occurs in the month of April during 4th to 26th April. During this period the ambient air temperature should remain between 18-22^{0}C. However, the temperature fluctuations and hails coinciding with full bloom result poor fruit set in apple. The bud break and petal fall is the most sensitive stage in apple when hail can reduce the prospective of good crop to almost off year. During 1996, 1998 and 2011 the temperature at the time of flowering remained in the optimum range and mild rains during post bloom period and no hails resulted good crop. In contrast the maximum temperature from 24-27^{0}C during flowering and dry as well as desiccating bloom period resulted in poor apple crop during 1999 and 2009. In the year 1997 and 2012 the hails coinciding full bloom resulted in poor fruit set.

In addition to this spring frost coinciding the flowering flushes especially the full bloom affects the fruit set adversely (Table 4).

Due to more rise in temperature during winters in wet temperate regions, apple cultivation has been impacted adversely, especially in mid altitudinal range of 1500 m – 2000 m amsl. The rise in temperature and reduced snowfall (Table 3 and Figure 1) has made this part of region vulnerable to climate change as result apple farming has been abandoned in the area falling upto 1500 m amsl. Awasthi *et al*. (1986) have also indicated that irregular bearing behavior of apple variety Starking Delicious is largely influenced by climatic conditions. The rise in temperature however, has created more moderate conditions for apple cultivation in Lahaul-Spiti and Kinnaur districts. This can be viewed as positive impacts of climate change in dry temperate climate above an elevation of 2472 m amsl.

The air temperature, cold wave and frosts are decisive factors in plant growth and development of subtropical fruit like mango. This crop is very sensitive to frost. Mango grows well in temperatures ranging from 23.8-29.4^{0}C. The temperature during inflorescence is crucial. Cool temperatures and frosting during inflorescence development reduce the number of perfect flowers drastically. However, it can tolerate temperatures as high as 48^{0}C during the period of fruit development and maturity. In mango, low temperature (2 to 11.5 ^{o}C), high humidity (> 80%) and cloudy weather in January & February months found to delay panicle emergence. The unseasonal erratic rains and increased frost events is affecting mango production in the subtropical regions of North-Western Himalayan region. In low hills – sub-tropical zones the regular frost events may be due to the increased gap between maximum and minimum temperature has affected the mango orchards. During the year 2006-2007 mortality of mango plants due to frost ranged between 40-83 %. The impact of the frost was noticed more on younger plantations as compared to the older ones.

The succulent vegetable crops are highly sensitive to climate conditions like heat, drought and cold waves. The rise in temperature affects crop duration, flowering, fruiting, ripening and quality with reduced productivity and economic yield. In tomato which is one of the major commercial crop this region, the high temperatures after pollen release decreased fruit setting, yields and seed set even when pollen was produced under optimal conditions. High temperature above 28^{0}C noticed to induce maximum flower and fruit drop in tomato. However, in high altitudes vegetable yields are expected to increase due to small increase in temperature as a result of increased length of growing period. Not only the high temperatures but low temperatures have also influenced vegetable production in the region. The cold wave during December 2002 and January 2003 noticed to cause considerable damage to brinjal, tomato and potato crops of the region.

Adaptation strategies

With apple production being greatly affected, mountain farmers are steadily moving towards other crop options. Farmers have shifted to cultivation of pomegranate, kiwi and vegetables like tomato, peas, cauliflower, cabbage and broccoli etc. In subtropical low hill region production of mango is being greatly affected by frequent occurrence of frost. Farmers in order to save their livelihoods have opted for protected cultivation of vegetables and flowers in a big way.

Table 4. Apple crop performance with respect to changing weather conditions in wet- temperate region of North-Western Himalaya

Good Crop Year	Weather Conditions
1996 and 1998	Well distributed winter rains Maximum temperature at flowering remained 18-22 ^{0}C Spring rains were in post bloom period Mild rains just before bloom period
2010-2011	Well distributed winter rains
Poor Crop Year	
1997	Hails coinciding full bloom resulted poor fruit set
1999	Dry and warm early winters Late snowfall/rainfall, less chilling hours Maximum temperature at flowering was in the range of 24-27 ^{0}C Bloom period remained dry and desiccating
1999	Dry and warm early winters Late snowfall/rainfall, less chilling hours Maximum temperature at flowering was in the range of 24-27 ^{0}C Bloom period remained dry and desiccating
2009-2010	Late and less snowfall and drought conditions resulted poor crop
2011-2012	Hails coinciding full bloom and fruit development stage resulted poor fruit set and poor quality of the left over crop

Conclusions

The rising temperature and reduced precipitation is bound to impact horticultural crops of the region. The impacts can be at any stage of crop growth and development, thus influencing the quality and yield. There is an urgent need to focus attention on studying the impacts of climate change on growth, development, yield and quality of horticultural crops. The focus should also be on development of adaptation technologies and quantify the mitigation potential of horticultural crops. Changing climate in North-Western Himalayan region brought forth new problems and questions, the solutions to which will be generated by combining farmers' ingenuity and new technologies. However, accepting change and getting in tune with nature seems to be the key to survival and prosperity of the mountain farmers.

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ХОРТИКУЛТУРАТА ВО СЕВЕРОЗАПАДНИ ХИМАЛАИ ВО ИЗМЕНЕТИ КЛИМАТСКИ УСЛОВИ

Бардвај Сатиш Кумар, Шарма Сом Дев

Апстракт

Во текот на изминатиот период, временските услови во целиот свет се менуваа и Химачал Прадеш од Северо-Западни Хималаи не е исклучок. За анализа на трендот на температурите и врнежите беа користени податоци за периодот 1973-1990 во влажно-умереният регион и за периодот 1971-1990 во суб-умереният регион како базни, дополнително се разгледувани два периода i) 1991-2000; ii) 2001-2011 а варијацијата е анализирана по сезони. Во суб-умереният регион максималната температура е зголемена во сите сезони, но сепак најголем пораст во однос на базниот период 1971-1990 од 3.11^{o}C е забележан во зимската сезона во периодот од 2001-2011. Просечната минимална температура се намалила во базниот период 1971-1990. Максимално намалување од 1.3^{o}C во однос на базниот период е забележан во есенската сезона во периодот од 2001-2011. Во овој регион во периодот 2001-2011 било утврдено намалување на врнежите во летната, пролетната и зимската сезона, иако, максимални намалувања од 115,23 mm биле забележани во летната сезона. Во влажно умерените и сушно умерените региони и максималните и минималните температури се зголемиле и зимите станале потопли. Јаболкото е главна култура на државата и претставува гордост на економијата. Сепак, порастот на температурите и намалувањето на снежните врнежи во текот на годините има негативно влијание врз производството на јаболко во државата. Порано снежните врнежи биле редовна појава во областите каде што се одгледувало јаболкото, но во периодот 1973-1985 (базен) било забележано намалување на снежната покривка од 430см на 51,33 см во периодот 2006-2010. Непогодните временски услови за време на развојот на јаболкото и формирањето на плодовите допринеле за намалување на продуктивноста на јаболката во регионот. Изненадувачки, овоштарниците под 1500 метри надморска височина биле непродуктивни. Во субтропската клима, на подножјето на Хималаите, мангото е важна култура но на него влијаат појавите на чести мразеви. Се оценува дека појавата на студени бранови во текот на зимските месеци исто така влијаат на градинарските култури во регионот. За да се прилагодат на променливите климатски услови земјоделците се преориентираа кон одгледување на калинка, киви и зеленчук вон сезона. Во субтропската зона, оштетувањата од мраз кај мангото станаа вообичаени. За да опстанат, земјоделците во оваа зона се префрлија кон одгледување на цвеќе и зеленчук во заштитени простори. Затоа, клучот за опстанок и просперитет на земјоделците во планинските подрачја е прифаќањето на промените и усогласувањето со природата преку следење на олеснувањата кои ги нуди науката и прилагодливите стратегии.

Клучни зборови: јаболко, манго, градинарски култури, снежни врнежи, мраз.

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Review Article

RECENT TRENDS IN VEGETABLE AND FLOWER CROP PRODUCTION IN REPUBLIC OF MACEDONIA

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Abstract
Vegetable and floriculture sectors in the country are considered as of great importance due to their growth and export potential, as well as potential for increase of their global competitiveness. Macedonia has around 50000-60000 ha under vegetables in the country. Most of the vegetable production is sold as fresh on the export and domestic market. The fresh vegetables industry plays an important role in the national agriculture and country economy as large portion of the export income in agribusiness comes from the vegetables sales. The fresh vegetable contributes with approximately 10% to the national GDP on annual basis. The production of fresh vegetables is either done on open field or production in glasshouses and/or plastic houses. The main fresh vegetables produced in glasshouses and exported are tomato, cucumber and pepper. The production of fresh vegetables is pretty regional and almost 80% is an output of the Southeastern Macedonian region. However in a total vegetable production (both for fresh consumption and for processing) beside the Southeastern region, other big producer, especially of processing pepper is the Pelagonija region. All the regions in the country produce vegetables, but quite smaller quantities of pepper or tomato. Production of flowers and ornamental plants at present in R. Macedonia is modest. The most important is the production of annual and biannual flowers, organized in southern part of the country and in Skopje. In this group several varieties of pot flowers can be added as the production is realized in plastic tunnels. It is estimated that around 6 to 8 million pieces of flower bed varieties were produced in the previous period. The production of cut flowers is small and organized on family farms mostly located in Gevgelija region. Ornamental and outdoor plants are produced in few nurseries offering large scale and high quality varieties.
Key words: vegetables, flowers, production, trends.

Vegetable production

Conditions for vegetable and flower crop production - the comparative advantages of the territory of the Republic of Macedonia significantly cause vegetable production to be one of the most important areas in agriculture. Centuries of tradition, climatic and soil advantages, and specific high quality and reputation gained in the wider region are the basis for successful production and marketing of vegetable products.

Table 1. Agroclimate regions

	Agroclimate regions	Types of soils	Climate conditions (temperature conditions)
I	**Submediterranan (40- 500 m altitude) subregions**: Gevgelia, Dojran, Valandovo, Demir Kapija, Strumica	- Alluvial - Delluvial - Meadow	Annual temperature Σ t^0 5200 ^{0}C Mean annual temperature $t^0$14.2^{0}C Days with $t^0 > 10^0$C 232-235 Days with $t^0 > 15^0$C 171-175
II	**Continental-submediterranean (100-600m altitude) subregions:** Tikvesh,Veles,Shtip, Kochani, Radovish, Parth of Strumica, Skopje, Kumanovo	- Alluvial - Delluvial - Rendsina - Meadow - Vertisols	Annual temperature Σ t^0 4650^{0}C Mean annual temperature $t^0$12.7^{0}C Days with $t^0 > 10^0$C 214-220 Days with $t^0 > 15^0$C 163-170
III	**Warm-continental 600-900m altitude subregions:** Polog, Kichevo, Struga, Ohrid, Pelagonija, Debar, Belchishte	- Alluvial - Delluvial - Rendsina - Vertisols - Reclaimed peat	Annual temperature Σ t^0 3975^{0}C Mean annual temperature $t^0$10.9^{0}C Days with $t^0 > 10^0$C 196-218 Days with $t^0 > 15^0$C 154-163
IV	**Cold-continental 900-1100m altitude subregions:** Kriva Palanka, Resen, Berovo, Delchevo	- Rankers - Brown- wood	Annual temperature Σ t^0 3790^{0}C Mean annual temperature t^0 9.0 Days with $t^0 > 10^0$C 166-190 Days with $t^0 > 15^0$C 136

Due to the relief, on the relatively small territory of the country, three modified types of climates are present (Mediterranean, Continental, Mountainous).There are favourable conditions for production of many vegetables. The analysis of the situation and potentials in the vegetable sector in the country from many aspects, such as the structure of area, products and production, as well as comparison with data and experience in this sector, provides an opportunity to set priorities and directions for development.

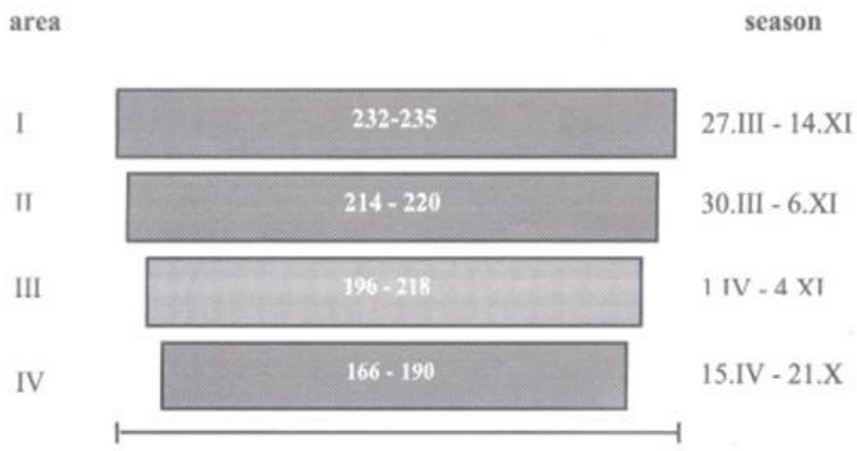


Figure 1. Duration of the season with T >10°C

Participation of vegetables in total value of agricultural production is 28.2% on average. Deviation from average + - 2.1 / 2.4

Table 2. Production of vegetables in time period 2005-2010

Production of vegetables	2005	2006	2007	2008	2009	2010
Crop products	78.4	77.0	73.8	68.8	72.2	74.1
Cereals (including seeds)	12.0	9.0	8.3	10.0	9.1	7.1
Industrial crops	9.2	7.3	6.5	4.3	7.3	8.1
Fodder crops	10.3	8.8	6.6	6.6	6.5	6.1
Vegetables	29.0	30.3	28.5	25.8	30.9	36.4
Potatoes (including seeds)	2.9	4.3	2.8	2.1	3.0	3.0
Fruit	11.1	11.9	13.1	12.9	11.0	10.3
Wine	3.9	5.5	8.0	3.9	4.4	3.1
Livestock products	21.4	22.8	25.8	30.9	27.5	25.4
Cattle	3.2	3.3	3.1	3.6	4.2	4.8
Pigs	3.4	3.2	4.9	4.3	4.41	4.4
Sheep and goats	1.0	2.8	2.0	1.9	2.1	1.9
Poultry	1.2	0.8	0.2	1.5	1.0	0.7
Milk	9.5	10.0	12.7	17.6	13.7	11.4
Eggs	2.7	2.5	2.7	1.7	1.7	1.8
Other agricultural products	0.4	0.3	0.2	0.2	0.5	0.3
Agricultural products	99.8	99.7	99.6	99.6	99.7	99.5
Agricultural services	0.2	0.3	0.4	0.4	0.3	0.5

In terms of area, of total 420,000 ha under arable land and gardens, vegetables are grown on more than 50,000 ha (12%), and after cereals (43%) is the largest area of a particular plant group. However, in the value of crop production, vegetable crops have the largest share (37.6%), while wheat covers 14.5%.

According to data from the Agricultural Census in 2007, the size of the plots at which vegetables are grown takes the following shares:

Size of the plots

Up to 0.50 ha	16,6 %
0.51 - 1.00	14.2 %
1.91 - 3.00	38.6 %
3.01 - 5.00	15.5 %
5.01 - 8.00	8.5 %
8.01 - 10.00	2.3 %
over 10.01	4.4 %

In the division parcels under 0.5 ha according to the size occupy 17% of the total area under vegetables, but they accounted for over 40% of the total. Out of over 22,674 entities that are dealing with vegetable production, only 643 are companies and over 97% are family farms. About 90% of the area under vegetables in the period 2005-09, belonging to following crops: potatoes, beans, cabbage, tomato, onions, watermelon, peppers, garlic, peas and cucumbers.

Vegetable crops in the period 2005-09 were grown on the following average area, production and yield by percentage share in the total production. Compared to countries that apply to major vegetable producers in the EU, on the territory of our country, despite the favorable conditions, the assortment is modest and fewer species are traditionally grown (mostly fruit, bulb and leafy vegetables).

Assortment - Despite relatively modest assortment of included species in vegetable production (49 and 21 type and subtype), the total number of recognized species is 886. On average for each type gardeners have availability of more than 18 varieties. Most of them are: tomato (150), potato (99), pepper (78), cabbage (72), onion (42), watermelon (41) salad (35), cauliflower (29) melon (27), cucumber (25), carrot (25), zucchini (19), endive (16), tomato (16), gherkin (15), peas (15), garlic (13), green beans (12), kale (12), radish (10), spinach (9), kohlrabi (9), leek (9), celery (9), broccoli (8), beans (8), decorative pumpkin (8), bottle gourd (8), brussels sprouts 5, parsley (5) and 15 other species and 5 eco-types. Out of this number, only 17 (1.9%) are domestic newly created varieties, mostly tomato (6), pepper, onion, cucumber and green beans (2), leek, spinach and peas (1).

Vegetable production in greenhouses - The total area of protected houses is changing in a very narrow boundary, averaging on about 4442 ha out of which under plastic houses is around 4,250 ha or 95.7%, while the glass houses are organized on 192 ha or 4.3% of the total area. Total production of the two types of protected houses is 302,830 t out of which 282,000 t or 93.1% from plastic houses, while the production in glass houses reaches 20,830 tons or 6.9%.

Table 3. Areas and total production in tonnes [t]

Vegetable crops		ẋ	%
Potato	Area (ha)	13.000	24
	Production, tones	191.000	25
	Yield (t/ha)	14.1	
Bean (including intercrop)	Area (ha)	13.500	24
	Production, tones	12.700	2
	Yield (t/ha)	9,4	
Cabbage	Area (ha)	3.950	7
	Production, tones	90.000	12
	Yield (t/ha)	22,8	
Tomatoes	Area (ha)	5.500	10
	Production, tones	125.800	17
	Yield (t/ha)	22,9	
Onion	Area (ha)	3.200	6
	Production, tones	37.500	5
	Yield (t/ha)	11,7	
Melons and watermelons	Area (ha)	6.300	11
	Production, tones	129.200	17
	Yield (t/ha)	20,5	
Pepper	Area (ha)	8.300	15
	Production, tones	141.200	19
	Yield (t/ha)	17	
Garlic	Area (ha)	1.000	2
	Production, tones	4.400	1
	Yield (t/ha)	4,4	0,6
Pea	Area (ha)	1.000	2
	Production, tones	2.100	0,3
	Yield (t/ha)	2,1	
Lentils	Area (ha)	100	0,2
	Production, tones	80	0,1
	Yield (t/ha)	0,8	
Cucumber	Area (ha)	1.400	2,5
	Production, tones	39.300	5
	Yield (t/ha)	26	

Effectiveness of the yields among the three leading crops grown in protected areas is in favor of glasshouses:

Table 4. Average annual production in greenhouses

Crops	Glasshouses [t/ha]	Plastic houses and tunnels [t/ha]
Tomato	99.2	60.0
Cucumber	150.0	100.0
Cabbage	35.8	33.0

Beside the cabbage where the difference is relatively small, only 2.8 t / ha or 8.5% in favor of glass houses for tomatoes the difference is highest; 39.2 t / ha, or 65.3%, and slightly lower in cucumber;50 t / ha or 50% more.

Vegetable consumption per capita - The consumption per capita in 2009 (data from SSO) amounted to 142.6 kg of fresh vegetables and 4.5 kg of processed vegetables. A total of 147.1 kg per capita vegetable used, 96.8% is consumed during the year fresh or processed in households and only 3.2% as a product of the processing industries.

Table 5. Vegetables consumption per capita

Vegetable product	Consumption per capita [kg]	Percentage of the total vegetable consumption
Potato	30.2	21.2
Pepper	28.5	20.0
Tomato	21.4	15.0
Cabbage	14.9	10.5
Melon	13.1	9.2
Onion	7.9	5.5
Beans	7.0	4.9
Legumes	1.4	1.0
Other	9.7	6.8

Processed vegetables - Vegetable needs as raw material for processing, according to the Macedonian Association of Processors (MAP) in the last period (2007-2009) averaged about 98,000 t. Most processing industries required; red pepper-type kapija around 47,000 tons or 48.0%, industrial tomato about 22,000 t or 22.5%, gherkins 5,000 tons or 5.1%, eggplant 4,600 t or 4.7%, beetroot 3,600 tons or 3.7%, cabbage 3,300 or 3.4%, peperoni 2,200 tons, or 2.3%, pepper-type bela kapija 2.300 t or 2.4%, pepper-type gamba 1,200 tons or 1.2% and onion 1.000 t or 1.0%.

The total amount is accounted on 92,200 t or 94.1% by these nine crops required for processing. Other vegetables that are required by processing industry in quantities are less than 1,000 tons per year (carrot, leek, green tomato, cauliflower, melon, green beans, broccoli, yellow pepper, onion, parsley, peas, etc). In the total amount they accounted 5,800 t or 5.9%.

Flower production

There is not a unified statistical data base neither for the domestic production neither for the trade with flowers, ornamental plants, seeds and seedling or bulbs and tubers. However, the growth in this sector is obvious: there are vast areas of public spaces decorated with flowerbeds almost in all Macedonian cities, the offer of bedding plants, cut flowers and flower pot plants is increasing and the number of companies dealing with landscaping and nursery sales is increasing .

The modest production of floriculture and ornamental plants at present in R. Macedonia is based on a long tradition. Until mid 80-ies of the last century, Macedonia was the main cut flower production

area, supplying the 22 million market of ex-Yugoslavia. In the last 15 years there is a trend of increasing number of private producers of flowers and ornamental plants.

According the statistics, in 2007 this production was developed on 691ha, but on small family farms, on the size of 1-3ha , even less than 0,5ha. In the last 15 years the most important are the production of : seasonal bedding plants, flower pot plants , cut flowers and ornamental plants.

Seasonal bedding plants - The production of seasonal bedding plants is of highest importance. This production becomes the most significant in the floriculture sector in R Macedonia.

Several producers became recognizable by quality products, investing and modernizing the infrastructure and equipment (Kitka in Skopje and Gradina Cvet in Vladevci). Recently they are the main suppliers of domestic market. The number of small producers of a vide range of products is also growing. No formal trade/distribution channel is organized by any of the respective producers. There is no evidence of the quantity of this production. It is estimated that in 2012 over 10 millions of seasonal bedding plants are produced. Cut flowers - Production of cut flowers (gerberas, chrysanthemums, callas, lilies, roses, alstromerias, irises) is small and seasonal, with modest quality and directed to the domestic market. This production is organized in plastic tunnels on family farms mostly located in Gevgelija, Skopje, Strumica and Bitola. The good example is the company Lilium from Bitola that has an average production of 100,000 stems of lilies, some calla and gladiola in plastic tunnels, export oriented.

Flower production and sales of cut flowers is not registered. However, some traders estimated that in summer period, this production cover close to 40% of domestic market. Seeds and seedlings for the above mentioned production are imported.Around fifty producers – professional farmers, work individually or through the registered companies. They all apply plastic tunnel production with drip irrigation, heating stations and small storage facilities. These producers trade their products either individually to the local flower shops or sell their products to the local distributors

Ornamental plants - Domestic production of ornamental and outdoor plants is organized by a number of private nurseries as well as several municipal public companies responsible for maintenance of the urban green areas such as Skopje, Bitola, Kavadarci, Strumica, Ohrid and Kumanovo. Three nurseries are big and important – the one in Tetovo region with 100ha and production of 300.000 tree, exported on the regional markets, then the nurseries in Bogdanci and Demir Kapija with diversified offer of outdoor plants of high quality for urban greenery and parks.

It is estimated that there are approximately 10-15 nurseries that traditionally produce limited range of outdoor plants with considerable variations in quality for local markets. The number of nurseries that import decorative trees and shrubs is increasing.

The nursery Hristovski in Bitola region, with production of approximately 150,000 rose trees per year, of which 1/3 is exported, has to be mentioned. Import and export of flowers and ornamental plants - There is only one Association of flower producers in the Country, in Gevgelija, established in 2005 with 28 individual members. The activities of the association are still very modest. Traders act mostly as importers specialized in particular segments. Most of the companies from this group are of small size and lack good storing / manipulation premises. However, there is one importer of pot plants with good storing facility, as well as one cut flowers importer/distributor that invested in cut flowers cold storage.

The import / export balance of the floriculture products in R. Macedonia fluctuates during the last years. For example in 2005 the value of the import was double of the size compared to the export, and in 2007, the values of the export and import were nearly identical. Export looks reasonably stable with the value of about 400,000 €. The import has a negative trend. In 2005 reached the value

of 755,000 € and in 2007 the value of the import vas only 416,000 €. It should be stressed that this reduction results from less imported outdoor trees. The value of imported cut flowers, especially roses, is increasing over the period 2005 – 2007. The roses are by far the most important cut flowers traded on domestic market.

Conclusions

Based on the presented data and brief analysis of vegetables and flowers production in the Republic of Macedonia, in order to increase the volume, quality, and competitiveness in this sector, the following suggestions and recommendations can be given:

- Farmers should be introduced to the biological properties of the varieties, their requirements, potential and required production technology. Over 900 varieties of vegetables are offered on the market, the most appropriate should be defined.
- To create positive interaction between the determining factors for yield, quality and earliness, a classification of vegetables and flowers, according to their biological needs is required. In some regions, larger quantities of a given vegetable, as it is the case with onion populations (buchinski gostivar), could be provide.
- Regulations for the implementation of appropriate healthy and certified seeds. Should be enforced. The last research showed the reduction of the yields and quality of certain vegetables, due to the low economic value of the seeds, or deformity of the seeds produced by the farmers themselves.
- Introduce the autochthony varieties that can be obtained, providing sufficient quantities of certain types that can create brand of vegetables of the Republic of Macedonia, and research the potentials for new varieties of flowers.
- It is recommended to improve the technologies for seedling production as the production of vegetables and flowers is growing.
- It is recommended to use the potentials in the South- Eastern and Central Vardar Region for early vegetable production in plastic houses, sector that should be governmentally supported.
- Introduce the IT in the process of planning, production, postharvest practices and distribution of vegetables, flowers and ornamental plants especially within the farmers.

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ПОСЛЕДНИ ТРЕНДОВИ ВО ПРОИЗВОДСТВОТО НА ЗЕЛЕНЧУК И ЦВЕЌЕ ВО РЕПУБЛИКА МАКЕДОНИЈА

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Апстракт

Секторот за градинарство и цвеќарство во нашата земја се од голема важност што се должи на нивниот пораст и извозен потенцијал, како и потенцијал за зголемување на нивната глобална конкурентност. Македонија има околу 50.000-60.000 хектари под зеленчук во земјава. Поголемиот дел од производството на зеленчук се продава за свежо на станските и домашните пазари. Индустријата за свеж зеленчук игра важна улога во националното земјоделството и македонската економија како резултат на приходот добиен од извозот во агробизнисот што доаѓа со продажбата на зеленчукот. Свежиот зеленчук придонесува со околу 10% од националниот БДП на годишна основа. Производството на свеж зеленчук е или на отворено или во стаклености и / или пластеници. Главни зеленчуци кои се произведуваат за свежо во стаклености и се извезуваат се доматот, краставицата и пиперката. Производството на свеж зеленчук е на регионално ниво и речиси 80% е од Југоисточна Македонија. Сепак во вкупното производство на зеленчук (и за свежа потрошувачка и за преработка) покрај Југоисточниот регион, други големи производители, особено за преработка на пиперката е Пелагонискиот регион. Сите останати региони во земјата произведуваат зеленчук, но количините од пиперка и домат се значително помали.

Производство на цвеќе и декоративни растенија во Република Македонија во моментов е скромно. Најважна е производството на едногодишните и двогодишните цвеќиња, организирани во јужниот дел на земјата и во Скопје. Во оваа група може да се додаде и саксиското цвеќе, бидејќи производството се реализира во пластеници. Се проценува дека во претходниот период беа произведени околу 6-8.000.000 различни видови на цветен расад. Производството на режен цвет е мало и организирано на семејни фарми главно лоцирани во регионот на Гевгелија. Декоративните растенија се произведуваат во неколку расадници кои нудат голем обем и висок квалитет на сорти.

Клучни зборови: зеленчук, цвеќе, производство, трендови.

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Review paper

CURRENT STATUS AND FUTURE PERSPECTIVES OF VEGETABLE GENETIC RESOURCES IN R. MACEDONIA

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Abstract
Genetic stock of vegetables, especially indigenous populations and old varieties, created throughout the centuries as a result of a long tradition of growing, represent valuable material and represents a significant genetic potential. A part of these local populations and species are endangered and threatens danger of extinction caused by intense technological development in the vegetable production, introduction of foreign hybrids and degradation of domestic vegetable seed production. All this provides good basis for their inventory, collection, long-term preservation and opportunity for their multifunctional use in order to prevent further genetic erosion. In R. Macedonia, recent activities regarding the preservation of vegetable genetic resources are made within SEEDNET program during the period 2005-2010. Vegetable Working Group organized several collection missions, as a result 507 accessions from 29 vegetables crops were inventoried and collected. The percentage of the total number of collected accessions is as follow: 30% belong to pepper collections, 10.6%- tomato, 9.3%- melons, 9.4%-onions, pumpkins -7.8%, with the remaining 24 vegetable crops percentage is small and ranges from 0.1% to 5.9%. Collected seed accessions have been documented in the main data base with adequate passport data following EURISCO descriptors, and then evaluated and partially uploaded in EURISCO data base. Accessions are stored in the gene bank, equipped for long-term storage-18°C and short-term storage +4 ^{o}C, located in the Institute of Agriculture in Skopje.
Key words: vegetable crops, genetic resources, conservation.

Introduction

Vegetable crops include a large number of species, mainly used as an essential complement to the daily diet, providing vitamins, minerals, fibre, specific amino acids and other active metabolites. Increasing the use of vegetables is considered to offer healthy benefits in all dietary situations. Some vegetables such as tomatoes, cabbages, watermelons and onions are among the most important crops according to total world production (FAO, 2001). Several authors have reviewed vegetable genetic resources in the last twenty years (Sloten, 1980; Crisp and Astley, 1988; Cross, 1998), largely emphasizing the need to accumulate and conserve in genebanks the genetic diversity that is most useful to breeders. One of the primary reasons to sustain conservation of plant genetic resources in genebanks is to prevent the loss of genetic diversity. Thus genebank material is becoming more attractive to breeders. At the same time, the management of collections can be based on better knowledge of the diversity in stock. The enhancement of the links between germplasm conservation and use will continue to depend, inter alia, on easy access to the genetic material (Magioni, 2004).

The Republic of Macedonia is small in territory (25713km^2), but the topography and the climatic conditions are very diverse. The specific climatic environment has caused creation of different vegetable landraces with certain degree of diversity (Martinovski Gj, Jankulovski D., 1994). They are cultivated in a traditional way in the garden, in a very small space in rural areas, without the use of pesticides. All this is a good basis for a more serious approach to research spicy vegetables in terms of inventory, collection, long-term conservation, and the possibility of their multipurpose use.
A part of these local populations and species are endangered and threatens danger of extinction caused by intense technological development in the vegetable production, introduction of foreign hybrids and degradation of domestic vegetable seed production (Agic et al, 2009.)
In the past, from 1969 to1973, several collecting missions were conducted in the Republic of Macedonia, as bilateral and international agreements, mostly with the USA. In lack of adequate storage facilities the collected germplasm from Macedonia was stored in gene banks at the National Seed Storage laboratory, Ford Collins, Colorado, USA.
The initiation of the SEED Net project in 2005 has facilitated and supported further national activities, along with forced cooperation among the countries in the region. In 2004 the SEEDnet program (South East European Development Network on Plant Genetic Resources) (http://www-seednet.cbm.slu.se), financed by Sida, was established with the purpose of supporting the countries in their efforts to establish and strengthen national and regional activities on PGR with special focus on conservation, utilization, collaboration and networking among the stakeholders at both national and regional levels. SEEDNet network was established, among the following partners: Albania, Macedonia, Kosovo, Serbia, Montenegro, Federation of Bosnia and Hercegovina, Republika Srpska, Croatia and Slovenia, Bulgaria, Greece, Romania, Hungary and Moldavia. The partners included in the network have to make active cooperation in the field of plant agro biodiversity conservation and use. The Institute of Agriculture, Skopje, was responsible for maintenance of all collections in genebank. Total storage capacity of the long-term storage chamber is 10 000 seed accessions, consisting of 30 vertical freezers (-18°C to -20°C). These capacity is fully sufficient for the activities planned in the next 5 years. Genebank was also equipped for preparation of seeds before storing. Infrastructure and capacities for seed collecting and storing were restructured, upgraded and improved, base, active and duplicate collections. Base and active collections are maintained at -18°C. Temporary and working accessions are stored at +4°C. Six working groups were established at the beginning of the project (cereals WG, vegetables WG, forage WG, industrial crops WG, fruit and Vitis WG and MAPsWG). They are organized and active both on national and on regional level. Academic staff from the Institute of Agriculture and Faculty of Agricultural science and food has participated in vegetable working group coordinated by curator. Within the first three years of the project lot of activities were performed for raising scientific, governmental and public awareness. Within this project, human capacities for conservation of PGR were upgraded through various trainings and workshops, organized by NGB, CBM, or by various education and research institutions in the countries participating in SEEDNet (Kratovalieva et al, 2009).

Material and methods

In order to achieve the strategic goals of SEEDNet vegetable working group, which are long-term conservation and sustainable utilization diversity of vegetable resources of East Europe through a well coordinated functional vegetable network, the activity from 2005-2010 are conducted at national and regional level.
Within the regional activities vegetable working group participated in three projects with titles:

1. Collection, Characterization and regeneration of indigenous onion (*Allium cepa* L.) and leek (*Allium porrum* L). germplasm for further ex-situ conservation, 2006- 2010“, as regional coordinator
2. South East European Solanaceae Germplasm Collection, Conservation and Sustainable Use, as a nacional coordinator
3. Pilot project of collecting the seed of local vegetable population by school children in some counties in Croatia and Macedonia, as a national coordinator

The achievement of these objectives and goal was foreseen through the following activities: inventorying of existing national vegetable genetic resources; compilation of regional list of Solanaceae genetic resources; national vegetable collecting missions; collected vegetable accessions multiplication and regeneration; national conservation's capacity evaluation; vegetable genetic resources characterization; regional vegetable database compilation. Implementation of certain activities is in accordance with international standards for gene bank prescribed by IPGRI (Guide to effective management of germplasm collections, IPGRI (Popsimonova et al. 2009). All passport data are being checked by the gene bank manager before uploading to EURISCO database. List of PGR in collections is prepared to be published in illustrated catalogue form (Kratovalieva et al, 2009).

Results and discussion

Vegetable Working Group organized several collection missions from 2005-2010, as a result 507 accessions from 29 vegetables crops were inventoried, collected, described and documented.

Inventorization and collection

During the collection expeditions we determined the target areas for inventory and collection of vegetable crops and fill out the collection forms and inventorying lists by EURISCO descriptors (passport data of all collections, recorded and computerized). Also, we were provided with all available information about traditional growing systems, local method of plant protection, utilization for consumption or as medical plants.

The large part of these vegetable accessions is represented by the mandate species where priority was given on old varieties and landraces, while minor vegetables are numerically much less represented. In mandatory list are included the species from the following families: Alliaceae, Brassicaceae, Solanaceae, Fabaceae, Cucurbitaceae, Asteraceae, Apiaceae, Chenopodiaceae. During the implementation of the Solanaceae projects several expeditions were conducted. A survey of Solanaceae genetic resources in R. of Macedonia was made by the participants of the VWG, focusing on tomato, pepper and eggplant. The visited places for Solanaceae collection is listed below: v. Sulan, v. Spas, v. Mogorce, v. Volino, v. Drslajca, v. Vak'v, v. Sermenin, v. Predjci, Predgradie, v. Veljusa v. Dobrejci, v. Dabile, v. Gradosorci, v. Zleovo. v. Gorno Lisice-Skopje, v. Grdovci-Kocani, v. Brazda- Skopje, v. Radovo- Strumica, v. Dobrejci- Strumica, v. Sopri-Valandovo. The percentage of the total number of collected accessions is as follow: 30% belong to pepper collections, 10.6%- tomato, 9.3%- melons, 9.4%- onions, pumpkins -7.8%, with the remaining 24 vegetable crops percentage is small and ranges from 0.1% to 5.9% (Table1.). From 2007-2010, the vegetable working group organized four collection missions in the South, West, Central, and South-West regions, mainly in rural areas, home gardens and traditional farms for the purpose of the Alliaceae project. As a result 48 onion accessions have been collected pungent types of onion produced by sets with yellow colour, and summer sweet onion landraces).

The other 21 were leek landraces with different light and dark green colour and a long stem. Each sample from the terrain is followed by: a unique collection number, GPS data, information about traditional method of cultivation and use, which are included in the Macedonian Collection form and photo documentation.

The detailed information for visited geographical localities with onion and leek is presented as follow: Struga- *v.Korosista, v.Vranista,* Ohrid- *v.Orman, v.Trebenista, v.Leskoec,* Bitola- *v. Lazec* Prilep- *v.Vogjani, v. Pasino Rufci* Gevgelija- *v.Prdejci , v. Mrzenci* Strumica- *v. Vasilevo, v. Dobrejci, v. Gradosorc, v.Veljusa v.S'cevo,* Skopje- *v.Gluvo, v. Dracevo, v. Lisice, v. Brazda* Kumanovo- *v. Dobrosane* Gostivar- *v. Gorna Banjica, v. Cajle* Debar- *v. Sulan, v. Spas* Valandovo- *v. Sopri.*

Passport data of vegetable genetic resources are well documented in Excel databases according to genebank standards, a database management system which is regularly updated and maintained. Database is not jet searchable on-line, but are our efforts for the future activities. Collected seed accessions have been documented in the main data base with adequate passport data following EURISCO descriptors, and then evaluated and partially uploaded in EURISCO data base.

EURISCO is a web-based catalogue that provides information about ex situ plant collections maintained in Europe. 72% of the vegetable accessions with passport data are uploaded in EURISCO data base. Accessions are stored in the gene bank, equipped for long-term storage-18°C and short-term storage +4 ^{o}C, located in the Institute of Agriculture in Skopje.

Characterization

Characterization is mostly based on morphological description with the use of recommended IPGRI Descriptor lists, UPOV Guidelines for every accession for determination of important characteristics. So far, 114 accessions (22.52%) of the total number of accessions are characterized, based on morphological and phenological traits (Table 1, Figure1). Characterization is made in the following crops: tomatoes (50%), peppers (37,5%), beans (100%) of the total number of collected accession.

Table1. Status of the vegetable collection during period of 2005-2010 year

No	Latin name/ common name	No. of coll. acc.	% of total	No. of acc. in EURISCO	% of coll. acc.	No. of regenerated acc.	% of coll. acc.	No. of caracterizated acc.	% of coll. acc.
1.	Lycopersicon esculentum L./tomato	54	10.67	42	77.78	27	50	27	50
2.	Capsicum annuum L./ pepper	152	30.04	123	80.92	12	7.89	57	37.50
3.	Solanum melongena L./ eggplant	4	0.79	4	100		0		
4.	Citrullus lanatus (Thunb.) Matsum. & Nakai/ watermelon	21	4.15	3	14.29	18	85.71		
5.	Cucumis melo L./ melon	47	9.29	9	19.15	37	78.72		
6.	Cucumis sativus L./ cucumber	6	1.19	4	66.67		0		
7.	Cucurbita sp./ pumpkin,squash	40	7.91	14	35		0		
8.	Lagenaria siceraria (Molina) Standl./ bottle gourd	6	1.19	6	100		0		
9.	Allium cepa L./ onion	48	9.49	40	83.33	26	54.17		
10.	Allium porrum L./ leek	21	4.15	14	66.67	7	33.33		
11.	Brassica oleraceae var. capitata L./ cabbage	13	2.57	13	100		0		
12.	Raphanus sativum var major/ radish	2	0.40	2	100		0		
13.	Phaseolus vulgaris L./ bean	30	5.93	30	100	30	100	30	100
14.	Phaseolus vulgaris var vulgaris/ green beans	16	3.16	16	100		0		
15.	Vigna angularis (Willd.) Ohvi & H. Ohashi/ bean, adzuki	2	0.40	2	100		0		
16.	Lactuca sativa L./ lettuce	5	0.99	5	100		0		
17.	Petroselinum crispum (Mill.) Nyman ex. A. W. Hill/ parsley	5	0.99	5	100		0		
18.	Apium graveolns L. var rapaceum/ celery	4	0.79	2	50		0		
19.	Pastinaca sativa L./ wild parsnip	4	0.79	4	100		0		
20.	Beta vulgaris L. subsp. Vulgaris/ beet root	3	0.59	3	100		0		
21.	Spinacia oleraceae l./ spinach	4	0.79	4	100		0		
22.	Rumex patientia L./ patience-dock, greens	4	0.79	4	100		0		
23.	Abelmoschus esulentus L.(Moench)/ lady's Fingers	9	1.78	9	100		0		
24.	Ocimum basilicum L./ sweet basil	1	0.20	1	100		0		
25.	Daucus carota L./ carrot	1	0.20	1	100		0		
26.	Anethum graveolens l./ dill, caper	1	0.20	1	100		0		
27.	Pisum sativum/ pea	2	0.40	2	100		0		
28.	Brassica oleraceae var. italica L./ broccoli	1	0.20	1	100		0		
29.	Total	506		364	71.94	157	31.03	114	22.53

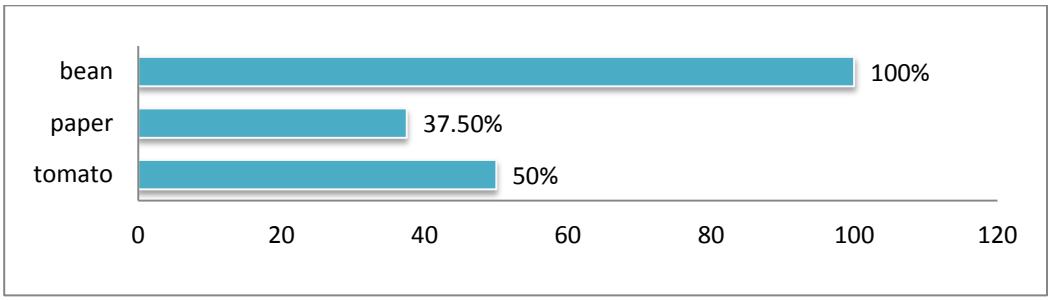


Figure 1. Distribution of the characterized accessions by crops

Regeneration

For multiplication needs, 157 accessions (31%) have been regenerated and were kept ex-situ and in the genebank. For that purpose the field trials were conducted. The percentage of the total number of regenerated accessions is as follow: 7.8% belong to pepper collections, leek 33%, 50%- tomato, 54%- onions, 78%- melons, 85.7%-watermelon, 100%-been (Figure 2). All data were properly documented in uploaded in on-line documentation system.

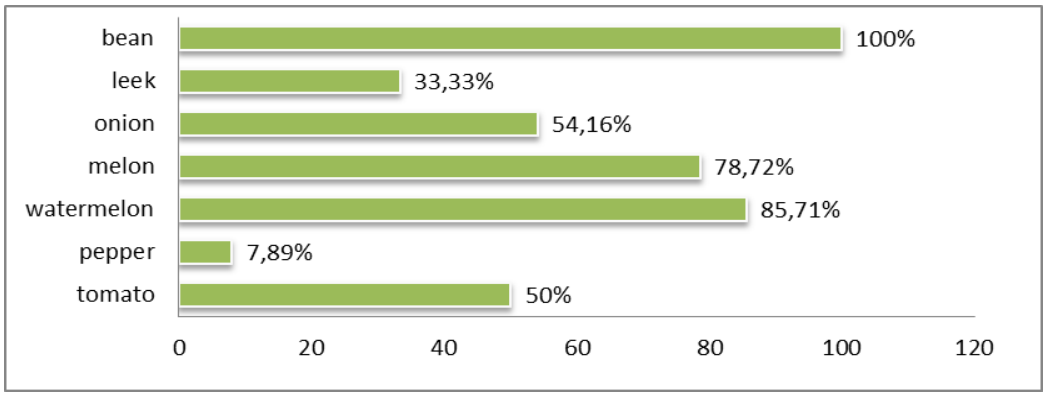


Figure 2. Distribution of the regenerated accessions by crops

Conclusions

During 2005-2010, SEEDnet project have enormously contributed to the management of vegetable genetic resources in South East countries, in national and regional level. Collaboration among the countries has been crucial for harmonization and transfer of the data and extends the scope of joint activities to the whole range of vegetable crops, obtained new knowledge tool for their conservation, long term preservation of accessions, strengthen collaborations and sharing responsibilities among vegetable working group. Future activities should be devoted to official establishment of National programme and strategy on PGRFA conservation on national level, followed by signing of International Treaty on PGR. Intensive pressure on Government for achievement of higher political awareness and continuous support in gene bank management (regeneration, characterization, evaluation of inventoried accessions, organization of mission for collection).

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СЕГАШНА СОСТОЈБА И ИДНИ ПЕРСПЕКТИВИ НА ГРАДИНАРСКИ ГЕНЕТСКИ РЕСУРСИ ВО Р. МАКЕДОНИЈА

Агич Рукие, Попсимонова Гордана

Апстракт

Генетскиот фонд од градинарски култури, особено автохтоните популации и стари сорти, створени низ векови како резултат на долгата традиција на одгледување, е вреден материјал и преставува значаен генетски потенцијал. Дел од овие локални популации и видови се загрозени и им прети опасност од изчезнување предизвикано од интензивен технолошки развој во градинарското производство, индродукција на странски хибриди и запоставување на домашно семепроизводство. Сето ова, дава добра основа нивно инвенторирање, колекционирање, долгорочна конзервација и можност за нивна повеќе наменска употреба, со цел да се спречи понатамошната генетска ерозија. Во Р. Македонија, понови истражувања во поглед на презервација на градинарските генетски ресурси се направени во рамките на СЕЕДНЕТ програмата, во периодот од 2005-2010 година. Работната група по градинарство организираше повеќе колекциони мисии, при што беа инвенторирани и колекционирани 507 примероци од 29 градинарски култури. Од вкупниот број колекционирани примероци процентуалната застапеност по култури е следна: 30% - пиперка, 10,6% - домати, 9,3% - дињи, 9,4% - кромиди, 7,8% - тикви, кај останатите 24 култури се движи од 0,1% - до 5,9%. Колекционираните семенски примероци се документирани во главната дата база со адекватни пасошки податоци по EURISCO дескриптори, а по направена проценка се препраќаат во базата на податоци EURISCO. Примероците се чуваат во ген банка, опремена за долгорочна чување на -18°C и краткорочно чување на +4°C, лоцирана во Земјоделскиот институт во Скопје.

Клучни зборови: градинарски култури, генетски ресурси, конзервација.

SECTION 4: FRUIT GROWING

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INFLUENCE OF THE FOLIAR FERTILIZATION ON QUALITY CHARACTERISTICS AND ECONOMIC EFFICIENCY OF APPLE CULTIVAR SMOOTHIE

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Abstract
The effect of the foliar fertilization with Biohumax and Humustim, applied in different rates (50, 100, 150 ml/da), on the yield and fruit quality of Smoothie apple cultivar was studied at the Institute of Agriculture-Kyustendil. The trees were grafted on rootstock MM 106 and planted at distances 4.5 x 2.5 m on leached cinnamonic forest soil (Chromic Luvisols). Average for the period the best results were obtained in the treatment with Humustim in dose of 50 ml/da, followed by Biohumax – 100 ml/da. The additional costs were minimal and did not affect economic efficiency. The examined rates of the foliar fertilizers did not have a significant impact on the fruit weight, content of dry matter, total sugars and titratable acids in the fruits of Smoothie.
Key words: apple, foliar fertilization, yield, economic efficiency.

Introduction

An attitude towards the positive effect of the foliar fertilizers application on the vegetative and productive manifestations of the apple trees, as well as the quality and storage capability of their fruits prevails in the scientific literature (Casero *et al*, 2002; Ciavatta and Benedetti,2002; Maur and Schröder,2002). There are also opinions of lack or even a negative effect on some biometrical indices (Perya, 2002).

Fertilization is one of the main agricultural activities associated with the intensification of fruit and impacts directly on the overall economic efficiency of apple production. In optimizing this factor it is possible to obtain high production and economic results (Krinkov, *et al*, 1990). According to Porro *et al*. (2002) developing effective combinations of fertilizers, as well as identifying the most appropriate phases of development of fruit trees for their implementation will enhance the effect of their application. These authors tested different variants of fertilization in apple orchard and found that combined fertilization (soil and foliar) reduced the occurrence of bitter spots and decay, and the concentration of Ca, Fe, Mn and Zn in the leaves increased. The content of these nutrients was higher in the fruits of this option, only the concentration of B was lower than that of the control.

It has been shown that foliar fertilization improves fruit quality, changes total acidity, pH, and their color (Policarpo *et al*, 2002; Stampar *et al*, 2002). It increases the content of glucose, sorbitol, solids, malic and citric acid and potassium in fruits (Hudina and Stampar, 2002). In foliar feeding with Vegaflor, apple yield increased by 19.7% (Hudska, 1976).

The aim of the investigation was to establish the effect of the organic fertilizers Biohumax and Humustim, used as foliar application in different rates, on the yield, fruit quality and economic efficiency of apple cultivar Smoothie.

Material and methods

The investigation was carried out during the period 2004-2006 with apple trees of the cultivar Smoothie, grafted on the clonal rootstock MM106. The experimental plantation was created in 1986. The soil was chromic luvisols with a slightly acid reaction (pH). The planting distances were 4.5 x 2.5 m. The soil surface was cultivated regularly, the irrigation was performed through drip irrigation equipment and plant protection was applied according to the schemes accepted at the Institute of Agriculture - Kyustendil.

The influence of two foliar organic fertilizers applied every year three times in 10-12 days intervals during May-June in the following variants was examined:

V1 – Humustim – 50 ml/da;
V2 – Humustim – 100 ml/da;
V3 – Humustim – 150 ml/da;
V4 – Biohumax - 50 ml/da;
V5 – Biohumax - 100 ml/da;
V6 – Biohumax - 150 ml/da;
V7 – the control (without treatment with organic foliar fertilizers);

The following indices were measured and analyzed: Fruit yield per tree, kg; Average fruit weight, g; Fruit quality - extra, first quality, second quality, according to ordinance № 108/12.09.2006 of MAF. Chemical composition of the fruits - content of dry matter (%, refractometrically), organic acids (%, titermetrically with 0,1n NaOH), and the total sugars (%, by Shoorl) (Stanchev et al., 1988). The chemical composition was determined on the basis of pooled samples of each option in the harvest every year; Additional gross production and net income, lv/da.

The results were statistically evaluated by analysis of variance (ANOVA) and LSD test was used for the identification of the significance of differences.

Results and discussion

Over the separate years there was no clear trend for the unidirectional influence of foliar fertilization on the average yields. Total for the period the application of both foliar fertilizers increases the yield compared to the control variant (Table 1). Variant 1 (Humustim–50 ml/da) is characterized by the highest fruitfulness and the total yield increase the control with 28.42%. With the increase of the Humustim dose to 100 and 150 ml/da (V2 and V3), while the second and third year yields are higher than V1 and control, the average for the period these variants are with lowest values. The differences between the different variants and the control were statistically significant. The treatment with Biohumax at a dose of 100 ml/da (V5) gives the best results and leads to increased yield by 27.8% compared to the control. Variants with 50 ml/da (V4) did not differ from the control, while that of 150 ml/da (V6) leads to an increase in the average yield of 11.12%.

The results of the biometric measurements analysis show that the examined doses of foliar fertilizers applied during the period May-June do not have a significant effect on the average fruit weight. Average for the period, the variation in the weight of the fruit is 92 to 109 g, indicating that foliar fertilization had no significant effect on their on-growing. The low average fruit weight is probably due to the extremely unfavorable weather conditions during the summer of 2005 (hot and very low relative humidity), which reduced yield and fruit size. The nutrients in this period are used mainly for shoot growth and increase of the leaf mass, and to a lesser degree - for size increase of

the still young fruit set. Moreover, during this period nutrients are mostly used for growth of shoots and increase foliage and to a lesser extent for the still-growing young ovaries. Differences between the variants and control are statistically unproven.

Table 1. Average yield (kg) and average fruit mass (g)

Variants	Year			Total kg/tree	% of the control	Average fruit mass, g
	2004 kg/tree	2005 kg/tree	2006 kg/tree			
V 1 - Humustim - 50 ml/da	146.85	7.95	81.11	235.91	128.42	94
V 2 - Humustim -100 ml/da	109.82	11.88	87.17	208.87	113.70	109
V 3 – Humustim -150 ml/da	111.99	11.15	87.15	210.29	114.47	100
V 4 – Biohumax -50 ml/da	97.11	5.65	82.4	185.16	100.79	92
V 5 – Biohumax - 100 ml/da	122.85	11.88	100.1	234.83	127.83	102
V 6 – Biohumax - 150 ml/da	100.89	12.34	90.89	204.12	111.12	98
V 7 - control	104.62	5.75	73.33	183.70	100	97
LSD 0.05	*18.03*	*4.7*	*24.78*			
0.01	*24.73*	*6.446*	*33.98*			
0.001	*33.66*	*8.774*	*46.25*			

The production qualification, average for the period of investigation, shows that the fruits of Extra quality are from 34.18 to 45.25%, the First quality fruits are about 19-27%, and the Second quality fruits - from 28.14 to 46.87% of the total harvest (Fig.1). The largest quantity of extra quality fruits is obtained in variant V5 (45.25%), followed by variant V2 (44.12%) and V6 (41.13%). The lower is the percentage variations in V1, V3 and V4, compared with the control V7 (39.72%).

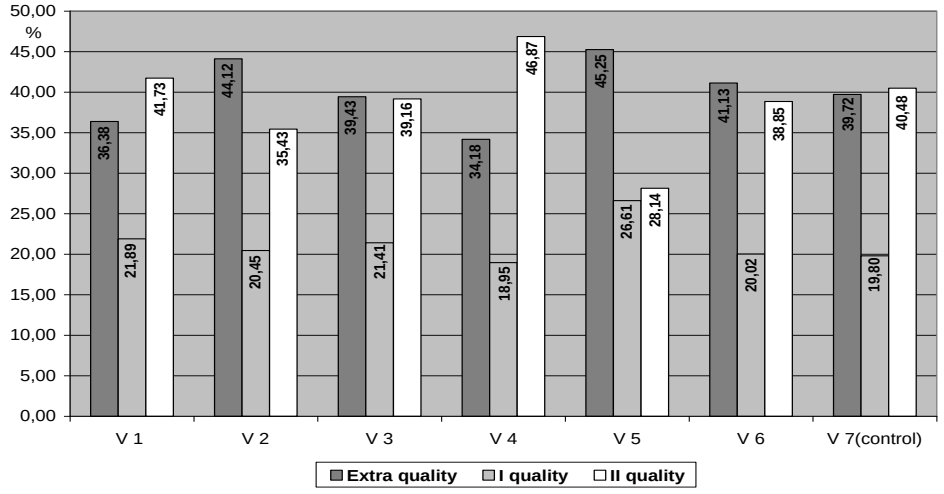


Figure 1. Quality of the fruits, average for the period 2004-2006

The influence of Humustim and Biohumax on the chemical composition of apple fruit is reflected in Table 2. Average for the period dry matter has higher values for the three variants of fertilization

with Biohumax compared to control. Upon treatment with a dose of 50 ml/da (V4) it is the highest (14.80%), which is 0.73% more than the control variant. Following in the variant with 150 ml/da (V6) - 14.27%, and the lowest is with the use of 100 ml/da (V5) - 14.23%. When using Humustim at 100 ml/da (V2) the values of dry matter were higher than the control by 0.63%. For the variant of 50 ml/da (V1) its content was equal to the control, and at V3 (150 ml/da) it had lower rates than the control variant by 1.3%.

Table 2. Chemical composition of the fruit, average for the period 2004 -2006

Variants	Dry matter (%)	Titratable acids (%)	Total sugar (%)
V 1 - Humustim - 50 ml/da	14.00	0.33	8.99
V 2 - Humustim -100 ml/da	14.70	0.35	9.14
V 3 – Humustim -150 ml/da	13.37	0.31	8.55
V 4 – Biohumax -50 ml/da	14.80	0.34	9.32
V 5 – Biohumax - 100 ml/da	14.23	0.32	9.24
V 6 – Biohumax - 150 ml/da	14.27	0.31	9.10
V 7 - (control)	14.07	0.34	9.13

The total sugars, in % to the fresh mass of the fruit, varied slightly among the different variants. When using Humustim they ranged from 8.55% (V3) to 9.14% (V2). In Biohumax variation of sugars is from 9.10% (V6) to 9.32% (V4), showing almost no difference between them as well as in comparison to the control. The content of titratable acids is not significantly influenced by applied foliar fertilizers. The differences between the tested variants are minimal and varied in the range from 0.31 to 0.35%.

The economic efficiency of foliar fertilization, average for the period 2004-2006 is presented in Table 3. The data show that compared with the control (without treatment with organic foliar fertilizers) when using Humustim a higher yield is produced which ranged from 746.71 to 1548.9 kg/da, and of Biohumax - from 43.31 to 1516.86 kg/da. The additional fruit production is related to the increase in the cost of harvesting - from 3.92 to 51.46 lv/da, while the extent of additional gross output obtained is from 23.82 to 851.89 lv/da. The overall economic effect of foliar fertilization of cultivar Smoothie can be judged by the resulting net income for the different variants. The treatment with Humustim - dose of 50 ml/da (V1) led to the highest additional net income - 800.43 lv/da, which is 32.4% more than the control. Follows the Biohumax variant at 100 ml/da (783.82 lv/da), where the increase was 31.8%. The least is the increase in net income in the treatment with the lowest dose Biohumax (V4) - 19.30 lv/da or 0.81% compared to the control.

Table 3. Economic efficiency of foliar fertilization, average for the period

Variants	Additional yield, kg/da	Additional costs, lv/da	Additional received	
			Gross production, lv/da	Net income lv/da
V 1 - Humustim - 50 ml/da	1548.90	51.46	851.89	800.43
V 2 - Humustim -100 ml/da	746.71	27.02	410.69	383.67
V 3 – Humustim -150 ml/da	788.84	28.68	433.86	405.18
V 4 – Biohumax -50 ml/da	43.31	3.92	23.82	19.90
V 5 – Biohumax - 100 ml/da	1516.86	50.45	834.27	783.82
V 6 – Biohumax - 150 ml/da	605.79	24.08	333.19	309.11

Conclusions

The organic fertilizer Humustim, used through foliar application on apple trees of cultivar Smoothie increases the yield from 13.7 to 28.4%, depending on the dose used. The influence of the other organic fertilizer Biohumax is less pronounced compared with the control and yields increased from 0.8 to 27.8%. Fruit quality is not affected significantly by the applied doses of foliar fertilization. The highest percentage of extra quality fruit is obtained by variants at 100 ml/da used for both fertilizers. The most economically effective is the treatment with Humustim at 50 ml/da, where the received additional gross production is 851.89 l v/da and the additional net income - 800.43 lv/da. Approximately the same efficiency is obtained by the use of Biohumax at 100 ml/da.

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ВЛИЈАНИЕ НА ФОЛИЈАРНОТО ЃУБРЕЊЕ ВРЗ КВАЛИТАТИВНИТЕ КАРАКТЕРИСТИКИ И ЕКОНОМСКАТА ЕФИКАСНОСТ КАЈ СОРТАТА НА ЈАБОЛКО СМУТИ (SMOOTHIE)

Илијана Радомирска, Димитар Сотиров

Апстракт

Ефектот на фолијарното ѓубрење со Biohumax и Humustim, аплицирани во различни количини (50, 100, 150 ml/da), на приносот и квалитетот на плодовите на сортата на јаболко Smoothie беше спроведено на Институтот за Земјоделство – Ќустендил. Овошките беа калемени на подлогата ММ 106 и садени на растојание од 4.5 x 2.5 m на процедна циметна шумска почва (Chromic Luvisols). Просечно најдобри резултати беа постигнати при третирање со Humustim во доза од 50 ml/da, проследено со Biohumax во доза од 100 ml/da. Дополнителните трошоци беа минимални и не се одразија на економската ефикасност. Испитаните дози од фолијарните ѓубрива немаа големо влијание врз тежината на плодовите, содржината на суви материи, вкупните шеќери и титрациска киселина во плодовите на сортата Smoothie.

Клучни зборови: јаболко, фолијарно ѓубрење, принос, економска ефикасност.

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Review paper

APPLE AREAS AND PRODUCTION IN BULGARIA AND CHINA

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Abstract
The present paper is a review, describing the harvesting areas and apple production in Bulgaria and China for the period 2001 – 2010. The soil, climatic and topographical conditions in most regions of these countries are favourable for apple growing and production of high quality fruits. The total apple plantation areas in the world are 4 696 259 ha and production is 69 511 975 tons for 2010. The main apple producer is China, which produces about 48% of total quantity. The areas of apple plantations in Bulgaria have constantly increased up to 1968 when they reached 30421 ha, but recently the areas planted with apple trees has decreased considerably and at present there are about 5239 ha. One of the reasons for the reduction of the planted areas is the land reform and the change of the ownership of the land.
Key words: apple, production, area, state, trends.

Introduction

The apple (*Malus domestica* L.) is one of the most profitable fruit crops, occupying one of the first positions of harvesting area and fruit production in the world. Compared to other fruit species of the temperate climate zone, it is characterized by great adaptability to different soil and climatic conditions, high yield, variety diversity, good storage and transport. Using appropriate varieties with different ripening time and sufficient capacity of cold storage equipment, can lead to year-round supply of fruits to the apple market (Djouvinov *et al*., 2002; Radomirska, 2008). The fruits contain valuable nutrient substances (pectin, sugars, acids, aromatic substances and mineral salts) and rank between the best organic and diet ffoods. They have multi-use - fresh consumption, juices, concentrates, dried fruits, jars, production of pulp, pectin and others (Velkov *et al*, 1970). The total apple plantation areas in the world for the period 2001-2010 gradually decreased - from 5 112 829 ha (2001) to 4 696 259 ha (2010). The decrease for the ten-year period was 416 570 ha (Fig.1). At the same time the apple production, with some fluctuations over the years, increase - from 55 196 632 t to 70 767 702 t, due to improved breeding technologies and increasing average yields per unit area.

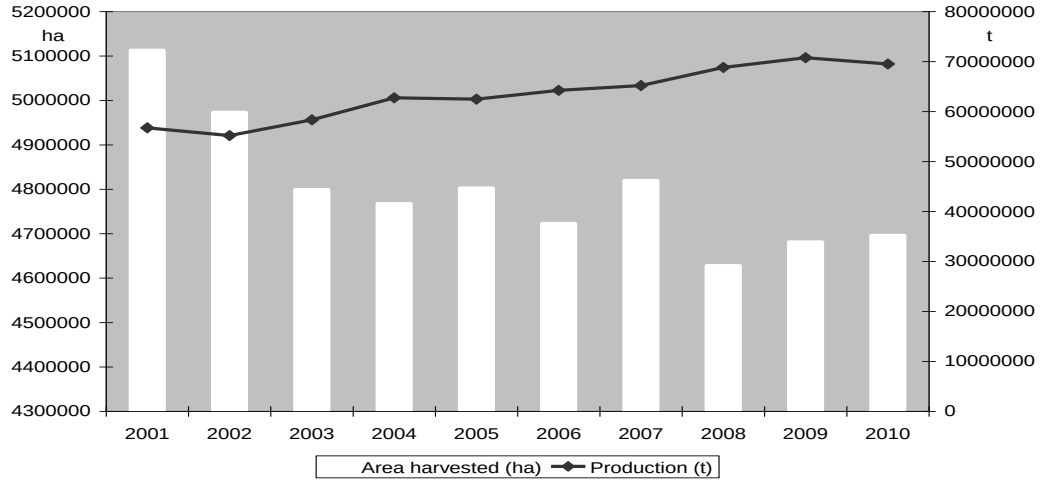


Figure 1. Area harvested (ha) and apple production (t) in the world, 2001 -2010

Apple production in Bulgaria

The Republic of Bulgaria is situated in South-Eastern Europe, in the eastern half of the Balkan Peninsula (41-45^0 northern latitude and 22-29^0 eastern longitude). It has a territory around 111 sq.km. The landscape is diversified – more than 2/3 of the area is situated up to 600 m above sea level. The climate is moderately continental with the Black Sea influence on East and the Mediterranean – on South. The average annual temperatures in the main fruit production regions are 11-12 ^{o}C. The coldest month is January (average temperature is –2°C). The warmest month is July (average temperature 25°C). The frost-free period for the above mentioned regions lasts for about 190-215 days or from 12-25 April to until 5 -15 November. The mean annual precipitation sum is from 450 to 850 mm. The most precipitation occurs in May and June. The relative air humidity is about 65-75%.

The climatic and topographical conditions in the valleys and the hilly regions are favorable for apple growing and production of high quality fruits. Total for the period 2001-2010 the harvested apple area in Bulgaria decrease with 47%. The trend for decrease is more noticeable in 2005, and then there are some fluctuations (Fig. 2). In 2010 apple trees in farms are 5239 ha and their distribution by region is as follows: South Central region - 37%, followed by the Southwest - 22% South East region - 18%, North and Northwest regions - 8% and North Central - 7%.

Bulgaria's production was only 0.06 % of world's production. This small share was due to change in ownership and nature of use of agricultural lands since 1989, leding to destructive processes, reducing the apple areas, average yields and total production of fruits. The main reasons for the unsatisfactory state of apple production were disrepair and expired depreciation period of plantations and low quality or lack of agricultural practices in their growing. The created new plantations were insufficient to replace the old ones (Makariev et al, 1994; Doychinova, 2000; Onchev, 2000; Todorova 2000; Domozetov, 2005). The observed trend of decreasing total apple production in 2004 retained until 2008, after which there was a significant growth and production reached levels higher than in 2001 (Figure 2). Production in 2001 was 42 710 t, in 2010 - 43 235 t, which is 1.2% higher. For the ten-year period 2008 is the year with the lowest production - 23 500 t.

With the accession of Bulgaria to the EU and the launching of programs for rural development the interest of farmers in creating new fruit plantations, is expected to strengthened, which will lead to increased areas and production.

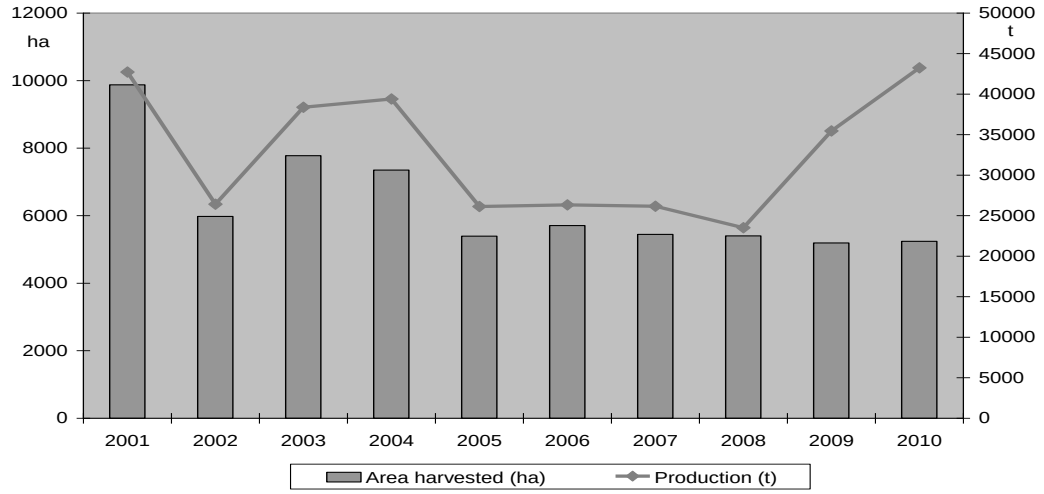


Figure 2. Area harvested (ha) and apple production (t) in Bulgaria, 2001 -2010

In the recent years the main apple cultivars represented in Bulgaria are: Golden Delicious, occupying 19.62% of the area, followed by Red Delicious by 9.29%, Granny Smith - 8.51%, Florina - 7.68% and Melrose - 6.26% (Figure 3). As result introduction activities of the Institute the following cultivars are also introduced and covered, but in a smaller size: Gloster, Mutsu, Djonagold, Molis Delicious, Fuji, Prima, Sharden etc. (Blagov, 1995; Djouvinov, 2002).

At present research work is being done on the improvement and diversification of cultivar assortment with the purpose for all-year-round supply of Bulgarian market with own fresh fruits. Special attention is being paid to the introduction of cultivars, which are virtually resistant to the key diseases – apple scab and powdery mildew. Several cultivars have been created in Bulgaria – Stoyanova krasavitsa, Rumyana, Trakiiska ranna, Trakiiska slava, Albena, Chervena jubileina and Trakiiska kasna, but they have not taken serious positions in our apple production.

In 2010, the latest Bulgarian apple cultivars created at the Institute of Agriculture – Kyustendil were approved - Besapara, Marlena, Martinica, Elegia and Gorana. They possess valuable biological and economic qualities and are expected soon to be fully included in our apple production cultivar lists. In the breeding of the new cultivars a special attention has been paid to their resistance to the major economically significant diseases (scab, powdery mildew and fire blight).

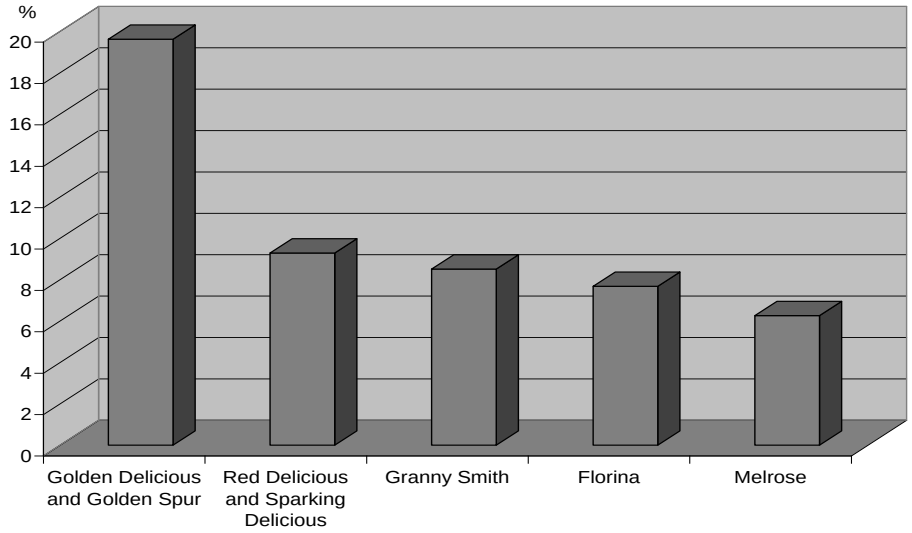


Figure 3. The most widespread apple varieties in Bulgaria, %

Apple production in China

China's climate is mainly dominated by dry seasons and wet monsoons, which lead to a pronounced temperature differences between winter and summer. In the winter, northern winds coming from high-latitude areas are cold and dry; in summer, southern winds from coastal areas at lower latitudes are warm and moist. The climate in China differs from region to region because of the country's extensive and complex topography.

Shandong province, which is one of the major production areas of apples in China, is located at the east part. It is between northern latitude 34° 25' and 38° 23'. Eastern latitude is between 114° 36' and 122° 43'. It belongs to the northern sphere middle latitude zone. The total area is 156 000 sq.km. East part of Shandong province face to ocean, west part is adjoining mainland. It belongs to a warm zone and season wind climate type. Rainfall concentrating, rainfall and hot time are same season. Four seasons are evident. Annually average temperature is 11-14°C, rainfall is between 550-2890 mm. Shandong province sunlight resource is abundant, average sunlight time is from 2300 to 2890 hour per year.

China is the main producer of apples in the world and this species is one of the most important fruits in the country. The proportion of cultivars grown and their ripening seasons however are not suitable for the fruit market. The production of early and mid season cultivars is only occupied by around 15% of the total apple production, while the production of late cultivars amounts to 85% of the total production. Based on the achievements of apple breeding for early and mid season cultivars in the past twenty years in China the authors would suggest that more attention should be paid to early and mid season cultivar development in future, some newly-bred early cultivars are also introduce (Guo Guo Nan *et al*., 2009).

In 2003, the apple output in China amounted to 35.4% of worldwide apple production, while the apple production in the developed countries amounted to 41.4%. In 2002 to 2003 China had exported apples of 440 thousand ton and concentrated apple juice of 417 thousand ton (Zhai Heng

et. al. 2005). Total for the period 2001-2010 apple fruit production has increased from 20,022,763 to 33,265,186 t, which is 66%, while the areas maintained a constant level of approximately 2,000,000 ha (Fig. 4).

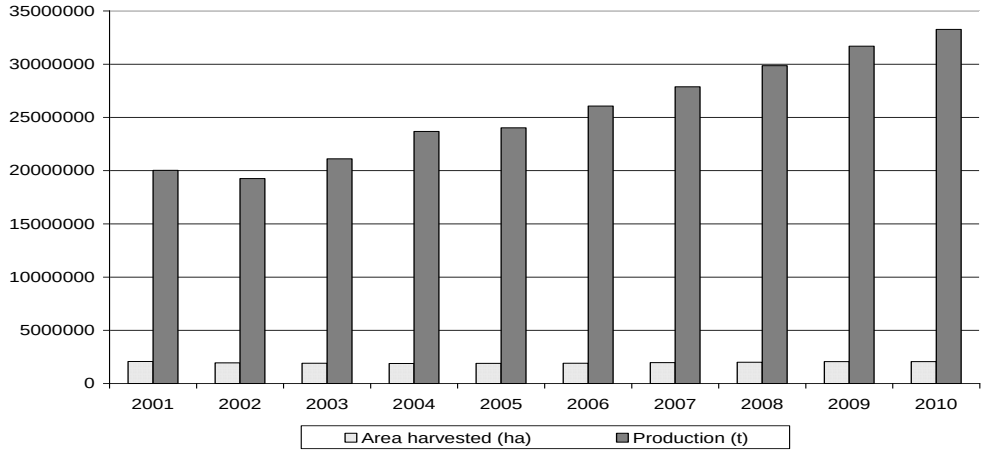


Figure 4. Area harvested (ha) and apple production (t) in China, 2001 -2010

Yantai is one of the two major production areas of apples in the province Shandong. In 2010, the occupied areas by the crop in the region were about 9% of the apple trees in China. Yantai's apples are known worldwide for its distinctive qualities - equal in shape, particle size and color. The fruits are aromatic, sweet, juicy and crunchy flesh. The main cultivars distributed there are: Fuji, Gala and Red Genaral (Table 1). The largest share of Apple Production falls on Fuji variety, occupying 82% of the total area and 81.7% of the apple production. Other varieties occupy a minor position in their share of the total area of apples in the country is as follows: Gala - 9.9%, Red Genaral - 5.4%, Jonagold and Shasa below 1%. Rate of production is almost the same as in the areas.

Table 1. Apple areas and production in Yantai in 2010

Varieties	Area, ha	Rate of area, %	Production, t	Rate of production, %
Fuji	145 807.3	82.06	3 700 000	81.71
Gala	17 600.9	9.91	351 000	7.75
Red Genaral	9 560.5	5.38	249 600	5.51
Jonagold	1 553.4	0.87	43 700	0.97
Shasa	893.4	0.5	18 800	0.42
Others	2 086.8	1.18	70 300	1.55
Total	177 675.6	100	4 528 000	100

It is believed that Chinese apple industry is entering a very important turn period from big apple production to a powerful apple production in the world. The future trend of Chinese apple industry is to keep the current acreage, to advance the yield per unit, to improve the quality of apple products and to encourage the development of the secondary and third industry. In the future, the

developmental focuses must be laid on the following aspects: establishing the modern cultural technical system, the modern storage and processing system and the transport distribution; enhancing science and technique support to the industry, improving the technical service method and meshwork and science and technique training for growers; elevating the standardization production; establishing the CHINA-GAP (Good Agricultural Practice),forming the traceability system in apple culture section; putting the quality control system and HACCP (Hazard Analysis Critical Control Point) into effect; establishing national apple association as soon as possible and assisting growers to organize themselves in association or cooperation; speeding up the research on international marketing of apple industry, and establishing public information service and professional consultant system/institution (Zhai Heng *et al.*, 2007).

Conclusions

Despite the favorable climatic conditions the share of Bulgaria in World Apple Production is extremely unsatisfactory. It is necessary both: an increase the apple areas and improvement of technologies to obtain higher yields.

In Bulgaria the most widespread apple cultivars are: Golden Delicious, Red Delicious, Granny Smith, Florina and Melrose but in the new plantations must be included and some of the newer varieties, particularly resistant to the most economically important diseases.

China is a major manufacturer of apple fruit in the world. Since 2001, apple production tends to steadily increase while keeping the area due to higher yields per unit area.

The largest production area in China is Shandong Province and major variety used is Fuji.

In the future will need to pay greater attention to the quality of the produced apple fruits in China.

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ПОДРАЧЈА И ПРОИЗВОДСТВО НА ЈАБОЛКО ВО БУГАРИЈА И КИНА

Илијана Радомирска, Димитар Сотиров, Сонг Лаигинг

Апстракт
Во овој труд е претставен описот на подрачјата за производство на јаболко и производство на јаболко во Бугарија и Кина во периодот од 2001 – 2010. Почвените, климатските и топографските услови во повеќето региони на овие земји се поволни за одгледување и производство на висококвалитетно јаболко. Вкупната површина под јаболко во светот е 4 696 259 ha а вкупното производство е 69 511 975 тони за 2010. Најголем производител на јаболко во светот е Кина, која произведува околу 48% од вкупното светско производство. Површините под јаболкови насади во Бугарија постојано се зголемуваа од 1968 , кога достигнаа 3 421 ha, но во последно време површините под јаболко значајно се намалија, и во моментот има ококу 5 239 ha. Една од главните причини за намалување на површините под јаболко е пренамена на земјиштето и промена на сопствениците на површините.
Клучни зборови: јаболко, производство, подрачје, држава, тренд.

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UDC:338.439.63:635.076(497.4)"2002/2011"
Original scientific paper

THE PRODUCTION AND THE CONSUMPTION OF FRUIT IN SLOVENIA OVER THE LAST TEN YEARS

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Abstract
The production and the consumption of fruit in Slovenia were estimated on the basis of supply balances of fruit. The fruit supply balance includes all fruit (fresh and processed) and all types of fruit species. It is made up of individual supply balances for fruit species. The supply balance of fresh fruit (includes only fresh fruit) was also prepared. Due to the importance of apples in the Slovenian fruit production the supply balance of apples (fresh and processed) and the supply balance of fresh apples are also presented in this paper. The results of the prepared supply balances are the self-sufficiency rate and the human consumption per capita. In the period 2002-2011 the fruit production depended on weather conditions and also on the impact of alternative fertility in extensive orchards. Slovenia is a net importer of fruit. In the structure of fruit foreign trade between 50 and 60% are citrus fruits and bananas. After 2002 the import and export of fruit was increasing rapidly. In the period 2002-2011 the domestic use of fruit fluctuated between 245 and 350 thousand tons of fruit annually of which more than a third were apples. The self-sufficiency rate of fruit was between 38 and 59%. In the period 2002-2011 each inhabitant of Slovenia on average consumed between 100 and 150 kg of fruit (half in fresh form) of which 30 to 45 kg were apples (around 25 kg were consumed in fresh form).
Key words: fruit, apples, supply balance, production, human consumption.

Introduction

Over the last ten years between 8.9 and 12.3 thousand hectares or a little less than 2% of utilised agricultural area was devoted to fruit production in Slovenia. In the structure of orchards extensive orchards with 55% prevail. As it may be seen from the Graph 1, the share of areas devoted to fruit production has been decreasing on account of the decrease of extensive orchard areas. In the total value of agricultural production fruit has contributed between 4 and 7% in the past few years. The yearly yield depends very much on the weather conditions and beside that it is influenced by alternative fertility of extensive orchards. In Slovenia, between 132 and 191 thousand tons of fruit yearly were produced in the past ten years. The three major fruit species, i.e. apples (82%), peaches (9%) and pears (4%) accounted for 95% of all fruit produced on the average of the last ten years (Zagorc *et al*., 2012).

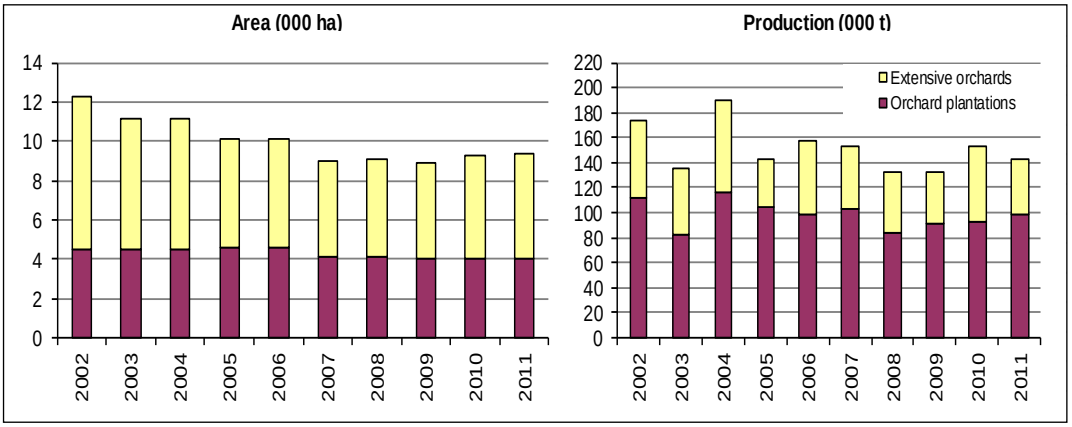


Figure 1. Area and production of fruit in Slovenia; 2002-2011

Table 1. Fruit production in Slovenia; 2002-2011

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production - total (000 t)										
Fruit	173,9	135,7	190,6	142,2	157,9	152,4	132,3	132,8	153,7	142,4
Apple	135,9	101,6	139,9	106,2	119,2	114,5	102,9	95,7	117,6	105,4
Pear	12,9	11,3	14,2	8,2	11,4	11,8	9,3	11,5	10,9	11,4
Peach	10,0	6,0	14,4	13,3	11,2	9,3	6,8	10,0	8,0	8,6
Other fruit	15,1	16,7	22,0	14,4	16,1	16,9	13,4	15,8	17,2	17,0
Production – orchard plantations (000 t)										
Fruit	112,5	81,8	116,4	105,2	99,0	103,7	84,2	91,4	92,8	99,3
Apple	93,9	70,2	92,9	84,5	79,9	87,0	71,6	72,6	77,3	81,3
Pear	5,9	3,6	5,3	3,1	4,1	4,3	3,1	4,7	3,8	4,6
Peach	8,9	5,4	13,3	12,5	10,2	8,1	5,8	8,9	6,9	7,6
Other fruit	3,7	2,7	4,8	5,1	4,8	4,4	3,6	5,2	4,9	5,7

Source: SURS (Statistical Office of the Republic of Slovenia)

On the average, 65% of fruit in Slovenia is produced in orchard plantations. After 2001 between 70 and 94 thousand tons of apples, between 5 and 13 thousand tons of peaches, between 3 and 6 thousand tons of pears and from 2 to 6 thousand tons of other fruit were produced in these plantations yearly.

Slovenia is a net importer of fruit. In spite of a bit lower fruit import in the past two years a pronounced trend of increasing fruit import has been observed, along with the fact that the import of processed fruit has been increasing more than that of fresh fruit. The fruit export has also been increasing since 2002. In the structure of fruit foreign trade between 50 and 60% are citrus fruits and bananas. Among the continental fruit species apple trade is the major one accounting for 15 to 20% in the structure of foreign trade over the last ten years. The export of apples (the majority of them are fresh apples), which depends very much on the production influenced by weather conditions and alternative fertility, has increased in the last ten years. The import of apples has increased in that period as well, mainly on account of the processed apples (apple juice). In spite of

all that, in Slovenia apples are one of the rare agricultural products with a positive foreign trade balance (Zagorc *et al*., 2012).

Table 2. Foreign trade of fruit in Slovenia; 2002-2011

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Import										
Fruit	158,6	160,5	177,3	221,1	205,1	254,5	324,9	318,4	276,7	271,5
Apple	19,3	10,5	15,3	27,2	19,6	29,4	39,1	40,4	39,9	38,3
Pear	2,3	2,8	2,9	5,6	5,6	6,8	6,7	6,8	6,5	6,3
Peach	8,4	7,2	9,9	13,9	11,5	11,8	15,4	14,0	12,4	11,6
Export										
Fruit	39,8	51,9	39,8	71,6	61,3	94,0	105,4	105,3	102,8	110,7
Apple	16,1	25,2	17,8	28,1	22,0	37,5	28,9	25,0	35,3	41,0
Pear	1,1	0,8	1,2	1,0	1,4	1,7	2,3	2,0	2,3	1,5
Peach	0,1	0,1	0,1	0,6	1,1	1,4	2,7	2,0	1,7	1,5

Source: SURS

Data on fruit yield together with data on foreign trade with fruits are the basis of the so-called fruit supply balance. The notion supply balance of fruit is a complex of standardised information on the supply and demand for fruit referring to the country as a whole. The two results of the prepared balance are the two indicators, i.e. the self-sufficiency rate (to what degree the domestic use is covered by the domestic production) and human consumption per capita (the quantity of fruit available to individual inhabitant in a certain period) that allow the comparison with other agricultural products and comparison with other countries. The self-sufficiency rate and the human consumption of fruit and/or apples in Slovenia has already been reported by several sources (Ministrstvo za kmetijstvo, gozdarstvo in prehrano, 1993, Žibrik, 1997, Alič, 2004, FAO, 2012, Gutman Kobal, 2012), however, for the time being there does not exist any official supply balance of fruit and/or individual fruit species.

The supply balances of major agricultural products are made following the uniform Eurostat methodology (Eurostat, 2001). The latter does not include a general fruit supply balance but only the supply balances of certain fruit species or fruit groups (apples, pears, fresh peaches, processed peaches, table grapes, oranges, citrus fruits, dried fruits) (Eurostat, 2002, Eurostat, 2009).

The knowledge about human fruit consumption is necessary for the monitoring of structure and development of fruit market and the assurance of information required for making agricultural policy decisions. The current experiment presents a basis for future official fruit supply balance and supply balances of individual fruit species. The current paper comments on the production and consumption of fruit based on the prepared supply balances exposing apples that are the major fruit species in Slovenia.

Material and methods

The term supply balance presents a synthesis of a great number of different statistical and other data from the field of agriculture and food industry. The fruit supply balance consists of individual supply balances of fruit species. Since the Eurostat methodology includes only supply balances of

some fruit species the missing fruit species supply balances were made and they were joined in a common fruit supply balance. When making supply balances the data on yield, production of industrial products and foreign trade with fruit were drawn from Statistical Office of the Republic of Slovenia (SURS) while numerous data refer to estimates provided by experts. Here it would be worthwhile drawing attention to fruit production in kitchen gardens which is widely spread in Slovenia but not included in supply balances since there do not exist any data on fruit production in kitchen gardens in Slovenia. The supply balances were made for the period 2002-2011 and they are expressed in the equivalents of fresh fruit. For the current paper the *fruit supply balance* including all fruit (fresh and processed) and all fruit species was made. Since from the aspect of nutrition it is very important to know data on the quantity of fruit consumed in the fresh form, further on a *supply balance of fresh fruit* is presented. Opposite to the former one the latter includes only fresh fruit since fruit intended for processing (puree, jam, dry fruit, juices) has been excluded from this balance. As similar supply balances are not made in other European countries, for the sake of comparison we have prepared one balance in the way that it is done in Austria. The *fruit supply balance according to Austrian methodology* includes fresh fruit and all processed products except juices (the processing of fruit into juices is excluded). Due to the importance of apples in the Slovenian agriculture the same way was used to present *apple supply balance* (fresh and processed apples), the *fresh apple supply balance* (without processed products) and *supply balance of apples according to Austrian methodology* (fresh apples and processed products without juices).

Results and discussion

Estimates based on the prepared fruit supply balances and fresh fruit supply balances show that between 245 and 350 thousand tons of fruit were consumed in Slovenia yearly after 2002 of which about 85% on the average were used for food. The remaining part of the consumption was estimated to have been used for industrial purposes (vinegar and brandy production) or they were lost as waste. The lowest consumption was recorded in 2003 when the yield suffered considerably from drought and the fruit import did not increase essentially in spite of a much lower production. The highest consumption was recorded in 2008 in spite of the low production because this was the year that witnessed the highest fruit import ever. The yearly consumption of apples in the period 2002-2011 ranged between 85 and 140 thousand tons presenting a good one third of domestic use of fruit in Slovenia. The consumption of fruit fluctuated the most severely between the drought year 2003 and the year 2004 when the fruit witnessed an extremely rich crop. Among the major continental fruit species apple consumption is the one to come the closest to its production. After 2001 about three quarters of apples were used for food on the average, which is a bit less than the other fruit species since the share of apples intended for processing into vinegar and brandy is higher if compared with the other fruit species.

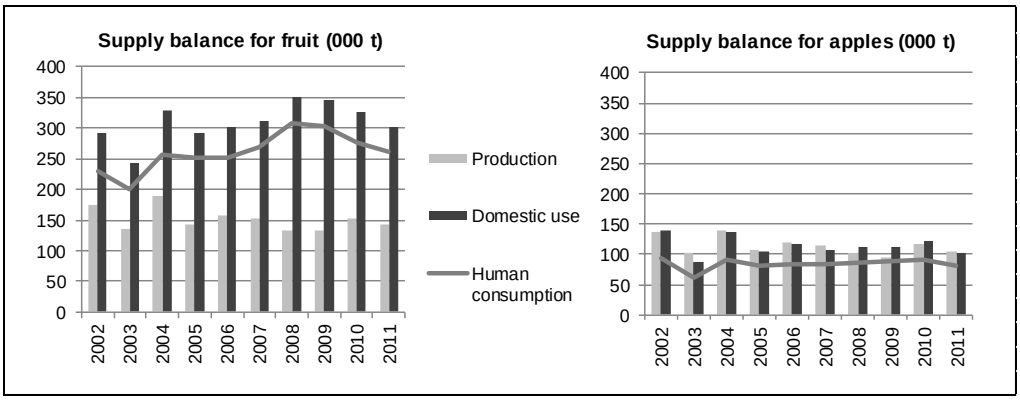


Figure 2. Fruit and apple production and consumption in Slovenia; 2002-2011

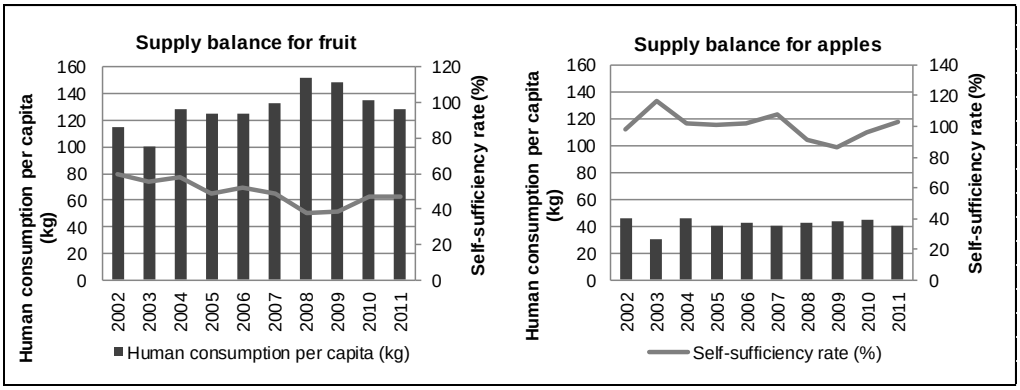


Figure 3. Human consumption of fruit and apples per capita and self-sufficiency rate of fruit and apples in Slovenia; 2002-2011

In the years between 2002 and 2011 an inhabitant of Slovenia consumed on the average from 100 to 150 kg of fruit in any form (calculated into the fresh fruit equivalent), of which between 30 and 45 kg were apples. If the extreme year 2003 is excluded in this period each inhabitant consumed 132 kg of fruit on the average (in the fresh fruit equivalent), of which 43 kg of apples.

There are relatively few international data on fruit consumption or they are often incomparable since for the estimation of fruit consumption different methodologies are used (Eurostat, 2002, Eurostat, 2009, Grüner Bericht, 2011, FAO, 2012). It is therefore interesting to compare the consumption of fresh fruit together with the processed fruit (juices excluded) with the neighbouring country Austria which was made possible by the supply balances for fruit and apples prepared on the basis of Austrian methodology. According to the calculations made, one fifth more fruit were consumed in Slovenia than in Austria (about 100 kg) on the average in the period 2006-2011 and the apple consumption in Slovenia was being higher by 15% (about 24 kg). The fruit production in Slovenia after 2002 covered between 38 and 59% of domestic use. The higher self-sufficiency rate on principle was reached in the years with good apple yield attained in extensive orchards and, opposite to that, the lower self-sufficiency rate was reached in alternative fertility years. In 2008 and

2009 when the self-sufficiency rate was the lowest, the fruit foreign trade balance was the most unfavourable, too.

Important information from fruit supply balances covers the question of what part of fruit was consumed in the form of fresh fruit. In the years 2002 to 2011 between 204 and 285 thousand tons of fresh fruit or between 83 and 132 thousand tons of fresh apples were consumed in Slovenia yearly. In the period mentioned above a good 150 thousand tons of fresh fruit were used for food, of which about 50 thousand tons of fresh apples. According to the first estimates the average of 60% of fruit and apples as well were used for food in the fresh form.

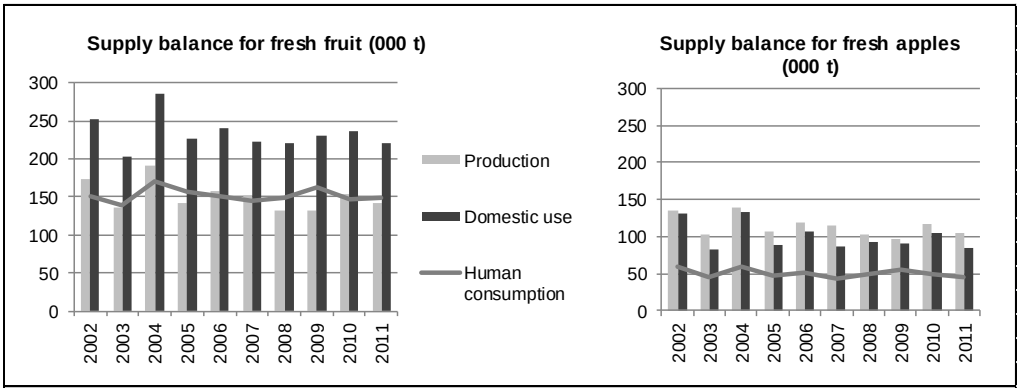


Figure 4. Fresh fruit and fresh apple production and consumption in Slovenia; 2002-2011

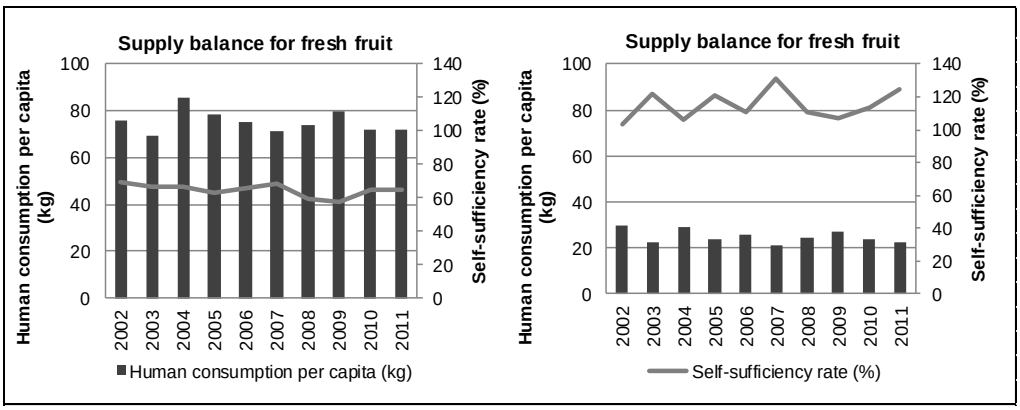


Figure 5. Human consumption of fresh fruit and fresh apples per capita and self-sufficiency rate of fresh fruits and fresh apples in Slovenia; 2002-2011

After 2002 an inhabitant of Slovenia consumed on the average between 70 and 85 kg of fresh fruit yearly, of which about 25 kg of fresh apples on the average.

About two thirds of domestic needs for fresh fruit in Slovenia are covered by domestic production reached by agricultural holdings. Apples are one of the rare agricultural products (Volk *et al.*, 2012a, Volk *et al.*, 2012b), of which the self-sufficiency rate both in the total (in some years) and the fresh consumption exceeds 100. The self-sufficiency rate of apples in the period starting from 2002 amounted to 86 and 117% and that of fresh apples to 103 and 131%.

Conclusions

In the period 2002-2011 the fruit production in Slovenia was considerably fluctuating since the height of yield depended on weather conditions and it was influenced by alternative fertility of extensive orchards. Slovenia is a net importer of fruit. In spite of a little lower import of fruit in the last two years a pronounced trend of its increase has been noticed. Also, the export of fruit has been increasing since 2002. The first estimates prepared on the basis of fruit supply balances and fresh fruit supply balances point out that the domestic use of fruit in Slovenia exceeds the domestic production. After 2002, between 245 and 350 thousand tons of fruit were consumed yearly, of which a good third were apples. In the years from 2002 to 2011, between 132 and 191 thousand tons of fruit were produced in Slovenia satisfying between 38 and 59% of domestic needs for fruit. In the period mentioned, between 96 and 140 thousand tons of apples were produced in the extensive orchards and apple orchards plantations. According to supply balance estimates the production mentioned above covered between 86 and 117% of domestic needs for apples in individual years while the self-sufficiency rate with fresh apples amounted to 103 and 131%. In Slovenia about 85% of fruit used on the average are intended for human consumption. An inhabitant of Slovenia consumed between 100 and 150 kg of fruit in all forms (calculated into fresh fruit equivalent) on the average in the years between 2002 and 2011, of which between 30 and 45 kg of apples. Data on the fresh fruit consumption are important above all from the nutritional point of view. According to the first estimates, in Slovenia 60% of fruit are consumed in the fresh form on the average.

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ПРОИЗВОДСТВО И ПОТРОШУВАЧКА НА ОВОШЈЕ ВО СЛОВЕНИЈА ВО ПОСЛЕДНИВЕ ДЕСЕТ ГОДИНИ

Марјета Пинтар, Барбара Загорч

Апстракт
Производството и потрошувачката на овошје во Словенија беа пресметани на база на балансот на снабдување со овошје. Балансот на снабдување со овошје ги опфаќа сите типови на овошје (свежо и обработено) и сите овошни видови. Направен е индивидуален баланс на снабдување за секој овоштен вид. Балансот на снабдување со свежо овошје (вклучува само свежо овошје) исто така е направен. Поради големото значење на јаболкото за Словенија, балансот на снабдување со јаболко (свежо и обработено) и балансот на снабдување со свежо јаболко исто така е презентиран во овој труд. Во периодот од 2002-2011 производството на овошје зависеше од временските услови. Словенија е нето увознк на овошје. Од увезеното овошје од 50- 60% се банани и цитруси. После 2002 увозот и извозот на овошје рапидно се зголемил. Во периодот 2002-2011 домашната употреба на овошје вариираше во границите помеѓу 245 и 350 илјади тони на овошје годишно од кои една третина беа јаболка. Стапката на само – задоволување со овошје беше помеѓу 38 и 59%. Во периодот 2002-2011 секој жител на Словенија просечно конзумирал од 100 до 150 kg на овошје (половина во свежа состојба) од кои 30 до 45 kg се јаболка (околу 25 kg беа конзумирани во свежа состојба).
Клучни зборови: овошје, јаболка, баланс на снабдување, производство, конзумирање.

UDC:634.22-152.7
Original scientific paper

THE SELECTION OF VEGETATIVE ROOTSTOCKS FOR PLUM

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Abstract
Modern plum cultivation involves the use of selected vegetative rootstocks, primarily those exhibiting lower vigour. Balkan region has a large fund of autohtonic cultivars and genotypes of stone fruits of the *Prunus* genus, which can be presumably used in the development of high-quality vegetative rootstocks. The present paper examines the possibility of vegetative rootstock selection in seven genotypes of autochthonous plums of different species of the *Prunus* genus, being as follows: *Prunus domestica* L. and *Prunus cerasifera* Ehrh. Plum vegetative rootstocks were propagated by mounding as a type of vegetative propagation. The rooting potential was very low in genotypes derived from *P. cerasifera* Ehrh. (2.8% and 3.5%). Relatively good regenerative ability was exhibited by the genus *P. domestica* L. The five genotypes showed a highly variable percentage of mother bushes responding to rooting, ranging from 10.4% to 90%.
Key words: plum, vegetative rootstocks, autochthonous genetic material.

Introduction

The selection for growing plum is currently of great concern. One of the main preconditions for successful cultivation plums is choise rootstock. Rootstock selection gains increasingly high importance due to current problems in the cultivation of the plum (plum pox virus). In stone fruit cultivation, vegetative rootstocks should be given priority over generative ones. A good rootstock is expected to be easily propagated (vegetatively or generatively); to be able to create a straight smooth tree that can be easily grafted; to be compatible with cultivated varieties; not to produce root shoots; to produce grafted fruit trees characterized by the lowest possible vigour, precocity and abundant cropping; to result in uniform fruit tree behaviour in the orchard; to have a good anchoring ability and adequate tolerance to mineral deficiency, these are general objectives of fruit tree rootstock selection (Misic, 1984).

The selection of rootstocks for plum cultivation is crucial to longevity, productivity, quality and maturation of the fruit of grafted cultivars. When cultivating the plum, priority should be given to vegetative rootstocks, which have not come into wide use under this region agroenvironmental conditions, yet (Milosevic, 2002). The advantages of vegetative rootstocks over generative ones include the following: seedling uniformity in both the nursery and the orchard, precocity of grafted cultivars, simpler method of propagation etc. The primary disadvantage of vegetative rootstocks is risk of virus transmission, hence the necessity for a strict safety control of the seedlings grafted on vegetative rootstocks (Milosevic, 2002).

Material and methods

Over 1998-2003, examinations were conducted on the possibility of selecting vegetative rootstocks for stone fruits from autochthonous genetic material.

The possibility of selection of vegetative rootstocks from autochthonous genetic material of plum was studied in seven genotypes of different cultivars of autochthonous plums of the genus *Prunus*, i.e. *Prunus domestica* L. and *Prunus cerasifera* Ehrh.:

- genotype 1/8 - Belosljiva (*P.domestica* L.)
- genotype 3/8 - Crvena Ranka (*P.domestica* L.)
- genotype 7/8 - Crnošljiva (*P.domestica* L.)
- genotype 8/8 - Crnošljiva (*P.domestica* L.)
- genotype 10/8 - Crnošljiva (*P.domestica* L.)
- genotype 5/8 - Džanarika (*P.cerasifera* Ehrh.)
- genotype 6/8 - Džanarika (*P.cerasifera* Ehrh.)

The seedlings of the genotypes examined were used to create a mother plantation of the selection I where mounding was employed during the growing season for testing of the root regeneration ability.

Mounding was used as a type of vegetative rootstock propagation. At the end of the growing season, testing for rooting was performed.

The analysis of the rate of rooting at the mother plantation of the selection I included the following:

- the ability to emit rooted shoots (number of mother bushes showing response),
- average number of rooted shoots per mother bush,
- average shoot length per mother bush,
- singling out individual bushes with a positive rate of rooting
- assessment of predispositions of certain species of the *Prunus* genus and their genotypes to vegetative rootstock selection.

Results and discussion

The rooting ability was examined in the mother plantation of the selection I made up of seedlings of seven autochthonous plum genotypes studied (table 1). The rooted shoot emission ability was tested in 1362 mother plants. The response to rooting was registered in 144 mother plants (accounting for 10.6 % of the total number).

The results presented in table 1 suggest a great difference between certain species of the *Prunus* genus as well as between certain genotypes within the same genus. Regenerative abilities were different in certain species of the *Prunus* genus.

The rooting ability in genotypes derived from *Prunus cerasifera* was found to be very low (the percentage of mother bushes showing response to rooting was very low – 2.8% and 3.5%, respectively). The percentage of mother bushes responding to rooting was highly variable, ranging from 10.4% to 90%.

The long-term examination of regenerative abilities of autochthonous plums aimed at vegetative rootstock selection (Lucic et al. 1994) indicates that if the number of individuals within the same genotype displays positive response to the rooting test (10-15%), this can be considered a good result. The rate of rooting is a crucial, but not the only selection parameter. This is the reason why further investigations included all of the genotypes that responded to rooting.

Table 1. Rooting ability in the mother plantation of selection I

Item	Genotype	Origin	Total number of mother bushes	Number of mother bushes showing response	% of mother bushes showing response
1	1/8	*P.domestica* L.	243	36	14.8
2	3/8	*P.domestica* L.	192	20	10.4
3	5/8	*P.cerasifera* Ehrh.	543	15	2.8
4	6/8	*P.cerasifera* Ehrh.	312	11	3.5
5	7/8	*P.domestica* L.	28	25	89.3
6	8/8	*P.domestica* L.	20	18	90.0
7	10/8	*P.domestica* L.	24	19	79.2
∑	7		1362	144	

The assessment of the potential of certain species of the genus *Prunus* to develop root on the mounded part of the aerial system suggests that seven of the ten genotypes derived from *Prunus domestica* L. produced rooted shoots (Paunovic, 2008). The rooting ability was also registered with the species *Prunus cerasifera* Ehrh., *Prunus insititia* L. and *Prunus spinosa* L. The number of rooted mother bushes per individual genotype was higher in the species *Prunus domestica* L. as compared to the other ones. Therefore, the highest potential to develop vegetative progeny in the production of vegetative rootstocks by mounding was exhibited by the above species.

For the purpose of developing vegetative rootstocks, the selection of mother bushes displaying the best shoot rooting performance was conducted at the mother plantation of selection I. The selection of plants with the best rooting ability will be used in further selection and research. As the rate of rooting is not the only parameter of vegetative rootstock selection, due attention should be given to other parameters - shoot emission and vigour.

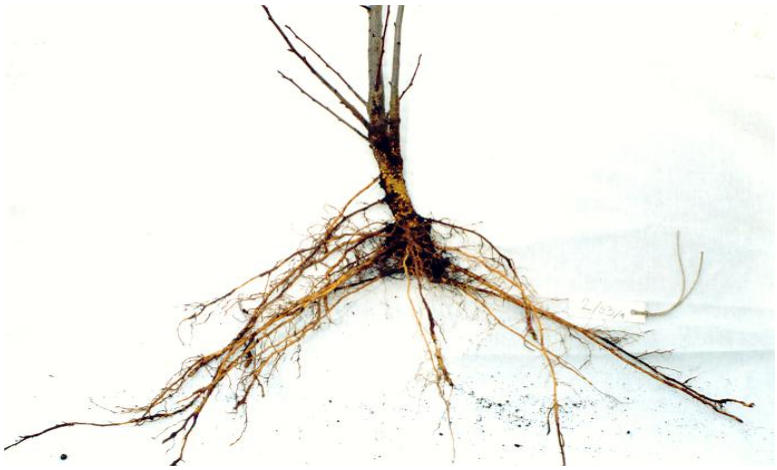


Figure 1. Rooted shoot of the *Prunus domestica* L

The average number and average length of the rooted shoots per mother bush are presented in table 2. The average shoot number per mother bush ranged from 2.4-4.1. The highest and lowest shoot numbers per mother bush were recorded in the genotypes 5/8 and 8/8, respectively. Lucic et al. (1994) report that the genotypes producing less than three shoots per mother bush are of no interest for further investigation as this is a small number of rooted shoots. Their further investigations involved genotypes with more than three shoots emitted. Kapetanović et al. (1972) examined vegetative progeny by mounding. The number of rooted shoots per mother bush in their research ranged from 6.1 in Ruzica to 13 in Banjalucka Bjelica. They reported that the number of rooted shoots was greatly dependent on climate conditions in the mounding period; namely, the rooting of mother bushes was determined to be lower during the drought period accompanied by high temperatures.

Apart from the number of rooted shoots, the above authors gave a review of the variations in the rooted shoot number per mother bush, suggesting that the number was rather high (ranging from 4.5-23 in Banjalucka Bjelica and from 2-11.5 in Ruzica).

As the number of rooted shoots per mother bush ranged in some genotypes, the selection of mother bushes with the highest production of rooted shoots to be used in further vegetative propagation should be conducted. The average length of the aerial part of the rooted shoots ranged from 29.7-44.3 cm (Tab. 2). The rooted shoots had lower height, which was favourable in terms of the selection of lower-vigour vegetative rootstocks. Kapetanovic and Prica (1976) reported good rooting per mother bush, but rather vigorous growth of rooted shoots, which was not favourable in terms of the selection of lower-vigour vegetative rootstocks.

Table 2. The average number and average length of rooted shoots per mother bush

Genotype	Number of mother bushes producing rooted shoots	Average number of rooted shoots per mother bush	Average length of rooted shoot aerial system (cm)
1/8	36	3.0	32.4
3/8	20	2.8	29.7
5/8	15	4.1	44.3
6/8	11	3.6	39.6
7/8	25	3.3	34.1
8/8	18	2.4	35.2
10/8	19	3.7	37.0

Conclusions

The long-term research results on the ability of selection of vegetative rootstocks for plums from autochthonous genetic material suggest the following:

Genotypes origin from *Prunus domestica* L. and *Prunus cerasifera* Ehrh. exhibited high variability in vegetative propagation.

The ability to develop new vegetative rootstocks from autochthonous genetic material was determined to be different in certain species of the *Prunus* genus. It was low among the *Prunus cerasifera* Ehrh. species and relatively good in *Prunus domestica* L.

All examined genotypes of the species *Prunus domestica* L. showed very different ability of root regeneration on the mounded shoot parts. Some autochthonous plum genotypes showing quite a wide range of the ability – from low (2.8-3.5%) to high (79.2-90%).
The rooted shoots had lower height (29.7-44.3 cm), which was favourable in terms of the selection of lower-vigour vegetative rootstocks.

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СЕЛЕКЦИЈА НА ВЕГЕТАТИВНИ ПОДЛОГИ ЗА СЛИВА

Горица Пауновиќ, Љиљана Бошковиќ-Ракочевиќ, Миљан Цветковиќ

Апстракт
Модерното производство на слива вклучува употреба на селектирани вегетативни подлоги. Балканскиот регион изобилува со автохтони сорти и генотипови на коскесто овошје од родот *Prunus*, кои може да се искористат за развојот на висококвалитетни вегетативни подлоги. Во овој труд е прикажана можноста за селекција на вегетативни подлоги во седум генотипови од автохтоните видови сливи од родот *Prunus*, следниве видови се искористени: *Prunus domestica* L. и *Prunus cerasifera* Ehrh. Кореновиот потенцијал беше многу мал кај генотиповите добиени од *P. cerasifera* Ehrh. (2.8% и 3.5%). Релативно добра регенеративна способност имаа подлогите добиени од родот *P. domestica* L. Петте генотипови покажаа високо варијабилен процент на вкоренување, во границите од 10.4 до 90%.
Клучни зборови: слива, вегетативни подлоги, автохтон генетски материјал.

UDC:634.11.076(497.6)"2005/2007"
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CHARACTERISTICS OF MATURE APPLE FRUITS DEPENDING ON THE TRAINING FORM AND PRUNING SYSTEM

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Abstract
The paper aim was to analyze the influence of training form and pruning system on the characteristics of mature apple fruits. The research was performed in Eastern Herzegovina (Ljubinje) in the period 2005 - 2007. The study included the cultivar Idared, Gloster and Melroza being 20 years old and grafted on MM106 rootstock. With a certain number of trees there have been performed reconstructions of training form spindle with short pruning to training form central axis (solaxe) with long pruning system, in order to increase the level of productivity. Variety characteristics were comparatively studied through: distribution of fruit depending on the diameter of the fruit and average weight according to the average size of fruits in different training forms and pruning systems. The participation of fruits with optimum size, was higher in solaxe training form during the research period for all cultivars. Solaxe training form with long pruning system show a higher cumulative yield that ranged from 27.67% in the cv. Idared, 32.22% in cv. Melroza and 74.03% in cv. Gloster. Research has shown that studied cultivars have higher yield and fruit quality in growing form solaxe with long pruning in relation to training form spindle and short pruning system. Introduction of the training form solaxe and long pruning system within the reconstruction of spindle resulted in the differences in yields. The differences in yield indicate positive effects of introduction of those treatments within analyzed cultivars with the special economic results for Idared and Gloster.
Key words: variety, spindle, solaxe, pruning system.

Introduction

By definition orchard system includes a coherent set that consists of the following components: growing type, planting density and specific combination cultivar/rootstock under given growth conditions (Monney et al, 1993; Blaser, 1996; Micic et al, 1998, 2005). The introduction of slender spindles in fruit production during seventies start realization of the „pedestrian orchard" concept, as a new intensive and highly productive period in the development of fruit production (Micic et al, 1998, 2001, 2005).

Solaxe growing form is formed as a combination of a vertical axis, which was originally called the ax and Solen (Hucbourg et al., 1996, Lespinasse JM, et Lauri P. E, 1999.). This provides a compound solen+ax=solaxe or Sun axis (Stampar, 2000). Solaxe has a number of advantages (Yuri, 2007), which is particularly manifested by increased average yield (Hansen, 2009), which in certain

production conditions may be 20 to 30 % more when compared to a slender spindle (Stampar, 2007).

In intensive training forms a basis for economical fruit prodution is yield (Blazek and Hluščikova, 2007; Lukic et al, 2005; Oparanica et al, 2000; Cvetkovic, 2001) that can be achieved by regular fruiting (without the appearance of alternative cropping) in certain combinations of cultivar/rootstock (Micic and Djuric, 1994; Keserović et al, 2005).

Material and methods

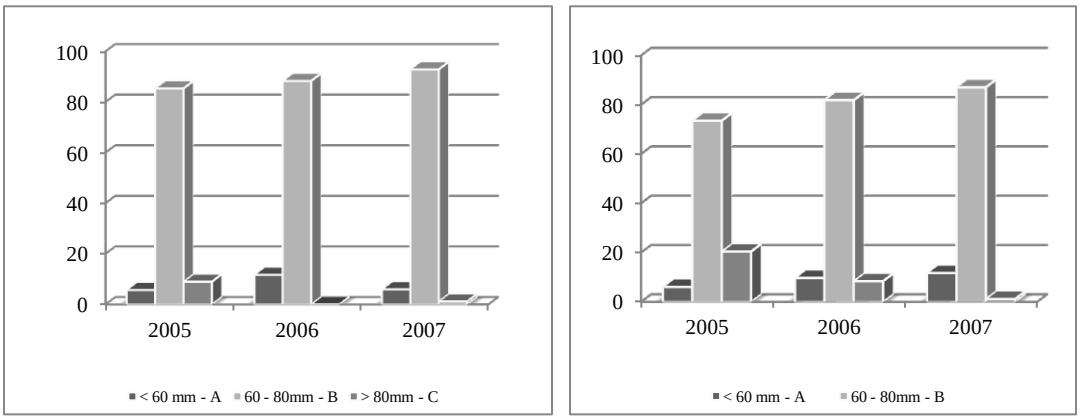
The research was performed in Eastern Herzegovina (Ljubinje) in the period 2005 - 2007. Study included the cultivars Idared, Gloster and Melroza, 20 years old grafted on MM106 rootstock. Orchard was establish in 1986. The planting distance is 4 × 1.3 m for all varieties. In plantation the standard agricultural practices was applied. Generally, trees are maintained in a "slender spindle" training form with the use of short pruning of productive tree. With a certain number of fruit trees (300) there have been performed reconstructions of training form being spindle with short pruning to training form central axis (solaxe) with long pruning system, in order to increase the level of productivity.

Characteristics of ripe fruit harvested from 20 trees grown in the form of spindle and central axis form, was analyzed during three years of research. The thinning of fruits was not implemented.

Distribution of the fruits in certain defined categories on fruit diameter base, and average weight of fruit in each category was measured. There are defined three fruit categories based on the size of fruit diameter: category B - fruit diameter from 60 to 80mm, which meets the standards of the first category and the extra fruit category; category A - fruit diameter less than 60mm and category C - fruit diameter greater than 80mm. Fruits from category A and C belong to second or outside of class. After fruit classification in the defined categories, for each category it was determined the average weight of fruit. All data were statistically analyzed and expressed in relative terms, and the mean structure with appropriate indicators of variations.

Results and discussion

Idared. Training form with long pruning system expressed the highest share of the fruits with optimal size when compared to the other two categories with a tendency to increase during the research period (data obtained from the central axis) (Graph 1). Share of small fruit (category A) was higher when compared to large fruit (category C). In the spindle training form with short pruning system there have been registered higher share of larger fruit within all years of study (except dominantly represented optimum sized fruit).



a. b.

Figure 1 (a, b). Distribution of fruit cv Idared depending on the diameter: a) central axis form – long pruning, b) slender form – short pruning.

Weight of fruits that are in the group with optimal diameter, is quite uniform regardless the growing form and pruning system and it is in the range of 129.50 to 154.73 g (Table 1). Special differences in fruit weight depending on the training form and pruning system are recorded in the group of large fruit (category C). Blazek and Hluscikova (2007) indicate that the average fruit weight of cv. Idared grafted on M9 rootstock in the first 10 years of fruiting ranged from 103.60 to 293.70 g, and the average fruit weight was 181,80 g. Examining the potential of cv Idared in Čačak in the previous period Cvetkovic (2001), states that the average fruit weight of cv Idared on the MM106 rootstock in an orchard 8 years of age was 184 g. Lukic et al. (2005), analyzing the properties of cv. Idared in Čačak in 2003-2004, were determined average fruit weight of 217.5 g.

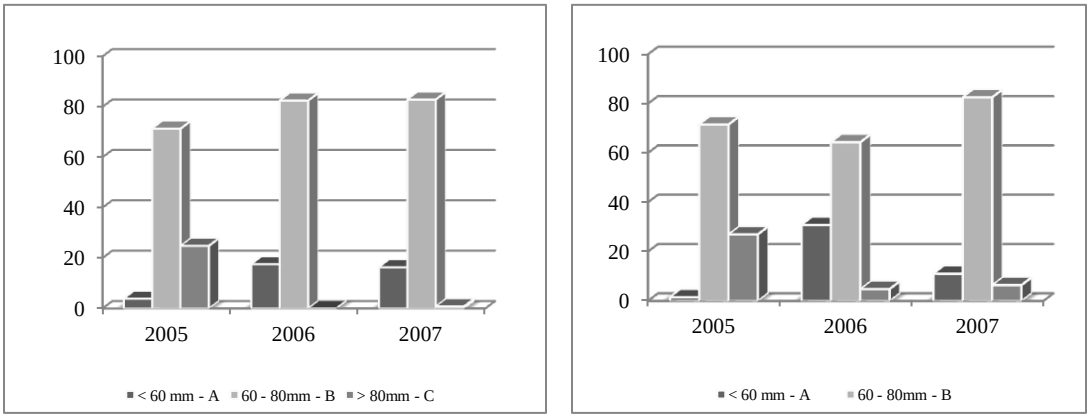
Table 1. The average fruit weight (g) cv. Idared depending on the average size of fruits in different growing form and pruning systems

	year	fruit diameter (mm)		
		< 60	60 – 80	80 – 100
spindle form – short pruning system	2005	89.71 ± 5.04	139.00 ± 5.21	198.30 ± 4.73
	2006	76.69 ± 4.34	133.30 ± 10.70	212.75 ± 4.98
	2007	82.66 ± 7.31	154.73 ± 6.27	204.48 ± 4.51
central axis form – long pruning system	2005	82.75 ± 4.48	129.50 ± 5.17	179.69 ± 2.55
	2006	83.00 ± 3.91	141.00 ± 7.36	–
	2007	70.69 ± 2.35	146.82 ± 4.31	179.42 ± 5.13

Oparnica et al. (2000), state the average weight of fruit from 169.72 to 189.00 g, depending on the type of fruit branches.

Gloster. In the central axis training form with long pruning system has highest percentage of fruits having optimal diameter with a tendency to increase participation during the study period (Graph 2). In 2006 and 2007, there where higher percentage of small fruits (category A) in relation to large fruits (category C). In spindle training form with short pruning system during the whole period of

research the highest percentage of fruits were with optimal diameter, with significant fluctuations over the years.



a. b.

Figure 2 (a, b). Distribution of fruit cv. Gloster depending on the diameter: a) central axis form – long pruning, b) slender form – short pruning

Weight of fruit cultivars Gloster in the group with optimal diameter is quite uniform, stating higher fruit weight in a spindle training form with short pruning. Fruit weight regardless training form and pruning system ranged from 77.25 to 240.19 g (Table 2).

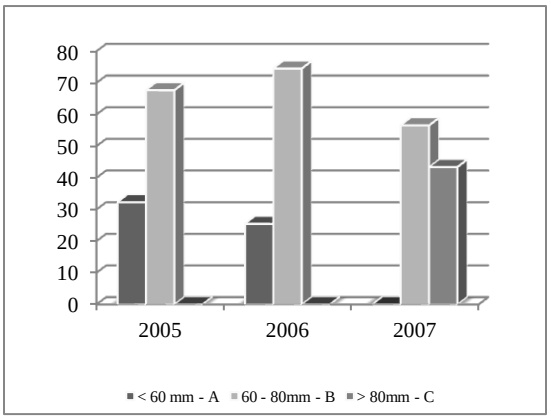
Table 2. The average fruit weight (g) cv. Gloster depending on the average size of fruits in different growing form and pruning systems

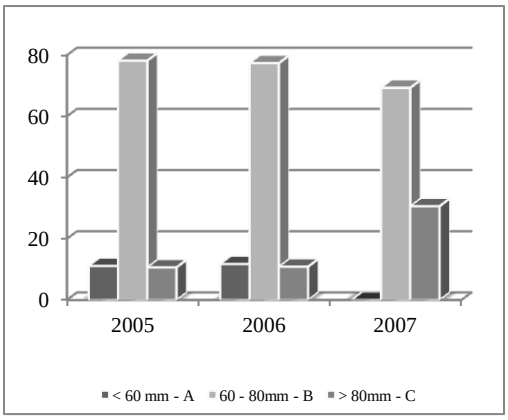
	Year	fruit diameter (mm)		
		< 60	60 – 80	80 – 100
spindle form – short pruning system	2005	91.25 ± 6.47	163.30 ± 4.11	240.19 ± 9.03
	2006	83.50 ± 4.63	148.62 ± 13.84	200.66 ± 6.17
	2007	79.86 ± 3.36	152.41 ± 7.79	198.30 ± 8.92
central axis form – long pruning system	2005	83.00 ± 3.18	144.80 ± 4.82	199.39 ± 4.97
	2006	77.25 ± 3.45	127.80 ± 6.29	–
	2007	83.18 ± 2.08	146.54 ± 6.28	208.89 ± 1.84

Blazek and Hluscikova (2007) report that the average fruit weight cv. Gloster in the first 10 years of fruiting ranged from 133.00 to 331.40 g, and the average weight for a period was 208.10 g. Cvetkovic (2001) states that the average fruit weight of cv. Gloster on M9 rootstock in the plantation age 3 years was 243 g. Oparnica et al. (2000), found the average weight of fruit from 216.14 to 246.36 g depending on the type of fruit branches.

Melrose. In both training form the share of the fruits with optimal size was the highest compared to the other two categories, especially in spindle. In growing form central axe there is indicated a

significant share of small fruits (category A) in 2005 and 2006 and large fruits (category C) in 2007 (Graph 3).





a. b.

Figure 3 (a, b). Distribution of fruit cv. Melrose depending on the diameter: a) central axis form – long pruning, b) slender form – short pruning

The average fruit weight of cv. Melrose ranged from 67.00 to 250.73 g, during the study period (Table 3).

Table 3. The average fruit weight (g) cv. Melrose depending on the average size of fruits in different growing form and pruning systems

	Year	fruit diameter (mm)		
		< 60	60 – 80	80 – 100
spindle form – short pruning system	2005	78.30 ± 5.71	150.10 ± 11.46	238.50 ± 28.50
	2006	67.00 ± 3.53	127.30 ± 10.46	222.80 ± 24.05
	2007	–	168.88 ± 6.27	250.73 ± 7.94
central axis form – long pruning system	2005	88.90 ± 3.44	145.78 ± 6.40	–
	2006	75.30 ± 3.44	122.69 ± 6.40	–
	2007	–	184.42 ± 5.81	220.93 ± 5.69

Blazek and Hluscikova (2007) report that the average weight of fruit varieties Melrose in the first 10 years of fruiting ranged from 144.80 to 343.70 g, and the average weight for a period of study was 227.10 g. Cvetkovic (2001) states that the average weight of fruit cv. Melrose from orchards 3 years of age was 215 g.

In all the cultivars there is a noticed higher yield in the central axis of training form in relation to the spindle. Percentage increase in yield ranged from 27.67 % in the cv. Idared, 32.22 % in the cv. Melorse to 74.03 % in the cultivar Gloster (Table 4). Absolute increase in Idared bringing the yield to 38.15 t/ha justified the reconstruction of training form and introduction of long pruning system. Blazek and Hluscikova (2007) reported that the average yield in the cultivar Idared in the first ten years with densities of 2500 trees/ha was at the level of 40.9t/ha which is consistent with the results

achieved in research. Studying the reconstructed Idared trees growing in spindle growing form (originally palmete) in Maribor, Štampar (2001), presents data on the average yield of 60 t/ha. Keserović et al (2005) reported data showing significant yield variation in cv Idared that varied from 3.65 to 60.42 t/ha. The average yield in the period was 25.52 t/ha.

Table 4. Average yields (t/ha) in different training forms and pruning systems

cultivar	year	spindle form – short pruning system	central axis form – long pruning system
Idared	2005	32.65 ± 2.91	26.52 ± 1.51
	2006	20.87 ± 1.92	49.47 ± 4.48
	2007	33.78 ± 2.39	35.46 ± 3.89
average		29.10	38.15
cumulative yield		87.30	111.45
difference in yield (%)		27.67	
Gloster	2005	11.01 ± 3.74	17.21 ± 4.34
	2006	15.01 ± 1.65	47.41 ± 6.23
	2007	30.94 ± 5.85	34.52 ± 4.85
average		18.98	33.05
cumulative yield		56.96	99.14
difference in yield (%)		74.03	
Melrose	2005	5.29 ± 0.99	12.15 ± 3.63
	2006	23.94 ± 4.27	25.23 ± 2.66
	2007	11.73 ± 1.85	16.79 ± 1.07
average		13.65	18.06
cumulative yield		40.96	54.17
difference in yield (%)		32.22	

Blazek and Hluscikova (2007) stateed that the average yield in the cultivar Gloster in the first ten years of cultivation and the planting density of 2500 plants per ha was 39.0 t/ha, which is slightly above average yields are get implemented in research.

Conclusions

Reconstruction of growing may be very successful in older fruit trees on vigorous rootstocks. During the three years it is possible to fully reconstruct the growing forms.

In all the cultivars increased yield was realized with central axe growing form with long pruning system in comparison with spindle growing form with short pruning system.

The difference in the cumulative yield ranges from 27.67 % in the cv. Idared to 74.03 % in the cv. Gloster. Absolute increase in yield has a special significance in cv. Idared.

In both growing forms for all cultivars fruit with optimal diameter constituted the largest percentage of total fruits. Slightly higher share of smaller and larger fruits were found in the spindle growing form. Average fruit weight in all cultivars was slightly lower than usual.

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КАРАКТЕРИСТИКА НА ЗРЕЛИТЕ ПЛОДОВИ ОД ЈАБОЛКА ВО ЗАВИСНОСТ ОД СИСТЕМОТ НА ОДГЛЕДУВАЊЕ И РЕЗИДБАТА

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Апстракт

Целта на овој труд беше да се испита влијанието на системот на одгледување и резидба врз карактеристиките на зрелите плодови од јаболка. Истражувањето беше спроведено во Источна Херцеговина (Љубиње) во периодот од 2005 - 2007. Во истражувањето беа вклучени сортите Ајдаред, Глостер и Мелрозе стари 20 години и калемени на ММ106 вегетативната подлога. На одреден број на дрва беше изведена реконструкција од витко вретено во солакса (solaxe) со долг систем на резидба, се со цел да се зголеми нивото на продуктивност. Карактеристиките на сортите беа компаративно испитани преку: дистрибуција на плодовите во зависност од дијаметарот на плодовите и просечната тежина према просечната големина на плодовите во различни системи на одгледување и резидба. Највисоко учество на плодови со оптимална големина во текот на истражувањето кај сите сорти беше забележана кај системот на одгледување солакса. Солакса системот на одгледување со долг систем на резидба покажа повисок кумулативен принос кој се движеше од 27.67% кај сортата Ајдаред, 32.22% кај сортата Мелрозе и 74.03% кај сортата Глостер. Истражувањето покажа дека испитуваните сорти имаат поголем принос и квалитет на плодовите при системот солакса со долга резидба , во споредба со витко вретено и кратка резидба. Кај овошките кај кои беше воведен системот на одгледување солакса со долга резидба преку реконструкција на системот на одгледување витко вретено, покажаа разлики во приносот. Разликите во приносот покажаа позитивен ефект од воведувањето на овој систем на одгледување кај испитуваните сорти, со поволни економски резултати за сортите Ајдаред и Глостер.

Клучни зборови: сорта, витко вретено, солакса, систем на резидба.

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Original scientific paper

THE CHOICE OF A NUTRIENT MEDIUM FOR IN VITRO VEGETATIVE PROPAGATION OF A STEP SOUR CHERRY (PRUNUS FRUTICOSA, PALL)

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Abstract
The process of *in vitro* vegetative propagation depends on various factors – fruit species, the age of explants, size and type of isolated explants, the season of explant collection. A nutrient medium is one of significant factors for successful process of micropropagation. Therefore, three nutrient media were examined for the multiplication phase of a step sour cherry shoot (*Prunus fruticosa*, Pall). They varied in mineral contents (MS – Murashige and Skoog, 1962: DKW – Driver and Kuniyuki, 1984 and WP – Lloyd and McCown, 1980). The following was added to nutrient media: saccharose (3%), agar (0.8%) and in mg l^{-1} – B_1 (0.5): B_6 (0.5): inositol (100): Ca-pantothenate(10): IBA (0.1): BAP (1.5) and GA_3 (0.1). Six nutrient media were tested for shoot rooting. In MS and DKW mineral solutions, salt concentration was reduced by half, while WP mineral solution was used according to the recipe. Beside that, root media contained saccharose (1%) and in mg l^{-1} –B_6 (4.0): inositol (200): biotin (0.2) and IBA (1.5 or 2.0). The best multiplication of step sour cherry shoots of genotype SV11 was accomplished on MS3-nutrient medium, about 5 shoots per culture, while the best multiplication of genotype SV 2 was accomplished on the medium DKW3. The nutrient medium for rooting with WP-mineral solution was the best for both examined genotypes. All shoots (100%) rooted on these media. The results of the research indicate the importance of the choice of a nutrient medium and show that it is possible to produce vegetative dwarfing rootstocks for a cherry and sour cherry by *in vitro* vegetative propagation of a step sour cherry.
Key words: step sour cherry (*Prunus fruticosa*, Pall), nutrient medium, *in vitro* vegetative propagation.

Introduction

A step sour cherry (*Prunus fruticosa*, Pall.) can be found in our region as shrubbery and hedges in abandoned vineyards and on rocky ground. So far it has been used for creating new rootstocks as one of the parents. Due to its extremely low vigor, it could replace vigorous rootstocks used up to now, which would facilitate all agrotechnical measures and reduce cherry and sour cherry production costs.

The selection program of the Department of fruit growing, viticulture, horticulture and landscape architecture undertakes the study and selection of dwarfing rootstocks for cherries and sour cherries. It has been selected several varieties of a step sour cherry (*Prunus fruticosa*, Pall.) which should be multiplied, and therefore, it has been studied the process of micropropagation of two genotypes.

Material and methods

Plant material: Shoot tips of two step sour cherry genotypes (SV2, SV11) were isolated from a natural population within the habitat on Fruska gora and put into *in vitro* culture.

Methods: Shoot tips of 5-7 mm in length were isolated in May from a natural population. After sterilization in accordance with the procedure presented in the paper by Gološin and Radojević (1985), the shoot tips of a step sour cherry were cultured on different nutrient media, depending on the phase of *in vitro* culture.

The basic nutrient medium contained a mineral solution (MS-Murashige and Skoog, 1962; DKW-Driver and Kuniyuki, 1984 or WP-Lloyd and McCown, 1980), saccharose (3%), agar (0.8%), and in mg l^{-1}: B_1 (0.5), B_6 (0.5), inositol (100) and Ca-pantothenate (10). Depending on the phase of growth and development, growth regulators were added to the basic nutrient medium in different concentrations. In the phase of shoot multiplication, the following was added to the basic nutrient medium: (in mg l^{-1}): BAP (1.5), IBA (0.1) and GA_3 (0.1). The media were marked according to the used mineral solutions as MS3, DKW3 and WP3. Six nutrient media were tested for shoot rooting. In the basic nutrient medium, the concentration of mineral salts was reduced by half (in MS and DKW) and saccharose to 1%, while the content of the following compounds was increased: (in mg l^{-1}) inositol (200), vitamin B_6 (4.0) and biotin (0.2) which was added to the medium for the first time. Two concentrations of indole butyric acid (IBA) in the medium were examined (1.5 mg l^{-1} IBA - MSO3, DKWO3 and WPO3; and 2.0 mg l^{-1} IBA - MSO4, DKWO4 and WPO4). Cultures were grown under controlled conditions at a temperature of 26±2 °C, with a photoperiod of 16h light/day. Rooted shoots were transplanted to plastic containers and acclimated in the laboratory, after which they were planted to a nursery.

Results and discussion

Formed leaf rosettes of the examined genotypes of a step sour cherry were subcultivated on different nutrient media for multiplication. Multiplication was conducted by formation of axillary buds (table 1). Shoot multiplication of a step sour cherry was more or less successful depending on the genotype and nutrient medium. On the examined media, a good multiplication was achieved for both genotypes (SV2 and SV11). The medium MS3 was the best for the multiplication of SV11 (4.87 shoots per culture), while DKW3 was the best for the genotype SV2 (3.75 shoots per culture). Dai Han Ping et al. (2001) argue that the best multiplication of a step sour cherry was accomplished on MS mineral solution, while Saponari et al. (1999) achieved the best multiplication of *P. mahaleb* on a medium with DKW mineral solution containing 1.0 mg l^{-1} of BA.

Table 1. Shoot multiplication of different genotypes of a step sour cherry (SV2, SV11)

Genotype of a step sour cherry	Nutrient medium	Total number of cultures	Newly formed buds	
			total number	average number
SV2	MS3	189	613	3.24
	DKW3	175	656	3.75
	WP3	139	331	2.38
SV11	MS3	373	1815	4.87
	DKW3	205	858	4.19
	WP3	145	318	2.19

Shoots which grew by 1 cm or more in the phase of multiplication were subcultivated on a medium for rooting. Depending on the mineral solution, the concentration of IBA in the medium and the genotype, it was achieved different rooting of tested genotypes of a step sour cherry in *in vitro* culture (table 2).

Table 2. Shoot rooting of different genotypes of a step sour cherry (SV2 i SV11)

Genotype of a step sour cherry	Nutrient medium	Number of shoots in a culture	Average number of roots per shoot	Average length of root (mm)	Rooted shoots	
					number	%
SV2	MSO3	18	3.50	50.86	4	22.22
	MSO4	19	0.00	0.00	0	0.00
	DKWO3	16	2.60	41.00	10	62.50
	DKWO4	14	2.33	29.14	6	42.86
	WPO3	16	3.56	36.45	16	100.00
	WPO4	16	4.50	50.29	16	100.00
SV11	MSO3	48	5.23	48.47	39	81.25
	MSO4	39	4.70	16.99	23	58.97
	DKWO3	30	5.17	56.16	24	80.00
	DKWO4	24	5.83	62.20	24	100.00
	WPO3	24	3.83	63.80	24	100.00
	WPO4	32	4.00	56.75	32	100.00

Rooting of the total number of shoots of the genotype SV11 was conducted on the three examined media: DKWO4, WPO3 and WPO4, while two media were used for the genotype SV2: WPO3 (fig. 2) and WPO4. The media with diluted (½) DKW mineral solution containing IBA proved to be satisfactory for *in vitro* rooting of *Prunus mahaleba* (Saponari et al., 1999). Besides achieving very good shoot rooting of the genotype SV11, on the basis of examining the formed root system, it could be said that the increasing concentration of IBA led to the appearance of callus, although a sour cherry does not have that tendency (Riffaud and Cornu, 1981), but this has not significantly influenced the acclimatization of the rooted shoots of a step sour cherry.

Rooted plants were planted in plastic containers with a mixture of peat:perlite (3:1) and acclimated under laboratory conditions. After 5-6 weeks, plants were acclimated forming new leaves. Different acclimatization was achieved (table 3), depending on the genotypes of a step sour cherry. 63 plants (53.39%) were acclimated out of 118 SV11 plants produced *in vitro*, while the shoots of the genotype SV2 were acclimated worse (13.63%) (Bijelić et al., 2003; Bijelić, 2004).

Table 3. Acclimatization of *in vitro* produced shoots of different genotypes of a step sour cherry (SV2 i SV11)

Medium for cherry and sour cherry	Number of plants for rooting	Number of rooted plants	Number of successfully acclimated plants	%
SV2	52	22	3	13.6
SV11	166	118	63	53.3

Acclimated plants of a step sour cherry were planted to a nursery within the experimental field of the Faculty of Agriculture in Rimski Sancevi, where their further growth and development is monitored under field conditions.

Conclusions

Based on the studying of *in vitro* propagation of a step sour cherry and different physiological response in *invitro* culture, it could be concluded that there are very clear genetic differences between the examined genotypes.

Efficient multiplication of a step sour cherry in *in vitro* culture is possible. It depended on the genotype and the content of a nutrient medium. Different mineral solutions and concentrations of growth regulators had a great influence on the rate of multiplication and shoot rooting. The best *in vitro* multiplication of shoots as well as adaptation of *in vitro* plants to environmental conditions showed the genotype SV11.

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ИЗБОР НА ХРАНЛИВА ПОДЛОГА ЗА IN VITRO ВЕГЕТАТИВНО РАЗМНОЖУВАЊЕ НА ВИШНА (*PRUNUS FRUTICOSA*, PALL)

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Апстракт

Процесот на in vitro вегетативно размножување зависи од ралични фактори: овошниот вид, староста на експлантот, големината и типот на изолираните експланти, сезоната на прибирање на експлантите. Хранливата подлога е еден од најзначајните за успешна микропропагација. Затоа, три хранливи подлоги беа испитани во фазата на размножување на изданок од степска вишна (*Prunus fruticosa*, Pall). Тие варираа во содржината на минерални материи (MS – Murashige and Skoog, 1962: DKW – Driver and Kuniyuki, 1984 and WP – Lloyd and McCown, 1980). Во хранливата подлога беше додадено следново: сахароза (3%), агар (0.8 %) и во милиграми l^{-1} – B_1 (0.5): B_6 (0.5): inositol (100): Ca-pantothenate(10): IBA (0.1): BAP (1.5) и GA_3 (0.1). Шест хранливи подлоги беа тестирани за проценка на вкоренувањето на изданоците. Во MS и MKW минералните раствори, концентрацијата на соли беше редуцирана за половина, додека WP минералниот раствор беше употребен според рецептот. Покрај тоа подлогата за ожилување содржеше сахароза (1%) и во mg l^{-1} –B_6 (4.0): inositol (200): biotin (0.2) и IBA (1.5 or 2.0). Најдобро размножување на изданоците од киселата цреша, генотип SV11 беше постигнато на хранливата подлога MS3 околу 5 изданоци по култура, додека најдобро размножување на генотипот SV 2 беше постигнато на хранливата подлога DKW3. Додека хранливата подлога за ожилување со WP минерален раствор беше најдобра за двата испитувани генотипови. Сите изданоци (100%) се ожилија во оваа хранлива подлога. Резултатите добиени од ова истражување, укажуваат на значењето на изборот на хранлива подлога и на можноста за производство на слабобујни вегетативни подлоги за цреша и кисела цреша со *in vitro* вегетативно размножување на киселата цреша.

Клучни зборови: степска вишна (*Prunus fruticosa*, Pall), хранлива подлога, *in vitro* вегетативно размножување.

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Original scientific paper

EFFECT OF BUMBLEBEES (BOMBUS TERRESTRIS L.) POLLINATION ON FRUIT SET OF SOME APPLE CULTIVARS

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Abstract
In this paper the results of the two years investigation of influence of bumblebees pollination to fruit set of some apple cultivars in Prespa region are carried out. In the apple orchard two TRIPOL-hives (TRIPOL-hive = three colonies of *Bombus terrestris* in corrugated plastic box with temperature insulation) per 1 ha were placed during blooming period. The investigation included the following: the percentage of initial fruits set and final fruit set after June dropping on the experimental fruit trees. The results showed that on the fruit trees which were on the smallest distance from bumblebee hives the percentage of initial fruit were the highest. Also, the final fruit set was the highest on the fruit tress which were on the smallest distance from bumblebees hives.
Key words: apples, bumblebees, pollination, fruit set.

Introduction

The pollination is crucial part of successful fruit production. The fruit-set of most apple cultivars depends on cross pollination, and thus on the synchronization of their bloom with that of a compatible cultivar and on pollinating insects (McGregor, 1976; Free, 1993; Delaplane and Mayer, 2000). Although honey bee (*Apis mellifera* L.) colonies are often used for pollination in apple orchards, several other species have been studied as alternative pollinators throughout the world.

Since the beginning of the nineties of 20th century the use of bumblebees as pollinators is well established. Several commercial companies throughout the world are rearing colonies of bumblebees. The commercial most used species is *Bombus terestris* L. On the beginning in practice bumblebees were mainly used for pollination in glasshouses and plastic tunnels, especially to pollinate tomatoes. Lately, the global trade in commercial bumblebee (*Bombus* spp.) colonies provides pollination services for both glasshouse and open-field crops (Velthuis H.H. and Van Doorn A., 2006). In our country up to now the bumblebees are use for pollination of tomatoes and strawberries in glasshouses and plastic tunnels. In the orchards mainly honey bees are used as pollinators. However, when climate conditions are unfavorable for honey bee flight activity (cold, cloudy, rainy, windy weather) during the blooming period of fruit plants, the pollination is insufficiently successful. Having in mind this condition, the fruit yields are reduced. Therefore in practice alternatives to honey bee as pollinators, especially for apples pollination, are seek. The aim of this research was to investigate the possibilities for usage of bumblebees' colonies for pollination of apple trees. Bumblebees are flying under excessive and severe weather conditions, when honeybees (*Apis mellifera*) stop their flight activities. They are also flying at lower temperatures

(8^0C), on cloudy days and under stronger wind. In comparison with honey bee, bumblebee mainly visit flowers to forage pollen, and transfer more pollen to the stamen with each flower visit, which increase the chance for successful fruit set (Goulson D. 2009).

Material and methods

The effect of bumblebee pollination was investigated on two apple cultivars, Mutsu and Granny Smith grafted on M9 rootstock. Two apple cultivars, Red chief and Idared grafted on MM 106 were used as pollinators. The orchard was established in spring 2004 with a planting distance of 3.5 x1.5 m (1905 trees/ha). In the orchard two TRIPOL-hives (Tripol hive = three colonies of *B. terrestris* L. in corrugated plastic box with temperature insulation) per 1 ha were placed at the beginning of the blooming period. The investigation was performed in 2009 and 2010 year. Regarding the hives' distance from the trees there were 3 variants: 1 variant -Trees on distance of 0-30 meter to bumblebee hives; 2 variant -Trees on distance of 30-50 meter to bumblebee hives; 3 variant -Trees on distance more than 50 meter to bumblebee hives. Ten trees of each cultivar per variant were selected randomly. The number of total flowers at experimental trees was counted during the beginning of blooming. The initial percent of fruit set was calculated 2 weeks after end of blooming. The final fruit set was calculated after the June dropping of the fruits. We have analyzed effects of the factors such as year, variety and variant (DO) on the percentage of initial and final fruit set by using common Generalized linear model (GLM).

Results and discussion

The results for the analyzed effects of the factors such as year, variety and variant (DO) on the percentage of initial and final fruit set are presented in table 1 and table 2.

The data show that all three factors had significant effect on initial fruit set and only variety and DO had effect on the final fruit set. The effect of the year on pollination, according to many authors, come from different weather conditions during the flowering and post-flowering time. Weather have a direct effect on pollinators' activity, but can also influence fruit set in other ways. Low temperatures during early spring can result in reduced pollen production and pollen viability (Faust, 1989), as well as ovule sterility (Williams, 1969). Insufficient sunlight hours in the 10-day-period immediately after flowering significantly reduces fruit set, even after an optimal pollination period (Williams, 1991).

Table 1. Analysis of the effect of year, variety and variant (DO) on the percentage of initial fruit set

Source	df	Mean Square	F
Model	5	13613,597	384,767**
Year	1	433,200	12,244**
Variety	1	10193,633	288,107**
DO	2	2762,175	78,069**
Error	115	35,381	
Total	120		

R Squared = 0,944

Table 2. Analysis of the effect of year, variety and variant (DO) on the percentage of final fruit set

Source	df	Mean Square	F
Model	5	6647,942	582,348**
Year	1	33,075	2,897**
Variety	1	5161,408	452,130**
DO	2	687,108	60,189**
Error	115	11,416	
Total	120		

R Squared = 0,962

The differences of percentage of fruit set between cultivars are coming from the different number of flowers per tree. According to many authors, cited by Misic (1994), the number of flowers is in negative correlation with the percentage of fruit set. Some cultivars have 3 to 4 times more flowers than others and because of that cultivars can provide satisfactory yields despite the lower percentage of fruit set.

The bumblebees' hives distance from the fruit trees had significant effect of initial and final fruit set. The differences of percentage of fruit set between variants came from different distance of the bumblebees' hives from the experimental trees. In table 3 and table 4 are presented LS means values of the percentage of initial and final fruit set of experimental trees from our study. The highest fruit set (initial and final) was determined in the first variant (the trees that were closest to the bumblebees' hives) and the lowest in the third variant (the trees that were farthest to the bumblebees' hives). Previously, many authors cited that the influence of the distance of the bumblebees' hives from the experimental trees have significant effect on the fruit trees pollination. According to them bumblebees have short foraging distance, comparing to the honey bees, and they are not flying far for foraging (Goulson D. 2009, Kevan *et al*.1993, Moritz and Wolf, 2007). Wolf and Moritz (2008) reported that mean foraging distance of *B. terrestris* was 267,2 ± 180,3 m. However, according to the same authors 40% of the workers foraged within 100 m of the nest.

Table 3. Adjusted means values and standard errors of the percentage of initial fruit set of experimental trees

DO	LS Mean ± Std. Error
1,00	28,475±0,940
2,00	21,950±0,940
3,00	11,975±0,940

Table 4. Adjusted means values and standard errors of the percentage of final set of experimental trees

DO	LS Mean ± Std. Error
1,00	18,450±0,534
2,00	15,925±0,534
3,00	10,350±0,534

The data show that the differences between all variants are significant. It means that the effect of bumblebee's pollination is reduced with their distance to the fruit trees.

Conclusions

1. The organized pollination with bumblebees indicated significant influence on the percentage of fruit set on both investigated cultivars and years.
2. The highest percentage of fruit set was determined in the first variant (the trees that are closest to the bumblebees' hives). The effect of bumblebees' pollination is reduced with their distance to the fruit trees. Significant reduction of fruit set on the trees of triploid cultivar Mutsu, which were more than 50 meters away from bumblebees' hives, was estimated.
3. In areas with unstable weather conditions, during the apple blooming period, the pollination with bumblebees can be an alternative to traditional pollination by honey bees or other insects. For organized bumblebee pollination we are recommending introduction of 2 to 3 Tripol -bumblebees' hives per 1 ha, but their position to the fruit trees should not be further than 50 meters.

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ЕФЕКТ ОД ОПРАШУВАЊЕТО СО БУМБАРИ (*BOMBUS TERESTRIS* L.) ВРЗ ЗАВРЗУВАЊЕТО НА ПЛОДОВИ КАЈ НЕКОИ СОРТИ ЈАБОЛКА

Х. Кипријановска, С. Банџо, В. Ѓамовски, М. Кипријановски, А. Узунов

Апстракт

Во трудот се дадени резиултатите од двегодишните испитувања на влијанието на опрашувањето со бумбари кај некои сорти јаболка во регионот на Преспа. Во насад од јаболка за време на цветањето беа населени 2 TRIPOL-кошници (TRIPOL-кошница е импрегнирана пластична кутија во која се населени три семејства од *Bombus terrestris*) на 1 хектар. Истражувањата вклучуваат: процент на почетно заврзување на плодови и финално заврзување на плодови по јунското опаѓање на плодовите кај експерименталните стебла. Резултатите покажуваат дека кај стеблата кои се на најмало растојание од кошниците со бумбари утврден е највисок процент на почетно заврзување на плодови. Исто така, кај овие стебла е утврден и највисок процент на финално заврзување на плодови.

Клучни зборови: јаболка, бумбари, опрашување, заврзување на плодови.

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DEEP PLANTING OF THE TREES - ALTERNATIVE WAY FOR CULTIVATION OF APPLE ON DWARFING ROOTSTOCKS IN CHANGED CLIMATE CONDITIONS

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Abstract
Intensive apple orchards are planted mostly on dwarfing rootstocks. These rootstocks have some disadvantages such as shallow and poor developed root system, sensitivity to drought, weakness anchorage, need of supporting system, e.t.c. Usually in practice, the trees are planted on depth to root necks. In some cases with a porpoise to reduce vigour, the trees are planted shallower, but there are cases when aimed improving of anchorage, the trees are planted deeper. In Macedonia, climate change expressed through reduced precipitation, are increasingly feel that deteriorating conditions for growing many traditional fruit crops. This situation highlights the need to introduce new practices in production technology in apple orchards. In this paper results of research of the influence on deeper planting of apple trees grafted on dwarfing rootstocks are presented. The orchard is being growing with standard technology. For investigation were used trees on the rootstocks M9 T337, M9 T984 and Mark 9) grafted with cv. 'Granny Smith'. At the establishment of the trail orchard were used: nursery trees with standard height of grafting and depth of planting and nursery trees grafted on height of 30 cm and planted on depth of 50 cm. The trial orchard was established in 2004 in Prespa region, and research is carried out from period of planting to 2012. During this period vegetative characteristics of the trees, yield and quality of the trees are followed. Also distribution of root system was investigated. It was found that deeper planted trees at all rootstocks are more vigorous and developed and can be managed without supporting system. Also these trees are more productive with better fruit quality.
Key words: apple, rootstocks, depth of planting, climate changes.

Introduction

Modern orchards of apples are grown on dwarfing rootstocks that provide low vigorous trees. The cheapest way to control vigour of the apple trees is by using adequate rootstock (Webster, 1993). Currently, the greatest interest in tree size control is the use of rootstock that produced trees near of M9 (Crassweller et.al., 2001). The clonal dwarfing apple rootstocks are popular in commercial orchards because they offer both small size and earlier production. Beside a lot of positive characteristics, dwarfing apple rootstocks have some disadvantages such as: shallow root system, poor anchorage in the soil, need of supporting system, sensitive to drought e.t.c. (Kiprijanovski et. al., 1997). In fruit growing practice, usually rootstocks in the nursery are grafted at the height of 10 to 15 cm above soil level and trees are planted at the level of the root neck (Kolecevski et. al., 2004). The dimensions of the apple trees are smaller when the dwarfing rootstocks are grafted

higher (Baart et. al., 1991). The apple trees which are grafted higher and are deeper planted have more vigorous growth. The higher grafted and deeper planted apple trees in arid regions, on alluvium soil and deficiency of water for irrigation, have higher growth, higher yield and better fruit quality (Kiprijanovski, Kolecevski, 1997). Aimed better anchorage of the trees and managing without support system Rom et. al. (1987) recommend deeper planting of apple trees on dwarfing rootstocks. Deep planting increased the vigor and yield of trees on M. 26 (Parry, 1974). Trilot et. al. (1989) reported that higher grafted and deeper planted apple trees grown less. This was resulted by poorly uptake of nutrients from the plough layer of the soil. Detail evaluation of each combination variety/rootstock/soil type/ecological conditions are necessary to determinate the optimal depth of planting of the fruit trees (Lyons et. al., 1983). Czynczyk et. al., (1989) conclude that deeper planted apple trees are more resistant to winter frosts. The cost of establishment of high-density orchards is still a major constraint on their profitability. Deep planting on rootstocks is being used as a technique to improve anchorage and remove or reduce the need for staking (Jackson and Harrison-Murray, 1986). Dwarf apple trees often need stakes as support to keep the trees upright. The cost of stakes is very significant in the total establishment costs of an orchard. Therefore growers are interested in growing the trees without stakes (Callesen, 1986).

Modern orchards are established on dwarf and semi-dwarf rootstocks. Rootstock M.9 has become most dominant for apples because of its suitability for high-density plantings (Wertheim, 1997). It is clear that intensive apple orchard should be established on the dwarfing rootstocks. But, in the regions with arid climate, with insufficient of rains especially in the summer months, and with deficit of water for irrigation, disadvantages of the dwarfing rootstock are more expressed. On the other hand, dwarfing rootstocks have poor anchorage and orchard should have supporting system. These disadvantages were the main reason to conduct researches of apple fruit growing on dwarfing rootstock with a higher grafting and deep planting of the trees. The aim of this research was to study the influence of depth planting of the trees under the agro-ecological conditions in Prespa region, the biggest apple production region in R. of Macedonia. Study was carried out trough the analyses of the vegetative growth, productivity, root development and possibility of removing or reducing the need of supporting system. On other hand, the climate change, expressed through reduced rainfalls and long lasting droughts, impose the needs for finding new measures aimed at adaptation to these conditions.

Material and methods

The research was performed in orchard placed in Prespa region. This region is located in the south-western part of R. Macedonia, on the banks of Lake Prespa, at altitude of 860 meters.

For establishment of the trial orchard trees, grafted on height of 10 and 30 cm above ground were used. The trees grafted on 10 cm were planted with grafted union 5 cm above ground (variant 1), and the higher grafted trees were planted 30 cm deeper (variant 2). The trees on rootstock M9T337, M9T984 and Mark 9 grafted with cultivar Granny Smith were investigated. The trial orchard have been established in spring of 2004 at spacing 3.5x1.5 m (1905 trees/ha). The trees were trained according to the slender spindle system and drip irrigated. The soil surface was maintained by grassing and mulching. The experiment has been arranged in randomized block design with four replications, 5 trees per repetition.

The dynamics of diameter growth of the trunk was carried out since planting of the orchard until 2011 (end of 8th leafs). Each year the trunk diameter was measured on 20 cm above ground, Dimensions of the crown (spread into and along the tree row) were measured at end of vegetation. Trunk cross section area (TCSA), tree canopy volume (TCV) and crown area (CA) were calculated from those measurements. Yield per tree was determinate on harvest time in period 2008-2012. Cumulative yield per tree and unit area was computed. Yield efficiency was calculated as kg/cm^2 TCSA, kg/m^3 TCV and kg/m^2 CA. The investigation of root system was carried out on the end of 2010 by digging up using free monolith method (Kolesnikov 1974).
Statistical analysis was performed using SPSS software. Independent samples t-test were used to analyse all the experimental data. Results were expressed at the $P<0.05$ level of significance.

Results and discussion

Agro ecological conditions in the area

The ecological conditions in certain region have an essential role in cost-effective and competitive apple production. Despite the fact that apples have a great ability to adapt nevertheless development of trees, bearing and fruit quality are in direct dependence of appropriate environmental conditions. In accordance with the existing conditions and achievements of science in practice are choice cultivars, rootstocks, and cultivation technology (Kiprijanovski 2011). Most apple cultivars give good results in a moderate continental climate with average annual temperature from 8 to 12^0C, vegetation temperature from 15 to 21^0C and with equally distributed rainfalls during the vegetation should be more than 600 mm (Misic 1994).
Some climatically and soil conditions registered in the area during research period and in the period 1950-1990 are shown in table 1 and 2.
Comparing the data for climatic conditions of the region can be found a significantly increase of temperature and reducing in annual rainfalls and relative humidity of the air in investigational period (2004-2011) relative to the previous period (1950-1990). The increased air temperature and diminished relative air humidity, especially in vegetation and summer, causing an increased water loss through evaporation and transpiration from plants. In order to maintain the required soil moisture in orchards in terms of increased losses there is a greater need for precipitation. Because the annual rainfalls are reduced water shortage in the soil must be replenish by irrigation. This lack of rainfalls and water deficit in shallow soil layers negatively reflects on development of the root system of trees especially when irrigation opportunities are limited. Hence, it could to emphasize that in the last period deteriorating conditions for growing apple orchards and imposes a need for finding new alternative ways of planting and cultivation of fruit trees.

Table 1. Agro climatic conditions in area along the period 2004-2011 and 1960-1990

Period	Parameter					
	Air temperature,^{0}C		Rainfalls, mm		Air humidity,%	
	2004-2011	1950-1990	2004-2011	1950-1990	2004-2011	1950-1990
Yearly	11.3	9.6	656.2	717.0	66	74
Vegetation	16.4	14.5	349.1	329.3	64	70
Summer	20.4	18.1	106.2	89.0	60	67

Accordingly the WRB classification the soil is Dystric Flufisol. According to Scheffer's and Schachtschabel's classifications the soil is a texture class clay loamy soil, which characterized with a very suitable texture which suits of the needs to the root system of apples.

Table 2. Texture and fertility of the soil in the trial orchard

Depth cm	$CaCO_3$ %	Humus %	Sand %	Silt %	Clay %	pH (KCl)	N %	P_2O_5 mg/100 g	K_2O mg/100 g
0-20	1.43	2.74	47.8	34.5	17.7	6.8	0.14	47.5	59.1
21-40	0	2.12	44.4	35.6	20.0	6.5	0.12	36.6	49.4
41-60	0	1.56	44.3	35.8	19.9	5.6	0.09	302	41.7

Tree growth

The diameter of the trunk is an integral indicator of the whole vegetative potential of the trees. The higher absorption of the root system helps increase the production of organic matter in the crown, and all these products together contribute to the forming of more elements of xylem and phloem, which at the end is being registered through the increase of the stem diameter. If the roots of the trees develop in better soil moisture conditions, the stem will have a stronger cambial activity, making the trunk growth higher.

Table 3. Trunk cross section area (TCSA), cm^2

Root-stock	Var.	At planting	Year after planting								Index
			1st	2nd	3rd	4th	5th	6th	7th	8th	
M9 T337	1	2.25	3.47	5.96	8.96	13.14	15.85	21.94	25.41	36.53	100
	2	1.63	3.66	8.86	12.64	16.61	26.04	35.66	41.60	54.22	148.5
	M	1.94	3.57	7.41	10.80	14.88	20.95	28.80	33.51	45.38	
	P-value	*.112*	*.719*	*.764*	*.944*	*.067*	*.001*	*.003*	*.004*	*0.012*	
M9 T984	1	2.48	3.1	5.97	9.92	12.12	16.22	21.86	25.09	33.65	100
	2	1.77	3.40	9.18	12.95	16.32	24.62	39.80	46.06	55.12	164.0
	M	2.13	3.25	7.58	11.44	14.22	20.42	30.83	35.58	44.39	
	P-value	*.036*	*.342*	*0.565*	*0.927*	*.041*	*.004*	*.000*	*.000*	*0.019*	
Mark 9	1	2.24	3.48	6.11	11.31	14.78	17.80	23.13	26.95	39.71	100
	2	1.70	3.28	8.62	11.42	15.87	18.52	27.19	32.01	45.63	114.9
	M	1.97	3.38	7.36	11.36	15.32	18.16	25.16	29.48	42.67	
	P-value	*.100*	*.504*	*.047*	*.025*	*.342*	*.644*	*.227*	*.174*	*0.256*	
Avrg	1	2.32	3.35	6.01	10.06	13.35	16.62	22.31	25.82	36.63	100
	2	1.70	3.45	8.89	12.34	16.27	23.06	34.22	39.89	51.66	141.0
	M	2.01	3.40	7.45	11.20	14.81	19.84	28.26	32.86	44.15	

Data for growth dynamic of TCSA for period from planting until 8th growing season are shown in table 3. At planting, the trees of all rootstocks and variants, had similar TCSA, but because deeper planted trees are measured higher the data have smaller values. At the end of the eighth vegetation largest TCSA had trees on rootstock M9 T984 who were deeper planted. The lowest mean values for TCSA were observed at trees on rootstock M9 T337 which were planted with standard

technology. At all rootstocks bigger TCSA was observed at deeper planted trees by an average of 41.0 %. The values for this parameter differ statistically among all tested rootstocks (table 3). Costante (1983) found approximately 20% less developed trees that have been planted according to the standard technology in comparison with deeper planted trees.
At the end of the eighth vegetation the trees from second variant had a larger crown (crown area and canopy volume). In terms of researched rootstocks, average for both variants, the least developed crowns had fruit trees grafted on Mark 9 (table 4). There are differences among the tested variants in crown volume due to the greater height of the leaders. The width of the crowns which determines the horizontal projection is limited through pruning of the trees because of there is no major differences between the tested variants. Kiprijanovski (1997) during examining the depth of planting at the variety Jonagold on rootstock M9 in an extremely arid conditions and insufficiently irrigation found 48.3% greater crown area and 76.8% greater crown canopy at trees that were highly grafted and planted 30 cm deeper than standard planted trees. Ugolik (1990) points out that trees grafted on vigorous rootstocks and deeply planted are many vigorously resulting in poor yield. Deep planting of spur' Red Delicious'/MM 111 resulted in greater tree height with fewer blooms and greater depth to first root (Jackson and Harrison-Murray, 1986)

Table 4. Crown parameters of the trees at the end of 8th vegetation

Rootstock	Var.	Crown area (CA), m^2	Tree canopy volume (TCV), m^3	Index
M9 T337	1	2.19	1.95	100
	2	2.45	2.44	125.1
	M	2.32	2.20	
	P-value	*0.48*	*0.484*	
M9 T984	1	2.08	1.82	100
	2	2.27	2.33	128.0
	M	2.18	2.08	
	P-value	*0.21*	*0.384*	
Mark 9	1	1.85	1.78	100
	2	2.03	2.15	120.8
	M	1.94	1.97	
	P-value	*0.702*	*0.230*	
Average	1	2.04	1.85	100
	2	2.25	2.31	124.9
	M	2.15	2.08	

Productivity of the trees
Productivity of the trees is the most important factor for successful cultivation of fruit plantations. The productivity depends on several factors such as genetic potential of the cultivar, ecological conditions, development of the tree, applied agro and pomotechnical measures, rootstock etc.
In investigational period the highest cumulative yield was registered on deep planted trees grafted on M9 T984 (104.2 kg). The lowest cumulative yield have trees grafted on M9 T984 and planted according standard technology. The average cumulative yield for researched period, in bouth

variants, has trees grafted on the rootstock M9 T984. (tab.5). Concerning depth of planting, trees for second variant have up to 27,8% higher yield compared to those planted with standard technology. Analyzing the data (table 5 and figure 1) it can be seen that at shallow planted trees there are large variations in yield per year. In all evaluated rootstock alternative bearing was notice, while at deeper planted trees this negativity has not been observed. Statistically significant differences between the variants in terms of the cumulative yield was notice at all evaluated rootstocks.

Table 5. Yield per tree and unit area

Root-stock	Var.	Yield, kg/tree					Yield, t/ha					Index
		2008	2009	2010	2011	Cumu-lative	2008	2009	2010	2011	Cumu-lative	
M9 T337	1	19.5	24.2	15.0	21.3	80.0	37.1	46.1	28.6	40.6	152.4	100
	2	17.4	24.8	24.9	26.3	93.4	33.1	47.2	47.4	50.1	177.8	116.7
	M	*18.5*	*24.5*	*20.0*	23.8	86.8	*35.1*	*46.7*	*38.0*	45.3	165.1	
	P-value	*0.59*	*0.83*	*0.00*	1.16	*2.58*	*1.12*	*1.59*	*0.12*	1.29	*4.1*	
M9 T984	1	17.5	22.5	13.0	18.8	71.8	33.3	42.9	24.8	35.8	136.8	100
	2	18.9	28.0	29.6	27.7	104.2	36.0	53.3	56.3	52.8	198.4	145.0
	M	*18.2*	*25.3*	*21.3*	23.3	88.1	*34.7*	*48.1*	*40.6*	44.4	167.8	
	P-value	*0.44*	*0.04*	*0.00*	0.78	*1.26*	*0.84*	*0.74*	*1.60*	1.86	*5.0*	
Mark 9	1	20.0	22.2	14.9	20.8	77.9	38.1	42.3	28.4	39.6	148.4	100
	2	18.6	21.8	26.1	29.4	95.9	35.4	41.5	49.7	56.0	182.6	123.0
	M	*19.3*	*22.0*	*20.5*	25.1	86.9	*36.8*	*41.9*	*39.1*	47.8	165.6	
	P-value	*0.465*	*0.89*	*0.00*	0.87	*2.22*	*0.88*	*1.17*	*0.25*	1.90	*4.2*	
Ave-rage	1	19.0	23.0	14.3	20.3	76.6	36.2	43.8	27.2	38.7	145.9	100
	2	18.3	24.9	26.9	27.8	97.9	34.8	47.4	51.2	53.0	186.4	127.8
	M	18.7	23.9	20.6	24.1	87.3	35.5	45.6	39.2	45.9	166.2	

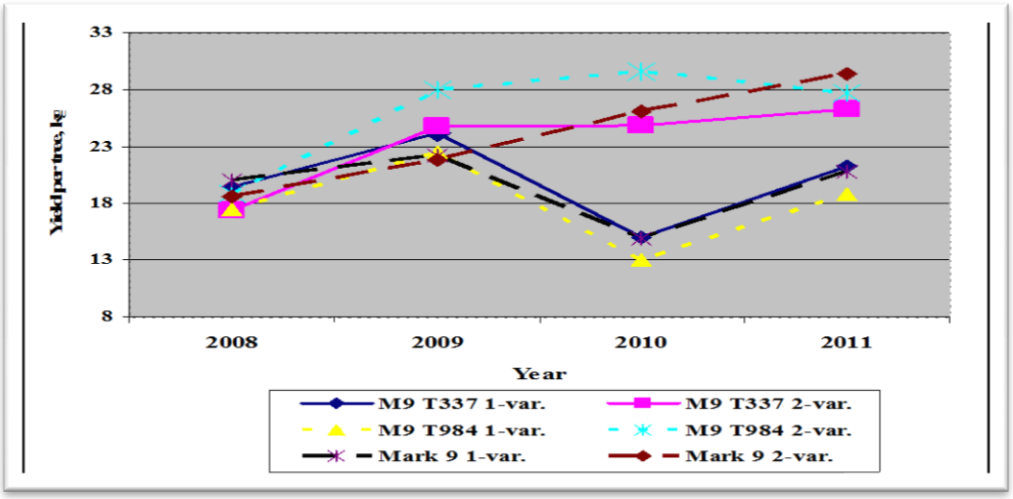


Figure 1. Dynamics of the fruiting at the trees

There is a positive correlation between the vigorousness and cumulative yield of the trees (Figure 2). Czynczyk et al., (2001) and Autio et al., (2001) testing new dwarfing apple rootstocks pointed that the trees on the rootstock Mark 9 have high yield efficiency. Barrit et al., (1997) reported that cumulative yield efficiency showed a linear decline as tree size increased for more apple rootstocks. Our researches showed that the increase of the vigorousness of the trees decreases the yield efficiency, expressed through yield per cm^2 /TCSA, but the trees with greater canopy have greater yield efficiency expressed through kg/m^2 crown area and kg/m^3 crown volume (Table 6). There are significant differences in yield efficiency between variants except yield efficiency expressed through kg/m^3 crown volume.

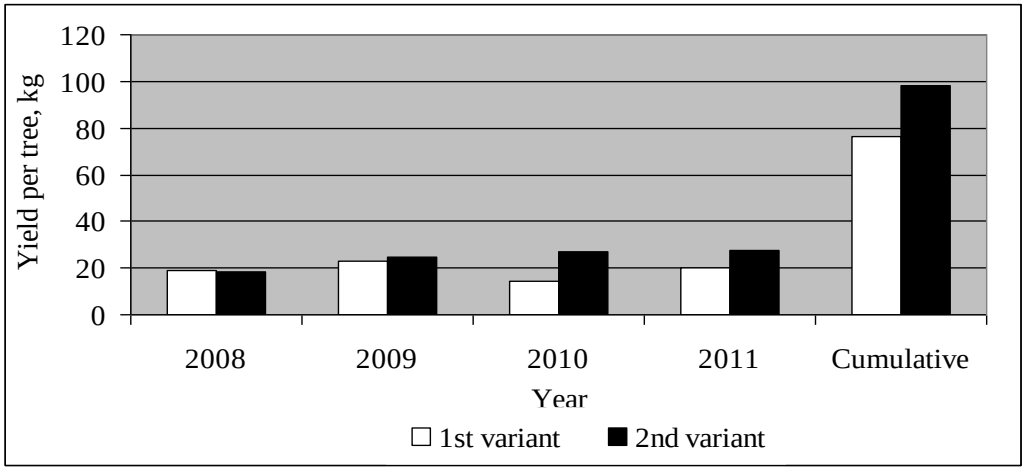


Figure 2. Average yield per tree for all rootstocks

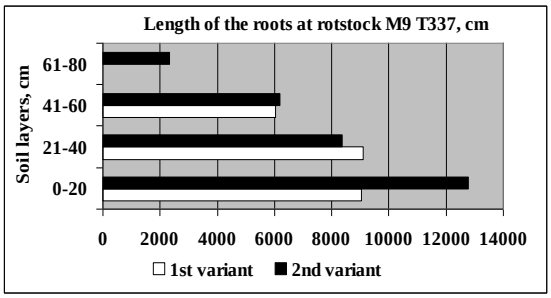
Table 6. Yield efficiency (average 2008-2011)

Rootstock	Var.	Yield/TCSA, kg/cm^2	Yield/CA, kg/m^2	Yield/TCV, kg/m^3
M9 T337	1	0.88	12.12	14.68
	2	0.61	13.69	14.11
	M	0.71	12.91	14.40
	P-value	*0.006*	*0.125*	*0.705*
M9 T984	1	0.80	11.80	14.15
	2	0.65	15.35	16.11
	M	0.71	13.61	12.78
	P-value	*0.120*	*0.226*	*2.120*
Mark 9	1	0.79	13.14	15.53
	2	0.82	15.25	16.27
	M	0.81	14.20	13.83
	P-value	*0.092*	*0.128*	*1.150*
Average	1	0.82	12.33	14.72
	2	0.69	14.73	15.47
	M	*0.76*	13.54	15.15

Root system attaches trees in the soil, provides them with the necessary nutrients and water, in the primary assimilation processes creates specific substances important for metabolism, growth and the generative activities of the trees. Distribution, structure and development of the root system of the fruit trees depends on the genetic nature of species, properties of the rootstock and the variety, soil type, manner of soil preparation before establishing of the trees, agrotechnical measures in the orchards and other factors.

Table 7. Distribution of the roots through soil layers, cm

Root stock	Var.	Length of the roots, cm					Mass of the roots, g				
		Depth of the soil, cm					Depth of the soil, cm				
		0-20	21-40	41-60	61-80	Cum.	0-20	21-40	41-60	61-80	Cum.
M9 T337	1	9051.2	9096.0	6044.7		24191.9	845.5	479.3	132.8		1457.4
	2	12778.3	8377.7	6198.8	2340.5	29275.3	766.7	492.9	211.8	72.5	1543.8
	M	10914.8	8736.8	6121.7	1170.3	26733.6	806.1	486.1	172.3	36.2	1500.6
M9 T984	1	6465.6	11691.2	5184.0		23340.8	637.6	482.3	176.5		1296.4
	2	8681.0	10370.0	5636.0	3291.2	28056.2	917.7	629.2	199.8	48.8	1795.5
	M	7573.3	11030.6	5410.0	1645.6	25698.5	777.7	555.8	188.1	24.4	1545.9
Average	1	7758.4	10393.6	5614.4		23766.4	741.6	480.8	154.7	.	1376.9
	2	10729.7	9373.8	5917.4	2815.9	28665.8	842.2	561.1	205.8	60.6	1669.7
	M	9244.1	9883.7	5765.9	1407.9	26216.1	791.9	520.9	180.2	30.3	1523.3



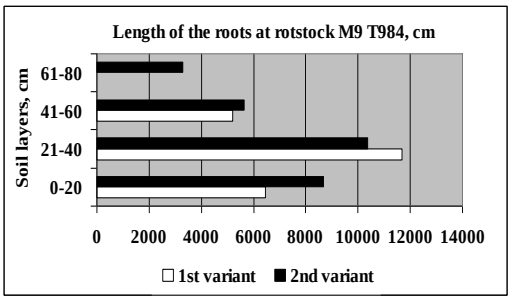
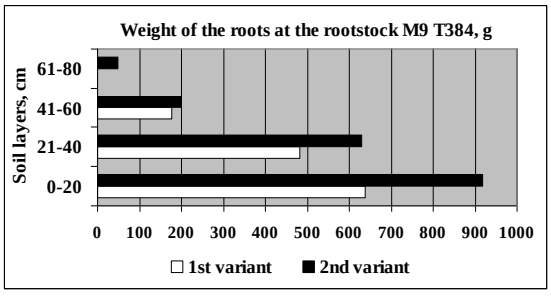


Figure 3 and 4. Distribution of the root length through soil layers



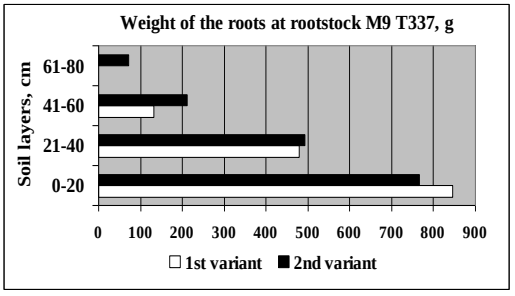


Figure 5 and 6. Distribution of the root weight through soil layers

Productivity of fruit trees largely depends on the development and architecture of the root system (Kolesnikov, 1974, Ristevski, 1995). The length of the roots at the apples directly depends on the distance of the planting and the type of rootstock (Atkinson, 1980). The study of the root system at the trees with different planting depth is conducted at the trees grafted on rootstocks M9T337 and M9 T984. From results (table 7 and Figures 3 and 4) it can be concluded that there is no big difference in the root system of the trees between rootstocks, but the differences are evident at planted trees of varying depth. Greater development of the roots system at deeper planted trees can be explained by the fact that through the underground stem of rootstocks after planting emerging new adventives roots, and these roots influence in much of the total mass and length of the roots system. At deeper planted trees root system, even at the planting, is placed in the soil layer where there is more moisture, and thus better conditions for the development and functioning of roots. The better developed roots have greater possibilities for the supply of trees with water and nutrients from the soil, which contributes to the development of the above-ground part of the trees. Mihailov (1973) found that deeper planted apple trees have 17% more developed roots. Kolecevski and Ristevski (1988) noted that the root system of apples on dwarfing rootstocks on heavy soils penetrates to a depth of ploughing (75 cm). Angelov (1976) found that 60% of the apple roots are in the 20-40 cm layer, and in the layer of 0-20 cm found 19-21% of the total roots. Our data are similar with results from previous studies.

Conclusions

The results got from conducted research show that the rootstocks, have a direct influence on vegetative behaviour and generative parameters of the apple trees. The deeper planting of the trees on dwarfing rootstocks in adequate ecological conditions has positive influence to growth of the apple trees in orchard. The yield affected of the growth of the trees. High growth trees are more productivity and the fruits have better quality. The root system at deeper planted trees is more developed and penetrates in deeper soil levels. Anchorage in soil of apple trees on dwarfing rootstocks is better at deeper planting. High grafted and deeper planted trees can cultivate in orchard without support system. At the establishing of apple orchards on dwarfing rootstocks (group M9) in drought climatically conditions, with deficit of water for irrigation, it can be recommend higher grafting and 20-30 cm deeper planting of the nursery trees.

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ДЛАБОКО САДЕЊЕ НА ОВОШКИТЕ-АЛТЕРНАТИВЕН НАЧИН НА ОДГЛЕДУВАЊЕ НА НАСАДИ ОД ЈАБОЛКА НА СЛАБО БУЈНИ ПОДЛОГИ ВО ИЗМЕНЕТИ КЛИМАТСКИ УСЛОВИ

Киприjановски Марјан, Ѓамовски Виктор, Арсов Тошо

Апстракт

Интензивни насади од јаболка се подигаат главно на слабо бујни подлоги. Овие подлоги имаат некои недостатоци како што се: плиток и слабо развиен коренов систем, осетливост на суша, слабо вкоренување, потреба од потпорна констукција и др. Во практиката обично садниците се садат на длабочина до кореновиот врат. Во некои случаи, со цел намалување на бујноста, садниците се садат поплитко, но има и случаи кога со цел подобрување на вкоренувањето садниците се садат подлабоко.

Во Македонија климатските промени изразени преку намалени врнежи се повеќе се чувствуваат, со што се влошуваат условите за одгледување на традиционалните овошни култури. Ваквата состојба ја нагласува потребата од воведување на нови практики при подигањето и одгледувањето на насадите од јаболка. Во трудот се презентирани резултати од истражувањето на влијанието на подлабокото садење на садниците врз однесувањето на овошките во насадот. Насадот е одгледуван според стандардна технологија. За истражување се користени подлогите М9 Т337, М9 Т984 и Марк 9 калемени со сортата Грени Смит. При подигањето на опитниот насад се користени две варијанти: садници кои се калемени на стандардна висина и истите се садени на длабочина до кореновиот врат и садници кои се калемени на висина од 30 cm и истите се садени на длабочина од 50 cm. Опитниот насад е подигнат во Преспанскиот регион, во 2004 година, а истражувањето е изведено во период од садењето до 2012 година. Во овој период се следени вегетативните карактеристики на овошките, приносот и квалитетот на плодовите и дистрибуција на кореновиот систем на овошките. Од истражувањето е констатирано дека подлабоко посадените овошки се побујни, поразвиени и може да се одгледуваат без потпорна констукција. Исто така подлабоко посадените овошки се попродуктивни и даваат плодови со подобар квалитет.

Клучни зборови: јаболка, подлоги, длабочина на садење, климатски промени.

UDC:634.13-152.61"323"(497.712)"2008/2010"
Original scientific paper

RESEARCH OF QUALITY CHARACTERISTICS OF SOME AUTUMN PEAR VARIETIES

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Abstract
The pear is quality, fine fruit which is appreciated and requested by the consumers. With the permanent increase of the standard and increased purchasing power, the demand of quality pear fruits becomes larger. In Macedonia there is not enough production of pears and because of that a big part of the needs are supplied by import. In the plantation are cultivated a big number of pear varieties with different quality characteristics and ripening time. In this paper the results from investigation of some quality characteristics of 10 pear varieties with autumn ripening time are presented. The researchers are carried out at the follow varieties: Harrow Sweet, Honey Sweet, Abate Fetel, Packhams Triumph, Conference, Magness, Starking Delicious, Highland and Kaiser. Bartlet was used as control variety. The research was carried out in the pear orchard located in the Skopje area. Investigation was conducted during tree consecutive years (2008-2010). The researches comprise: time of harvesting, weight and dimensions of the fruits, dimensions of the stalk, content of soluble solid matters, total sugars and total acids. Organoleptics evaluations of the fruits were done on two occasions: beginning of October and beginning of December. Based on investigations it was concluded that beside standard variety Bartlet the best quality have the variety Harrow sweet, Abate Fetel and Packhams Triumph.
Key words: pear, variety, quality, evaluation.

Introduction

The pear is fine, delicious fruit, widely grown in temperate zones in the world. Worldwide area under orchards of pears and production is increasing steadily (Segre, 2002). The assortment which cultivated in different regions varied related size of the fruits, their shape, texture and flavors (Janick, 2002). The varieties mainly suited to the environmental conditions in adequate area and demand by consumers. The existing pear assortment worldwide, is becoming too conservative and therefore, the market conditions and the sensibility of certain varieties towards some pests and diseases, request not only complementing of the existing assortments but also a replacement of varieties with more quality characteristics of the fruits and less sensitive to the unfavorable biotic and abiotic factors (Gliha, 1997). Pear breeding objectives are complex, but most pear breeders share a number of common purposes such as fruit quality, storage ability, consistent production, diseases and pests resistance (Bell et al., 1996). The adaptation to the ecological conditions including the pest and disease resistance, are the main goals of selection of new pear varieties (Belini, 2002). During the classification of the varieties by their resistance towards certain pests and

diseases, Belini (1997), puts the varieties Harrow Delight, Harvest Queen, Harrow Sweet, Honey Sweet and Magness, in the group of Fire Blight resistant varieties. The pear production is facing a line of problems mainly concerning the sensitivity of the varieties towards diseases which largely endangers the pear productivity. In many ways, the pear remains a problem for producers and consumers. The producers have to content with hardiness like early blooming, sensitive of frosts, fire blight and psylla susceptibility, sunburns, difficulties with handling of the fruits that must be carefully picked and ripened to achieve maximum quality. To the consumers, appearance and taste related size, color and form of the fruits, perfect proportion of the texture, flavor, acidity and sweetness of the flesh have primary importance. There are many definitions of quality. The most widely used is perhaps fitness for use (Tijskeens et al., 1998). A more recent definition of quality is meeting the expectations (MacFie, 1997). Some consumers like pears juicy, buttery and melting texture with a good flavour. However there are consumers that prefer pears with a crispy and juicy texture to a buttery and melting one (Hoehn et al. 1996). Pears must ripen before they are ready to eat. Eating quality depends on ripeness stage and ripening progress proceeded more rapidly in fruits picked at later picking times (Zerbini, 2002). A major objective of breeding is to develop cultivars combining fire blight resistance and high fruit quality. Pear sensory attributes suited to satisfy consumer were studied by Kappel et.al. (1995). New cultivars to have changes to be successfully introduced in a pear producing area must be of eating quality comparable or superior to those already affirmed. Before the economic transformations in Macedonia pear production reached over 20.000 tones. Later, the area under orchards and pear production decreased rapidly. Nowadays, the pear production is not satisfied for domestic needs. Especially in the autumn and winter period the markets are supply with imported high prised pears nearly unaffordable for the consumers. The reasons for this situation lay mostly in the appearance of epiphitotonic measures of the psylla and Fire Blight, for which the producers have lack of information and knowledge (Ristevski, 2004). In the present years interest among the producers for establishing the pear orchards is increasing. One of the manners for advancement of the production is improvement of the assortment structure and increase of the participation of quality and productive varieties. Proper cultivar choice is a very important factor for the cost effective production of pear, especially in conditions where the technology of growing and consumers require reduced application of pesticides. Pear intended for fresh consumption quality of the fruits regards appearance, size and especially taste is very important. Pear fruits of different varieties vary in the range of morphological, anatomical-histological, physiological, physical and chemical properties that are manifested in the appearance (color, shape, size), taste, aroma, consistency, firmness, time of harvest, storage ability, transportability and others. The sum of these properties constitutes the quality of the fruits.

Material and methods

The field researches of the pear varieties, varieties have been carried out in the area Trubarevo near Skopje. The trial orchard has been established in the spring 1997 with the varieties Harrow Sweet, Honey Sweet, Abate Fetel, Packams Triumph, Conference, Magness, Starking Delicious, Highland, Kaiser and Bartlet as control variety. A quince BA29 has been used as a rootstock. For the incompatible varieties was used Cure as interstock. The distance between trees was 4x1.5 m. The research was conducted during period 2008-2010. The orchard has been established on a fertile loam soil. The area has been maintained with a clean cultivation until the seventh vegetation, and

after that with natural grassing. In the orchard drip irrigation system was installed. The fruit crowns have been formed by the spindle bush system. During the research, the following parameters have been observed: ripening time, productivity and fruit quality of the evaluated varieties. Yield per tree and yield per unit area was calculated, the pomological characteristics was determinate by measuring dimensions of the fruits and stalk using a caliper with a sensitivity of ± 0.1 mm. The weight of the fruits was measured on an electronic balance with a sensitivity of ± 0.01 g. The chemical characteristics were determined after harvesting. The content of soluble solids, total sugars (TS) and titratable acids (TA) were researched in laboratory by standard methodology. Sugar: acids ratio was estimated. Organoleptic characteristics of the fruits are evaluated troughs their appearance and taste. Evaluation was conducted by spontaneously selected 30 consumers. The evaluation was carried out in two occasions at 5 October and 5 December. After harvesting the fruit were placed and stored in a laboratory refrigerator at temperature of 0-2 ^{0}C. The statistic analyses have been performed by an analysis of the variance, and the testing of the differences by LSD-test.

Results and discussion

Ripening time and yield per tree

Time of ripening is an important characteristic of the variety in terms of determining the harvesting season, consumption and the potential ability to storage of the fruits. Ripening of the pears is associated with variety characteristics and environmental conditions in the respective region. The researched group includes varieties with late summer and autumn time of ripening. All tested varieties ripen after Bartlet and in period of one month. The earliest ripen fruits of variety Honey Sweet, and the latest fruits of the variety Packams Triumph (table 1). High yield, as well fruits with good quality is a major goal in fruit production. In the pear orchards the yield depends of many complex factors such as environmental conditions, variety, combination variety/rootstock, planting density, training system, growing technology etc. In the researching period the highest average yearly yield per tree and unit area gave the variety Harrow Sweet (21.4 kg/tree and 35.65 t/ha), followed by the variety Conference, Packams Triumph and Magness (table 1). The lowest yield was determined at variety Honey Sweet followed by Starking Delicious and Highland.

Table 1. Ripening time, yield per tree and per unit area (average 2008-2010)

Variety	Time of ripening	Yield per tree, kg	Yield per unit area, t/ha
Bartlet	28.8	17.8	29.59
Honey Sweet	30.8	12.1	20.13
Starking Delicious	4.9	14.4	24.05
Highland	13.9	15.4	25.71
Magness	13.9	18.7	31.15
Conference	20.9	20.3	33.81
Abate Fetel	23.9	18.6	31.01
Harrow Sweet	25.9	21.4	35.65
Kaiser	28.9	18.6	30.98
Packams Triumph	30.9	19.4	32.26
	$LSD_{0.05}$	1.73	2.88
	0.01	2.37	3.94

Pomological characteristic of the fruits

In modern fruit production dimensions and weight of individual fruit is a very important characteristic hence varieties with larger fruit in general have a higher price. The dimensions and weight of the fruits are dependent on a number of factors such as genetic potential, abundance, growing technology, environmental conditions, etc. Analyzing the data for the fruit weight we can concluded that the varieties Bartlet, Abate Fetel, Highland and Packams Triumf have large fruits. The fruits of varieties Starking Delicious, Kaiser and Conference are with good size. The variety Honey Sweet, Magness and Harrow Sweet have fruits with smaller but satisfactory size and weight (table 2). Gliha (1997) describing some pear varieties, stated that the variety Abate Fetel has large to very large fruits (180-320 g), varieties Bartlet, Highland, Kaiser and Packams Triumph have large fruits (180-280 g) Conference and Starking Delicious have medium large fruit (160-180 g) and Harrow Sweet and Magness have fruits with medium to small size (160-170 g).

Among other environmental conditions and winds can cause damage in the pear orchards pushing the fruits. Generally varieties with long and strong stalks of the fruits are more resistant to winds but here there are exceptions (Ristevski et.al., 2004). The varieties Starking Delicious, Abate Fetel have very short stalk and these varieties are very sensitive on winds. In contrast variety Pakams Triumph although there is a large fruit has a long and thick stalk and fruits are not susceptible to winds.

Table 2. Pomological characteristics of the fruits

Variety	Weight, g	Fruits, mm			Stalk, mm	
		Height (H)	Width (W)	Ratio: H/W	Length	Thickness
Bartlet	215	85.9	69.1	1.24	34.4	4.3
Honey Sweet	145	68.4	48.7	1.40	19.4	3.8
Starking Delicious	190	73.2	71.6	1.02	26.3	2.9
Magness	160	81.9	59.6	1.37	14.0	5.4
Conference	175	94.6	69.0	1.37	28.0	6.1
Abate Fetel	265	124.5	73.3	1.70	22.3	4.1
Highland	212	94.4	76.3	1.24	33.5	3.4
Harrow Sweet	165	83.9	67.5	1.24	28.2	3.8
Kaiser	194	102.2	76.2	1.34	39.2	3.4
Packams Triumph	235	90.4	79.3	1.14	38.3	5.2
$LSD_{0.05}$	11.5	10.1	8.6	0.10	2.5	0.2
0.01	15.5	13.6	11.6	0.13	3.4	0.3

Content of some chemical components in the fruits

The pear fruits can use as fresh and processed into various types of processing. Fruits have a high nutritional, energy and dietary value. Chemical composition varies in rather wide limits, depending on the variety. The content of some chemical matters in fruits determine the quality and technological value of the varieties. From this aspect of particular importance is content of soluble solids and titratable acids. Content of certain chemical substances in fruits is variety characteristic, but it also depends on many other factors such as environmental conditions, the method of cultivation, degree of maturity, the yield, etc. In practice, more appreciated is the fruit with higher

soluble solids content regardless of whether there are intended for fresh use or processing. Ratio sugar/acids content gave determinate the taste of the fruits. Pear generally contains little acids so dominates sweet taste. Analyzing the data on the fruit quality, it can be pointed out that the average content of soluble solids and total acids in the fruits are different at certain varieties (table 3). The fruits from the varieties Conference, Harrow Sweet, Kaiser and Honey Sweet highlight for their high content of soluble solids matters. The highest content of the titratable acid have fruits from varieties Bartlet and Packams Triumph, and very low acids have the fruits of the variety Kaiser and Abate Fetel. These varieties have and the highest total: total acids ratio.

Table 3. Content of some chemical components in the fruits

Variety	SSM , %	TS, %	TA, %	TS: TA ratio
Bartlet	14,3	9.2	0.36	25.6
Honey Sweet	15.3	9.6	0.25	38.4
Starking Delicious	13.6	8.7	0.24	36.3
Highland	13.9	8.9	0.25	35.6
Magness	15.1	7.9	0.20	39.5
Conference	18.6	11.5	0.21	54.8
Abate Fetel	13.6	7.8	0.13	60.0
Harrow Sweet	17.4	12.1	0.33	36.7
Kaiser	16.3	9.4	0.15	62.7
Packams Triumph	15.4	11.8	0.27	43.7
$LSD_{0.05}$	2.5	2.5	0.05	9.3
0.01	3.4	3.4	0.07	12.6

Sensory evaluation of the fruits

To assess the quality and value of various fruits decisive role have the final consumers. Evaluation of the quality, attractiveness and acceptability of fruits of pear varieties in a certain period of consumption season is done through tasting of fruits. Without continuously monitoring consumer needs and desires as well as their involvement in creating assortments can not harmonize production with consumption of fruits prosperity. Standard analytical measurements like soluble solids and titratable acidity have shown in apple poor correlation with sensory perception and the same is true for pear (Watada et.al., 1981). It is difficult to give an objective assessment for taste of the pears because it depends on the taste and habits of individuals, individual regions and even whole nations (Gliha, 1997). Sensory evaluation is increasing its importance in supporting breeding and introduction of new cultivars (Hampson et.al., 2000).

Table 4. Sensory evaluation of the fruits

Variety	October 5th			December 5th		
	Appearance (0-5)	Taste (0-5)	Total (0-10)	Appearance (0-5)	Taste (0-5)	Total (0-10)
Bartlet	4.04	4.32	8.36	3.75	4.05	7.85
Honey Sweet	3.18	4.34	7.52	3.05	3.40	6.45
Starking Delicious	3.65	4.11	7.76	3.45	3.64	7.09
Highland	3.77	3.68	7.45	3.98	3.75	7.73
Magness	3.46	4.46	7.92	3.40	3.55	6.95
Conference	3.07	4.11	7.18	3.28	4.20	7.58
Abate Fetel	4.15	3.00	7.15	4.30	3.45	7.75
Harrow Sweet	4.54	4.44	8.98	3.45	3.65	7.10
Kaiser	3.12	3.45	6.57	3.10	4.10	7.20
Packams Triumph	3.16	3.45	6.61	3.95	3.85	7.80
$LSD_{0.05}$	0.43	0.48	0.91	0.24	0. 32	0.56
0.01	0.59	0.65	1.24	0.33	0.44	0.77

Eating quality is very difficult to measure objectively. To determine how consumers accept the fruits of different pear varieties in terms of organoleptic properties sensory evaluation was made. Sensorial tests were performed on visual and eating traits. In first term of evaluation (October 5th) the best scores for appearance and taste derived fruits from variety Harrow Sweet and Bartlet followed by Magness and Starking Delicious (table 4, figure 1). Kapel and Quamme (1987) stated that the fruits of variety Harrow Sweet were given high preference rating by trained panelist, which rated the flavor as good as that have fruits of Bartlet. This is confirmed in our researches. The lowest scores got the fruits from varieties Kaiser and Packams Triumph. Probably the low scores on these varieties isare due to the late maturing and the fruits were not sufficient ready for consumption. In second term of evaluation (December 5th) the best grades received the fruits of the variety Bartlet and Packams Triumph, and the lowest grades got fruits from variety Honey Sweet and Magness (table 4, figure 2). Due to poor ability to store the fruits of the variety Harrow Sweet in second term of evaluation drastically reduced their quality.

According average values of two conducted sensory evaluations, fruits from Bartelet are characterized with the best organoleptic characteristics, followed by Harrow Sweet, Highland and Abate Fetel (figure 3). Based on the evaluation of the consumers, only fruits from Abate Fetel and Highland have better appearance that taste (figure 3).

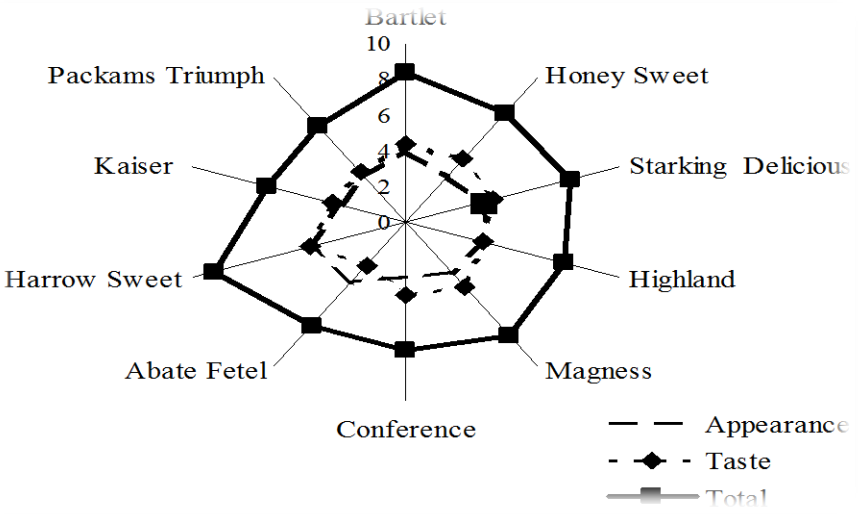


Figure 1. Sensorial profiles of the fruits from pear varieties on October 5th

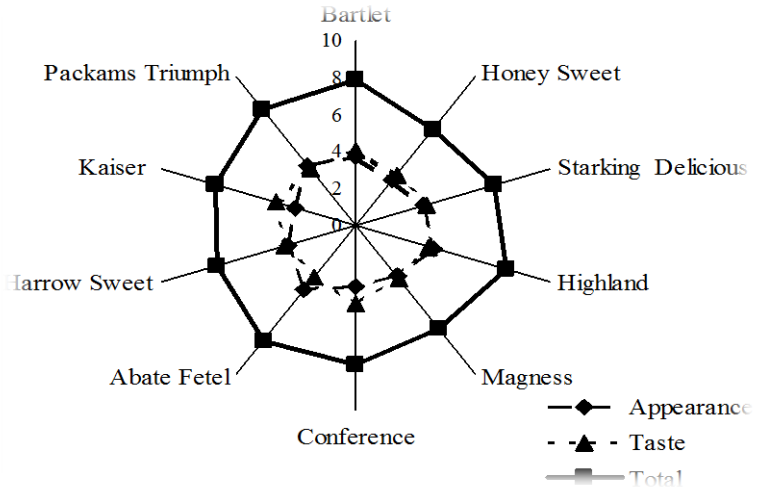


Figure 2. Sensorial profiles of the fruits from pear varieties on December 5th

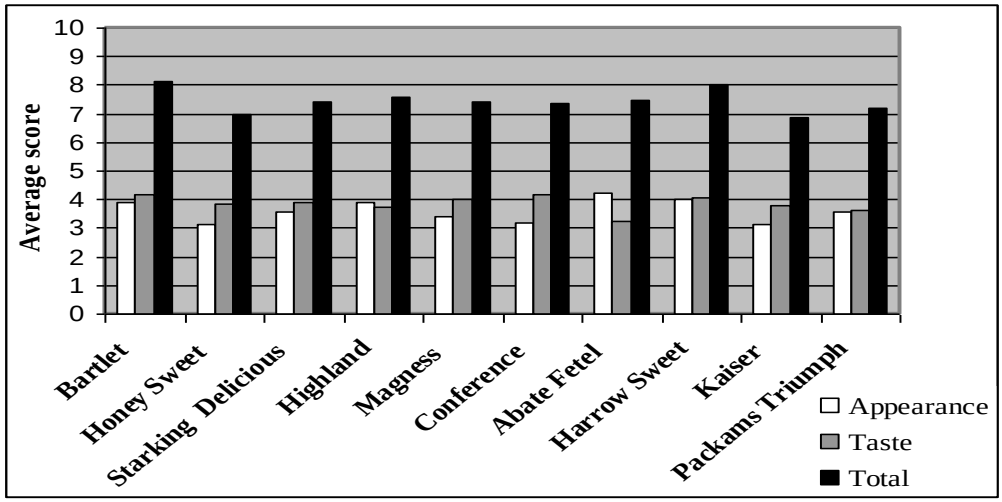


Figure 3. Average value of sensory evaluation of the fruits (October 5th and December 5th)

Conclusions

Based upon researches of the production and the quality characteristics of some autumn pear varieties a few conclusions can be made:

-The varieties resistant to Fire Blight (Harrow sweet, Honey Sweet and Magness) the best productive attributes and quality characteristics of the fruits has Harrow Sweet variety. Despite resistance to fire blight it is less sensitive to psylla, it has excellent productivity and good quality of the fruits. Due to this, this variety can be recommended for growing in the commercial orchards.

- From varieties which are belonged in assortment which is sensitive to the Fire Blight the best results despite variety Bartlet were obtained at Packams Triumph and Abate Fetel. These varieties can be recommended for growing in some typical agro ecological areas. The standard variety Conference is very sensitive to sunburn and the variety Kaiser is very susceptible to Fire Blight and to the psylla and these varieties are not recommend for growing in our production regions.

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ПРОУЧУВАЊЕ НА КВАЛИТЕТНИ КАРАКТЕРИСТИКИ НА НЕКОИ ЕСЕНСКИ СОРТИ КРУШИ

Киприjановски Марjан, Арсов Тошо, Ѓамовски Виктор

Апстракт

Крушата е квалитетно, фино овошје кое е ценето и барано од страна на потрошувачите. Со постојаното зголемување на стандардот и куповната моќ на населението побарувачката на квалитетни плодови од круша станува се поголема. Во Македонија нема доволно производство на круша и поради тоа голем дел од потребите се обезбедуваат преку увоз. Во насадите се култивираат голем број сорти со различни квалитетни карактеристики и време на зреење. Во трудот се презентирани истражувањата на некои квалитетни карактеристики на плодовите од 10 сорти круши со есенско време на зреење. Во проучувањето се опфатени следните сорти: Harrow Sweet, Honey Sweet, Абате Фетел, Пакамс Триумф, Конференс, Магнес, Старкинг Делишес, Хајланд и Боскова Тиквичка. Сортата Виљамовка е употребена како контрола. Проучувањата се изведени во насад од круши лоциран во скопскиот регион во период од три последователни години (2008-2010). Во истражувањето беа вклучени следните параметри: време на зреење, маса и димензии на плодовите, димензии на дршката, содржина на растворливи суви материи и вкупни киселини. Органолептички оценувања на плодовите се правени во два термина и тоа на почетокот на октомври и почетокот на декември. Врз основа на истражувањето констатирано е дека покрај сортата Виљамовка добар квалитет на плодови имаат и сортите Harrow Sweet, Абате Фетел и Пакамс Триумф.

Клучни зборови: круша, сорти, квалитет, оценување.

UDC:634.11-152.61
Original scientific paper

EFFECT OF APPLE VARIETIES ON THE QUALITATIVE CHARACTERISTICS OF APPLE CHIPS PREPARED WITH OSMOTIC TREATMENT

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Abstract
The aim of this research is to examine the effect of apple varieties on the qualitative characteristics of the chips obtained by applying osmotic drying as pretreatment. For this aim apple chips is prepared from five apple varieties: Idared, Mutsu, Jonagold, Granny Smith and Red Delicious. Qualitative characteristics are examined using a sensoric analysis. Qualitative properties covered by sensoric analysis are: color, aroma, taste, texture and crispy. Samples were cut with a special knife with thickness 1 to 2 mm in the form of a disc diameter of 18 mm. Osmotic solutions were prepared from aqueous solution of sucrose with a concentration of 50%. After 60 min osmotic treatment, samples were dried in air-dryer at 100°C, 120 min. In terms of color best results are obtained for the variety Mutsu, which by the panelists was evaluated with 3.72 while the weakest score is evaluated variety Granny Smith 2.97. Best scores in terms of taste and aroma are obtained from Idared variety, which for aroma is evaluated 3.41 and for taste 3.70, while in terms of aroma and taste again the weakest score was assessed with the variety Granny Smith 2.79 and 2.68. The highest scores in terms of mechanical properties are obtained for the Idared while the weakest of the variety Granny Smith. Best results for eligibility are obtained for Idared variety 3.93, then Jonagold 3.77, Mutsu 3.66, Red Delicious 3.18 while the lowest scores were obtained for the variety Granny Smith 2.77.
Key words: apple, osmotic treatment, chips, sensory analysis.

Introduction

Growth of the population and living standards impose the need for increased food production in quantity, and even more by its quality. Fruits as foods with a lower energy value are more demanding in human nutrition. Apple fruits with their high nutritional properties in human diet have a significant place.

Humans have long used apples as refreshments and food as medicine. Apple fruits are rich in a number of biologically active substances such as carbohydrates, organic acids, vitamins, minerals and anthocyanins. These fruits belong to the group of foodstuffs with high dietetic and prophylactic activity. Apple is the most grown continental fruit species. Apple production in the world is steadily increasing.Apple fruits have a certain period of harvest, and can be consumed during the whole year. This situation highlights the need to storage fruits for a longer period. As a result of microbiological and biochemical activity fruit quality during storage is constantly deteriorating. This imposes the need of development of various methods of preserving fruit quality and extending the period for their consumption. Using different methods of processing apple fruits become fit for

consumption for a long period of time. Dehydration is a classic method of food storage for a long period. Using this method of preservation provides keeping fruits for a long period, while providing less weight and requires less space for storage. Fruit drying commonly performed by applying heat under controlled conditions in order to remove part of the water. This prevents the development of microorganisms, reduces enzyme activity and chemical reactions. Due to the heat treatment in the process of drying comes to a deterioration of certain physical characteristics of fruits such as taste, color and texture. Deterioration of these characteristics makes fruits to become less attractive for the consumers. Besides physical appearance, classical dried fruit have less of certain nutritional components such as vitamins and antioxidants which again reduce the biological value of the product. This disadvantages leads for use of new methods by the food processing industry for improvement of the quality attributes of dried fruits. Need to introduce new methods for drying allows development of different dehydration methods such as: osmotic, microwave, infrared and ultrasonic dehydration various hybrid technologies etc. The application of the osmotic dehydration on food products offers energy efficient procedure with minimal processing and reaching high quality food. Osmotic dehydration has great potential market for the production of high quality food of various kinds. Osmotic dehydration can be defined as a process of simultaneous development of dehydration and absorption by immersion in osmotic solution. In this process, biological material carried out in two opposite processes of mass transfer. This is made possible by the osmotic pressure which occurs as a result of the difference in the concentration of osmotic solution and the solution in the tissues in biological material across the cell membrane tissues. Cell membrane is not selective so along with water to remove other components of biological material, such as: sugars, organic acids, minerals and vitamins.

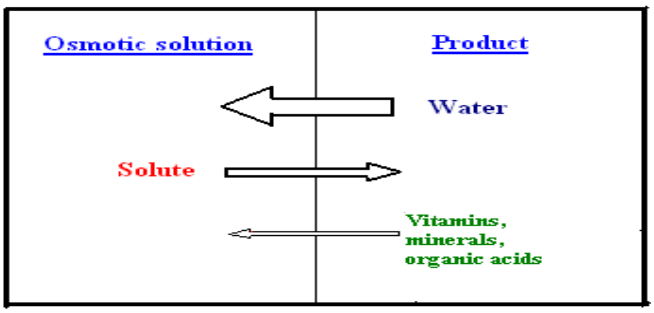


Figure 1. Mechanism of mass transfer with osmotic dehydration

Diffusion of those components is negligible with comparison to water loses and absorption of diluted particles from osmotic solution (Mastrantonio et.al.2005, Ramaswamy, 2003).

An apple chip is attractive product that greatly increases the value of often cheap raw material and expands the production in range of products of apples.

In apple production orchards large number of varieties with different biological and quality characteristics of fruits was used. The choice of variety depends on the environmental conditions in the region, the tradition of growing, the demands of consumers, the purpose of fruits etc. (Kiprijanovski, 2009). During osmotic dehydration among the most important variables affecting the mass transmission beside osmotic pressure, the structure of plant tissue has great influence (Mauro et.al. 2005). Chemical composition of the fruits and physical structure such as porosity, content of plant fiber and skin have also influence on osmotic dehydration (Wais et. al. 2004). Fruits

from the different apple variety differ in numerous parameters which determinate their quality, among them is certainly structure of mesocarp. The main aim of this paper is to determinate the influence of different apple varieties on quality of the chips obtained from osmotic dehydration.

Material and methods

Fruits from the 5 different apple varieties (Idared, Mutsu, Jonagold, Granny Smith and Red Delicious) were used as a material for this investigation. Fruits were collected from the production orchards in R. of Macedonia. Fruits were harvested in full maturity and till the moment of drying was kept in the cold storage at temperature of 4 ^{o}C. Osmotic solutions were prepared with concentration of sucrose. Before osmotic treatment fruits were slices in pieces with circle shape, thickness 1- 2 mm and diameter of 18 mm. Prepared samples were measured on analytical scale, accuracy ±0,0001 g. After the measurement samples are submerged in 50 % osmotic solution. Submerging time was 60 minutes. Relationship between fruit weight and solution was 1:15. Temperature during osmotic treatment was 23-25 ^{0}C. After the treatment fruit slices were dried in conventional drying oven in the duration of 120 minutes. After that was packaged in inter atmosphere of nitrogen in polypropylene. Color change is determined by usage of colorimeter Dr. Lange spectro-color. Color was determinate at fresh, osmotic treated and conventional dried samples during different time intervals. Calibration of the colorimeter was conducted by the manual of the producer. Tree color parameters were measured: L* (light), a*(greenish) and b*(yellowish). Index of darkening was determinate using following equilibrium:

$$I_{pot} = \frac{100}{0,17}\left(\frac{a^{*} + 1,75L^{*}}{5,645L^{*} + a^{*} - 3,012b^{*}} - 0,31\right)$$

Texture of the samples was determinate with TA-XT2 Texture analyzer, Stable Micro System Ltd. For evaluation of the acceptance of the products by consumers, sensory analyzes of the organoleptic attributes of the apple chips was conducted. Evaluation was performed by the 42 panelist between 21-64 years of age. Four of them were male and 38 were female. In the questionnaire, panelists used descriptive and hedonistic test and product evaluation scale intensity.

Results and discussion

For determination of the quality value of each food product final consumers have key role. Evaluation of quality attractiveness and acceptance of the apple chips was preformed trought sensory analyzes of the color, aroma, taste, texture, crispiness and final acceptance. Samples were rated on a scale of 0 to 5. Data of sensory analysis are shown in Table 1 and Figure 1. Concerning the color, the best score from the panelist are given to the apple chips from the Mutsu variety (3.72), while the lowest score was given to the apple chips from Granny smith variety (2.97). The percentage of moisture loss and absorption of soluble substances in the conditions under which it is prepared chips from apples (50% concentration of osmotic solution during osmotic dehydration of 60 minutes) affect the color of the resulting chips. Slices from Mutsu variety has a high percentage of moisture loss (34.41%) and absorption of sucrose (65.87%) while the pieces of the variety Granny Smith has small values of these variables, 13.05% for water loss and 9.98% for the absorption of sucrose. Large values of the water loss and absorption soluble solids contribute to reducing the intensity of the enzyme and unenzyme bolding.

Table 1. Intensity of sensorial characteristics of the cips of different apple cultivars

Cultivar	Color	Aroma	Taste	Texture	Crispness	Acceptability
Idared	3.54	3.42	3.71	4.06	4.35	3.94
Mutsu	3.73	3.27	3.48	3.65	3.88	3.67
Jonagold	3.67	3.27	3.52	3.85	3.98	3.77
Granny Smith	2.98	2.79	2.69	2.81	2.83	2.77
Red Delicious	3.13	3.06	3.00	3.42	3.75	3.19
M	3.41	3.16	3.28	3.56	3.76	3.47

The percentage of moisture loss and absorption of sucrose was also affected the taste and aroma of apple chips. Best grades in terms of flavor and aroma are achieved at variety Idared which aroma is evaluated with 3.41 and taste 3.70. The lowest score for this attributes, again has chips from Granny Smith variety with 2.79 and 2.68 (Fig. 1). Losses of water in the chips from Idared was 37.50%, while absorption of sucrose 67.42%. We presume that high absorbed quantity of sucrose in chips from Idared variety was neutralized by the present acids.

Concerning mechanical attributes highest values were obtained from the chips of Idared while lowest from chips of Granny Smith. It can be concluded that higher quantity of removed water and absorption of the sucrose leads to the texture keeping and increase of crispiness on the chips.

Chips from Idared were high ranked concerning acceptance, followed by Jonagold, Mutsu and Red delicious. The lowest was ranked chips from Granny smith (Figure 1). These results are in accordance to the values of percentage of water losses and sucrose absorption. Taking into account average value of the sensory analyzes by the panelist about acceptance of the apple chips from all variety (3.47) it can be concluded that chips obtained from osmotic treatment is acceptable by the consumers.

Table 2. Instrumental data for color of the apple cultivars

Sample	Color of the apple cultivars (BI)				
	Idared	Mutsu	Jonagold	Granny Smith	Red Delicious
Fresh	8,33	15,00	17,75	17,56	16,29
Osmotically treated	11,30	19,24	23,90	22,81	29,07
Chips	52,31	44,40	31,70	46,56	54,09

Table 3. Instrumental data for crispness of the apple cultivars

Sample	Crispness of the apple cultivar				
	Idared	Mutsu	Jonagold	Granny Smith	Red Delicious
Fresh	1,01	1,10	0,91	1,40	1,01
Osmotically treated	1,35	0,92	1,76	2,64	0,75
Chips	0,25	0,70	0,27	0,58	0,82

Color and crispness of the fresh samples, osmotic treated and apple chips are give in Table 2 and Table 3. Results are presented trough index of bolding (BI). The best results were obtained at chips from Jonagold, while lowest value for this parameter has chips from Red Delicious. Chips from Idared have highest crispness while chips from Red Delicious have the lowest (Table 3).

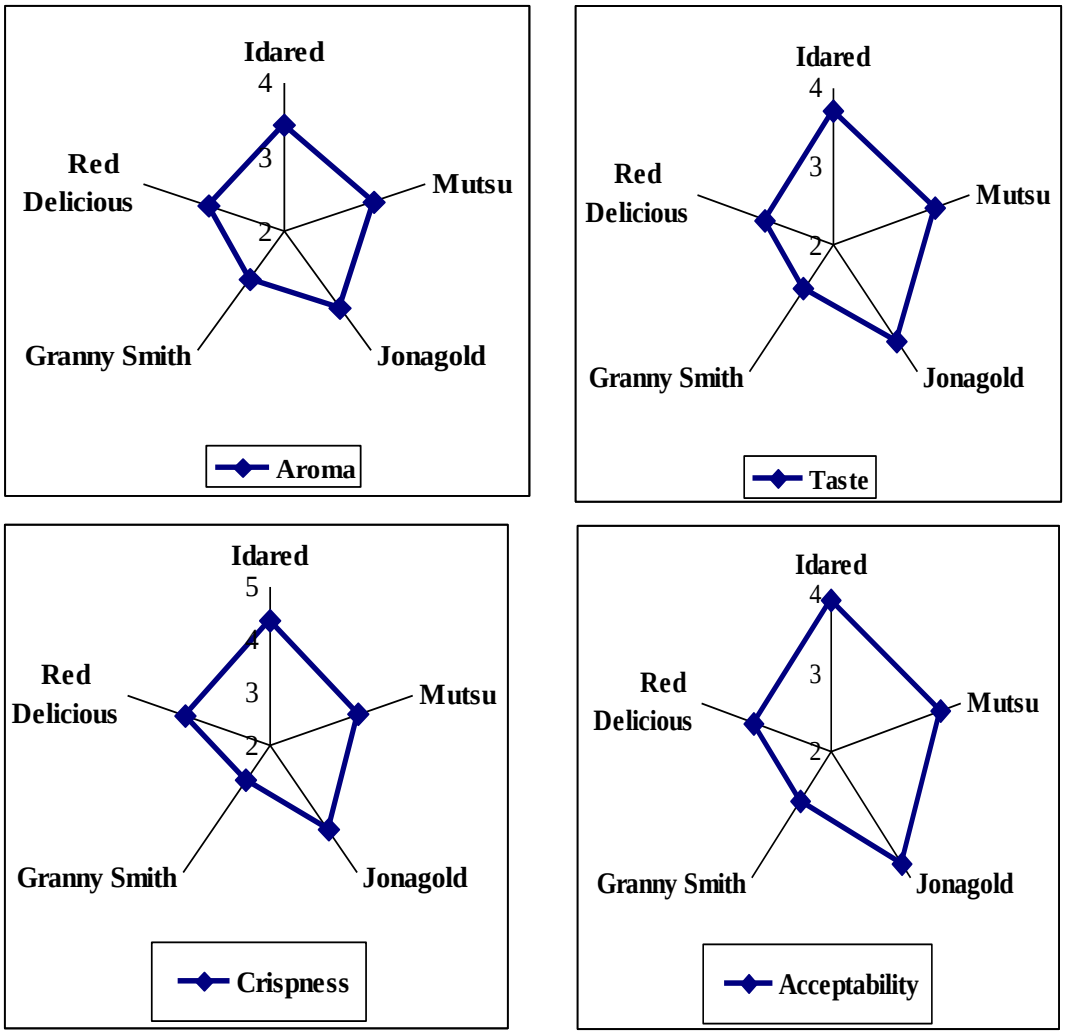


Figure 2. Sensorial profiles of the of apple cips by different assessed parameters

Conclusions

The results got from conducted research show that:

-A chip obtained by osmotic treatment of the five varieties of apples has been accepted by the panelists.

-From sensory analysis best apple chips with osmotic treatment are obtained from a variety Idared while the worst from the variety Granny Smith.

-Sensor properties of apple chips produced by osmotic treatment depend on the percentage of removed water and sucrose absorption during osmotic pretreatment.
-In practice it can be recommended that fruits from Idared variety can be used for producing apple chips by drying through osmotic way.

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ВЛИЈАНИЕ НА СОРТАТА ВРЗ КВАЛИТАТИВНИТЕ СВОЈСТВА НА ЧИПС ОД ЈАБОЛКА ПРИПРЕМЕНИ СО ОСМОТСКО ТРЕТИРАЊЕ

Арјан Ганији, Кипријановски Марјан

Апстракт

Целта на ова истражување е да се испита ефектот на јаболковите сорти врз квалитативните својства на чипси од јаболка подложени на осмотско сушење. За оваа цел се подготвени чипси од јаболка од пет сорти на јаболка: Ајдаред, Муцу, Јонаголд, Грени Смит и Црвен Делишец. Квалитативните својства се испитувани со употреба на сензорна анализа. Квалитативните својства кои се опфатени со сензорната анализа се: боја, арома, вкус, текстура и крцкавост. Примероците беа сечени со специјален нож во форма на диск со дијаметар од 18 mm и дебелина од 1 до 2 mm. Осмотскиот раствор беше подготвен од воден раствор на сахароза со концентрација од 50 %. После 50 минутно осмотско третирање, примероците беа сушени во сушална на 100 °C, во времетраење од 120 минути. Во однос на бојата најдобри резултати се добиени кај сортата Муцу, која од страна на оценувачите беше оценета со оценка 3.72, додека најниски резултати се добиени кај сортата Грени Смит. Најдобри резултати во однос на вкусот и аромата се добиени кај сортата Ајдаред, чија што арома беше оценета со 3.41 а за вкус 3.70, додека во однос на вкусот и аромата повторно најнизок резултат беше постигнат кај сортата Грени Смит 2.79 и 2.68. Највисоките резултати по однос на механичките карактеристики се дебиени кај Ајдаред додека најниските резултати се добиени кај сортата Грени Смит. Најдобри резултати во однос на подобноста се добиени кај сортата Грени Смит 2.77.

Клучни зборови: јаболко, осмотско третирање, чипси, сензорна анализа.

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Original scientific paper

MATHEMATICAL MODELS OF A PEAR, VARIABILITY AND APPLICATIONS

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Abstract
Various factors have influence on growth and development of bio-materials. Therefore, shape variability is very important and should be examined. In many processes of heat exchange, as well as in other processes in bio-material handling, very important role play the physical properties of a fruit such as dimensions, shape, surface area and volume. The objective of this work is to find a function which approximates a pear border line as precisely as possible. Previously described estimation of an average pear border line is relying on the sixth order polynomial and proposed algorithm. Also, two different ways of calculating the Williams pear border line are earlier shown. The first one includes spline functions as an estimation of a pear border line, while the second way uses regression function obtained by the nonlinear regression method. The regression function has two independent variables, length and total length of a pear. Border lines of all pears in the sample are fitted with one regression function with large precision (R2=97.48). Surface area and volume of a pear is now calculated based on the regression function and total pear length. In this paper, it is compared different ways of pear border line calculation. Presented surveying methods should be a non-destructive one.
Key words: shape variability, integral calculus, cubic spline, nonlinear regression.

Introduction

Physical properties of fruit (dimensions, shape, surface area and volume) have very important role in many processes of heat exchange and other processes of biomaterial handling (Mohsenin, 1980).Various factors influence the growth and development of bio-materials. Therefore, shape variability is very important and should be examined. It is well known that fruits, including pears, are dominantly irregular in shape. Certain number of measurements must be made for full characterization of fruit shape. Analysis of three mutually perpendicular axes usually contains enough information for volume or surface area modeling. The finite element method was used to discretize the governing differential equations over the actual 3D pear geometry (Wang *et al*., 2006). Pear dimensions were evaluated during the drying process and those data were used to calculate the pear surface area and volume (Guine *et al*., 2006). Cut pears were photographed horizontally and vertically against a millimeter-scaled paper. The shape of the whole pear was replaced with two regular bodies, half of a sphere and a cone. The dimensions and volume were also investigated for cherries (Ochoa *et al.*, 2007), almond cultivars (Altuntas *et al*., 2010) and mango (Spreer and Müller, 2010). If color is an important factor, then the use of digital images is essential (Quevedo *et al*., 2009; Purlis and Salvadori, 2009; Altuntas *et al.*, 2010;). Xiao-bu *et al.* (2010) also used digital images to detect the apple defects. Optimization of digital images was widely studied

(Acketa and Matić-Kekić, 2000; Matić-Kekić *et al.*, 1996). An image processing-based method is appropriate for measuring the volume and surface area of ellipsoidal agricultural products such as lemons, peaches, limes and eggs (Sabliov *et al*., 2002). Now, let us make a short introduction to the approximation one of three methods, that will be presented here. For various kinds of approximation problems, it is frequently advantageous to use piecewise polynomials instead of polynomials. Reason for this lies in the fact that using low-degree polynomials locally is usually more accurate and more efficient than using a high-degree polynomial globally (Ascher *et al*., 1995). The main idea of cubic spline function is that it remains twice continuously differentiable over the observed interval. Program package Mathematica 6 (Wolfram, 1991) was employed for testing the cubic spline approximation of pear border line and for all necessary numerical integrations. This software is very applicable in many other problems related to agriculture (Bodroža-Pantić *et al.*, 2008) and to optimization (Matić-Kekić and Acketa, 1997; Acketa *et al.*, 2000).

The aim of this study was to compare various mathematical expressions for Williams pear border line. Those expressions allow easy estimation of both pear surface area and volume. The presented surveying method should be a non destructive one. Confirmation of precision of mathematical model for pear border line approximation was performed in Dedović *et al.* (2011), as follows: firstly, volumes of the pears were measured by Archimedes' method; secondly, volumes were calculated using numerical integral calculus with assumption that pear could be observed as a rotation body; thirdly, relative errors for calculated volumes were given.

Material and methods

Thirty fruits of Williams pear (*Pyrus communis*) were randomly selected and then halved through the longitudinal axis. Each half was split along the same axis to generate two pear quarters. The core and seeds were removed and half of a pear was placed in a two-axis system, such that the total length (*L*) of the pear was on *l*-axis, and width (*W*) was on the *w*-axis. Zero point was placed at the bulbous end of the pear (see Fig. 1).

The coordinates of the seven points, located on the pear border line $T_i(A_i,B_i)$, i=0,…,6, are presented in Babić *et al.* (2012) and Dedović *et al.* (2011).

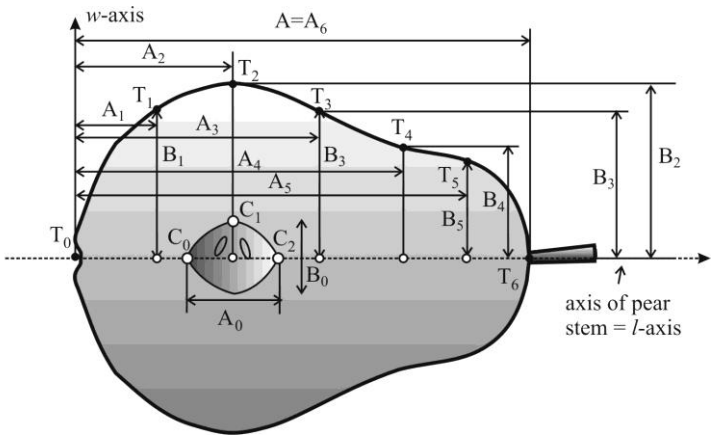


Figure 1. The pear outline and its measured points T_i (A_i,B_i), i=1,…,6, as well as dimensions of pear core A_0 and B_0. Point $T_0(0,0)$ is start point of Cartesian coordinate system with *l*-axis (length) and

w-axis (width); $A_1=0.5\cdot A_2$, $A_3=0.5\cdot(A_2+A_4)$, $A_5=0.5\cdot(A_4+A_6)$, $C_0=(0.5\cdot(A_2-A_0),0)$, $C_1=(A_2,B_0/2)$ and $C_2=(0.5\cdot(A_2+A_0),0)$. This figure is taken from Babić *et al*. (2012).

Among basic dimensions, thickness of a pear was not measured because it was assumed (www.rainierfruit.com/products/pears/img/pears.pdf) that pear could be represented as rotating body, where "stem axis" was, actually, the axis of rotation. Based on this assumption, pear thickness was equal to pear width, and surface area and volume of a pear could be calculated using formulas (1) and (2), respectively. However, pear border line function $f(x)$ must be defined first. Generally speaking, the formulas for the surface area S and volume V of the rotating body within the interval (a,b), where a is the starting point on the x-axis and b the last point on the same axis, for a non negative period of function $f(x)$ are:

$$S(f(x),a,b)=2\pi\int_a^b f(x)\cdot\sqrt{1+(f'(x))^2}\,dx \qquad \text{(surface area of rotating body)} \qquad (1)$$

and

$$V(f(x),a,b)=\pi\int_a^b (f(x))^2\,dx \qquad \text{(volume of rotating body)} \qquad (2)$$

Volumes of the pears from sample, were measured by Archimedes' method and calculated by formula (2), where $f(x)$ was border line function (polynomial function (4), spline function (5) or regression function (6)). Also, surface area of the pears from sample, were calculated by formula (1), where $f(x)$ was border line function.

The quarter of one pear is additionally bounded with two lateral flat surfaces. Flat surface area, denoted as *FS*, bounded by the x-axis and $f(x)$, is calculated as:

$$FS(f(x),a,b)=\int_a^b f(x)\,dx \qquad (3)$$

for $f(x)\geq 0$, $x\in(a,b)$. Surface area and volume of a seed core, can also be calculated by using (1) and (2) since seed core can be considered as a rotating body, too.

Results and discussion

1. Polynomial fitting

In Babić *et al*. (2012), function $f(x)$, which is approximation of pear border line, passes through all seven points T_i, i=0,1,2,…,6 on the average pear border line. Function $f(x)$ is actually sixth order polynomial $P(l)$,

$$P(l)=4.1135\cdot l-0.2531\cdot l^2+0.0093\cdot l^3-0.0002\cdot l^4+2.083\cdot 10^{-6}\cdot l^5-8.5968\cdot 10^{-9}\cdot l^6 \qquad (4)$$

where $l\in[0,\overline{L}]$ is an independent variable, i.e. l is pear length which takes values from 0 to $\overline{L}$, while the average total length of pears is marked as $\overline{L}$ =84.3 mm.

2. Spline functions

The next objective is to determine the polynomial function of lower order than sixth, with the same outline representation. High order of polynomial $P(l)$ produces very small coefficients multiplying l^5 and l^6, which causes less precision and greater errors during the numerical calculations of volumes and surfaces area. If cubic spline involves all seven characteristic points T_i, i=0,1,…,6, the interval of the average pear length [0,84.3] has to be split into four parts. The first subinterval [0,29] contains points T_0, T_1 and T_2, the second one [29,44.5] contains T_2 and T_3 points, the third

subinterval [44.5,60] contains points T_3 and T_4, and the fourth subinterval [60,84.3] contains points T_4, T_5 and T_6. Thus, cubic spline $s(l)$ in (5) is represented by four polynomial functions of third order (one polynomial for each subinterval).

In case when total length of a pear is L=84.3, the function describing pear border line is

$$s(l)=\begin{cases} 3.09764\cdot l-0.0984982\cdot l^2+0.00102846\cdot l^3,\ l\in[0,29], \\ 30.1456-0.011803\cdot l+0.00841199\cdot l^2-0.000196814\cdot l^3,\ l\in[29,44.5] \\ -75.7114+7.10387\cdot l-0.151026\cdot l^2+0.000994001\cdot l^3,\ l\in[44.5,60] \\ 628.3-27.9943\cdot l+0.432242\cdot l^2-0.00223695\cdot l^3,\ l\in[60,84.3] \end{cases} \quad (5)$$

Two previously described methods are based on the same idea. Firstly, functions which approximate average pear border line (polynomial or spline functions) pass through all seven points on the average pear outline. Secondly, those functions are used for stretching or compressing of pear border line for each pear, using the previously proposed algorithm. However, there is the following limitation: for each total pear length, new polynomial function or spline function must be created (this means that each pear from a sample has a shape which can be obtained by stretching or compressing a pear with average border line). In general, it cannot be correct because the shape of a pear from the same cultivar does not have to be equal to the shape of an average pear. These problems can be overcome by using the following approach.

3. Nonlinear regression

Our aim (Dedović *et al.* 2011) was to create only one function which could describe the variability of pear boarder line.

So, the surface (6) is accepted as the final model for pear border line variability:

$$Q(l,L)=-\frac{40.6437}{L^5}\cdot l^6+\frac{116.805}{L^4}\cdot l^5-\frac{130.088}{L^3}\cdot l^4+\frac{72.6492}{L^2}\cdot l^3-\frac{22.9904}{L}\cdot l^2+4.26753\cdot l \quad (6)$$

Very high coefficient of determination R^2=97.48% is obtained for the confidence level of 95%. The main advantage of this model is that there is no need for extra algorithm as in Babić *et al.* (2012). Another advantage is that this (third) method is more precise than the first two methods previously presented. Moreover, all experimental points were used in nonlinear regression method and not only the mean values of seven coordinates on the pear border line.

Conclusions

The Williams pear border line function is presented by: polynomial function, spline function and nonlinear regression function.

Cubic spline has similar properties as the polynomial function for average pear border line approximation. The only advantage of cubic spline is more acceptable polynomial coefficients.

Pear border line variability implies that priority must be given to the nonlinear regression function for the following reasons:

-it calculates pear border line for smaller and larger pears more precisely than other two proposed functions;

-volumes obtained by using regression function as pear border lines approximation are different from real volumes (measured by Archimedes' method) with relative error 6.97%. Removing the three smallest pears from the sample, relative error is 4.24% only (Dedović *et al.* 2011). Very high

precision in volume of the pears calculation implies that surface area of a pear can be calculated very precisely as well.
-it is clear that precise determination of the pear border line function, surface area and volume of a pear is more accurate;
-only one function is sufficient for pear border line formation, for arbitrary total pear length;
-this function does not require any additional algorithm.
These results are useful for packing, storage as well as in technology processes, biomaterial handling and drying processes.

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МАТЕМАТИЧКИ МОДЕЛИ НА КРУША, ВАРИЈАБИЛНОСТ И АПЛИКАЦИИ

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Апстракт
Различни фактори влијаат врз порастот и развојот на биолошките материјали. Затоа, разликите во обликот се многу значајни и треба да се испитуваат. При процесите на размена на топлина, како и кај други процеси при справувањето со биолошки материјал, многу значајна улога имаат и физичките карактеристики на овошјето како што се димензии, форма, површина и волумен. Целта на ова истражување е да се изнајде функција со која граничната линија кај крушата се пресметува што е можно попрецизно. Предходно опишаните пресметки за просечната гранична линија на круша се базираат на шестиот полиноминален ред и предложен алгоритам. Исто така, два различни начини за пресметување на Вилијамовата гранична линија на крушата се предходно прикажани. Првиот опфаќа долги функции за пресметка на граничната линија на крушата, додека при вториот начин се користи регресивна функција која е добиена со нелинеарен регресивниот метод. Регресивната функција има две независни променливи, должина и вкупна должина на круша. Граничните линии на сите примероци од круши се вклопени во една регресивна функција со голема прецизност (R^2=97.48). Површината и волуменот на крушата се пресметани врз основа на регресивната функција и вкупната должина на крушата. Во овај научен труд се споредени различни начини на пресметување на граничната линија на крушата.
Клучни зборови: различни облици, интегрална пресметка, cubic spline, нелинеарна регресија.

SECTION 5: GENETICS AND PLANT BREEDING

UDC:635.652:575.22(497.781)
Original scientific paper

GENETIC VARIABILITY OF SOME MORPHOLOGICAL AND PRODUCTIVE TRAITS OF LOCAL BEAN POPULATIONS (PHASEOLUS VULGARIS L.)

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Abstract
Diversity and genetic variability of ten local bean populatios (*Phaseolus vulgaris* L.) from Kichevo region, for several morphological and productive traits have been analysed in two-years experiment. The population Tetovski grav (Tetovo bean) was used as standard for comparation with the other populations. Regarding the obtained results, populations are divergent for nearly all of the investigated traits: leaf color, shape and persistence, color of flower wings and bracteole, color of immature and dry pods, pod shape, shape of pod cross-section, pod wall fibre, position of pods, position and orientation of pod beak, number of pods per plant, number of seeds per pod, seed pattern, color, brilliance and shape, 100 grains mass and seed yield per plant. Population's yield per plant varied from 118.8 g to 181.8 g, except for the Trkalezen bel grav (45.3 g). Highest yield, and the only one higher than the standard, had Splesnat tetovec, therefore we recommend it for wide production in Kichevo region. The variability within the populations for all traits was low. Among the investigated productive characters, in average of all populations, least variable trait was the number of seeds per pod (9.74% CV), while most variable was grain mass per plant (12.72% CV). In average of all of the productive traits, the population Bel cincar had highest variability (20%). The populations Siten cincar, Splesnat tetovec, Trkalezen bel grav and Splesnat tetovec were most uniformed (approximately 15% CV). Compared to the standard Tetovski grav, other populations differ significantly for large number of the traits.
Key words: *Phaseolus vulgaris* L., bean local populations, diversity, variability, morphological traits, productive traits.

Introduction

Genus *Phaseolus* originates from America, or more specificaly two centres of origin: Mesoamerican and Southamerican are recognized by many researchers (Toro *et al*. 1990, Gepts *et al*. 1986, Voysest *et al*. 1994, Angioi *et al*., 2009; Kwak *et al*., 2009). Approximately 70 *Phaseolus* wild species are more important for the development of a humankind (Freytag and Debouck, 2002), out of which five are domesticated and cultivted in the past. Among them, *Phaseolus vulgaris* L. or common bean is the most widely cultivated, taking 90% of the world bean production. In Europe bean was primarily grown as decorative plant, and later as a food crop. During the Turkish rule this crop spreads in Macedonia and Serbia with noumerous populations characterized primarily with large seeds. Still today some landraces are locally named "turkish seed". Balkan Peninsula is

considered as secondary center of origin due to the high bean diversity present in this region (Krasteva, 2002).

R. Macedonia has long tradition of bean cultivation. Farmers in the rural areas maintain various populations within several decades (Ivanovska and Popsimonova, 2006). In Kichevo region populations with white compressed or kidney shaped grains are predominant, which local name is most often variation of the well known Tetovski grav (Tetovo bean). However, populations with patterned and colored grains are grown as well. Due to absence of bean breeding program this rich diversity of local poulations was not determined till present. Main breeding objective in all programs is yield improvement (Ghobary and Abd-Allah, 2010). Seed yield is a complex trait affected by many factors and success of its improvement relay on use of characters directly associated with yield as selection criteria (Karasu and Oz, 2010, Chitra and Rajamani, 2010, Cabral *et al*. 2011). Therefore, the objective of present study was to estimate the genetic variability of some morhological and productive characters of ten populations collected from Kichevo region. The information obtained will be used as value indicators for conservation of this material in the gene bank, and for establishment of breeding collection in the future program.

Material and methods

The diversity and genetic variability of ten local bean populations (*Phaseolus vulgaris* L.), maintained by farmers from Kichevo region for a long period have been analized. Populations with their local name and origin are listed in Table 1. Landrace Tetovski grav, cultivated on larger areas in RM, was used as a standard for comparation with the other populations. The experiment was conducted in two years (2006 and 2007) at the village Crvivci, Kichevo, on 640 m above sea level, by use of RCBD with three replications. Planting was performed manually, in May 2006 and April 2007, in nests with 50x50cm distance, with 4-5 seeds in each nest. After the planting, standard agrotechnical measures were applied. The plants were irrigated 3 times in 2006 and five times in 2007. For determination of populations diversity, plant characters were recorded according to Descriptor list for *Phaseolus vulgaris* (IPGRI, 1982).

During the vegetation and after the harvest qualitatuive characters of leaves (color, shape and persistence), flowers (color of wings and bracteoli), pods (color of immature and dry pods, shape, curvature, position on the plant, cross-section shape, pod wall fiber, beak position and orientation) and seed (coat pattern, coat darker and lighter color, brilliance and shape) were analyzed. Productive characters: number of seeds per pod (average of 10 pods/plant), number of pods per plant, mass of 100 seeds (g) and seed yield per plant (g) were evaluated.

In IPGRI and UPOV descriptors seed shape is visuelly clasified in 4 groups. Genchev (1989) suggests classification based on the variation among the three seed dimensions. Five shapes (Tab. 2) are grouped according to the relations length : width and height : width of seeds (Dekaprelevic, 1925; citation by Tudzarov, 1981). This classification is similar to the botanical and it is used in many experiments (Vasić, 1986). Seed dimensions were measured from 10 seeds per each plant.

The obtained data were analyzed for variance using the statistical package SPSS. For determination of genotypes variability basic statistical parameters for the characters were estimated for each repetition and year. The differences between means were compared by LSD test. Statistical significance was considered at $P<0.01$ and $P<0.05$ level.

Table 1. Local name and origin of the investigated populations

No	Original local name	Translation of local name	Origin (village)
1	Tetovski grav	Tetovo bean	v. Forino
2	Bel cincar	White cincar	v. Bigor Dolenci
3	Sharen trkalezen grav	Paterned round bean	v. Tuin
4	Siten cincar	Small cincar	v. Bachishta
5	Splesnat tetovec	Compressed tetovo bean	v. Zajas
6	Sharen cincar	Paterned cincar	v. Bigor Dolenci
7	Trkalezen bel grav	Round white bean	v. Rechani
8	Splesnat grav	Compressed bean	v. Tuin
9	Kafen i crn cincar	Brawn and black cincar	v. Bigor Dolenci
10	Splesnat kichevski	Compressed kichevo bean	Kichevo

Table 2. Classification of bean seed shape based on the relations among the seed sizes

Subspecies	Seed shape	Length : width	Height : width
Sphaericus (Savi)	Sphaerical	1,0-1,3	0,66-1,0
Ellipticus (Mart.)	Eliptical	1,3-1,7	0,71-1,0
Oblongus (Savi)	Oval	1,7-2,3	0,71-1,0
Subcompressus	Semicompressed	1,3-1,7	0,36-0,7
Compressus (D.C.)	Compressed	1,7-2,3	0,36-0,7

Results and discussion

The variability of populations regarding their qualitative characters is presented in Fig. 1. All characters are listed in the legend along with the relation among alternative forms of the characters. Populations having the given form enclosed in the parenthesis are listed with the numbers specified in Table 1. Highest diversity among the genotypes with the largest number (4) of alternative trait forms was determined for the color of flower wings, pod position, darker color of the seed coat and shape of the seed. All plants were uniformed only for two characters: bracteole color (green) and position of the pod beak (marginal). Low diversity (with two alternative trait forms) was registered for leaf color and persistence, pod wall fiber, pod beak orientation and seed coat pattern. Bean seed has high variations regarding the size, shape and color, depending on the genotype. This phenotype variation is important for commercial purposes, influencing on cookability, processing, taste and texture of the grains (Adams and Bedford, 1993, Kelly *et al.*, 1998). Varieties with white seeds are predominant on the Balkan Peninsula (Mitranov, 1981a; Vasić *et al.*, 1993). In the collection of 129 genotypes maintained by the Institute of Field and Vegetable Crops in Novi Sad, Vasić (2004) also determined high diversity regarding the seed shape and color, out of which most seeds were white, greeny-yellow, pale green, gold, patterned, brawn, pink and black. Populations with colored seeds are also maintained by the farmers, mainly for their own needs. In the collections of South America, bean with black, red and patterns of different colors is predominant (Antunes *et al*., 1981; Voysest *et al*., 1994). Breeding directions are often determined by the seed shape and color (Acquaah *et al*., 1992; Brothers and Kelly, 1993; Gvozdanović *et al*., 1996).

Number of seeds per pod

The population Siten cincar had highest number of seeds per pod in both years (5.83 in 2006, 4.56 in 2007). Compared to the standard Tetovski grav, only 3 populations had statistically significant diferent average values. The values were higher in 2006 in almost all of the populations (Tab.3). Similar results for the number of seeds per pod obtained by analyses of different varieties and populations are reported by Mitranov (1981a, 1981b) with average values of 3.8-5 seeds; Vasić *et al*. (1996) with 3.22-4.05 seeds, Stoilova and Kiryakov (2000) with 4.2 seeds, Vasić *et al*. (2002) with 2.8-4.4 seeds, Vasić (2004), with 2.4-4.4 seeds, Duran *et al*. (2005) with 2.8-4.2 seeds, Kazemi *et al*. (2012) with 3.2-3.9 and Salehin and Rahman (2012) with 4.5-6.1 seeds per pod. Highest variablity among the plants was recorded in the population Tetovski grav in 2006 (14,44%), and in general all populations were more variable in this year (Tab. 3). In average the variability of this trait was low (9.74%), which is in accordance with the results obtained by other autors (Adams, 1967, 1982; Mitranov, 1981a, Vasić *et al*., 1996, Duran *et al*., 2005). On the contrary, Stoilova and Kiryakov (2000) have determined higher variability (29%) in 40 bean samples maintained by the genebank in Sadovo.

Number of pods per plant

Highest pod number in the two years was determined in the population Splesnat grav (81.63 in 2006, 59.42 in 2007), and the smallest mean value was recorded in Bel cincar (49.17 in 2006, 33.52 in 2007). The only exception was found in Trkalezen bel grav, which also have three times smaller plant height and belongs to other growth group (Tab.3). The values of all populations were higher in 2006, while only Splesnat grav had significantly higher value (70.53) than the standard (65.57). Vasić (1994) also determined 17-74.9 pods per plant, as well as Kazemi *et al*. (2012) – 25.6-50.5. Lower average values are reported by Mitranov (1981b), 11-54; Stoilova and Kiryakov (2000), 14.3; Vasić *et al*. (2002), 4.4-14.6, Vasić (2004), 3.1-18.9, Salehin and Rahman (2012), 7.1-8 and Hossein *et al.* (2012), 19.64-30.15, due to various growth groups of the examined material. For the same reason much larger range of average values are published by Bozoclu and Sozen (2007), 1-163 pods, and Yongzhong (1994), 17.2-100 pods. The uniformity of the plants within the populations was much smaller in two populations in 2007 (21.42% in Bel cincar and 22.74% in Splesnat kichevski), although all populations expressed high variability in this year (Tab. 3). Most stable in 2007 was Tetovski grav (12.89%) and in 2006 Splesnat kichevski (9.50%). Compared to the relatively low variability of this trait determined in this research, other autors refer higher variability in their investigations: 30-44% (Vasić, 1994), 38.1% (Stoilova and Kiryakov, 2000), 33.6-40% (Vasić, 2004) and 28.6% (Duran *et al.*, 2005), also becouse of the different growth groups of analyzed material.

Mass of 100 grains

The grain mass along with the number of grains per pod and number of pods per plant are directly contributing to the yield. Whatever the breeding directions are, the primary goal is creation of high yielding varieties with different grain size (Ninhuis and Singh, 1986, Karasu and Oz, 2010). The values for this character are obtained by measurement of 100 air-dried seeds from each plant. In average for the two years, highest values expressed Kafen and crn cincar (67g) and Bel cincar (66g). Values over 60g were recorded in Splesnat tetovec, Sharen cincar and Splesnat grav as well (Tab. 3). During the analysis of 1000 grains mass in various bean genotypes, Vasić registered lower average values: 322-448g (Vasić *et al*., 1995), 161.8-443.8g (Vasić *et al*., 2002) and 161.8-483.1g (Vasić, 2004). Similar results are published by Duran *et al*. (2005) with average 100 grains mass of

23.3-42.7g, Stoilova and Kiryakov (2000) with 46.7g, Salehin and Rahman (2012) with 39.6-44.5g and Hossein *et al*. (2012) with 26.7-44.6. Higher values (16.2-80g), in accordance with the results obtained in this investigation are registered by Bozoglu and Sozen (2007) in the collection of 292 local bean populations in Turkey. The populations were less uniformed for 100 grains mass in 2006 (14.43%-22.75%), while in 2007 the variablity was lower and ranged from 7,57% to 15,15% (Tab. 3). Similarly, Duran *et al*. (2005) determined 10.6% variability, but also lower uniformity (42.2%) is reported by Stoilova and Kiryakov (2000) and (27.2%) by Vasić (2004). Zizumbo-Villareal *et al*. (2005) analyzed wild, weedy and cultivated bean populations. They registered average mass of 100 grains 6g, 20g, 39g and variability of 12-50%, 19-21%, 37-42%, consequently.

Seed yield per plant

The values for the seed yield are obtained indirectly through the values of the previously described characters. Yield of all genotypes was much smaller in 2007 (38.35-164.20g), than in 2006 (52.32-211.95g), with highly significant diferences among the years. In average for the two years highest seed yield per plant was recorded in Splesnat grav (181.8g) and Splesnat tetovec (177.8g). Only these populations have overcome the standard yield (156.8g). Interpopulation variability was higher in 2006 (25-41%) compared to 2007 (19-32%) in almost all of the genotypes (Tab. 3).

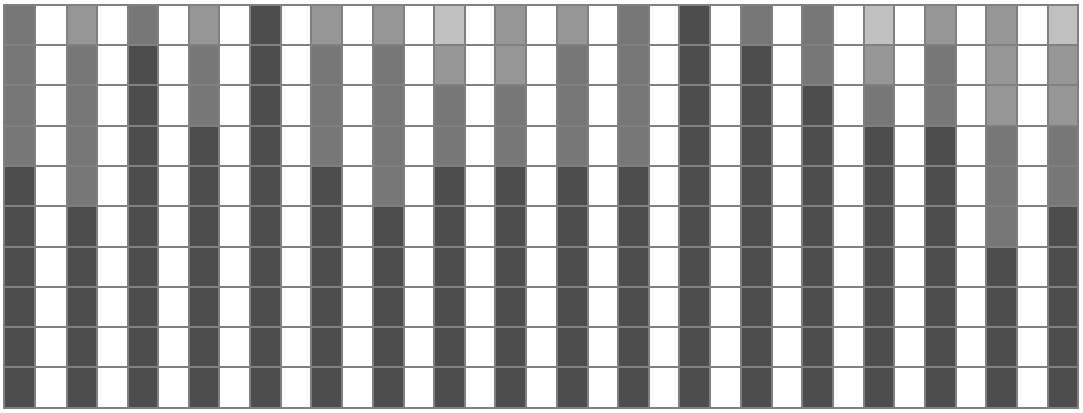


Figure 1. Variability of qualitative characters of the investigated bean populations

Legend:

1. Leaf color: medium green 6 (1, 2, 4, 5, 8, 10), dark green 4 (3, 6, 7, 9);
2. Leaf shape: quadrangular 5 (4, 5, 6, 7, 9), triangular 4 (1, 2, 3, 8), oval 1 (10);
3. Leaf persistence: intermediate 9 (1, 2, 3, 4, 5, 6, 8, 9, 10), all leaves persistent 1 (7);
4. Flower wings color: white 7 (1, 2, 4, 5, 7, 8), pale lilac 2 (6, 9), lilac 1 (3);
5. Calyx / bracteole color: green 10;
6. Immature pod color: shiny green 6 (1, 2, 4, 6, 7, 9), green 3 (5, 8, 10); dull green to silver grey 1 (3);
7. Dry pod color: pale yellow to white 5 (2, 4, 6, 7, 10), deep yellow 4 (1, 5, 8, 9), carmine red 1 (3);
8. Position of pods: combined 6 (1, 2, 3, 4, 7, 8, 9), centre 2 (10), base 1 (5), top 1 (6);
9. Pod cross-section: pear-shaped 6 (1, 2, 4, 7, 8, 10), roundelliptic 2 (3, 5), very flat 2 (6, 9);
10. Pod curvature: straight 6 (1, 2, 3, 6, 7, 9), slightly curved 3 (5, 8, 10), curved 1 (4).
11. Pod wall fiber: strongly contracting 6 (3, 4, 6, 7, 9, 10), leathery podded 4 (1, 2, 5, 8);

12. Pod beak position: marginal 10 (all genotypes);
13. Pod beak orientation: downward 9 (1, 2, 3, 4, 5, 6, 7, 9, 10), straight 1 (8);
14. Seed coat patterns: absent 8 (1, 2, 4, 5, 7, 8, 9, 10), rhomboid spotted 1 (3), striped 1 (6);
15. Seed coat darker color: white 7 (1, 2, 4, 5, 7, 8, 10), purple 1 (3), brown and black 1 (9), black 1 (6);
16. Seed coat lighter color: white 7 (1, 2, 4, 5, 7, 8, 10), brown 2 (3, 6), brown and black 1 (9);
17. Brilliance of seed: medium 4 (2, 4, 7, 8), shiny 3 (1, 5, 10), matte 3 (3, 6, 9);
18. Seed shape: kidney shaped 5 (1, 2, 5, 6, 9), elliptic 2 (3, 6), semi-compressed 2 (8, 10), oval 1 (4).

Vasić *et al*. (1996) determined lower yield per plant (29.8-147.5 g) by analysis of 2 lines and 3 varieties of bean. Among them, the line selected from the population Tetovac had highest yield, which is in accordance with our results, having in mind that Tetovac originate from Tetovski grav. They also reported variability of 37.7-42.7% for these genotypes, which together with the variability of 15-30% determined by Vasić (2004) by analysis of 129 genotypes is in accordance with our results. Higher range of mean values (1-99g) is reported by Bozoglu and Sozen (2007) in 292 local populations from Turkie, while much lower mean values (8.4-17.7g) and variability (29,8%) are published by Duran *et al*. (2005) obtained by investigation of 65 bean samples from Carebean, due to the determinant growt type of the genotypes.

Table 3. Mean values and variability of the populations for the productive characters

Genotypes	Year	Number of seeds per pod		Number of pods per plant		Mass of 100 seeds (g)		Seed yield per plant (g)	
		$\bar{X}$	CV(%)	$\bar{X}$	CV(%)	$\bar{X}$	CV(%)	$\bar{X}$	CV(%)
Tetovski grav	2006	4.64	14.44	77.50	10.93	58.26	22.75	211.74	33.52
	2007	3.56	9.06	53.64	12.89	52.81	14.90	101.86	25.86
	Avrg	4.10		65.57		55.54		156.80	
Bel cincar	2006	4.57	12.53	49.17	12.59	72.94	20.94	167.13	33.01
	2007	3.53	12.36	33.52	21.42	59.06	15.15	70.49	32.04
	Avrg	4.05		41.34		66.00		118.81	
Sharen trkalezen grav	2006	4.54	10.83	67.82	19.76	56.64	22.64	178.35	41.41
	2007	4.52	7.35	45.27	19.45	56.36	10.59	115.60	24.21
	Avrg	4.53		56.54		56.50		146.98	
Siten cincar	2006	5.83	11.86	74.28	10.59	40.34	14.43	176.07	25.66
	2007	4.56	7.08	49.94	14.90	30.66	13.46	70.09	23.26
	Avrg	5.19		62.11		35.50		123.08	
Splesnat tetovec	2006	4.42	11.88	76.08	12.30	62.04	17.90	211.95	30.05
	2007	4.39	6.67	49.52	14.98	65.96	7.57	143.69	19.46
	Avrg	4.40		62.80		64.00		177.82	
Sharen cincar	2006	4.27	11.35	55.16	13.18	61.17	17.34	146.82	31.91
	2007	4.13	7.04	34.68	17.17	63.83	13.45	90.96	20.86
	Avrg	4.20		44.92		62.50		118.89	
Trkalezen bel grav	2006	3.98	7.17	23.56	17.63	55.62	15.27	52.32	25.54
	2007	3.86	6.99	16.62	15.50	59.38	10.18	38.35	23.51
	Avrg	3.92		20.09		57.50		45.33	
Splesnat grav	2006	4.23	9.57	81.63	9.59	57.43	18.83	199.40	25.41
	2007	4.24	7.83	59.42	15.42	64.57	10.96	164.20	24.58
	Avrg	4.23		70.53		61.00		181.80	
Kafen i crn cincar	2006	4.36	10.08	61.61	12.57	72.72	16.73	197.25	28.08
	2007	3.77	8.28	37.46	16.43	61.28	13.22	87.67	27.51
	Avrg	4.06		49.53		67.00		142.46	
Splesnat kichevski	2006	4.28	12.08	71.59	9.50	48.98	18.31	151.22	27.70
	2007	4.38	10.44	45.14	22.74	60.02	12.78	119.23	30.86
	Avrg	4.33		58.37		54.50		135.23	
Average variability			9.74		14.98		15.37		27.72
$LSD_{0.05}$	For	0.239		3.253		5.177		25.43	
$LSD_{0.01}$	genotypes	0.321		4.357		6.854		34.06	
$LSD_{0.05}$	For years	0.107		1.455		2.288		11.37	
$LSD_{0.01}$		0.144		1.949		3.065		15.23	

Conclusions

The examined bean populations from Kichevo region showed high diversity regarding most of the characters. Highest diversity of the plants for the qualitative characters was determined for the flower wings color, pod position, seed coat darker color and seed shape. All plants had green bracteole color and marginal pod beak position. Low diversity was registered for leaf color and persistency, pod wall fibre, pod beak orientation and seed coat patterns. Concerning the productive characters, in general the mean values were higher in 2006. Two populations, Splesnat tetovec and Splesnat grav, had highest average values in the two years and were the only ones with higher yield than the standard Tetovski grav. Intrapopulation variability was lowest for seed number per pod and highest for seed yield per plant. Nearly all traits were more variable in 2006, except for the number of pods per plant that expressed higher variability in 2007.

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ГЕНЕТСКА ВАРИЈАБИЛНОСТ НА НЕКОИ МОРФОЛОШКИ И ПРОДУКТИВНИ СВОЈСТВА КАЈ ЛОКАЛНИ ПОПУЛАЦИИ ГРАВ (*PHASEOLUS VULGARIS* L.)

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Апстракт

Анализирани се дивергентноста и генетската варијабилност на десет локални популации грав (*Phaseolus vulgaris* L.) од кичевско, во текот на двегодишен експеримент за повеќе морфолошки и продуктивни својства. Популацијата тетовски грав се користеше како контрола за споредба со другите популации. Според добиените резултати од анализата, популациите се дивергентни речиси за сите анализирани својства: боја и форма на листови, опаѓање на листовите при берба, боја на цветни крилца и на брактеоли, боја на мешунки во техничка и во потполна зрелост, форма на мешунка и форма на напречен пресек на мешунката, присуство на целулозни конци во мешунката, позиција на мешунките на растението, поставеност и ориентација на клунчето на мешунката, број на мешунки на растение, број на семки во мешунка, боја, сјајност и облик на семе, форма на шарата на семето, маса на 100 семки и принос на семе од растение. Приносот на растение вариираше од 118,8 g до 181,8 g, со исклучок на приносот на тркалезен бел грав (45,3 g). Највисок и единствено повисок принос од стандардот имаше сплеснат тетовец и затоа оваа популација се препорачува за широко производство во кичевско. Варијабилноста на единките за сите својства беше ниска. Од анализираните продуктивни својства, просечно за сите популации најмалку варијабилно својство беше бројот на зрна во мешунка (9,74%), а најваријабилна беше масата на зрна од растение (27,7%). Врз основа на сите продуктивни својства, популацијата бел цинцар беше најваријабилна (20%), а популациите ситен цинцар, сплеснат тетовец, тркалезен бел грав и сплеснат грав беа најуниформни со варијабилност од приближно 15%. Во однос на стандардот тетовски грав, останатите популации се разликуваа значајно за најголем број својства.

Клучни зборови: *Phaseolus vulgaris* L., грав, локални популации, дивергентност, варијабилност, морфолошки својства, продуктивни својства.

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Original scientific paper

MULTIVARIATE ANALYSIS OF QUANTITATIVE TRAITS IN MAIZE HYBRIDS

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Abstract
Eight maize hybrids (Zea mays) have been evaluated for 12 quantitative traits in Macedonia during 2009 year, under rainfed and irrigated conditions. The characters included in this study were plant height, plant height to the first ear, number of ears per plant, ear length, ear diameter, number of rows per ear, kernel length, kernel weight per plant, 1000 kernel weight, hectoliter weight, days between anthesis and silking and vegetative growth duration. All the traits were analyzed using multivariate analysis techniques (two-way cluster and principal component analyses). The first three PCs with eigenvalues >1 contributed to 87.68% of the variability amongst analyzed hybrids. The two-way cluster analysis categorized the hybrids in two clusters. The quantitative traits were classified in three main clusters, each composed of different number of subclusters. Both methods revealed that the hybrids under investigation displayed a wide range of variation for most of the traits that could be further on exploited in a breeding programme. Further work on the selected plant material will be continued for additional characterization of the maize genotypes and direct use in breeding and production.
Key words: principal component analysis, two-way cluster analysis, quantitative traits, maize.

Introduction

Maize (Zea mays L.) is one of the most important cereal crops in the world. On a global level, maize has gained tremendous importance due to rising demand from diversified sectors like food, feed and ethanol production. To address global needs which are mainly due to continuing growth of the world population and energy insufficiencies, improvement of maize productivity and quality through breeding is vital (Tester and Langridge, 2010).

Information on the variability of the breeding material and classification of the available germplasm into genetically divergent groups is imperative for deciding which method will be applied in breeding programmes (Babic et al., 2008). At the same time, a precise description of the starting breeding material is essential for the final result of the breeding process. For genetic improvement of maize, identification or creation of genotypes that are high yielding and adapted to specific environmental conditions is very important. Among various abiotic and biotic stress factors, drought makes a significant contribution to the maize genotype (Löffler et al., 2005, Setimela et al., 2005). As a result, one of the main objectives in maize breeding programs is the selection of genotypes which will withstand drought stress (Golbashy et al., 2009, Richards et al., 2002). Multivariate data analysis is one of the techniques that facilitate a graphic display of the underlying latent factors and as such, it provides an interface between the individual samples and the variables under study

(Nielsen and Munck, 2003). If the dissimilarity between two genotypes is defined on a multivariate criterion, it is useful to be able to determine which plant characteristics cause the dissimilarity as well as the relative contributions of the various characteristics to the total variability in the germplasm (Ariyo 1993). The classification of diversity among the genotypes into groups with similar characteristics can be utilized to produce superior hybrids for enhanced crop production (Ariyo, 1993; Aydin et al., 2007). In the current study, a set of data comprising agronomic traits of 8 commercial maize hybrids were subjected to multivariate data analysis, namely, PCA and two-way cluster analysis. The main objectives of this study were (1) to explore the extent and pattern of phenotypic variability in maize hybrids based on their agronomic data, (2) to classify the germplasm into similar groups and (3) to identify the main traits contributing to the overall variability.

Material and methods

Eight maize hybrids from diverse backgrounds and maturity groups were used in this study. The experiment was established as a nested design with three replications, and two treatments: with and without irrgigation at Gradsko, Macedonia during 2009 growing seasons. Distance between the rows was 0.7 m with hills spaced according to the maturity group. Plots were overplanted and thinned, obtaining a final density of approximately 68027 plants/ha for the hybrids ZP360 and OS378 which belong to FAO 300, 62111 plants/ha for the hybrids ZP480 and OS499 (FAO 400), 57143 plants/ha for hybrids ZP599 and OS552 (FAO 500) and 52910 plants/ha for the hybrids ZP677 and OS602 (FAO 600). Plant height (cm), plant height to the first ear (cm), number of ears per plant, ear length (cm), ear diameter (cm), number of rows per ear, kernel length (cm), kernel weight per plant (g), 1000 kernel weight (g) and hectoliter weight (g) were estimated on a sample of 10 plants from each plot. Days between anthesis and silking and vegetative growth duration were determined on a plot basis. Two-way cluster analysis and PC analysis were performed using R statistical package.

Results and discussion

Effective application of multivariate analysis techniques on agronomic characters can result in meaningful grouping of studied hybrids (Mostafavi et al., 2011). On the basis of their genetic diversity and with regard to analyzed quantitative traits, the maize hybrids were grouped into two major clusters by the two-way cluster analysis. Both clusters comprised four hybrids and were further on divided on two subclusters. The quantitative traits were divided in three groups, each containing different number of subgroups (Fig. 1).

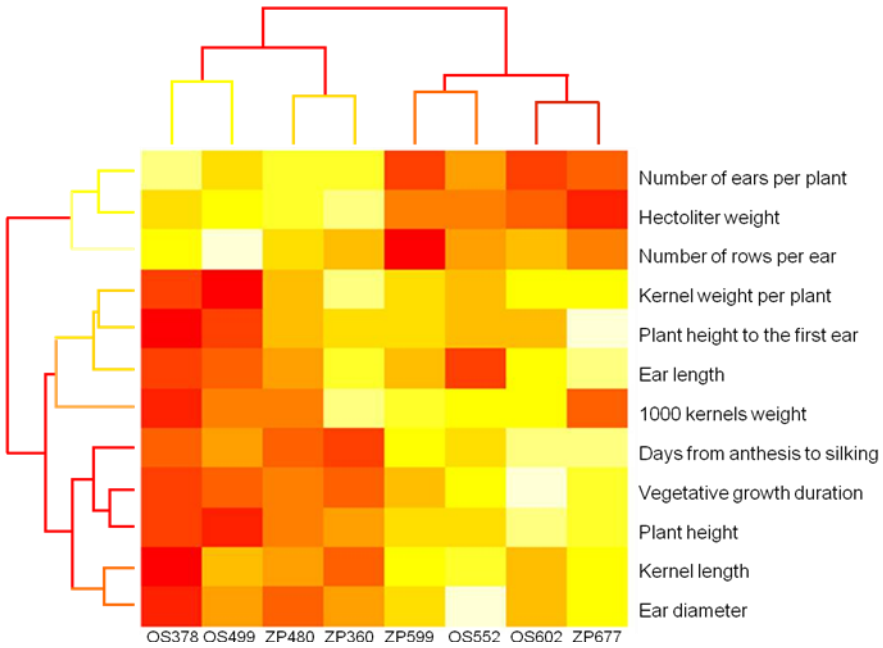


Figure1. Two-way clustering of quantitative traits in maize hybrids

Number of ears per plant, hectoliter weight and number of rows per ear were classified into the third cluster. The second cluster comprised kernel weight per plant, plant height to the first ear, ear length and 1000 kernel weight. The remaining traits were included into the first cluster. The principal component analysis gave remarkably similar results as the two-way cluster analysis. The highest portion of the total variability of studied hybrids was encompassed in the first three PCs. The first PC explained 40.84% of the total variability, the second 27.24% and the third 19.59%, which sums 87.68% of the total variability (Table 1). The highest correlation with the first PC showed plant height (0.687), vegetative growth duration (0.807) and days between anthesis and silking (0.939). The same traits were positioned in the first subcluster of the first cluster on the heatmap. Kernel length and ear diameter, which were included in the second subcluster of the first cluster, had high correlation with both PC3 (0.672 and 0.774, respectively) and PC1 (0.551 and 0.609, respectively). Ear length, plant height to the first ear and kernel weight per plant, which comprised the second cluster, had highest positive associations with the PC2. In addition, 1000 kernel weigh was separated from them and had highest positive correlation with the PC3 (0.863). Analyzed characters that were negatively correlated with the all three PCs (number of ears per plant, hectoliter weight and number of rows per ear), belonged to the third cluster. As a result, it can be observed that plant height, vegetative growth duration, days between anthesis and silking, kernel length and ear diameter were characters that mostly contributed to the variability of the analyzed maize hybrids. The factor loadings for the PC1 and PC2 are presented on Figure 2.

Table 1. Principal component loadings of quantitative traits in maize

Rotated Component Matrix	Components		
	PC1	PC2	PC3
Plant height	.687	.628	.235
Plant height to the first ear	.342	.816	.315
Vegetative growth duration	.807	.408	.281
Days between anthesis and silking	.939	.234	.153
Kernel weight per plant	.581	.759	.258
Number of ears per plant	-.812	-.320	-.353
Ear length	.077	.943	.046
Ear diameter	.551	.053	.774
Kernel length	.609	.133	.672
Number of rows per ear	-.418	-.490	-.322
1000 kernel weight	-.069	.357	.863
Hectoliter weight	-.960	-.176	-.031
Eigen vector	7.861	1.467	1.193
% of Variance	40.841	27.243	19.592
% of Cumulative Variance	40.841	68.084	87.676

As noted by Cui et al. (2001), although many clustering algorithms are available for exploring genetic diversity in crops, it is rarely obvious which one would be the best for a particular data set. Similarly, it is hardly known *a priori* which trait or group of traits will be best to use in clustering. Recently, PCA has been used by various authors for the reduction of multivariate data into a few artificial varieties which can be further used for classifying of materials. This approach is especially valuable for the screening of a large number of genetic resources by a large number of descriptor variables (Cartea et al., 2002; Granati et al., 2003; Kamara et al., 2003; Marticorena et al., 2010; Beiragi et al., 2012). Based on the studied phenotypic traits, Wietholter et al. (2008) concluded that the traits that most contributed to the classification of Brazilian corn landraces were plant height, ear insertion, female flowering, male flowering and kernel row number per ear. Similar results were presented by Aydin et al. (2007). Though quantitative traits could be better used for grouping of maize genotypes, highly heritable qualitative and quantitative traits were preferred. Based on this, Abu-Alrub et al. (2006) used kernel traits as best descriptors for classifying Peruvian highland maize germplasm, followed by ear traits. Tassel traits were found to be less reliable descriptors for classifying the germplasm. This was more evident for the traits *viz*. ear height, number of kernels/row and 100 seed weight (Ranatunga et al., 2009).

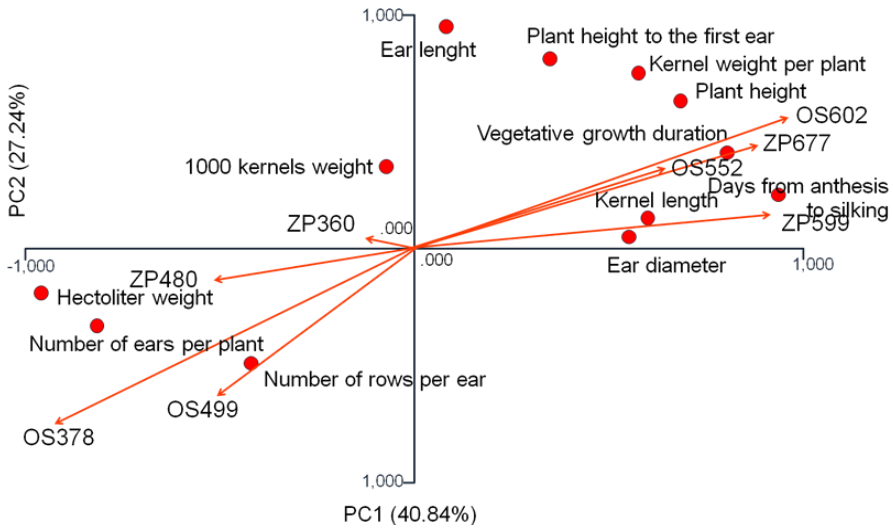


Figure 2. Principal component analysis of quantitative traits in maize

Conclusions

The two-way cluster analysis and principal component analysis provided useful analytic and graphic tools to study and characterize germplasm, in this study maize hybrids, especially when the characterization is based on the study of phenotypic, morphological and agronomic descriptors where the influence of environmental factors is possible.

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МУЛТИВАРИЈАЦИСКА АНАЛИЗА НА КВАНИТИТАТИВНИТЕ СВОЈСТВА КАЈ ХИБРИДИ ПЧЕНКА

Јанкуловска Мирјана, Бошев Дане, Ивановска Соња, Јанкулоски Љупчо, Кузмановска Билјана, Танасковиќ Вјекослав, Ангелеска Симона

Апстракт

Во рамките на истражувањето беа евалуирани 12 квантитативни својства кај 8 хибриди пченка (Zea mays), во услови со и без наводнување. Беа анализирани својствата: висина на растение, висина до првиот кочан, број на кочани од растение, должина на кочан, дијаметар на кочан, број на редови на кочан, должина на зрно, маса на зрна од растение, маса на 1000 зрна, хектолитарска маса, денови од метличење до свилење и должина на вегетација. Сите својства беа анализирани со помош на мултиваријациски техники двонасочна кластер-анализа и анализа на главни компоненти). Првите три PC со eigen вредности>1со 87,42% учествуваа во варијабилноста помеѓу хибридите. Двонасочната кластер-анализа ги раздвои анализираните хибриди во две групи. Квантитативните својства беа групирани во три кластери, согласно првите три PC. Двата метода покажаа дека анализираните хибриди се многу варијабилни во однос на повеќето својства, што може да биде искористено во селекциските програми. Одбрани хибриди пченка ќе бидат искористени за дополнителни анализи, како и вклучување во селекциска програма или директно производство.

Клучни зборови: двонасочна кластер-анализа, анализа на главни компоненти, квантитативни својства, пченка, хибриди.

UDC:635.64:575.22
Original Scientific PAper

OPTIMIZATION OF PCR CONDITIONS TO AMPLIFY DNA MICROSATELLITES IN TOMATO (LYCOPERSICON ESCULENTUM MILL.)

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Abstract
DNA microsatellites are important molecular tools in determination of genetic variability among organisms. The aim of this study was to optimize PCR conditions for amplification of twelve microsatellite loci (LESSF, LECH13, LE21085, LEMDDNa, LEEF1Aa, LELEUZIP, LEWIPIG, LELE25, LE20592, TMS9, LE2A11 and LECHSOD) using tomato (*Lycopersicon esculentum* Mill.) DNA samples. Tomato DNA was isolated using Promega's Wizard ® Genomic DNA purification kit and CTAB method slightly modified during previous study. Six morphologically different tomato varieties (var. *grandifolium* (with red fruits), var. *cerasiforme* (with yellow fruits), var. *pruniforme*, var. *pyriform*e and var. *racemigerum*) were included in the research. In this study, PCR conditions for amplification of selected microsatellite loci were optimized using appropriate primer pairs. Amplification conditions were modified by altering the number of cycles and concentration of DNA. DNA concentration of 15 ng and 30 cycles gave the best amplification for nine of twelve microsatellite loci (LECH13, LE21085, LEMDDNa, LEEF1Aa, LELEUZIP, LE20592, TMS9, LE2A11 and LECHSOD). The optimal PCR conditions were the same for these microsatellite loci, except annealing temperature for LE21085 locus (50 °C). Attempts to optimize the PCR conditions for LESSF locus, LEWIPIG locus and LELE25 locus were unsuccessful. The optimization of PCR conditions requires individual approach regarding the different genotypes and variable laboratory conditions. Obtained PCR products could be used in molecular characterization of tomato varieties.
Key words: DNA microsatellites, PCR, optimization, *Lycopersicon esculentum*.

Introduction

The microsatellites known as simple sequence repeats (SSRs) are new class of DNA markers which are used for detecting a higher level of genetic variability. The term microsatellite was coined by Litt and Luty (Joshi *et al.*, 1999). They are short tandem repeats (2-10 bp), middle repetitive, tandemly arranged, hypervariable DNA sequences dispersed throughout fungal, plant, animal and human genomes (Kahl, 2001). SSRs have been used in population genetics, parentage testing, individual identification and for shortening breeding programs (Ben-Meir *et al,*. 1996). Microsatellites are present in both coding and noncoding regions and are usually characterized by a high degree of length polymorphisms (Zane *et al.*, 2002).

With the PCR discovery in late 1980s, microsatellites became the most powerful Mendelian markers ever found (Jarne and Lagoda, 1996). SSR-containing fragments are flanked by conserved DNA. These sequences could be used as templates for designing appropriate primers for amplifying

the DNA section with microsatelites. Most primers generated distinct amplification products, resulting in fingerprint-like banding patterns after agarose gel electrophoresis and ethidium bromide staining. These fingerprints allowed distinction among different plant taxa at an interspecific as well as intraspecific level (Weising *et al.*, 1995). An important limitation, however, regarding the use of microsatellites for polymorphisms or genetic diversity studies is the prior need for optimization of the PCR conditions for each SSR marker (Doğrar and Akkaya, 2011). This process includes different factors that can affect PCR reaction such as: Mg++ concentration, DNA quantity, number of cycles, annealing temperature etc. This study is dealing with optimization of the PCR amplification conditions for 12 regions that contain DNA microsatellites in tomato genome.

Material and methods

Plant material

The six different tomato varieties used in this research were obtained from GenBank of Agricultural Institution in Skopje. According to Brezhnev, those tomato varieties belong to three subspecies of *Lycopersicon esculentum* Mill. (var. *grandifolium* from subsp. *cultum* Brezh.; var. *cerasiforme* (with red fruits), var. *cerasiforme* (with yellow fruits), var. *pruniforme* and var. *pyriforme* from subsp. *subspontaneum* Brezh. and var. *racemigerum* from subsp. *spontaneum* Brezh.).

DNA extraction

DNA was extracted from few fresh leaves of 10 individual plants per each variety using Promega's Wizard ® Genomic DNA purification kit. DNA was also extracted from pooled seeds of each variety using slightly modified CTAB method (Doyle & Doyle, 1987 and Cullings, 1992, Miskoska-Milevska *et al.*, 2011). The sample intake was 50 mg of tomato leaves i.e. seeds. DNA quality was checked in 0.8 % agarose gel, stained with ethidium bromide.

PCR conditions

All PCR amplifications were performed in a thermal cycler (Techne TC-512). The optimization of PCR conditions for amplification of microsatellite loci (LESSF, LECH13, LE21085, LEMDDNa, LEEF1Aa, LELEUZIP, LEWIPIG, LELE25, LE20592, TMS9, LE2A11 and LECHSOD) was carried out using appropriate primers, produced by Operon, Huntsville, AL. They were labeled using the method of tailed primer because later on the PCR products were included in fragment analysis by DNA analyzer. The fluorescent labeled M13-primer was designed by Applied Biosystems, USA. PCR amplification products were analyzed by 2 % agarose gel electrophoresis, stained with ethidium bromide and photographed under ultraviolet light by using G-Box system (Sygene).

The DNA extraction and optimization of the PCR conditions were done in the Laboratory for biochemistry and molecular biology within the Department of Biochemistry and Genetic Engineering at the Faculty of Agricultural Sciences and Food - Skopje.

Results and discussion

The microsatellite primers have been already efficiently used for studies of genetic diversity, mapping and variety identification in different crops. They are specific for each individual genome or specie. The appropriate selection and combination of microsatellites loci are important in receiving of specific profiles that could be used to assist genetic characterization. The selection of twelve microsatellites loci was based on the number of alleles and diversity index from previous studies (Arens *at al.*, 1995; Smulders *et al.*, 1997; Bredemeijer *et al.*, 1998; Areshchenkova and

Ganal, 1999, Vosman *et al.*, 2001, Alvarez *et al.*, 2001, Bredemeijer *et al.*, 2002. He *et al.*, 2003; Villalta *et al.*, 2005; Garcia-Martinez *et al.*, 2006).

The primers selection is extremely important for effective amplification. In this study, PCR conditions for amplification of selected microsatellite loci were optimized using appropriate specific primers. Also, fluorescent labeled M13 primer was included in the research. The primers were labeled with the method of tailed primer. It includes three primers: forward primer with M13 universal tail at 5' end, reverse primer without a tail and fluorescent labeled M13 primer. Namely, the tail of forward primer has the same sequence as fluorescent labeled M13 primer. M13 primer consists of 19 bases (5'-CACGACGTTGTAAAACGAC-3') and was fluorescent labeled at 5' end. 6-FAM (blue dye) was used for fluorescent dyeing. In this way fluorescent labeled M13 sequence was incorporated in PCR products and at same time enables their detection by DNA analyzer. Some general information for selected microsatellites and appropriate primer pairs are shown in Table 1.

The study showed that there was no single set of conditions that could be applied to all PCR amplifications. Each specific microsatellite locus was efficiently amplified after precise adjustment of its component concentrations, its optimal time and its optimal annealing temperature.

Table 1. General information for microsatellite loci and primers used in this study

Locus	Repeat motif	Primer sequences (5'-3')	Fragment size (bp)
LESSF	$(CCCCA)_4$	F: M13-tac gct ctc aag tac cgt aag R:cct aca ttg aca tga cca aat	216-320
LECH13	$(TA)_{6-1}(GA)_4$	F: M13-taa caa tca aaa gaa ctt cgc R:atc ccc tta ttg att aca tcc	124-132
LE21085	$(TA)_2(TAT)_{9-1}$	F: M13-cat ttt atc att tat ttg tgt ctt g R: aca aaa aaa ggt gac gat aca	90-132
LEMDDNa	$(TA)_9$	F: M13-att caa gga act ttt agc tcc R: tgc att aag gtt cat aaa tga	204-420
LEEF1Aa	$(TA)_8(ATA)_9$	F: M13-aaa taa tta gct tgc caa ttg R: ctg aaa gca gca aca gta ttt	131-220
LELEUZIP	$(AAG)_{6-1}TT(GAT)_7$	F: M13-ggt gat aat ttg gga ggt tac R: cgt aac agg atg tgc tat agg	96-110
LEWIPIG	$(CT)_{8-1}(AT)_4$	F: M13-gag tca aag ttt gct cac atc R: ctc ttc tga act tgc ttt gag	247-269
LELE25	$(TA)_{13-1}$	F: M13-ttc ttc cgt atg agt gag t R: ctc tat tac tta tta tat tcg	211-250
LE20592	$(TAT)_{15-1}(TGT)_4$	F: M13-ctg ttt act tca aga agg ctg R: act tta act tta tta ttg cca cg	150-175
TMS9	$(GATA)_{26}$	F: M13-ttg gta att tat gtt cgg ga R: ttg agc caa ttg att aat aag tt	337-354
LE2A11	$(ATCT)_{5-1}$	F: M13-aat ttt gta agg aga aga cgg R: tca tat tct tca cac caa agg	143-176
LECHSOD	$(CTT)_6$	F: M13-tta tca att cat cat tgt ggc R: agg ggt agt gac agc ata aag	195-207

F - Forward primer (5'-3') R - Reverse primer (5'-3') M13 tail: 5'-cac gac gtt gta aaa cga c-3'

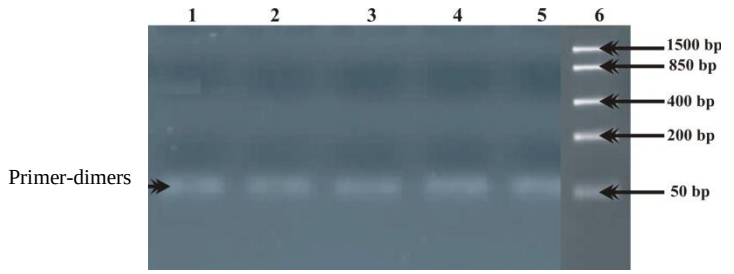


Figure 1. Agarose gel electrophoreses (20 g/L): Lanes 1-5 - illustration of failure to amplify LESSF locus; lane 6 - 50 bp DNA ladder

In practice, many reasons can cause failure of PCR amplification. Some of the often encountered problems during PCR optimization include: no detectable PCR products or a low yield of the desired product, the presence of nonspecific bands, the formation of "primer-dimers" or "primer-oligomer" (Figure 1).

Different amplification conditions of selected microsatellites were found in previous studies (Arens *at al.*, 1995; Smulders *et al.*, 1997; Vosman *et al.*, 2001, Bredemeijer *et al.*, 2002). In our study, PCR did not work under the conditions described in published literature. This happened probably due to the different protocol of DNA extraction from tomato and different laboratory conditions. Therefore, it was necessary to make some modification in PCR protocols for each microsatellite in order to produce readable results. Namely, according to Doğrar and Akkaya (1999), when amplifying the SSR markers, it might be necessary to optimize PCR cycling conditions for each marker, since the reported conditions are tuned for particular thermocycler, particular types of PCR tubes and brands of components used in those reactions. The different brands of reagents or thermocyclers, also even the minor differences between the wall thicknesses of the PCR tubes, could be a critical point and might result in inadequate PCR amplification (Doğrar and Akkaya, 1999).

Selected microsatellites required PCR optimization for each pair of primers. For nine microsatellites, amplification conditions were modified by altering the number of cycles and concentration of DNA. In published PCR protocols were presented various values for number of cycles, 45 cycles Vosman *et al.*, 2001, Bredemeijer *et al.*, 2002) and 30 cycles (Arens *at al.*, 1995; Smulders *et al.*, 1997). Obtained results showed that 30 cycles were optimal for nine of the analyzed microsatellite loci.

The annealing temperature was specified for each primer in the relevant reference. The number of cycles and annealing temperature for each microsatellites locus are listed in Table 2.

The used amplification procedure was the one already presented by Arens *et al.* (1995) but with some modifications. The DNA concentration was increased in the reaction mixture (15 ng). Instead of 50 mM KCl and 20 mM Tris-HCL (pH 8.4) was used 1 x PCR buffer (Promega). As mentioned before, fluorescent labeled M13 primer (0.032 μM) was added to the PCR mix, in order to continue later with fragment analysis. Figure 2 illustrates obtained results from PCR amplification of LEMDDNa locus for different DNA concentrations.

Table 2. Number of cycles and annealing temperatures for analyzed primers

Locus	Number of cycles	Annealing temperature
LECH13*	30	55 ºC
LE21085*	30	50 ºC
LEMDDNa*	30	55 ºC
LEEF1Aa*	30	55 ºC
LELEUZIP*	30	55 ºC
LE20592*	30	55 ºC
TMS9**	30	55 ºC
LE2A11*	30	55 ºC
LECHSOD*	30	55 ºC

* Smulders *et al.*, 1997

**Areshchenkova and Ganal, 1999

The amplification reaction was carried out in a total volume of 25 μL, containing 15 ng DNA, 1 x PCR buffer without $MgCl_2$, 1.5 mM $MgCl_2$, 0.1 mM dNTP, 0.5 U of *Taq Gold* polymerase, 0.32 μM of forward primer, 0.32 μM of reverse primer and 0.032 μM of fluorescent labeled universal M13 primer. The optimal PCR conditions were the same for the microsatellites, except annealing temperature for LE21085 locus (50°C).

Also, optimization of PCR conditions included minimizing the duration of denaturing, annealing and extension steps during the amplification cycles (per 45 seconds). The time of final extension was altered to 4 minutes. Basically, PCR reactions for nine of the analyzed primers were performed in the following conditions: one cycle of 94 ºC for 3 minutes; 30 cycles of 94 ºC for 45 seconds, 50 ºC or 55 ºC for 45 seconds and 72 ºC for 45 seconds. After the final cycle, elongation step of 72 ºC for 4 minutes was added.

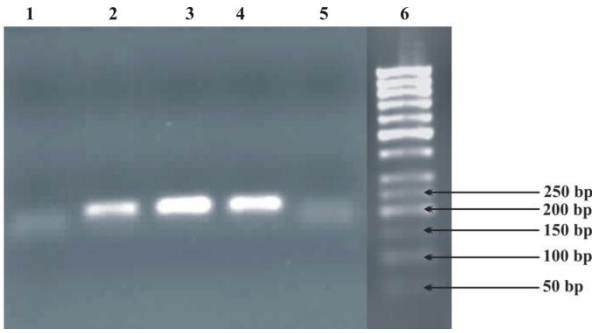


Figure 2. Illustration of PCR amplification of LEMDDNa locus for different DNA concentrations in agarose gel (20 g/L): Lane 1- negative PCR control (no DNA); lanes 2, 3 and 4 - PCR products; lane 5- failure to amplify LEMDDNa locus; lane 6 – 50 bp DNA ladder

Successful amplification of LE20592 locus in different tomato DNA is shown in Figure 3.

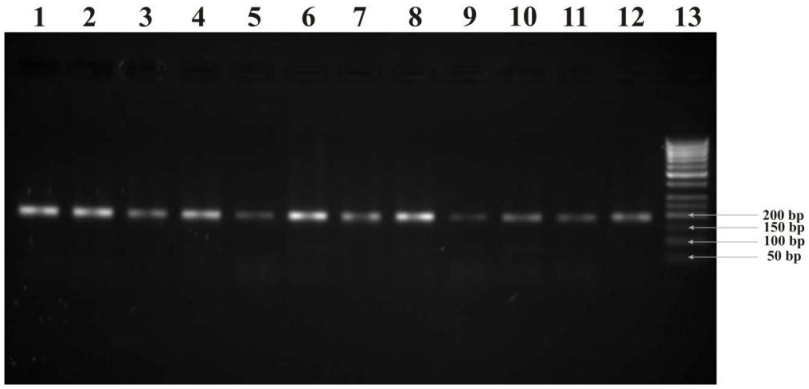


Figure 3. Agarose gel electrophoreses (20 g/L) of PCR products for LE20592 locus in different tomato DNA samples: lanes 1 - 12 - PCR products; lane 13- 50 bp DNA ladder

The quality and quantity of template DNA obtained with different DNA extraction protocols may also affect the PCR results (Narina *et al.* 2011). In this research, two different DNA isolation protocols were used and they gave the same results in PCR amplification for selected microsatellite loci.

Optimization of conditions for nine of the DNA microsatellites (Table 2) was done successfully. With these microsatellite loci, PCR amplification was observed in all six varieties. Three microsatellites did not generate amplification in research tomato varieties. Namely, PCR products were not observed for LESSF locus, LEWIPIG locus and LELE25 locus (Figure 1). This problem could be directly related to different genotypes and variable laboratory conditions. Also, these results are in accordance with the results published by Smulders *et al.* (1997). According to Smulders *et al.* (1997) the lack of amplification of an allele in certain cultivars or accession could be a result of divergence in the primer sequence flanking the microsatellite, creating a null-allele. It can also appear by the production of an undetectable amount of PCR product (Lavi *et al*., 1994). The effect of mismatches on amplification may vary with primer length, sequence context and reaction conditions (Devos *et al.*, 1995). According to Bell and Ecker (1994), the optimal PCR conditions for the amplification of a fragment will differ between genotypes. Based on these facts, it is obvious that optimization of PCR conditions would be necessary for individual cultivars or species from which no fragments have yet been amplified (Smulders *et al.*, 1997). According to Narina *et al.* (2011), the genomic DNA sequence variation between two different species might cause the variation in cross amplification success as the primers might identify a different region in the species of interest from the expected region.

Conclusions

In this study, PCR conditions for nine of twelve microsatellite loci (LECH13, LE21085, LEMDDNa, LEEF1Aa, LELEUZIP, LE20592, TMS9, LE2A11 and LECHSOD) were optimized. Therefore, only these nine pairs of primers were used for molecular characterization of corresponding tomato varieties. These microsatellites gave amplification across six tomato varieties. Attempts to optimize PCR conditions for the rest three microsatellites loci (LESSF, LEWIPIG and LELE25) were unsuccsessful and they were not part of the other research studies.

Also, it is important to point out that during the optimization of PCR conditons it is necessary to have individual approach regarding the different genotypes and variable laboratory conditions.

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ОПТИМИЗАЦИЈА НА PCR-УСЛОВИТЕ ЗА АМПЛИФИКАЦИЈА НА ДНК-МИКРОСАТЕЛИТИ ВО ДОМАТ (*LYCOPERSICON ESCULENTUM* MILL.)

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Апстракт

ДНК-микросателитите се важна молекуларна алатка во одредувањето на генетската варијабилност кај организмите. Целта на ова истражување беше оптимизација на PCR-условите за амплификација на дванаесет микросателитски локуси (LESSF, LECH13, LE21085, LEMDDNa, LEEF1Aa, LELEUZIP, LEWIPIG, LELE25, LE20592, TMS9, LE2A11 и LECHSOD) со користење на ДНК примероци од домат (*Lycopersicon esculentum* Mill.). Изолацијата на ДНК беше реализирана со користење на комерцијален кит на Promega и CTAB-методот со мали измени во текот на претходното истражување. Во истражувањето беа вклучени шест морфолошки различни вариетети домати (var. *grandifolium* (со црвени плодови), var. *cerasiforme* (со жолти плодови), var. *pruniforme*, var. *pyriform*e и var. *racemigerum*). Оптимизацијата на PCR-условите за амплификација на избраните микросателитски локуси беше остварена со користење на содветни прајмери. Условите за амплификација беа изменети во однос на бројот на циклуси и концентрацијата на ДНК. Амплификацијата на деветте микросателитски локуси (LECH13, LE21085, LEMDDNa, LEEF1Aa, LELEUZIP, LE20592, TMS9, LE2A11 и LECHSOD) беше најдобра при конценрација на ДНК од 15 ng и 30 циклуси. Оптималните PCR-услови беа исти за овие микросателитски локуси, со иклучок на температурата на анилирање за LE21085 локусот (50 °C). Неуспешно завршија обидите за оптимизација на PCR-условите за LESSF-локусот, LEWIPIG-локусот и LELE25-локусот. Оптимизацијата на PCR-условите бара индивидуален пристап во однос на различни генотипови и варијабилни лабораториски услови. Добиените PCR-ампликони може да се користат во молекуларна карактеризација на различни вариетети домати.

Клучни зборови: ДНК-микросателити, PCR, оптимизација, *Lycopersicon esculentum*.

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RESULTS OF THE INVESTIGATIONS OF MORPHO-BIOLOGICAL AND PRODUCTIONAL PROPERTIES OF SOME DOMESTIC AND FOREIGN VARIETIES OF ORIENTAL TOBACCO

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Abstract
For investigation of some morpho-biological and productional characteristics of certain varieties of oriental tobacco, four domestic and three foreign varieties were set up in 2007 and 2008 in the field of Scientific Tobacco Institute – Prilep. Domestic variety P 12-2/1 was used as a check. Investigations were made on diluvial soil, using randomized block design with 4 replications and the results obtained were statistically processed by the method of analysis of variance. From the results obtained, the following conclusions can be drawn: The results show that: the highest average height of the stalk with inflorescence was observed in the variety Gumus Hadzhikej (104.47 cm) and the lowest in P 12-2/1 (42.88 cm); the highest leaf number per stalk (55.6) was obtained in P-76/85, and the lowest in the variety Greek Basma (29.2); the largest leaf was measured in Greek Basma variety (26.50 cm length x 12.37 cm width), and the smallest in the Izmir variety (17.12 cm length x 7.15 cm width); the highest yields (25 g/stalk and 3673 kg/ ha) were obtained in the variety P-76/85 and the lowest in Izmir variety (8.5 g/stalk and 1847 kg/ha).
Key words: tobacco, oriental varieties, yield.

Introduction

The structure of tobacco production in R. Macedonia is dominated with over 95% by the oriental tobacco types Prilep, Yaka and Djebel. Apart from these three types, in the last few years the production of the type Basmak was also registered, accounting for 8.54% of the total yield of oriental tobacco in the country. Scientific Tobacco Institute-Prilep is constantly creating new varieties, interesting for their characteristics both to farmers and to manufacturers. Due to different influences of soil and climatic conditions on the properties of analyzed varieties, two year investigations were necessary to obtain more reliable results. Varieties that are included in investigations are typical representatives of the type. For some of them (Greek Basma, Izmir, Gumus Hadzhikej) such investigations were needed in order to study their growth and development in our agroecological conditions and to assess their yield and quality.

Considering the fact that breeding is a long-term process based on phenotypic and genotypic studies of the available plant material, the most frequent investigations are those of the characters related to yield. The aim of this paper is to present the results on morphobiological and productional characters of the varieties investigated and to give directions for further selection work in creation of new varieties of oriental tobacco.

Material and methods

Field trials were carried out in Tobacco Institite (TI) - Prilep during 2007 and 2008, with seven recognized varieties of oriental tobacco, such as: Prilep 12 - 2/1 (check), Prilep 76/86, PNS-72 and P-23 (R. Macedonia), Basma (Greece) and Izmir and Gumus Hadzhikej (Turkey). Tobacco seed was provided from the collection of Tobacco Institute-Prilep and its Gene bank. The experimental design of the plot was randomized block system with four replications.

Macedonian varieties were transplanted at 45 x 15 cm spacing, with 34 plants in each row and 102 plants in a plot. Introduced varieties (Izmir, Greek Basma, Gumus Hadzhikej) were transplanted at 45 x 12 cm spacing, with 42 plants in a row and 126 plants per plot. Morphological measurements were made on 20 plants from each replication. Due to their morphological characters (habitus, leaf length, etc.), the varieties Greek Basma, Izmir and Gumus Hadzhikej can be transplanted at lower spacing, just as in the countries of their origin (Turkey, Greece). The estimation of yields per stalk and hectare, due to different spacing of tobacco plants, was made in accordance with the useful plot area. The results of morphological measurements were processed by variational-statistical method and differences between the mean values were tested by LSD test. The arithmetic mean (x), the error of the arithmetic mean (sx), standard deviation (δ) and coefficient of variation (CV%) were calculated according to the methods specified by Najceska (2002) and Filiposki (2011).

Meteorological data for air temperature (°C) and precipitation (mm) during the vegetation of tobacco in the examined period (May to September) are shown in Table 1.

Table 1. Meteorological data for the period May – September 2007/2008, Tobacco institute - Prilep

Meteorological data	Year	Monts					**X** /∑
		V	VI	VII	VIII	IX	
Mean monthly air temperature ˚C	2007	16.9	21.6	25.3	23.7	16.9	20.9
	2008	16.7	19.9	22.3	23.6	15.8	19.7
Total precipitations mm	2007	74.3	79.5	5.3	54.2	16.6	229.9
	2008	41.3	10.0	11.0	11.0	110.0	183.3
Days with precipitations	2007	14	11	1	2	5	33
	2008	8	5	4	2	10	29

Results and discussion

Morpho-biological and productional characteristics

Karajankov et al. (2007) reported that tobacco plant height is a type and varietal character. According to the data presented in Table 2, the highest stalk height with inflorescence was measured in Turkish variety Gumus Hadzhikej (104.47 cm). This variety had a mean value of 103.72 ± 0.79 cm in 2007, and 105.22 ± 0.76 cm in 2008. The check variety Q 12-2/1 had the lowest average height (42.88 cm), with a mean value of 43.65 ± 0.68 cm in 2007 and 42.10 ± 0.89 cm in 2008. According to the above, P 12-2/1, PNS-72 and P-23 are classified as short height varieties and P-76/85 Greek Basma, Izmir and Gumus Hadzhikej as varieties with medium growth.

Table 2. Stalk height with inflorescence, cm

Variety	2007			2008			Average	Difference	
	$\bar{x} \pm c\bar{x}$	σ	cV%	$\bar{x} \pm c\bar{x}$	σ	cV%		Absolute cm	Relative %
P 12-2/1 Ø	43.65±0.68	1.41	3.23	42.10±0,89	2.34	5.66	42.88	/	100.00
P-76/86	88.90±0.77 $^{++}$	3.72	4.18	79.40±0.96 $^{++}$	5.22	6.57	84.15	+41.27	196.27
PNS-72	57.38±0.98 $^{++}$	3.87	6.80	58.82±0.87 $^{++}$	3.15	5.35	58.10	+15.22	135.51
P-23	47.39±0.67	1.52	3.20	48.88±0.79^{+}	2.15	4.39	48.14	+5.26	112.27
Greek Basma	82.50±0.85 $^{++}$	4.25	5.15	86.85±0.78^{++}	3.77	4.34	84.68	+41.80	197.49
Izmir	83.67±0.80 $^{++}$	4.57	3.82	107.75±1.02^{++}	7.87	7.30	95.71	+52.83	223.23
Gumus Hadzhikej	103.72±0.79 $^{++}$	4.61	4.45	105.22±0.76^{++}	4.34	4.13	104.47	+61.59	243.66

	2007	2008
LSD 5%=	4.15 cm stalk height with inflorescence $^{+}$	6.62 cm stalk height with inflorescence $^{+}$
1%=	5.69 cm stalk height with inflorescence $^{++}$	9.08 cm stalk height with inflorescence $^{++}$

Error of the mean value was the highest in Izmir ± 1.02 cm in 2008, and the same year nonuniformity was recorded in this variety. The lowest error of the mean value was recorded in P-23 ± 0.67 cm, which shows that it is considerably stable and uniform variety. In 2007, the lowest standard deviation of 1.41 cm was estimated in variety P 12-2/1, and the lowest variational coefficient of 3.20% in variety P-23. In 2008, the largest standard deviation of 7.87 cm and variational coefficient of 7.30% was recorded in Izmir variety. The investigated varieties are characterized by relatively low values of these two parameters, which is a sign of stability and uniformity of the stalks. With LSD test, statistical significance of 1% in the two years of investigation compared to the check was estimated in P-76/86, PNS-72, Greek Basma, Izmir and Gumus Hadzhikej compared to the check (P 12-2/1). Number of leaves in investigated varieties is shown in Table 3.

The highest average number of leaves (55.6) was recorded in variety P-76/86, with mean values ranging 53.0 ± 0.80 in 2007 and 58.2 ± 1.02 in 2008. The lowest average of number of leaves was counted in Greek Basma (29.2), with mean values of 31.4 ± 0.71 in 2007 and 27 ± 0.92 in 2008. The standard deviation and vartiation coefficient are low, which is an indication of indicator for stable varieties. LSD test showed that the varieties were highly significant, except for the variety Gumus Hadzhikej. Karajankov et al. (2007) divided all tobacco types and varieties into three basic groups according to their leaf size. Korubin Aleksoska (2005) reports the highest length of middle belt leaves in oriental variety Dz-291, with mean and mean error values of 25,67 cm $\pm$ 0,37 cm ($\bar{x} \pm c\bar{x}$**).**

Table 3. Number of leaves

Variety	2007			2008			Average	Difference	
	$\bar{x} \pm c\bar{x}$	σ	cV%	$\bar{x} \pm c\bar{x}$	σ	cV%		Absolute	Relative,%
P 12-2/1 Ø	37.9±0.77	1.60	4.23	32.6±0.67	1.02	3.13	35.2	/	100.00
P-76/86	53.0±0.80 ++	2.42	4.56	58.2±1.02 ++	4.24	7.29	55.6	+20.35	157.73
PHC-72	42.8±0.93 ++	2.59	6.06	40.0±0.65 ++	1.18	2.95	41.4	+6.15	117.45
P-23	47.2±0.73 ++	1.76	3.74	47.5±0.64 ++	1.39	2.93	47.4	+12.1	134.33
Greek Basma	31.4±0.71	1.13	3.61	27.0±0.92	1.61	5.99	29.2	-6.05	82.84
Izmir	41.6±0.60 ++	1.06	2.54	41.2±1.08 ++	3.42	8.30	41.4	+6.15	117.45
Gumus Hadzhikej	42.5±0.96 ++	2.78	6.54	42.2±0.90 ++	2.40	5.70	42.4	+7.1	120.14

	2007	2008
LSD 5%	= 1.79 number of leaves +	2.38 number of leaves +
1%	= 2.46 number of leaves ++	3.27 number of leaves ++

Table 4. The largest leaf length , cm

Variety	2007			2008			Average	Difference	
	$\bar{x} \pm c\bar{x}$	σ	cV%	$\bar{x} \pm c\bar{x}$	σ	cV%		Absolute cm	Relative %
P 12-2/1 Ø	25.03±0.77	1.11	4.42	25.43±0.89	1.42	5.57	25.23	/	100.00
P-76/85	22.04±1.00	1.98	8.98	26.55±1.01	1.93	7.27	24.30	-0.94	96.29
PNS-72	22.70±1.12	1.56	6.87	22.52±0.96	1.47	6.54	22.61	-2.62	89.62
P-23	20.98±0.79	1.05	5.02	21.33±0.69	0.72	3.36	21.16	-4.08	83.85
Greek Basma	25.49±0.90	0.91	3.59	27.50±0.82	1.31	4.78	26.50	+1.27	105.01
Izmir	17.50±0.82	1.49	8.53	16.74±1.09	1.41	8.39	17.12	-8.11	67.86
Gumus Hadzhikej	19.32±0.83	1.86	9.62	19.84±1.04	1.52	7.65	19.58	-5.65	77.61

According to the data presented in Table 4, the average length of the largest leaf on the stalk ranges from 26.50 cm in variety Greek Basma to 17.12 cm in Turkish variety Izmir. In 2007, the highest values for standard deviation (1.98 cm) and variation coefficient (8.98%) were obtained in variety P-76/86. In 2008, the lowest standard deviation of 0.72 cm and variation coefficient of 3.36% was recorded in variety P-23. It can be concluded that the highest variation coefficient of 9.62% for this character was recorded in variety Gumus Hadzhikej, which is probably due to low adaptibility of this variety to agro-ecological conditions and the applied cultural practices, which were the same for all varieties. According to the length of the largest leaf on the stalk, Turkish varieties are characterized by smaller size of the middle belt leaves. Such a positive characteristic allows them to participate with in higher classes in purchase random. The largest leaf width in investigated varieties is shown in Table 5.

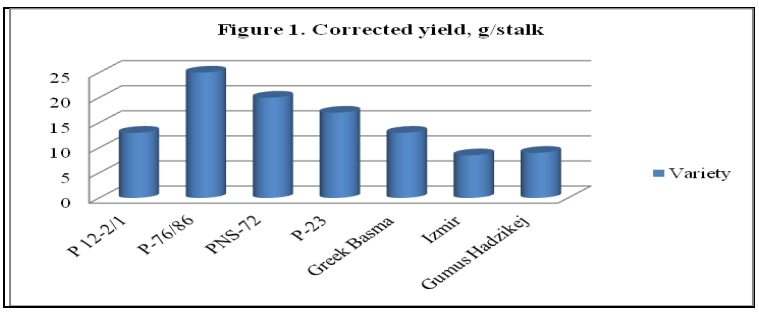
Table 5. The largest leaf width, cm

Variety	2007			2008			Average	Difference	
	$\bar{x} \pm c\bar{x}$	σ	cV%	$\bar{x} \pm c\bar{x}$	σ	cV%		Absolute, cm	Relative %
P 12-2/1 Ø	10.72±0.79	0.78	7.30	11.97±1.09	1.00	8.37	11.35	/	100.00
P-76/85	11.20±1.11	0.98	8.72	13.45±1.13	1.22	9.09	12.33	0.98	108.64
PNS-72	11.15±1.08	0.93	8.31	11.48±0.94	0.71	6.19	11.32	-0.03	99.74
P-23	9.95±0.91	0.59	5.91	10.40±0.94	0.64	6.19	10.18	-1.17	89.69
Greek Basma	11.88±0.73	0.45	3.79	12.85±1.02	0.94	7.29	12.37	1.02	108.99
Izmir	6.74±1.09	0.56	8.23	7.55±1.14	0.70	9.21	7.15	-4.2	62.98
Gumus Hadzhikej	8.88±1.28	1.03	11.68	9.00±1.15	0.85	9.46	8.94	-2.41	78.80

Table 6. Corrected yield, g/stalk

Variety	Year	g/stalk	Average	Difference	
				Absolute, g	Relative, %
P 12-2/1 Ø	2007	12.00	13.00	/	100.00
	2008	14.00			
P-76/86	2007	25.00^{++}	25.00	+12	192.31
	2008	25.00^{++}			
PNS-72	2007	20.00^{++}	20.00	+7	153.85
	2008	20.00^{++}			
P-23	2007	17.00^{++}	17.00	+4	130.77
	2008	17.00^{++}			
Greek Basma	2007	12.00	13.00	0	100.00
	2008	14.00			
Izmir	2007	8.00	8.5	-4.5	65.38
	2008	9.00			
Gumus Hadzhikej	2007	9.00	9.0	-4	77.61
	2008	9.00			

		2007	2008
LSD	5%	1.93 g/stalk $^{+}$	1.91 g/stalk $^{+}$
	1%	2.64 g/stalk $^{++}$	2.62 g/stalk $^{++}$



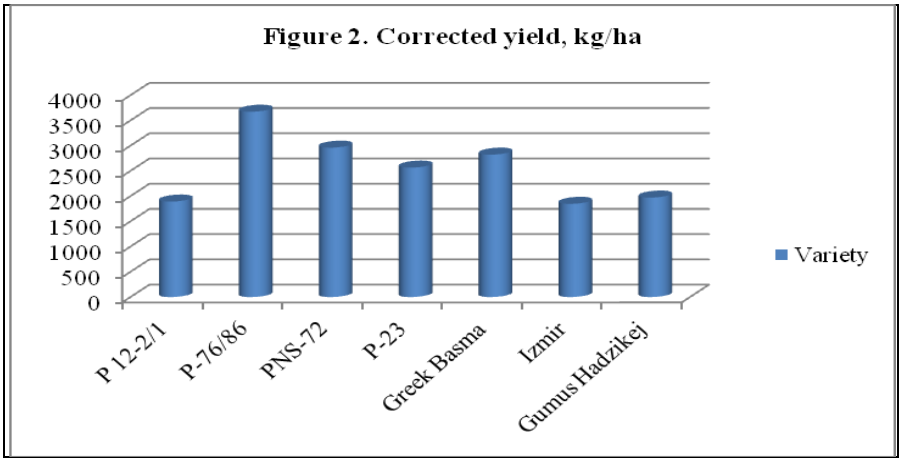
Data in Table 5 show the highest average width of the largest leaf on stalk in variety Greek Basma (12.37 cm) and the least in variety Izmir (7.15 cm). In 2007, the highest standard deviation of 1.03 cm and variation coefficient of 11.68% was recorded in Turkish variety Gumus Hadzhikej, and the lowest variations in Greek Basma. In 2008 the highest standard deviation of 1.22 cm and variation coefficient of 9.09 was registered in variety P-76/86. The highest variations in this year were recorded in the variety P-23.

Table 7. Corrected yield, кg/ha

Variety	Year	kg/ha	Average yield	Difference	
				Absolute, kg	Relative, %
P 12-2/1 Ø	2007	1708	1892	/	100.00
	2008	2075			
P-76/86	2007	3657	3673	+1781	194.16
	2008	3688			
PNS-72	2007	2922	2961	+1070	156.54
	2008	3000			
P-23	2007	2543	2565	+674	135.60
	2008	2587			
Greek Basma	2007	2543	2822	+930	149.17
	2008	3100			
Izmir	2007	1759	1847	-45	97.62
	2008	1934			
Gumus Hadzhikej	2007	2035	1971	+80	104.23
	2008	1908			

		2007	2008
LSD	5%	313 kg/ha $^{+}$	265 kg/ha $^{+}$
	1%	429 kg/ha $^{++}$	364kg/ha $^{++}$

According to the data presented in Tables 6 and Table 7 (Figure 1 and Figure 2), the highest average yield per stalk (25 g) and per hectare (3673 kg) were obtained in variety P-76/85, while the lowest one in the variety Izmir (8.5 g per stalk and 1847 kg per hectare). Statistically significant differences of 1% for this character (g/stalk and kg/ha) were recorded in varieties P-76/86, PNS-72 and P-23 in both years of investigation. Statistically significant difference of 1% for the character kg / ha was estimated in Greek Basma in both years, and in variety Izmir in 2007 (LSD=5%). Compared to the introduced varieties, the local varieties of the type Prilep gave higher yield.



Conclusions

The highest stalk with inflorescence was observed in Gumus Hadzhikej variety (104.47 cm), with mean values of 103.72 ± 0.79 cm in 2007 and 105.22 ± 0.76 cm. in 2008. The check variety P 12-2/1 showed the lowest average height (42.88 cm), with mean values of 43.65 ± 0.68 cm in 2007 and 42.10 ± 0.89 cm in 2008. According to variational and statistical data for this character, we concluded that these varieties are stable. Varieties P 12-2/1, PNS-72 and P-23 are classified as varieties with small height, while varieties P-76/86, Greek Basma, Izmir and Gumus Hadzhikej are classified as varieties with medium height. The highest number of leaves was recorded in variety P-76/86 (55.6), with mean values of 53.0 ± 0.80 in 2007 and 58.2 ± 1.02 in 2008. The lowest average number of leaves was found in Greek Basma (29.2), having a mean value of 31,4 ± 0.71 in 2007 and 27 ± 0.92 in 2008. Standard deviation and variation coefficient were low, which is an indication of stable varieties.

The average length of the largest leaf ranges from 26.50 cm in Greek Basma to 17.12 cm in Izmir variety. The highest average width of the largest leaf was recorded in Greek Basma (12.37 cm), while the lowest was in Izmir variety (7.15 cm).

The highest average yield (25 g/stalk and 3673 kg/ha) was registered in P-76/86, while the lowest (8.5 g/stalk and 1847 kg/ha) in Izmir variety.

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РЕЗУЛТАТИ ОД ПРОУЧУВАЊЕТО НА МОРФО-БИОЛОШКИТЕ И ПРОИЗВОДНИТЕ СВОЈСТВА НА ДОМАШНИ И СТРАНСКИ ОРИЕНТАЛСКИ СОРТИ ТУТУН

Каролина Кочоска, Илија Ристески

Апстракт
Со цел да се проучат некои морфо-биолошки и производни својства кај некои домашни и странски ориенталски сорти тутун, во текот на 2007 и 2008 година во кругот на Научниот Институт за тутун - Прилеп беше поставен опит со 4 домашни и 3 странски ориенталски сорти тутун, каде како контролна варијанта беше користена домашната сорта П 12-2/1. Испитувањата беа изведени на делувијален тип на почва во 4 повторувања по методот случаен блок систем, а добиените резултати беа варијационо статистички обработени по методот на анализа на варијанса. Добиените резултати покажаа дека: во просек, со најголема височина на стракот со соцветие се одликува сортата Ќумус Хаџикеј (104.47 cm) а со најмала (42.88 cm) контролната сорта П 12-2/1. Со најголем број на листови по страк (55.6) се одликува сортата П-76/85, а со најмал (29.2) сортата Грчка басма. Сортата Грчка басма се одликува со најголема должина на најголемиот лист од стракот (26.50 cm) и широчина(12.37 cm), а со најмала должина (17.12 cm) и широчина (7.15 cm) се одликува сортата Измир. Највисок принос по страк (25 g) и хектар (3673 kg) регистриран е кај сортата П-76/85, а со најнизок принос по страк (8.5 g) и хектар (1847 kg) се одликува сортата Измир.
Клучни зборови: тутун, ориенталски, сорти, принос.

UDC:633.71(497.775)
Expert paper

RESULTS OF BROADLEAF TOBACCO BREEDING IN SCIENTIFIC TOBACCO INSTITUTE - PRILEP

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Abstract
Scientific Tobacco Institute - Prilep possesses a rich collection of varieties and lines of Virginia and Burley tobaccos, which has been well maintained and regularly enriched. As a result of intensive breeding, many varieties and lines of these types have been created, distinguished by their high yields and quality. The aim of this investigation is to present the basic characteristics of both registered varieties and the newly created perspective lines. The presented varieties and lines were obtained by intervarietal hybridization, all of them in male-sterile form. Later, they were included in varietal trials. The results of Burley tobacco breeding show that, starting from the first registered Macedonian Burley B-96/85 CMS F_1, each following variety (line) were increased in size, number of leaves and yields (e.g., from 3000 kg/ha in B-96/85 CMS F_1 to 4350 kg/ha in Pelagonec CMS F_1). The quality and number of dry leaves were typical for Burley tobacco. The results for Virginia show that, starting from the first registered variety of Macedonian Virginia MV-1, all subsequent lines had larger dimensions, higher leaf number and increased yields (e.g., from 2500 kg/ha in MV-1 to 3591 kg/ha in the line V-88/09 CMS F_1. The color of dry leaves in most of these lines was golden yellow, which is typical for this type of tobacco.
Key words: tobacco, varieties, lines, Virginia, Burley.

Introduction

In parallel with selection of oriental and semioriental tobaccos, Scientific Tobacco Institute works on selection of broad-leaf varieties of the types Virginia and Burley. The share of raw material of these two types in composition of cigarettes is over 75% and it is the main carrier of taste and strength of tobacco smoke. Great attention during the selection process is paid to three main objectives: increase of yield, higher resistance to diseases and improvement of some characters which contribute to achieve higher quality of the raw material. The main goal of the selectionists of these two tobacco types is to obtain primarily male-sterile varieties that will be better in one or more characters than the already created. Fertile and male-sterile varieties and lines of domestic and foreign origin are used as genetic basis for hybridization. As a result of these activities, a number of Virginia and Burley varieties and lines which give satisfactory yields have been created, with raw material bearing all characteristics of the corresponding type. From the multiannual trials of Virginia and Burley varieties and lines it can be seen that most of the characters within the corresponding type are different, but they are still characteristic for the type to which they belong.

Material and methods

Data from previous investigations carried out in the Experimental field of Scientific Tobacco Institute - Prilep with five Burley and 6 Virginia varieties and lines were used as material for presentation of the results. Soil on which the trials were set up was of alluvial and colluvial type. From transplanting to the end of curing, all cultural practices typical for corresponding tobacco type were applied. Subject of analyses for the type Burley were sublimated results of the varieties B-96/85 CMS F1, Burley 1 CMS F_1, B-2/93 CMS F_1, Pelagonec CMS F_1 and line B-98/ N CMS F_8. For the type Virginia, analyses were made on variety MV-1 and lines V-78/07 CMS F_1, V-82/07 CMS F_1, V-63/04 CMS F_1, V-53 CMS F_1 and V-88/09 CMS F_1. Analyzes were made on the length and width of the largest leaf, leaf number, stalk height, yield per hectare and the color of dry leaves (raw material).

Results and discussion

Results for both types of tobacco presented in the tables are product of multiannual measurements and observations of certain characteristics of the varieties, and as such they can be taken as basic. Although these properties are strictly genetically controlled, they are closely related to soil and climate conditions in the region of growing, applied agrotechnics, conditions in which tobacco was cured, etc.

Characteristics of Burley tobaccos

Some of the characters in investigated varieties and lines of burley tobacco obtained by intervarietal hybridization are presented in Table 1.

Table 1. Characteristics of Burley varieties and lines

Characters (average values)	Varieties/Lines				
	B 96/85 CMS F_1	Burley-1 CMS F_1	B-2/93 CMS F_1	Pelagonec CMS F_1	B-98 N CMS F_8
Length/Width of the largest leaf, in cm	58 × 36	60 × 37	63 × 39	70 × 42	65 × 38
Leaf number per stalk	30	30	30	34	32
Stalk height, in cm	195	185	200	200	188
Yield/ha	3000	3500	4000	4350	3690
Cured leaves color	light brown	brown	light brown to brown	light brown to brown	brown

As can be seen from the data in Table 1, the highest length (70 cm) and width (42 cm) of the largest analyzed leaf was recorded in hybrid variety Pelagonec CMS F_1, the last recognized creation of the Scientific Tobacco Institute - Prilep. The lowest length (58 cm) and width (36 cm) of the largest leaf was recorded in the first recognized Burley variety B-96/85 CMS F_1. In other varieties and lines the length of the largest leaf ranges from 60 cm in variety Burley 1 CMS F_1 to 65 cm in line B-98 / N CMS F_8, and the width ranges from 37 cm in Burley 1 CMS F_1 to 39 cm in B-2/93 CMS F_1.

The lowest number of leaves per stalk (30) was found in varieties B-96/85 F_1, Burley 1 CMS F_1 and F_1 B-2/93 CMS 1, and the highest (34) in variety Pelagonec CMS F_1. In line B-98 / N CMS F_8 a

total of 32 leaves was counted. According to Djugerski (2009), in creation of new Burley varieties, the number of technically suitable leaves on the stalk should range from 26 to 32.

The highest stalk (200 cm) was measured in varieties B-2/93 CMS F_1 and F_1 Pelagonec CMS F_1, and the lowest (185 cm) in variety Burley 1 CMS F_1. Risteski et al. (2012) in 2010 and 2011, in the Experimental field of Tobacco Institute- Prilep made investigations on 6 Burley varieties and came to conclusion that the average stalk height ranged between 150,5 cm in variety B-21 to 191,5 cm in variety Pelagonec CMS F_1. The same author (2011), describing the basic characteristics of Pelagonec CMS F_1 states that stalk height in this variety can be expected to range from 180 to 220 cm.

The highest yield per hectare (4350 kg) was found in variety Pelagonec CMS F_1, and the lowest (3000 kg) in variety B-96/85 CMS F_1. Line B-98 / N F8 CMS reached a yield of 3690 kg / ha. Korubin - Aleksoska Ana (2004) reports that the yield of dry mass in variety Burley 1 CMS F_1 ranges from 3500 to 4000 kg/ha and in B-2/93 CMS F_1 from 3500 to 4500 kg / ha.



Figure 1. B-96/85 CMS F_1



Figure 2. Burley-1 CMS F_1



Figure 3. B-2/93 CMS F_1



Figure 4. Pelagonec CMS F1



Figure 5. B-98/N CMS F8

Through the color of cured leaves of Burley tobacco, organoleptic assessment of the quality of raw material can be made. According to the applicable Standards for qualitative assessment of leaf tobacco of the type Burley, tobaccos in all shades of light brown color are classified in I grade tobaccos, and all other colors go to the lower grades. The color of cured leaves in varieties described in Table 1 refers to cured leaves from the middle belt, which are also carriers of the character stalk yield. From the description of leaf color it can be concluded that the most typical color for the type Burley (light brown to brown) is found in varieties Pelagonec CMS F_1 and F1 B-2/93 CMS F_1, due to which this raw material is mainly classified in upper grades. Predominantly brown color is observed in raw material of the variety Burley 1 CMS F_1 and line B-98 / N CMS F_8, but it has somewhat lower quality compared to the raw of previously mentioned varieties. Light brown raw material was observed in variety B-96/85 CMS F_1, i.e. compared to other varieties investigated, this variety gives somewhat lower quality.



Figure 6. MV-1 CMS F_1



Figure 7. V-53 CMS F_1



Figure 8. V-78/07 CMS F_1



Figure 9. V-82/02 CMS F1



Figure 10. V-63/04 CMS F1



Figure 11. V- 88/09 CMS F_1`

Characteristics of Virginia tobacco

Basic characteristics of some varieties and lines of Virginia tobacco obtained in intervariety hybridization are presented in Table 2.

Table 2. Characteristics of Virginia varieties and lines

Characters (average values)	VARIETIES/LINES					
	MV-1	V-53 CMS F_1	V-78/07 CMS F_1	V-82/02 CMS F_1	V-63/04 CMS F_1	V-88/09 CMS F_1
Length/Width of the largest leaf, in cm	55 × 35	58 × 36	63 × 38	62 × 37	61 × 36	66 × 41
Leaf number per stalk	26	33	30	30	30	33
Stalk height, in cm	195	197	182	183	185	186
Yield/ha	2500	3549	2634	2896	2998	3591
Cured leaves color	Lemonish yellow	Golden yellow	Golden yellow	Golden yellow	Golden yellow	Golden yellow

According to the presented data, the biggest length (66 cm) and width (41 cm) of the largest leaf were observed in line V-88/09 CMS F_1 and the smallest (55 cm length and 35 cm width) in variety MV-1. In other tobacco lines, the length of the largest leaf ranges from 58 cm in F1 V-53 CMS F_1 to 63 cm in V-78/07 CMS F_1, and the width from 36 cm in lines V-53 CMS F_1 and V-63/04 CMS F_1 to 38 cm in V-78/07 CMS F_1. The lowest number of leaves per stalk (26) were registered in the variety MV-1 and the highest (33) in varieties V-53 CMS F_1 and V-88/09 CMS F_1. In all other lines the number of leaves was 30. A number of authors (Cavkaroski D. et al., 1992, Ristski I. 2000, Haws. S.N.J. Ir (1978) reported the occurrence of the so-called mammoth properties in Virginia tobacco, when unusually large number of leaves are formed on the stalk and plants begin to bloom when a daylight decrease. According to the presented results, the maximum stalk height was recorded in line V-53 CMS F_1 (197 cm) and the minimum height in line V-78/07 CMS F_1 (182 cm). In other varieties and lines this character ranged from 183 cm to 195 cm in varieties V-82/07 CMS F_1 and MV-1, respectively.

The highest yield per hectare was recorded in line V-88/09 CMS F_1 (3591 kg) and the lowest in variety MV-1 (2500 kg). In other investigated lines, the yield per hectare ranges from 2634 kg in V-78/07 CMS F_1 to 3549 kg in line V-53 CMS F_1.

Kocoska K. (2008) and Risteski I. (2011), in their investigations conducted in Tobacco Institute-Prilep during 2003 and 2004 reported that the average yield per hectare of the American fertile variety Sp. G-58 was 2828 kg. The same authors made investigations with other Virginia varieties in 2008 and 2009 on the same location and revealed that the American fertile variety K-326 achieved an average yield of 2684 kg/ha. From this it can be concluded that, in view of this character, the newly created Virginia varieties in Tobacco Institute -Prilep are not far behind some well-known American varieties.

Organoleptic assessment of quality of this tobacco type, among other indicators, takes into consideration the color of cured leaves. According to the operative Standards for qualitative assessment, I class consists of leaves from the middle belt with lemonish yellow, yellow, golden yellow and orange color, bright and uniform. The raw material of the variety MV-1 is characterized by a lemonish yellow color, while all other lines are golden yellow. Tobacco raw in all other colors and shades is classified in lower grades. It can be concluded again that, with regard to the color of cured leaves, the new varieties created in Tobacco Institute provide a good quality raw typical for Virginia tobacco.

The objectives and aims of Tobacco Institute-Prilep will continue to be directed toward creating male-sterile hybrid varieties of the types Virginia and Burley, because they displayed a series of advantages compared to fertile varieties. In many cases they appeared to be more vigorous and achieve better yields compared to their parents, which is a kind of transgression. It was also noted that these varieties have a faster root growth and a more uniform development, with better adjustment to environmental stress, higher resistance to diseases, etc.

Conclusions

According to the leaf size, all of the investigated Virginia and Burley varieties and lines can be classified in the first grade tobacco.

According to the character number of leaves per stalk, except for the variety MV-1, which has 26 leaves, all other varieties and lines in both tobacco types are characterized by higher number of leaves.

According to the character stalk height, all of the investigated varieties and lines belong to the group of high tobaccos.

As a result of somewhat bigger leaf size and higher number of leaves per stalk, Burley tobacco varieties give higher yields/ha compared to those of the type Virginia, but both types are achieving yields close to the world average.

All varieties and lines maintained the characteristic color of the type to which they belong.

A common conclusion can be drawn that Tobacco Institute has made an undisputed progress in breeding of these two types, which is confirmed by the fact that each newly created variety or line is characterized by improved properties compared to the previously created.

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РЕЗУЛТАТИ ОД ОПЛЕМЕНУВАЊЕТО НА КРУПНОЛИСНИТЕ ТУТУНИ ВО НАУЧНИОТ ИНСТИТУТ ЗА ТУТУН- ПРИЛЕП

Илија Ристески, Каролина Кочоска

Апстракт
Научниот Институт за тутун – Прилеп располага со богата колекција на сорти и оплеменувачки линии од типовите вирџинија и берлеј кои редовно се збогатуваат и одржуваат. Како резултат на интензивното оплеменување на овие два типа тутун, создадени се повеќе сорти и линии кои се одликуваат со многу добри приноси и квалитет. Целта на испитувањето е да се прикажат основните карактеристики на веќе признатите сорти и перспективните линии. Сите сорти и линии кои се предмет на презентација добиени се по пат на меѓусортово вкрстување, и сите се во машкостерилна форма. Подоцна истите беа вклучени во сортови опити. Резултатите од оплеменувањето на типот берлеј покажуваат дека почнувајќи од првата призната македонска сорта Б-96/85 ЦМС F_1 кај секоја наредна сорта (линија), димензиите, бројот на листовите и приносите се зголемуваат (пример од 3000 kg/ha кај Б-96/85 ЦМС F_1, до 4350 kg/ha кај сортата Пелагонец ЦМС F_1).Квалитетот и бројот на сувите листови се типични за типот берлеј. Резултатите од оплеменувањето на типот вирџинија покажуваат дека почнувајќи од нашата прва призната македонска сорта МВ-1 сите последователни линии се одликуваат со поголеми димензии и број на листови, а приносите се зголемуваат (пример од 2500 kg/ha кај МВ-1, до 3591 kg/ha кај линијата V-88/09 ЦМС F_1). Бојата на сувите листови кај повеќето линии е златно жолта карактеристична за овој тип на тутун.
Клучни зборови: тутун, сорти, линии, вирџинија, берлеј.

SECTION 6: ANIMAL BIOTECHNOLOGY

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Review paper

REGIONAL DISTRIBUTION OF CATTLE, SHEEP AND GOAT FARMS IN THE REBUPLIC OF MACEDONIA, ACCORDING TO FARM SIZE AND BREED STRUCTURE

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Abstract
In the Republic of Macedonia the multitude of farms are cattle farms with an average capacity of up to 5 heads (74,6 %). The highest number of heads form all categories are bred in the Pelagonia region (19,6%), followed by the Skopje region (15,68%). The Vardar region has the least number of cattle (5,49%). Cattle crosses represent the majority of their kind in R. Macedonia (43,91%), followed by the Holstein - Frisian breed (39,65%). Out of the total number of sheep farms in the country, 41,69% are farms with a size of 50 heads, whereas farms with the size 51 - 100 and 101 - 500 heads are present with 20% and 30,4% respectively. Farms with a size of 301 – 500 heads consist 5,32% of the total number of sheep farms and farms with 501 -1000 and above 1001 heads are present with 2,30 % and 0,30% respectively. The highest number of sheep are bred in the Eastern region (22 %), after which is the Pelagonia region (16,9 %) and the Skopje region with the lowest number of 4,5%. Highly represented in the breed structure of the sheep population in R. Macedonia are the Ovcepolka (26,9%) and Sharplaninska pramenka (18,4%) strains.Out of the total number of goat farms in R. Macedonia, farms with a size of 1-5 heads consist the greatest percentage (65,09%), followed by farms with a size of 6-20 heads which participate in the total number with (26,05%). The eastern region has the highest number of goats (46,7%). In the breed structure of the goat population, highest participation was noted for indigenous goat breed (67,17 %). The presence of the Saneen breed is 11,75%, the Alpine 6,55 % and mixed breeds deriving from them are present with 4,19% and 10,34% respectively.
Key words: farm size, breed structure, regional distribution.

Introduction

Long-term development of livestock production in the future will primarily be determined by: environmental conditions, tradition of livestock production, farm size and economic factors. As a very important sector of agriculture livestock production occupies an important place in the structure of farmers' income, but also in the overall economy. The ability to converse plant food in high quality food products for human populations gives special significance to the livestock production. The agricultural sector is one of the most important sectors in the Macedonian economy. The share of this sector in the gross domestic product of the Republic of Macedonia is around 10% and increases to 15% if we take into account

the food industry. Livestock accounts for 27,5% of the value of agricultural production (Economic calculation in agriculture, SSO, 2002-2010). Cattle, sheep and goats breeding in the country are mainly performed by individual farmers. The production is orientated for its own consumption, but part of this production is marketed to dairy plants and slaughterhouses. It is noticeable, existence of a number commercially oriented family farms, large specialized livestock production enterprises, whose number is declining. According to the State Statistical Office of the Republic of Macedonia, in 2010 the highest percentage of cattle, sheep and goats (97,1% of cattle, 95,8% of sheep and 98,7% of goats) were located in individual farmers, while the rest goes to business sector (SSO, Yearly Report, 2011). Main aim of this paper is to determine regional distribution, farm size and breed structure of cattle, sheep and goats in the country as main indicators which will serve to evaluate production capacity of different regions in the country but also to recommend future activities in order to improve and increase production from ruminants. Operational data form Food and Veterinary Agency (FVA) in 2012 are used to determine regional distribution, farm size and breed structure of cattle, sheep and goats in the country.

EU trends in cattle, sheep and goat sector

Success in milk production, or total milk produced is primarily influenced by the technology of breeding and breed genetic capacity. Specialized dairy cattle farms in the EU, according to the system of EU farm typology and classification, is the cattle farm in which more than 2/3 of the income is realized from milk production. In these farms most of the agricultural lands are processed to produce food for their own needs. Production technology and farm management is directed towards the production of milk and specialized farms are poorly diversified. Most of the farms in the EU-15 are breeding at least 50 or more heads, which was not the case in the EU-10, where most of the farms were located in the herd size up to 10 or fewer heads. But, in the period 2000-2007 only large farms in the EU-15 with more than 100 heads of cattle were able to buy new breeding heads, while farms with more than 10 heads, farms in the EU-10, failed to raise livestock, while those farms with under 10 cattle heads have reduced the quantity and slowly disappeared. As a result of a number EU policies the number of dairy cattle in the last decade decline. Overall decline in the number of milking cows in the EU-15 in the period 1990-2010 is almost 33%, with the lowest average rate of decline registered in Denmark, France, Ireland and the Netherlands. During 2000-2010 decline in the number of milking cows continues, following parameters are noted: decrease of 12% (EU-15), 20% (EU-10) and 14% (EU-27) (Evaluation of CAP measures applied to the dairy sector, 2011).

This situation, the distribution of farms and their size affects milk production, even 87% of the milk in the EU-15 and 56% of the EU-10 comes from specialized farms. Despite this fragmentation in the production, large reduction of the quantity and the emergence of the tendency to increasing farm size and increase production indicating strong restructuring of the EU cattle milk production (e.g. Germany, the trend of reducing the cattle number from 5,2 million in 1996 to 4,2 million cows in 2006, but there was milk yield increase from 5,8 t per head to 7,3 t. In this period there was also a change in the number of farms from 186000 in 1996 to 92000 in 2006, and the increase in the average number of cattle on a farm from 28 heads in 1996 to 46 heads in 2006), (European Commission, 2010b).

Dairy sheep production is usually based on local breeds, well adapted to the production areas which are in many cases less favoured. Sheep use natural resources of low interest for other species, helping the maintenance of ecological equilibrium and natural landscape. In addition, they contribute to the maintenance of economical activity and population in rural areas (Ugrante and Gabina, 2004). At the European level, sheep and goat breeding represent minor agricultural activity representing 3,6% of the total value of livestock production in the EU-27. However, in certain Member States, sheep and goats farms occupy a significant part of the overall agricultural area: 31% in UK and 20% in Ireland, Spain, Romania and Italy. Sheep sector is characterized by a reduction of the quantity of sheep meat breeds (33% less reproductive sheep heads for meat production during the period 2000-2009), while the total number of sheep intended for dairy production has grown steadily (+43% number of milking sheep). Generally it can be seen a downward trend in the total number of sheep from 1990 (-1% per year) and slightly accelerated decline after 2005 (-3%). The number of goats was reduced by 11% in the period 1990-2009. This reduction was still compensated by productivity gains, which resulted in increased production of goat's milk. As main recent developments in dairy sheep breeding in EU can be noted: 9% increase of milk production from 1995, almost 2/3 of the milk produced is purchased and processed by commercial dairies with considerable variation among Member States, exports of EU-produced cheese is 3/4 of world trade with cheese; stable prices for sheep's milk in recent years, with differences between Member States. As the trend in most EU countries where sheep are milked there has been a rapid development of "productive breeds" in Spain is Assaf breed, where this breed according to the national census exceeds local dairy breed Churra, while sheep breed Lacaune is considered to be represented by more than 200000 reproductive sheep heads. Similar is the situation in Greece and Slovakia where the races Lacaune and East Friesian breed are the only sheep breeds on the rise (de Rancourt and Carrère, 2011). In dairy goat breeding following trends are noted: 10% increase in milk production from 1995, goat milk purchase compared sheep milk is lower intensity and noticeable number of producers process milk on their farms, marginal international trade of goat cheese, constant price growth of goat milk in the Member States that are major producers of goat milk (Evaluation of the CAP measures for the sheep and goat sector–Executive summary, 2011).

Livestock sector at primary level

Cattle breeding

A dairy cattle breeding is closely associated with technology of breeding and overall crop production. It is an expression of two biological and technological differently organized systems (milk and meat) which are interconnected, where meat production is in negative correlation with milk production. Considering the characteristics of the production, especially milk production, many factors will affect the volume of production. Data as: heads quantity, breed, farm size, breed and head regional distribution, as well as breeding technology provide the appropriate information for production capacity in terms of milk production. According to operational data FVA in 2012 about 40,797 cattle farms are registered in the Republic of Macedonia, with a total of 263283 cattle in all categories, with average farm size of 6,5 cattle per farm, taking into account all cattle categories. The data indicate that the average size of a farm in the Republic of Macedonia is different from the average size of cattle farms in some EU member states, Greece (14 cattle per farm) and

Austria (86 cattle per farm), but it is still twice the average size cattle farms in Montenegro (Marković et al., 2011).

Regional distribution

According to its structure and orientation cattle farms are small, traditional and low productive, with milk yield from 2,000 up to 3,000 liters (SSO, 2011). Largest number of cattle, according to the operational data of FVA in 2012 (Figure 1), in all categories are present in Pelagonija region (19,6%), followed by Skopje (15,68%), while the Vardar region is characterized with lowest distribution of bovines (5,49%). In other regions the distribution of cattle ranged from 9,29% (Southwest) to 14,73% (Polog).

Farm size

High percent (74,6%) of cattle farms in the Republic of Macedonia bred up to five heads. Also quite low percentages (21,1%) of farms are farms from 6 up to 20 heads. Approximately 4 % of cattle are farms with more than 20 highly productive heads and slightly higher annual milk production, and only 1% of the cattle farms, which usually are carriers of milk production and quality genetic material, are farm with over 50 breeding heads. Data structure of farms in 2012 is given in Figure 2 and Figure 3.

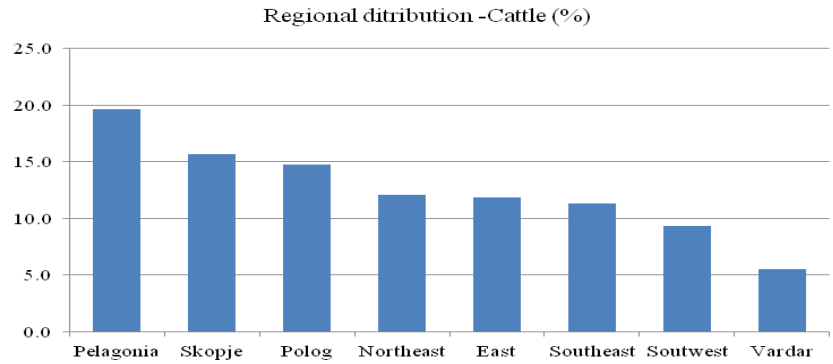


Figure 1. Cattle regional distribution

A similar trend in the farm size is observed in certain regions of the country (Figure 3). The unfavorable structure, regarding farm size, is present in: Southwestern (83,42%), Polog (79,13%) and Northeastern (70,73%) region where predominant farms are cattle farms with less than five heads. In these regions farms which should be carriers of cattle dairy production (from 51 up to 100 heads) are almost absent, although in these regions is very high percentage of registered holdings (Southwest 13,3%, Polog 21,8% and the Northeast 12,9%) regarding total number of registered farms in the country. In other regions also highly present are farms under five heads, but in these regions, there is a slightly better distribution of farms according to their size. Smallest number of farms in the category under five heads was noted in the Eastern region (63,89%). Category of cattle farms from 6 up to 20 heads ranges from 17,50% in the Southeast up to 27,37% in the Eastern region of country. While in Skopje and Northeastern region in this category (from 6 up to 20) are registered 26% of the farms. In other regions this category of farms is under 20% with the lowest (15,16%) value noted in the Southwestern region.

Farms that have a potential for milk production, according to farm size are farms with size of 21 up to 50 heads (small family farms). Generally speaking, compared to other categories of cattle farms their participation is quite small. Lowest percent of farms from this category is present in the Southwest (1,16%), and the highest percent in the Eastern (6,80%) and Skopje region (6,0%). This category of farms in Pelagonia and Vardar region is present with only 5,63% and 5,88%, respectively. In the other three regions in the county distribution of those farms is approximately 4% and in the Polog region is 1,63%. As regions where there is a little bit higher farm distribution of cattle farms with 51 up to 100 heads are: Skopje (3,67) and Vardar (3,07) region, while in other regions this category is less than 2%, with the lowest value in the Southwestern region (0,19%). The presence of large farms (farms with more than 101 breeding heads) is quite small and unevenly distributed in the country, 1,20% of the farms in the Vardar region belong to this category and 0,38% of the farms in Pelagonia region. In other regions the presence of this category of farms is low, with lowest value in Polog region where 0,02% of the farms are representative of this category.

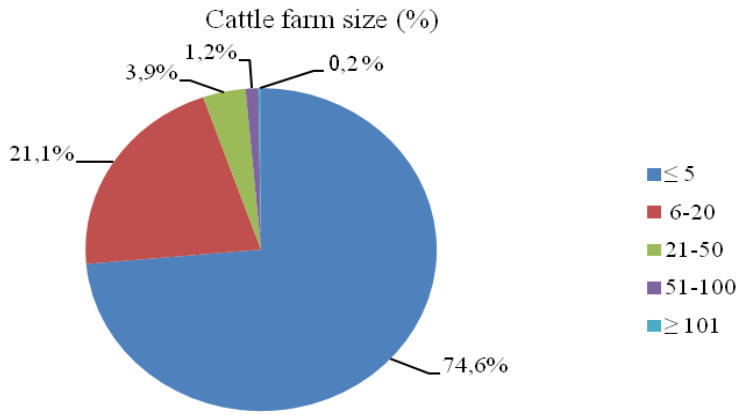


Figure 2. Cattle farm size

Breed structure

Breed structure, genetic capacity but also breeding technologies among other factors have a significant impact on total milk production. In order to determine breed distribution in the country cattle farms were classified according to cattle breeds present in the country. The total number of farms in the Republic of Macedonia, according to their ordinal number of the holding is 40,737, but since in one farm can be bred more cattle breeds, with separation of the breeds that are present in a farm and their registration, their number is higher. Bovine breeds distribution is shown in Figure 4. The results indicate that the largest share in the cattle population in the Republic of Macedonia belongs to crosses with 43,91%, Holstein-Friesian breed is present with high percentage (39,65%) in the country. Breed distribution according to regions is suggesting that crosses are present in a range from 67% in Skopje to 27% in Pelagonija and Polog region. It should be noted that the share of dairy breeds such as Holstein- Friesian, regarding total number of cattle is highest in Pelagonija region (64,2%) and Polog region (56, 3%), and lowest in the Skopje region (11,86 %). Based on the analysis and comparison of the data in the Republic of Macedonia in the period 2006-2012, there was

a reduction in the number of farms. The total number of dairy farms in the Republic of Macedonia in 2006 was 48741, to be reduced up to 40737 in 2012, according to their ordinal number of the holding. While in 2006 approximately 86% of farms were farms with 1-5 cows, and the proportion of large farms over 30 cows was 0,7%. In 2012, there was a slight improvement in the structure of farms, but again most of the farms (73,6%) belong to the category number up to 5 heads, cattle farm with 10 cattle were 87,6%, while about 3% belong to the category over 30 heads. Lowest percent (0,27%) belongs to farms breeding over 100 heads.

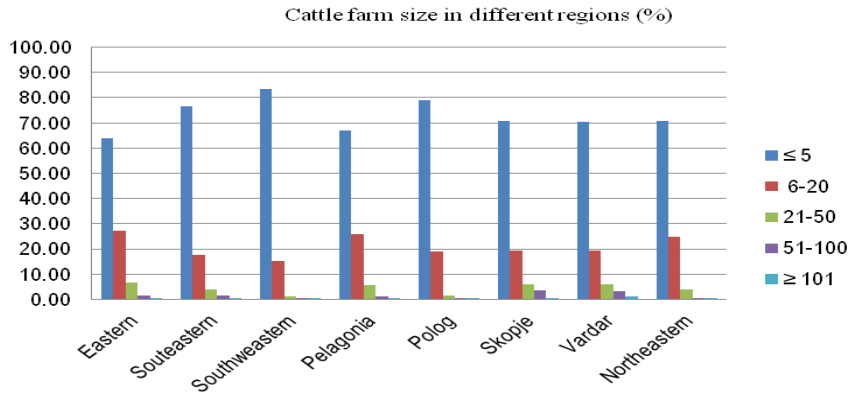


Figure 3. Cattle farm size in different regions (%)

Sheep breeding

Specific climatic conditions, the mountainous nature of the terrain, the advantage of the sheep to make full use of the capacities of rural (marginal) areas, then the ability to maintain economic capacities of the rural population, as well as the tradition of sheep breeding are ideal for development of sheep breeding in the Republic of Macedonia. The sheep milk, at least until now, mainly is intended for domestic market and it is the raw material for processing of different types of cheeses and other dairy products. Sheep milk production in the Republic of Macedonia in a longer time of period shows significant oscillations.

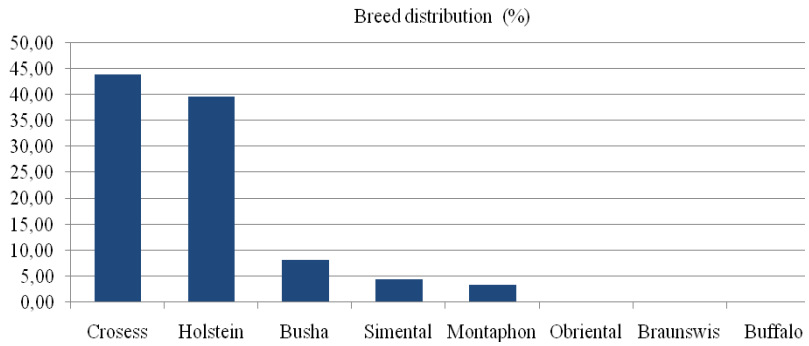


Figure 4. Breed distribution

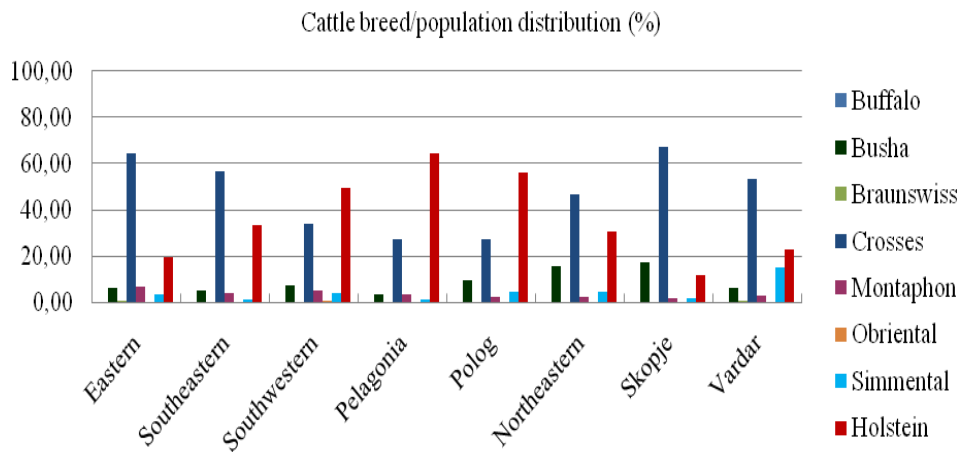


Figure 5. Cattle breed distribution in different regions

Totally produced sheep milk is affected by the number of breeding sheep in the country, genetic capacity and farm practice. Regarding ownership structure the highest percentage (97 to 98%) of the total milk production in the past period belongs to the individual farmers (SSO, 2011). While the rest amount of milk production belongs to the large agricultural enterprises and cooperatives. Considering the characteristics of sheep breeding technologies, several factors (climate, economic characteristics and farm size, as well as the technology of breeding) significantly affect the volume of sheep milk production. Mainly in sheep breeding are present two production systems (extensive and intensive) with multiple subsystems. In our conditions dominates extensive semi nomadic system. But the production of sheep milk generally distinguishes six systems that are based on the length of suckling period. Breeding technology in the Republic of Macedonia in most sheep farms is traditional, which means lambing once a season (January-February), lambs weaning (March-April) and milking period until the middle of July. System of sheep breeding in the Mediterranean pool often have a dual direction of production (excluding wool because of the low interest and low price), where two-thirds (or three-quarters) of income is due to milk and one-third (or one-quarter) of the income is a result of the production of meat. Although a high proportion of income in the sheep breeding is connected with milk production very few dairy sheep in the country are under the control of the productive and reproductive traits. Less than 0,3 to 0,5% of milking sheep, or in about 1500 dairy sheep in the country are under control of the productive and reproductive traits. Implementation of monitoring and determination the genetic quality and milk yield in sheep breeding is with low-intensity in the country. Undoubtedly this low coverage, lack of reproduction centers and low level of education of farmers adversely affect the development and utilization of the country's overall capacities in sheep breeding. According to operational data FVA in 2012 in the Republic of Macedonia 6671 sheep farms are registered with a total of 750,201 sheep heads in all categories, that the average size of sheep farms would be 113,4 heads per farm, taking into account all sheep breeding categories.

Regional distribution

According to the operational data of FVA, most of sheep population are bred (Figure 6) in the Eastern region (22,0%), followed by Pelagonija (16,9%), while the Skopje region is characterized with the least sheep heads (4,5%). In other regions the percentage of sheep heads ranges from 9,0% (Southeast) up to 14,27% (Southwest).

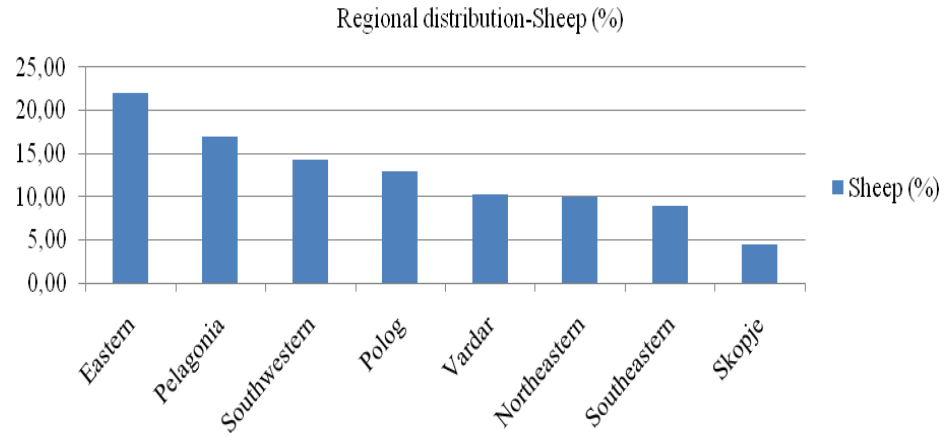


Figure 6. Sheep regional distribution

Farm size

Majority (41,69%) of sheep farms belong to group of farm which are breeding up to 50 heads, farms with a size of 51 up to 100 and from 101 up to 300 heads cover 20% and 30, 4%, respectively. Only 5,32% of sheep farms in the country belong to farms with 301 up to 500 heads. Very small part of the overall structure of the sheep farms belong to large farms from 501 up to 1000 and more than 1001 heads, 2,30 and 0,30%, respectively (Figure 7). Highest number of sheep farms (Figure 7) in the Republic of Macedonia is located in the categories up to 50 and from 101 up to 300 sheep. High density of farms (Figure 8) in the category up to 50 heads was noted in the Eastern (59,6%), Northeast (55,69%) and Skopje region (41,53%). In other regions this category of farms is between 20% and 33% with the lowest values in Pelagonija (12,13%) and Vardar (8,61%) region. Unlike other regions where most farms still belong farms under 50 heads, in four regions of the country (Pelagonija, Southwestern, Polog and Vardar) prevailing in farm size from 101 up to 300 sheep. In addition, 57,11% of the farms in Pelagonija, 47,19% of the farms in the Vardar region, 43,31% of the farms in the Polog and 35,38% of the farms in the Southwest region, belong to the category from 101 up to 300 heads. High distribution of farms in the category from 301 up to 500 heads were observed in Polog (14,29%) and Vardar (14,98%) region, while the same category had lowest distribution (2,27%) in the Northeast region. Farms with over 1001 heads are present in all regions with the exception of the Skopje region, and the highest presence (1,25%) of these farms was observed in Polog region.

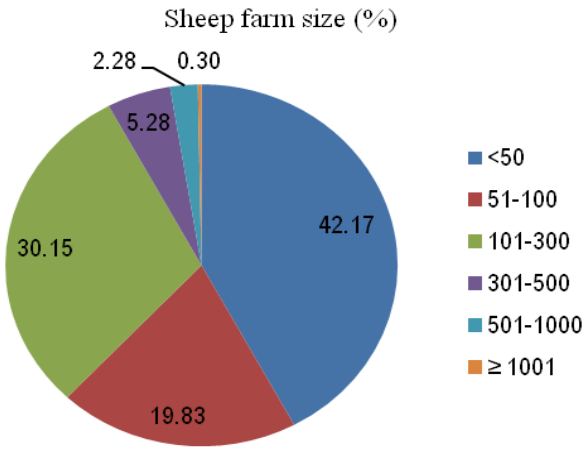


Figure 7. Sheep farm size

Breed distribution

Regarding breed structure of sheep population in the country, most frequent sheep population is Ovchepolian (201,673 heads, or 26,9%), and Sharplaninian (138 290 heads, or 18,4%) pramenka, with their usual concentration in the regions were those population are originated (Figure 9). Crosses of different breeds are present with 24% and Württemberg crosses are present with 16,3% of the total number of sheep. Highest concentration of crosses was observed in Skopje and Vardar (81,5%) region. Dairy breeds as Awassi, Blackhead Pleven, and East Friesian breed are insignificantly present. Crosses with Awassi breed have very low participation in the sheep population, accounting about 4% of the total number of sheep, with largest distribution in Pelagonija region (13 478 heads) (Figure 10).

Goat breeding

Considering the climatic conditions, as well as the experiences of other countries, the Republic of Macedonia has capacity for adequate development of goat breeding and through the formation of pure breed goat farms and application of intensive farming or semi intensive goat breeding systems. Goat breeding in the Republic of Macedonia posse's high development capacity including breed genetic improvement, higher milk production, which in turn will offer economic benefits to farmers. Main products from goat breeding in the country are different types of cheese that are commonly placed on the domestic market, but also production and sale of fresh milk. The highest part of income from goat breeding is accomplished by milk production, but a very small number of dairy goats are under control of productive and reproductive traits. Less than 0,2% of the population of dairy goats, or less than 1000 heads, are included in activities regarding monitoring and determining the genetic quality and milk yield. Undoubtedly this low coverage, lack of repro-centers and low level of education of farmers adversely affect the further development and utilization of the overall capacities of goat breeding.

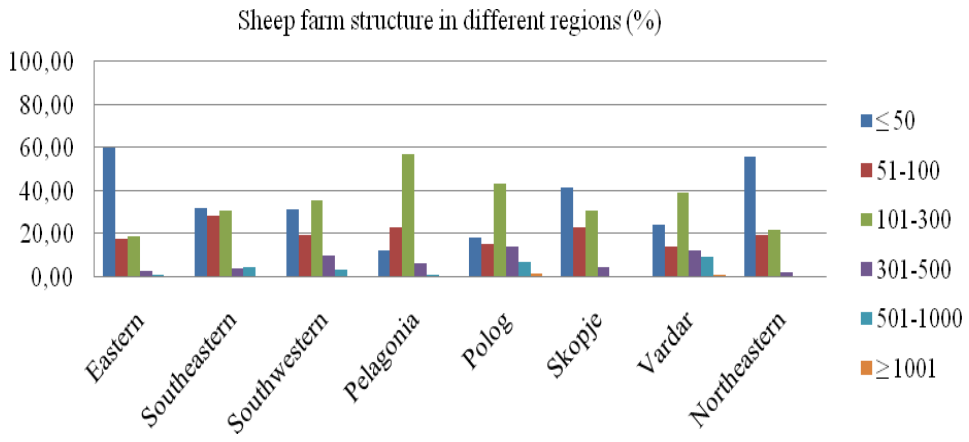


Figure 8. Sheep farm structure in different regions

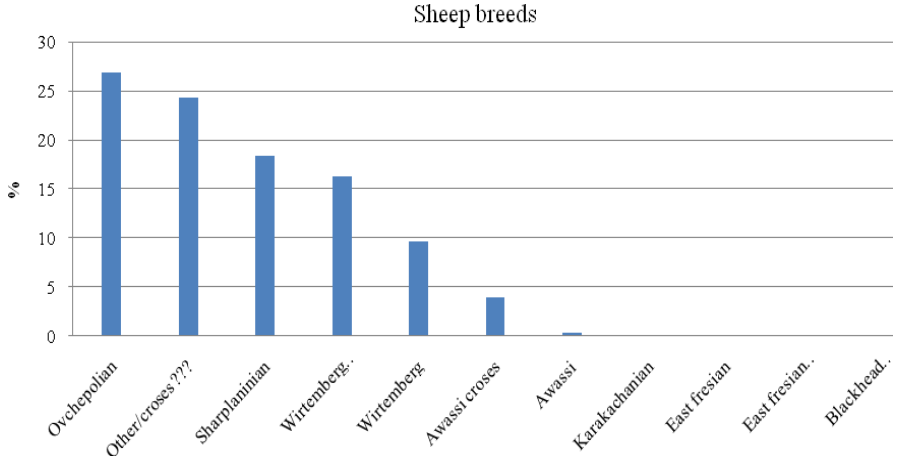


Figure 9. Sheep breeds in the country

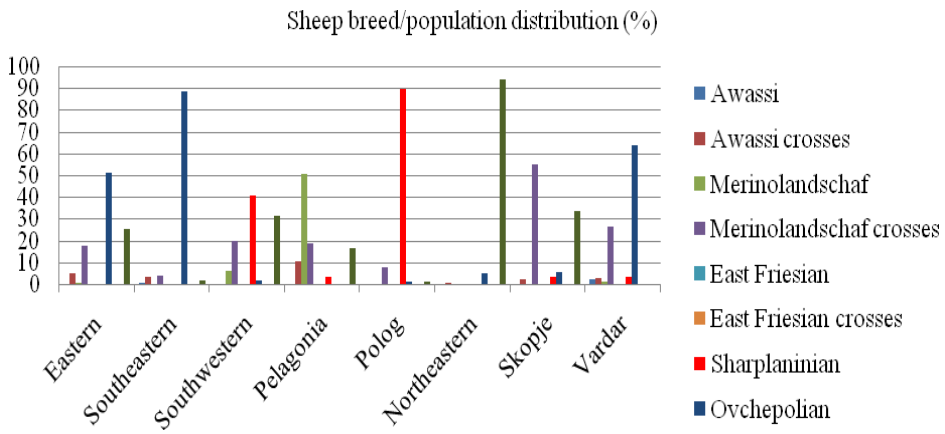


Figure 10. Sheep breed distribution

Regional distribution

According to the operational data FVA, Southeast and Eastern region are characterized by the highest number of goats which occupy 46,7% of the total number of goats in the Republic of Macedonia (Figure 11), low goats density was noted in Skopje region (4,1%), while in other regions they are present in a range from 6,0% (Polog region) to 12,8% (Vardar).

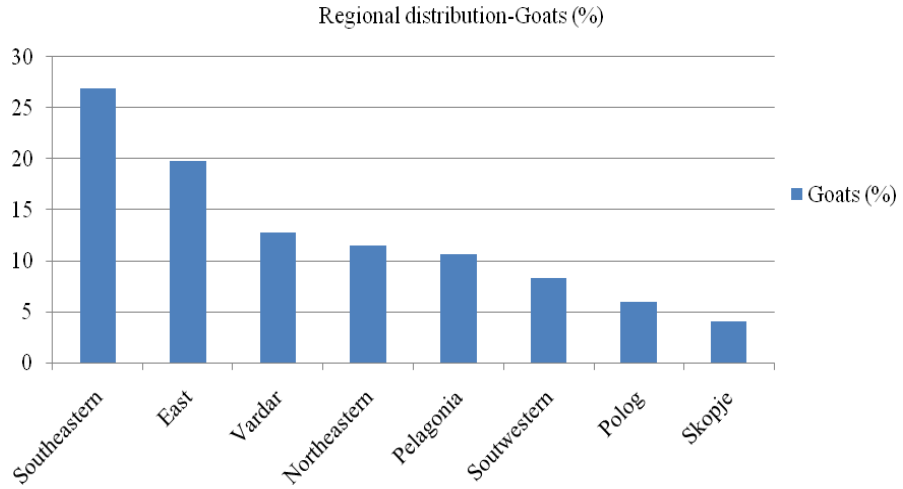


Figure 12. Goats regional distribution

Farm size

According to operational data FVA in 2012 (Figure 13) in the Republic of Macedonia 5746 goat farms are registered, with total of 48,492 goats, that will give average farm size of 8,4 heads per farm, taking into account all breeding categories. The majority (65,09%) of goat farms in the Republic of Macedonia are farms wit up to 5 heads, goat farm size from 6 up to

20 goats comprise 26,05% of the total number of farms. A small percentage (6,61%) of farms belong to goat farms from 21 up to 50 heads, while very low percentage belongs to farms which are breeding 51 up to 100 (1,76%), 101-200 (0, 40%) and more than 200 (0,09%) goats. Goat farms (Figure 14) up to 5 heads are mostly present in the: Eastern region (80,18%), Southeast (63,6%) and Skopje region (64,4%). In the Northeastern region 52,85% of farms belong to this category. In other regions this farm category is smaller and ranges from 48,18% in the Vardar, 46% in the Southwest and Polog up to 31,96% Pelagonija region. Although Pelagonija region is a region with the lowest distribution of farms up to 5 heads, this region compared to all other regions in the country has highest percent (43,35%) of goat farm in the category from 6 up to 20 heads. In the Southwest, Polog and Skopje region this category of farms is present with 39,34%, 37,89% and 30,37%, respectively. Lowest distribution (16,85%) of this farm category is present in the Eastern region. In the most important category of farms, farms with a size from 51 up to 100 heads, only the Vardar region have double-digit distribution (10,00%). Two-times smaller distribution, regarding Vardar region, has Pelagonija region (5,70%), while the remaining regions have even smaller distribution (under 5%). Distribution of farm category between 101-200 heads is very low in the country, but still 182 farms in the Vardar region belong to this category. In all other regions, the presence of this category of farms is below 1%. Farms larger than 201 heads are recorded in the Southeastern and Skopje region but with very with low distribution, 0,23% and 0,24% respectively, while in all other regions of these farms are not present.

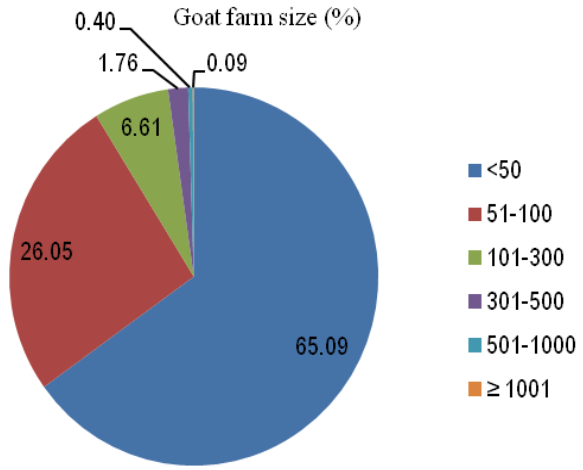


Figure 13. Goat farm size

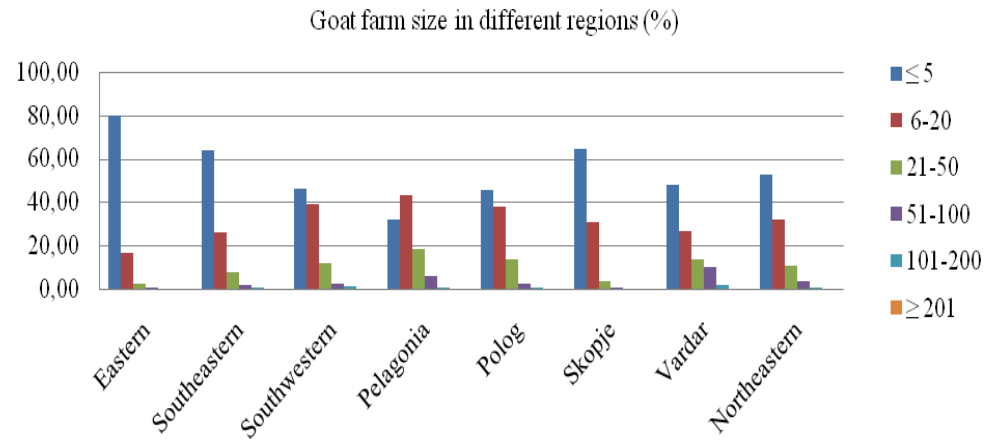


Figure 14. Goat farm size in different regions

Breed structure

Largest share in the goat population in the Republic of Macedonia has a domestic goat, representing 67,17% of the total goat number (Figure 15) and it dominates with over 85% in the Eastern, Southeastern and Southwestern region. Saanen goat participate with 11,75%, Alpine breed with 6,55%, while their crosses participate with 4,19% and 10,34% respectively (Figure 16).

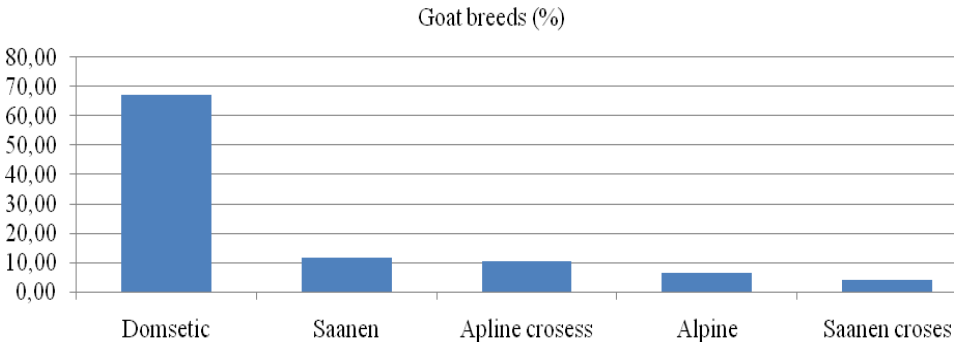


Figure 15. Goat breeds in the country

Breed distribution according to regions, suggesting that Saanen goat is the most present in Northeastern, Pelagonia and Skopje region. Dairy breeds and their crosses in the country occupy only one-third from total population but they are usually bred in small herds. Insignificant part of the population of dairy goats is under control of productive and reproductive traits, as well as the low level of primary and secondary education of farmers significantly contribute to reducing the development capacity of goat breeding. The absence

of the application of appropriate methods of breeding and nutrition of goats on the majority of the farms are limiting factors in terms of improving dairy capacity.

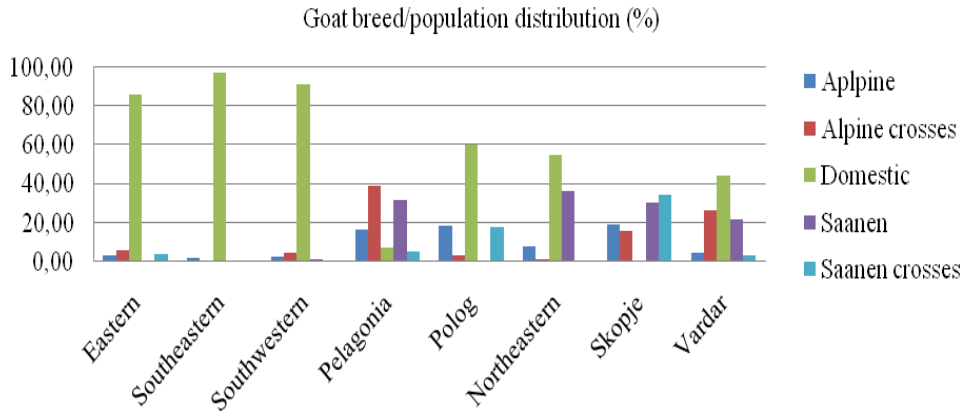


Figure 16. Goat breed/population distribution in different regions

Conclusions

Based on analyzed data, can be concluded that the greatest potential for cattle dairy production, given the largest presence of Holstein- Friesian breed, have Pelagonija (3183 l per cow) and Polog region (3138 l per cow). Significant presence of crosses in other regions in the country (from 33,8% up to 67,3%) is a solid base for the dairy industry. However, the small farm size is an unfavorable characteristic of cattle breeding in the Republic of Macedonia. This weakness becomes more pronounced if is noticed that during this analysis the total number of cattle in the country is included, rather than only dairy cows, affecting further reducing of farm size, and thus the total capacity to milk production. Also, the small population of dairy cows, which is under the control of the productive and reproductive traits, as well as the low level of primary and secondary education of farmers, has significant effect on dairy cattle breeding. Main characteristics of sheep breeding in the country is a preponderance of small (up to 50 heads) in the Eastern, Northeastern, and in the Skopje region) and medium-sized farms (101-300 heads in Pelagonija, Vardar and Polog region). Regarding the breed structure of sheep population in the Republic of Macedonia is characterized by a very small distribution of the dairy breeds and their crosses, regarding high presence of domestic breed and their crosses with meat-wool breeds (Württemberg). Insignificant part of dairy sheep population in the country is under the control of the productive and reproductive traits, as well as the low level of primary and secondary education of farmers have strong influence on sheep breeding. High distribution of goat farms with less than 5 heads except in Pelagonia region, dominance of domestic goat breed in the country regarding dairy goat breeding as well as low percent of goat population included under the control of the productive and reproductive traits are main weakness in this sector. Future activities in ruminant sector should be orientated in: increasing farm specialization and size and application of modern production technologies in dairy farming. Improvement of breed structure on farms, breeding dairy breeds, but also genetic

improvement of indigenous populations should be main direction in the country regarding ruminant breeding.

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РЕГИОНАЛНА ДИСТРИБУЦИЈА НА ГОВЕДАРСКИ, ОВЧАРСКИ И КОЗАРСКИ ФАРМИ ВО РЕПУБЛИКА МАКЕДОНИЈА, СПОРЕД ГОЛЕМИНАТА НА ФАРМАТА И РАСОВАТА СТРУКТУРА

Владимир Џабирски, Кочо Порчу, Ѓоко Буневски, Соња Србиновска, Драгослав Коцевски, Срећко Ѓоргиевски и Горан Трајковски

Апстракт

Во Република Македонија најголем број од говедарските фарми се фарми со просечна големина на фарма до 5 грла (74,6%). Најголем број од грлата во сите категории од видот говедо се одгледуваат во Пелагонискиот регион (19,6%), односно во Скопскиот регион (15,68 %). Најмал број на грла е забележан во Вардарскиот регион (5,49%). Мелезите се најзастапени (43,91%), додека Холштајн-фризиската раса е застапена со 39,65%. Од вкупниот број на овчарски фарми во земјата 41,69% отпаѓа на фарми со големина до 50 грла, додека фармите со големина од 51-100 како и фармите од 101-500 грла се присутни со 20% и 30,45%, респективно. Фармите со големина од 301-500 грла зафаќаат 5,32% од вкупниот број на овчарски фарми во земјата. Овчарските фарми со големина од 501-1000 грла и над 1001 грло се застапени со 2,30% и 0,30%, респективно. Најголем број на овци се одгледуваат во Источниот регион (22%), по кој следува Пелагонискиот регион (16,9%) и скопскиот регион со 4,5%. Највисоко застапена во расовата структура во овчарство е овчеполската овца (26,9%) и Шарпланинската праменка (18,4%). Од вкупниот број на козарски фарми во Р Македонија фармите со големина од 1-5 грла се најзастапени (65,09%), по кој следат фармите со големина од 6-20 грла кои пак учествуваат во вкупниот број со 26,05%. Источниот регион на земјата има најголем број на кози (46,7%). Во расовата структура на популацијата кози најголем процент е нотиран ка домашната автохтона коза (67,17%). Присуството на Санската коза е 11,75%, Алпина е застапена со 6,55% додека нивните мелезите се присутни со 4,19% и 10,34%, респективно.

Клучни зборови: големина на фарма, расова структура, регионална дистрибуција, говеда, овци и кози.

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EGG PRODUCTION AND EGG QUALITY PARAMETERS OF LAYERS FED DIETS WITH OR WITHOUT ADDED PHYTASE

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Abstract
Balancing the nutrients (especially Ca and P essential macro minerals responsible for high egg production and eggshell quality in laying hens), in the diets for layers selected for low body weight, but high egg sizes is a state of art. Whole cycle egg production results (egg number, laying percentage, feed consumption) and egg quality parameters (egg size, shell strength, yolk color and Hough Units) were compared in two groups of ISA Brown layers fed isoprotein and isocalloric diets without (NP) or with (AP) phytase enzyme at level of 0.01%. Trial group diet supplemented with phytase, contains lower level (on average 0.5%) of Non Phytate Phosphorus (NPP) source-Mono-Calcium-Phosphate (MCP). Non significant differences in daily laying percentage (81.02% vs 80.83%) and number of egg produced per hen housed (297.96 vs 297.99) were recorded. Analyzes revealed non significant differences in egg size and shell strength (60.96g vs 61.38g; 3851.05 vs 3928.67 g/cm^2) between the groups. Some significance, not attributable to the phytase supplementation, in yolk color (9.23 vs 10.53) and Hough Units (70.88 vs 67.64) were monitored for trial and control group, respectfully. Correlations between eggshell strength and egg weight were non significant. Modification of the feed formula through lowering the NPP and phytase supplementation is valuable approach that decrease the feed costs but does not influence number, size and quality of the eggs produced.
Key words: poultry, nutrition, phosphorus, phytase, egg production, egg quality.

Introduction

Balancing the nutrient in the feeding of the modern type egg layers is a state of art. High selection pressure toward better feed conversions have lead to decreased body weight, therefore lower feed intake capacities and higher egg sizes in these birds. These two characteristics are in high negative correlations therefore leads to need of fine tuning the nutrients essential for maintaining high performance (egg number) and high quality products (medium to big sized eggs with sufficiently strong shell). Beside Ca, Phosphorus (P) is accounted as essential mineral responsible for high egg production and egg shell quality in

laying hens. Organically-bound phosphorus salts of phytic acid (phytate phosphorus) is almost unavailable for the metabolism of birds (Klis et al, 1996; Kornegay 1996; Angel et al., 2002;) meaning that birds can hardly use phytate P due to evolutionary lack of enzymes that will degrade the phytate molecules. On the other side Non Phytate Phosphorus (NPP) sources as feed ingredients, are rather expensive but also limited, non-renewable resources, therefore inorganic part of P ingredients in the feed are often reduced with efforts of helping the birds to reach for phytate P in the grain sources (corn, barley, wheat, soya e.t.c) through supplementation with exogenic phytase enzymes. It is well known that low levels of available phosphorus have negative effect on production records, and that supplementations of exogenous phytase can help overcoming these negative effects. For example adverse effects of a low P (1.3 or 1.1 g/kg NPP) diets were overcome with phytase supplementation in the experiment of Francesch et all, (2005). There are numerous reports of many authors that supplementing diets with an exogenous phytase enzyme does not affect production level. In many of the studies improved performances in terms of better feed conversion ratios are reported, and significantly improved shell quality (Jalal and Sheideler 2001; Lim et al., 2003; Liebert et al., 2005; Liu et al, 2007; Rubio et al 2009; Skřivan et al, 2010; Meyer and Parsons 2011; Singh et al, 2011). Panda et al (2005b) compare different levels of non-phytate phosphorus (NPP) sources in the diets of White Leghorn at the beginning of the production period and conclude that low level of 0.15% NPP (180 mg/b/d) in the diets enables reasonable production performance but decrease the live weight, during 28 to 44 weeks of age and that higher amount are needed for improve bone mineralization. Same authors, (2005a) in different article reported the results obtained by adding phytase to the low NPP diets (1.2 and 1.8gNPP/kg). Addition of phytase to 1.2gNPP/kg diet significantly enhanced the body weight and equals groups fed diets containing 1.8-3.0gNPP/kg feed. Adding phytase to diets with NPP levels beyond 1.8 g/kg revealed no additional advantage in hen day egg production, food intake, food efficiency, shell weight, shell thickness and shell strength while egg weight, specific gravity and Haugh units were not influenced by phytase supplementation. In the trial of Koelkebeck and Boling, (2009), supplement feed with enzyme phytase resulted in substantially improved egg production. Comparative analyze of the production results in advance aged Hy-Line White-36 layers (60-72 week of age) fed diets with phytase in comparison with the group fed conventional diet was performed by Zaghari et al (2008). They found no significant difference in egg production, egg shell thickness and breaking strength. Their final conclusion was that phytase improves P utilization in older hens. Mohammed et all (2010), in their article report improvement in production (egg number) of Hy-Line White-36 hens fed diets containing rice bran and supplemented with phytase. They find better feed conversion and shell thickness but lower egg size in the groups fed phytase supplemented diets. In the experiment of Yildiz et al (2010), layers at age 22-42 weeks were fed basic diets (16% CP, 2800kcal/ME/kg and 13.86mg/kg^{-1} Mn) supplemented with three different levels of Mn (0, 35and 70mg kg^{-1}) and phytase (0, 100 and 500U). No significant differences were find in body weight, egg production, egg weight, feed conversion ratio and egg quality characteristics. This experiment was conducted to follow the production data of two flocks of layers, fed diets with or without added phytase, where diets lower in NPP were supplemented with phytase, through the whole production cycle. R. Macedonia is in the region where high summer

temperature causes problems in the shell thickness especially in the flock of advanced age, therefore phytase could be a possible solution for improvement of the shell quality.

Material and methods

Two farm houses (trail and control) were housed with ISA Brown pullets fed isoprotein and isocalloric diets with (Added Phytase - AP, trial or F+) or without (No Phytase- NP, control or F-) added exogenous phytase enzyme. Total and available phosphorus phase feeding level (Phase0 – F0, >28; Phase1- F1, 28-50 and phase2-F2, >50 weeks of age) was calculated in the diets formula according the recommended nutrient requirements (table 1). Lower level (on average 0.5%) of Non Phytate Phosphorus (NPP) sourced from Mono-Calcium-Phosphate (MCP), and exogenous phytase (Ronozyme P 5000) supplementation at level of 0.01%, was used in the trial group. In-house environmental and management conditions were similar for both groups of layers. Egg production results and egg quality parameters were compared in trial and control group. Egg quality analyzes were performed in the laboratory for egg marketing quality control at the Institute for animal biotechnology of the Faculty of agricultural science and food, using Egg Multi Tester EMT 5200 and Eggshell Gauge (Robotmation Co. Ltd., Tokyo, Japan). This equipment offers unbiased, computerized measure of the physical characteristics of eggs (weight, yolk color, Hough Units) and eggshell (egg breaking strength). Statistic analyses on results were performed by computer program STATISTICA module ANOVA and Fisher's LSD test to determine the level of statistical significant difference between the groups for the parameters of interest.

Table 1. Diet formulas used in the trial

	NP Diet F0 -	AP Diet F0 +	NP Diet F1 -	AP Diet F1 +	NP Diet F2 -	AP Diet F2 +
Ingredient	%	%	%	%	%	%
Corn	42.76	43.65	44.49	45.70	44.58	45.49
Barley	5.00	5.00	9.20	9.20	10.00	10.00
Soya been meal	30.42	30.25	24.43	23.97	23.75	23.58
Rape seed meal	4.00	4.00	4.80	4.80	5.00	5.00
Vegetable oil	5.81	5.51	5.20	4.84	4.28	3.97
Limestone	9.56	9.56	9.56	9.63	10.20	10.25
Salt	0.26	0.26	0.27	0.27	0.22	0.22
Sodium bicarbonate	0.21	0.21	0.17	0.17	0.29	0.29
MCP	1.50	1.03	1.20	0.73	1.04	0.56
DL-Methionine 98%	0.10	0.10	0.13	0.13	0.10	0.10
Enzyme – Ronensime phytase 5000 (+ or -)	0.00	0.01	0.00	0.01	0.00	0.01
Betaine – Methionine	0.05	0.05	0.02	0.02	0.03	0.02
Cholin – Chloride	0.08	0.08	0.03	0.03	0.01	0.01
Vit.-Min. premix	0.50	0.50	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00	100.00	100.00
ME KCal / kg	2740.00	2740.00	2750.00	2740.00	2700.00	2690.00
Dry matter	89.00	89.00	88.80	88.80	88.70	88.70

Humidity	11.00	11.00	11.20	11.20	11.30	11.30
Crude ash	13.87	13.44	13.51	13.07	14.00	13.58
Crude fat	7.48	7.20	6.94	6.60	6.04	5.76
Crude proteins	17.95	17.96	16.27	16.17	16.14	16.15
Crude fiber	4.20	4.22	4.18	4.19	4.21	4.23
Lysine	0.96	0.96	0.85	0.85	0.83	0.83
Methionine	0.44	0.44	0.39	0.39	0.39	0.39
Met + Cystine	0.75	0.75	0.68	0.68	0.68	0.68
Ca	3.80	3.80	3.80	3.80	4.00	4.00
P (total)	0.67	0.57	0.60	0.50	0.57	0.47
P available	0.39	0.30	0.33	0.25	0.30	0.21
P Phytase liberated	0.00	0.09	0.00	0.08	0.00	0.09
P avail + P Phytase liber	0.39	0.39	0.33	0.33	0.30	0.30
P organic	0.03	0.02	0.03	0.02	0.02	0.02

Diet F0 +, F1 + and F2 + = diets supplemented with Phytase & F0 -, F1 - and F2 - = diets without Phytase

Results and discussion

Two flocks performed quite similar in terms of daily laying percentage (81.02% vs 80.83%) proving that different diets have no significant effect on production performances (Figure 1). These findings are in-line with the previously published results (Ciftci et al, 2005; Liebert et al, 2005, Yildiz et al, 2010). Number of egg produced per hen housed was almost similar (297.96 vs 297.99) as well as the feed consumption (table 2).

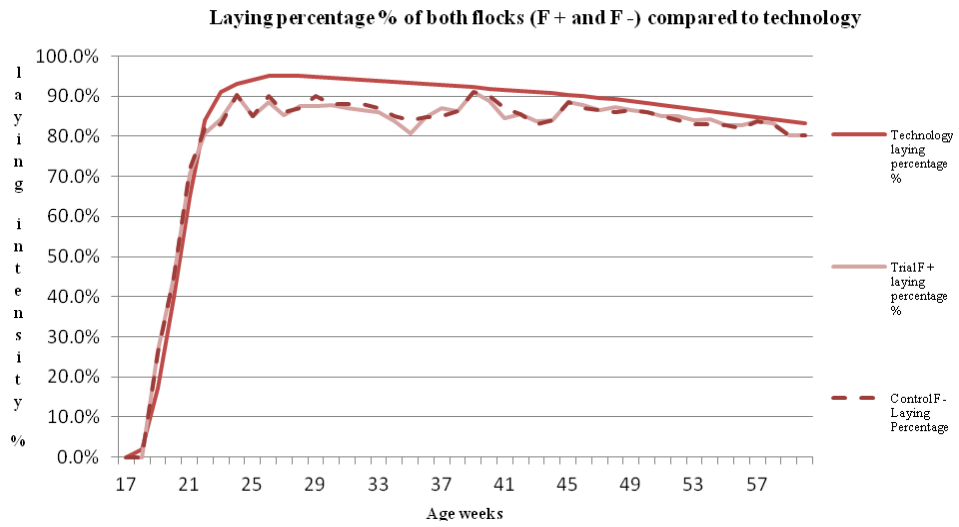


Figure 1. Egg production curves for both flocks

Table 2. Production parameters of two flocks

Production parameters	Control farmhouse F -	Phytase supplemented feed farmhouse F +
Feed consumption/hen housed	41.99	41.66
Number of egg produced/hen housed	297.96	297.99
Average production %	81.02	80.83

Egg quality parameters were not significantly influenced by different diets. Average egg size was 61.38g for NP (F-) group, while hens fed phytase supplemented F+ (AP) diet group, produced slightly smaller eggs (60.96g). This non significant difference in egg size was noticed through all feeding phases (F0, F1 and F2) and is comparable with the result published by Zaghari et al (2008). Shell strength of the two groups of layers at all three feeding phases were on average 3988.40 and 3871.13, 3861.68 and 3756.36, 3946.80 and 4041.60 for the first (>28 weeks of age), second (age 28-50 weeks), and third phase of production (>50 weeks of age) for both groups (without added phytase – NP and with added phytase – AP), respectively (table 3).

Table 3. Egg quality parameters

	Shell strength g/cm^2		Egg weight (g)		Yolk color (Roche 1-15)		Hough Units	
	Means	STD	Means	STD	Means	STD	Means	STD
Added Phytase First phase AP F0 +	3871.13	840.99	59.26	6.81	9.55	1.15	67.52	8.93
Added Phytase Second phase AP F1 +	3756.36	1028.88	62.44	8.53	8.94	0.70	74.46	7.68
Added Phytase Third phase AP F2 +	4041.60	692.78	61.16	7.91	9.25	0.47	69.68	7.32
No Phytase First phase NP F0 -	3988.40	892.23	59.82	8.70	10.79	1.21	64.03	7.90
No Phytase Second phase NP F1 -	3861.68	992.57	62.77	9.15	9.69	1.37	72.50	7.70
No Phytase Third phase NP F2 -	3946.80	832.66	61.78	3.00	11.99	0.65	64.50	6.17
Average for AP or F +	3851.05	897.19	60.96	7.78	9.23	0.91	70.88	8.63
Average for NP or F -	3928.67	913.13	61.38	8.25	10.53	1.45	67.64	8.52
Average for both groups	3890.52	902.30	61.17	7.99	9.89	1.38	69.23	8.69

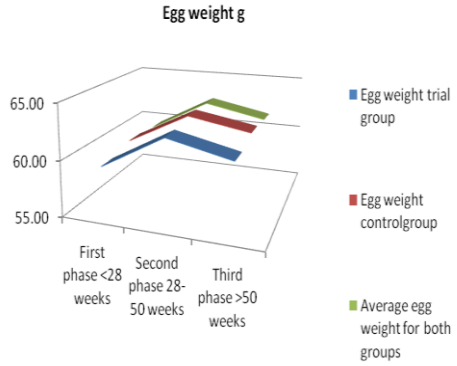


Figure 2. Egg weight data

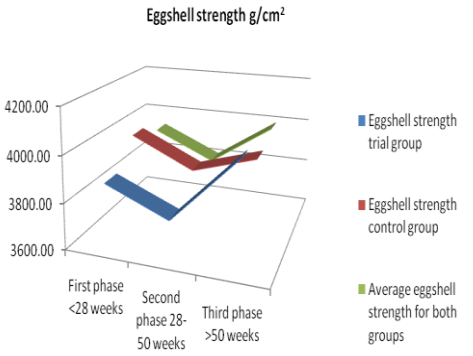


Figure 3. Eggshell strength data

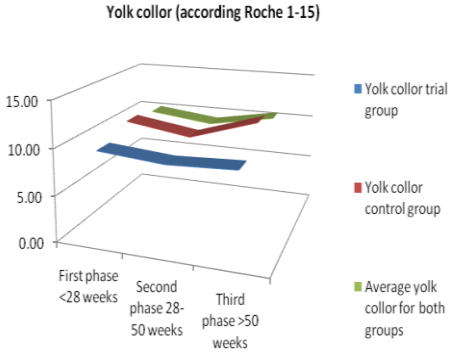


Figure 4. Eggs yolk color data

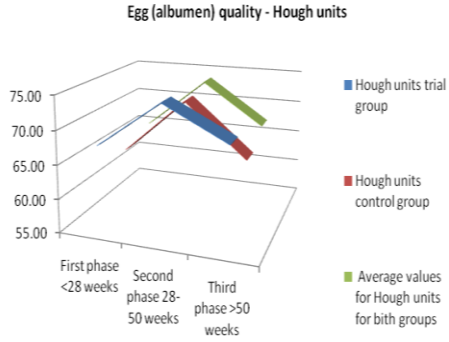


Figure 5. Egg albumen quality (Hough units) data

Our results for LSD test of the egg quality parameters, revealed no significant difference between F - and F + groups in egg weight (table 4) and shell strength (table 5) that is inline with the published results of Panda et al (2005a). Significant difference in the comparison between groups for the yolk color, presented in table 6, are hardly atributable to the effect of phytase but is probably effect of the added coloring agents in the vitamin mineral premix, at the stage of mixing the feed in the feed plant. LSD test of Hough units revealed significantly lower values at the feeding phase 1 (F1) in both diet groups compared to the other feeding phases (F0 and F2). This is most probably due to the seazonal effect (high summer temperatures) that coincidence with this feeding phase. Small, negative but non significant correlations were noticed between egg weight and egg shell strength (r=-0.090524).

Table 4. Egg weight LSD test between the groups

LSD Test; Variable: EGG_WEIG (fitaza.sta)						
Marked differences are significant at p < .05000						
	M=59.256	M=62.436	M=61.160	M=59.824	M=62.772	M=61.780
AP F0		0.174	0.533	0.807	0.133	0.409
AP F1			0.672	0.253	0.883	0.828
AP F2				0.658	0.593	0.863
NP F0					0.197	0.517
NP F1						0.742
NP F2						

Table 5. Eggshell strength LSD test between the groups

LSD Test; Variable: SHELLSTR (fitaza.sta)						
Marked differences are significant at p < .05000						
	M=3871.1	M=3756.4	M=4041.6	M=3988.4	M=3861.7	M=3946.8
AP F0		0.666	0.625	0.659	0.972	0.828
AP F1			0.408	0.373	0.686	0.580
AP F2				0.877	0.601	0.818
NP F0					0.626	0.904
NP F1						0.805
NP F2						

Table 6. Yolk color LSD test between the groups

LSD Test; Variable: YOLK_COL (fitaza.sta)						
*Marked differences are significant at p < .05000						
	M= 9.5522	M= 8.9360	M= 9.2500	M= 10.792	M= 9.6920	M= 11.990
AP F0		0.048*	0.455	0.000*	0.650	0.000*
AP F1			0.432	0.000*	0.013*	0.000*
AP F2				0.000*	0.270	0.000*
NP F0					0.000*	0.003*
NP F1						0.000*
NP F2						

Table 7. Hough Units LSD test between the groups

LSD Test; Variable: HOUGH_UN (fitaza.sta)						
*Marked differences are significant at p < .05000						
	M=67.522	M=74.456	M=69.680	M=64.026	M=72.500	M=64.500
AP F0		0.003*	0.470	0.126	0.030*	0.312
AP F1			0.107	0.000*	0.381	0.001*
AP F2				0.057	0.340	0.143
NP F0					0.000*	0.872
NP F1						0.008*
NP F2						

Conclusions

Feeding layers with lower level of NPP has no detrimental effects on egg production and egg quality parameters if the diet is supplemented with exogenous phytase enzyme. Supplementation of phytase enables the hens to use P from the grains therefore allows decreased NPP (inorganic sources of P, in this case MCP) levels for at least 0.5%. Additional effect of such feeding technology approach is reduced feed costs due to lower production costs but also due to lower feed consumption or better feed conversion.

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ПРОИЗВОДСТВО НА ЈАЈЦА И КВАЛИТЕТ НА ЈАЈЦА ОД НЕСИЛКИ ХРАНЕТИ ПРИ ДИЕТА СО И БЕЗ ДОДАДЕНА ФИТАЗА

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Апстракт

Балансирање на хранителните материи (посебно Са и Р како есенцијални макро минерали одговорни за високата продукција на јајца и квалитетот на лушпата кај несилките), во смеските за несилки селекционирани на мала жива маса, но голема маса на произведените јајца, е уметност. Производните резултати во текот на целиот циклус (број на јајца, интензитет на несивост, консумација на храна) и параметрите за квалитетот на јајцата (големина на јајцата, цврстина на лушпата, боја на жолтокот и Hough-ови единици) беа споредувани кај две групи на ISA Brown несилки без додавање (НП) или со додавање (АП) ензим фитаза на ниво д 0.01%. Смеската на опитната група со додадена фитаза, содржеше намалено количество (во просек 0.5%) од суровината Моно Калциум Фосфат (МКФ) како извор на НеФитински Фосфор (НФФ). Не беа забележани сигнификантни разлики во интензитетот на несивост (81.02% vs 80.83%) и бројот на произведени јајца по вселена несилка (297.96 vs 297.99). Анализите покажаа несигнификантни разлики помеѓу групите во големината на јајцата и цврстината на лушпата (60.96g vs 61.38g; 3851.05 vs 3928.67 g/cm^2). Слаба сигнификантна разлика, која не може да се припише на додавањето на фитаза, во бојата на жолтокот (9.23 vs 10.53) и Hough-овите единици (70.88 vs 67.64) е монитирана кај опитната и контролната група респективно. Кореалциите помеѓу големината на јајцата и цврстината на лушпата беа несигнификантни. Модификацијата на составот на смеската преку намалување на НФФ и додавање на фитаза е вреден пристап кој ги намалува трошоците за исхрана без да влијае на бројот, големината и квалитетот на произведените јајца.

Клучни зборови: живина, исхрана, фософор, фитаза, јајцепроизводство, квалитет на јајце.

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COMPARING PRODUCTION DATA OF LAYERS UNDER COVENTIONAL AND RESTRICTIVE FEEDING PROGRAM

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Abstract
Experiment was conducted to compare *ad libitum* feeding and quantitative feed restriction technique applied on egg producing ISA Brown layers. Pullets of same age were placed in two farm houses under similar environmental conditions and fed *ad libitum* until the age of 40 weeks. One of the flocks was put under gradual decline of daily feed allowance (controlled quantity of daily feed consumed), starting from 40 weeks of age onward, while the other flock remain on the usual *ad libitum* feeding technique. Both flocks were kept until the end of the exploitation period (80 weeks of age). Nutrient composition of the feed was defined according the recommended requirements and age of the layers. Records of the production (number and size of the eggs), mortality, feed consumption, feed conversion and egg quality parameters were collected during the experiment. Feed consumption of layers under restrictive feeding program was 41.85kg and of the full fed ones 42,87kg of feed (based on the hen housed number). This means 1kg of saving in terms of feed or roughly 0.3EUR/bird/cycle. Expressed in terms of standard 100 000 layer farm it is 30000EUR/cycle. Daily feed consumption was 113.12g of daily feed consumption for the trial flock and 117.39g in control group of layers. Laying percentage was not significantly different in control and trial flock (81.59 vs 80.55%). Feed conversion rate was 2.355 vs 2.299 kg feed/kg egg mass or expressed per egg 143.87g vs 140.44g feed/egg in the control (*ad libitum*) and restrictive feeding group, respectively. Egg size was same for both groups (61.08g vs 61.08g egg size). No differences were noticed in the egg quality parameters (Hough Units, eggshell strength, yolk color) between both groups. Restrictive feeding applied on layers at age of 40 weeks lead to lower feed consumption, lower production costs and has no negative effect on the egg production (egg number, size and quality).
Key words: poultry, restrictive feeding, egg production, egg quality.

Introduction

Modern layers are genetically sized toward smaller body weight but higher egg mass produced under optimal management and feeding conditions. Feed consumption is affected

by feed quality, temperature, age and level of egg production and many other variables. But it is interrelated and bird driven only if full-fed programs are applied. Even if there are thoughts that some restriction could be applied in order to control the level of daily feed consumption by the manager, additional efforts in this direction is lacking. It is due to need of additional investments in equipment, know how e.t.c. but there are also easily managed approaches that does not need many extra efforts and still offered some gain in terms of profitability. Poultry breeders know well that broiler breeders are subjected to restrictive feeding program that, if properly applied, does not influence the production and on the contrary influence the efficiency thus profitability. Overconsumption of feed under the full-feeding protocols always results in a excessive body fat buildup even in a layer genotypes negatively influencing feed conversion rates without benefit for the egg producers. Today's high feed price makes such restrictive feeding techniques actual to be applied in egg producing farms. Restrictions of 12 to13% in feed quantity were suggested by Swanson and Johnston (1975). They claim that this is possible at early age before peak of production, without negative effects on egg production records and with substantial economic savings. Kuney and Swanson (1979) reported possibilities for applying restriction at later stage (after 40 weeks of age) but they mentioned the importance that this restriction should be introduced gradually to reduce the stress of restriction.

The effect of restrictions on the levels of 11% and 8% during the first laying cycle and 12% and 10% during the second cycle were analyzed by Kuney and Enos (1980) in comparison with *ad libitum*-fed layers. In their reports restrictive feeding programs significantly improved feed efficiency escorted with non significant depressions laying rate and increased shell thickness. Quantitatively restriction (feeding 105 g/bird/day) initiated at different stages of production on performance and economic returns of White Leghorn layers were analyzed by Cunningham and Polte (1984). Conclusions were that that early feed restriction resulted in reduced egg production and size while restriction started at age of 38 and 45 weeks lead to egg production comparable to the *ad libitum* fed hens and lower feed costs.

In the conducted experiments Cunningham (1984) concluded that if start of restriction is at age of 36 weeks and is not severe, but rather offers 105g/bird/day, production results are comparable full feeding program offering less fed usage and improved profitability, demonstrating that maximum production levels do not always mean maximum returns.

Feed restriction programs applied in the experiments of Miles and Jacqueline (2000), resulted in slight decrease egg size, but support the theory that feed restrictions should be applied at later stages of production when majority of the eggs being produced fall into the large size category.

Material and methods

Basic idea of the trial lies in, maybe, the forgotten technology of restrictive feeding of layers where total input of feed (as un approach for reducing the costs of production) is reduced and as a consequence lower feed costs are made, but production results are maintained at the satisfactory level. Such approach logically leads to reduced feed inputs, lower levels of manure produced, but having in mind the genetically high egg producing predisposition of the modern laying genotypes, keeping the production records on restrictive amount of daily feed allowances is a challenge. Such restriction feeding

techniques are usual for broiler breeders and are seldom practiced on layer stocks. According the published records, there are different opinions about the age of the layers when this feed restriction should start and all of them have positive and negative sides.

The age of 40 weeks is the age when the birds gave most of their genetic potential of egg production in terms of reaching high peak (92-3-4% intensity of egg production at age of 28-30 weeks) and also sufficiently long period (10-12 weeks) of producing over 90%. At this age birds start to have a tendency of producing oversized eggs (and this happened especially at the latest stages of production when their body size reaches maximum – leading to maximal daily consumptions, lower intensity of egg production, but high daily egg mass output due to the size of the eggs) under *ad libitum* feeding technique. This period of egg production usually compensate for the smaller egg size at the beginning of the laying period therefore contributing to the average feed to egg mass conversion rate figures. Unfortunately these oversized eggs are very often escorted with poor shell quality leading to breakage, leakage and distribution problems, thus, failing compensate with extraordinary profit from premium price. Since egg number and size are partly genetically determined characteristic, it could be modified through feed management techniques. Usual approach of keeping the size of the eggs at these latter stages of production at desired level is through lowering the feed density but then it rises up the feed conversion ration and in terms of money it is a game of costs vs returns.

Based on all previously mentioned assumptions, comparative trial with two flocks of ISA Brown pullets that were housed in two farm houses at age of 16 weeks 16818 pullets in control farm house and 17587 in the trial farm house) is conducted.

Birds were fed formulas based on the recommended nutrient levels (table 1) and managed (lighting) appropriate to the age and weight, following the management manuals. The only difference was restrictive feeding program applied to the trial flock after the age of 40 weeks. Basically, daily feed allowances were recalculated, and defined amount of feed was delivered to the layers after the age of 40 weeks. This means that two flocks were kept under same condition (*ad libitum* feeding technique) at the beginning of laying period till age of 40 weeks. After this age the trial farm house flock was subjected to gradual feed restrictions through limited daily feed consumption. Control of the daily allowance of feed (Diet F1-up to 50 weeks of age and F2 – >50weeks) was performed calculating the final desired feed consumed (Table 2).

The technology of restrictive feeding applied in the trial suppose gradual introducing of 115g daily feed allowance per bird in the period of 14 days after the age of 40 weeks, than slowly reducing it to 11-112g/bird/day. These amounts are only calculative figures and the exact amounts were calculated on the spot before the beginning of the trail feeding program depending on the history of feed spent / bird housed up to the age of 40 weeks (this should be on the level of 17.5kg/bird housed). Beside this basic assumption for the calculation of the daily feed allowance for the period after week 40, lies in the feed consumption goal of reaching 48kg feed/ bird housed at age of 80 weeks.

Table 1. Nutrient composition of different diets (phase feeding) used in the experiment

	Diet F0	Diet F1	Diet F2
Ingredient	%	%	%
Corn	43.00	44.55	44.07
Barley	5.00	9.00	11.00
Soya been meal	34.15	29.61	28.65
Vegetable oil	5.70	5.00	4.00
Limestone	9.50	9.53	10.00
Salt	0.25	0.28	0.24
Sodium bicarbonate	0.22	0.17	0.29
MCP	1.46	1.21	1.11
DL-Methionine 98%	0.10	0.10	0.10
Betaine – Methionine	0.04	0.02	0.03
Cholin – Chloride	0.08	0.03	0.01
Vit.-Min. premix	0.50	0.50	0.50
Total	100.00	100.00	100.00
ME KCal / kg	2750.00	2750.00	2720.00
Dry matter	88.90	88.90	88.80
Humidity	11.10	11.10	11.20
Crude ash	13.55	13.50	13.89
Crude fat	7.48	7.01	6.01
Crude proteins	17.99	16.45	16.01
Crude fiber	4.10	4.10	4.20
Lysine	0.95	0.85	0.83
Methionine	0.45	0.40	0.39
Met + Cystine	0.75	0.67	0.67
Ca	3.77	3.81	3.98
P (total)	0.68	0.61	0.60
P available	0.40	0.35	0.33

Based on all previously mentioned assumption and figures, definite quantity of feed to be spent in the period after 40 weeks is calculated and daily feed allowance derivates out of this total figure, as it is presented in the table below (table 2). If the feed spent by the week 40 is higher than 17.4kg stated in table 2, then the amount that should be delivered to the birds after this age should be proportionally decreased.

Actual goal was to have same production % (laying intensity) in both farm houses (control and trial) keeping the size of the eggs at the same level that in overall will lead to better feed/egg mass conversion ration in favour of trial group. Egg production and egg quality parameters were analyzed to compare control feeding technique with *ad libitum* feeding technique.

Table 2. Example for calculation of the restrictive (control) feeding technique

Number of hen housed	18 000		
Age (period)	>40 weeks	40-80 weeks	18-80 weeks
Total feed consumption for the period (kg)	17.4	30.6	48
Daily consumption (g)	112.9	109.3	111
Total quantity of feed needed (kg)	313 200	550 800	864 000
Weekly quantity of feed needed (kg)	14 236	13 770	13 936
Daily quantity of feed needed (kg)	2 034	1 968	1 990
Mortality up to 40 weeks (3%)	540		
Number of remained hens at age 40 weeks		17 460	
Daily feed consumption (g)		(1968 / 17460) = 112.7	

Results and discussion

Both group of layers performed quite well and close to the technological levels presented in the ISA BROWN manuals (graph 1) during the period of investigation (409 days). In general no significant differences were noticed in comparison of the production parameters in the control (*ad libitum*) and restrictive feeding group. Average laying percentage was 81.59 for the control and 80.55% for the trial group of layers (table 3) and only high mortality rates (graph 2) during the extremely hot summer days were noticed as a problem, but affects both flocks. It could be noticed that rate of mortality was even slightly lower in the trial than in the control group probably due to lower body weight and less body fats.

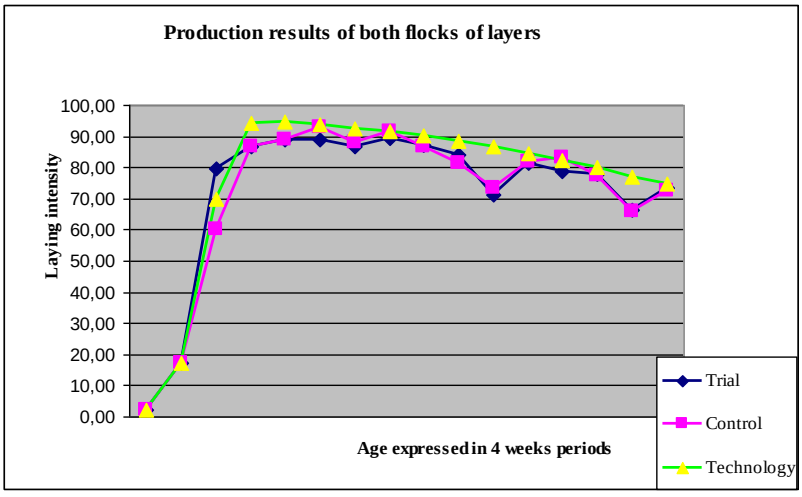


Figure 1. Egg production curves for both flocks

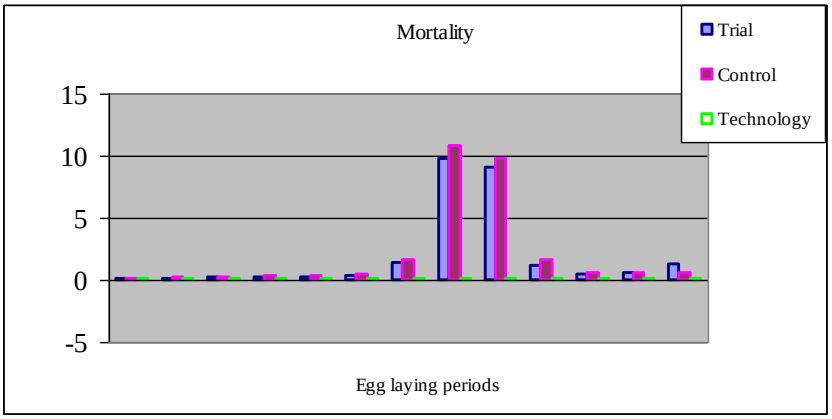


Figure 2. Mortality rates for both flocks

As could be noticed from the records of production for both flocks (table 3), full feeding has no advantage over restrictive (controlled amount of daily feed allowance) feeding technique in terms of production data. Number of eggs and kilograms of egg mass produced per hen housed are equal. Careful monitoring of production results revealed that control feeding techniques has some advantages over full feeding approach.

Feed spent per average hen and hen housed in the control (*ad libitum* fed) group is higher compared to the trial group of hens and this is directly attributable to the applied restrictive feeding technique. What is the most important this higher amount of feed consumed did not reflect the number of eggs produced because it was same in the control and trial flock.

Feed conversion is also one of the crucial production parameters. Expressed in terms if feed conversion rate trial group was superior to control one (2.299 vs 2.355) resulting in less feed per egg spent, therefore lower cost price of the eggs. Figures for amount of feed spent per produced egg are in favour of trial group. Namely, control flock spent 143.87g feed per produced egg, that is more than the feed spent per egg produced in the trial group (140.44g) meaning that the trial group spent 3.4g less feed compared to the hens of control group. These fact leads to better financial results of the layer farm activity if restrictive feeding technique is applied.

Size of the eggs produced influences all important productivity and profitability parameters. Number of egg and size of the produced eggs in the control and trial flock are presented in the table 4 below. These egg size records, followed in both groups, revealed that actually no difference in the average egg size were found between both groups (61.08g vs 61.08g). Only notification for the egg size is that 0.5% less L sized eggs, 0.7% more M sized eggs and 0.1% less S sized eggs were produced in the trial group similar like in the experiment of Miles and Jacqueline (2000). Additionally, less dirty and broken eggs were monitored in this group. No significant differences were monitored in the egg quality parameters presented in the table 5.

Lower feed consumption can be realized through proper and sound management of feed quantity on a daily basis. Feed consumption records presented in table 3 the showed that layers under restrictive feeding program consumed 41.85kg and the full fed ones 42,87kg of feed (based on the hen housed number). This means 1kg of saving in terms of feed or

roughly 0.3EUR/bird/cycle. Expressed in terms of standard 100 000 layer farm it is 30000EUR/cycle. This is a final result of lower daily feed consumption. These figures in our experiment were 113.12g of daily feed consumption for the trial flock and 117.39g in control group of layers.

Results from our study (comparable results between restricted and full feeding programs) resemble the results reported in the study of Cunningham and Polte, 1984 where restriction was started at age between 38 and 45 weeks. In their study just like in our case trial (restrictive fed hens) group consumed smaller quantity of feed and produced smaller (non significantly) egg size due to production of higher number of medium sized eggs.

Table 3. Production parameters of two flocks

Production parameters	Control flock	Trial flock
Avrage number of layers in the trial period	15016	15986
Total Quantity of feed consumed	720950kg	735990 kg
Quantity of feed spent / average number of layers	48kg	46.01 kg
Quantity of feed spent / housed number of layers	42.87	41.85
Average daily feed consumption (g)	117.39	113.12
Number of eggs / average hen	333.70	327.83
Number of eggs / hen housed	301.66	300.89
Kg eggmass / average hen	20.38	20.03
Kg eggmass / hen housed	18.20	18.20
Feed conversion - kg feed / kg egg mass	2.355	2.299
Average egg weight (g)	61.08	61.08
Average laying intensity %	81.59	80.55
Feed spent (g) / egg	143.87	140.44

Table 4. Number and size of the produced eggs

Egg size	Number of eggs		%	
	Control flock	Trial flock	Control flock	Trial flock
XL	232240	243180	4,63%	4,64%
L	2312770	2396630	46,15%	45,73%
M	1748290	1865770	34,89%	35,60%
S	144720	145800	2,89%	2,78%
DIRTY	497670	516600	9,93%	9,86%
BROKEN	75350	72720	1,50%	1,39%
TOTAL	5011040	5240700	100.00%	100.00%

Table 5. Egg quality parameters

Egg quality	Control flock	Trial flock
Average eggshell strength value	3897.00	3835.00
Average yolk color value (according LaRoche)	8.9	10.40
Average Hough Units value	71.80	71.20
Average weight of the analyzed eggs	60.20	60.15

Our data confirms that gradually applied restrictive feeding programs reduce the drop of production due to the stress at point of starting with changed (restrictive) feeding program and were in agreement with the findings of Kuney and Swanson 1979, even that in their experiment time limited approach in restriction was applied.

Recorded data in our trial confirms that restrictive feeding technique is appropriate management tool for situations when high feed price exist. Lower feed consumption, lower production costs, less environmental pollution without affecting the productivity parameters are the outcomes of applying this feeding technique. Equal number of eggs and equal average egg size (61.08) in both groups both groups support this fact.

Conclusions

Production parameters are not affected in the layer flock subjected to restrictive feeding program after the age of 40 weeks, if the restrictions are reasonable, sound and gradually applied. Restrictive feeding technique is efficient tool for improving the efficiency of egg production in terms of feed conversion ratio, thus leading to lower feed costs and improved profitability, especially in the upcoming periods of high world market grain, ingredients and feed prices. It should be considered every time when egg producers are facing high feed prices because it helps maintaining the profitability of the industry to desired level. Based on obtained results of this trial, such feeding technique is approved to be used after 40 weeks of age in layers.

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СПОРЕДБА НА ПРОИЗВОДНИТЕ РЕЗУЛТАТИ КАЈ НЕСИЛКИ ПРИ КОНВЕНЦИОНАЛНА И РЕСТРИКТИВНА ИСХРАНА

Срећко Георгиевски, Драгослав Коцевски, Владимир Џабирски, Ѓоко Буневски, Владо Вукович, Кочо Порчу, Николова Недељка, Сашко Арсов, Горан Тасев

Апстракт

Експеримент е организиран за да се спореди *ad libitum* техниката и техниката на квантитативна рестриктивна исхрана применета на јајценосните ISA Brown несилки. Јарки на иста возраст се сместени во два објекта во слични услови на одгледување и хранети *ad libitum* до возраст од 40 недели. Едното јато е ставено на постепено намалување на дневната дажба (контролирано количество на дневно консумираната храна) по навршување на 40 недели возраст, додека другото јато е оставено на вообичаената *ad libitum* технологија на исхрана. Обете јата се одгледувани на овој начин се до крајот на експлоатациониот период (80 неделна возраст). Нутитивниот состав на смеските е дефиниран во согласност со препорачаните потреби и возраста на несилките. Записи за производството (број и големина на јајца), морталитет, консумација на храна, конверзија на храна и параметрите за квалитетот на јајцата се собирани за време на експериментот. Консумацијата на храна на несилките каде е применета рестриктивна исхрана изнесуваше 41.85kg а кај оние кои беа хранети по волја 42,87kg храна (изразено врз база на бројот на вселени несилки). Ова значи 1kg заштеда во храна или околу 0.3EUR/птица/циклус. Изразено во термини на стандардна фарма со големина од 100000 несилки истото изнесува 30000EUR/циклус. Дневната консумација изнесуваше 113.12g за опитната и 117.39g за контролната група на несилки. Интензитетот на несивост не се разликуваше сигнификантно во контролното и опитното јато (81.59 vs 80.55%). Конверзијата на храната беше 2.355 vs 2.299 kg храна/kg јајчена маса или изразено по произведено јајце 143.87g vs 140.44g храна/произведено јајце кај контролната (*ad libitum*) група и групата на која е применета рестриктивна исхрана, соответно. Не се забележани разлики во параметрите за квалитет на јајцето (Хофови единици, цврстината на лушпата, бојата на жолтокот) помеѓу групите. Рестриктивната исхрана применета на несилки на возраст од 40 недели резултираше со намалена консумација на храна, намалени производни трошоци без негативно да влијае на производните параметри (број, големина и квалитет на јајцата).

Клучни зборови: живина, рестриктивна исхрана, јајцепроизводство, квалитет на јајца.

UDC: 636.32/.38:575.22(497)
Early communication

POLYMORPHISMS IN OVINE αS_1-CASEIN GENE AMONG AUTOCHTHON STRAINS OF PRAMENKA BREED SHEEP IN BALKAN

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Abstract
Alfa s_1 casein represents the main milk protein fraction which has an important role in the transport calcium phosphate in milk . There are four alleles (A, B, C and D) present in the α_{s1}-casein gene. Polymorphisms were detected within ovine α_{s1}-casein gene using PCR – RFLP. One hundred seventeen DNA samples were isolated from 6 different strains of Pramenka sheep from different parts of the Balkan Peninsula: Karakachanka (Macedonia), Svrljiska (Serbia), Bardoka (Kosovo), Istarska (Croatia), Dubska (Bosnia and Herzegovina) and Pivska (Montenegro). Three distinct patterns (designated nonA/nonA, nonA/A and A/A) were observed. Allelic frequencies were 0.08/0.92 A/nonA. No polymorphisms were observed in Bardoka and Istarska strains and all animals carried the nonA/nonA genotype. The highest diversity, related to α_{s1}-casein gene, were in the Karakachanka strain where 7 animals had nonA/A genotype, while 2 carried genotype A/A.
Key words: sheep, Pramenka, α_{s1}casein, polymorphisms.

Introduction

α_{s1} casein, composed of 215 amino acids is the main milk protein fraction. It has an important role in the transport of calcium phosphate. There are four alleles (A, B, C and D) present in the α_{s1} casein gene. In domesticated ruminants α_{s1} casein is polymorphic and the variants are related to the milk yield and quality (1). The aim of this study was to determine the polymorphisms in ovine α_{s1} casein gene present six autochthonic strains of Pramenika breed on the Balkan Peninsula which is most economically important sheep breed in this region. Polymorphisms were detected using Polymerase Chain Reaction – Restriction Fragment Length Polymorphisms (PCR – RFLP) by digestion with Mbo II restriction enzyme (2).

Material and methods

One hundred seventeen DNA samples were taken from 6 different strains of Pramenka sheep breed from different parts of the Balkan Peninsula as follow: Karakachanka from Macedonia (20 samples), Svrljiska from Serbia (20 samples), Bardoka from Kosovo (19 samples), Istarska from Croatia (19 samples), Dubska from Bosnia and Herzegovina (20 samples) and Pivska from Montenegro (19 samples) (3). Genomic DNA was extracted from blood samples using the method reported by somebody (yr). Briefly, which include Proteinase K which proteolysis DNase causes cell lyses, phenol-chloroform purification from proteins and alcohol precipitation. The region of interest from ovine α_{s1} casein -casein gene where the polymorphisms occur was amplified.

The PCR reaction mixture for amplification of the part from the ovine α_{s1} casein - gene. Briefly, 25 µl containing: 200 ng of genomic DNA, 1x PCR reaction buffer, 2.5 mM $MgCl_2$, primers: α_{S1}-F GGTGTCAAATTTAGCTGTTAAA and αS_1-R GCCCTCTTCTCTAAAAAGGTTT in final concentration of 1 pM and 2 U of Taq DNA polymerase. The conditions for amplification were: 3 minutes 95^0C (hot start), and 35 cycles of: denaturation at 95^oC for 30 sec, annealing at 55^oC for 30 sec and amplification at 72^oC for 45 sec.

The final elongation was performed at 72^oC for 10 minutes. The amplified products were checked on 1.5 % agarose gel electrophoresis (AGE). The digestion of amplified DNA was performed using Mbo II restriction enzyme in a mixture with total volume of 25 µl which contained: 1x Restriction buffer, 15 µl of amplified DNA and 5 U of RE. Restriction fragments were analyzed by 3% agarose TBE gel electrophoresis.

Results and discussion

The amplified fragment of interest from alfaS1 gene was 372 bp in length. (Fig. 1). Three distinct patterns (nonA/nonA, nonA/A and A/A) were observed in the PCR-RFLP analysis of ovine αS_1-casein gene (Fig. 2). The nonA allele exhibited two fragments at 306 bp and 66 bp as expected based on known sequences (2). In addition to 66 bp fragment, the A allele created bands of 160-bp and 146 bp which slightly interfere between them. NGenotype frequencies of 117 sheep samples from 6 different strains of Pramenka sheep were 0.02 for A/A, 0.12 for nonA/A and 0.86 for nonA/nonA. Allele frequencies among estimated DNA samples were in ratio 0.08/0.92 A/nonA.

In the Bardoka and Istarska strains, no polymorphisms were observed and all animals were heterozygous for the nonA genotype. Only one animal exhibited a DNA sample with the nonA/A genotype among the Svrljsika and Dubska strains. The Pivska strain exhibited five nonA/A genotypes. The highest diversity in the αS_1-casein gene was present in the Karakachanka strain where 7 animals had nonA/A genotypes, while 2 carried the A/A genotype. These observations are partially consistent with the published data related to the genetic diversity among the reported strains of Pramenka breed determined by microsatellite and mitochondrial DNA analysis (3,4). It those studies it was reported that the Karakacanka strain formed a genetically divergent population and has a largest deviation in the frame of Pramenka breed based on DNA microsatellites analyses (3,4).

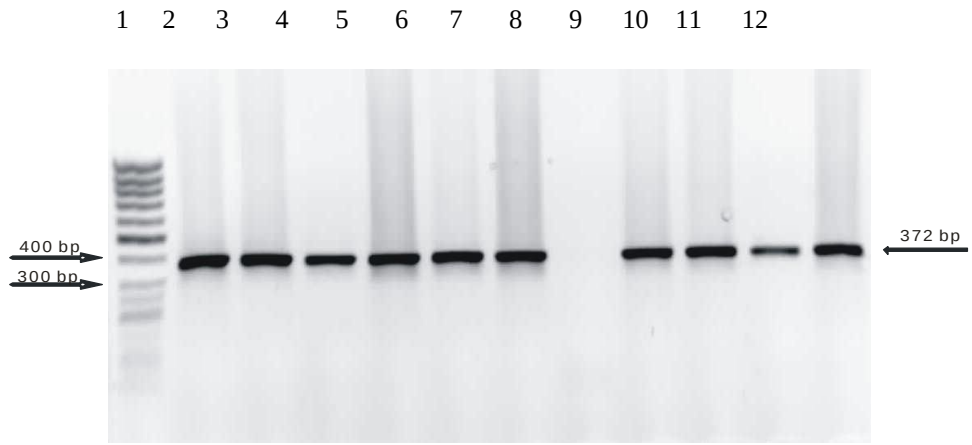


Figure 1. 1.5% AGE of PCR fragment (372 bp), line #1 – DNA ladder, lane #2-7 and 9-12 - samples; line #8 – negative control.

Three distinct patterns (nonA/nonA, nonA/A and A/A) were observed in the PCR-RFLP analysis of ovine αS_1-casein gene (Fig. 2).

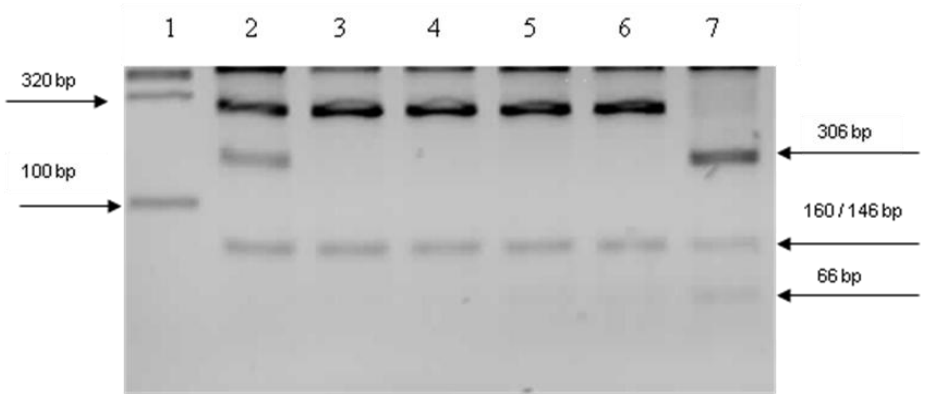


Figure 2. 3% AGE of *Mbo II* digested PCR products: line #1 – DNA ladder; line #2 - A/nonA, lines #3-6,– nonA/nonA; line #7- A/A.

Conclusions

The heterogeneity of Karakachanka strains in terms of DNA microsatellites, mitochondrial DNA and polymorphisms of αS1 casein gene compared to other strains of Pramenka sheep is likely due its geographical isolation and because it is a very small population it is subject to the effects of inbreeding.

Acknowledgement

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ПОЛИМОРФИЗАМ КАЈ ОВЧИОТ αS_1 КАЗЕИН ГЕН МЕЃУ АВТОХТОНИТЕ СОЕВИ НА ПРАМЕНКА ВО БАЛКАНОТ

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Апстракт

Алфа S 1 казеинот ја претставува најважната фракција од млечните протеини кој има улога во преносот на калциум фофатот во млекото. Досега се откриени 4 алели на генот за алфа S1 казеин. (A, B, C и D). Зполиморфизмите беа детектирани со PCR-RFLP. Сто и седумнаесет примероци на ДНК беа изолирани од 6 соеви на расата праменка од различни краишта на Балканскиот полуостров и тоаЧ Каракачанка (Македонија), Сврљишка (Србија), бардока (Косово), Истарска (Хрватска), Дубска (Босна и Херцеговина) и Пивска (Црна Гора). Три различни случаи се идентификувани и обележени како nonA/nonA, nonA/A и A/A. Алелната фреквенција изнесуваше 0.08/0.92 за A/nonA. Кај Истарскиот и бардока сојот не се откриени полиморфизми и сите животни се носители на генотипот nonA/nonA. Највисока диверзификација поврзана за генот за алфа S1 казеин е утврдена кај Каракачанскиот сој каде седум животни имаат nonA/A генотип, а 2 животни се носители на генотип A/A.

Клучни зборови: овци, праменка, алфа S1 казеин, полиморфизми.

UDC: 597.551.2-111.11:543-545.2
Early communication

ELECTROPHORETIC DETERMINATION OF FEMALE SPECIFIC PROTEIN IN KOI CARP AS A TOOL FOR GENDER IDENTIFICATION: TECHNIQUE COMPARISON

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Abstract
The development of plasma biomarkers has proven to be more challenging than initially anticipated. In the past, the identification of fish species was carried out mainly by examining the external morphological characteristics. Gender identification among fish species based on morphological features is very difficult and therefore the electrophoresis of plasma proteins can be used as a useful molecular tool. In this survey, native polyacrylamide gel electrophoresis (Native-PAGE) and sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) were applied to analyze plasma proteins of koi carp (*Cyprinus carpio haematopterus*). The electrophoregrams showed that using SDS-PAGE as a technique is possible to discriminate male from female samples based on the presence of female specific protein (FSP) which can be used as a suitable marker. The Native-PAGE is not showing differences between male and female plasma samples. In the electrophoregrams obtained from SDS-PAGE, the molecular weight of FSH is approximately 143 kD and it is in according with pervious findings from the studies of different fish species.
Key words: koi carp, seum proteins, female specific protein, PAGE.

Introduction

Different methods have been successfully developed and used to collect diverse types of information associated with proteins. This is especially the case for the identification and quantification of proteins in complex samples, such as plasma. Numerous studies have demonstrated the impact of proteomics on answering key biological questions; especially those that help us understand vital functions of a living system. (Surinova *et al.,* 2011). Plasma proteins are kind of mirror on the physiological status in the organism.

Mulcahy, (1967) described changes in the plasma proteins of salmon, which were correlated with infection by Ulcerative Dermal Necrosis (UDN). The plasma electrophoretic patterns in health and UDN, differed quantitatively in the relative amounts of protein in the major protein fractions, and qualitatively in the occurrence of new fractions in some of the diseased fish. It provides the basis for a diagnostic method of UDN outbreaks.

In the past, the identification of fish species was carried out mainly by examining the external morphological characteristics. Currently, electrophoresis of sarcoplasmic proteins, plasma proteins, liver proteins and a number of enzymes often have been used by some researchers as an aid in the species or gender identification of fish (Pinerio *et al.*, 2001).
Despite the fish being of commercial significance and an interesting specimen for academic studies as well, limited studies exist on aspects of physiological changes associated with reproductive cycle and gametogenesis. Kumar Lau *et al.*(1999) presented eletrophoretetic profile of plasma proteins at different stages of maturation and attempts to trace the presence of female specific protein or vitellogenin. This study intends to show that the plasma proteins of same fish species can show electrophoreticaly different pattern related to gender.

Material and methods

Twenty-one koi carp *(Cyprinus carpio haematopterus)*, with a mass between 190 and 1200 g, were obtained from an experimental fishery at the Graduate school of environmental sciences at Ohio State University, Columbus USA. The blood was taken from dorsal aorta of live individuals. The blood samples were centrifugated at 1500 rpm for 10 minutes to separate the plasma. The obtained plasma was used for electrophoretical analysis of proteins.
SDS-PAGE was performed according to Laemmli (1970) method. Plasma proteins were separated on 16 x 12 cm and a 1 mm thick gel. The gel consisted of 3% stacking part on which proteins were stocked and a 12.5% running part on which proteins were separated. Each plasma sample was mixed with a buffer composed of 10% glycerol, 2% mercaptoethanol, 2% SDS and 0.01 bromphenol blue. Protein concentrations were adjusted to 2 μg/μl and 20 μl of samples were loaded on the stacking gel. The electric power of 300 Volts was used until the line of brome phenol blue came to the lowest part of the gel. The duration of electrophoresis was around 3 hours. After the electrophoresis, the proteins were stained with 0.04% Commassie Brilliant Blue R-250 in 40% ethanol and 5% acetic acid, and then distained in 10% acetic acid. Middle range protein ladder from 29 – 205 kD was used as a standard during the electrophoresis.
Native PAGE was done using the procedure established by Efremov *et al.* (1981). Plasma proteins were analyzed on gel with the dimensions of 16 cm x 12 cm x 0.1 cm using 12% acrylamide in 6 M urea. Each plasma sample was mixed with a buffer composed of 20% sucrose, 10% mercaptoethanol, 10% acetic acid and 0.01 brome- phenol blue. Protein concentrations were adjusted to 2 μg/μl and 20 μl of samples were loaded on the stacking gel. During the electrophoresis the electric power of 300 Volts was used for 5 hours.. After the electrophoresis, the proteins were stained with 0.04% Commassie Brilliant Blue R-250 in 40% ethanol and 5% acetic acid, and then distained in 10% acetic acid. As a comparative samples were used plasma samples from bassfish, yellow perch and bovine plasma sample.

Results and discussion

In the Figure 1 and 2 are shown the electrophoregrams from SDS-PAGE and Native PAGE of fish plasma proteins.

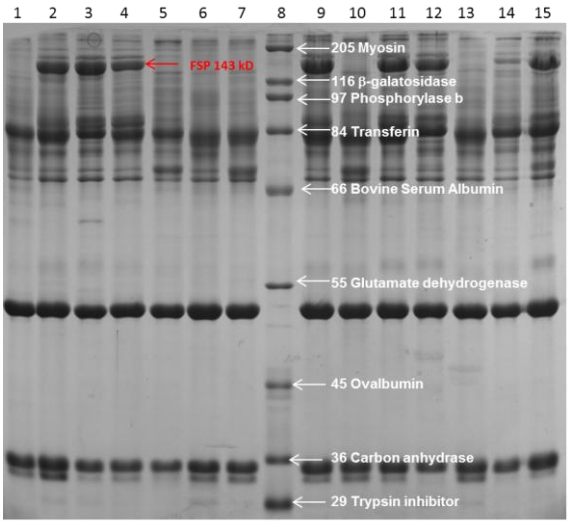


Figure 1. 12.5% SDS-PAGE on plasma proteins from 14 samples of koi carp. #1 male/827 g, #2 female /586 g, #3 female/697 g, #4 female/734 g, #5 male/502 g, , #6 male/294 g, #7 male/635 g, #8 Broad Range Standard (myosin 205 kD, galatosidase 116 kD, phosphorilase b 97 kD, transferrin 84 kD, bovine plasma albumin 66 kD, glutamate dehydrogenase 55 kD, ovalbumin 45 kD, carbon anhydrase 36 kD and trypsin inhibitor 29 kD) #9 female/663 g, #10 male/1200 g, #11 female/747 g, #12 female/750 g, #13 male/194 g, #14 male/325 g, and #15 female/287 g.

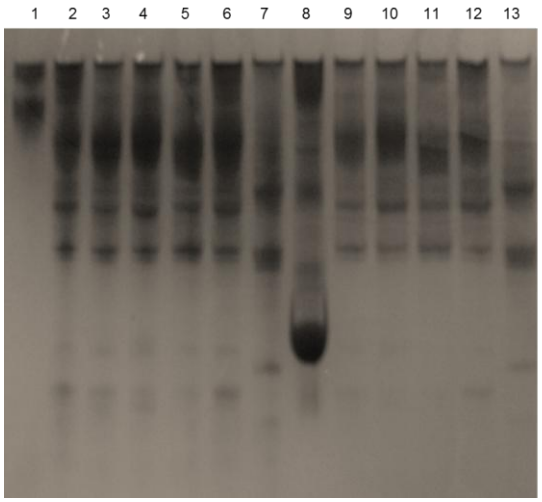


Figure 2. 12% Native-PAGE on plasma proteins from 14 samples. #1 bass fish, #2 female /586 g, #3 female/697 g, #4 female/734 g, #5 male/502 g, #6 male/294 g, #7 male/635 g, #8 bovine plasma proteins, #9 male/1200 g, #10 female/747 g, #11 female/750 g, #12 male/194 g, #13 yellow perch.

Electrophoretic plasma protein profile of female *Cyprinus carpio haematopterus* – koi carp obtained by SDS-PAGE reveals appearance of female specific protein. Previously it was characterized as 143 kDa female-specific glycolipoprotein (FSP) which is a calcium-binding protein (Komagata *et al*,. 1991). The protein is evidently absent in the plasma of males. There is an only one male sample (#14), where the FSP is slightly appearing. Native PAGE didn't show an appearance of FSP but it shows the differences between plasma protein samples from different fish species (Yilmaz *et al*, 2007). The electrophoregrams also showed the individual differences among the plasma samples, but they were not subject of interest of this study. Electrophoresis of plasma proteins have been widely used in the classification of fish. These kinds of studies brought about a new look to taxonomical evaluation. Discrimination of related taxa can be easily made according to their electrophoretic results of plasma proteins (Theophilus and Rao, 1998).

Conlusions

SDS-PAGE can be used as a techinique for gender determination of koi carp based on identification of the presence of female specific protein in plasma sample.

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ЕЛЕТРОФОРЕТСКА ДЕТЕРМИНАЦИЈА НА ЖЕНСКИ СПЕЦИФИЧЕН ПРОТЕИН КАЈ *KOI CARP* КАКО АЛАТКА ЗА ИДЕНТИФИКАЦИЈА НА ПОЛОТ: СПОРЕДБА НА ТЕХНИКА

З. Т. Поповски, Б. Р. Димитриевска, Е. Мискоска-Милевска, К. Порчу, К. Банџо

Апстракт

Со развојот на биомаркерите во плазма се докажува дека тие стануваат многу поинтересни отколку што се претпоставувало. Порано, идентификацијата на различните видови риби било воглавно базирано на анализирање на надворешните морфолошки карактеристики. Одредувањето на полот кај различни видови риби засновано на морфолошки особини е многу тешко и затоа електрофорезата на плазма протеините може да се користи како соодветна молекуларна алатка. Во оваа истражување, нативната полиакриламид гел електрофореза (Нативна ПАГЕ) и содиум-додецил-сулфат полиакриламид гел електрофорезата (СДС-ПАГЕ) беа користени за анализа на плазма протеините кај кои крапот (*Cyprinus carpio haematopterus*). Електрофореграмите покажуваат дека СДС-ПАГЕ како техника може да прави разлика помеѓу машки и женски единки базирано на присуство на женски специфичен протеин (ЖСП), кој може да биде искористен како соодветен маркер. Нативната ПАГЕ не покажува разлики помеѓу машките и женските плазма примероци. На електрофореграмот од СДС-ПАГЕ, молекулската маса на ЖСП е околу 143 кД и е во согласност со претходните истражувања кај други видови риби.

Клучни зборови: koi carp, серум протеини, полово специфичен протеин, PAGE.

UDC:636.4(497.7)
Original scientific paper

QUALITATIVE AND QUANTITATIVE EVALUATION OF OXYTETRACYCLINE RESIDUES IN COW'S MILK IN TETOVO, MACEDONIA

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Abstract
This study was carried out from 2011 to 2012 to evaluate qualitative and quantitative oxyteteracycline residues in cow's milk produced in different rural areas of Tetovo in Macedonia. Our research has evaluated presence of oxytetracycline residues in raw milk produced from 20 milking cows' farms in Tetovo region in Macedonia. About 156 milk samples were controlled by application of ELISA test for qualitative evaluation of oxitetracycline residues. All positive samples were frozen and analyzed with high performance liquid chromatography (HPLC) method for qualitative evaluation of oxytetracycline in Institute of Food Safety and Veterinary in Tirana. By this control performed using ELISA was evaluated that 4.5% (7/156) of raw milk samples were positive for oxytetracycline residues. All positive milk samples were tested with HPLC to evaluate the quantity of oxitetraxycline. The detected levels of positive samples were as following: 60ug/l, 80ug/l, 140ug/l, 220ug/l, 3000 ug/l, 1200 ug/l and 1400ug/l (ppb). Positive results are confirming treatment of milking cows with high doses of oxytetracycline which may contain the drug in the milk for lengths of time.
Key words: residues, oxyteteracycline, milk, cows, Tetovo.

Introduction

Oxytetracycline is a broad-spectrum veterinary antibiotic and is used to kill many pathogenic bacteria. For a long time it is used in lactating and non-lactating dairy cattle for the treatment of bacterial infections such as enteritis, pneumonia, diphtheria, infections infection caused by chlamydia, genital infections, urethritis and other infections in animals. Regulatory limits protect consumers from over-exposure to oxytetracycline above maximum residue limit (MRL) of 100ug/l milk (Lewis, 1997; Alica et al., 2003). As antibiotic with broad-spectrum of tetracycline, oxytetracycline works by interfering with the ability of bacteria to produce proteins that are essential to them. Effect of this antibiotic is related to stops the spread of the infection and the remaining bacteria are killed by the immune system or eventually die (Bishop et al., 1994). However, some strains of bacteria have developed resistance to this antibiotic, which has reduced its effectiveness for treating some types of infections (Grave et al., 1993). Using oxyteteracycline for treatment of different animal infections remains a very effective way to control many infections in milking cows. Even

thought the advantages of treatment the oxyteteracycline residues are having adverse effects on people allergic to antibiotics. Use of this antibiotic build up antibiotic-resistant organism in humans and cause inhibition of starter cultures used to produce cultured milk products such as yogurt and cheeses (Alica et al., 2003). For these reasons it is important effectively control of oxitetracycline residues in milk and therefore, regulatory authorities have enacted maximum residue limits (MRLs) for oxytetracycline in milk (EMEA; 1995). Many countries have introduced in national residues monitoring programs the control for residues of oxytetracycline in cow s' milk used for human consumption. On this context, Republic of Macedonia is realizing each year national residues monitoring plan according to EU specific legislation for residues control. Detectable concentrations of antibiotic residues in milk supplies higher than the MRLs are not allowed to be used to by consumers. One of main cause for having residues in cow s' milk is treatment of metritis and other genital infections having the incidence ranged from 10 to 15 % (Lewis, 1997). The most commonly observed diseases recorded in the dairy farms are mastitis in average incidence until 30% (Alica et al., 2003). According to the results of other studies disease conditions such as dystocea, retained fetal membrane, metabolic problem and foot problem recorded in dairy farms are having the incidence above 15%. Other authors are reporting that more than 50% of the farmers interviewed utilized oxytetracycline, and only 5% of the farmers were aware of dry cow therapy for controlling mastitis (Forst et al., 1991). Administration of antibiotics was accomplished using the routes of intramuscular, intramammary, intrauterine and peros in 52.9%, 30.9%, 8.8% and 14.7% of the farms respectively (Grave et al., 1999). For above reason oxitetraxycline in milking cows is commonly used and risk of residues of this group of antibiotics is higher.

Material and methods

Study was focused in 20 cattle farms located in Tetovo district in Macedonia. 156 raw milk samples were collected every month from different dairy farms in Tetovo. Attention was paid to collection of milk samples analyzed were of different farms from different locations. Milk samples were kept in the refrigerator (4°C) until analysis and were analyzed within two days at most.

Use of ELISA for qualitative detection

For detection of oxytetracycline residues in raw milk samples collected from milking cows in Tetova are used MaxSignal® Oxytetracycline ELISA Test Kit. It is a competitive enzyme immunoassay for the qualitative and quantitative analysis of milk samples. The method is based on a competitive colorimetric ELISA assay. During the analysis, sample is added along with the primary antibody specific for the target drug. If the target is present in the sample, it will compete for the antibody, thereby preventing the antibody from binding to the drug attached to the well. The secondary antibody, tagged with a peroxidase enzyme, targets the primary antibody that is complexed to the drug coated on the plate wells. The resulting color intensity, after addition of substrate, has an inverse relationship with the target concentration in the sample. Use of MaxSignal® Oxytetracycline ELISA Test is performed according to instruction closed to kit box.

HPLC analysis for qualitative detection of positive samples

All positive samples confirmed by MaxSignal® Oxytetracycline ELISA Test are tested with HPLC to quantify the residue of oxytetracycline. To perform HPLC procedure are used chemicals and material: Acetonitrile and methanol were of HPLC grade; oxalic acid dihydrate Suprapur and Na2HPO4 heptahydrate; ethylene diamine tetraacetic acid (EDTA) disodium salt, citric acid monohydrate (Thermo Fischer Scientific) were of purity grade. Solid phase extraction (SPE) column Oasis HLB, 3 cc, 60 mg was purchased from Waters (Milford, USA). The vacuum unit for SPE was purchased from Supelco. The other hardware included an analytical balance (Kern, Balingen, Germany), a cooling centrifuge (Mechanika Precyzyjna, Poland), and a rotary vacuum evaporator (Bűchi, Flawil, Switzerland), (Petkovska et al., 2006).For the qualitative and quantitative evaluation, the external standard method was used. Each sample was analyzed in duplicates way at the least, every series containing a blank sample. Simultaneously, aliquots of the milk samples with the addition of standard solutions of known concentrations were measured. The detection and quantization limits were established based on the standard deviation of the blind test and the slopes of the calibration curves, repeatability was based on 20 parallel determinations and the recovery was based determinations of the milk sample with the addition of the solution of standards of known concentrations (50µg/l and 100µg/l). Basic statistical processing was done using the Unistat software, Version 5.1 (Unistat Ltd. 1998).

Results and discussion

Raw cow s' milk samples before analytical process was controlled with ELISA to find out if the oxytetracycline residue is present or not. Even thought the MaxSignal® Oxytetracycline ELISA Test is used also for quantitative evaluation of oxytetracycline residues, many of studies recommended use of it only for qualitative detection. In our study we use this kit to find out the presence of oxitetracycline in milk. Then all positive cases were performed with HPLC to quantify the level of oxytetracycline residues. The antibiotic residues of positive samples which showed residues oxytetracicline above MRLs were 5/156 or 3.2%. Oxytetracycline was found being present in all positive samples in a concentration from 60-1400µg/l. Levels of oxiteteracycline in five positive milk samples above MRL were respectively 140ug/l, 220ug/l, 3000 ug/l, 1200 ug/l and 1400ug/l. The positive milk samples were analyzed by HPLC for oxitetraxycline quantification. A given sample was regarded as positive for oxytetracycline if its retention time and peak corresponded to that of the standard. Retention time was considered a reasonably unique identifying characteristic of a given samples (Ding and Mou; 2000; Cinquina et al., 2003).

Table 1. Milk samples collected in dairy farms and positive case of oxytetraxycline residues from 2011-2012 in Tetovo, Macedonia

No. farms	No. milk samples	Detection of oxitetraxycline residues with HPLC (%)	Above MRL (100 µg/L) in %
20	156	4.5% (7/156)	3.2% (5/156)

Table 2. Qualitative evaluation of raw cow s' milk samples confirmed positive by HPLC

Milk samples	Qualitative evaluation by HPLC
1.North part of Tetovo	60 ug/l
2.West part of Tetovo	80 ug/l
3.West part of Tetovo	140 ug/l
4.West part of Tetovo	220 ug/l
5.South part of Tetovo	300 ug/l
6.West part of Tetovo	1400 ug/l

The area inscribed by the peak isproportional to the amount of substance separated in the chromatographic system. To get the concentration of oxytetracycline, a reference standard of a known concentration had been injected in to the HPLC and concentration of the sample was extrapolated from the curve peak area. Studies in Europe carried out for detection of oxytetracycline residues in raw milk produced by milking cows reported values of incidence from 0, 5% to 2, 7 % (Grave et al., 1999; Allara et al., 2001). There are many studies confirming the low incidence from 0, 01%- 1.5%. In some cases in Germany and USA the incidence of level of oxytetracycline was higher than 5% and the cause was attributed the genital infections in milking cows (Heeschen et al., 1996). Comparing of chromatograms of reference standards, oxytetracycline HCl and some samples those were positive for oxytetracycline from the dairy farms were performed in these study to detect level of this antibiotic in milk. The range for oxytetracycline residue level was 0µg/l to 1600µg/l (Grave et al., 1999). The antibiotic residue positive samples which showed residues of oxytetracycline were 7 (4.5%).

Conclusions

The oxytetracycline residues of milk samples collected in dairy farms in Tetovo in Macedonia showed positive cases of oxytetracycline in 4.5% of total samples confirmed by MaxSignal® Oxytetracycline ELISA Test. Performing analytical control with HPLC oxytetracycline residues above MRLs were confirmed in 5 samples or 3.2%. The most of milk samples originated from west part of Tetova confirming values of incidence of oxytetracycline above the MRL and the risk of oxytetracycline residues in cow s' milk produced in this area.

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КВАЛИТАТИВНА И КВАНТИТАТИВНА ЕВАЛУАЦИЈА НА РЕЗИДУИ ОД ОКСИТЕТРАЦИКЛИН ВО КРАВЈО МЛЕКО ВО ТЕТОВО, МАКЕДОНИЈА

Менсур Камбери, Капелан Сулај

Апстракт

Оваа студија беше спроведена од 2011 до 2012 да се оценат квалитативните и квантитативните остатоци на oxyteteracycline во кравјо млеко произведени во различни рурални подрачја на Тетово во Македонија. Нашето истражување го оценува присуство на остатоци од антибиотик во суровото млеко произведено од фармите со 20 молзни крави во тетовскиот регион во Македонија. Вкупно 156 примероци на млеко беа контролирани со примена на ЕЛИСА тест за квалитативна евалуација на остатоци од oxitetracycline. Сите позитивни примероци беа замрзнати и анализирани со високо перформансна течна хроматографија (HPLC), метод за квалитативна евалуација на антибиотик, анализата беше реализирана во Институтот за безбедност на храната и ветерина во Тирана. Со оваа контрола користејќи ELISA се оцени дека 4,5% (7/156) од суровото млеко одредени примероци беа позитивни за остатоци на oxitetracycline. Сите позитивни млеко проби беа тестирани со HPLC да се оцени количеството на oxitetraxycline. Откриени нивоа на позитивните примероци беа: 60ug / л, 80ug / л, 140ug / л, 220ug / л, 3000 ug / л, 1200 ug / l и 1400ug / л (ppb). Позитивните резултати го потврдуваат третманот на молзење крави со високи дози на oxytetracycline кој може да содржи лекови во млекот за одреден временски период.

Клучни зборови: остатоци, oxyteteracycline, млеко, крави, Тетово.

UDC: 636.4 (497.7)
Review paper

REVIEW OF THE ACHIEVED RESULTS IN THE PIG PRODUCTION OF THE REPUBLIC OF MACEDONIA

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Abstract
In the last ten years the pig production of the Republic of Macedonia has a positive trend. This study was realized during 2010 and 2011 under the state herd book project. The registrations and the major part of analyzes are conducted via WinPig software. The used methodology was based on the daily individual registration of the "feeding days". Six pig farms "from farrowing to finish" were the subject of the investigation. The information's were adjusted and the results by farm were calculated. The most of farm results show positive trend of the analyzed traits. In 2010 and 2011 from the analyzed 11344 and 12294 inseminations the conception rate was 85,4 and 84,0%, respectively. The number of total born piglets was 11,7 and 11,92, the number of born alive was 10,98 and 11,2, the number of still born was 0,74 and 0,72, respectively from 9272 and 9918 realized farrowing's in 2010 and 2011. The number of weaned piglets was 9,4 and 9,9, the lactation mortality rate was 14,8 and 12,0% with individual weight of 6,2 and 6,7kg, respectively from 9270 and 9729 realized weaning's in 2010 and 2011. The number of empty days per litter was 16,8 and 13,8, the farrowing index was 2,30 and 2,33, under lactation length of 26,8 and 27,2 days in 2010 and 2012, respectively. Finally the number of weaned piglets per sow per year increased for 1,4 piglets in 2011 compared with 2010 (21,7 p/s/y in 2010 vs. 23,0 p/s/y in 2011).
Key words: pigs, livestock production, farm results.

Introduction

Several analyzes were conducted since 1990's related with the pig performances on-farm in the Republic of Macedonia (Belicovski *et al*., 1993, Belicovski *et al*., 1994, Belicovski *et al*., 1995, Belicovski *et al*., 1996, Vukovic *et al*., 2004). They shows that pig husbandry in the country is driving through the time with various results depend of explored farm and year. Generally, in the last ten to twenty years the pig production of the Republic of Macedonia has a positive trend in many relevant performances. The quality of the carcasses on the slaughter line (Vukovic *et al*., 2006 and Vukovic *et al*., 2010) shows that the market pressure had positive effect on the farms who improve the production in all segments and reach the European level.

Farm results in the developed counties mostly are compared under the several performances like: farrowing rate(%), number of born alive per litter, number of weaned piglets per sow per

year, non-productive days per litter, farrowing index and others which becomes internationally accepted like an indicators of overall swine farming success. The most commonly used indicator is the number of weaned pigs per sow per year (w/s/y). This figure could express the overall farming results having in mind that factors affecting weaned pigs per year are many and they are incorporated into regular management of the pig farms (www.daff.qld.gov.au, 2012). The reached average level in some EU breeding organizations on the large number of farms was 28,8 w/s/y in 2011 (www.pigprogress.net, 2012) and some others in 2010 predict new targets of 35 w/s/y since at that time the 5% of the best farms realized production of 32 to 34 weaned piglets per sow per year (www.wattagnet.com, 2010).

Material and methods

This study was realized during 2010 and 2011 under the state herd book project. The registrations and the major part of analyzes are conducted via WinPig software. The used methodology was based on the daily individual registration of the "feeding days". Six pig farms "from farrowing to finish" from Republic of Macedonia were the subject of the investigation in the equal periods in 2010 and 2011, respectively. The information's were adjusted and the annual results by farm were calculated for the following traits: the number of services, the conception rate (%), the total number of born piglets/litter, the number of born alive piglets/litter, the number of still born piglets/litter, the number of weaned piglets/litter, the pre-weaning mortality(%), the farrowing index, the non-productive days (days) and the number of weaned piglets per sow per year. The source of analyzed data were recorded as a result of the total number of services per farm and year in 2010 (n=11344) and in 2011(n= 12294). The distribution of services per farm, year and total is presented in the Graph 1. The litter size traits and other analyzed traits were observed from 9272 and 9918 realized farrowing's in 2010 and 2011 and from 9270 and 9729 realized weaning's in 2010 and 2011.

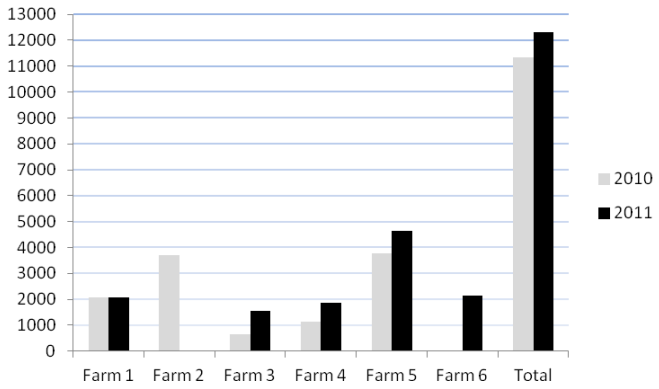


Figure 1. Number of services per farm and year

Results and discussion

In 2010 and 2011 from the analyzed 11344 and 12294 inseminations the average conception rate for all analyzed farms was 85,4 and 84,0%, respectively (Graph 2). The greater and the

smaller conception rate are determined in 2010 (Farm 3 vs. Farm 1). The annual trend per separate farms and overall is negative or variable since generally farms shows decreasing of the insemination success in 2011. The observed differences per year are not large, however they could express the variations per farms in management and could indicate possible negative influences of the genetic and non-genetic factors. The overall results for the conception rate in observed farms generally shows acceptable results above 80%. Compared to the observed conception rate (%) in sows per Macedonian farm published in the past (Belicovski *et al*., 1993) the analyzed results were much higher.

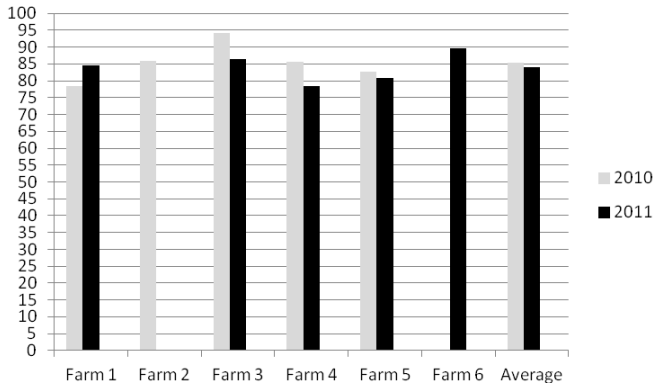


Figure 2. Conception rate (%) in sows per farm and year

The average number of total born piglets per litter was 11,70 and 11,92, the average number of born alive per litter was 10,98 and 11,20 and the average number of still born per litter was 0,74 and 0,72 (Graph 3, Graph 4 and Graph 5), respectively in 2010 and 2011. Trend per year shows that observed gain on the total born and born alive is 0,22 piglets per litter and much lower changes of the average number of still born piglets (-0,02 per year). The observed trend is close to the predictions for genetic improvement of those traits on the phenotypic level (Vukovic et al., 2002).

Observed average number of born alive per litter realized in the Macedonian pig farms in 2010 and 2011, compared with those published before (Belicovski *et al*., 1993) were much higher (10,98 and 11,20 vs. just 9,30 piglets).

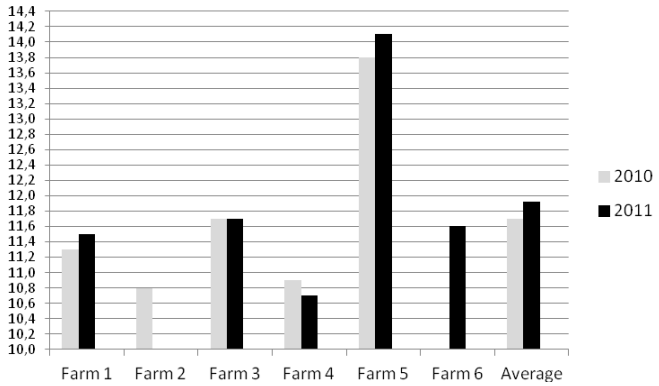


Figure 3. Total number of born piglets/litter per farm and year

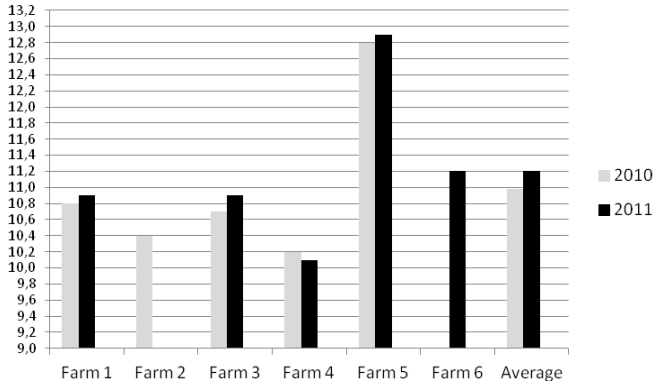


Figure 4. Number of born alive piglets/litter per farm and year

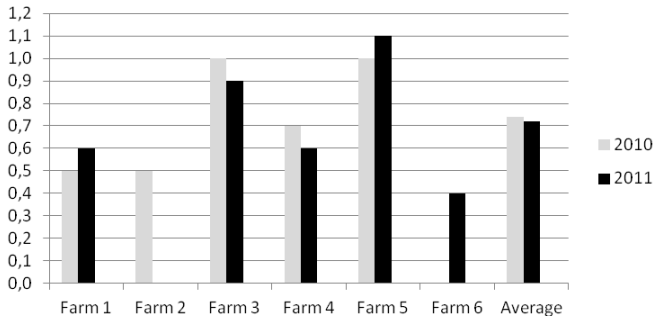


Figure 5**.** Number of still born piglets/litter per farm and year

The number of weaned piglets was 9,4 and 9,9, the pre-weaning mortality rate was 14,8 and 12,0% in 2010 and 2011, respectively (Graph 6 and Graph 7).

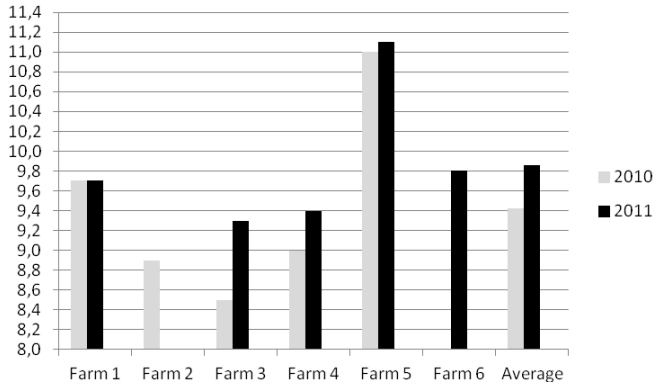


Figure 5. Number of weaned piglets/litter per farm and year

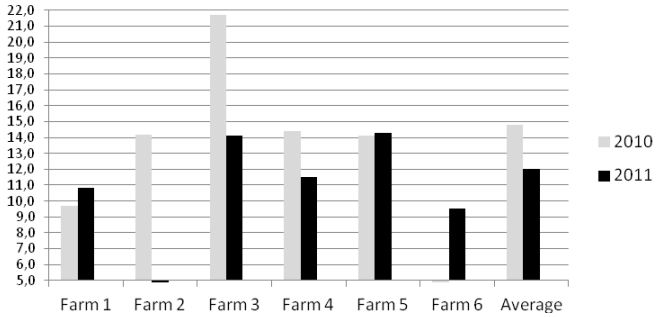


Figure 6. Pre-weaning mortality per farm and year (%)

Decreasing of the pre-weaning mortality rate of -2,78% generally support the greater number of weaned piglets per litter in the observed years (0,44 piglets per litter). The expressed result means significant improvement in the farrowing management and utilizing of the higher number of live born piglets per litter on the phenotypic level. In average, the realized level is much higher with the level observed in the period 1990-1992 (Belicovski *et al*., 1993) for the number of weaned piglets per litter (7,77 vs. 9,42 and 9,86 piglets) and much lower for the pre-weaning mortality rate (15,29% vs. 14.8 and 12,00%).

The results of the number of empty days per litter (16,8 and 13,8 days) and the farrowing index (2,30 and 2,33) in 2010 and 2011, respectively are presented in the Graph 8 and 9.

The observed level farrowing rate in average (2,22 vs. 2,30 and 2,33) and individually per separate farms in two periods (1990-1992 according Belicovski *et al*., 1993 and the actual investigation for 2010-2011) shows positive trend. Annually on the farm level, the combination of the observed non-productive days per farm (Graph 9) and litter size traits at farrowing (Graph 3, 4 and 5) and at weaning (Graph 6 and Graph 7) the overall results per farm and year could be compared under the complex indicator - number of weaned piglets per sow per year (Graph 10.).

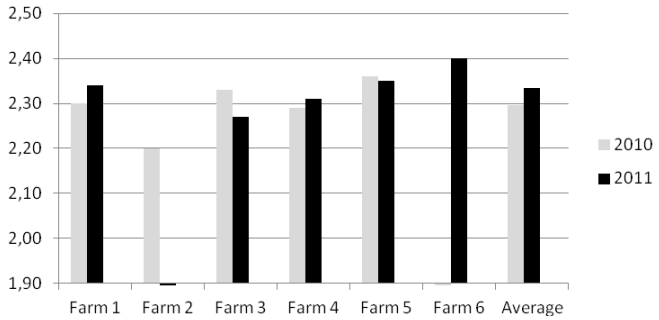


Figure 7. Farrowing index per farm and year

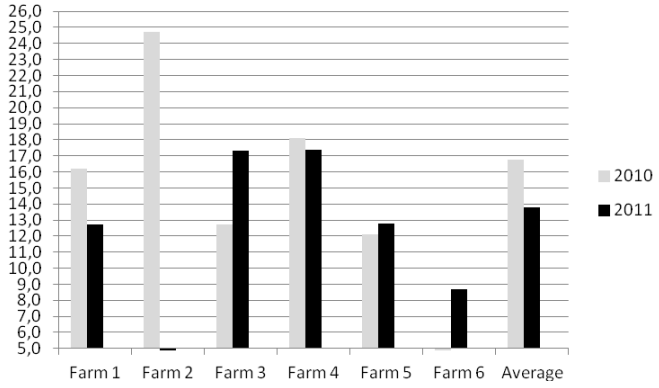


Figure 8. Non-productive days per farm and year (days)

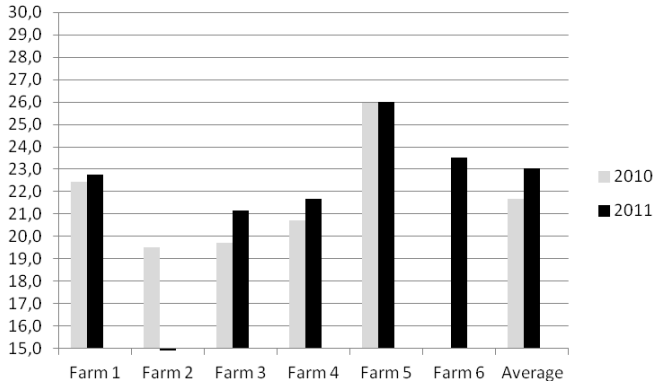


Figure 9**.** Number of weaned piglets/sow per farm and year

According conducted investigation the number of weaned piglets per sow per year increased for 1,4 piglets in 2011 compared with 2010 (21,7 p/s/y in 2010 vs. 23,0 p/s/y in 2011). In addition if we indirectly calculate the number of w/s/y under the input parameters used from the investigation finalized in early nineties (Belicovski *et al*., 1993) we could come to the average number of only 17,25 piglets. Is very clear that in 20-21 years absolute progress on the phenotypic level is 4,45 and 5,75 w/s/y, respectively. The realized progress is going much faster in the last years, however if we linearly divide the absolute gain for two observed years the trend is 0.22 to 0.28 w/s/y which is consistent with previously predicted trends (Vukovic et al., 2002).

The overview of the achieved results in the investigated years are showed in the Table 1. According those results and expressed trends compared with previous investigations in the Republic of Macedonia (Belicovski *et al*., 1993, Belicovski *et al*., 1994, Belicovski *et al*., 1995, Belicovski *et al*., 1996, Vukovic *et al*., 2004) we could summarized that Macedonian pig husbandry significantly improve the farm performances. The observed results are expressing progress in the better control of the factors responsible for proper swine farm

management (usage of superior genetic, artificial insemination, better feeding and housing and much higher level of applied knowledge in daily production).

Table 1. Overview of annual results of the Macedonian pig farms (2010-2011)

Parameteres/traits	2010	2011	Difference
Conception Rate %	85,4	84,0	-1,40
Preg. days/Lit	115,4	115,6	0,14
Total born/Lit	11,70	11,92	0,22
Live born/Lit	10,98	11,20	0,22
Born dead/Lit	0,74	0,72	-0,02
Pigs weaned/Lit	9,4	9,9	0,44
Wean.weight/pig	6,2	6,7	0,55
%Pre-w mortality	14,8	12,0	-2,78
Suckl. days/Lit	26,8	27,2	0,36
Non-prod. days/Lit	16,8	13,8	-2,98
Lit/Sow/Year	2,30	2,33	0,04
Pigs weaned/sow/yr	21,7	23,0	1,35
Number of serves	11344	12294	950
Farrowing	9272	9918	646
Total Weanings	9270	9729	459

Conclusions

In the last twenty years the pig production of the Republic of Macedonia has a positive trend of annual improvements observed under common farm performances. Compared with the European's Macedonian pig farms figures are easily coming closer by achieved results.

The average level of production results observed in 2010 and 2011 per Macedonian farms were: the conception rate of 85,4 and 84,0%, the number of total born piglets per litter 11,7 and 11,92, the number of born alive per litter 10,98 and 11,2, the number of still born per litter 0,74 and 0,72, the number of weaned piglets per litter 9,4 and 9,9, the pre-weaning mortality rate of 14,8 and 12,0%, the number of empty days per litter 16,8 and 13,8, the farrowing index 2,30 and 2,33, respectively.

The number of weaned piglets per sow per year increased for 1,4 piglets in 2011 compared with 2010 (21,7 p/s/y in 2010 vs. 23,0 p/s/y in 2011). The realized trend in this complex trait was 0,22 to 0,28 w/s/y in the last twenty years on the phenotypic level.

Acknowledgement

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ПРЕГЛЕД НА ПОСТИГНАТИ РЕЗУЛТАТИ ВО СВИЊАРСКОТО ПРОИЗВОДСТВО ВО РЕПУБЛИКА МАКЕДОНИЈА

Вукович В., Анднов С .

Апстракт

Во последните десет години на свињарското производство во Република Македонија има позитивен тренд. Оваа студија се реализира во текот на 2010 и 2011 година преку проектот за воведување на матично книговодство. Регистрацијата и поголемиот дел од анализите се извршени преку WinPig софтвер. Користената беше методологија која се базира на дневата поединечна регистрација на "хранидбени денови". Шест свињарски фарми "од прасење до тов" беа предмет на анализа. Информациите беа обработени а резултатите беа пресметани по фарма. Поголемиот дел од резултатите по фарма покажуваат позитивен тренд од анализираните својства. Во 2010 и 2011 година од анализираните 11.344 и 12.294 инсеменации степенот на концепција беше 85,4 и 84,0%, респективно. Вкупниот број на родени прасиња беше 11,7 и 11,92, бројот на живо родени беше 10,98 и 11,2 , бројот на родени беше 0,74 и 0,72, односно од 9272 и 9918 реализираат прасења во 2010 и 2011 година. Бројот на одбиени прасиња беше 9,4 и 9,9, лактационата смртност беше 14,8 и 12,0%, со поединечна тежина од 6,2 и 6,7 кг, респективно од 9270 и 9729 реализираат обивања во 2010 и 2011 . Бројот на празни денови по легло беше 16,8 и 13,8 , индексот на прасење беше 2,30 и 2,33, должината на лактацијата изнесуваше 26,8 и 27,2 дена во 2010 и 2012, респективно. Конечно бројот на одбиени прасиња по маторица беше годишно зголемен за 1,4 прасиња во 2011 година во споредба со 2010 година (21,7 P / S / у во 2010 наспроти 23,0 P / S / у во 2011 година).

Клучни зборови: свињи, добиток, фармски резултати.

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Original Scientific Paper

DEFINING OF BREEDING GOALS OF HOSTEIN CATTLE IN THE R. OF MACEDONIA

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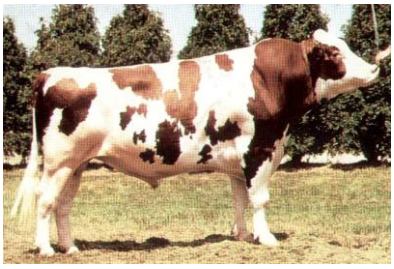
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Abstract
According to the Low of Animal Production of R. of Macedonia from 2008, for every breed of cattle in our state is nessesery to create a separate breeding program. Black and white (Holstein) population is a dominant highproductive breed of cattle, which is aimed for high dairy production. Facing the obtained results from controlling of several bigger cattle farms in our state, the following breeding traits and goals for our hostein population are recommended: milk production – more than 8.000 kg per cow for standard lactation, milk fat content – more than 4%, milk protein content – more than 3,4%, body weight of cows – 600-700 kg, height of withers of cows – 135-145 cm, udder – spacious, simetric, with good support of ligaments and lifted from the surface, well adapted for machine milking, with the average milk speed 2,3-2,5 kg/min. Also, the other important breeding goals are: producing healthy cows with good adaptation, less somatic cells content in milk, healthy and flexible animals with good longlasting, with healthy udder, good fertility and big capacity for growing. Because of the fact that breeding goal is an economic category, in future it is essential to increase dairy production by more forage crops, by better consumption ability with the pararel increasing of body capacity. The previous is important from the aspect of the production economy, as well as from the ecological agricultural and dairy production and products with better quality in the R. of Macedonia.
Key words: cattle, selection, Holstein, breeding goals, breeding program.

Introduction

Holstein or Black and White breed is the most productive dairy breed in the world, which has relatively large body capacity and ability to consume large forage crops, as well as with good adaptation and accommodation ability. Therefore, Holstein cows are spreaded al aover the world, from the East to the West, from the meadows to the mountain regions. This breed is rearing mainly for intensive dairy production, which is connected with intensive plant production.





Picture 1 Picture 2

Picture 1. Black and white (BW) type of Hosltein cattle . Picture 2 Red and white (RW) type of Holstein cattle

Black and white (Holstein) population is a dominant breed in the world, with almost 20% from the total cattle population in the world (Trajkovski and Bunevski, 2006). In the R. of Macedonia, from the total number of cattle, 42% belong to Holstein breed. It is a high productive breed aimed for high milk production.

Breeding strategies

In different parts of the world, there are several different breeding strategies of cattle production, which vary from the different points of view:

- Balance between profitable, market oriented and sustainable production,
- Results of Holsteinization (± effects),
- How to continue? Breeding for functional traits, or using the heterozis effects or ?

Anyway, the influence of dual-purpose breeds of cattle in intensive and extensive production system is increasing in the Europe and in the world (Simmental and its crossing with RHF, or Simmental with beef breeds.

Common strategies for dairy production in the world are: a) “high input” strategy (in USA, Canada, Israel, Japan, etc.);b) “low input” strategy (N. Zealand, Australia, etc.);c) “medium input” strategy, with “high performance” cattle and “permanent pasture using” strategy (Switzerland, etc.);d) using dual-purpose cattle breeds – “dual-purpose cow strategy” (mainly in middle Europe: Baravia, Austria, etc.).

Defining the breeding goals

Theoretically, the breeding goal represents the directed genetic improvement of the certain charactedistics realized in successive generations of animals which accomplish the desired production through the future, but expectes economic, social and ecological production conditions (Groen, 2000). The clear definition of breeding goals means what we have to expect in the future. So, definition of breeding goals is the first step of every breeding program for each breed of cattle. But for each productive type and breed of cattle, there are different separated breeding objectives, depending by defferent zootechnical, economical and market conditions. From the point of view from the farmers, every breeding goal ought to satisfy 2 main conditions: 1) maximal profit in current productive conditions, and 2) with realization risk in the working limits (Groen, 2000). According to the breeding goals, the following breeding and selection program ought to be adapted for each breed of cattle, with the emphasis on defining traits, agregate genotype, variances, covariances, fixed and random

effects, heritabilities and other parameters. Finaly, all breeding goals are directly or indirectly connected with the profit function on the farm, so they have an ecomonical value.

Size of Holstein population and cattle breeding in the R. of Macedonia

From the total population of cattle in our state (269.443 heads – Annual Statistical Review of RM, 2011), 41,57% or totaly 112012 heads belong to Holstein population.

Table1. Population of black and white cattle in the R. of Macedonia from 2008 to 2010 (Veterinary Chamber of the Ministry of Agriculture, 2010)

Breed of cattle/Year	2008		2009		2010	
	No. of heads	In %	No. of heads	In %	No. of heads	In %
Black and white cattle	101843	41,80	109525	42,49	112012	41,57
Total No. of cattle	243667	100,0	257724	100,0	269443	100,0

Our cattle rearing is based mainly on small individual farms which number takes 95% from total cattle breeding, and on small number of large cattle farms (with more than 100 heads) which are specialized for intensive cattle production. Individual farmers have a small number of cattle per farm – in 2011 the national average is 6,5 heads of cattle per farm. In our state there are totally 45.127 registered dairy producers, which posses 91% from total cattle heads and have 1 to 9 cows per farm (graph 1), which is in correlation with their small ownership of agricultural land per farm. From the other side, larger farms are the nucleus of high-productive cattle genetics, mainly of black and white cattle.

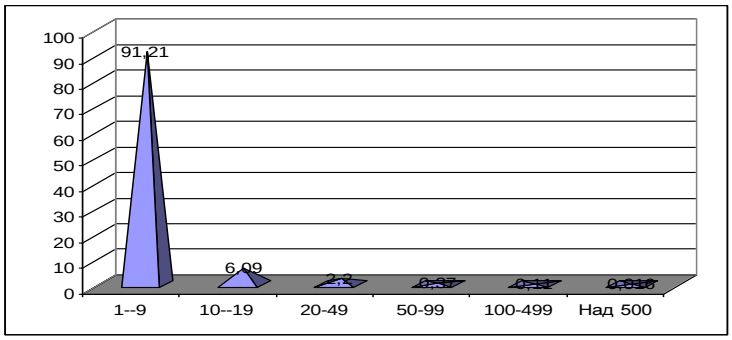


Figure 1. Structure of cattle farms according to their average number of cows per farm in RM (MAFW, 2010)

Material, method of work, obtained results and discussion

In the following tables are presented the results from the controlled dairy farms of Holstein cattle in 2011 in the R. of Macedonia.

From table 3 can be considered that the average milk production in Holstein population in 2011 for all controlled lactations on 5 biggest farms in the RM is 6171 kg, but calculated on III lactation is 6640 kg milk. Compared with the other Holstein population in the other countries, it is similar with the neighbouring countries, but lower than western and north European countries (from 8000-10000 kg milk) (Trajkovski and Bunevski, 2006).

Table 2. Results of the controlled 5 biggest farms for milk production traits in Hosltein farms in 2011

Farms	Average milk yield per cow for all lactation, kg	Milk yield calculated on III lactation, kg	Milk fats, %	Milk proteins, %	Dry non-fat matters in milk, %	Relative weigth of milk
Farm 1	6947,5	7085.3	4,21	3,62	9,76	1,0338
Farm 2	7915,0	8587,8	3,68	3,59	9,59	1,0325
Farm 3	5504,0	6329,9	3.72	3.65	9.69	1.0321
Farm 4	5842,0	6171,8	4,64	3,79	10,06	1,0336
Farm 5	4645,6	5021,4	4,00	3,48	9,19	1,0307
Average	6170,82	6639,3	4,05	3,626	9,658	1,0325

Also, comparing with the other reproductive traits for Holstein population in the other countries, it is similar with the neighbouring countries, but lower than western and north European countries, due to the selection work and realization of the breeding programs for that breed of cattle.

Table 3. Results of analyzes of several reproductive traits of controlled cows on 5 biggest farms in 2011 in RM

Parameter	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5	Average
Length of pregnancy, days	282,5	283	283	282	283	282,7
Age at first insemination, months	15,9	16,5	15,2	16,0	16,8	16,08
Age at first delivering, months	25,8	25,6	24,6	29,6	40,5	29,22
Twinning, %	1,1	1,5	2,5	1,0	1,3	1,48
Average number of semen doses per insemination	2,3	2,5	1,5	2,5	2,4	2,24
Annual mortality of calves, %	3,5	1,1	4,0	7,8	3,9	4,06

Breeding program for Holstein cattle in the R. of Macedonia

Every breeding program has the following steps of its realization: 1) defining the breeding goals, 2) defining the breeding program, defining the selection criteria, 4) creating of breeding scheme, 5) creating a breeding structure, 6) creating the mating plan, 7) progeny controlling, and 8) economical analyses of the breeding program.

According to the Low of Animal Production (2008), in 2010 was prepared the Common Breeding Program for Livestock Selection (CBPLS) by the Ministry of Agriculture, and a Breeding program for Holstein cattle in Macedonia was recommended in 2011. In the Breeding program, totally more than 30 traits are taken in account for the Hosltein selection, devided in several groups of traits:

a) Productive traits: milk production (in kg), milk fats (in % and kg), milk proteins (in % and kg), dry matters in milk (in %), and specific weight of milk (in %),

b) Reproductive traits: calving period (in days) and service period (in days);
c) Exterier traits: body mass (in kg), wither height (in cm), body length (in cm) and chest circumference (in cm),
d) Linear traits – 18 traits according to the World Holstein Association Program,
e) Other traits: milking spead, delivering difficulties, desease resistance, number of Somatic cells (SCC), fertility, growing, longlasting etc.

Breeding goals for Holstein cattle in the R. of Macedonia

The main breeding objective for Holstein cows in economical dairy production. That high milk yield could be produced by rearing of big cows (with 140 cm of wither heigth), with large and long bodies, which can have a good ability of consumption of big amount of forage crops. The udder ought to be large, spacious, well balanced between fore and rear quarters and balanced udder index, with good support ligaments and proper size of teats which are simetric settled on the udder quarters, as well as well adapted for machine milking. Legs ought to be thin, with derisable pasture, and with strong and healthy hoofs. Holstein cows ought to have a high milk production on different climate and environmental conditions. Specialy desireable animals are those with a good resistance on deseases, with good longlasting, good fertility, early maturing, easy delivering, good conductivity at milking and with well growing (daily gain). Holstein heifers ought to have a fast development and to have 390-420 kg of body weight at 15-16 months of age at the first insemination, i.e. 24 to 26 months of age on their first delivering.

The main breeding goals for Holstein population in the R. of Macedonia are presented in table 4.So, the main breeding goals in selection of Holstein cows are directed to the genetic improvement of:

- Production traits (kg of milk, kg and % of milk fats, kg and % of milk proteins),
- Reproductive traits (with the special emphasis on calving interval in days),
- Linear (exterior) traits of their conformation, and
- Other traits connected with their functionality, resistency, milk quality, longlasting and efficiency.

Table 4. Main breeding objectives for Holstein cows in the R. of Macedonia

Milk production:	– more than 8.000 kg per cow for standard lactation
Milk fat content:	– more than 4%,
Milk protein content:	– more than 3,4%
Body weight of cows:	– 600-700 kg
Height of withers of cows:	– 135-145 cm
Udder:	– spacious, simetric, with good support of ligaments and lifted from the surface, well adapted for machine milking
Average milking speed:	2,3-2,5 kg milk/min
Other important breeding goals:	producing healthy cows with good adaptation, less somatic cells content in milk, healthy and flexible animals with good longlasting, with healthy udder, good fertility and big capacity for growing

According Boicherd (2010), cattle selection has been long oriented towards production, in a non sustainable way. Now cattle have to face new challenges for sustainable production with its three pillars: economic, societal and environmental. So, breeding objectives should be adapted to efficiently account for all traints involved in sustainability. Boicherd (2010) showed that after the long period of selection on production, most functional traits have been deteriorated, sometimes up to a critical point, and need to restore. This is particularly the case for fertility, mastitis resistance, longevity, metabolic diseases (e.g.: - 1% conception rate (CR) per year in Holstein). From the other side, most of the functional traits have a low heritability (0.02-0.10) and are difficult to select.

Future of Holstein breeding goals and selection

Cattle selection has been long oriented towards production, in a non sustainable way. Cattle have to face new challenges for sustainable production with its three pillars: economic, societal and environmental. Breeding objectives should be adapted to efficiently account for all traits involved in sustainability. Dairy production today has: a) very high level of performance traits, b) increasing herd sizes, c) increasing occurrence of diseases, d) time for observing cows limited. So, we have to select a so called "functional and healthy cow'. Genetic improvement requires: 1) definition of traits, 2) Recording schemes, 3) Knowledge of genetic parameters, 4) Economic weights, 5) Inclusion in breeding goal. From the International comparison of dairy bulls, MACE EBVs from Interbull April 2012 will forse five major traits in cows selection: protein in kg (as an indicator of production); overall Udder (indicator of conformation); longevity; SCS (indicator of udder health); calving to First Service (indicator of fertility). Even there is no global effect from using of Genomic Selection (GS) yet, in future, animals are evaluated from their DNA information, with markers covering the genome. GS is already applied on dairy cattle and will be extended of other situations in the near future. It is a unique opportunity to:

1) Have a more balanced genetic trend - genetic trend up to doubled! Opportunities for a more diversified objective,

2) Select for new traits considered as unachievable until recently – right now where is a disconnection between performance recording (in a reference population) and Selection (of candidates without performance) = Flexibility!,

3) Accuracy is the same for males and females,

4) For some traits recorded on a high scale, the accuracy is little dependent on heritability.

In near future we have to expect the rapid use of GS and its beneficions.

Conclusions

According to the controlled traits and obtained results of milk production and reproduction traits in Holstein cows in Macedonia, the following breeding traits and goals for our Holstein population are recommended: milk production – more than 8.000 kg per cow for standard lactation, milk fat content – more than 4%, milk protein content – more than 3,4%, body weight of cows – 600-700 kg, height of withers of cows – 135-145 cm, udder – spacious, simetric, with good support of ligaments and lifted from the surface, well adapted for machine milking, with the average milk speed 2,3-2,5 kg/min. Also, the other important breeding goals are: producing healthy cows with good adaptation, less somatic cells content in milk, healthy and flexible animals with good longlasting, with healthy udder, good

fertility and big capacity for growing. So, in the future selection of dairy cattle more emphasis ought to be given to the functual traits, not only on milk production.

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ДЕФИНИРАЊЕ НА ОДГЛЕДУВАЧКИТЕ ЦЕЛИ НА ХОЛШТАЈН ГОВЕДАТА ВО РЕПУБЛИКА МАКЕДОНИЈА

Буневски Ѓоко, Коцевски Драгослав, Џабирски Владимир, Тројачанец Сњежана, Порчу Кочо

Апстракт

Согласно Законот за сточарство на РМ од 2008 година, потребно е за секоја поважна раса говеда во нашата земја да се креира посебна одгледувачка програма. Црно-белата (холштајн) популација на говеда претставува доминантна благородна раса говеда која интензивно се одгледува за производство на млеко. Согласно производните параметри кои се добиени во контролираните поголеми фарми во Р. Македонија, предложени се следниве одгледувачки цели за холштајн говедата: млекопроизводство – над 8000 кг/крава за стандардна лактација, содржина на млечна маст – над 4%, содржина на протеини во млекото – над 3,4%, телесна маса кај кравите – 600-700 кг, висина на гребенот кај кравите од 135 до 145см, виме - пространо, уедначено, со добра потпора од лигаменти и подигнато од подот, прилагодено за машинско молзење, просечната молзност треба да биде 2,3 - 2,5 кг млеко/мин, а други битни карактеристики се: добиваање здрави грла со добра адаптациона способност, помал број на соматски клетки, здрави и флексибилни животни со добра долговечност, со здраво виме, добра плодност и голем капацитет за раст. Поради фактот што одгледувачката цел е економска категорија, во иднина е многу важно производството на млеко да се зголемува со поголемо учество на волуминозната добиточна храна. Тоа би се постигнало со зголемување на способноста за консумација на животните, со паралелно зголемување на форматот на грлата. Тоа е важно како од аспект на економичноста на производството, така и од аспект на еколошкото земјоделско производство на млеко во Р. Македонија со подобар квалитет на производите.

Клучни зборови: говеда, селекција, холштајн, одгледувачки цели, одгледувачка програма.

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Original scientific paper

USAGE OF BIOPROTECTIVE CULTURES IN VACUUM-PACKAGED CHICKEN BREASTS IN CASING

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Abstract
The advantage of bioprotective cultures using arises from the fact that it is not necessary to declare E- number which is obligatory for additives and causes skepticism among the consumers. The purpose of this research is to determine the influence of bioprotective cultures B-2 SafePro *(Lactobacillus sakei)* and B-LC-48 *(Lact. curvatus)* in vacuum packaged chicken breast on: pH values, sensory characteristics, total bacteria count and the amount and appearance of purge in vacuum packaging. Smoked chicken breasts in casing are used in this research, which are sliced and packaged in vacuum. Depending on the bioprotective culture used and the manner of its application, before vacuum packaging, the following five product groups are made: 1-reference products without bioprotective culture, 2-A-products with spray application of bioprotective culture B-2 SafePro, 2 -B products with droplet application of the bioprotective culture B-2 SafePro, 3-A-products with spray application of bioprotective culture B-LC-48 and 3-B products with droplet application of bioprotective culture B-LC-48. Smoked chicken breasts treated with droplet application, from the bioprotective culture B-2 SafePro, compared to the other product groups, gave the most satisfactory results in all tested parameters.
Key words: bioprotective cultures, pH, sensory characteristics, microorganisms.

Introduction

The awareness of consumers, through education, constantly increases. If the food is hygienically unsafe (pathogenic microorganisms, contaminants, radiation) it might cause diseases and organic illness. On the other hand, additives are used to inhibit multiplying and developing of undesirable microorganisms. Constant consuming of food that contains additives of chemical origin could result in undesirable effect on human body. This conclusion requires new criteria in food sector especially in meat industry. Those criteria allow long shelf life and improving the sensorial characteristics of meat products without using additives of chemical origin. Something like this is possible only if bioprotective microorganisms are used. This implies inoculating with lactic-acid bacteria which inhibit the spoilage and pathogenic microorganisms. The purpose of this paper is based on the previous researches and literature informations for issues described in it. The attention in this research is directed towards determination the influence of bioprotective cultures *(Lact. sakei)* and B-LC 48 *(Lac.bac. curvatus)* in vacuum-packaged chicken breast

on: pH values, sensorial characteristics, total number of bacteria and the amount and appearance of purge in vacuum packaging.

The advantage of bioprotective cultures using results from the fact that declaring E-numbers is not necessary which is obligatory when using additives which causes skepticism among the consumers.

Canned meats (definition and division)

Canned meats are defined as a products manufactured from: meat, animal fats, viscera, residues of fat and connective tissues and additives which are exposed to the influence of heat in hermetically sealed containers (cans, glass, tubes, casings from allowed plastic and aluminum material) (Џинлески, 1990).

Depending on the regime of heat treatment, two types of canned meats are distinguished: semi-shelf stable and shelf stable canned meats (Korce-Pavlic D, 2003). Smoked chicken breasts in casing belong to the group of chunks of canned meats. These types are produced from cured or cured and smoked pork, beef and mutton, tongues, solid fats and additional ingredients.

Microorganisms in food production and preservation

Employing of microorganisms in food production and preservation is as old as the production of food is. Desirable and undesirable microorganisms are part of meat products micro flora. The undesirable micro flora contain the following microorganisms: *Esherichia coli, Listeria monocytogenes, Clostridium perfringens,* which are involved in meat spoilage processes, whereas slime producing bacteria are: *Achromobacter, Flavobacterium, Alcaligenes, Pseudomonas* and *Serattia.*

Those microorganisms could be transfered to meat through: soil, dust, equipment etc. That is the reason why this type of spoilage appears in the producing area, not only due to inappropriate process for cooling the meat but due to irregular hygienic conditions, as well. When the slime appears in the producing areas, with the aim to keep the meat safe, the following actions should be taken: meat is put into the cooling chambers where the temperature is around 0-2^{0}C, the air moisture is lowered while the air circulation is increased. Under these conditions slime producing bacteria can not be reproduced, meat dries and future development of the spoilage processes is stopped. (Џинлески Б, 1990).

Desirable microflora are: lactic-acid bacteria and *Micrococcus*. To stimulate the bacterial growth, increasing the medium acidity i.e. decreasing the pH value is necessary (Беличовска Даниела, 2007). Lactic-acid bacteria convert the carbohydrates in meat using them as an energy source. As a result of this, lactic acid is created which decreases the pH value resulting in products shelf life extending.

Employing the bioprotective culture b-2 safepro (lactobacillus sakei)

B-2 SafePro is a single strain culture containing *Lac. sakei* (microaerophilic bacteria) in freeze-dried form and can be applied in cooked and cured meat products. The theoretical and experimental knowledge date from the 1987 year, when, for the first time, the bacterium was isolated from fresh beef packed in modified atmosphere (MA).

So far the application of B-2 SafePro always resulted in inhibiting the following bacteria: Listeria *monocytogenes, Brochothrix thermosphacta, Leuconostoc sp* etc., which are a part of the spoilage micro flora, which appears as a result of temperature regime changes during keeping the products. During growth of B-2 in a product a part of the fermentable sugars are

converted into lactic acid. In the 1991 a research was conducted for the profile of acidification of *Lactobacilus sakei*. In a liquid medium (MRS-IM) at 10^0C, 1% sugars were added, significant in meat production. Acidification was observed in medium where sucrose (disaccharide consisting of fructose and glucose) is added, as well as in medium where glucose is added. Neither addition of lactose nor maltodextrin caused acidification (Jelle, 1991). *Lactobacilus sakei* has limited lipolytic activity against fat of animal origin and low proteolytic activity (Jelle, 1991). The strain does not produce biogenic amines, H_2O_2 or bacteriocin. B-2 is capable of growing at 2^0C, and its optimum growth temperature in MRS-agar is 35^0C. However exceeding the temperature limits of below 20 and above 40^0 C, results in longer lag phases and lower acidification rates. In the same temperature range, addition of salt, generally, results in slower acidification. Even salt concentrations as low as 2% slightly inhibits the activity of B-2. B-2 is not active in the presence of 10% salt. At optimum temperature conditions, the absolute maximum level of salt that allows growth of B-2 is 6% with inoculation level higher than 10^6 CFU/ml.

Concerning the other commonly used meat additives, B-2 has been shown to survive the addition of 450 ppm Na-meta bisulfate in vacuum packed fresh British sausage. However the culture did not grow to the same level (from 10^7 to 10^9 CFU/g) as in the sausage without Na-meta bisulfate. Addition of $NaNO_2$ (100 ppm prolonged the lag phase of B-2 for 1 day at 10^0C (Andersen, 1997). Beside the anti-microbic effects typically for B-2, its applying in dry and semi-dry meat products results in improving their sensorial characteristics.

The mode of action for the inhibitory effect of B-2 on *Listeria* and other microorganisms is not specifically known. However, based on the mechanisms generally described in the literature, it is assumed that so called „competitive exclusion“ is the major reason for success of B-2, though unknown mechanisms could be responsible, as well. „Competitive exclusion“ is due to a critical balance between the growth of the competitive culture versus the contaminant at the specific conditions. That balance could be upset if growth parameters are changed for both microorganisms. In the case of B-2 the major competitive factors are: faster growth at storage conditions compared to the contaminant, faster utilization of easily fermentable nutrients, fast distribution at meat surface, quick removal of oxygen i.e. lowering the redox potential, production of inhibitory organic acids and lowering the pH.

Employing the bioprotective culture b-lc-48 (lactobacillus curvatus)

B-LC-48 is a single strain culture containing (*Lactobacillus curvatus*) (facultative anaerobic bacteria) in freeze-dried form. This bioprotective culture is recommended for bioprotection of different types of Ready-To-Eat food products which are packed under vacuum or modified atmosphere and cold-stored. Due to competitive exclusion and bacteriocin production *L.curvatus* contributes to suppressing growth of indigenous lactic-acid bacteria and *Listeria monocytogenes*. B-LC-48 grows at 4-40^0C and survives freezing. The culture does not ferment saccharose and lactose and, consequently, if lactose or saccharose are added, the acid formation will be limited. B-LC-48 is packed in water proof and air proof aluminium foil pouch. Culture should be stored at temperatures below -17^0C to have a shelf life for at least 18 months. At +5^0C the shelf life is at least 6 weeks. The culture is applied by spraying its suspension onto the product surface after cooking. It is necessary during the treatment salt to be limited below 10%.

Material and methods

Smoked, sliced and vacuum-packed chicken breasts in casing are used in this research. They are produced according to the usual technological procedure which is applied in meat processing facility "Lecker" in countryside of Trebosh - Tetovo.

After heat treatment and cooling, the products are sliced. Then slices are vacuum packed in polyethylene bags. Depending on the bioprotective culture used and the manner of its application, before vacuum packaging, the following five product groups were made:

1-reference products without bioprotective culture,

2-A-products with spray application of bioprotective culture B-2 SafePro,

2-B products with droplet application of bioprotective culture B-2 SafePro,

3-A-products with spray application of bioprotective culture B-LC-48 and

3-B products with droplet application of bioprotective culture B-LC-48.

The following bioprotective cultures are used: B-2 SafePro, single strain culture of *Lactobacillus sakei* in freeze-dried form, and B-LC48, also, single strain culture of *Lact. curvatus* in a convenient freeze-dried form. These bioprotective cultures should be stored at temperatures below -17^0C in order the shelf life to be at least 18 months. They are packed in aluminium foil pouches (25 g). These bioprotective cultures are product of Chr.Hansen, Danemark.

Following methods are used:

Culture preparation and application

The culture must be dissolved in non-chlorinated water. One pouch (25 g) is dissolved in ½ liter of water. One half of the solution is used for spray application and the other half for droplet application. Automatic dispenser standardized to a quantity of 0,25 ml is used for droplet application. One droplet of 0,25 ml is enough for 100 g of meat product. After the preparations, droplet and spray application with solution of bioprotective culture B-2 SafePro is done, and then in the same way B-LC-48 application is completed. It should be noted that spray application with plastic atomizer does not offer complete accuracy in terms of the solution amount that should be applied to the product surface. The solution should be applied on both sides of the sliced product. Because these products are vacuum-packed distribution of culture onto the surface are less critical.

pH measuring: before heat treatment, after heat treatment and 30 days after production. Digital pH-meter Metler Toledo MP 120 is used. pH values, before and after heat treatment are obtained by direct measuring with probe, and results are displayed on the pH meter.

Sensory characteristics examination (appearance, color, odour, taste, texture and consistence), 30 and 60 days after production.

Total number of bacteria examination (microbiological examination), 30 and 60 days after production.

Purge description at 40 days after production (clear, colorless or milky, slimy, thick).

Purge amount into packages (%)

That information is obtained by digital scale measuring (American Weight Scales, Inc.), with accuracy ± 0,1 g in vacuum-packed products before and after opening the bag, after previously removed purge. The purge is removed from the surface and from the inside of the bag by paper. After that the product is put again in previously opened bag, and then measured again. The difference between the weight of the product, before and after opening

the bag, expressed in percentage in relation to the weight of the product before its opening, expresses the purge extracted from the product during its keeping.

Results and discussion

Bioprotective cultures solubility, pH value and sensorial characteristics of smoked chicken breasts, produced with and without bioprotective cultures, is evaluated. The amount of purge is described and calculated and microbiological analyses are conducted.

It is concluded that bioprotective culture B-LC-48 is more difficult to dissolve compared to B-2 SafePro.

The results of pH value measurement, 30 days after production are presented in Table 1.

Table 1. pH values of the products

Days after production	Product groups				
30	1	2-A	2-B	3-A	3-B
	6,18	5,46	5,45	5,68	5,8

The lowest pH value is found in smoked chicken breasts where bioprotective culture B-2 SafePro is applied. pH value of 5.45 has been observed in products with droplet application of bioprotective culture, while the products with spray application have shown a pH value of 5.46. The highest pH (6.18) has been found in referent group of products that had not been treated with bioprotective cultures. The lower pH value is a factor that has a significant influence on extending the shelf life of the product.

The results from sensorial evaluation made in the periods of 30 and 60 days after production are presented in Tables 2 and 3.

Table 2. Sensorial evaluation of products, 30 days after production

Groups	Appearance	Colour	Odour	Texture	Consistence	Taste	Total
Points	1-5	1-5	1-5	1-10	1-10	1-15	Max.50
1	4,83	3,3	3,3	8,17	8,5	10,50	39,1
2-A	4,8	4,17	3,8	8,33	8,33	12,40	41,33
2-B	4,17	4,20	4,2	8,5	8,5	12,50	41,70
3-A	4,33	4	3,83	8,17	8,17	12,50	41
3-B	4,33	4,17	3,5	8,17	8,17	12,17	40,5

The products treated with bioprotective culture B-2 SafePro with droplet application, in total, are sensorially the most acceptable (41.70 points) 30 days after production. They, also, exhibit the best results regarding colour, odour, texture, consistence and taste.The referent group of products, without bioprotective cultures, has the worst sensorial grade in total (39.1 point).

According to the percentage of purge, 40 days after production (Table 4), it could be concluded that it is the lowest (2.73%) in the group of products treated with B-2 SafePro with droplet application (2-B). The same group of products has, also, the best results regarding the characteristics of purge (clear and slime-free with an excellent odour),

compared to the rest of the product groups. The highest amount of purge (3.74%) has been found in referent group that has not been treated with bioprotective cultures. This group has the worst purge characteristics: slimy, milky and thick.

Table 3. Sensorial evaluation of products, 60 days after production

Groups	Appearance	Colour	Odour	Texture	Consistence	Taste	Total
Points	1-5	1-5	1-5	1-10	1-10	1-15	Max.50
1	3,50	3,33	2,78	8,11	8	6,55	31,98
2-А	4	4,44	4,33	8,22	8	11	39,42
2-Б	4,33	4,44	4,67	8,22	8,55	11,2	40,8
3-А	4,33	4,22	3,44	7,44	8,11	8,77	36,55
3-Б	4	3,89	3,22	8,11	8,44	8,66	36,78

The products treated with bioprotective cultureB-2 SafePro with droplet application, also, in total, are sensorially the most acceptable (40.8 points), 60 days after production. The referent group of products, without bioprotective cultures, has the worst sensorial grade in total (31.98 points). The results for purge amount found in the bags, along with the description of the purge, 40 days after production are presented in Table 4.

Table 4. Purge amount and its description, 30 days after production

Product groups	Purge amount (%)	Description of the purge
1	3,74	Milky, thick and slimy
2-А	2,89	Milky, slime free, excellent odour
2-Б	2,73	Clear, slime free, excellent odour
3-А	2,99	Milky and slime free
3-Б	2,92	Milky and slimy

Microbiological examinations of referent group (without bioprotective cultures) and control groups (treated with bioprotective culture), have been done at the Veterinary institute, Skopje, 30 and 60 days after production. No pathogenic bacteria have been found, both, 30 and 60 days after production. However, the total bacteria count has been proven to be higher in referent group of products (without bioprotective culture) than the control groups (treated with bioprotective culture).

Conclusions

Based on the research results, the following conclusions can be presented:

Smoked chicken breasts treated with bioprotective cultures have lower pH values than products which are not treated with bioprotective cultures. The lowest pH value is found in smoked chicken breasts treated with bioprotective culture B-2 SafePro, droplet application.

Products treated with biprotective cultures are sensorially more acceptable then untreated products. The products treated with bioprotective culture B-2 SafePro, droplet application, are sensorially the most acceptable.Percentage of purge in vacuum packages is lower in products treated with bioprotective cultures than untreated products. Purge amount (%) is

the lowest in products treated with B-2 SafePro, droplet application. The same products have the most favorable purge characteristics. Total bacteria count is evidently higher in referent group of products which are not treated with bioprotective cultures compared to the control groups, treated with bioprotective cultures.

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УПОТРЕБА НА БИОПРОТЕКТИВНИ КУЛТУРИ ВО ВАКУУМ ПАКУВАНИ ПИЛЕШКИ ГРАДИ ВО ЦРЕВО

Пејковски Златко, Ужевска Дана

Апстракт

Предноста на користењето на биозаштитните култури произлегува од фактот дека не е потребно декларирање на Е-бројот кој е задолжителен при употребата на адитиви и предизвикува скептицизам кај широката потрошувачка маса. Целта на ова истражување е да се утврди влијанието на биозаштитните култури B-2 SafePro (Lactobacillus sakei) и B-LC-48 (Lactobacillus curvatus) при нивната апликација во производот вакуумирани димени пилешки гради во црево врз: pH вредноста, сензорните карактеристики, вкупниот број на бактерии и количеството и изгледот на издвоената течност во вакуум пакувањата. Во испитувањата се користени димени пилешки гради во црево, нарежани и пакувани во вакуум. Во зависност од употребената биозаштитна култура и начинот на нејзина апликација, пред вакуум пакувањето, изработени се следниве пет групи производи: 1-референтни производи без аплицирана биозаштитна култура, 2-А-производи со спреј апликација на биозаштитната култура B-2 SafePro, 2-B-производи со апликација со накапување на биозаштитната култура B-2 SafePro, 3-А- производи со спреј апликација на биозаштитната култура B-LC-48 и 3-B- производи со апликација со накапување на биозаштитната култура B-LC-48. При тоа димените пилешки гради со апликација со накапување на биозаштитната култура B-2 SafePro, во споредба со преостанатите групи производи, даваат евидентно подобри резултати за сите испитувани параметри.

Клучни зборови: биопротективни култури, pH, сензорни карактеристики, микроорганизми.

SECTION 7: NATURAL RESOURCES MANAGEMENT AND ENVIROMENT PROTECTION

UDC: 631.4(497.7)
UDC: 502.521:502.175(497.7)
Review paper

ESTABLISHMENT OF SOIL MONITORING SYSTEM IN REPUBLIC OF MACEDONIA

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Abstract
Soil is a finite natural resource. Land and soils deliver key ecosystem services and are pillars of the green economy. They support human well-being and provide sustenance for all including the poor, and are a source of new employment and economic progress. Unfortunately, their degradation is a serious global problem because of its adverse impact on their properties, on agricultural productivity, on food security, climate change, and sustainability of the ecosystem. In the Republic of Macedonia there has not been established monitoring of soil properties and soil degradation and therefore monitoring of the condition and changes of soil properties is necessary for soil protection, preservation of its natural functions and prevention of degradation processes. Soil monitoring implies continual monitoring of certain parameters of soil with purpose of gathering information on changes of the condition and characteristics of soil, and identifying the form and intensity of soil degradation. Without the development of the system by which information on negative changes in the soil would be continually gathered, there can be no timely response to prevent or alleviate such changes.
Key words: soil, monitoring, soil properties, soil degradation, soil protection.

Introduction

"Because it's everywhere, we tend to overlook the fact that soil is a limited natural resource" (Rio + 20: Goals for Healthy Soils and the Role of the Global Soil Partnership). All soil researchers emphasize that soil is a finite natural resource. Technically, the soil is a renewable natural resource, because its formation goes on perpetually. However, due to the fact that pedogenesis is a very slow process, the soil is non-renewable for all practical purposes, which is why according to (Varallyay 2000 and Montanarella 2007), cit. Ličina V. et. al. (2011), scientists classify it as a conditionally renewable resource. Soil formation and restoration on the geological substrate take thousands of years, whereas the processes of soil degradation and soil loss are sometimes much more rapid and might occur in a matter of seconds or minutes, such as is the case with soil erosion or other kinds of natural or anthropogenic accidents.

As a dynamic polydisperse system with its many functions, the soil provides support for the entire ecosystem. It is a reactor, transformer and integrator of material and energy from other natural resources (solar radiation, atmosphere, surface and subsurface waters, biological resources). Soil is

the foundation of agricultural development and ecological sustainability, provide the basis for food, feed, fuel and fiber production, clean water availability, nutrient cycling, organic carbon stocks, one quarter of global biodiversity, and serve as a platform for construction and construction material. These functions are performed on different levels and are determined by inherent soil characteristics (e.g. texture, organic matter content, pH, cation exchange capacity, porosity etc.) and external environmental (climate, terrain, hydrological, biological) and anthropogenic (soil-use and management) factors (Georgely T. et.al 2007).

"The Father of India's Green Revolution", M. S. Swaminathan said that *"Soil anaemia also breeds human anaemia. Micronutrient deficiency in the soil results in micronutrient malnutrition in people, since crops grown on such soils tend to be deficient in the nutrients needed to fight hidden hunger. (...) Managing our soil and water resources in a sustainable and equitable manner needs a new political vision."*

However, despite the essential role that soil plays in the life of people, there is increasing degradation of soil resources due to inappropriate practices, burgeoning population pressures and inadequate governance over this essential resource. These include: decline in biodiversity and organic matter, erosion, compaction, floods and landslides, contamination (local and diffuse), sealing and salinization (Margareta Cvetkovska, Tatjana Mitkova.et.al 2007, Татјана Миткова et.al 2009). Therefore, the issue of the maintenance of soil resources is not merely an academic question, it is also an obligation owed to nature by both the individual and society as a whole.

Soils are often perceived as a second-tier priority and no international governance body to support coordinated global action on their management exists. For these reasons, FAO and a group of partners have launched the Global Soil Partnership (GSP) to improve global governance of the world's soil resources in order to guarantee healthy, productive soils for a food secure world - and to work together to sustain other essential ecosystem services on which our livelihoods and societies depend. Soil monitoring is an integral part of environment protection system and a major instrument of decision-making for the sustainable management and cost-efficient utilization of this resource (Sekulic et al. 2011).

Monitoring is the process of repeated observing, for defined purposes, of one or more elements of the environment according to pre-arranged schedules in space and time and using comparable methodologies for environmental sensing and data collection. It provides information concerning the present state and past trends in behaviour of the soil, or according to Bašić (2002), the soil protection strategy can be represented as shown below:

4M + 2P or 4M = Monitoring + Measuring + Mapping + Modeling + 2P = Predicting + Prevention

The significance of soil monitoring was emphasized by the European Union which, by Decision No 1600/2002/EC, raised the significance of soil protection to the level of water and air protection. In 2006, the European Commission gave a Proposal for a Directive of European Parliament and of the Council establishing a framework for the protection of soil and amending Directive 2004/35/EC, COM (2006)232) whose goal is to ensure soil protection based on principles of protection of soil functions, prevention of soil degradation, alleviation of effects of degradation and repair of degraded soils.

Where we are?

Macedonia has a long tradition of monitoring environmental quality, particularly in the fields of water and ambient air. Monitoring of biosphere, waste and noise are in the initial stages. The most

important institutions involved in monitoring are the Ministry of Environment and Physical Planning (MEPP), the Hydrometeorological Administration (HMA), Institute for Public Health of the Republic of Macedonia (IPHRM) and the corresponding regional bodies (Environmental Monitoring Strategy, 2004).

Due to the fact that R. Macedonia is an agricultural country, it is important understand the role of the soil as an indispensably resource for this practice. However, in our country the process of monitoring soil properties and soil degradation has not been implemented yet, i.e. the current legislation does not cover soil monitoring. According to the Law on Agricultural Land, the Ministry for Agriculture, Forestry and Water Supply should define the substances that are harmful to the agricultural land and their maximum allowed concentration in the soil. However, the corresponding book of regulation has not been prepared. Soil monitoring is done within different projects, but without coordination between the projects. That is why establishing a monitoring system for the soil properties conditions and changes is more than necessary for their protection, as well as for protection of the natural functions of the soil and prevention of the degradation processes. Total area of the Republic of Macedonia (25,713 km^2), 44,04% is still an important agricultural area (source: map CORINE Land COVER, Environmental Indicators of the Republic of Macedonia, 2008). Land use distribution in the R Macedonia (in %) and land distribution by bonity classes in % are given in Table 1 and Figure 2.

Following trends can be distinguished: around 17,35% of the territory is classified as unproductive land; only one-half of agriculture land is arable land. This represents one-fourth of the territory; only 8 % of the arable land belongs to the higher land use classes. The reduction of the arable surfaces continues in its most fertile sections as the result of different types of degradation.

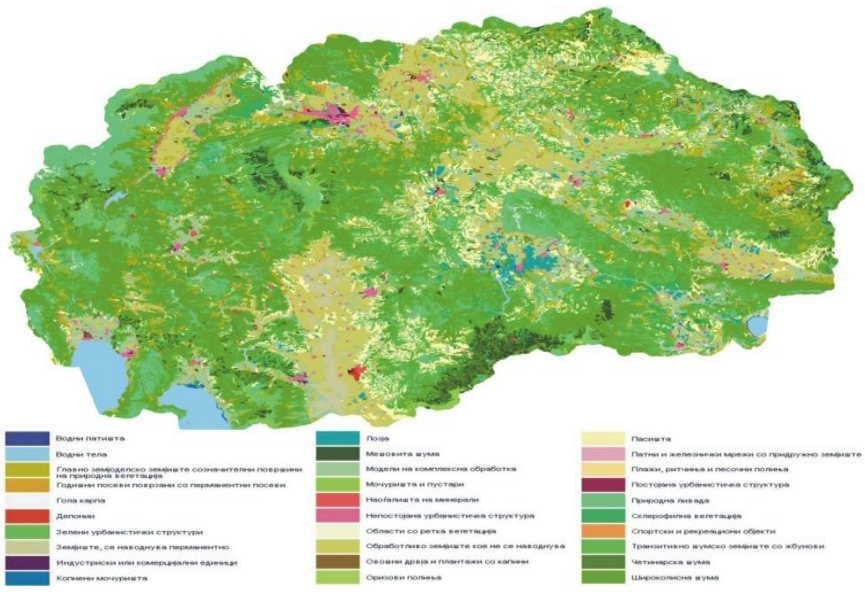


Figure 1. Map CORINE Land COVER, source: Environmental Indicators of the Republic of Macedonia, 2008

Table 1. Land use distribution (ha and %)

Land use distribution	Area in ha	Total land percentage	Arable land percentage; unproductive land percentage
Total land	2.543.216	100,00	-
1. Productive land	2.101.812	82,64	-
1.1. Forest land	981.812	38,60	-
1.2. Agriculture land	1 120.000	44,04	-
1.2.1. Pastures	608.000	23,90	-
1.2.2. Arable land	511.000	20,09	100,00
1.2.2.1.Ploughlands and vegetable gardens	415.000	16,32	81,21
1.2.2.2. Orchards	14.000	0,55	2,74
1.2.2.3. Vineyards	21.000	0,82	4,11
1.2.2.4. Natural meadows	61.000	2,40	11,93
2. Unproductive land	441.404	17,35	-

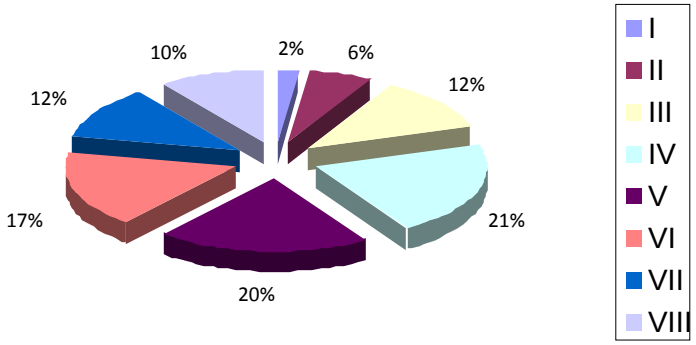


Figure 2. Land distribution by bonity classes in %

What we have to do

Following the Stabilization and Association Agreement between the Republic of Macedonia and the European Communities and their Member States, Macedonia is contract-bound to approximate its national legislation to the relevant EC legislation. This process of approximation includes approximation to a large number of EC legal obligations in the environmental sphere. Monitoring, in the comprehensive EC sense of the word, plays an important role in most of the relevant environment-related EC directives as well as the transposed Macedonian draft laws.

Structural changes in the Republic of Macedonia in the recent decade have given rise to overlaps concerning the responsibilities for monitoring and the activities of different institutions. Many activities are regulated by laws that are more than 30 years old. The monitoring responsibilities have varied for different environmental media. Since there was no overall national strategy or institution that integrated and coordinated the monitoring activities, the responsibilities and activities have been split between different Ministries or other institutions. There are overlaps regarding the institutional responsibilities and activities for some of the environmental media and gaps for others.

For successful and efficient management with its natural resources, each country must prepare its inventory by preparing appropriate maps (foundation) in a modern digital format, as well as establish adequate databases where the graphic (charts, maps, satellite images etc.) will be stored and interconnected with the appropriate tables where numerical data are contained defining and quantifying the natural resources (attributive data).

The preparation and printing of the Soil Map of the Republic of Macedonia will represent not only a sublimation of the efforts that have been put in the course of several decades by a pleiad of experts in the field of the study of soils, but also creation of a powerful toll in the country's economic development planning process especially in agriculture, forestry, rural development, protection of the environment (especially soils under degradation), prevention of any changing of the agricultural soils' application, realization of land consolidation and arrondation, preparation of the agricultural bases of certain areas, spatial planning, organization of the organic agricultural production etc.

Establishment of soil monitoring system

Soil quality varies with site conditions and management practices. Soil quality monitoring may be performed at several levels, from global estimates for the entire country or its parts to estimates for a single production plot.

Monitoring programmes, as part of the entire concept, must be agreed upon beforehand by the monitoring partners. Data, information and decisions constitute part of a strategy. Such monitoring programmes are the outcome of communication between the experts involved in designing such systems together with the decision-makers (or the population) making use of the information. Monitoring programmes aim to yield relevant information at reasonable costs. The monitoring should be viewed and implemented as:

– monitoring and protection of agricultural land (systemic control of the soil fertility, testing the soil's heavy metal content and other hazardous substances, examining the effect of fertilizers on crop quality and yield and examining the changes in the soil's chemical properties as well as the irrigation water quality) and

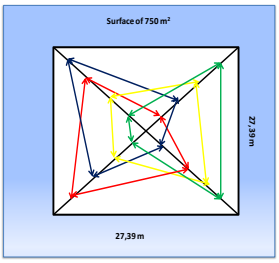
– soil monitoring for environmental protection and sustainable development (systemic observation of soil quality through observing the soil degradation assessment indicators, as well as undertaking and implementing remedial measures to eliminate the consequences of soil contamination and degradation regardless of whether they occur naturally or as a result of anthropogenic degradation).

Technical aspects of monitoring (networks, parameters and methods). The soil monitoring will be realized in 3 phases:

– field survey including collection of soil samples for laboratory analysis (ISO 10381-1:2002 and ISO 11464:2006);

– laboratory analysis (chemical, physical, physical-mechanical, biological, productive properties, etc.) are in accordance with the ISO standards

– statistical processing of the results.



Soil sampling sheme



Soil sampling of the profile in undisturbed condition

Figure 3. Soil sampling sheme and soil sampling of the profile in undisturbed condition

As a conclusion

Why monitoring?

Set up one single monitoring system at the state level.

Manage and maintain the data base for soil quality.

Provide information for the management of soil quality regarding soil quality control, identification of priorities, information of the public about soil quality and alert situations

Fulfill international obligations.

Such system will enable the different applications regarding food security, climate change mitigation and adaptation, provision of ecosystem services, soil suitability analysis, soil degradation assessment, etc.

The system will also allow the integration of soils with other disciplines and will be fundamental for monitoring the status of soils as per human interventions though land use changes and climate change impacts.

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ВОСПОСТАВУВАЊЕ НА МОНИТОРИНГ СИСТЕМ НА ПОЧВИТЕ ВО РЕПУБЛИКА МАКЕДОНИЈА

Татјана Миткова, Миле Маркоски

Апстракт
Почвата е ограничен природен ресурс. Во екосистемот, земјиштето и почвите обезбедуваат клучни функции и се столбови на зелената економија. Тие се подршка за благосостојбата на човечката цивилизација во насока да се обезбеди храна за сите, вклучително и за сиромашните, и се ресурс за нови вработувања и економски напредок. За жал, нивната деградација е клучен глобален проблем бидејќи има негативно влијание на нивните својства, врз продуктивноста на земјоделското производство, врз безбедноста на храната, климатските промени и одржливоста на екосистемот. Во Република Македонија не се спроведува мониторинг на почвените својства, ниту за почвената деградација. Затоа, воспоставувањето на мониторинг на состојбата и промените на почвените својства е повеќе од потребно за нивната заштита, за заштита на нејзините природни функции и за превенција од процесите на деградација. Мониторингот на почвата подразбира континуирано следење на одредени параметри на почвата со цел собирање информации за промените на состојбата и карактеристиките на почвата, и идентификување на формата и степенот на нејзината деградација. Без развој на систем со кој постојано ќе се собираат информациите за негативните промени во почвата, не може на време да се одговори односно да се преземат мерки за да се спречат или намалат ваквите промени.
Клучни зборови: почва, мониторинг, почвени својства, почвена деградација, заштита на почвата.

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Original scientific paper

TOBACCO STALKS AS RENEWABLE RAW MATERIAL FOR AGRO-INDUSTRIAL UTILIZATION

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Abstract
Tobacco stalks as agricultural waste are renewable raw material that can be converted into useful products and energy. It is noteworthy that, at 40 % moisture content, about 5 tons of tobacco stalks per hectare and year are produced only in six months duration. The objective of this study was to determine the morphological properties and chemical composition of stalks of Burley tobacco, variety B 98/N (cellulose, *Klason* lignin and acid soluble lignin, ash, total nitrogen and dry matter) and to evaluate its suitability for agro-industrial utilization. After harvesting of the leaves, part of the stalks were collected and air-dried in greenhouse and the rest were left to dry in field, under atmospheric conditions. The stalks were analyzed according to ASTM standard methods for the determination of moisture, ash, and lignin. The *Kurshner-Hoffer* method was used for determination of cellulose. The average values of length, diameter, and weight of dried tobacco stalks were determined as 170 cm, 8.5 cm, and 210 g, respectively. Content of cellulose was found to be 38.5 % in air-dried stalks and 36.4 % in field dried stalks. Contents of total lignin, *Klason* lignin and acid soluble lignin in air-dried stalks were 22.5 %, 20.7 % and 1.80 %, respectively. The results indicate that cellulose and lignin content in air-dried stalks are slightly higher, compared to those dried in field. It was found that 30 % of the nitrogen, 18 % of the ash, and 35 % of the organic matter may be lost from tobacco stalks if they are dried in field.
Key words: tobacco, stalks, cellulose, lignin, utilization.

Introduction

Tobacco (*Nicotiana tabaccum* L.) is an annual plant of 0.8-2.5 meters in height depending on the variety. It is grown and culturally managed for high quality grade leaf for manufacturing a number of tobacco products. Every year, large amounts of tobacco stalks are produced, most of them being disposed of as wastes, incorporated into soil or burned in the field (Agrupis and Maekawa, 1999). This agricultural waste from harvesting of tobacco farms are useful substitute for traditional wood raw materials in the pulp and paper industry and xylose (Shakhes *et al*., 2011; Akpinar *et al*., 2011). Agricultural residues such as tobacco stem are renewable sources of energy (Sun and Cheng, 2002; Martin, *et al*., 2008). Tobacco waste presents an alternative to inorganic fertilizer. It is possible to

use tobacco stalk as a soil amendment due to its high organic matter and low toxic element content (Okur, *et al*., 2008; Chaturvedi *et al*., 2008).

Tobacco stalk is composed largely of cellulose, a polymer of glucose; hemicellulose, a complex polymer of which the main chain consists primarily of xylans or glucomannans; and lignin, a complex phenolic polymer (Agrupis *et al*., 2000; Kajita *et al*., 2002). They are consisting of phloem and xylem cells and its hardening begins as floral initiation occurs. Delaying topping till full bloom allows the stalks to harden and accumulated lignin, cellulose and hemicellulose (Palmer and Perace, 1999; Flower, 1999). Cellulose and lignin are crucial for structural integrity of the cell wall and stiffness and strength of the tobacco stalk and root. In addition, lignin waterproof the wall enabling transport of water and solutes through the vascular system, and they play a role in protecting plants against pathogens. The secondary cell wall thickenings that form the spiral rings of the tobacco xylem elements are rich in lignin in addition to cell wall materials. Lignin is concentrated in the xylem elements of the vascular bundle in the leaf tissue and xylem elements of the stalk tissues. Cellulose along with hemicellulose and pectin are deposited in the primary and secondary cell walls of the various cell types (Esau, 1967; Hepworth and Vincent, 1998). Commonly used method for the quantitative determination of cellulose in hardwood and softwood materials is Kurshner-Hoffer method. This gravimetric method involves multi step extraction of noncellulosic compounds from plant material (Browning, 1967, ASTM, 1993).

Unlike the other cell wall components of tobacco plant, the lignin is mostly insoluble in mineral acids. A method developed by the ASTM is the most commonly employed method for determination of the lignin in wood and non wood samples (Agrupis and Maekawa, 1999). The approach, a modification of the Klason process consists of treating the stalk samples with 72% sulphuric acid, followed by a dilute acid step, to hydrolyze the polysaccharides, extracting of the majority of the lignin as an insoluble residue. This acid insoluble lignin is quantified gravimetrically after extraction and filtration. This value, however, does not represent the total lignin content of the sample. A small portion of the lignin is solubilized during the hydrolysis and its remaining dissolved in the filtrate from insoluble lignin preparation. This lignin fraction is referred to as acid soluble lignin and may be quantified by ultraviolet spectroscopy, which relies on the acid soluble lignin's adherence to Beer's law (Agrupis and Maekawa, 1999, Akpinar *et al*., 2011). An absorptivity (extinction coefficient) value of 110 $L/mol^{-1}cm^{-1}$ is used to calculate the amount of acid-soluble lignin present in the hydrolysate. The 205 nm absorptivity reported for most woods fall in the range of 88 to 113 $L/mol^{-1}cm^{-1}$. (Kaar and Brink, 1991). Together, the acid insoluble and soluble determination quantify the total lignin content of a sample.

Tobacco is an important crop in the Republic of Macedonia and significant efforts are made to restart production of Burley tobacco. About 5 tons of stalks from this tobacco type per hectare in year are produced in only six months duration. The literature findings showed that stalks and other tobacco waste could be used in various products, in the production of pulp and paper, bio-ethanol, as well as, inorganic fertilizer (Sun and Cheng, 2002; Chaturvedi *et al*., 2008; Martin, *et al*., 2008; Shakhes *et al*., 2011).

The objective of present work was to determine the usability of dried tobacco stalks. The morphological properties and chemical composition of stalks of Burley tobacco type (B 98/N variety) were investigated to evaluate its agro-industrial usability. Also, considered the influence of the manner of drying on chemical composition of stalks was evaluated.

Material and methods

Plant Material. The field and laboratory research was set up in Scientific Tobacco Institute-Prilep in 2010 and 2011 years. Tobacco variety B 98/N was grown according to the standard agriculture practice for tobacco type Burley, on plant spacing of 50 cm within and 90 cm between rows, i.e. at planting density of about 22 000 plants per ha. Six tobacco harvests were harvested according to the conventional regime. The morphological traits of forty stalks of the middle plot row, i.e. length, diameter, and weight, as well chemical composition of stalks were determined.

Stalk Drying Treatments. After harvesting the leaves, forty stalks were marked. Twenty of marked stalks were air-dried in greenhouse until achieving moisture content of 15-20 %. Other twenty tobacco stalks were left to dry in field one month, under atmospheric conditions. Ten stalks from the two manner of drying were analyzed whole and ten were cut into upper, medium and lower leaf position. First, stalks were cut into smaller pieces to about 3-5 cm length and then ground by a Retsch ZM1 mill (Germany) to pass a 110 mm screen. Final sizing of powdered samples was done through the use of a sieve of 0.5 mm.

Chemicals. For cellulose and total nitrogen determination of stalks reagent grade 96 % ethanol, sodium hydroxide, Kjeldahl catalyst (Cu-Se), 0.1 mol/L hydrochloric acid, 65% nitric and boric acid (Merck, Germany) were used. Determination of acid insoluble and acid soluble lignin was done with analytical grade 72% sulphuric acid purchased from Merck (Germany).

Characterization of stalk. The moisture content was determined by drying at 105 ^{o}C till constant mass. The ash content in stalk was determined by dry oxidation at 575 ^{o}C till constant mass achievement. The nitrogen content (N) was determined by *Kjeldahl* method (Veverka *et al.,* 1993). The nitrogen was quantified by mineralization within a strong acid medium, containing 98% sulphuric acid, followed by steam distillation and titrimetric determination of NH^{+4}/NH_3.

Determination of cellulose. The cellulose content was determined following *the Kurshner-Hoffer* approach, by treating 2 g of sample with 50 mL of alcoholic nitric acid solution under reflux, during four cycles per 1h. After each cycle, the alcoholic nitric acid solution was removed and a fresh amount was added. At the end of the four cycles, the cellulose was filtered, washed, dried and weighed.

Determination of Klason acid insoluble lignin. The mixture of ground tobacco stalk (0.3 g) was mixed with 72% sulphuric acid (3 mL) was heated at 30 ^{o}C, 1h with stirring. After adjusting of acid concentration to 4 % w/w by adding deionised water, the mixture was autoclaved at 125 ^{o}C and 15 psi pressure, for 1h. Acid insoluble lignin was defined as the residue corrected for acid-insoluble ash, retained on a medium porosity filter crucible after the primary 72% and secondary 4% H_2SO_4 hydrolysis steps.

Determination of acid soluble lignin. Acid soluble lignin was determined by measuring the absorbance of the hydrolysate at 205 nm wavelength on a Varian Cary Scan 50 spectrophotometer (Switzerland) in 1cm quartz cells, at 25 ^{o}C. Acid soluble lignin content was calculated using the extinction coefficient of 110 $L/mol^{-1}cm^{-1}$ (Kaar and Brink, 1991). The total lignin content was obtained by the addition of acid insoluble or Klason lignin and soluble lignin obtained by both methods.

Statistical analysis. Statistical analysis was performed using STATISTICA 8 software (StaSoft, Inc., Tulsa, USA).

Results and discussion

The dried stalks of Burley tobacco type (B 98/N variety) were characterized with 179 cm length, diameter of 8.5 cm and 210 g weight (mean values). The air dried stalks were with good shape and free from fungal attack or other degradation. Darker color and signs of degradation caused by exposure to water and wind were determined at the stalks left to dry in the field.

The chemical analysis of whole tobacco stalks, air and field dried stalks, is presented in Table 1. Each presented data stands for the average values of the two years survey. The cellulose was determined as major component, followed by acid insoluble lignin.

Table 1. Chemical composition* of the air dried (A) and field dried (F) tobacco stalks.

	Cellulose		Total lignin		Acid insoluble lignin		Acid insoluble lignin	
	A	F	A	F	A	F	A	F
Average value (%)	38.53	36.38	22.47	21.32	20.72	19.43	1.77	1.90
Standard deviation	0.12	0.15	0.16	0.12	0.12	0.15	0.05	0.06
Relative standard deviation (%)	0.31	0.40	0.73	0.55	0.56	0.77	2.92	3.33

*Calculated to the corresponding dry matter weight.

The average cellulose content of 38.53% determined in air dried stalks was higher than cellulose content of 36.38% found in field dried stalks. The air dried and field dried stalk were characterized with the total lignin content of 22.47% and 21.32%, respectively. The acid insoluble content in air dried stalks (20.72%) was more than eleven times higher that soluble lignin content in it (1.77%). Content of acid soluble lignin content in field dried stalks was found to be 1.90%, which was slightly higher than of air dried.

The published data highlighted that the genetic makeup and cultural management conditions have the primarily influence on morphological characteristics and chemical composition of tobacco plant (Flower, 1999). The cellulose content in the tobacco stalk, stem and mid-rib portion of the leaf is higher than its content determined in the lamina portion of leaf. In the process of drying the absolute content of cell wall polymers does not change. Due to the reduction of the content of the other organic materials in the stalk and steam, the content of cell wall polymers increases (Tso, 1990; Agrupis and Maekawa, 1999).

In Table 2 is presented the quantity of cellulose, lignin and ash determined in the air dried and filed dried tobacco stalks.

Table 2. Comparison of chemical composition of tobacco stalks.

Constituent	Tobacco stalk		Tobacco stalks (Shakhes *et al*., 2011)	Tobacco stalks (Akpinar *et al*., 2011)
	A	F		
Cellulose (%)	38.53	36.38	39.20	not analyzed
Total Lignin (%)	22.47	21.32	18.90	24.50
Acid insoluble lignin (%)	20.72	19.43	not analyzed	23.00
Acid soluble lignin (%)	1.77	1.90	not analyzed	1.50
Ash (%)	5.90	4.84	6.86	6.40

The cellulose contents determined in B 98/N tobacco variety were slightly lower than cellulose content established by Shakhes *et al*. (2011). In relation to the content of lignin in stalks, Akpinar *et al*. (2011) determined content of acid insoluble lignin of 24.50% and 23.00 % acid soluble lignin. The total lignin content of 18.90% confirmed by Shakhes *et al*. (2011) was lower, compared with the data obtained from this research and from Akpinar *et al*. (2011). The ash content of 5.90 % and 4.84 % determined in air and field dried stalks was lower that ash content published in literature (Akpinar *et al*., 2011; Shakhes *et al*., 2011). According to the obtained results for cellulose content determined in the different parts of stalks, exactly, in the lower, the middle and in the upper part, can be concluded that the cellulose content is highest in the lower part of the stalk, 39.3% in air dried and 37.9% on field dried stalks (Figure 1). In both variants of stalks, in the upper part quantity of cellulose content is the lowest, compared with the cellulose quantity in lower and middle part of stalks. The differences in the determined quantities of lignin in the examined parts of the stalks, in air dried and filed dried stalks, were insignificant. The biggest quantities of lignin of 23.00 and 21.80% were determined in the upper part of air dried and field dried stalks, respectively. In relation to the content of lignin in different part of Burley stalk, Agrupis and Maekawa (1999) determined higher content of acid insoluble lignin of 17.9% in lower and 17.2% in upper part. The content of acid soluble lignin in lower part was 3.1% and 3.3% in upper. They found higher cellulose content in lower and upper part of stalk (40.1% and 39.5%, respectively) in comparison to our results (39.30% and 37.90%, respectively).

In terms of chemical composition (Figure1) the lower part of the stalks contains higher cellulose and lignin than the middle and upper part which is expected since the latter is less mature, hence, less fibrous and less lignified.

On the other hand, the upper part of the stalks contains more ash and total nitrogen than the lower one. Ash content increasing from the lower to the upper part of the air dried stalk and was 5.13%, 5.88% and 6.69%, respectively (Figure 2).

Identical dynamics of ash content is noted in field dried stalk, but that variant has smaller values. In relation to the content of ash, Agrupis and Maekawa (1999) determined higher content (7.9% and 10.2%, respectively) in comparison to our results.

The nitrogen content determined in field dried stalk (low, middle and upper part) differed significantly from the air dried stalk (Figure 2). In the low and medium part of air dried stalks, total

nitrogen quantities of 0.84% and 0.92% was established. In upper part the ash content in the highest and reaches 1.25%.

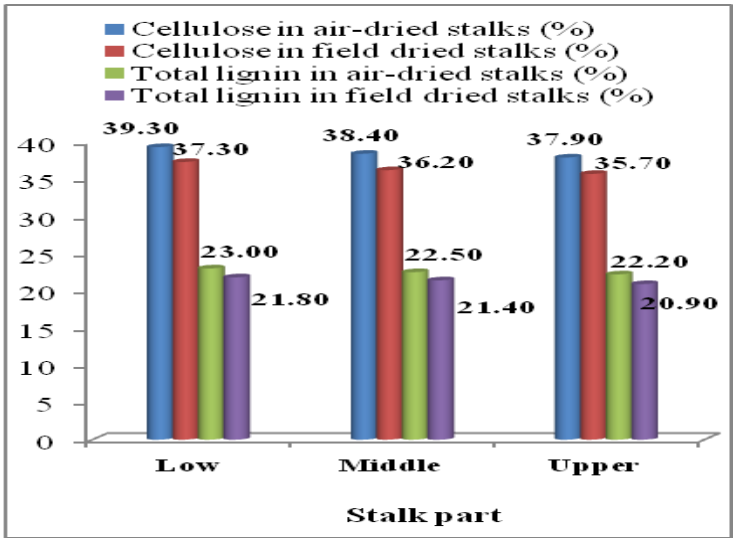


Figure 1. Cellulose and total lignin dynamics in relation to the stalk position

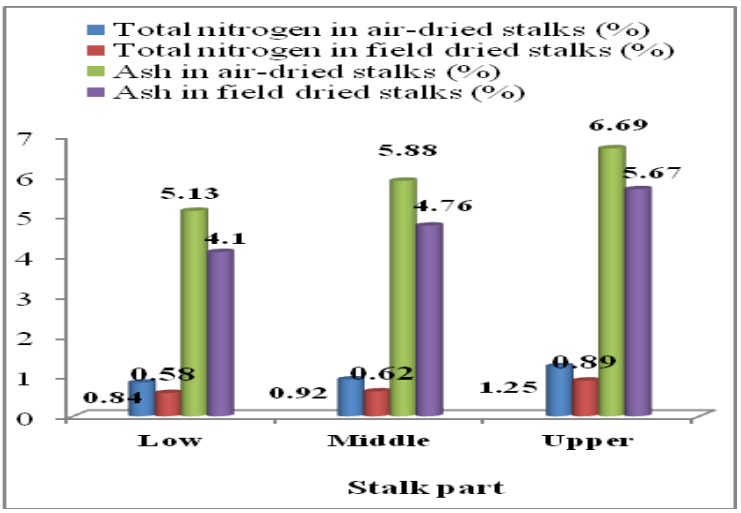


Figure 2. Total nitrogen and ash dynamics in relation to the stalk position

Method for lignin determination is optimized for tobacco stalks, and consists of two steps. The first step performs the determination of acid-insoluble lignin, and the filtrate is used to determine acid soluble lignin. This enables the content of insoluble and soluble lignin to be determined in the same sample. A reliable analysis of total lignin can be accomplished on as little as 300 mg of sample with a relative standard deviation of 0.73 and 0.55.

High cellulose content and lignin are considered desirable for pulp and paper industry because it have been correlated with high pulp yield (Agrupis et al., 2000; Shakhes et al., 2011). For bio-

ethanol production, the efficiency of cellulose hydrolysis had been found to be positively correlated with materials which have high cellulose and low lignin content (Martin, et al., 2008; Sun and Sheng, 2002). This means that due to the higher value of lignin and lower cellulose field dried stalks have lower usability for pulp production. The higher ash content has negative impact to pulp yield (Shakhes et al., 2011). Increasing the rate of nitrogen fertilizer (up of 300kg N/ha) increases the amount of ash, and concentration of nicotine, total and protein nitrogen (Pospišil et al., 1998). Although the content of the ash was sufficiently high, because the lower nitrogen content the stalks haven't potential for application as soil fertilizer.

Conclusions

The results of this work show that the analyzed components in dried stalks of tobacco variety B 98/N are present in quantities comparable with the literature data.

The proposed analytical methods are suitable for the reliable characterization and quantification of cellulose and lignin in tobacco stalks.

Tobacco stalks posses high cellulose content and lignin are considered desirable for pulp and paper industry.

Although the content of the ash was sufficiently high, because the lower nitrogen content the stalks haven't potential for application as soil fertilizer.

The utilization of this material for pulp and ethanol production does not only solve the proper disposal of these wastes, but also provides an opportunity to use tobacco for unconventional purposes.

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ТУТУНСКИТЕ СТРАКОВИ КАКО ОБНОВЛИВА СУРОВИНА ЗА АГРО-ИНДУСТРИСКО ИСКОРИСТУВАЊЕ

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Апстракт

Тутунските стебла како земјоделски отпад претставуваат обновлива суровина што може да се преработи во корисни производи и во енергија. Може да се забележе дека околу 5 тони тутунски стебла по хектар со 40% содржина на влага се произведуваат за само шест месеци. Целта на овој труд е да се утврдат морфолошките својства и хемискиот состав на стеблата од тутунот од типот Берлеј, сорта Б 98/ N (целулоза, Klason лигнин, лигнин растворлив во киселина, пепел, вкупен азот и сува материја) и да се оцени нивната соодветност за агро-индустриска употреба. По бербата на листовите, дел од стеблата се собрани и воздушно сушени во стаклара, а останатите се оставени да се сушат во поле, под дејство на атмосферските услови. Во стеблата се одредени содржината на влага, пепел и лигнин според ASTM стандардни методи. Метод по Kurshner-Hoffer е употребен за утврдување на застапеноста на целулозата. Просечните вредности за должина, дијаметар и тежина на исушените тутунски стебла изнесуваат 170 cm, 8,5 cm и 210 g, соодветно. Содржина на целулоза изнесува 38,5% во воздушно исушените стебла и 36,4% во стеблата сушени во полски услови. Содржината на вкупниот лигнин, Klason лигнинот и во лигнинот растворлив во киселина во воздушно исушените стебла изнесува 22,5%, 20,7% и 1,80%, соодветно. Резултатите покажуваат дека вредностите за целулоза и лигнин во воздушно исушените стебла се малку повисоки, во споредба со сушените во полски услови. Исто така, може да се каже дека кога тутунските стебла се сушат во полски услови има губиток од 30% од азотот, 18% од пепелта, и 35% од органските материи.

Клучни зборови: тутун, стебла, целулоза, лигнин, употреба.

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THE WATER FOOTPRINT AS A MEASURE OF THE AGRICULTURAL WATER CONSUMPTION AND POLLUTION

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Abstract
The world's water resources are under increasing pressure due to consumption and pollution associated with different human activities. Around 70% of the current water withdrawals are for agricultural production. This quantity refers to the volume of water withdrawn from various sources and generally used for crop cultivation during dry periods of year. The water footprint is an indicator that gives a new dimension to the analysis of the global water consumption and pollution patterns. This is an indicator that incorporates not only the "traditional" water consumption as a result of water withdrawals (blue water), but also consumption of water that is readily available in the nature (green water), as well as the "consumption" of water that is required to assimilate the pollution discharged (grey water). The total water footprint in agricultural production in the world is 8,363 km^3/yr, out of which 7,404 km^3/yr is the water footprint of crop production. The share of animal production in the total agricultural water footprint is 29% or 2,422 km^3/yr. Considering the total global water footprint of humanity of 9,087 km^3/yr, agricultural production has the largest share of 92.0%. The agricultural production consumes the entire green water component of the global water footprint of humanity, whereas its share in the blue water component is 92.2%. Because of its considerable share in the grey water footprint of humanity (65.6%), the agricultural production can be considered the largest water polluter in the world.
Key words: water consumption, agriculture, water footprint.

Introduction

The available fresh water resources are distributed unevenly on the planet. The average global renewable water resources, which are in most part comprised of the surface water flows, reach a total of 42,780 km^3/yr (Shiklomanov, 2000). The largest available quantities are found in Asia and South America (13,510 and 12,030 km^3/yr respectively), and the least in Australia and Oceania (2,400 km^3/yr) and Europe (2,900 km^3/yr). The average global renewable water resources per capita are around 7,600 m^3/person/yr (Vučijak *et al.*, 2011). Australia and Oceania have the largest available volume (83,700) and in Asia water is the least available (3,920 m^3/person/yr). The presented numbers are constantly changing due to the population growth in the world. Based on the UN estimates, the global population of around 1.65 billion at the beginning of the 20th century increased to over 6 billion by the end of the century (Vučijak *et al.*, 2011). The UN predicts that the population will reach 9 billion by 2050. The population growth between 1970 and 1994 caused

diminution of available water resources from 12,900 to 7,600 m^3/person/yr (Shiklomanov, 2000). The largest decline rates were observed in Africa (around 2.8 times), Asia (2.0 times) and South America (1.7 times), whereas in Europe the available water resources per capita declined by only 16%.

Data on the global water consumption indicate that the largest share (around 70%) is used in agriculture (Appelgren, 2004) for the irrigation of approximately 250 million hectares of arable land in the world. This is only 17% of the global arable land, but it provides more than 1/3 of the world's harvest. In order to provide food for increasing population, more and more land has to be cultivated and irrigated. Livestock farming has been increasingly using water in the recent years as well. In many countries over 90% of water withdrawn is used for irrigation, and in many European countries (e.g. Spain, Portugal, Greece) this share is over 70% (Saejis and van Berkel, 1996). Irrigation is essential particularly in developing countries, which strive to secure enough food for their populations.

The afore-mentioned consumption is mostly related to water withdrawn from the environment and delivered to crops in dry seasons in order to secure their growth and development. These interventions offset the water deficit in the soil, which cannot be achieved by natural processes, e.g. by precipitation, surface or ground water recharge, etc. The volume of water required for irrigation is typically quantified based on the crop evapotranspiration rate ET_c (e.g. Hoekstra and Hung, 2005), which is a complex process of transferring moisture by evaporation of water from wet surfaces – soil and water, and transpiration from plants (Ćerić *et al*., 2003).

The volume of water used for irrigation is a typical indicator of the water consumption in agriculture. Although this indicator gives some useful information, it does not provide full picture in regard to the total water requirements for the production of agricultural products. This paper presents the agricultural water consumption expressed as the water footprint, which is an indicator introduced in 2002 with the aim to comprehensively assess the volume of water used in production or in different human activities.

Material and methods

Numerous human activities consume or pollute water – e.g. irrigation, swimming, cleaning, washing, cooling, processing, etc. Until recently, the total consumption or pollution of water were considered as the sum of consumption or pollution from each individual activity. However, Hoekstra (2003) introduced an idea that the consumption and pollution of water should be considered in the entire production and consumption chain, and should be measured by the water footprint.

The water footprint is defined as the total volume of freshwater that is used to produce the goods and services consumed by an individual or community (Hoekstra and Chapagain, 2008). It is an indicator that considers not only the volume of water that is directly used in a production or consumption process, but indirect use of water as well. In this context, direct consumption refers to the use of water in any particular process, whereas indirect (virtual) consumption is the volume of water used for products or services that are inputs in the considered process (Figure 1). The water footprint is therefore the total volume of water used in all phases of the production or consumption of any product. For example it includes water consumed for the growth of crops that are used in a production process, water used in all phases of the production chain, including the volume of water

that is required to dilute the pollution discharged from the process to environmentally acceptable level.

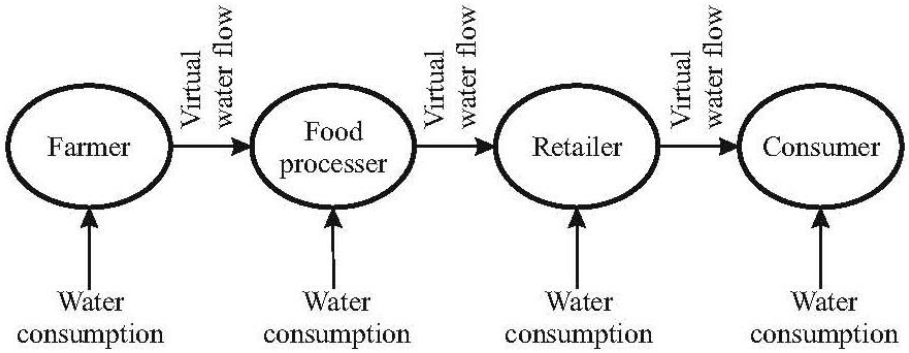


Figure 1.The virtual water chain

The concept of the water footprint is similar to the ecological footprint which was introduced in 1990's (Rees, 1992; Rees and Wackernagel, 1994; Rees, 1996) and which represents a surface of land and water that is required for the production of resources necessary for the population and reception of pollution being discharged. Thus, whereas the ecological footprint quantifies the surface of the land required to sustain the human population, the water footprint indicates the quantity of water used for the same purpose (Hoekstra, 2009). The water footprint considers three components (Figure 2): (i) consumption of water available in soil and plants as moisture (green water footprint), (ii) consumption of water withdrawn from surface and ground water bodies (blue water footprint), and (iii) consumption of water required to receive the pollution discharged (grey water footprint). Traditionally, only the blue water footprint is considered as the actual water consumption. However, plants use available moisture in the soil and the green water footprint should not be ignored in the global analysis of the water consumption. The grey water footprint is also important as it refers to the pollution of water resources. This component, however, does not represent the volume of discharged wastewater, but is rather defined as the volume of water required to assimilate the pollution to the existing water quality standards (Hoekstra, 2009).

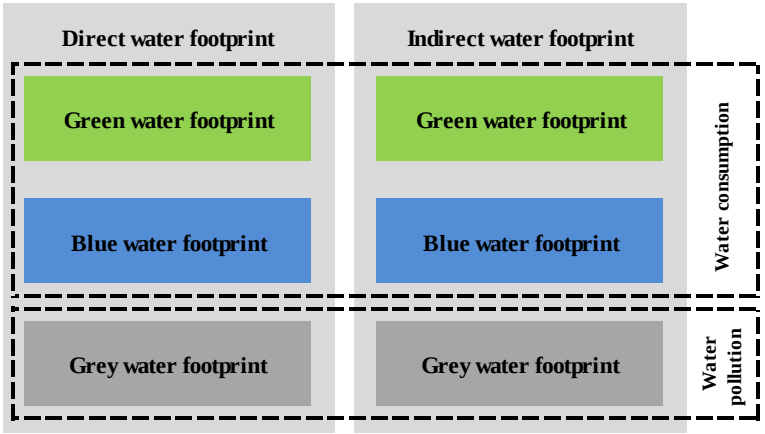


Figure 2. Components of the water footprint (Source: Hoekstra *et al*., 2009)

The water footprint can be assessed for any product, but also for any group of consumers (e.g. person, family, city, country, etc.) or for a producer or group of producers in a sector, in which case it is defined as the sum of the respective water footprints.

When the water footprint of a group of consumers in an area (e.g. country) is considered, a new spatial dimension can be introduced in the analysis. Specifically, the import and export of products lead to import and export of virtual water that is embedded into the product. In this case the consumers of the products are spatially disconnected from the processes that produce the products (e.g. Naylor *et al*., 2005). Countries that import the products are actually externalizing their water footprint, thus creating pressure on exporting regions and not in the area of consumption. Cotton clothes are an example of products that typically create the virtual water trade from one region to another. The production of a cotton T-shirt has the water footprint of approximately 2,000 liters, and this water footprint is generated by the final user. The water footprint however is transferred to countries in which different stages of the production cycle are located – e.g. China, India and Pakistan, which are cotton producing countries, and Malaysia where the T-shirts are produced (Chapagain *et al*., 2006). If the cotton T-shirts are exported to Europe, it can be asserted that the European consumers actually use the water resources from other countries.

Results and discussion

Water Footprint in Agriculture

The water footprint in agriculture depends on the type of agricultural product. For example, lattice has the water footprint of 130 liters for a kilogram of the product, whereas the water footprint of 1 kg of chocolate is as much as 24,000 liters (Table 1). The numbers presented in Table 1 are the global average, and they vary significantly in different regions in the world according to the type of production process and some other factors (Hoekstra, 2008). If we consider the production of beef, the water footprint is calculated based on the parameters of an industrial production system – an animal is grown for three years before it is slaughtered to produce approximately 200 kg of boneless meat. In this period the animal consumes around 1,300 kg of grains (wheat, barley, oats, corn, soybean, and other grains), 7,200 kg of roughages (pasture, hay, silage and other roughages), 24 m^3 of water for drinking and 7 m^3 for servicing (Hoekstra, 2008; Hoekstra, 2010). In order to produce 1 kg of boneless meat, 6.5 kg of grains is used, also 36 kg of roughages and 155 liters of water for drinking and servicing of the animals. As 15,300 liters is used to produce the animal feed, the water footprint of one kilogram of beef equals to 15,500 liters.

From the afore-mentioned example one can understand the difference between the assessment of the traditional water consumption and the water footprint. The traditional calculation shows that 155 liters of water is used for the production of 1 kg of beef, which is actually the volume used in the production process for drinking and maintenance of the animals and facilities. However, this is only direct consumption which makes 1% of the total water consumption (the water footprint), whereas the remaining 99% is virtual water.

Table 1. Water footprint of some agricultural products*

Agricultural product	Unit	Water footprint (liter)	Agricultural product	Unit	Water footprint (liter)
Apple, pear	1 kg	700	Maize	1 kg	900
Beef meat	1 kg	15,500	Milk	250 ml	250
Beer	250 ml	75	Olives	1 kg	4,400
Wheat bread	1 kg	1,300	Orange	1 kg	460
Cabbage	1 kg	200	Peach, nectarine	1 kg	1,200
Cheese	1 kg	5,000	Pork	1 kg	4,800
Chicken	1 kg	3,900	Potato	1 kg	250
Chocolate	1 kg	24,000	Rice	1 kg	3,400
Coffee	125 ml	140	Sugar (sugar cane)	1 kg	1,500
Cucumber, pumpkin	1 kg	240	Tea	250 ml	30
Dates	1 kg	3,000	Tomato	1 kg	180
Lettuce	1 kg	130	Wine	125 ml	120

*Source: Hoekstra, 2008

Water Footprint of Crop Production

The global water footprint of crop production is estimated at 7,404 km^3/yr for the period from 1996-2005 (Mekonnen and Hoekstra, 2010), which is around 17% of the renewable water resources in the world. The largest water footprint comes from the production of wheat (1,087 km^3/yr), rice (992 km^3/yr) and corn (770 km^3/yr), so these three crops consume more than 38% of the global water footprint of crop production. Other significant crops are fodder crops, soybeans, sugar cane, cotton, barley, sorghum, oil palm, coconuts, millet and coffee, which consume another 34% of the global water footprint of crop production. All other crops consume the remaining 28% of the water footprint.

Around 78% of the global water footprint of crop production is the green water footprint, 12% is the blue water footprint, and the remaining 10% the grey water footprint. For most of the crops the share of the green water footprint in the total consumptive water footprint (green and blue) is more than 80%. However, wheat and rice have large blue water footprints, and they contribute with more than 45% in the global blue water footprint of crop production. The grey water footprint in the crop production is related to the use of fertilizers. Wheat, rice and corn together account for about 56% of the global grey water footprint. For most of the crops the consumptive water footprint (green and blue) is smaller for irrigated crops than for rain-fed crops. The reason is that irrigated crops have better yields than rain-fed crops. For example, the water footprint of apple produced in a rain-fed farming system is 883 m^3 per ton (Table 2), as compared to 734 m^3/t in an irrigated farming system.

It can also be observed that shifting from rain-fed to irrigation farming system will reduce the total consumptive water footprint (green and blue) from 717 to 694 m^3/t, which is also true for the grey water footprint (reduced from 167 to 71 m^3/t). For some crops, however, the introduction of an irrigation farming system will increase the total water footprint per ton, which is the case e.g. with soybeans, sugar cane and rapeseed (Table 2).

Table 2. Water footprint of rain-fed and irrigated crops*

Crop	Farming system	Yield (t/ha)	Global water footprint (km^3/yr)				Unit water footprint (m^3/t)			
			Green	Blue	Grey	Total	Green	Blue	Grey	Total
	Rain-fed	2.48	610	0	65	676	1,629	0	175	1,805
Wheat	Irrigated	3.31	150	204	58	411	679	926	263	1,868
	Global average	2.74	760	204	123	1,087	1,278	342	208	1,828
	Rain-fed	2.69	301	0	30	331	1,912	0	190	2,102
Rice	Irrigated	4.67	378	202	81	661	869	464	185	1,519
	Global average	3.90	679	202	111	992	1,146	341	187	1,673
	Rain-fed	8.93	24	0	6	30	717	0	167	883
Apple	Irrigated	15.91	8	8	2	18	343	321	71	734
	Global average	10.92	33	8	7	48	561	133	127	822
	Rain-fed	2.22	328	0	5	333	2,079	0	33	2,112
Soybean	Irrigated	2.48	24	12	1	37	1,590	926	85	2,600
	Global average	2.24	351	12	6	370	2,037	70	37	2,145
	Rain-fed	1.63	62	0	12	74	1,783	0	356	2,138
Rapeseed	Irrigated	1.23	4	9	1	14	1,062	2,150	181	3,394
	Global average	1.57	66	9	13	88	1,703	231	336	2,271

*Source: Mekonnen and Hoekstra, 2010

Although the yields are better with the irrigation systems, this happens because the actual evapotranspiration increases and approaches potential evapotranspiration. The data suggest that the irrigation apparently increases the water consumption; however, the consumption per ton of yield is typically smaller. From this one can understand the significance of the irrigation farming systems, which contribute not only to better crop yields, but also to more sustainable use of water resources.

Water Footprint of Animal Production

An increasing consumption of animal food, such as meat or milk, is present in the last decades as a consequence of an economic development and the growth of the population income. The global meat production doubled from 1980 to 2004, due to increase of the meat, milk or milk products consumption of 5% annually in developing countries (FAO, 2005). These products have large unit water footprints, which has caused an increase in the global water footprint of animal production. For the period from 1996 to 2005 the global water footprint of animal production was 2,422 km^3/yr (Mekonnen and Hoekstra, 2010a). A major portion comes from the livestock feed, around 98% of the total water footprint. The volume of water that is used for drinking, servicing or feed preparation is relatively small and amounts to 1.1%, 0.8% and 0.03% respectively.

The water footprint by animal categories shows that the growth of beef cattle consumes 33% of the global water footprint of animal production (Table 3). Another significant animal categories are dairy cattle (19%), pig (19%) and broiler chicken (11%).

Dairy cow has the largest average annual water footprint per animal of 2,056 m^3/yr, which is more than for an average human (Mekonnen and Hoekstra, 2010a). On the other hand, the broiler chicken generates an average annual water footprint of only 26 m^3 per animal. The distribution of the total water footprint of animal production to green, blue and grey component greatly depends on the type of production system (Table 4), and significantly varies across the countries. Table 4 also shows that

the water footprint of meat increases from chicken (4,300 m^3/t), goat (5,500 m^3/t), pork (6,000 m^3/t), and lamb (10,400 m^3/t) to beef, which has the largest water footprint of 15,400 m^3/t (Mekonnen and Hoekstra, 2010a). The main cause of such variation is different feed conversion efficiency – beef production requires eight times more feed per kg of meet produced than pork production and as much as 11 times more feed than chicken production. Another significant reason is the feed composition, particularly the share of concentrate feed that has a significantly larger water footprint than roughages. The portion of the concentrate feed for chicken broiler is much higher (the global average 73%) as compared to beef (only 5%).

Table 3. Total water footprint by livestock categories*

Livestock	No. of animals in the world (millions)	Average water footprint (m^3/animal/yr)	Annual water footprint	
			(km^3/yr)	(%)
Beef cattle	1,267	630	798	33
Dairy cattle	228	2,056	469	19
Pig	880	520	458	19
Broiler chicken	9,923	26	255	11
Horse	112	1,599	180	7
Layer chicken	5,046	33	167	7
Sheep	1,052	68	71	3
Goat	750	32	24	1
Total	19,258		2,422	100

* Source: Mekonnen and Hoekstra, 2010a

Dairy cow has the largest average annual water footprint per animal of 2,056 m^3/yr, which is more than for an average human (Mekonnen and Hoekstra, 2010a). On the other hand, the broiler chicken generates an average annual water footprint of only 26 m^3 per animal. The distribution of the total water footprint of animal production to green, blue and grey component greatly depends on the type of production system (Table 4), and significantly varies across the countries. Table 4 also shows that the water footprint of meat increases from chicken (4,300 m^3/t), goat (5,500 m^3/t), pork (6,000 m^3/t), and lamb (10,400 m^3/t) to beef, which has the largest water footprint of 15,400 m^3/t (Mekonnen and Hoekstra, 2010a). The main cause of such variation is different feed conversion efficiency – beef production requires eight times more feed per kg of meet produced than pork production and as much as 11 times more feed than chicken production. Another significant reason is the feed composition, particularly the share of concentrate feed that has a significantly larger water footprint than roughages. The portion of the concentrate feed for chicken broiler is much higher (the global average 73%) as compared to beef (only 5%).

Impact of Crop and Animal Production on the Global Water Footprint

The total global water footprint of agriculture amounts to 8,363 km^3/yr (Mekonnen and Hoekstra, 2010a), out of which 7,404 km^3/yr is related to the water footprint of crop production (Table 5). As explained earlier, the water footprint of animal production is composed of the water footprint of animal feed (98%) and the volume of water consumed for drinking, livestock servicing and feed preparation. Out of the water footprint of animal feed, which amounts to 2,376 km^3/yr, the volume

of 1,463 km^3/yr is related to the cultivation of crops used for animal feed, and the remaining volume to pasture. This shows that as much as 20% of the total water footprint of crop production (7,404 km^3/yr) is actually related to the animal feed. The share of the animal production in the total water footprint of agriculture is 29%.

As the total global water footprint of humanity is estimated at 9,087 km^3/yr (Hoekstra and Mekonnen, 2012), the share of agriculture is as much as 92.0%. The industrial sector contributes with 4.4% to the global water footprint, while the remaining 3.6% is related to the population water supply. The data show that the agriculture is the major contributor to the global water consumption. The agriculture consumes the entire water from the global green water footprint (Figure 3), while its share in the global blue water footprint is 92.2%.

According to this indicator, the agriculture is also the largest water polluter because of its share of 65.6% in the global gray footprint.

Table 4. Green, blue and grey water footprint of animal products (global average)*

Product	Farming system	Water footprint (m^3/t)			Product	Farming system	Water footprint (m^3/t)		
		Green	Blue	Grey			Green	Blue	Grey
Beef	Pasture	21,121	465	243	Chicken	Pasture	7,919	734	718
	Mixed	14,803	508	401		Mixed	4,065	348	574
	Industrial	8,849	683	712		Industrial	2,337	210	325
	Average	14,414	550	451		Average	3,545	313	467
Lamb	Pasture	15,870	421	20	Eggs	Pasture	6,781	418	446
	Mixed	7,784	484	67		Mixed	3,006	312	545
	Industrial	4,607	800	216		Industrial	2,298	205	369
	Average	9,813	522	76		Average	2,592	244	429
Goat	Pasture	9,277	285	0	Milk	Pasture	1,087	56	49
	Mixed	4,691	313	4		Mixed	790	90	76
	Industrial	2,431	413	18		Industrial	1,027	98	82
	Average	5,185	330	6		Average	863	86	72
Pork	Pasture	7,660	431	632	Cheese	Pasture	5,371	293	241
	Mixed	5,210	435	582		Mixed	3,903	463	377
	Industrial	4,050	487	687		Industrial	5,078	500	406
	Average	4,907	459	622		Average	4,264	439	357

*Source: Mekonnen and Hoekstra, 2010a

Table 5. The global water footprint of agriculture

Water footprint category	Water footprint			
	Green	Blue	Grey	Total
Water footprint of agricultural production				
Water footprint of crop production	5,772	899	733	7,404
Water footprint of grazing	913	–	–	913
Direct water footprint of livestock*	–	46	–	46
Total	6,685	945	733	8,363
Water footprint of animal production				
Water footprint of feed crop production	1,199	105	159	1,463
Water footprint of grazing	913	–	–	913
Direct water footprint of livestock*	–	46	–	46
Total	2,112	151	159	2,422
* drinking, servicing and feed mixing				
Source: Mekonnen and Hoekstra, 2010a				

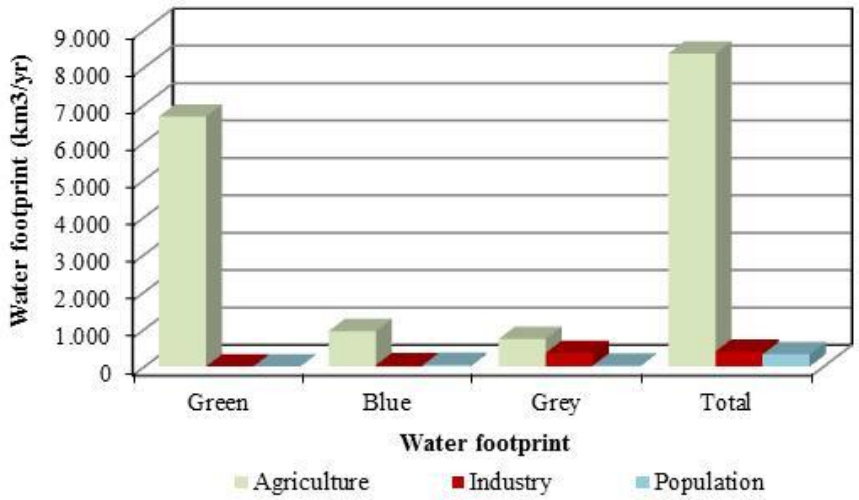


Figure 3. Distribution of the global water footprint per main categories

Conclusions

The world's water resources are under increasing pressure due to consumption and pollution associated with different human activities. The total consumption or pollution of water are often considered as the sum of consumption or pollution from different activities, and until recently little attention has been paid to the consumption and pollution of water in the entire production or consumption chain. The approach which takes into account the use of water in the entire production and consumption chain has gained more attention after the concept of the water footprint was introduced at the beginning of the century. The water footprint is a comprehensive, multi-dimensional indicator of the water use, which covers not only the direct water consumption of a

producer or consumer, but also indirect water consumption. The water footprint thereby incorporates not only the "traditional" water consumption as a result of water withdrawals (blue water), but also consumption of water that is readily available in the nature (green water), as well as the "consumption" of water that is required to assimilate the pollution discharged (grey water).

Agriculture is a particularly significant water user at the global scale. Measured by the water footprint, agriculture consumes about 92% of the water resources that mankind use for its needs. It is commonly perceived that the reduction of the agricultural water footprint can be achieved by the introduction of good agricultural practices, which is an approach that will for most part impact the gray water footprint. This is accomplished by reducing the quantity of chemicals used, introducing better techniques and taking care of the timing of their implementation. In theory the gray water footprint can be reduced virtually to zero by switching to organic farming, but in reality this is difficult if not impossible to achieve. The green and blue water footprint of agriculture (m^3/t) can be reduced by increasing the water use efficiency, e.g. by introducing more efficient irrigation techniques (drip, sprinkler irrigation etc.) as compared to traditional ones (surface irrigation). One possible way of reducing the global agricultural water footprint is to replace products that have large water footprint with products of a similar nutritional value but smaller water footprint. In this regard, a general conclusion can be made that it is more efficient to obtain calories, protein and fat through crop than animal products, since the water footprint per calorie and gram of protein and fat is larger for animal than crop products.

Regardless of the available options, reducing the global water footprint of agriculture will be a major challenge in the future because of the rapid population growth on the planet and the growing food demand. To achieve this goal it is necessary to involve not only farmers but also consumers of agricultural products, as well as all other stakeholders.

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ТРАГИ ОД ВОДА КАКО МЕРКА ЗА ОПРЕДЕЛУВАЊЕ НА ПОТРОШУВАЧКАТА НА ВОДА И ЗАГАДУВАЊЕТО

Ќериќ Адмир, Вучијак Бранко

Апстракт

Водните ресурси во светот се под постојан притисок, пред се поради зголемената потрошувачка и загадување на истите поврзани преку различни активности на човекот. Околу 70% од денешната потрошувачка на вода отпаѓа на земјоделското производство. Ова количество се однесува на волуменот на вода потрошен од различни извори и генерално користен за одгледување на земјоделските култури во сушните периоди од годината. Трагите од вода е еден вид индикатор кој дава една нова димензија во анализата на глобалната потрошувачка на вода и загадувањето. Ова е индикатор кој ја вклучува не само традиционалната потрошувачка на вода (сина вода), но исто така и потрошувачката на вода која е лесно достапна во природата (зелена вода), како и потрошувачката на вода која е неопходна за испуштање и ослободување на загадувањето (сива вода). Вкупните траги од вода во земјоделското производство во светот се 8,363 km^3/годишно, од кои 7,404 km^3/годишно се од растителното производство. Учеството на анималното производство во вкупните траги од вода е 29% или 2,422 km^3/годишно. Земајќи ги вкупните траги на вода од 9,087 km^3/годишно од човечки активности, може да се види дека земјоделското производство го има најголемото учество со 92%. Земјоделското производство ја користи целата компонента од зелена вода од вкупните траги на вода за луѓето, поради што неговото учество во компонентата сина вода изнесува 92%. Поради значајното учество во сивата вода (65,6%), земјоделското производство може да се вбори во најголемите загадувачи во светот.

Клучни зборови: потрошувачка на вода, земјоделство, траги од вода.

UDC: 635.649-167.4(497.711)"2005/2007)
Original scientific paper

DETERMINATION OF EVAPOTRANSPIRATION UNDER DIFFERENT IRRIGATION AND FERTILIZATION TECHNIQUES IN GREEN PEPPER CROP PRODUCTION

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Abstract
The field experiment was conducted with green pepper crop *Bela dolga* grown in experimental plastic house near by the Faculty of Agricultural Sciences and Food in Skopje, during the period of May to October in 2005, 2006 and 2007. The main aim of this investigation was to determine evapotranspiration (ETP) in two-stem pruned ("V"system) green pepper crop under different irrigation and fertilization techniques and regimes. Also, the evapotranspiration coefficient was determined during this investigation, which can be used as parameter for indirect calculation of total crop water requirements during the vegetation. Therefore, four experimental treatments were applied in this study. Three treatments were irrigated by drip irrigation and drip fertigation (KK1, KK2, KK3), while the last one was irrigated by furrow irrigation with conventional application of fertilizer (control treatment $Ø_B$). From the average results obtained in three years of investigation, it can be concluded that there are negligible differences in ETP and ETk between the treatments KK1 and KK2 (drip fertigation every 2 and 4 days), what is result of closer irrigation interval of these two treatments. As a result of longer frequencies between the irrigations, the treatment KK3 (drip fertigation scheduled by tensiometers) showed 4,5-5,5% higher evapotrasnpiration in comparison with KK2 and KK1, and from 24 to 25,5% higher ETk in comparison with KK1 and KK2. The results for ETP and ETK in treatments KK1 and KK2 showed statistically significant differences in comparison with treatment KK3. The effect of the irrigation and fertilization techniques on evapotranspiration and ETk are presented by the results from the treatment KK3 and $Ø_{B.}$ Namely, the control treatment showed 15% higher ETP, or almost 30% ETk in comparison with KK3. The results are statistically significant at 0,01 level of probability.
Key words: potential evapotranspiration, evapotranspiration coefficient, drip fertigation, furrow irrigation, green pepper.

Introduction

Evapotranspiration represents the water loss from a combined surface of vegetation and soil (Hatfield *et al.*, 1990). Generally, evapotranspiration (ET) is referred as a combination of two separate processes whereby water is lost from the soil surface by evaporation and from the crop by transpiration. Evaporation and transpiration occur simultaneously and there is no easy way of

distinguishing between the two processes. Apart from the water availability in the topsoil, the evaporation from a cropped soil is mainly determined by the fraction of the solar radiation reaching the soil surface. This fraction decreases over the growing period as the crop develops and the crop canopy shades more and more of the ground area. When the crop is small, water is predominately lost by soil evaporation, but once the crop is well developed and completely covers the soil, transpiration becomes the main process (Allen *et al.*, 1998).

The term potential evapotranspiration (ETP) was introduced by Thornthwaite in 1948, and was defined as the maximum rate of water loss by crop through the transpiration and evaporation under ideal conditions of soil moisture and vegetation. In natural conditions, evapotranspiration is presented by ETa, or actual evapotranspiration (Iljovski, 1992; Iljovski and Cukaliev, 1994; Bošnjak, 1999). The evapotranspiration rate from a reference surface, not short of water, is called the reference crop evapotranspiration or reference evapotranspiration and is denoted as ETo. The reference surface is a hypothetical grass reference crop with specific characteristics.

As is well known, the factors who affects of the evapotranspiration are: weather parameters, crop characteristics, soil conditions, irrigation techniques, applied agro-technical measures, etc. Allen *et al.*, (1998) reported that the only factors affecting ETo are climatic parameters. Consequently, ETo is a climatic parameter and can be computed from weather data. ETo expresses the evaporating power of the atmosphere at a specific location and time of the year and does not consider the crop characteristics and soil factors. The FAO Penman-Monteith method is recommended as the sole method for determining ETo.

Crop evapotranspiration can be measured or calculated using a variety of approaches. Generally, in irrigation practice, the methods for measuring and estimation of ET can be classified as direct and indirect methods (Evett, 2007; Howell and Meron, 2007; Iljovski and Cukaliev, 2002; Dragović, 2000; Bošnjak, 1999). The indirect methods are based on empirical and mathematical models, where the climatic parameters are of primary importance, and most of them do not consider the crop characteristics or soil factors. Therefore, for greater precision the direct methods are characterized, because most of them simulate natural conditions or ET is determined directly in the field. The most used direct methods in irrigation practice for measuring of ETP are lysimeters, soil water balance method, method of field conditions with experimental trials and etc. (Iljovski and Cukaliev, 2002; Dragović, 2000; Bošnjak, 1999). Therefore, the main objectives of this study were to determine and compare evapotranspiration (ETP) under different techniques and regimes of irrigation and fertilization in green pepper crop production in Skopje region and to evaluate evapotranspiration coefficient as affected by methods of application of water and fertilizers. The determination of crop evapotranspiration in our investigation was realized by soil water balance method.

Material and methods

The field experiment was conducted with two-stem pruned ("V" system) green pepper crop 'Bela dolga' grown in experimental plastic house near by the Faculty of Agricultural Sciences and Food in Skopje (42° 00' N, 21° 27' E), during the period of May to October in 2005, 2006 and 2007. The soil type is coluvial (deluvial) soil (FAO Classification) disturbed with urban activities. The soil chemical characteristics of the experimental field are presented in Table 1.

Table 1. Soil chemical characteristics of the experimental field

Layer cm	$CaCO_3$ %	Organic matter %	pH		ECe dS/m	Available N mg/100 g soil	Available forms mg/100 g soil	
			H_2O	KCl			P_2O_5	K_2O
0-20	3,24	0,90	8,02	7,30	2,40	3,10	17,79	32,15
20-40	3,80	0,84	8,08	7,26	2,28	2,47	13,36	19,38
40-60	3,59	0,56	8,03	7,35	2,25	2,80	8,40	16,10

According to the recommendations and literature data for the region (Maksimović, 2002; Lazić *et al.*, 2001; Jankulovski, 1997), green pepper planted in our condition and yields up to 60 t/ha, needs the following amount of nutrients: N 485 kg/ha, P_2O_5 243 kg/ha and K_2O 585 kg/ha. The application of the fertilizer for the treatments was done in two portions (before planting and during the growing season), what is common practice in our country. For all treatments, the first portions of the fertilizers was done before planting of green pepper, while the rest of the fertilizers needed for achieving the targeted yield was applied through the fertigation system for drip fertigation treatments (Table 2) and conventional fertilization on soil for control treatments (spread in two portions, flowering and fruit formation). All investigated treatments have received same amount of fertilizers, but with the different methods and frequencies of application of water and fertilizers. The idea was to investigate the influence of irrigation and fertilization method on ET and ETk in green pepper crop production.

Table 2. Type and amount of fertilizers in drip fertigation

N 485	P_2O_5 243	K_2O585	kg/ha	N:P:K	
		48	318 kg/ha	15:15:15	before replanting
/	195	128	375 kg/ha	0:52:34	drip fertigation
/	/	411	802 kg/ha	0:0:51+18S	drip fertigation
437	/	/	952 kg/ha	46:0:0	drip fertigation
485	243	585			

Remark: the same amounts and quantity of fertilizers were used for furrow irrigation treatment

The fertigation equipment for drip fertigation treatments was Dosatron 16, with a plastic barrel as reservoir for concentrated fertilizer. The whole amount of fertilizer was dissolved in the barrel and barrel was sealed to avoid evaporation of the water. The source of water was the water supply system for the city of Skopje (very high quality of water).The irrigation of the experiment (treatment KK1, KK2 and $Ø_B$) was scheduled according long-term average daily evapotranspiration for green pepper crop for Skopje region (Table 3). Long term average evapotranspiration was calculated by FAO software CROPWAT for Windows 4.3 using crop coefficient (kc) and stage length adjusted for local condition by Faculty of Agricultural Sciences and Food. Because the use of drip irrigation and application of the water was only on part of the total surface, the daily evapotranspiration of drip irrigation treatments was decreased for 20% (coefficient of the coverage). In each experimental year, the irrigation and fertigation regime have occurred from 20-25 May until

10-15 October. The irrigation scheme used in the experiment was designed according to randomized block design for experimental purposes with four treatments in three replications.

Table 3. Daily and monthly crop water requirements for green pepper crop for the Skopje region

Months	V	VI	VII	VIII	IX	X
mm/day	1.9	3.6	5.5	5.0	3.7	1.8
mm/monthly	59	108	171	155	111	54

Generally, the experimental treatments were set up according to the daily evapotranspiration rate. The idea was to investigate not only irrigation and fertilization techniques, but also irrigation and fertilization frequency and their effect on ETP and ETk.

Treatment 1 (KK1): Drip fertigation according to daily evapotranspiration with application of water and fertilizer every two days;

Treatment 2 (KK2): Drip fertigation according to daily evapotranspiration with application of water and fertilizer every four days;

Treatment 3 (KK3): Drip fertigation according to tensiometers measurements;

Treatment 4 ($Ø_B$): Furrow irrigation according to daily evapotranspiration with application of water every seven days and classic fertilization (spreading of fertilizer on soil).

The size of each plot (replication) was 6.6 m^2 (25 plants in 0.75 m of row spacing and 0.35 m plant spacing in the row). Each plot (replication) was designed with five rows of crop. There were five plants in each row.

The crop evapotranspiration was determined by direct measurement with soil water balance method at soil layer 0-100 cm depth (Tanaskovic *et al.*, 2006; Dragović, 2000; Bošnjak, 1999; Allen *et al.*, 1998; Cukaliev, 1996). The method consists of assessing the incoming and outgoing water flux into the crop root zone during the vegetation. In our investigation, the main parameters for estimation of ETP were irrigation (I) and initial or active soil moisture at the beginning of vegetation (Wi) as incoming water flux and active soil moisture on the end of vegetation (We) as potential outgoing water flux. As was mentioned above, our investigation was realized in experimental plastic house, where precipitations (P) were ignored. Also, as a result of controlled irrigation practice, surface runoff (RO) and deep percolation (DP) were excluded from this estimation. The subsurface water and water transported upward by capillary rise (CR) didn't have influence on water income in the root zone, and they were ignored. Therefore, crop evapotranspiration (ETP) was determinate under equation ETP = (I+Wi)-We. The crop evapotranspiration coefficient ETk was estimated as ratio between ETP and dry matter yield. Collected data were subjected to statistical analysis of variance and means were compared using the least significant difference (LSD) at the 1 and 5% level of probability ($P<0.01$ and $P<0.05$) test.

Results and discussion

The meteorological conditions during the research

The pepper crop has exceptional requirements according to the climatic conditions. If climatic conditions are unfavorable or if they vary, the productivity and yield of the pepper crop can be significantly decreased. The pepper crop needs a lot of heat during whole growing period, what is connected with its native place of origin, the tropical zone (Gvozdenović, 2004; Jankulovski, 1997).

If the temperature is below 15°C, there are possibilities to increase the falling of flowers (Gvozdenović, 2004; Lazić *et al.*, 2001). Also, the flowers and fruits can fall if the temperature goes up to 35°C (Đurovka *et al.*, 2006). The optimal temperature for growing of pepper in controlled environment is 20-25°C during the day time and 18-20°C during the night (Đurovka *et al.*, 2006). Bosland and Votava (2000) reported that the best pepper yields can be obtained when the air temperature during the day time is between 18-32°C, especially in the stage of fruit formation. The average seasonal temperature in our investigation for the experimental plastic house (average in the growing period) during 2005, 2006 and 2007 was 22.83°C, 22.95°C and 24.1°C respectively (Table 4). During the period of the biggest fructification (June-August) the average temperature in all three years was in the frame of the optimum values recommended by Bosland and Votava (2000).

Table 4. Monthly average air temperature (°C) in Skopje region (according to the National Hydro-meteorological Service) and in the experimental plastic house (by our measurements), during the green pepper vegetation

Year / Months	Average temperature (°C) in Skopje region			Average temperature (°C) in the experimental plastic house		
	2005	2006	2007	2005	2006	2007
V	18,0	17,8	18,6	20,9	20,5	21,6
VI	20,9	20,6	23,9	24,1	23,6	27,1
VII	24,1	23,4	27,1	28,2	27,2	31,0
VIII	22,1	23,3	25,1	26,1	26,9	28,9
IX	19,1	19,5	17,7	22,2	22,7	20,6
X	12,7	14,0	12,7	15,5	16,8	15,4
Average	19,48	19,77	20,85	22,83	22,95	24,10

Generally, pepper crop has great crop water requirements during the vegetation period, which is the result of the poorly developed root system and huge biomass exposure to strong transpiration (Lazić *et al.*, 2001; Jankulovski, 1997; Iljovski and Cukaliev, 1994). It is well known that pepper crop is most sensitive to water shortage (drought) during the flowering and fruit formation. The Skopje area in that period is characterized with highest temperatures and insolation, so the evapotranspiration is at its highest rate. Usually rainfalls are down to a minimum in that period.

Data presented in Table 5 shows that all three years of testing were characterized as very wet years with a lot of rainfall in the growing season. As was mentioned above, our testing was conducted in a controlled environment (plastic house), where water income does not have any influence on the crop evapotranspiration, which means that the total water income was presented by irrigation water requirements (almost 75%) and initial or active soil moisture at the beginning of vegetation (almost 25%).

For normal pepper crop growing and for high and quality yields, the optimal relative humidity should range from 60 to 70%. Gvozdenović (2004) reported that lower relative air humidity followed by high temperature can affect flower and fruit falling. Jankulovski (1997) reported that relative air humidity in plastic houses should be around the 70%.

With the exception of October, the average relative humidity during all three years of our investigation was close to recommended values for the plastic houses.

Data for relative air humidity during the investigation are shown in Table 6.

Table 5. Monthly precipitation (mm) in Skopje region

Year	2005	2006	2007
Months	Precipitation (mm)	Precipitation (mm)	Precipitation (mm)
V	72,4	19,2	96,2
VI	38,4	94,7	34,8
VII	36,9	39,0	1,2
VIII	73,3	29,2	52,7
IX	34,2	43,3	27,2
X	50,1	56,9	140,0
Average	305,3	282,3	352,1

In any case, it should be pointed out that our investigation was realized in a controlled environment of an elementary type (plastic house), where the temperature and relative air humidity were heavily controlled and regulated, only with manual opening of side vents. In this relation, Jankulovski (1997) reported that regulation of microclimate condition in plastic houses is harder than in green houses.

Table 6. Monthly average relative humidity (%) in Skopje region (according to National Hydro-meteorological Service) and in the experimental plastic house (by our measurements), during the green pepper vegetation

Year / Months	Average relative humidity (%) in Skopje region			Average relative humidity (%) in the experimental plastic house		
	2005	2006	2007	2005	2006	2007
V	63	59	65	72	74	73
VI	56	64	56	63	71	61
VII	55	59	38	60	63	53
VIII	65	57	51	71	60	60
IX	68	60	58	74	66	68
X	71	70	75	81	80	83
Average	63	61,5	57,2	70,2	69	66,3

Influence of irrigation and fertilization techniques on ETP, ETk and green pepper yield

As was mentioned above, the crop evapotranspiration (ETP) was determined by direct measurement with soil water balance method at soil layer 0-100 cm depth, under permanent content of soil moisture and nutrients, as well as permanent agro-technical measures. The water balance method in our investigation was realized by assessment of the water income and active soil moisture at the end of vegetation into the crop root zone. The water income was estimated through the irrigation water requirements and initial or active soil moisture at the beginning of vegetation. Irrigation water requirement for the treatments KK1, KK2 and $Ø_B$ is presented as water quantity applied during the vegetation (read on the volumetric meter); with periodic soil samplings for controlling of momentary soil moisture and realized irrigation regime. The irrigation water requirement for the

treatment KK3 was obtained by tensiometers readings installed in the soil. The Initial or active soil moisture at the beginning of vegetation is presented as the difference between field capacity (FC) and permanent wilting point (PWP). Cukaliev (1996) has calculated initial or active soil moisture at the beginning as a difference between momentary soil moisture and permanent wilting point, but in our case we refilled the soil moisture up to field capacity before starting with the irrigation regime. The active soil moisture at the end of vegetation is calculated as a difference between momentary soil moisture at the end of vegetation and permanent wilting point. The difference between water income (irrigation water requirements and active soil moisture at the beginning) and active soil moisture at the end of vegetation is the potential evapotranspiration. The results for water balance and ETP, separately by year of investigations are presented in Table 7, 8 and 9. From the results shown in Table 7, it can be concluded that the content of active soil moisture at the end of vegetation in the treatments KK1 and KK2 is from 53 to 71% higher in comparison with KK3.

Table 7. Water balance and ETP (m^3/ha) for 2005

Treatment	Wi	I	Total income	We	ETP	Comparison with KK1 (%)	Comparison with KK2 (%)
KK1	1824	4882	6706	1903	4803	100	102,3
KK2	1824	4999	6823	2126	4697	/	100
KK3	1824	4510	6334	1242	5092	106,0	108,4
$Ø_B$	1824	5819	7643	1829	5814	121,1	123,8

The main reason for higher content of active soil moisture at the end of vegetation in the treatments KK1 and KK2 is irrigation application rates scheduled according to the average daily evapotranspiration with continuous keeping of soil moisture in the frame of field capacity (short irrigation frequencies, 2 or 4 days). Tanaskovik *et al.*, (2006) reported similar results in drip fertigation treatments at two and four days in tomato crop production. On the other hand, the treatment with tensiometers readings (KK3) and drip irrigation frequency every 8 or 10 days (which is not the typical frequency for drip irrigation), presented lower active soil moisture at the end of vegetation. Generally, it can be concluded that the final irrigation application rates (2-3 rates) at the end of vegetation in the treatments KK1 and KK2 couldn't be applied, in order to decrease the participation of irrigation water requirement (I) in total water income, without negative effects on the yields. If the results for ETP in 2005 are presented in comparative values, then potential evapotranspiration in the treatments KK2 and KK1 is lower by 23,8 and 21,1 % in comparison with $Ø_B$, while in comparison with KK3 ETP it is about 8,4 and 6% lower.

Table 8. Water balance and ETP (m^3/ha) for 2006

Treatment	Wi	I	Total income	We	ETP	Comparison with KK1 (%)	Comparison with KK2 (%)
KK1	1824	4517	6341	1548	4793	100	102,3
KK2	1824	4543	6367	1680	4687	/	100
KK3	1824	4176	6000	1100	4900	102,2	104,5
$Ø_B$	1824	5328	7152	1512	5640	117,7	120,3

In 2006, as result of proper controlling of the final irrigation application rates, the active soil moisture at the end of vegetation in the treatments KK1 and KK2 was lower by 22,9 to 26,5% when compared to the previous year. The potential evapotranspiration in treatments with drip fertigation was lower by 15 to 20,3 % compared to the treatment with furrow irrigation and spreading of fertilizers.

The decreasing trend of active soil moisture at the end of vegetation continued in following year, which can be connected to a higher temperature in comparison with 2005 and 2006. Also, the results for potential evapotranspiration in all treatments are connected with the temperature. Various researchers indicate the direct influence of temperature on ET (Evett 2007; Iljovski and Cukaliev 2002; Allen *et al.*, 1998; Doorenbos *et al.*,1986; Doorenbos *et al.*, 1984). Namely, the results for ETP in 2007 are almost for 275 to 543 m^3/ha higher compared with 2006, when the least evapotranspiration was registered.

Table 9. Water balance and ETP (m^3/ha) for 2007

Treatment	Wi	I	Total income	We	ETP	Comparison with KK1 (%)	Comparison with KK2 (%)
KK1	1824	4550	6374	1306	5068	100	/
KK2	1824	4716	6540	1400	5140	101,5	100
KK3	1824	4489	6213	880	5333	105,2	103,6
$Ø_B$	1824	5517	7331	1142	6189	122,1	120,4

Table 10. Average results for ETP, yield and ETk, for all three years of investigation

Treatment	ETP m^3/ha	ETP comparison with KK2 (%)	Yield (t/ha)	D.M. yield (t/ha)	ETk	ETk comparison with KK1 (%)
KK1	4888	101	73,15	12,24	399,3	100
KK2	4842	100	69,18	11,98	404,2	101,2
KK3	5108	105,5	63,42	10,19	501,3	125,5
$Ø_B$	5881	121,5	56,99	9,07	648,4	162,4
LSD: 0,05	56,45		1,80	0,72	34,09	
LSD: 0,01	76,16		2,43	0,98	46,85	

From the results presented in Table 10, it can be concluded that there are negligible differences in ETP and ETk between the treatments KK1 and KK2 (drip fertigation every 2 and 4 days), what is a result of closer irrigation interval of these two treatments. Statistically, there is no significant difference in ETP and ETk between treatment KK1 and KK2. So, in this case, the decision for the frequency of drip fertigation in a range of two to four days should be made according to the yield, not according to the ETP and ETk. Drip fertigation frequency every two days achieves a yield that is significantly higher than the yield if fertigation is applied with four day frequency (KK2). Bar Yosef (2003) reported better pepper yields in treatment with drip fertigation 2 or 3 times a day (71 t/ha) compared with every day (68 t/ha) or every 2 day drip fertigation (66 t/ha). Also, various

researches reported better yields in pepper and other crops by using of high-frequency surface drip irrigation and fertigation in comparison with low frequency surface drip irrigation and fertigation (Tanaskovik, 2011; Iljovski *et al.*, 2003; Tekinel and Kanber, 2002; Phene, 1995; Oğuzer *et al.*, 1991; Topçu 1988). On the other hand, as a result of longer intervals between the applications, the treatment KK3 (drip fertigation scheduled by tensiometers) showed 4,5-5,5% higher evapotrasnpiration in comparison with KK2 and KK1, and from 23,9 to 25,5% higher ETk in comparison with KK1 and KK2. The results for ETP and ETK in treatments KK1 and KK2 showed statistically significant differences in comparison with treatment KK3. According to the results of the average green pepper crop yields presented in Table 10, it is clear that the high drip fertigation frequency create better environment for increasing of yields in comparison with low drip fertigation treatment (KK3). So, our results show that the time difference between two applications of water and fertilizers higher than four days will significantly decrease the yield and increase ETP and ETk of green pepper crop due to increased water stress. Metin Sezen *et al.*, (2006) in their investigations with different irrigation regime in pepper crop, reported the best yield in the treatment with drip irrigation frequency of 3 to 6 days with average ET from 519,5 mm, while in the drip irrigation treatment with irrigation frequency from 6 to 11 days and 9-15 days yield and water use efficiency decrease. Doorenbos *et al.* (1986) reported that prolonged water deficit limits growth and reduces yields in tomato crop.

The effect of irrigation and fertilization techniques on ETP is presented by the achieved results in treatments KK3 (drip fertigation with tensiometers readings) and $Ø_B$ (furrow irrigation and spreading of fertilizers). Namely, in almost the same irrigation intervals, the treatment KK3 obtained almost 15% lower ETP compared with $Ø_B$, which is a result of the application of fertilizers through the drip irrigation system. The results are statistically significant at 0,01 level of probability. Also, the drip fertigation treatment showed a statistically significant higher yield compared with furrow irrigation and spreading of fertilizer. The effect of the drip fertigation can be explained by the fact that with drip fertigation the root zone is simultaneously supplied with water and readily available nutrients. Haynes (1985) reported that if nutrients are applied outside the wetted soil volume they are generally not available for crop use. Hagin *et al.*, 2002 reported that in a fertigation system, the timing, amounts, concentrations and ratios of the nutrients are easily controlled and compared by a conventional fertilizer application and irrigation. Dasberg and Or (1999) reported that increased yields using drip irrigation can be attributed to several factors: higher water use efficiency because of precise application directly to the root zone and lower losses due to reduced evaporation, runoff and deep percolation; reduced fluctuations in the soil water content resulting with avoidance of water stress etc. A number of other investigators give reports with higher yields, efficient use of water and fertilizers and lower ETP in different crops when fertilizers were injected through the drip system in comparison with conventional application of fertilizers (Tanaskovik *et al.*, 2011; Cukaliev *et al.*, 2008; Tanaskovik *et al.*, 2006; Halitligil *et al.*, 2002; Al-Wabel *et al.*, 2002; Castellanos *et al.*, 1999; Petrevska K. J. 1999; Papadopoulos, 1996).

The total dry matter yield in drip fertigation treatments, show the same pattern as a fresh fruit yield. The results are statistically significant at 0,01 level of probability. Halitligil *et al.*, (2002) reported that with the same quantity of fertilizer but different methods of application, drip fertigation shows higher dry matter yield in comparison with treatment with spreading of fertilizers on soil.

The positive effect of drip fertigation on ETk is presented by the differences between the treatments KK3 and $Ø_B$. From the results, it can be concluded that the treatment KK3 has an almost 30% lower ETk coefficient in comparison with furrow irrigation and spreading of fertilizers on the soil. The average ETk coefficient achieved in treatments KK1 and KK2 are pretty close to average transpiration coefficient of 330 presented by Lazić *et al.*, (2001). Tanaskovik (2005) and Petrevska (1999) achieved a lower ETk coefficient in tomato crop with drip fertigation in comparison with furrow irrigation and spreading of fertiliser.

Generally, the obtained results for ETP in our investigation are lower than those recommended by Iljovski and Cukaliev (1994), from 7000 to 8000 m^3/ha and Doorenbos *et al.*, (1986), from 600 to 900 mm. This is a result of the proper and controlled irrigation and fertilization regime during all three years of investigation, especially in drip fertigation treatments. It is important to mention that our results are connected to proper water management in agricultural production, especially in the forthcoming period when the climate changes are expected to have an influence on water resources in our country.

Conclusions

The least average potential evapotranspiration (ETP) is achieved in the treatments with drip fertigation at 2 (4888 m^3/ha) and 4 days (4842 m^3/ha). Statistically, there is no significant difference. On the other hand, as a result of longer intervals between the applications, the treatment KK3 (drip fertigation scheduled by tensiometers) showed 4,5-5,5% higher evapotrasnpiration in comparison with KK2 and KK1. The results for ETP in the treatments KK1 and KK2 showed statistically significant differences in comparison with treatment KK3 (5108 m^3/ha). The effect of irrigation and fertilization techniques on ETP is presented by the achieved results in treatments KK3 and $Ø_B$. Namely, in almost the same irrigation intervals, the treatment KK3 obtained almost 15% lower ETP compared with $Ø_B$ (5881 m^3/ha), which is a result of the application of fertilizers through the drip irrigation system. The results are statistically significant at 0,01 level of probability.

The highest average yields are achieved in treatments KK1 and KK2 with 71,11 t/ha and 68,40 t/ha, while in treatment KK3 the average yield was almost 6-9 t/ha lower (62,61 t/ha). The results are statistically significant at 0,01 level of probability. It is clear that the high drip fertigation frequency creates a better environment for increasing of yields in comparison with low drip fertigation treatment. The least average yield is achieved in treatment $Ø_B$ (54,74 t/ha). The treatments with drip fertigation statistically showed a significantly higher yield compared with furrow irrigation and spreading of fertilizer. Also, the total dry matter yield in drip fertigation treatments, show the same pattern as a fresh fruit yield. The results are statistically significant at 0,01 level of probability.

The treatments KK1 and KK2 show the best ETk coefficient or 400 in average. The highest ETk was achieved in treatment $Ø_B$ almost 650, which is a result of improper irrigation and fertilization technique. The positive effect of drip fertigation on ETk is presented by the differences between the treatments KK3 and $Ø_B$. From the results, it can be concluded that the treatment KK3 has an almost 30% lower ETk coefficient in comparison with $Ø_B$. Statistically, the results are significant at 0,01 level of probability.

Generally, the obtained results for ETP and ETk in our investigation are lower than those recommended by the literature. This is as result of the proper and controlled irrigation and fertilization regime during all three years of investigation, especially in drip fertigation treatments. It

is important to mention that our results are connected to proper water management in agricultural production, especially in the forthcoming period when the climate changes are expected to have an influence on water resources in our country.

Finally, from our research we can conclude that the optimal frequency for irrigation and fertigation of green pepper crop in similar conditions is from two to four days. The final decision of the frequency of drip fertigation in a range of two to four days should be done according to the yield, not according to the ETP and ETk.

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ОПРЕДЕЛУВАЊЕ НА ЕВАПОТРАНСПИРАЦИЈА КАЈ ПИПЕРКА ПРИ ПРИМЕНА НА РАЗЛИЧНИ НАЧИНИ НА НАВОДНУВАЊЕ И ЃУБРЕЊЕ

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Апстракт

Истражувањето беше спроведено во периодот од мај до октомври во 2005, 2006 и 2007 година, кај пиперка од сортата Бела долга, одгледувана во заштитен простор-пластеник на опитните површини на Факултетот за земјоделски науки и храна во Скопје. Главна цел на истражувањето беше да се определи потрошувачката на вода (ETP) кај пиперка одгледувана со контролиран раст на стеблото (V-систем), при примена на различни начини и режими на наводнување и ѓубрење. Покрај главната цел, во истражувањето беше определен и транспирациониот коефициент (ETk), кој исто така како параметер може да послужи за индиректно утврдување на потрошувачката на вода. За таа цел, четири варијанти беа поставени во истражувањето. Три варијанти (КК1, КК2, КК3) беа залевани со систем капка по капка и истовремена апликација на хранливите материи преку системот (фертиригација), додека една варијанта беше наводнувана со бразди и класично ѓубрење (контролна варијанта $Ø_Б$). Од добиените просечни резултати за сите три години на истражување, може да се заклучи дека разликите во ETP и ETk помеѓу КК1 и КК2 (фертиригација на 2 и 4 дена) се многу мали, дури и незначителни, што се должи на блискиот интервал на залевање на двете варијанти. Варијантата КК3 (фертиригација со помош на тензиометри), како резултат на подолгиот интервал на залевање покажа 4,5-5,5% повисока евапотранспирација во споредба со КК2 и КК1, односно од 24 до 25,5% повисок ETk во споредба со КК1 и КК2, а разликите се високо статистички значајни. Ефектот на техниката на наводнување и ѓубрење врз евапотранспирацијата и ETк, може да се види при споредба на варијантите КК3 и $Ø_Б$, каде ETP и ETk се за 15, односно 30% повисоки кај контролната варијанта. Резултатите се високо статистички значајни на ниво на веројатност од 0,01.

Клучни зборови: потенцијална евапотранспирација, евапотранспирационен коефициент, фертиригација, наводнување со бразди, пиперка.

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Review paper

APPROACHES ON EFFICIENT WATER USE FOR IRRIGATED AGRICULTURE IN GAP REGION OF TURKEY

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Abstract
Use of water in agriculture is very important for agricultural production and decreasing the impacts of drought. Global water use in agriculture is approximately 70% in not only Turkey but also in the world. Due to the fact that there has been a competitive among domestic, industrial and agricultural sectors in terms of water use, the most pressure is on the irrigated agriculture. Use of water in agriculture plays the important role in terms of negative effects of climate change and inappropriate irrigation applications. The amount of irrigation water of 5 000-6 000 m^3 per ha are used in the modern irrigation systems while the amount of irrigation water more than 10 000 m^3 per ha are used for conventional irrigation. Additionally to use a large amount of water causes risks of salinity and erosion for irrigated lands. There has not been only one way to overcome these problems. These could be technical and institutional approaches. The precautions must be applied as integrated with all the applications. Technical precautions could be using modern irrigation systems, improving irrigation scheduling for efficient water use, water harvesting, using wastewater, terracing, building small dams, mulching and less soil ploughing. Institutional precautions are to improve the functional structures of water user associations and irrigation cooperatives. In this article, due to risk of climate change and drought especially in Southeastern Anatolia Region of Turkey, irrigation problems and the precautions for the effective use of water in agriculture are discussed.
Key words: irrigation, efficient use of water, water management, Southeastern Anatolia Region, Turkey.

Introduction

Agriculture has the greatest potential for solving the problems of global water scarcity and effective use of water. Thus, irrigation is the most input in increasing crop production especially for arid and semi arid regions. Considering food demand and human life, irrigation investments have become more important in all over the world. Over 70% of available water in the irrigated areas is used for agriculture; however competition for the limited water resources in the dry areas is increasing with domestic and industrial demand reinforced by high population growth rates, improvements in living conditions and changing expectations, depriving agriculture of substantial amounts. There will be new water allocation between sectors and water currently available to agriculture is likely to decrease further (Cetin et al., 2009).

Water scarcity is a situation where there is insufficient water to satisfy normal requirements (Winpenny, 2009). Many of the causes for water scarcity are inter-related and are not easily distinguished. These may be population growth, food production, climate change and variability, land use, water quality, water demand, sectoral resources and institutional capacity, poverty and economic policy, water resource management, international waters, political realities and sociological issues. Southeastern Anatolia Project (GAP), that is an integrated regional development project was laid in 1980, in Turkey. GAP, was initially undertaken as a program to develop water and land resources of the region and consequently planned as a package comprising 13 projects envisaging irrigation schemes and hydraulic power plants in the basins of the Euphrates and the Tigris. The surface area of the region is 75,358 square kilometers constituting 9.7 % of the total surface area of the country (Figure 1). Turkey has 8.5 million hectares of irrigable land in near future and about 20 % of this land is in Southeastern Anatolia. The GAP region has a share of about 10 % in both the total population and geographical area of Turkey.

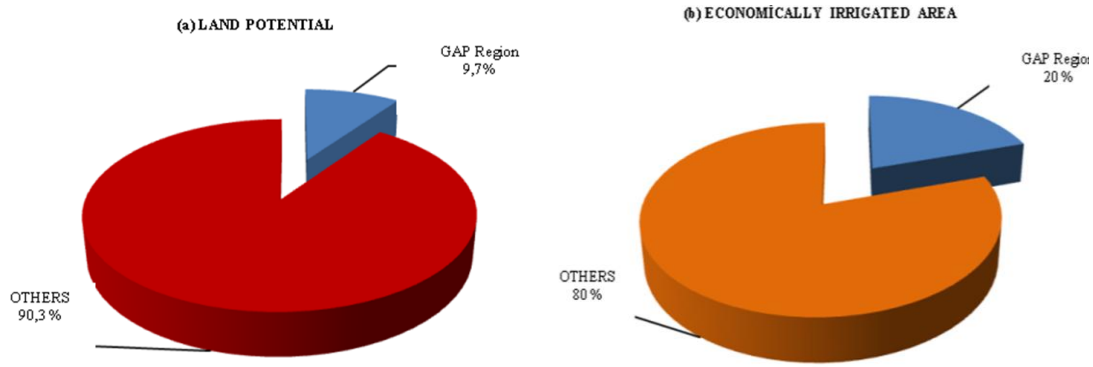


Figure 1. Land potential of GAP Region (a), **e**conomically irrigated area of GAP Region (b)

GAP, is one of the world's largest and most ambitious regional development projects, which includes not only a giant water resources development plan, but also large-scale investment in a wide range of development-related sectors such as agriculture, energy, transportation, telecommunications, health care, education as well as urban and rural infrastructure. GAP as it is presently conceived, is a US$32 billion multi-sectoral, integrated regional development program, which primarily aims at strengthening economic, environmental, cultural, social, institutional aspects of human development in this economically disadvantaged region by significantly raising the prevailing living standards and quality of life.

GAP package included 22 dams, 19 hydraulic power plants and irrigation covering an area of 1.7 million hectares. The main components of the GAP project were the Atatürk Dam, Sanliurfa Tunnels, and Sanliurfa-Harran irrigation system. Presently, area of 189 951 ha are irrigated by Ataturk Dam, in the near future, area of 882 000 ha will be irrigated (Cetin, 2011). With the preparation of GAP Master Plan in 1989, the project transformed into an integrated regional development effort also covering such diverse fields as rural and urban infrastructure, housing, transportation, communication, agricultural and industrial development, tourism, education and health. Later on, parallel to developments taking place in the world, the philosophy of sustainable human development was adopted in the context of GAP activities upholding the principles of

human development, participation, equality and fairness. At present, besides its water resources development program, the GAP is implemented as an integrated regional development project based on sustainable human development covering many other sectors as well.

Effects of Irrigation on Regional Development

In the GAP Region, 1.822 million hectares is planned to be irrigated. By the end of 2009, a total of 300 397 ha were irrigated in Euphrates and Tigris Basin. Almost 72 093 ha of irrigation network construction is still underway while in the planning stages are 1,448,556 ha. Around 16,5% of irrigation projects are operated. It has shown irrigated areas in the GAP Region on the Table 1.

Irrigation has changed crop pattern in GAP Region, and the farmers have started to use new agricultural techniques. Considering development and increasing life standard in the region by means of irrigation, the beneficial impacts of irrigation will be (i) increased crop production and increased farm income, (ii) increased cropping intensity and crop diversification, (iii) increased farm employment and (iv) increased farm consumption and increased permanent wealth (Cetin, 2011). Crop pattern before GAP and planned crop pattern in the part of named Lower Euphrates of GAP including Harran Plain are given in Table 2 and 3. According to dry conditions, the highest crop ratio is winter wheat and barley (51 %) and legumes (31 %). According to the crop pattern of GAP Project, the ratio of cotton will have been the highest (34.3 %) and the second highest ratio of the crops were winter wheat and barley (27,9%).

Table 1. Irrigated area in the GAP Region according to the years (Anonymous, 2012)

Years	Irrigated Area (ha)	Net irrigated area opened during the year (ha)
2002	198.854	4.758
2003	206.954	8.100
2004	224.604	17.650
2005	245.613	21.009
2006	262.335	16.722
2007	272.972	10.637
2008	287.295	14.323
2009	300.397	13.102

Realized crop pattern in the areas before GAP and starting irrigation of GAP is given in Table 4. Cotton grown ratio was 50.0-69.0 % and 59.0-79.0 % in Ceylanpınar and Akçakale Irrigation Schemes before GAP. Although there were no any cotton crops for the dry areas in Harran Plain, the ratio of cotton has reached dramatically through 91-96%.

Table 2. Crop pattern before GAP in Harran Plain of GAP (Fakioglu, 1989)

Crops	Area Sown (%)
Wheat + Barley	51
Lentil + Chick Pea	31
Sesame + Sun flower	3
Fallow	13
Others	2
Total	100

Table 3. Planned crop pattern according to irrigation conditions of Harran Plain (Fakioglu, 1989)

Crops	Area (%)
Cotton	34.3
Wheat + Barley	27.9
Tuber crops	8.1
Vegetables	7.5
Fruits	4.5
Forages	4.7
Grapes + Pistachio	2.5
Poplar tree	3.8
Others	6.7
Sub Total	100.0
Second crops (Sesame, corn, groundnut and soybean)	16.5
Total	100.0+16.5

Table 4. Realized crop pattern in some of irrigations schemes in GAP (DSI, 1997)

Crops	Irrigation Schemes Name					
	Ceylanpınar*		Akçakale*		Harran	
	1994	1995	1994	1995	1995	1996
Cotton	50.0	69.0	59.0	79.0	96.0	91.0
Wheat + Barley	37.0	25.0	37.0	20.0	--	--
Horticultural crops	13.0	6.0	2.0	1.0	1.0	2.0
Corn	--	--	--	--	--	3.0
Others	--	--	2.0	--	3.0	4.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

*Started irrigation projects by ground water (wells) before GAP

This situation has increased the incomes of the farmers. However, besides use of over irrigation, undesired crop pattern applied on the contrary planned crop pattern is the most important problems. These applications indicate that more irrigation water can be consumed or used.

Farmers' incomes have increased with starting irrigation in this region. For example, the value added per person was 596 USD in the region before irrigation in 1995; it was 1241 USD in 2008. This is significantly increased for human life. Considering all the sectors development, especially irrigation investments and increasing agricultural production will be play enormous role for the development in near future (Anonymous, 2012).

Applications and Approaches for Irrigation on Efficient Water Use

When soil and water resources have not been managed considering the characteristics of soil and water resources, it can not be stated on sustainability of soil and water resources. On the other hand, many problems might occur; such as soil and water loss, soil and water pollution, soil erosion, soil salinity. Considering different irrigation methods, surface irrigation methods are widely used in Turkey. In this respect, the main problem is the use of excessive irrigation water. According to some

of the research results, average 900-1000 mm irrigation water is enough to get maximum yield on cotton in Harran Plain. At the beginning of irrigation years, the farmers have applied irrigation water between 1200-1500 mm. Considering the last research result, the affected area by salinization increased from 11 430 ha in 2000 to 17 767 ha within 10 years showing 55 of increment. Salinization and high ground water levels increased by means of irrigation (Cullu et al., 2010). Also, over irrigation has resulted drainage problems. There is no only one way to overcome these problems. Efficient water use could be achieved using the integrated approaches or applications of technical and institutional approaches.

Technical Approaches and Applications: Efficient water use might be considered as different applications. These could be using modern irrigation systems for irrigated agriculture, improving irrigation scheduling for efficient water use, water metering, water harvesting, using wastewater, terracing, building small dams, mulching and less soil ploughing. The most important issue in terms of irrigation is not to apply considering volumetric measurements per area. Thus, some sanctions must be applied to the farmers who use exceed water and for other inappropriate applications. Some precautions for preventing irrigation problems and inappropriate applications must offer to the decision makers and the government. The precautions must be applied as integrated with all the applications.

The sustainable use of water resources under aridity may imply effective adoption and implementation of integrated land and water resources planning, improving of water distribution and irrigation systems, valuing the water as an economic, social and environmental good, adoption of appropriate water and irrigation technologies, the users participation in water resources and system management and education and training of water managers, operators and users. For example, there are no sanctions to provide irrigation water to farmers on the basis of volume. If it is applied, the farmers and irrigation unions will have an effective and efficient use of irrigation water.

Institutional Approaches and Applications: In Turkey, allocation of irrigation water to the farmers in irrigation schemes performed by means of Water User associations (WUAs) and Irrigation Cooperatives (ICs). These establishments, WUAs and ICs, are directed by democratic rules under the framework of the present laws. However, there are practically some mismanagement in these establishments. There are many different reasons for this. These are habits and education level of the farmers, local conditions, history, customs, local or national politicians, social structure of the region. Thus, these authorities, WUAs and ICs, must be controlled by decision makers and/or governments to get more appropriate in terms of efficient management. In this way, an effective water management and water saving can be achieved. For that reason, the Law (Law No: 6172) for Water User Associations has been enacted nowadays.

Conclusions

Use of micro-irrigation systems especially drip irrigation plays significant role on water saving for irrigated agriculture. Thus, use of pressurized irrigation systems should be supported directly or indirectly by governments. Fortunately, this was started by 2007 in Turkey initiated in our country by the end of the year 2007. In addition, the present large-scale surface irrigation projects, and farm irrigation networks must be converted to the pressurized irrigation systems.

Another main problem is not to use amount of irrigation water considering volumetric basis. For that reason, over or exceed irrigation in Turkey is one of the major problems. These applications

cause deterioration on soil conditions. The farmers have believed that the more water is equal to more crop yield. Thus, they have not been considered the deterioration of soils, and particularly soil salinization and alkalinity.

The sustainable use of water resources may imply with implementation of integrated land and water resources planning, improving of water distribution and irrigation systems, considering the water as an economical, social and environmental resource. In addition, use of appropriate water and irrigation technologies, the participation of the users in water resources and system management, and education and training of water managers, operators and users are the other factors affecting irrigation management. On the other hand, there are many different direct or indirect ways to be considered in use of efficient water. These may be surface water harvesting, terracing, building small dams, using non-conventional water resources, water conservation and water saving practices and management, water metering, water pricing, to develop new crop varieties resistant to water stress, improving irrigation systems, improving irrigation scheduling and deficit irrigation.

As a result, there is no only one way to overcome this problems but an integrated management in irrigated agriculture must be planned and implemented. Thus, regional, national and/or international new approaches and mechanisms on water and irrigation management should be organized.

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ПРИСТАП ЗА ЕФИКАСНО КОРИСТЕЊЕ НА ВОДАТА ЗА НАВОДНУВАЊЕ ВО ЗЕМЈОДЕЛСКОТО ПРОИЗВОДСТВО ВО GAP РЕГИОНОТ ВО ТУРЦИЈА

Неше Узен, Онер Цетин, Мурат Караер

Апстракт

Водата има големо значење за земјоделското производство и влијае на намалување на негативните ефектите од сушата. Глобалното користење на водата во секторот земјоделството во Турција, но и на светско ниво е приближно 70%. Поради фактот дека денес постои постојана конкуренција во поглед на користење на водата помеѓу домашниот сектор, секторот индустрија и земјоделското производство, очигледно е дека најголемиот притисок се јавува токму во земјоделството, односно наводнувањето на земјоделските култури. Исто така, водата во земјоделството има важна улога во поглед на намалување на негативното влијание на климатските промени и неправилното наводнување. Кај модерните техники на наводнување, нормата на наводнување изнесува од 5 000 до 6 000 m^3/ha, додека кај традиционалните техники на наводнување таа се движи дури и над 10 000 m^3/ha. Дополнителен проблем при користењето на поголемо количество на вода преставува ризикот од засолување или ерозија на површините кои се наоѓаат под наводнување. Генерално, во праксата не постојат единечни мерки за решавање на овие проблеми. Потребен е технички и институционален пристап за решавање на истите, преку интегрирање на сите мерки. Техничкиот пристап потребно е да опфаќа мерки како модерни системи за наводнување, подобрување на режимот на залевање за поефикасно користење на водата, конзервација на водата, користење на отпадни води, терасирање, изградба на мали вештачки акумулации, мулчирање и помала обработка на почвата. Институционалниот пристап опфаќа мерки за подобрување на структурата на функционирање на водните заедници и кооперативите за наводнување. Оттука, поради ризикот од влијанието на климатските промени и сушата во југо-источниот регион на Анатолија во Турција, во овој труд се изложени проблемите од праксата на наводнување, како и мерките за поефикасно користење на водата во земјоделското производство.

Клучни зборови: наводнување, ефикасно користење на водата, управување со водите, југо-источен регион на Анатолија, Турција.

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FORMATION, GENESIS, EVOLUTION AND CLASSIFICATION OF SOILS ON LIMESTONES AND DOLOMITES MOUNTAIN JABLANICA

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Abstract
In this paper are presented the results of research conditions of formating, the genesis, evolution and classification of calcomelanosols and calcocambisols on Jablanica mountain. On different localities of the Jablanica mountain were excavated 18 basic pedological profiles of calcomelanosols with subtypes: organogenic (5) organomineral (12) and brownized (1) and 4 profiles brown soils on limestone and dolomites with a typical subtype. In addition, data were collected for conditions of soil forming factor (parent material, relief, climate, vegetation and human impact). Surveyed soils are formed only on pure limestones, dolomitised limestone and silicated limestone, mountainous terrain at an altitude of 900-1990 m. Investigated soils are formatted under variety of oak and beech communities, but in subalpine belt under alpine grassland communities. Examined soils on Jablanica mountain are extend into four climate-vegetation belts. By cutting and burning the forest erosion process is intensified. Calcomelanosols are the first stage in the evolution of soils on compact limestone and dolomites. Jablanica mountain evolutionary series has following order: organogenic –organomineral – brownized calcomelanosol - calcocambisol (brown soil on limestone and dolomite).
Key words: soil, conditions for forming, genesis, evolution, classification.

Introduction

Calcomelanosols and calcocambisol formation on limestones and dolomites are highly spread out in the Republic of Macedonia. By Filipovski (1996), calcomelanosols comprising 220 000 hectares and occupy 8.6% of the territory of the Republic of Macedonia. According to the same author Filipovski (1982) calcocambisols formation on limestones and dolomites cover about 92 944 ha of the territory of the Republic. Taking into account highly spread out of calcomelanosols and calcocambisols formation on limestones and dolomites as well as the possibility of greater use in agriculture and forestry purpose of this paper came out. Mountain Jablanica, by its geological structure is built around the same of silicate rocks and limestone.

The subject of this paper are soils formation only on pure limestones and dolomites. On Mountain Jablanica we found two soil types formation on pure limestone: calcomelanosols and calcocambisols. Soil cover is intermittent and is bordered by limestone and dolomite rocks. Depth profile of these soils changed to the little distance. Calcomelanosols overgrown with grass and

forest vegetation. Grassland vegetation is mainly used for grazing cattle, and the lower part is used as meadows of which gets hay. Calcocambisols are deeper soils compared to calcomelanosols and mainly are under forest vegetation, lower part under grassland vegetation and favorable habitats for development forest and grassland vegetation.

Material and methods

On mount Jablanica were excavated, studied and described morphologically 22 profiles on limestones and dolomites of which 18 calcomelanosols with subtypes: organogenic (5), organomineral (12) and brownized (1) and 4 profiles brown soils on limestone and dolomite (calcocambisols) with a typical subtype (Petkovski, et al., 1993). In addition, data were collected for conditions of soil forming (parent material, relief, climate, vegetation and human impact). Since these profiles were colected soil samples for laboratory analysis. Field trials are conducted according to generally accepted methodology in our country (Filipovski, edit. 1967).

Results and discussion

Review of soil forming factors that affect the formation of calcomelanosols and calcocambisols on Jablanica Mountain is shown in Table 1.

Geographical conditions and relief

Jablanica Mountain extends in a north-northwest and south-southeast. The mountain is widespread in the region of 41˚05 'to 41˚30' north latitude and 20˚30'to 20˚40' eastern longitude. Morphological notes with several tops over 2000 meters high. The highest of which is the Black Stone with 2257 m. Its eastern slopes cut through with more narrow and deep valleys and very steep down in Struga field and valley of the Black Drim.

Investigated soils are formed in mountainous landscapes Jablanica mountain at an altitude of 900 - 1990 m. The highest parts of the investigated area extend organogenic calcomelanosols. In the lower parts of the mountain extend organomineral and brownized calcomelanosols. Calcocambisols are extend with previous, on flatly relief forms.

Geological composition

Jablanica is a silicate and carbonate mountain prevalence carbonate rock. Investigated soils are mainly formed on pure limestone and less on silicated limestones and dolomitized limestones (Table 2).

Climate and vegetation

Investigated soils occur in more climate vegetation belts, because parent material is crucial soil forming factor. Republic of Macedonia can be divided into 8 vertical climatic vegetation belts (Filipovski *et al.*,1996). Investigated soils extend down into 4 climatic vegetation belts and because it is inhabited by different plant communities. Calcocambisols of mountain Jablanica prevalent at an altitude of 1000-1380 m. Warmer exposures and lower altitudes are found under plant communities oak and hop hornbeam, and higher altitudes and colder exposures under community submountain and mountain beech. Calcomelanosols encountered at an altitude of 900-1990 m. Organomineral and brownized calcomelanosols extends on smaller altitude are covered under xerophilous plant communities, while those at higher altitudes and colder expositions under mezophytic associations. Organogenic calcomelanosols are spread out highest in investigated area and can be found under the subalpine grassland associations and mesophytic forest communities.

Human impact

In the past, the cutting and burning of the forest was particularly intense in the subalpine region.With it's enhanced erosion and impact of forest vegetation is replaced by grass vegetation. Also with excessive grazing and trampling causes erosion.

Table 1. Some Soil forming factor of soil forming on limestone and dolomites on Jablanica mountain

Prof N°	Horizon and depth in cm	Parent material	Altitude m	Exposition	Inclination %	Stoniness %	Rockyty %	Phytocenosi
Calcomelanosol – *Organogenic*								
9	A (0-25)	Limestone	1400	Northeast	40-50	20-30	30-40	as. Aceri obtusati-Ostryo-Fagetum Em at Riz.1988
38	A (4-24)	Dolomite with layers of limestone	1300	Northeast	> 50	60-70	50-60	as.Festuco heterophyllae-Fagetum Em 1965*
8a	A (0-22)	Limestone	1550	East	> 50	40-50	70-80	as. Aceri obtusati-Ostryo-Fagetum Em at Riz.1988
60	A (0-10)	Limestone	1950	Northwest	45-50	35-40	45-50	as. Onobrychi-Festucetum syllenicae Ht. 1936
61	A (0-12)	Limestone	1970	North	> 50	60-65	50-60	as. Onobrychi-Festucetum syllenicae Ht. 1936
Calcomelanosol – *Organomineral*								
3	A (3-28)	Limestone	1200	Northeast	40-50	20-30	30-40	as.Querco-Ostryetum carpinifoliae Ht.1938
4	A (4-40)	Limestone	1350	North	30-40	20-30	30-40	as. Aceri obtusati-Ostryo-Fagetum Em at Riz.1988
5	A (3-26)	Limestone	1500	Northeast	50-60	10-20	20-30	as. Aceri obtusati-Ostryo-Fagetum Em at Riz.1988
7	A (0-21)	Dolomitised limestone	1500	Northeast	50-60	10-20	20-30	as. Aceri obtusati-Ostryo-Fagetum Em at Riz.1988
11	A (0-27)	Limestone	1000	North	30-40	30-40	30-40	as.Querco-Ostryetum carpinifoliae Ht.1938
20	A (0-18)	Limestone	1400	East	30-40	60-70	50-60	as. Juniperetum oxycedri-communis Riz.prov.
22	A (0-30)	Limestone	1300	Northeast	15-20	20-25	30-35	as.Querco-Ostryetum carpinifoliae Ht.1938
30	A (0-29)	Limestone	1250	West	35-40	40-45	35-40	as.Festuco heterophyllae-Fagetum Em 1965*
33	A (0-36)	Limestone	900	North	40-50	10-20	10-20	as.Querco-Ostryetum carpinifoliae Ht.1938
35	A (0-27)	Limestone	1500	Southeast	50-60	50-60	20-30	as.Pteridio-Asphodeletum albae Em 1976
4a	A (0-25)	Limestone	1200	North	30-35	20-30	20-30	as.Querco-Ostryetum carpinifoliae Ht.1938
62	A (0-18)	Limestone	1990	North	50-55	40-45	50-55	as. Onobrychi-Festucetum syllenicae Ht. 1936
Calcomelanosol – *Brouwnized*								
8	O (0-8) A (8-36) (B)rz36-52	Limestone	1500	East	40-50	30-40	40-50	as. Calamintho grandiflorae-Fagetum Em.1965**
Calcocambisols (typical)								
1	A(2-21) (B)rz21-55	Dolomitised limestone	1000	West	30-40	10-20	20-30	as.Querco-Ostryetum carpinifoliae Ht.1938
2	A (3-20) (B)rz20-35 (B)rz35-70	Silicated limestones	1140	South	30-35	20-30	30-40	as.Querco-Ostryetum carpinifoliae Ht.1938
10	A (0-24) (B)rz24-58 (B)rz58-70	Silicated limestones	1200	Northeast	40-45	20-25	30-40	as.Festuco heterophyllae-Fagetum Em 1965*
21	A (2-21) (B)rz21-73	Silicated limestones	1380	North	50-60	20-30	20-30	as. Calamintho grandiflorae-Fagetum Em.1965**

*syn as. Fagetum submontanum macedonicum Em 1965** syn as. Fagetum montanum macedonicum Em 1965

Genesis

According to Filipovski (1996) influenced by the factors described in calcomelanosols occur following three soil forming processes: 1. Dissolving $CaCO_3$ and $MgCO_3$ from limestone and dolomite and their rinsing; 2. Accumulation organic matter and the formation of humus horizon and 3. Forming (B)rz horizon in brownized calcomelanosols.

The genesis of brown soils on limestone and dolomites (calcocambisols) are characterized by the following processes: 1. Accumulation mull and half row humus; 2. Decarbonization; 3. Slight acidification; 4. Slight chemical weathering by weak clay formation; 5. Fixation and hydratation Fe_2O_3 and 6. Releasingon the clay residuum of limestone (Filipovski 1984).

Evolution

Calcomelanosols are the first stage in the evolution of soils on compact limestone and dolomites. Jablanica Mountain evolutionary series has following order: organogenic – organomineral – brownized calcomelanosol - calcocambisol (brown soil on limestone and dolomite).

Classification

Investigated soils (Table 3) are classified according classification of Former Yougoslavia (Škorić *et al.,* 1985)

Table 2. Parent material of investigated soils

Parent material	Profile N^o
Limestone	9,8a,60,61,3,4,5,11,20,22,30,33,35,4a,62,8
Dolomite with layers of limestone	38
Dolomitised limestone	7,1
Silicated limestone	2,10,21

Table 3 Classification of calcomelanosols and calcocambisols on Jablanica mountain

Soil types	Subtypes	Varieties	Forms	Profiles
Calcomelanosols	Organogenic	Lithic	Mollic horizon	9, 38, 8a, 60, 61
	Organomineral	Lithic	Mollic horizon	3, 4, 5, 7, 11, 20, 22, 30, 33, 35, 4a, 62
	Brownized			8
Calcocambisols	Typical	Deep	Clayey	1, 2, 10, 21

Conclusions

Soils that are aim of investigation are formed in mountainous landscapes Jablanica mountain at an altitude of 900 -1990 m. The highest parts of the investigated area extend organogenic calcomelanosols. In the lower parts of the mountain extend organomineral and brownized calcomelanosols. Calcocambisols are extend with previous, on flatly relief forms. Investigated soils are formed predominantly on pure limestones, less on dolomitised limestone and silicated limestone.

Calcomelanosols and calcocambisols of mountain Jablanica extend down into 4 climatic vegetation belts and because it is inhabited by different plant communities. They are developed under various oak and beech associations, while in the subalpic region under high-mountain grass associations.

The genesis of calcomelanosols are characterised three soil forming processes:

1. Dissolving $CaCO_3$ and $MgCO_3$ from limestone and dolomite and their rinsing; 2. Accumulation organic matter and the formation of humus horizon and 3. Forming (B)rz horizon in brownized calcomelanosols.

The genesis of calcocambisols are characterized by the following processes:

1. Accumulation mull and half row humus; 2. Decarbonization; 3. Slight acidification; 4. Slight chemical weathering by weak clay formation; 5. Fixation and hydratation Fe_2O_3 and 6. Releasing on the clay residuum of limestone.

Jablanica Mountain evolutionary series has following order: organogenic – organomineral – brownized calcomelanosol – calcocambisol.

In our investigation we found three subtype calcomelanosols: organogenic, organomineral and brownised, and one typical subtype calcocambisol.

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ГЕНЕЗА, ЕВОЛУЦИЈА И КЛАСИФИКАЦИЈА НА ПОЧВИТЕ ОБРАЗУВАНИ ВРЗ ВАРОВНЦИ И ДОЛОМИТИ НА ПЛАНИНАТА ЈАБЛАНИЦА

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Апстракт

Во овој труд се изнесени резултатите од истражувањата на условите за образување, генезата, еволуцијата и класификацијата на варовнично-доломитните црници и кафеавите почви врз варовник и доломит на планината Јабланица. На различни локалитети на планината Јабланица беа ископани 18 основни педолошки профили на варовнично-доломитни црници со поттиповите:органогени (5), органоминерални(12) и браунизирани (1) и 4 профили на кафеави почви врз варовници и доломити со еден поттип типични. Притоа, беа собрани податоци за условите на почвообразување (матичен супстрат, релјеф, клима, вегетација и влијание на човекот). Испитаните почви се образуваат само на чисти варовници и доломити, на планински релјеф на надморска височина од 900-1990 м. Образувани се под разни дабови и букови заедници а во субалпскиот појас под високопланински тревни заедници. На планината Јабланица испитуваните почви се простираат во четири климатско- вегетациски појаси. Со сечење и палење на шумата засилена е ерозијата. Варовнично-доломитните црници претставуваат прв стадиум во еволуцијата на почвите врз компактни варовници и доломити. На планината Јабланица еволуционата серија го има следниот редослед: органогена – органоминерална – браунизирана варовнично доломитна црница – кафеава почва врз варовник и доломит.

Клучни зборови: почва, услови за образување, генеза, еволуција, класификација.

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IMPACT OF PRECIPITATION UPON NITRATE LEACHING AND CROP YIELD AT DIFFERENT PIPE DRAINAGE SPACING

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Abstract
The goal of three-year investigations was to determine the influence of precipitation upon drainage discharge and its duration, concentration of nitrates in drainage water, amount of nitrates leached and yields of crops grown: winter wheat, oilseed rape and soybean, at four different pipe drainage spacings (15 m, 20 m, 25 m and 30 m) on pseudogley-gley soil. Investigations were carried out at the experimental amelioration site "Jelenščak" near Popovača, in the period from 1 October 2008 to 30 September 2011.Winter wheat (2008/09), oil seed rape (2009/10) and soybean (2011) were grown at the experimental site. Identical agricultural management practices were applied in each year in all pipe spacing variants. Total nitrogen rates applied amounted to 183.6 kg. ha^{-1} (2008/09), 175.5 $kg.ha^{-1}$ (2009/10) and 130 $kg.ha^{-1}$ (2011).Research results show that drainage discharge and its duration depended on the amount and distribution of precipitation during the study period. The highest drainage discharge was determined at the narrowest pipe spacing (15 m), while its longest duration was observed at the widest spacing (30 m). No drainage discharge was registered in the growing season of the dry 2011. The highest nitrate concentration in drainage water, in all pipe spacing variants, was recorded with the occurrence of the first drainage discharges and was higher than MAC (10 $mg.L^{-1}$ $N0_3$ - N). It was only after the autumn crop harvest that nitrate concentration was below MAC. The amount of nitrates leached, in each year and at each pipe spacing, depended on the drainage discharge and nitrate concentration in drainage water. Crop yields in the production year were statistically significant between the set pipe spacings (2008/09 and 2009/10), while they were not statistically significant in 2011. Effect of pipe drainage in draining surplus water from soil was positive in humid years while no effect of pipe drainage was recorded in the dry year.
Key words: precipitation, pipe spacing, drainage discharge, nitrate leaching, crop yield.

Introduction

In the Republic of Croatia, hydromorphic soils caver an area of 1,789,070 ha. Hydroameliorative systems of surface drainage have been completed on 600,054 ha (33.5 %) of the said area, surface drainage systems have been partially built on 518,830 ha (29.0 %), while there are no surface drainage systems on 670,186 ha (37.5 %). Areas on which surface water had to be regulated by subsurface drainage (pipes) amounted to 820,350 ha. Thus far, subsurface drainage has been

installed at an area of 161,530 ha (19.7 %), so subsurface drainage still remains to be provided on 658,820 ha (80.3 %) (Marušić, 1992).

Agricultural production is very risky on such developed/undeveloped agricultural areas, especially when surplus and/or deficit of precipitation occurs before or during the growing season. Such conditions make production planning very difficult and/or almost impossible, because production, and thereby also yield, depends on the weather conditions, making yields of field crops and their quality highly variable. This is the reason why most agricultural producers and part of the general public speak about the so called natural disasters, caused by floods or droughts.

Besides yields achieved and quality of agricultural products, we hear everyday discussions about the environment and its protection, namely, how much agriculture with all its inputs (mineral fertilizers and protection agents) influences the pollution of the natural resources soil and water, or about what should be done to act according to the principles of sustainable management, which implies production cost-effectiveness, environmental conservation, that is, its protection and prevention of further excessive pollution of ground and drinking water, notably by nitrates. Due to easy leaching of nitrates and its harmful consequences for people, the EU Nitrates Directive (91/676/EEC) was issued on water protection against pollution caused by nitrates of agricultural provenance due to inadequate and excessive nitrogen fertilization and incorrect storage of stable manure. The directive defines the responsibilities of the EU member countries regarding introduction of protection and supervision measures, and prescribes the conditions and measures for protection against nitrate pollution to be applied at farms. As part of the EU accession process, the Republic of Croatia has adopted this directive and incorporated it in its national legislation. Application of the Nitrates Directive will start after Croatia becomes a full member of the EU.

The goal of three-year investigations was to determine the influence of precipitation upon drainage discharge and its duration, concentration of nitrates in drainage water, amount of nitrates leached and yields of crops grown: winter wheat, oilseed rape and soybean, at four different pipe drainage spacings (15 m, 20 m, 25 m and 30 m) on pseudogley-gley soil.

Material and methods

Investigations were conducted from 1 October 2008 to 30 September 2011 at the experimental amelioration site "Jelenščak" in the central Sava Valley (in the vicinity of Popovača) on hydroameliorated pseudogley-gley soil. The wider terrain area, including the experimental site, is situated in an area of relatively flat relief (I<1‰) at the average height above sea-level of 95.0–96.0 m. Prior to the application of hydroamelioration, the terrain was utilized for extensive public pastures, which were also covered by typical hydrophilic vegetation (Šimunić, 1995). The terrain on which the trial was set up is situated in the peripheral part of the Nature Park Lonjsko polje (Fig.1).

The shape of the terrain and the position of the experimental amelioration site (table) within it are shown in Figure 2. The experimental amelioration site comprises four different pipe spacings (15 m, 20 m, 25 m and 30 m) laid out in four replications (Figure 3). Pipe length is 95 m in all spacing variants, pipe diameter is 65 mm, average slope is 3 $^{0}/_{00}$ and average is depth 1 m. Drainage pipes are combined with contact (hydraulic) material gravel and drain directly into an open detailed canal. Pipe spacing of 25 m (with the said pipe length of 95 m) has an appertaining area of 1425 m^2; pipe spacing of 20 m has an area of 1900 m^2; pipe spacing of 25 m has an area of 2375 m^2 and pipe

spacing of 30 m has an area of 2850 m^2. Drainage discharge in each pipe spacing variant was continuously measured with the aid of a limnigraph, installed at the pipe outlet to the canal.
Climatic data used were provided by the weather station at Sisak, at ca. 15 km distance from the experimental amelioration site.



Figure 1. Location of the experimental amelioration site

The same crop was grown in each year in all pipe spacing variants and identical agricultural management practices were applied. Winter wheat was grown in the first year, oilseed rape in the second year, while soybean was produced in the third year.
Winter wheat was sown in October 2008. Total nitrogen rate applied was 183.6 $kg.ha^{-1}$. The crop was harvested at the beginning of July 2009. Oilseed rape was sown in mid-September 2009 and total amount of nitrogen added with fertilization was 175.5 $kg.ha^{-1}$. The crop was harvested at the beginning of July 2010. Soybean was sown at the beginning of April 2011 and a total of 135 $kg.ha^{-1}$ nitrogen was added with fertilization. Crop was harvested in mid-September 2011. Crop yield was measured at each pipe spacing and was expressed at 13% grain moisture level. Drainage water was sampled during drainage discharge, each ten days on average. Drainage water samples were taken separately for each pipe at the pipe outlet to the canal. Concentration of nitrates in drainage water was determined spectrophotometrically with 2.6-dimethylphenol (HRN ISO 7890-1:1998).
The amount of nitrates leached (at each pipe spacing) was calculated from the data on average monthly concentration of nitrates in drainage water and total monthly amount of drainage discharge. The annual value was obtained by summing up the monthly values of nitrates leached at each spacing.
ANOVA was applied for drainage discharge, its duration, nitrate concentration and crop yield in the tested pipe spacing variants; in the case of $p \leq 0.05$, Duncan's Multiple Range Test was performed.



Figure 2. The terrain and the position of the experimental amelioration site (table) "Jelenščak" – within the red frame (www.googlemaps.com)

To facilitate interpretation of research results, site factors (soil) and climate (precipitation) were taken into consideration.

Pseudogley-gley and its characteristics

As per textural composition, hydroameliorated pseudogley-gley soil (Figure 4) is silty clay to 75 cm depth, silty clay loam at 75 cm to 115 cm depth, and silty clay from 115 cm to 130 cm (Table 1). It belongs to the class of porous soils (average porosity 49 vol.%), on the borderline between medium and high water retention capacity (average water capacity 45 vol.%) and of very low air retention capacity (average air capacity 4 vol.%), as well as of very low water permeability (average water permeability 0.011 m/day). According to the MKCl reaction to 75 cm depth, the soil has acid reaction; according to humus content to 35 cm depth, it is fairly humus-rich; according to the supply of available phosphorus and potassium (to 35 cm depth), it is in the poor availability class.

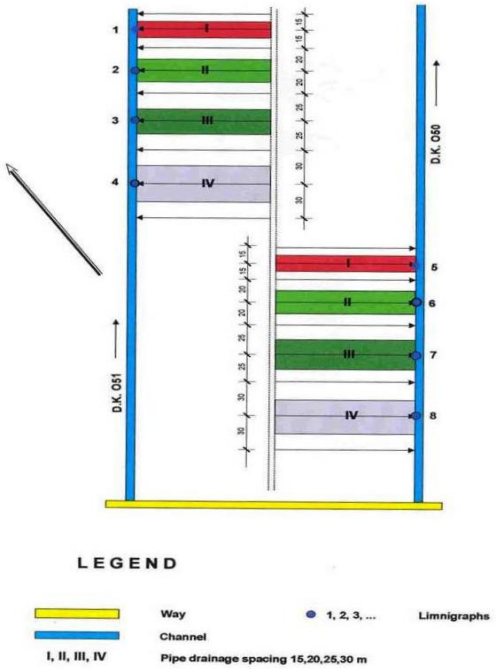


Figure 3. Scheme of the experimental amelioration site "Jelenščak"

Climate (precipitation)

According to its general climatic characteristics, the Sisak region belongs to the central-European temperate climate, warm climate zone, moderately rainy climate with expressly continental traits. In the twenty-year period (1986 - 2005), an average of 925 mm of precipitation fell in the Sisak region, which fluctuated from 614.8 mm to 1086.9 mm. The growing seasons had 523.4 mm or 56.6 %, which is a characteristic of the continental precipitation regime. Monthly precipitation maxima were recorded in late spring and late summer parts of the year (June and September). The multiyear average and distribution of precipitation over the year allow the conclusion that the precipitation regime is favourable for agricultural production. However, to get a better insight into monthly and annual precipitation and its distribution, probability of its occurrence should be calculated (Table 1) as well as the occurrence return period (Table 2).



Figure 4. Pseudogley-gley soil profile

Based on the multiyear precipitation average, the Sisak region is on the borderline between semi-humid and humid climate (Kf = 81.9) pursuant to Lang's rain factor, whereas pursuant to the monthly heat index of Gračanin, the region belongs to moderately warm climate (T=11.3°C).

Climatic and hydrological characteristics of the studied region are some of the indispensable indicators for the planning and designing of drainage systems, since multiyear precipitation, its monthly or seasonal distribution or maximum daily precipitation and its intensity define the key characteristic of climate and determine the type of agriculture and management on ameliorated areas.

Table 1 presents the probability of monthly precipitation occurrence for the weather station Sisak, which was calculated according to the formula:

$$Fa = \frac{2n-1}{2y} \text{ x } 100$$

Fa - occurrence probability (%)

n - number of equivalent occurrences or observations

y – total number of occurrences or observations

Return period of precipitation occurrence was calculated according to the formula:

$$P = \frac{y}{n}$$

P – Return period

It is evident from Table 1 that the probability of precipitation occurrence in 50 % cases was 948.3 mm (value taken from Fa=52.5 %), while the probability of precipitation occurrence was 1005.9 mm in 22.5 % cases. It is evident from Table 1 that the listed sums of annual precipitation (1005.9 mm and higher) were allocated to class I and that their occurrence can be expected every 4th year.

Table 1. Occurrence probability of monthly and annul precipitation (Fa) (mm), WS Sisak, 1986-2005

Entry	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Sum	Fa (%)
1	90.7	114.1	95.8	151.9	198.6	190.4	151.5	182.3	229.9	178.2	196.5	136.4	1086.9	2.5
2	84.9	79.4	84.4	125.8	176.5	178.6	148.1	160.6	228.3	147.2	172.5	133.8	1038.7	7.5
3	84.5	77.8	80.8	91.2	172.7	153.6	124.4	158.1	147.3	131.5	137.3	129.7	1023.4	12.5
4	79.0	71.7	68.4	83.7	107.0	152.7	114.2	150.3	140.7	123.9	136.8	104.3	1008.1	17.5
5	73.4	69.6	63.8	82.1	98.9	129.3	105.8	117.5	130.0	114.9	134.8	103.7	1005.9	22.5
6	71.2	64.2	63.1	79.9	97.7	127.9	105.1	105.9	121.3	109.9	124.5	84.7	992.8	27.5
7	67.6	62.7	63.0	78.3	89.7	127.3	103.6	93.0	115.0	98.9	122.4	76.2	977.7	32.5
8	66.8	57.3	59.7	76.6	83.4	119.6	85.9	92.9	105.2	93.1	121.9	70.4	960.1	37.5
9	66.6	48.4	55.9	75.5	81.4	102.5	77.2	83.2	103.2	78.7	104.5	69.9	958.7	42.5
10	57.4	48.4	54.9	73.7	75.9	102.5	73.3	82.3	95.4	72.8	89.3	64.9	948.5	47.5
11	55.9	47.7	54.1	73.0	75.8	94.0	64.4	82.1	86.0	71.4	88.3	56.4	948.3	52.5
12	55.9	43.3	52.6	65.7	65.0	91.9	63.8	76.5	83.5	70.1	85.9	55.6	938.8	57.5
13	55.1	36.5	52.5	65.5	63.9	89.0	51.3	68.7	82.5	68.8	72.2	50.5	925.1	62.5
14	42.8	34.8	38.7	65.0	63.9	81.9	50.1	65.6	80.1	61.8	71.2	44.5	923.9	67.5
15	42.3	31.3	37.6	61.3	54.8	63.7	45.1	60.6	79.4	60.9	63.5	43.8	912.3	72.5
16	41.6	30.7	35.5	55.6	44.1	51.4	44.6	47.1	58.8	46.3	57.7	39.8	879.5	77.5
17	29.1	21.3	29.6	46.9	35.0	47.4	41.9	24.9	41.6	35.6	55.8	32.1	868.7	82.5
18	22.7	12.3	27.6	46.7	32.5	47.4	40.8	22.7	38.2	30.0	30.8	28.1	865.1	87.5
19	17.5	11.1	26.7	46.2	26.0	42.5	37.7	20.3	33.9	20.3	25.8	24.8	829.2	92.5
20	13.0	4.5	5.1	29.6	25.8	40.0	30.5	10.5	25.4	12.8	17.2	18.7	614.8	97.5

Table 2. Return period of annual precipitation sums, WS Sisak

Class	Precipitation (mm)	Number of equivalent occurrences (n)	Return period (P)
I	1100-1000	5	4
II	1000-900	10	2
III	900-800	4	5
IV	800-700	0	0
V	700-600	1	20

Results and discussion

Research results are presented in Tables and Graphs.

Drainage discharge and its duration

Table 4 provides monthly and total precipitation amounts during the studied period as well as monthly and total drainage discharge in the growing seasons for the different pipe spacings.

Table 3. Precipitation during the growing season (mm), Weather Station Sisak

Year	IX	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	Σ
2008./09.	***	88.1	86.1	101.1	113.2	40.4	53.6	31.3	44.2	153.2	***	***	***	711.2
2009/10.	30.2	88.4	102.2	94.8	105.4	88.6	66.3	59.0	156.9	146.2	64.9	***	***	1002.9
2010./11.	***	***	***	***	***	***	***	31.2	31.7	125.0	88.3	42.0	30.2	348.4

*** Non-growing season

Table 4. Monthly and total drainage discharge for different drainpipe spacings (mm)

Year	Pipe spacing (m)	IX	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	Σ (mm)
2008/09	15	***	11	26	64	67	19	24	7	0	32	***	***	***	250
	20	***	11	24	64	65	18	25	7	0	31	***	***	***	245
	25	***	12	25	63	66	20	24	8	0	29	***	***	***	247
	30	***	12	25	63	65	18	23	7	0	27	***	***	***	240
2009/10	15	0	0	25	63	67	56	28	5	33	47	0	***	***	324
	20	0	0	23	62	65	55	28	5	32	47	0	***	***	317
	25	0	0	20	60	62	52	25	4	32	47	0	***	***	302
	30	0	0	20	59	60	52	25	4	31	46	0	***	***	297
2010/11	15	***	***	***	***	***	***	***	0	0	0	0	0	0	0
	20	***	***	***	***	***	***	***	0	0	0	0	0	0	0
	25	***	***	***	***	***	***	***	0	0	0	0	0	0	0
	30	***	***	***	***	***	***	***	0	0	0	0	0	0	0

*** Non-growing season

Table 5. Total drainage discharge (mm), % of precipitation and duration of drainage discharge for different drainpipe spacings (days) in winter wheat and oilseed rape production

Year	Drainpipe spacing (m)	Total drainage discharge (mm)		% of precipitation	Duration of drainage discharge (days)	
2008/09	15	250	a	35.2	98	A
	20	245	b	34.4	102	B
	25	247	bc	34.7	105	Bc
	30	240	d	33.7	114	D
		F=19. 38 c=3.49			F= 25.42 c=3.49	
2009/10	15	324	a	32.3	118	A
	20	317	b	31.6	124	B
	25	302	c	30.1	132	C
	30	297	d	29.6	140	D
		F=131.08 c=3.49			F=116.09 c=3.49	

Values marked with different letters are statistically significant, according to Duncan's Multiple Range Test

Precipitation amount, distribution and time of precipitation occurrence during the investigation period influenced the drainage discharge and its duration (Tables 4 and 5), both at the annual and monthly levels, as well as the differences between the tested pipe spacings. No drainage discharge was recorded in any pipe spacing variant in the growing season of 2011.

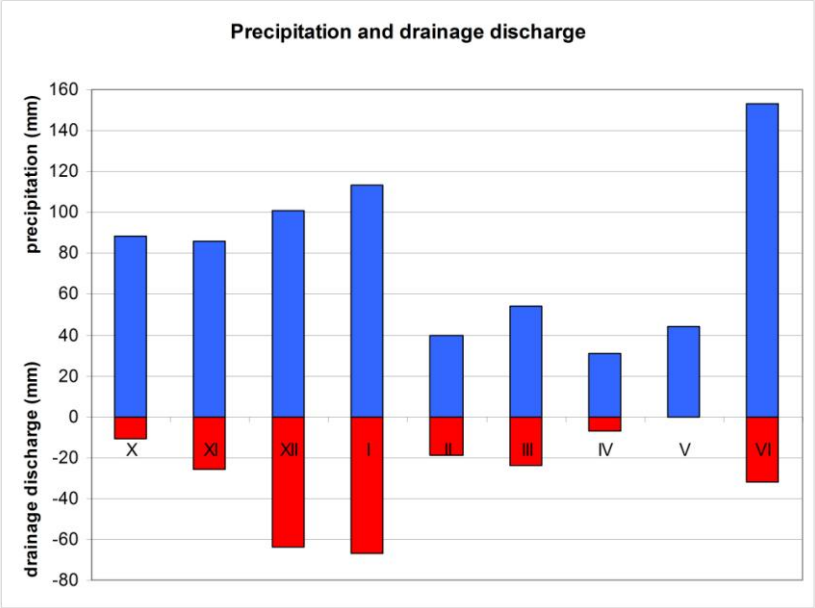


Figure 1. Monthly precipitation values and monthly drainage discharge values, for the drainpipe spacing of 15 m in winter wheat production (2008/09)

In winter wheat production in 2008/09, the first drainage discharges in all pipe spacing variants were recorded in October (Graph 1 represents the graphic precipitation and drainage discharge flowchart for pipe spacing of 15 m), whereas the first drainage discharges in 2009/10 were recorded in November (Graph 2).

Drainage discharge was recorded after the soil water supply was filled up with precipitation from the preceding months. In the winter-spring period, monthly drainage discharge in all pipe spacing variants followed the monthly amounts of precipitation, that is, the higher the monthly amount of precipitation, the higher was the drainage discharge, and vice versa. In the late spring and summer months, due to intensified growth and development of plants, the amount of drainage discharge was not proportional to precipitation. Namely, evapotranspiration was increased at later plant development stages due to higher spring and summer air temperatures, so that lower drainage discharge was recorded in all pipe spacing variants.

In years in which drainage discharges were registered, the highest drainage discharge was determined at the narrowest pipe spacing (15 m), whereas the lowest was recorded at the widest pipe spacing (30 m). As regards drainage discharge duration, Table 5 shows that the shortest duration was determined at the narrowest pipe spacing (15 m), and the longest at the widest pipe spacing (30 m). Thus, the discharge and its duration are inversely proportional values, which may be attributed to the drainage system efficiency.

According to the investigations conducted by Šimunić (1995), Petošić et al. (1998) and Tomić et al. (2002), narrower pipe spacing is more efficient for draining surplus water from drained soils, since larger amounts of water are drained in s shorter period of time and better water-air relationships in soil are created faster, which is a prerequisite for timely application of agricultural management practices on hydroameliorated arable areas.

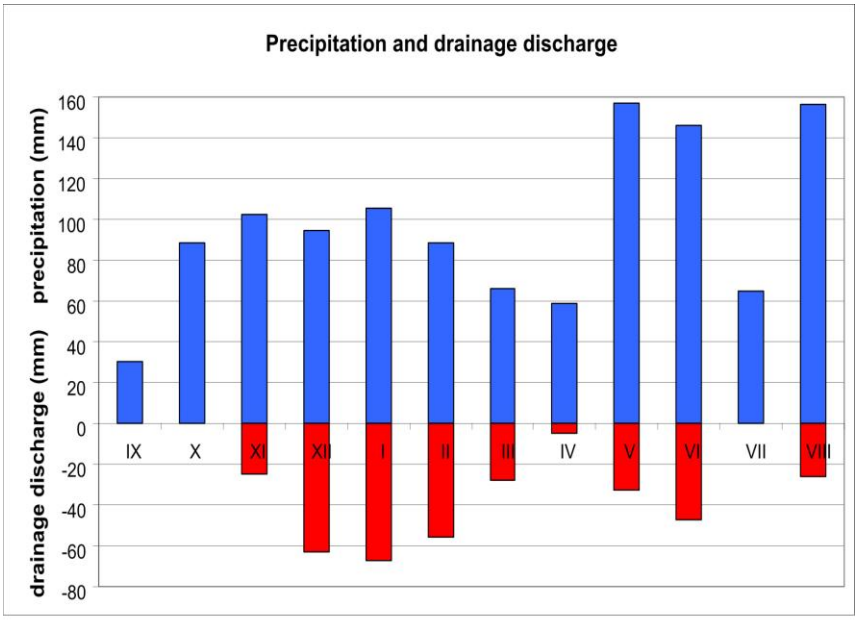


Figure 2. Monthly precipitation values and monthly drainage discharge values, for the drainpipe spacing of 15 m in oilseed rape production (2009/10)

Nitrate concentration in drainage water

Maximum and average concentrations of nitrates in drainage water were higher than MAC (10 mg. L^{-1}) in all pipe spacing variants while minimum values were below MAC (Table 6; Graphs 3 and 4). The highest nitrate concentration was recorded in October (2008), and in November (2009), after sowing and basic fertilization, when the first higher precipitation occurred and caused drainage discharge, as seen in Graphs 3 and 4.

Nitrate concentration deceased in subsequent months in all pipe spacing variants, and then it increased in March 2009 and in February 2010, also in all spacing variants (post fertilization–topdressing of crops with 54 $kg.ha^{-1}$ nitrogen).

Table 6. Maximum and average concentration of nitrogen (mg.dm^{-3}) in drainage water

Drainpipe spacing (m)	October 2008-June 2009			September 2009-June 2010		
	Max	Average		Max	Average	
15	23.12	13.90	a	47.85	21.84	a
20	23.18	13.71	a	50.13	21.47	a
25	24.59	12.57	b	48.59	21.14	a
30	23.53	12.65	b	43.53	20.37	a
		F=6.37 c=3.49		F=0.013 c=3.49		

Values marked with the same letter are not statistically significant, according to Duncan's Multiple Range Test.

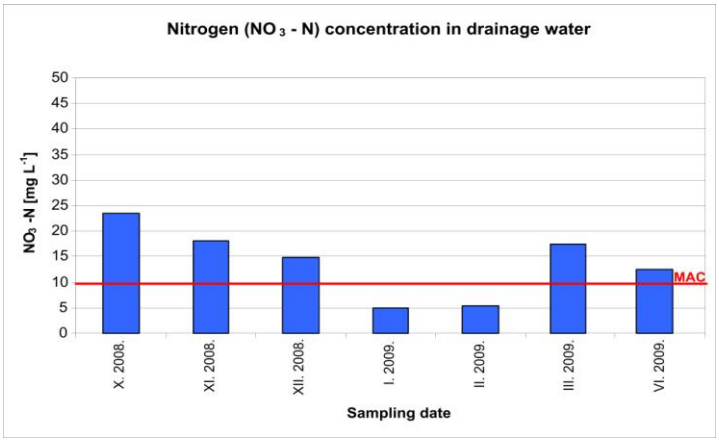


Figure 3. Fluctuation of nitrogen concentration in drainage water, for the drainpipe spacing of 15 m in winter wheat production (2008/09)

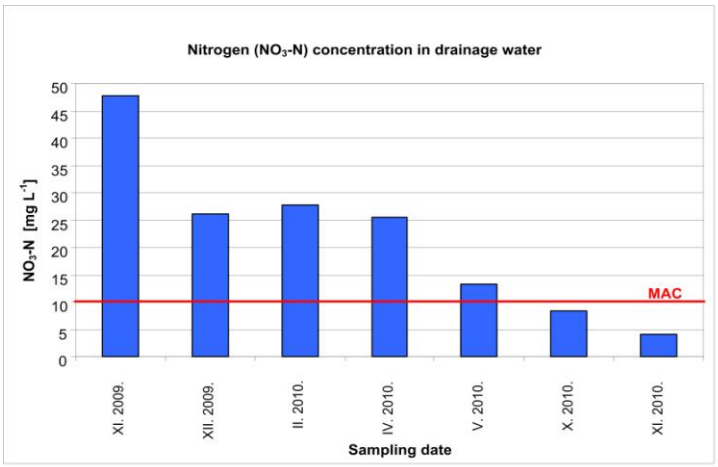


Figure 4. Fluctuation of nitrogen concentration in drainage water, for the drainpipe spacing of 15 m in oilseed rape production (2009/10)

In subsequent months, nitrate concentration decreased despite the second nitrogen application (40.5 kg.ha^{-1}) (2010). This reduction in nitrogen concentration can be explained by the fact that in later spring months crops have a well-developed habitus, which enables higher nitrate uptake, and thereby its lower leaching. Nitrate concentration in May 2010 and June 2009 was still above MAC. It was only in the autumn that nitrate concentration values were below MAC in all pipe spacing variants. The difference in nitrate concentration between pipe spacings was statistically significant in 2008/09, whereas it was not significant in 2009/10. Similar results for nitrate concentration in drainage water were obtained by Rossi et al. (1991), Šimunić et al. (2002; 2011) and Bensa et al. (2007).

Leaching of nitrates with drainage water

Amounts of nitrates leached at different pipe spacings are given in Table 7.

Table 7. Nitrate leached with drainage water (kg.ha^{-3}) and percentage of nitrogen leached relative to total N added with fertilization

Drainpipe spacing (m)	October 2008- June 2009		September 2009-June 2010	
	Kg.ha^{-1}	%	Kg.ha^{-1}	%
15	34.8	19.0	70.8	40.3
20	33.6	18.3	68.1	38.8
25	31.0	16.9	63.8	36.4
30	30.4	16.6	60.5	34.5

As can be seen from Table 7, there are differences in the amount of nitrates leached both between investigation years and pipe spacings. In both years, the highest amount of nitrates leached was found at the pipe spacing of 15 m, while the least nitrates were leached at the pipe spacing of 30 m. In fact, highest leaching occurred at the pipe spacing of 15 m, where the highest drainage discharge was measured and vice versa, while leaching was the lowest at the pipe spacing of 30 m, where the lowest drainage discharge was measured. According to Mesić et al. (2007), the amount of nitrogen leached is linearly correlated with the amount of drainage discharge. The difference in the amount of nitrates leached in 2009/10 and 2008/2009 is also attributed to the above listed findings. As already mentioned, there was only a small difference in the amount of nitrogen added with fertilization, so the amount of nitrogen added could not affect the twice larger amount of nitrogen leached. The lower impact on the amount of nitrogen leached could be ascribed to crop requirements for nitrates at particular development stages.

Crop yields

Crop yields per pipe spacing are presented in Table 8.

Table 8. Winter wheat, oilseed rape and soybean yields (t.ha^{-1})

Drainpipe spacing (m)	Winter wheat (t.ha^{-1})		Oilseed rape (t.ha^{-1})		Soybean (t.ha^{-1})	
15	5.30	a	3.30	a	2.32	a
20	5.10	b	3.03	b	2.40	a
25	4.95	b	2.69	c	2.39	a
30	4.75	c	2.38	d	2.29	a
	F=15.6 c=3.49		F=49.38 c=3.49		F=2.61 c=3.49	

Values marked with different letters are statistically significant, according to Duncan's Multiple Range Test.

As can be seen from Table 8, there are differences in crop yields achieved in the tested pipe spacing variants both between years and between pipe spacings. Highest wheat and oilseed rape yields were achieved in the 15 m pipe spacing variant, while the highest soybean yield in 2011 was obtained at the pipe spacing of 20 m. Lowest yield in all investigation years was that of the 30 m pipe spacing variant. Differences in winter wheat yield determined in 2008/09 were statistically significant at the tested spacings, except for the spacing of 20 m and 25 m. In the second investigation year, oilseed rape yields were statistically significant in the tested pipe spacing variants, while no statistically significant differences between pipe spacings were found for soybean production in the dry 2011. Very similar results were reported by Tomić et al. (2002) and Tomić et al. (2007.a 2007.b), Mesić et al. (2008) and Šimunić et al. (2011), who maintain that the effect of the drainage system (pipe spacing) influences the yield, since system functionality is reflected in hydrological parameters such as drainage discharge and its duration. In the dry 2011, the different pipe spacings were not in the function of drainage, so they had no influence on soybean yield. At the same experimental site, Tomić et al. (2002) and Šimunić et al. (2011) determined statistically significant differences in wheat and maize yields in some years, with the highest yields in the pipe spacing variants of 15 m and 20 m. Further, these authors think that crop yield and differences between the pipe spacings tested could also be caused by fertilizer rates and fertilization dynamics, weather conditions at sowing and other agricultural management practices applied.

Conclusions

Three-year investigations of the influence of precipitation upon drainage discharge, concentration and leaching of nitrates, and crop yields in different pipe spacing variants on hydroameliorated soil in the central Sava Valley point to the following conclusions:

The highest drainage discharge and its longest duration were determined at all pipe spacings in the oilseed rape growing season, i.e., in the period with the largest amount of precipitation (2009/10). Lower drainage discharge was recorded in all pipe spacing variants in the winter wheat growing season, i.e., in the period with less precipitation (2008/09), while drainage discharge was not recorded in any pipe drainage variant in the growing season of soybean, i.e., in the period with the lowest precipitation (2011).

The recorded maximum and calculated mean values of nitrate concentration in drainage water were higher at all pipe spacings in the oilseed rape growing season, in the period with the highest precipitation and highest drainage discharge (2009/10), compared to the wheat growing season, when lower precipitation and lower drainage discharge were recorded (2008/09).

The calculated amount of nitrates leached in all pipe spacing variants was higher in 2009/10 than in 2008/09 (the amount of leached nitrates is the product of multiplication of monthly drainage discharge at each pipe spacing by nitrate concentration at each pipe spacing).

The recorded winter wheat yield (2008/09) at each pipe spacing was statistically significant between pipe spacings, except between 20 m and 25 m spacings. The oilseed rape yield recorded at the set pipe spacings was statistically significant between all pipe spacings, whereas soybean yield was not statistically significant at the tested pipe spacings.

The results indicate that the draining of hydromorphic pseudogley-gley soil by pipe drainage (combined drainage) is justified, but also call for caution in the management of ameliorated areas because of the altered pedophysical and pedochemical properties of hydroameliorated soil.

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ВЛИЈАНИЕ НА ВРНЕЖИТЕ ВРЗ ИСПИРАЊЕТО НА НИТРАТИТЕ И ПРИНОСОТ НА ОДГЛЕДУВАНИТЕ КУЛТУРИ ПРИ РАЗЛИЧНИ РАСТОЈАНИЈА ПОМЕЃУ ЦЕВКИТЕ ЗА ОДВОДНУВАЊЕ

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Апстракт

Целта на тригодишното истражување беше да се утврди влијанието на врнежите врз дренажното оттекување и неговото траење, концентрацијата на нитратите во дренажната вода, количината на испраните нитрати и приносот од пченица, маслодајна репка и соја одгледувани на почвен тип псевдоглеј (поттип глејна почва), при четири различни растојанија помеѓу дренажните цевки (15 м, 20 м, 25 м и 30 м). Истражувањата се спроведени на мелиорациското експериментално поле "Јеленшчак" во близина на Поповача, во периодот од 1 октомври 2008 до 30 септември 2011 година. Експерименталните истражувања со озимата пченица беа поставени во 2008/09 година, со маслодајната репка во 2009/10 година, додека експерименталните истражувања со сојата беа извршени во 2011 година. Во секоја експериментална година беа поставени исти агротехнички мерки кај сите варијанти со различни растојанија помеѓу цевките. Вкупната количина на аплициран азот изнесуваше183.6 kg.ha^{-1} (2008/09), 175.5 kg.ha^{-1} (2009/10) и 130 kg.ha^{-1} (2011). Резултатите од истражувањето покажуваат дека дренажното оттекување и неговото траење зависат од количината и распоредот на врнежите во периодот на истражувањето. Најголема количина на дренажно оттекување е забележана кај најтесно поставените цевки (15 m), додека најдолго траење на оттекувањето е утврдено кај најширокото растојание (30 m). Во сушната 2011 година за време на вегетацискиот период не е регистрирано дренажно оттекување. Максималната концентрација на нитрати во дренажната вода, кај секое растојание помеѓу цевките е утврдена со појавата на првите дренажни оттекувања и беше повисока од максимално дозволената концентрација - МДК (10 mg.L^{-1} $N0_3$ - N), а дури на есен по жетвата на културите концентрацијата била под МДК. Количината на испраните нитрати во секоја година и кај секое растојание помеѓу цевките зависи од дренажното оттекување и концентрацијата на нитратите во дренажната вода. Приносот од екпериментираните култури во 2008/09 и 2009/10 година беше статистички оправдан помеѓу различните растојанија на цевките, додека во 2011 година, разликите не беа статистички оправдани. Од истражувањата, утврдено е позитивно влијание на одводнувањето во похумидните години во споредба со посушните години.

Клучни зборови: врнежи, растојание помеѓу цевки, дренажно оттекување, испирање на нитрати.

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THE LEVEL OF ACIDITY CHANGES AND CONTENT OF MOBILE ALUMINIUM AFTER LIMING

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Abstract
Numerous chemical factors limit normal growth of plants on acid soils. Limited fertility of acid soils is caused by a high concentration of H- and Al-ions, some organic acids and heavy metals, as well as by a lower availability of significant group of nutritive elements (P, Ca, Mg, B, Zn, Mo). Particularly harmful effect is expressed by aluminum. Liming, as acid soils remediation measure, is successful in elimination of the above mentioned unfavorable soil properties. Field trials have been done on soil type Dystric cambisol. The trial was established as random complete block design (RCBD). The three doses of hydrated lime ($CaO \times H_2O$) have been applied in order to reduce acidity: the one was on the level of partial liming (1/3 Y_1 CaO and 1/2 Y_1 CaO), and the as full liming (Y_1 CaO). Liming strongly affected the studied parameters. The major changes caused by liming were observed in pH, hydrolytic acidity, level of base saturation percentage (V%), and mobile aluminum content. Full liming eliminated soil acidity and improved significantly the all properties of the soil adsorption complex. Partial liming gave a satisfactory result, especially in decreasing of mobile aluminum content.
Key words: liming, pH, hydrolytic acidity, aluminium, Dystric cambisol.

Introduction

Primarily acidic soils create a number of difficulties in agriculture, especially in the production of high quality and biologically valuable food. There are many factors that limit fertility of the land. High concentrations of H and Al ions, and some organic acids and heavy metals, as well as a small number of available nutrients (P, Ca, Mg, B, Zn, and particularly Mo) are just some of these factors. At acid soils with $pH \leq 5.5$ Al-toxicity is the main stress factor for plants (Merino-Gergichevich *et al*., 2010; Poschenrieder *et al*., 2008), and in such conditions it is linked to the prevailing pressure for adaptation of cultivated plants (Ryan and Delhaize, 2010).

Harmful effects of mobile aluminum can be viewed from two aspects. First, its indirect impact through the reduction of solubility is being noticed, as well as availability of nutrients. Namely, aluminum ions, among other things, block the adsorption of phosphorus and potassium, and cause disturbing crop growth and development (Zheng, 2010). In addition there are indirect and direct effects, when Al ions act toxic on the plant. The acidic environment increase presence of trivalent aluminum cations - Al^{3+} (Lidon and Barreiro, 2002; Kochian *et al*., 2005), which is the most toxic of all types Al (Delhaize and Ryan, 1995). The best recognized Al-toxicity effects have been

noticed and are well described in the root (Barceló and Poschenrider, 2002, Ma, 2007; Panda and Matsumoto, 2007). A serious problem that appears at high concentrations of aluminum is the inhibition of root growth. It has been noticed that aluminum influences the formation of immature and poor root system, which has limited ability to adopt mineral nutrients and also increases the risk of stress caused by drought (Marcshner, 1991). More precise, toxic effect is being caused by the inhibition of lateral root and root hairs, interruption of feeding with P and Ca and inhibition of growth of shoots (Fageria *et al*., 1988; Foy, 1988). However, the upper parts of the plants may be damaged (Merino-Gergichevich *et al*., 2010), especially leaves, and about which is rarely known. Today, there are more evidences of the negative effects of aluminum on the light absorption, photosynthetic electron transport, gas exchange (Chen *et al*., 2005a, Chen *et al*., 2005b; Chen, 2006), photoprotective systems (Chen *et al*., 2005a; Ali *et al*., 2008), pigments (Chen *et al*., 2005a; Mihailoovic *et al*., 2008; Milivojević *et al*., 2000), as well as other elements associated with the structure or function of the photosynthetic apparatus. Calcification of acid soils is one of the key factors which can keep or even improve their productivity (Mao *et al*., 2008; Repšiene and Skuodiene, 2010). By using the materials containing Ca fundamentally are being changed: physical, chemical and biological properties of the soil, which creates good preconditions for high efficiency of agricultural practice. Therefore, this research has the aim to investigate use of different levels of calcification in an acid soils, such as the Dystric cambisols, defines its effect on the degree of change on acidity and content of mobile Al, as important factors which limit the fertility.

Material and methods

Studies were conducted on the soil Dystric cambisol near Leposavić (Kosovska Mitrovica) during two consecutive years (2009 and 2010 years). Test crop was wheat cultivar Pobeda.

Prior to the formation of experimental field, average samples of soil have been sampled for analysis of chemical properties of Dystric cambisols: pH (H_2O and KCl), hydrolytic acidity (H), total adsorbed basic cations (S), cation exchange capacity (T), base saturation percentage (V%) and mobile Al. The obtained data are being used to determine the level of calcification in terms of elimination of excess acidity and to evaluate the effect of pH on the improvement of mobile Al content in the soil. For calcification has been used CaO with high degree of purity. The material is applied in both years in September, precisely before primary treatment, so it has been properly distributed over the surface and entered into the soil by plowing.

The quantities of CaO which have been applied, were calculated according to the value Y_1 in the soil and the size of the experimental plots (50 m^2). Three variants of calcification have been determined and applied: 1/3 Y_1 CaO (V-3), 1/2 Y_1 CaO (V-4) and Y_1 CaO (V-5), and two variants without calcification: variant with NPK (V-2) and the variant without liming and fertilization - control (V-1). Fertilizers were applied with the variant performed with calcification. In all cases, the dose of active nutrients: nitrogen, phosphorus and potassium were the 120 kg N/ha for P_2O_5 and K_2O, 90 kg/ha ($N_{120}P_{90}K_{90}$). Fertilization has been done by the standard technology for the production of wheat.

The experiment has been performed as a randomized complete block design (RCBD) with four replications. The size of experimental plot was 50 m^2.

In both years, during the stage of wheat tillering (TL), 5 months after liming and after the harvest (AH), 10 months after liming, the pH was determined in distilled water and 1M KCl using a pH

meter ISKRA MA 5740, and exchangeable Al or cell by the method of Sokolov in soil extract with 1M KCl, so it has been firstly determined by the total substitutional acidity, and then precipitation of Al with NaF and influence of Al-ions in forming of substitutional acidity. The hydrolytic acidity - H (by Kappen's method), total adsorbed basic cations - S (by Kappen's), cation exchange capacity - T (mathematically as S + H), base saturation percentage - V% (mathematically as S / T x 100) were detected only after harvesting wheat.

Data were analyzed using standard statistical methods of analysis of variance (ANOVA) using Microsoft Excel 2007 and Statistical Program 5.0. Data analysis has been used to interpret the results and draw conclusions.

Results and discussion

The effects of different liming on active and substitutional acidity during these years are given in Table 1. Results from the table clearly indicate the very significant effect of applied CaO. The changes were evident in the first checking after 5 months of treatment (in the stage of wheat tillering), and the variant with the lowest amount of the calcification materials. Differences between treatments where no CaO has been applied (V-1 and V-2) and in which CaO has been applied (V-3, V-4 and V-5) are statistically highly significant.

There were clear differences between varieties with the calcification done. All differences were statistically significant, except for changes in the acidity of the active tillering stage (TL) 2009, when the differences between first (V-3) and second level (V-4) partial calcification, were at the level of statistical significance. Such changes of substitutional, as well as of the active acidity support the necessity of calcification of acid soils (Busari *et al*., 2008; Jelic *et al*., 2011, Mao *et al*., 2008; Repšiene and Skuodiene, 2010), in order to create favorable conditions for easy growth and development of plants. In particular, it refers to a group of plants that are not sufficiently tolerant to soil acidity.

It should be underlined changes of pH during one growing season. Specifically, during the period between the first (tillering stage) and other checks (after harvest), there was a small decrease of pH. This trend is expected since many processes in soil, above all, rinse, and the adoption of Ca by plants lead to loss of calcification materials, which leads to a decrease of pH. Therefore, often is being stated a time limited (temporality) effects of these measures (Brković and Petrović, 1995), so because of these reasons it is necessary to repeat after a certain time. Since the problem of acidity can not be definitively resolved, it is completely acceptable regular application of lime material that would soil acidity maintain at an acceptable level (Garscho and Parker, 2001).

In this way benefits would be multilateral. Smaller quantities calcification materials would be on one side, economically viable, and on the other side can ensure better availability of nutrients, as well as a more favorable environment for the growth and development of crops.

The changes were noticed with hydrolytic acidity (H), total adsorbed basic cations (S), cation exchange capacity (T), base saturation percentage (V%), and the results of the influence of liming on these properties of Dystric cambisols are given in Table 2.

The intensity of changes depended on the level of calcification (partial, half, full), and the amount of applied Ca. As expected the highest changes have appeared in the treatment where full calcification has been done. Here hydrolytic acidity (H) has been very significantly reduced, while base saturation percentage (V%) has been increased compared to the variants where calcification has not

been applied. Accordingly, with full calcification total adsorbed basic cations (S) has been increased, and cation exchange capacity (T) has been decreased, but the differences are statistically significant only related to V-1 and V-2. Changes of these calcification parameters on soil type – pseudogley, noted Dugalić *et al.*, 2002.

Table 1. The changes of pH in H_2O and 1M KCl after liming

	pH (H_2O)				pH (1M KCl)			
	2009		2010		2009		2010	
Before the trial	5.45		5.52		4.85		4.87	
In the trial	TL	AH	TL	AH	TL	AH	TL	AH
V-1	5.45	5.43	5.42	5.50	4.83	4.83	4.84	4,83
V-2	5.50	5.51	5.41	5.47	4.75	4.79	4.79	4.82
V-3	5.92	5.89	5.90	5.84	5.23	5.30	5.29	5.24
V-4	6.17	6.15	6.18	6.14	5.57	5.56	5.60	5.58
V-5	6.79	6.77	6.87	6.73	6.24	6.20	6.24	6.19
LSD (0.05)	0.24	0.08	0.10	0.09	0.12	010	0.14	0.09
LSD (0,01)	0.35	0.12	0.14	0.13	0.17	0.14	0.20	0.12

Table 2. Changes Y_1, S, T and V (%) after liming

	H (m.eq · 100 $^{-1}$g)		S (m.eq · 100 $^{-1}$g)		T (m.eq · 100 $^{-1}$g)		V (%)	
	2009	2010	2009	2010	2009	2010	2009	2010
Before the trial	9.44	9.07	8.98	9.00	18.42	18.06	48.79	49.59
In the trial								
V-1	10.61	9.12	9.20	8.60	19.81	17.77	46.33	48.25
V-2	9.31	9.46	8.62	9.42	17.94	18.89	47.81	49.87
V-3	5.01	4.98	11.75	10.92	16.85	15.91	70.24	68.66
V-4	3.39	3.50	11.60	11.54	14.77	15.12	77.82	73.54
V-5	1.95	2.25	11.93	12.77	13.55	14.02	85.77	87.09
LSD (0.05)	1.10	1.02	1.73	1.38	2.56	1.76	5.21	4.58
LSD (0,01)	1.58	1.46	2.49	1.98	3.68	2.53	7.49	6.57

Partial (V-3) and half (V-4) calcification have also achieved satisfactory results, particularly in reducing hydrolytic acidity and increasing base saturation percentage. However it should be noted that the effect of both of these variants, when it comes to total adsorbed basic cations and cation exchange capacity, was very close to those results which were achieved by using the biggest quantity of CaO. This effect of small amounts of calcification material once again supports a findings that in this way can be successfully improved the unfavorable properties of acid soils.

Mobile aluminum, as one of the limiting factors for crop production on acid soils, at the Dystric cambisols was at the level which has been expected for depressing effect on crops. However, calcification in all the years of research and at all levels of melioration, radically changed a picture of mobile Al content, and the results are shown in Table 3.

Table 3. Changes of mobile aluminium content (mg · 100 g^{-1}) after liming

	2009		2010	
Before the trial	12.26		13.86	
In the trial	TL	AH	TL	AH
V-1	12.28	12.21	13.62	13.80
V-2	12.32	12.54	13.92	13.87
V-3	5.26	5.56	6.25	6.39
V-4	2.17	2.37	2.44	2.62
V-5	0.48	0.40	0.47	0.42
LSD (0.05)	0.35	0.28	0.35	0.07
LSD (0,01)	0.50	0.40	0.50	0.10

Contents of mobile $Al^{3+,}$ in both years, strongly changed in the entire variant with CaO. Thus, during the first phase of determining in the phase of tillering of wheat, in the variant with full calcification, it has been found Al content in trace amounts. According to results of other authors calcification had the same effect on other soil types, as pseudogley (Dugalić *et a*l., 2002, Jelic et al., 2011), Dystric albeluvisol (Repšiene and Skuodiene, 2010), rinsed pseudogley and cambisol (Pivić *et al*., 2011). At the same time, at the partial variant (V-3), and in particular the partial calcification, mobile aluminum content is reduced to a level when it significantly reduces the risk of its toxic effects on crops. In the treatments V-3 and V-4 during the growing season it has been registered a slight increase of the mobile Al content.

Conclusions

Based on the result of trials and laboratory investigation of the influence of liming on acidity and aluminum content in soil type Dystric cambisols, the following conclusions can be drawn: applying of CaO has quickly acted and maximum changes before a determination has been made in the tillering phase of wheat. The biggest changes have been detected in the reduction of all forms of acidity and content of mobile Al, and increasing the base saturation percentage. The degree of reduction in content of mobile Al with partial (1/3 Y_1) and in half calcification (1/2 Y_1) justify and affirm these levels in calcification of acid soil. Main benefits of lower levels of calcification were lower investments in calcification material, and reducing the content of mobile Al below the level of toxicity.

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НИВОТО НА КИСЕЛОСТ И ИЗМЕНАТА НА МОБИЛНИОТ АЛУМИНИУМ ПОСЛЕ КАЛЦИЗАЦИЈА

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Апстракт

Голем број на хемиски фактори го ограничуваат нормалниот раст на растенијата на кисели почви. Ограничената плодност на киселите почви е предизвикана од висока концентрација на H и Al-јони, некои органски киселини и тешки метали, киселоста влијае и на пониската достапност на значајна група на хранливите елементи (P, Ca, Mg, B, Zn). Особено штетно делува содржината на алуминиум. Внесувањето на варовник кај киселите почви како мерка за санација е успешна во елиминирањето на горенаведените неповолни почвени својства. Теренските испитувања се направени на почвениот тип Дистричен камбисол. Опитот беше поставен како случаен комплетен блок дизајн (RCBD). Трите дози од CaO x H_2O беа применети со цел да се намали киселоста: едната беше на ниво на делумна примена на варовник (1/3 Y1 CaO и 1/2 Y1 CaO), и како целосна примена на варовник (Y1 CaO). Главните промени предизвикани од апликацијата на варовникот беа забележани во pH вредноста, хидролитичката киселост, нивото на заситеност со бази (V%), и мобилни содржина на алуминиум. Целосната доза од примена на варовникот ја елиминира почвената киселост и значително ги подобори и останатите својства на почвениот адсорптивниот комплекс. Делумната апликација на варовникот даде задоволителни резултати само во намалувањето на мобилната содржина на алуминиумот во почвата.

Клучни зборови: варовник, pH, хидролитичка киселост, алуминиум, Дистричен камбисол.

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Original scientific paper

THE NUMBER OF MICROORGANISMS IN DEPTS IN ALLUVIAL SOIL IN SKOPJE REGION

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Abstract
The soil represents living and dynamic environment for different types of microorganisms. With their enzyme activity microorganisms participate in the creation of plant nutrients. Thus, microorganisms participate in the creation and maintenance of soil fertility and are considered as biogenic indicators. In this paper, the total number of microorganisms, actinomyces, diazotrophs, fungi and cellulolytic, denitrifying, ammonifying and nitrifying microorganisms was examined in alluvial soil in Jurumleri locality, Skopje. The number of microorganisms was studied at three different depths (0-10 cm, 10-20 cm and 20-30 cm). The examined soil has favorable physical and chemical properties for growth and development of microorganisms. It was found that most of the studied groups of organisms are present at a depth of 0-10 cm, while ammonifying bacteria are mostly present at a depth of 20 - 30 cm.
Key words: soil, bacteria, actinomyces, diazotrophs, yeasts, cellulolytic, denitrifying, ammonifying, nitrifying microorganisms, molds.

Introduction

Soil represents a complex system composed of solid, liquid and gaseous phase. The solid phase consists of organic and mineral matters, liquid of water and substances dissolved in it, and the gaseous phase consists of oxygen, carbon dioxide, nitrogen, hydrogen, ammonia, etc. All three phases are interrelated and their relationship affects fertility and soil microbial activity (Filipovski G, 1974). The quantitative and qualitative composition of soil microorganisms is different in different types of soils and depends on abiotic (temperature, moisture, acidity, content of organic and mineral substances) and biotic factors (microorganisms, plants, animals and humans and their interaction). The number of microorganisms and their activities in the soil is an important indicator of soil fertility since in the soils with formed profile they maintain its structure, the level of organic matter and through the transformation of materials they provide plants with soil nutrients. Microorganisms in the soil are deployed in horizontal and vertical direction, depending on the latitude, climatic factors, soil type, type of microorganisms and according to the depth of the profile and the altitude. Target of this research is to examine the number of different groups of microorganisms by depth of the profile on alluvial soil in the region of Skopje.

Material and methods

Research are made on alluvial soil in the vicinity of Skopje, particularly in Jurumleri with geographical position of the soil profile on 41 ° 58'20, 84 "north and 21 ° 33'24, 44" east on 276 m altitude. Soil analysis are made for the mechanical composition (Table 1) and chemical properties of the soil (Table 2).

The mechanical composition of the soil depends from the subsoil and the processes that occur during soil genesis and the evolution of soil (Mitrikeski J., Mitkova T, 2006).

In terms of mechanical composition of the soil dominates the fraction sand and dust, which reflects very well on the physical properties of the soil. According to the classification of soils by Scheffer and Schachtschabel, examined soil belongs to the group of loam.

Table 1. Mechanical composition of the soil

Depth in cm	Coarse sand 0,2-2 mm	Cramp (fine) sand 0,02- 0,2	Total	Dust 0,02-0,002	Clay <0,002	Clay + dust
0-20	2.87	56.53	59.40	34.60	6,00	40.60
20-40	3.46	60.24	63.70	34.30	2.00	36.30
40-60	3.09	50.11	53.20	42.40	5.00	47.40
60-80	5.18	41.72	46.90	45.66	7.44	53.10
80-115	1.78	42.15	43.93	45.95	10.12	

Table 2. Chemical composition of the soil

Depth in cm	pH		Total N %	Humus %	$CaCO_3$	Readily available nutrients in the soil	
	H_2O	n KCl				P_2O_5	K_2O
0-20	8.1	7.2	0.1698	2.83	9.9	16.47	20.10
20-40	8.2	7.2	0.0708	1.18	10.83	15.29	18.10
40-60	8.7	7.3	0.066	1.10	11.66	4.31	18.20
60-80	8.7	7.3	0.051	0.85	9.99	5.29	20.40
80-115	8.7	7.3	0.0378	0.63	10.83	3.72	22.10

Based on the presented data about the chemical composition of the soil was determined that the soil according to U.S. classification has neutral to moderately alkaline reaction of the soil solution and in the deeper layers (strata) alkalinity increases. The presence of carbonates in the soil is important because it strongly influences on the chemical composition of the soil, particularly on the reaction of the soil solution, so according to Penkov (1996) the soil belongs to carbonate rich soils.

Examined soil is poor to moderately rich with humus; total N content is in correlation with the level of humus in the soil and its presence decreases with increasing of the depth. The presence of P_2O_5 and K_2O in the top layers shows that the soil is middle provided, and in the deeper layers these values are declining.

The samples for microbiological analysis of the soil are taken aseptically on depth of 0-30 cm. The soil samples are taken in spring and are analyzed in the microbiological laboratory of the Faculty of Natural Sciences and Mathematics.

In the soil are studied different groups of microorganisms according to standard methods (Jarak and Govedarica, 1997).

Tests are made with the method of sowing on adequate dilution of soil on selective nutrient substrates and incubation on temperature of 28 ºC and the total number of microorganisms and ammonia forming bacteria 3-4 days, nitrifying bacteria (nitric forming bacteria), nitrate forming bacteria and nitrate reducing bacteria 5-7 days, fungi and actinomyces 2-3 days.

The total number of microorganisms in the soil is examined on substrate of soil agar (10^{-6}); nitrifying bacteria (nitric forming bacteria) are grown on a substrate esbi agar (10^{-6});

nitrate forming bacteria are determined on mineral substrate with composition: $(NH_4)_2SO_4$ 2g, K_2HPO_4 1g, $MgSO_4$ 0,5 g, $FeSO_4$ 0,4 g, NaCl 0,4 g, $CaCO_3$ 1g, $MgCO_3$ 1 g, agar 1,5% ,distilled water;

nitrate reducing bacteria are studied on mineral substrate with composition: KNO_3 2g, K_2HPO_4 1g, $MgSO_4$ 0,5 g, $FeSO_4$ 0,4 g, NaCl 0,4 g, CaCO3 1g, $MgCO_3$ 1 g, agar 1,5%, distilled water; ammonia forming bacteria are examined by the method of titer on liquid substrate- nutrient broth, using a reagent- leaves soaked with Krupov reactive which is prepared from one part 3% H_2SO_4 and two parts aqueous solution of fuchsin; cellulose splitting microorganisms are studied using carboxyl methyl cellulose (10^{-2}); yeasts are tested on the substrate Czapek-Dox Agar with composition: $NaNO_3$ 2g, KH_2PO_4 1g, $MgSO_4$ 0,5 g, KCl 0,5 g, $FeSO_4$ 0,1 gr, sucrose 300 g, agar 200 g) (10^{-4}); molds are determined on the substrate Czapek-Dox Agar with composition: $NaNO_3$ 2g, KH_2PO_4 1g, $MgSO_4$ 0,5 g, KCl 0,5 g, $FeSO_4$ 0,1 g, sucrose 300 g, agar 200 g) (10^{-4}); actinomyces are determined on synthetic agar according to Krasiljnikov (composition: K_2HPO_4 5g, $MgCO_3$ 5g, NaCl 5g, KNO_3 10g, $FeSO_4$ 10 g, $CaC0_3$ 150g, sucrose 200 g, agar 160 g), (10^{-5}).

Results and discussion

The results from the microbiological tests are shown in Table 3.

in the surface layer, and with increasing of the depth their number decreases.

Bacteria are prokaryotic organisms that have a key role in the process of circulation of matter. Fertile soils contain between one hundred million and a billion bacteria in one gram of soil, their biomass is between 300 - 3000 grams per m^3 of soil, their presence entirely depends on the amount of organic matter, pH, the content of water, air, warmth, light, crop rotation and other agro-technical measures.

The average number of bacteria in the examined soil at a depth of 0-10cm is 88 per gram of soil, at a depth of 10-20cm is 132 per gram of soil and at depth of 20-30 cm is 64. Most bacteria per gram of soil are noted at a depth of 10-20 cm.

Actinomyces are heterotrophic organisms; saprophytes with developed digestive system with ability for decomposition of the organic complex such as humus, chitin, cellulose that for other organisms is difficult to decompose (Waksman, 1945).

Environmental conditions in the soil are suitable for the development of actinomyces and they are most numerous in the surface layer of 0-10 cm.

Table 3. Number of microorganisms by depth in alluvial soil (10^x /g soil)

Soil layer (strata)	Total no. of bacteria	Actinomyces	Nitrifying bacteria	Yeasts	Cellulose splitting microorganisms	Nitrate reducing bacteria	Molds	Ammonia forming bacteria	Nitrate forming bacteria
0-10 first iteration	81	139	230	70	144	221	16	+++	184
0-10 second iteration	61	193	111	95	180	213	38	++	228
0-10 third iteration	122	161	150	95	134	233	33	+	195
10-20 first iteration	79	22	57	30	77	102	16	+++	137
10-20 second iteration	110	35	80	24	53	110	18	++	107
10-20 third iteration	209	20	88	14	42	82	5	+	83
20-30 first iteration	15	42	74	34	83	93	6	+++	59
20-30 second iteration	36	15	102	45	107	83	11	+++	97
20-30 third iteration	141	66	100	87	52	82	6	++	65

Physiological groups of microorganisms - ammonia forming bacteria, nitrate reducing bacteria, nitrate forming bacteria and nitrifying bacteria (nitric forming bacteria) are important for the circulation of nitrogen, carbon, sulfur, phosphorus and other elements. The ammonia forming bacteria with a role to decompose organic nitrogen compounds are numerous in the examined soil, so at a depth of 0-10 cm and 10-20 cm the number of ammonia forming bacteria is equal, and their number is highest at a depth of 20-30 cm. Microorganisms that oxidize ammonia up to nitrates are nitrate forming bacteria and they are most numerous in the surface layer, with increasing of the depth their number declines. Nitrate reducing bacteria are microorganisms that reduce the nitrates up to elemental nitrogen. They are most numerous in the surface layer of the soil.

Cellulose splitting microorganisms decompose the cellulose in the soil, thus creating oxy-acids that enrich the soil with nitrogen substances. The number of cellulose splitting microorganisms is greatest in the surface layer of 0-10 cm (up to 152 per gram of soil).

Molds grow better in acidic soils, because they are acid-fast, although they are numerous in soils with neutral reaction. The number of molds in the examined soil is higher.

Conclusions

Based on the results of the research we concluded that:

The mechanical structure and chemical properties of the soil are favorable for development of all studied groups of microorganisms.

The depth of the soil affects the number of microorganisms.

The total number of microorganisms is highest in the soil layer at a depth of 10-20 cm.

The ammonia forming bacteria are most frequent in the soil layer of 20-30 cm, while all other groups of microorganisms – actinomyces, nitrifying bacteria (nitric forming bacteria), nitrate forming bacteria, nitrate reducing bacteria, yeasts, molds and cellulose splitting microorganisms are most numerous in the surface layer of 0-10 cm.

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БРОЈНОСТА НА МИКРООРГАНИЗМИТЕ НА РАЗЛИЧНА ДЛАБОЧИНА ВО АЛУВИЈАЛНА ПОЧВА ВО СКОПСКО

Олга Најденовска, Даниела Димовска, Џоко Кунгуловски, Наталија Атанасова Панчевска

Апстракт
Почвата претставува жива, динамична средина во која живеат различни видови микроорганизми. Преку ензимската активност микроорганизмите учествуваат во создавањето на хранливите материи за растенијата. Оттука, микроорганизмите учествуваат во создавањето и одржувањето на плодноста на почвата и претставуваат индикатори на нејзината биогеност. Во овој труд се испитувани вкупниот број на микроорганизми, актиномицетите, азотофиксаторите, габите, целулолиотичките микроорганизми, денитрификаторите, амонификаторите, и нитрификаторите во алувијална почва, во н. Јурумлери, Скопско. Бројноста на микроорганизмите е испитувана во три различни длабочини (0-10 см, 10-20см, и 20-30см). Испитуваната почва има поволни физичко - хемиски својства за живот и развиток на микроорганизмите. Констатирано е дека најголем број на испитуваните групи микроорганизми е на длабочина од 0-10 см, а амонификаторите на длабочина од 20 – 30 см.
Клучни зборови: микроорганизми, алувијални почви.

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HYDROCARBON IMPACT & ITS CONSEQUENCES ON ENVIRONMENT AND FOOD CHAIN IN OILFIELDS

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Abstract
This study shows the presence of high levels of hydrocarbon pollution on flora, biological diversity and agricultural land in Fier area with an impact on agricultural development. Ecosystems in Fier district provide resources and opportunities for the economic development of society, offering natural wealth such as sea and land, tourism, biotic world such as forests, wetlands, etc. Mediterranean climatic and specific conditions of the aquatic ecosystem have identified a covered field and a diverse fauna. Flora is characterized by a long vegetation period, which may even exceed 10 months. Fauna is constantly shrinking as a result of vegetation cover damage due to hydrocarbon concentration, both in land, air and surface water.
Key words: Fluorescence parameters, photosynthetic activity, Phragmites Australis, Eucaliptus Camaldulensis, invasive species, vegetative stage.

Introduction

Referring to the phyto-climatic point of view, the region under study extends to Mediterranean forests and shrub land belt and is characterized by a diversity of habitats and plant communities, such as riverbed vegetation, freshwater wetland or different stages of their degradation, natural, semi-natural and artificial or created by human activity. It is very rare to see pieces of natural vegetation. More often one can notice considerable surfaces covered by Rubus ulmifolius (thorns) and Paliurus spina-christi (bramble). Other indicators of this degradation are spread in a considerable degree of species such as invasive species as Dittrichia viscosa, and anthropogenic species, etc. Agricultural production provides 50% of all personal income in the region of Fier. Fier district has 17.5% or 122,241 hectares of agricultural land in the country and exports many agricultural and livestock products to other markets within Albania. Cultivation, including wheat, maize, vegetables, industrial plants and forages, cover nearly 86% of the agricultural district area, while forests cover 14%. Agriculture in Fier is more developed and there are more forests compared to other districts.

Material and methods

Biological diversity is an indicator of environmental health in a certain area, including living beings of plant and animal origin. The richer is the diversity of living beings, the more diverse is the interaction between them and the fauna and flora world. Biologic balance degradation in the region

under study is due to hydrocarbon pollution. The database collected in polluted areas is further examined in laboratory conditions and results are compared to standard values.

Biological diversity assessment in agricultural environments due to hydrocarbon pollution

Hydrocarbon negative impact is manifested differently. However, the fumigant action and asphyxia are probably the most serious. Field work has enabled an assessment of health and population density of plants and animals in the two comparative areas: both in hydrocarbon polluted areas and hydrocarbon-free areas. This has been achieved by:

1. Assessing wild plant populations, through remote observation and macro analyses, where 3-4 rectangular squares are assigned in the selected area, each square of 1000m2, with a distance of more than 1000 meters from each other. After the square is checked by naked eye, surfaces containing rare plants are marked. This is expressed in m2 per 1000m2;
2. Observing birds flying on the water, on trees or on the checked square, and indicating the number of birds that the naked eye might catch;
3. Performing an analytical check, for instance, in a 1000m2 square are checked five quadrates of 1m2 each, with regards to the plant species and their development;
4. Checking for rain worm density under the context that rain worm is the most active creature for earth hygiene. For this, 10 holes are dug in every 5 hectares, each with dimensions 50 x 50 x 50cm2. The soil is carefully burrowed and the number of earthworms and other creatures is recorded;
5. Checking water canals for living beings. To do this, some samples are taken from a liter of water. After the water is drained through cheesecloth the living creatures are numbered;
6. Checking the health status of agricultural plants in the selected sector, where 100 plants per 5ha are examined for the presence of aphids, mycosis, red apple, and main illnesses.

The present study is focused, both in hill and field areas, in main plants, as well as in lands which are distant from pollution sources.

Assessment of pollution in agricultural lands caused by oil extraction

Fier region is characterized by diversity in the cultivation of arable crops, like wheat, corn, vegetables, industrial plants and forages and covers over 20% of the national necessities of the country. Some industrial plants such as sunflowers and soy are concentrated in Fier and cover respectively 83.5 and 72.5% of the area at national level. The soils of this area are considered as problematic since they are often under the pressure of oil exploitation. One of the factors of such degradation is oil exploitation in 23,000 ha. Such lands show a high variability of pH, whose values range from 7.2 to 8.5, classifying them into lands of neutral to alkaline character. Furthermore, the ratio of Ni content in all these soils is relatively high. Its content stands between values from 215.9 to 284 mg/kg; which is a proof of toxic levels of such element found in soil (Table1).

With regards to Pb element content, it is found that such lands contain it in a significant level, but not as high as those accepted by EU. Whereas Vanadium (Vn) indicates values of high fluctuations from 48 to 108 mg/kg dry land, thus being an indicator of land contaminated by Vanadium. With regards to the content of hydrocarbon in soil, it is found that it appears at high values ranging from 117.2 to 454.3 mg/ per 100gr. We are of the opinion that the high content of heavy metals (Ni, Vn and Pb) in oilfields affects soil pollution. Moreover, the analysis of hydrocarbons in the area that result in high concentrations further reinforces the conclusion on oil extraction activity impact in soil pollution in this area.

Table 1. The contend of polluted elements in oilfields soil

The monitories points and the sample site	pH	Ni (mg/kg), dry soil	Pb (mg/kg), dry soil	Vn (mg/kg), dry soil	Total hydrocarbon (mg/100gr)
Patos- Marinez P1 0-30cm	7.2	250	114	92.1	246
Patos- Marinez P2 0-30cm	7.2	215	114	48	129
Patos- Marinez P3 0-30cm	8.5	284	126	108	454
Patos- Marinez P4 0-30cm	8.1	215	137	83	117
Average	7.75	241	122.7	82.7	236.5

Assessment of pollution impact on agricultural land flora in oilfields

Albanian flora stands out for its high diversity which is thought to be as a result of the geographical position of Albania, and that heavily depends on the topography and climate of the area. Such flora, apart from being rich in species, shows high levels of native species in the study area. The presence of high levels of pollution has serious consequences on the flora and fauna of this area. The analysis of chlorophyll fluorescence parameters and the assessment of the photosynthetic leaf activity are conducted through the appropriate fluorescence imaging equipment, namely FluorCam 700 MF, at the Institute of Biological Research. Herb samples are taken in Patos-Marinëz area. (Table 2) [1]

Table 2. The analysis of chlorophyll fluorescence parameters

Place spread	Herbs	Fluorescence parameters			Assessment of the photosynthetic		
		Fo	Fm	Fv	Rfd	qN	NPQ
Zharrez Spring	Phragmites australis 1-1	126.71	357.29	230.58	1.479	0.855	1.087
	Phragmites australis 1-2	120.01	362.91	242.9	1.552	0.834	1.124
Zharrez Spring	Eucaliptus camaldulensis	159.94	640.33	480.39	1.786	0.856	1.718
	Eucaliptus camaldulensis 2-2	132.79	601.69	468.9	3.072	0.922	2.737
Gjanice River	Phragmites australis 3-1	110.99	509.71	398.72	3.043	0.914	2.583
	Phragmites australis 3-2	163.65	774.58	610.93	1.806	0.793	1.639
Gjanice River	Eucaliptus camaldulensis 2-1	124.46	459.3	334.84	1.557	0.856	1.186
	Eucaliptus camaldulensis 2-2	122.59	415.09	292.49	1.411	0.822	0.995

Based on the table data, fluorescence images and on the fluorescence kinetics curves, it results that the indicators of herb photosynthetic activity analyzed in such areas are low, expressed more clearly in leaves being under a fully developed vegetative stage (approximately 3-4 months). Leaves which indicate a higher photosynthetic activity (Eucaliptus camaldulensis 2-2, Phragmites australis 3-1) are leaves under a new vegetative stage (of nearly one month old). The low values of photosynthetic activity indicators as well as leaves chlorophyll fluorescence dispersion (gradient and non

[1] Analyzes were carried out in biological research institute, Academy of sciences during 2010

uniformity) indicate the negative impact of oil hydrocarbon pollutants found in this area. (Fig 1,2,3,4)

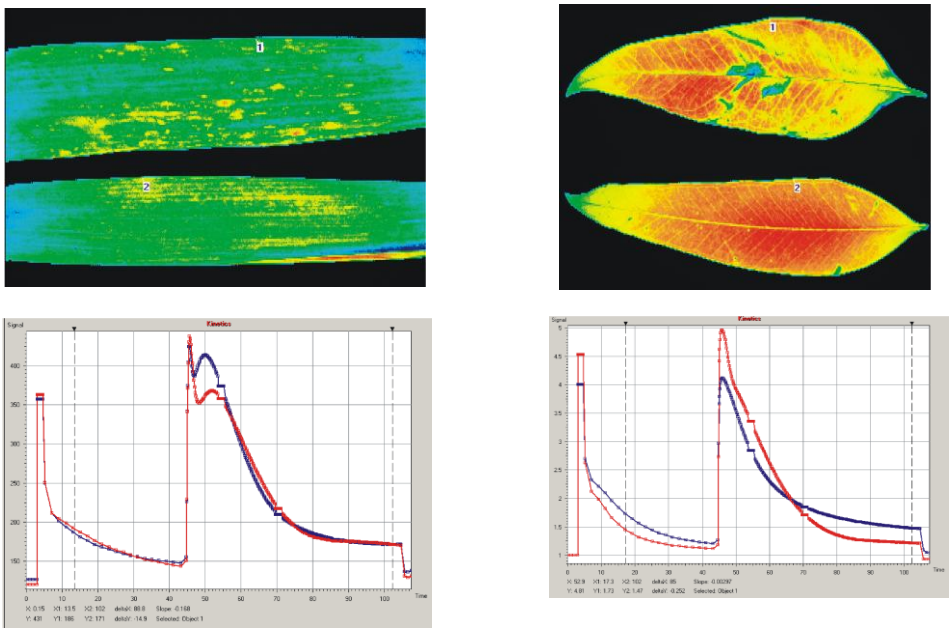


Figure 1. Fluorescence images and on the fluorescence kinetics curves. Phragmites australis, Zharrez Spring

Figure 2. Fluorescence images and on the luorescence kinetics curves. Eucaliptus camaldulens, Zharrëz Spring

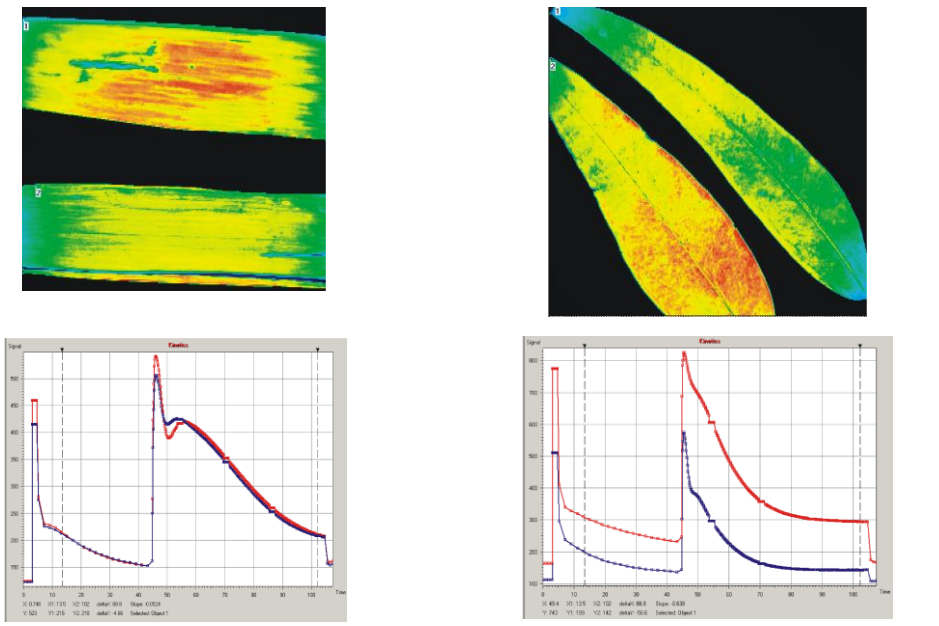


Figure 3. Fluorescence images and on the fluorescence kinetics curves. Phragmites australis, Gjanice river

Figure 4. Fluorescence images and on the fluorescence kinetics curves. Eucaliptus camaldulensis, Gjanica river

Other indicators of such degradation are the considerate spread of such invasive species as *Dittrichia viscosa* and anthropogenic species as *Asphodelus aestivus, Andropogon ischaemum, Erigeron sp*. etc. Elements of Mediterranean forest and shrub belt in individual cases are encountered nearby or within such areas such as *Rubus ulmifolius* (bush), *Paliurus spina-christi* (shrub) or under areas covered by natural vegetation such as *Phlomis fruticosa, Quercus coccifera, Spartium junceum.*

Conclusions

As a conclusion we can say that the entire area represents a stage of native vegetation degradation (degradation that continues to this day) not in very high values in terms of biodiversity;

Oil extraction and processing activity in the region, besides anthropogenic activity, has caused a high level of pollution and considerable loss of biodiversity values. The following two are the most visible indicators of this activity:

1. Increase of morbidity from various diseases (Picture 1,2, 3, 4)
2. Higher morbidity by pests (Picture 5,6)



Picture 1. Pollution effects on Phragmites australis leaves



Picture 2. Pollution effects on Populus canadensis leaves



Picture 3. Pollution effects on Rubus ulmifolius leaves (necrosis)



Picture 4. Pollution effects on Calystegia sepium leave (necrosis



Picture 5. High presence of pests



Picture 6. High presence of pests

Hydrocarbon contamination consequences in the oil extraction area not only influence environmental pollution (water, air, land), but also the biodiversity of the area, and then further the food chain;

Arable agricultural lands, degraded and abandoned lands, occupy roughly more than half the area of the region under study;

Biodiversity is affected more than in all other ecosystems;

Repeated plow activity in such lands without protective measures has led to irreparable scale damage and currently a large part of the agricultural land area are abandoned;

Regardless the extension in this belt, the flora of such environments has almost nothing in common with the vegetation of this belt;

Degradation represents the highest stage of former primitive forest degradation (that may have existed in the area) dominated by ilqja (Quercus ilex), as a result of anthropogenic abusive activity through intensive deforestation, cutting, burning, grazing, repeated works and leaving such lands fallow for a long period of time, and what is more important, as a result of the high level of pollution caused by drilling and exploitation activities of the area for oil extraction purposes;

Soils of this area are physically eroded in large scale and in many cases has surfaced rock sole;

Recommendations

Improvement of infrastructure and technology in the oil extraction and processing industry;

Areas of highly oil hydrocarbon contamination must undergo a "Phyto-rehabilitation" process;

There is an urgent need for intervention for its improvement through forestation with native species;

Forestation intervention would rehabilitate the landscape, reduce the dust level and improve somewhat air quality.

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ВЛИЈАНИЕ НА ЈАГЛЕВОДОРОДОТ И НЕГОВИТЕ ПОСЛЕДИЦИ ВРЗ ЖИВОТНАТА СРЕДИНА И СИНЏИРОТ НА ИСХРАНА ВО ОКОЛИНАТА НА НАФТЕНИТЕ ПОЛИЊА

Алма Шеху, Алфред Мулај, Сеит Шалари, Хазир Положани, Марјанти Гури

Апстракт

Во овој труд се анализира присуство на високо ниво на загаденост од јаглеводород во флората, биолошкиот диверзитет и земјоделско земјиште во областа Фиер и неговото влијание врз развојот на земјоделството. Еко-системите во областа Фиер обезбедуваат ресурси и можности за економски развој на општеството, нудејќи природни богатства како што се море и копно, туризам, шуми, мочуришта, итн. Медитеранските климатски и специфични услови на водните еко-системи го идентификуваат опфатеното поле и разновидната фауна. Флората се карактеризира со долг вегетациски период, кој може да надмине дури и 10 месеци. Фауната постојано се намалува како резултат на штета врз вегетацискатa покривка штосе должи на концентрацијата на јаглеводород во земјата, воздухот и површинските води.

Клучни зборови: Флуоресцентни параметри, фотосинтетска активност, Phragmites Australis, Eucaliptus Camaldulensis, инвазивни видови, вегетациски период.

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626.812:543.421(497.115)
Original scientific paper

THE IMPACT OF MINING INDUSTRIAL PROCESSES OF "TREPÇA" COMPLEX IN THE QUALITY OF RIVERS TREPÇA AND SITNICA

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Abstract
Mitrovica a city that lies in northern part of Kosovo is recognized as the biggest center with the largest metallurgic and mining complex Trepça in Europe. The Mining activities in Mitrovica resulted with a dramatic environmental pollution. The ore processing until 2000 and the existence of three tailing damps contribute to the dissemination of hazardous material in air, soil and water. As a result of uncontrolled water discharge of industrial processes such as: discharged water from mining and flotation in Stan Terg and First Tunnel, Metallurgy and zinc battery factory in Mitrovica, rain waters from industrial landfills, water from drainage channels that flow directly into rivers without prior treatment show serious problem regarding to pollution of Trepca and Sitnica rivers, adding a high level of heavy metals concentration which exceed international standards. The main objective of the present investigation was to evaluate and analyze the impact of these industrial processes in the quality of water of Trepça and Sitnica rivers. The Atomic Absorption Spectrometry (Shimadzu AA-6300) was applied for the determination of lead, zinc, cadmium, copper and iron levels in Trepça Flotation Laboratory. It was found that the level of lead (0.6434 mg / L), zinc (2.08 mg / L), copper (0.1374 mg / L), iron(0.7132 mg / L) and cadmium (0.015 mg / L) concentration is relatively high. Pollution of rivers with heavy metals represents a permanent threat to flora, fauna and the population living in the region. Therefore in the conclusion the study presents recommendations for possibility of eliminating or reducing the concentration of heavy metals.
Key words: heavy metals, river pollution, Atomic Absorption Spectrometry.

Introduction

Beside the use of water in many different branches of industry, river water is a subject to contamination from raw concentrated discharges of these industrial waters. (Dukovic, J, et al 2000). By exploiting the natural resources man developed and diversified industrial production economy, but it increases the content of chemicals in aquatic environments, especially the heavy metals and organic micropollutants (pesticides, poliklor-difenilet, chlorinated organic substances, aromatic hydrocarbonspoliciklike, etc..), by discharges of solid, liquid and gaseous, urban, industrial, agricultural and mining. All these pose a threat to aquatic ecosystems, affecting the water quality. (Çullaj, A.2005).

Environmental pollution from industrial processes is great danger in the city of Mitrovica, although the chemical industries today are not operating. However, these industrial processes continue to have an impact on environmental pollution, especially in aquatic ecosystems where the problem is pollution of river Sitnica and Trepca. Impact on the pollution of revers Sitnica and Trepca have the dischargd and untreated water from the battery factory and chemical industry, drainage water from the tailings of jarosite and phosophogips. Flotation factory for the production and processing of ferrous metals in technological process uses the relatively large amounts of water. After completion of these technological process the water is discharged into rivers without any pollution with preliminary treatment. The main characteristics of Sitnica and Trepca river and Trepces is the pollution contaminated with heavy metals that often exceeds the allowed values??.Heavy metals are highly toxic in their compounds and some of them even in their basic form.

Heavy harmful metals are, mercury, arsenic, cadmium, kallai, chromium, zinc and copper.These metals are widely used in industry especially in metal galvanic wardrobe and some products like batteries and accumulators. These metals can be introduced into the environment wherever these products are produced, used and disposed.Heavy metals are extreme toxic because their corresponding compounds ions are soluble in water and can be absorbed immediately into the body.

It is clear that the earlier pollution in this area has been very heavy. 1980 Studies show that all vegetables and wheat planted in the Mitrovica area containing large concentrations of lead.People who feed on these plants are at risk to take the lead to three times more than the maximum allowed by the OBSH. (Rozaje D. et al 1983). Concentrations of lead in the blood of residents of Mitrovica were several times higher than the population of Pristina.

It is estimated that about 9,000 children in Mitrovica may have blood lead concentration of 40 ug / dL.In this case the determination of heavy metal concentraton is made by atomic absorption spectrometric method Shimadzu AA-6300, in the laboratory flotation Trepca tunnel first, and analysis results show that the contamination level of lead and zinc is several times higher than the allowed European standards.

Material and methods

First sample was taken in Frasher, approximately a mile and a half away from landfill.Second sample was taken 500 m away from the new bridge of French KFOR called „Verdunit Bridge".Third sample was taken at the beginning of the dump and the fourth sample was taken at the end of the industrial waste dump Mitrovica Industrial Park.While the first sample is picked in river Trepca on the mine of Trepca, the second sample was taken after the discharge of industrial wastewater from Flotation and the third sample was taken after Trepqes and Sitnicas union.

Water samples were placed in polyethylene containers, which have been cleaned with same water from which the sample was taken. (Korca,B. 2003). Samples are identified by serial number and place of receipt.In the taken samples it is determined the concentration of heavy metals, Pb, Cd, Zn, Cu and Fe, and pH.Ph-has been calculated with pH meter apparatus. 100 ml of sample of were placed in erlenmeyer and previously they were filtered to remove the insoluble substances. In every sample was added a 1 ml concentrated HNO3, and are placed in electrical roshon up to the boiling point.Samples were then cooled, and as a result of evaporation the amount of sample is reduced.Samples are placed in a normal container and are leveled with distilled water. Çiriq,J.,Vajgan,Peshiq, Hemisko Tehnoloski Prirucnik.

For each element after they optimized the respective conditions as wave length, lamp position, the position of fuzed , type of flame and the fissure spectral width the absorbance of standard solvents was measured and the calibration curves were constructed and parameters of lead,zinc, cadmium, copper and iron have been calculated.(Atomic Absorption Spectrometry, Method Manual, ISSME 3-010101, Thermo electron Corporation, Cambridge, Solaar House),Institut za Nuklearne Nauke, (1951).

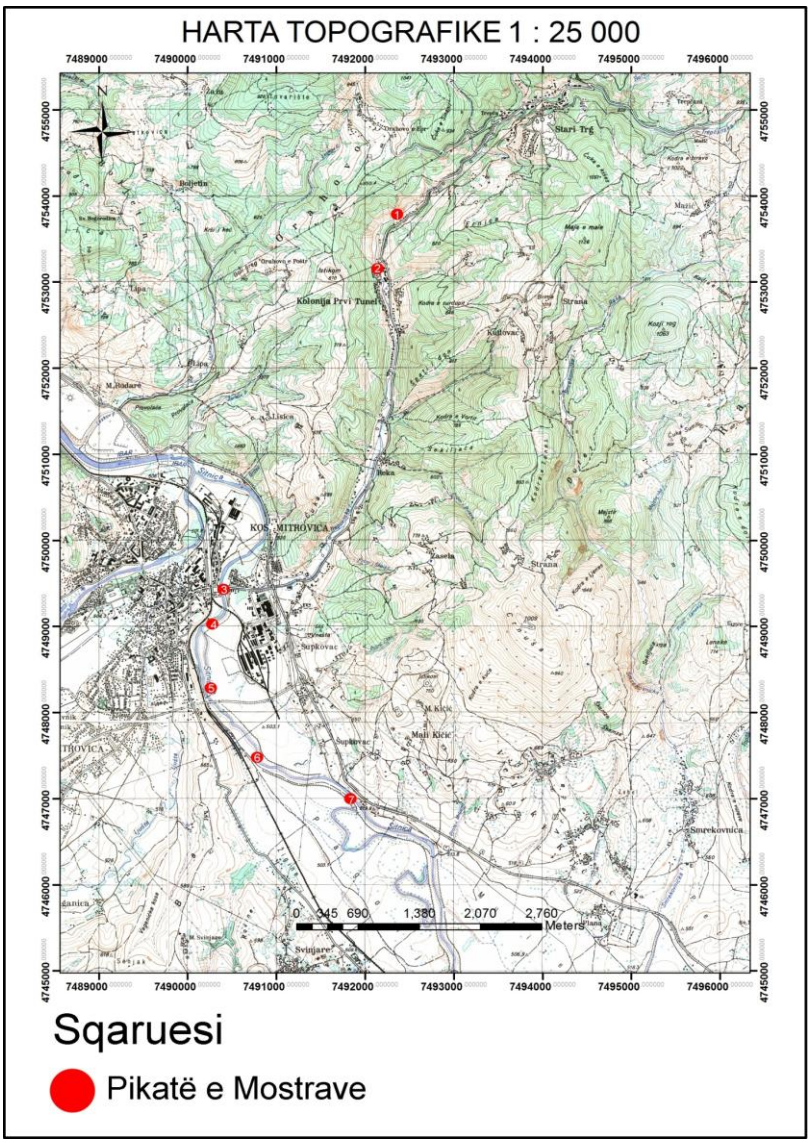


Figure 1. The topographic presentation of Sitnica River and Trepqe samples

Results and discussion

The following Table 1 shows the aty metals in the samples that were taken in the Sitnica River.

Table 1. Values of heavy metals and pH in Sitnica River

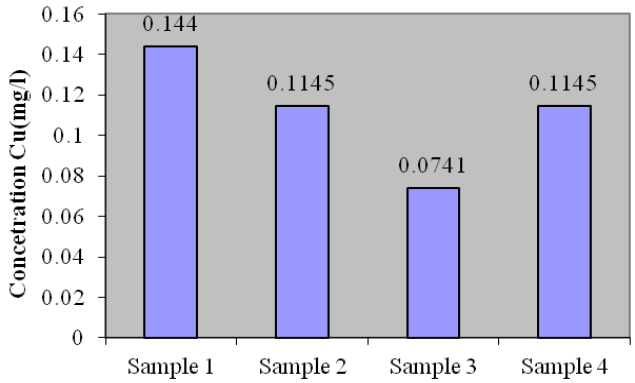
	Europian Union Directive 98/83/EC	Sample 1	Sample 2	Sample 3	Sample 4
pH	6-8.2	7.67	7.70	7.69	7.78
Cu mg/L	0.01-1.0 mg/L	0.144	0.1145	0.0741	0.1145
Cd mg/L	0.005-0.01 mg/L	0.0049	0.0056	0.0055	0.0036
Zn mg/L	0.2-1.0 mg/L	0.017	0.0367	0.5136	1.3536
Pb mg/L	0.005-0.01 mg/L	0.0293	0.1746	0.0696	0.1467
Fe mg/L	0.3-1.0 mg/L	0.0877	0.6922	0.077	0.0306

Table 2. Values of heavy metals and pH in river Trepca

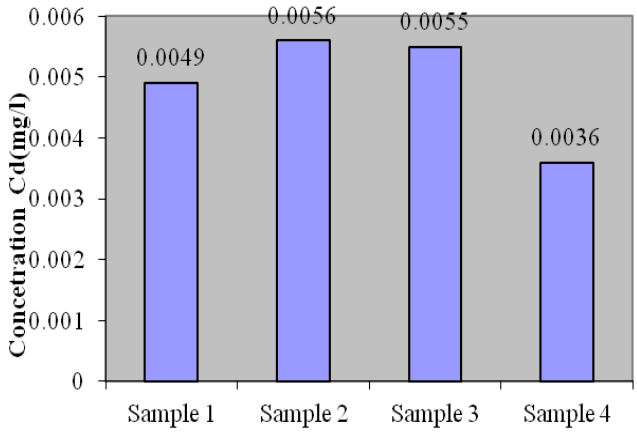
	Europian Union Directive 98/83/EC	Sample 1	Sample 2	Sample 3
pH	6-8.2	7.07	8.1	7.85
Cu mg/L	0.01-1.0 mg/L	0.1276	0.1374	0.0549
Cd mg/L	0.005-0.01 mg/L	0.0037	0.0048	0.0045
Zn mg/L	0.2-1.0 mg/L	0.0546	2.08	1.2349
Pb mg/L	0.005-0.01 mg/L	0.1311	0.6434	0.3178
Fe mg/L	0.3-1.0 mg/L	0.1956	0.7132	0.1089

Based on the results obtained from the samples and analysis is clear that contamination is evident. Significant values of concentration of heavy metals mainly lead and zinc were observed in river waters Trepqes where comes the merging of river water and the discharging water that comes out of Flotation.

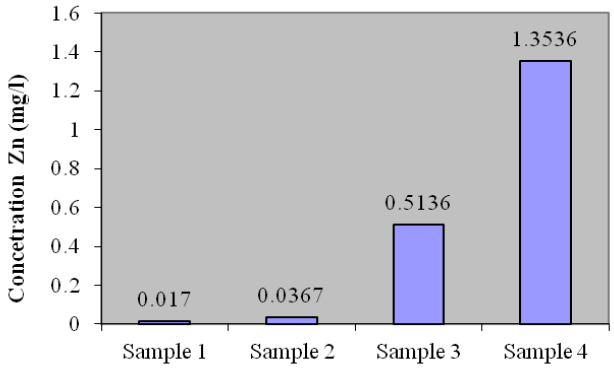
In the following figures it is shown the concentration of metals Cu, Cd, Zn, Pb and Fe.

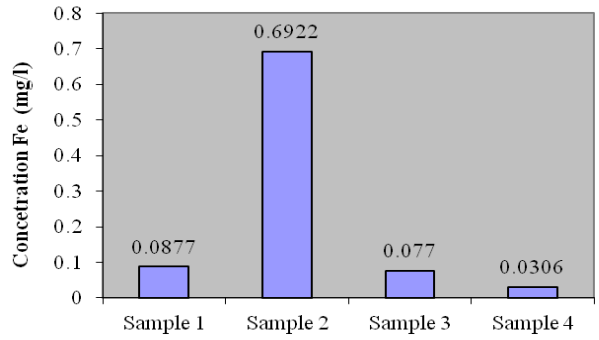


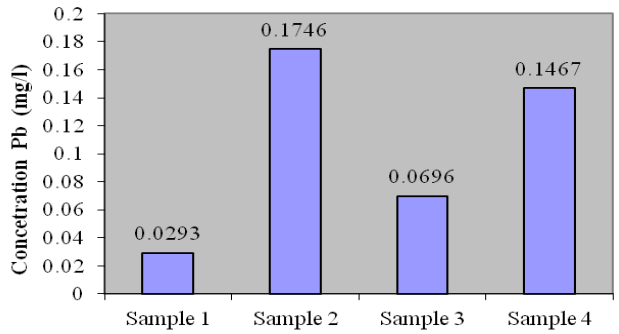
The pH values in all samples in Trepca and Sitnica rivers do not exceed the standard values. The figure shows that copper in the third sample does not exceed the standard values of pollution, otherwise the three other samples of the copper concentration exceeds the allowed values above 0.1 mg / L.



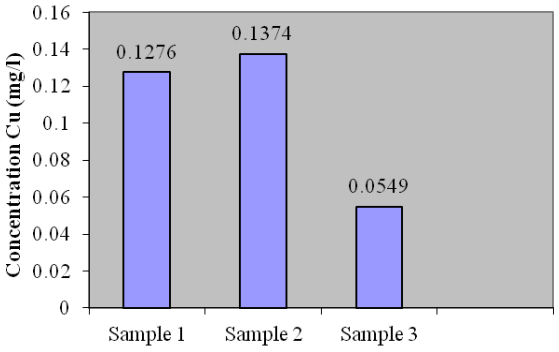
Based on the values obtained from the analysis no contamination with cadmium is present.

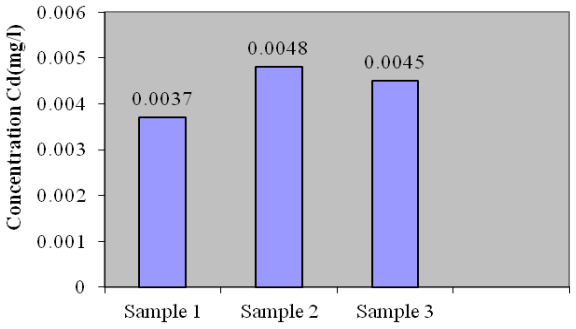


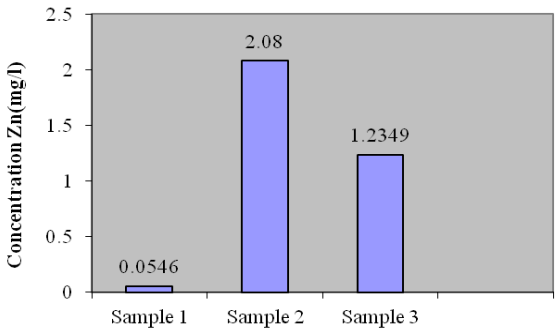


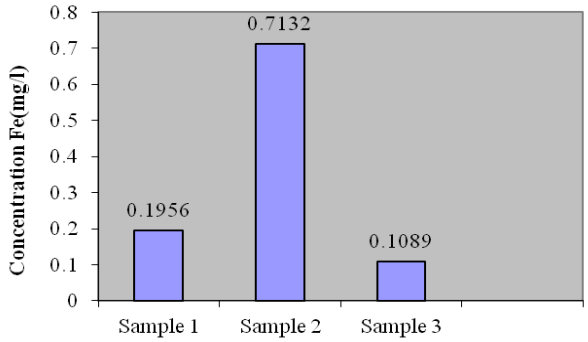


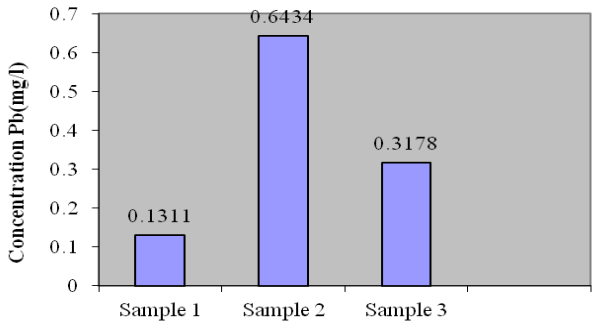
Based on the results obtained from sampling the contamination with heavy metals is evident. Significant values of concentration of lead and zinc were observed in river waters and exceed the standard values 0.2 mg / L, ie, 0.005 mg / L referred to by the European Union Directive 98/83/EC. The contamination with lead and zinc is result of wastewater discharges from drainage and industrial waste landfills (jarosite and phosphogyps). In the following figures it is shown the concentration of metals Cu, Cd, Zn, Pb and Fe.


Concentration Cu (mg/l)
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0.1276
0.1374
0.0549
Sample 1
Sample 2
Sample 3


Concentration Cd(mg/l)
0.006
0.005
0.004
0.003
0.002
0.001
0
0.0037
0.0048
0.0045
Sample 1
Sample 2
Sample 3


Concentration Zn(mg/l)
2.5
2
1.5
1
0.5
0
0.0546
2.08
1.2349
Sample 1
Sample 2
Sample 3





Values which are obtained as a result of analyzing of water samples in Trepca River are very high compared with the limited standard values. The sample taken in the discharged water from the flotation process show very high values of heavy metal, mainly with lead and zinc. As result of contamination with heavy metals this river is categorized in the fourth category.

Conclusions

Thanks to the research we conclude that contamination with heavy metals like lead, zinc is present in River Trepqe and Sitnica.The largest concentration of contaminants is observed in the vicinity of the point discharge of industrial wastewater of flotation.Since there was no industrial waste compacting and regular coverage of landfills in PIM, still these landfills continue to be a environmental pollutants of Sitnica River.

By ending this paper, we came to the conclusion that there are some possibility that in the future these pollutants can be removed or reduced to the allowable limit values:

1. Both industrial landfills should be covered with plastic fossils for reasons of environmental protection from pollutants.
2. The coverage of landfills with soil layers and their vegetation.
3. The Treatment of sewage and that industrial waste before they are discharged into the water of the river.

In recent times new technologies are discovered thanks to the scientific work and efficient processes devices which allow the removal of contaminants from polluted waters of acid derived from the

mining. This process of treatment is possible with the use of less hazardous chemicals in such rechnology that will facilitate the application.

If we take proper handling of dumps, repairing the state of equipments in the cleaning facilities waste water from industries and the preliminary treatment of sewage flowing into the river the pollution will not exceed the allowed standard values of heavy metals pollution .

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ВЛИЈАНИЕТО НА РУДАРСКИТЕ ИНДУСТРИСКИ ПРОЦЕСИ НА „ТРЕПЧА“ КОМПЛЕКСОТ ВРЗ КВАЛИТЕТОТ НА РЕКИТЕ ТРЕПЧА И СИТНИЦА

Флора Ферати, Михоне Кероли-Мустафа, Ариана Кјара-Јли

Апстракт

Митровица, градот кој се наоѓа во северниот дел на Косово е признат како најголем центар со најголемиот металуршки и рударски комплекс Трепча во Европа. Рударските активности во Митровица резултираа со драстично загадувањето на животната средина. Преработката на руда до 2000 година и постоењето на рударски отпади придонесете во ширење на штетни материи во воздухот, почвата и водата. Како резултат на неконтролираното испуштање на вода од индустриските процеси како што се: испуштени води од рударството и флотација во Stan Terg и First Tunnel, фабрика за металургија и цинк батерии во Митровица, дождовници од индустриски депонии, вода од одводни канали кои истекуваат директно во реките без претходно управување, претставуваат сериозен проблем во однос на загадувањето на реките Трепча и Ситница, додавајќи високо ниво на тешки метали кои ги надминуваат меѓународните стандарди. Главната цел на ова истражување беше да се оцени и да се анализира влијанието на овие индустриски процеси врз квалитетот на водата на реките Трепча и Ситница. Атомска апсорпциска спектрометрија (Shimadzu AA- 6300) беше применета за одредување на нивото на олово, цинк, кадмиум, бакар и железо во лабораторијата за флотација во Трепча. Се покажа дека нивото на концентрација на олово (0,6434 mg/L), цинк (2,08 mg/L), бакар (0,1374 mg/L), железо (0,7132 mg/L) и кадмиум (0,015 mg/L) е релативно висока. Загадување на реките со тешки метали претставува постојана закана за флората, фауната и населението кое живее во регионот. Затоа во заклучокот на трудот се презентираат препораки за можноста за елиминирање или намалување на концентрацијата на тешки метали.

Клучни зборови: тешки метали, загадување на река, Атомска апсорпциска спектрометрија.

SECTION 8: FOOD QUALITY AND SAFETY

UDC:543.4:663.252:634.863
Original scientific paper

THE USE OF NEW SPECTROPHOTOMETRIC ASSAYS FOR THE DETERMINATION OF ANTIOXIDANT ACTIVITY OF RED WINES

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Abstract
With increasing interest in the function and diversity of antioxidants in foods, several *in vitro* methods for measuring antioxidant activity of grapes, fruits, beverages and their products have been developed. Some of these methods are time-consuming and suffer from lack of selectivity and short linear dynamic range, involve long pre-treatment steps to remove interfering species and require complicated and expensive instruments. The present paper describes sensitive, low-cost and fast assays for determination of antioxidant activity of red wine based on its inhibiting effect on the reaction of bromate with hydrochloric acid. Proposed method involve addition of a known excess of bromate and methyl orange to sample in an acid medium, and measurement of absorbance at 505 nm The reliability of the new assay was established by parallel determination by the reference 2,2`-diphenyl-1-picrylhydrazyl (DPPH) assay and there were no noticed significant difference between the proposed and the standard method.
Key words: Red wines, antioxidant activity, spectrophotometeric method.

Introduction

Phenolic compounds are a group of biologically active compounds, which are involved in many metabolic routes of plants. This is a heterogeneous group constituted by catechins, anthocyanidins, tannins, flavonones, flavones, flavonols and hydroxybenzoic and hydroxycinnamic acids, among others. These compounds posses antioxidant properties which are thought to be related with a reduction in the risks of coronary or cancer diseases, thus having a direct influence on human health. Phenolics may be present in different products of plant origin, like fruit juices, olive oil and red or white wine. They play a key role as antioxidants due to the presence of hydroxyl substituents and their aromatic structure, which enables them to scavenge free radicals (Villano et al., 2007).
Flavonoids as well as other phenols and related compounds are also found in finished products, such as wine or beer. They are in part responsible for the color, fragrance, and to some extent for the taste, and therefore the quality of the wine. The composition and amount of phenolic compound depends on the sample, origin of raw material, elaboration process and storage conditions. Hence, these compounds are significant for wine production, as they can be used to control the quality of red and white wine and to determine the varietal origin by quantitative analysis of the flavonoid content (Lachman et al, 2009; Rodriguez-Diaz et al., 2006). Very high amounts of polyphenols in fruits can have negative effects on the quality of grape juice and wine. Autoxidation of polyphenols

to yellow- or brown-colored quinones. Furthermore, polyphenols can react with proteins, carbohydrates and minerals. This also leads to decrease in quality. Along with polyphenols grapes also contain polyphenoloxidases, which catalyze the oxidation of polyphenols to quinones (Harkensee et al., 2006).

With increasing interest in the function and diversity of antioxidants in foods, several *in vitro* methods for measuring antioxidant activity of food, beverages and biological samples have been developed. The most commonly used antioxidant capacity assays include oxygen radical absorbance capacity (ORAC assay), reducing power, determination of total phenols, 2,2-azino-di-(3-ethylbenzothialozine-sulphonic acid) (ABTS assay), 2,2-diphenyl-1-picrylhydrazyl (DPPH assay), hydroxyl radical-scavenger activity, superoxide radical-scavenger activity and lipid peroxidation inhibition. These methods differ in terms of their assay principles and experimental conditions. Because multiple reaction characteristics and mechanisms are usually involved, no single assay will accurately reflect all antioxidants in a mixed or complex system (Li et al., 2009).

Some of these methods are time-consuming and suffer from lack of selectivity and short linear dynamic range, involve long pre-treatment steps to remove interfering species, require complicated and expensive instruments, or use reagents that are not commercially available. Methyl orange, such as many acid dyes, are prone to oxidation to form colorless products in an acid medium, thus providing a suitable analytical approach for the indirect assay of inorganic ions (Ensafi et al. 2002), organic compounds (Basavaiah et al. 2005), and pharmaceuticals (Basavaiah et al., 2006). The produced bromine and chlorine react with methyl orange and this reaction causes decolorization of the solution. However, no bromate–hydrochloric acid reaction has been developed for the determination of antioxidant activity of wine. The present paper describes a sensitive, simple, low-cost, and fast method for determination antioxidant activity of wine based on its inhibiting effect on the reaction of bromate with hydrochloric acid.

The employed method is based on a reaction between bromate and chloride ions in highly acidic media. Bromate can be reduced by hydrochloric acid, producing bromine and chlorine: $10\ Cl^- + 2\ BrO_3^- + 12\ H^+ \rightarrow 5\ Cl_2 + Br_2 + 6\ H_2O$.

Decolorization of methyl orange by the reaction products was used to monitoring the reaction spectrophotometrically at 505 nm.

Material and methods

Chemicals and samples

All chemicals and reagents were of analytical grade and were obtained from Sigma Chemical Co. (St. Louis, MO, USA), and Merck (Darmstadt, Germany). There was used the following chemicals: 2,2`-diphenyl-1-picrylhydrazyl free radical (DPPH), $KBrO_3$, methyl orange, methanol, ethanol, hydrochloric acid. Two selected wines, red wine Vranac (Rubin, Kruševac), and rose wine Rose (Rubin, Kruševac) from different grape cultivars grown in south Serbia were analyzed.

Determination of antioxidant activity

New inhibiting assay

The inhibited reaction was monitored spectrophotometrically by observing the change in the absorbance at 505 nm of following reagent solution:

An aliquot of the diluted wine was transferred into a 10-ml volumetric flask, and then 1 ml of hydrochloric acid, followed by a 1.0 ml methyl orange and 1.0 ml bromate were added to the solution. The change in the absorbance with time was measured for 1 − 15 min from the initiation

of addition of the last drop of the bromate solution. Inhibition of methyl orange degradation in percent (I%) was calculated in following relationship:

$$\text{Inhibition (\%)} = (A_{\text{sample 5 min}}/\text{Int}_{\text{sample}} - A_{\text{blank 5 min}}/\text{Int}_{\text{blank}}) \text{ x } 100$$

where $A_{\text{blank 5 min}}$ is the absorbance of the control reaction 5 min after addition of the last drop of the bromate solution, $\text{Int}_{\text{blank}}$ is intercept from regression equation of the control reaction, A_{sample} is the absorbance of the system with tested wine 5 min after addition of the last drop of the bromate solution, and $\text{Int}_{\text{sample}}$ is intercept from regression equation of the system with wine. All the solutions were kept at 22 ºC. All experiments were carried out in triplicate for reproducibility of results.

DPPH assay

Antioxidant activity of test wine samples was determined by using free radical scavenging (DPPH) assay (Radovanović et al, 2010; Villano et al., 2007). This antioxidant assay is based on the measurement of DPPH radical colour loss due to the changes in absorbance at 517 nm, caused by the reaction of DPPH radical with the test sample. After 20 min at room temperature, $A_{517\text{ nm}}$ was measured against the blank.

The DPPH-scavenging activity of each wine sample was calculated from the decrease in absorbance according to following relationship:

$$\text{Scavenging activity (\%)} = [1 - (A_{\text{sample}} - A_{\text{blank}})/A_{\text{control}}] \text{ x } 100$$

where: A_{control} is the absorbance of control, A_{blank} is the absorbance of diluted wine sample and A_{sample} is the absorbance of the diluted wine sample with the same concentration of DPPH-radical as in control.

Statistical analysis

Three analytical replicates were carried out on each grape sample. The standard deviation was calculated by ANOVA using the Minitab statistical package (Minitab Inc., State College, PA, USA).

Results and discussion

The electronic absorption spectra of methyl orange aqueous solution before (curve 1) and after addition of hydrochloric acid (curve 2), as well as after addition of bromate (curve 4) and after addition of bromate and wine (curve 3) are shown in Fig. 1.

It is observed that the absorption spectrum of methyl orange in water at pH = 5.9 (weakly acidic) is characterized by one band in the visible region, with maxima located at 464 nm, and by two bands in the ultraviolet region, located at 271 and 199 nm. The chromophore contain azo linkage has absorption in the visible region, while the benzene ring and the naphthalene ring have absorptions in the UV region. The naphthalene ring absorption wavelength is higher than that of benzene ring.

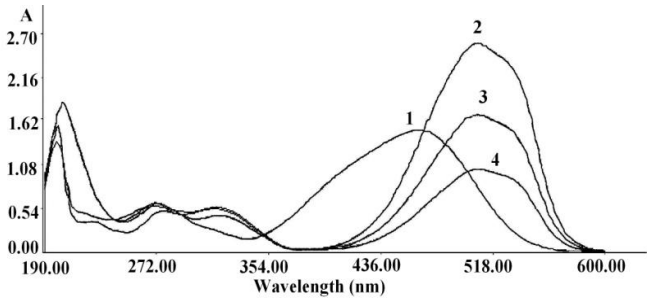


Figure 1. Absorption spectra of methyl orange aqueous solution: weakly acidic medium (pH = 5.9) (curve 1); in acid solution (pH = 0.6) (curve 2); in acid solution, 5 min after addition of potassium bromate (curve 4); in acid solution in presence of wine, 5 min after addition of potassium bromate (curve 3)

The spectrum recorded after addition HCl in aqueous solution of methyl orange, at pH = 0.6, was characterized by four bands at 505, 312, 272 and 205 nm. The same bands are present in the spectrum after addition of bromate and after addition bromate and wine in acid solution of methyl orange. The absorbance changes of methyl orange at 505 nm as functions of reaction time in aqueous solutions, in the presence of wine, bromate ions and hydrochloric acid, are shown in Fig. 2. The decrease of absorption band at 505 nm during the reaction indicates a rapid degradation of methyl orange. As a result of the presence of nitrogen to nitrogen double bond of the azo dye, as the most active site for oxidative attack. Complete discoloration of solution was observed after 10 min. At the same time, a mild increase in the absorbance at 312 nm is observed. As the change in the absorbance at 312 nm is considerably less significant than the one at 505 nm, the band in the visible area is chosen for the spectrophotometric monitoring of the reaction. The presence of wine in the medium causes a slower reaction which, in the absence of wine, is fairly fast. The inhibition effect of wine is due to its reaction with produced bromine and chlorine. This inhibitory effect on the reaction system depends on the wine sample (Fig 2). The higher antioxidant activity of wine, the slower decolorization reaction proceeds.

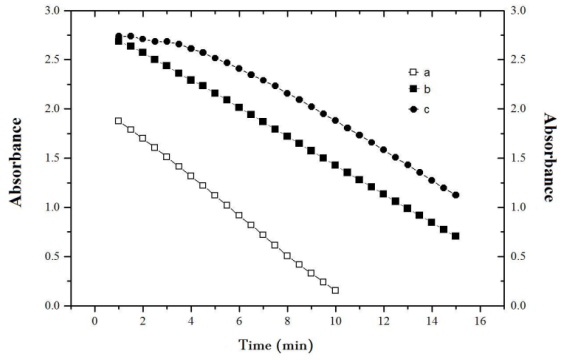


Figure 2. Absorbance change of methyl orange–bromate–HCl−wine system: (a) blank reactions, (b) rose wine Rose, (c) red wine Vranac

As expected, the red wines had significantly higher antioxidant activity compared to rose wine. This is due to a greater grape skin and seed contact time and temperature for the fermentation process for red wines. The percentage inhibition for red wine Vranac was 61.8% for DPPH and 59.41% for new assay, when the inhibition for diluted rose wine Rose, was 29.35% (DPPH assay) and 25.15% (new assay).

The good agreement between these two methods indicates the successful applicability of the proposed method for the determination of antioxidant activity of wine samples.

Conclusions

It is verified that the red wines have higher phenolic content levels than rose wines and the same result is obtained for antioxidant activity. The good agreement between results of DPPH assay and new inhibiting assay indicate the successful applicability of the proposed method for the determination of antioxidant activity of wine.

Acknowledgment

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ПРИМЕНА НА НОВА СПЕКТРОФОТОМЕТРИСКА АНАЛИЗА ЗА ОПРЕДЕЛУВАЊЕ НА АНТИОКСИДАНСНАТА АКТИВНОСТ НА ЦРВЕНИ ВИНА

Јоргованка Бојиќ, Александра Радовановиќ, Бранимир Јованчичевиќ, Блага Радовановиќ

Апстракт

Со зголемување на интересот за функцијата и разновидноста на антиоксидансите во храната, се резвиени неколку *in vitro* методи за мерење на антиоксиданснатa активност на грозје, овошје, пијалаци и нивните производи. За некои од овие методи е потребно време, се карактеризираат со недостаток на селективност и краток линеарен динамички опсег, потребни им се долги чекори на предтретман за да се отстранат компонентите кои пречат и бараат комплицирани и скапи инструменти. Во овој труд е опишана осетлива, ефтина и брза анализа за определување на антиоксиданснатa активност на црвено вино базирана на неговиот инхибирачки ефект врз реакцијата на бромат со хлороводородна киселина. Предложениот метод се изведува со додавање на познат вишок на бромат и метил оранж на примерокот во кисела средина, и мерење на апсорбанцата на 505 nm. Веродостојноста на новиот метод е воспоставена со паралелно определување со референтната 2,2`-дифенил-1-пикрилхидразил (DPPH) анализа, пришто не беше забележана значајна разлика меѓу предложениот и стандардниот метод.

Клучни зборови: црвени вина, антиоксидансна активност, спектрофотометриски метод.

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Original scientific paper

IMPACT OF FREEZING ON NUTRITIONAL COMPOSITION IN DIFFERENT VARIETIES OF RED PEPPERS

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Abstract
Red peppers have a high content of biological active components in their nutritional composition which are essential for human health. The high content of vitamin C and carotenoids in peppers are variable depending on variety, degree of maturity, applied agro-technical measures and method of processing. Freezing is one such applied method of preservation. Freezing the peppers stops or slows growth of microorganisms and enzymatic process. Three varieties of peppers, each with an intense red color were frozen: *kurtovska kapija, palanechko chudo* and *horgosh*. The freezing of the peppers was performed industrially, as cubes 10 x 10 mm, at tunnel for fast deep freezing, on T of about – 34 ˚C ± 1 ˚C. Frozen peppers were packed into suitable packaging. The analyses were performed on fresh and frozen peppers for their nutritional composition: total dry matters, sugars by HPLC-RI, total acids, vitamin C, total carotenoids, beta-carotene by HPLC-DAD, fats, proteins, cellulose and ash. The variety *horgosh*, as a spicey variety of pepper, had been characterized with the highest content of total dry matters: 11.446 % for fresh and 10.518 % for frozen. This variety had the highest content of bioactive components: vitamin C (135.908 mg/100 g) and total carotenoids (690.15 µg/g). By comparing analyzed nutritional components for frozen as opposed to fresh peppers, there was noticed a decreasing of total dry matters content, and thereby on sugars, proteins and fats. In frozen peppers, a decreasing of vitamin C, beta-carotene and total carotenoids content was noticed.
Key words: red peppers, freezing, nutritional composition.

Introduction

The pepper belongs to the family *Solanaceous*, species *Capsicum annuum L*. and is an important vegetable crop, increasingly used because of its economic importance and also its chemical composition. There are different varieties of peppers, in different shades of color (green, yellow, orange, red and purple), in different shapes and sizes and with characteristic flavors (Lucier et al., 2001). The pepper is a very important raw material for the canned food industry. It can be used fresh or processed and can be dried, pickled, cooked, biologically fermented and frozen (cut into slices or cubes) (Marković et al., 1998). Depending on the type of product desired, peppers in various stages of technological and physiological maturity are used. Most of the products require

mature peppers, with an intensive red color and also with a high content of dry matter (Marković et al., 1998).

In their chemical composition, the peppers contain nutrients and bioactive components whose quantities depend on environmental factors present during cultivation, variety of the pepper and the degree of ripeness. The nutritional value of peppers is due to the presence of nutritional components: carbohydrates, protein, fiber, organic acids, fats and minerals (Marković et al., 1998). The rich chemical composition with excellent sensory properties (taste, color, smell), make peppers irreplaceable in human nutrition (Marković et al., 1998). Peppers are an excellent source of natural pigments, carotenoids, and vital micronutrients such as vitamin C in significant amounts and vitamin E (Somos, 1984). Vitamin C has antioxidant properties and therefore is essential for human biological functions, by acting preemptively on usual degenerative processes (Davey et al., 2000). The red color in the fruits of mature peppers is due to the presence of natural pigment carotenoids including: capsorubin cryptoxanthin and zeaxanthin, as esters of fatty acid. The most important pigments are capsanthin and its isomer capsorubin, which represent 30-60 % and 6-18 % respectively, of the total number of these carotenoids in the fruits (Nadeem et al., 2011). The intensity of the red color is primarily a function of the amount of these pigments; Hungarian and Spanish spicy varieties of peppers, used for production of spicy peppers, have a high content of capsanthin and capsorubin, compared with other varieties (Govindarajan, 1985). It was set out that different factors influence the composition and quantity of carotenoids and bioactive components, such as vitamninite C and E, which have an important role in stability of colored substances during ripening, processing and storage of red peppers (Biacs et al. 1992; Daood et al. 1996). The importance of carotenoid components in human nutrition is well known, not only because some of them are precursors of vitamin A, but also as an antioxidant in cells to protect from degenerative diseases (Stahl et al., 2003).

Freezing as a technological procedure for preservation of food has been known for a long time. It is a canning procedure, where application of low temperatures prevents the activity of microorganisms (Vereš, 2004). According to some sensor indicators (smell, taste, color) frozen food is a little different from fresh, not processed food (Vereš, 2004).

The frozen pepper is a product obtained by preparation and freezing of whole or parts of pepper fruits. The requirements for quality of frozen peppers, which are cut into slices or cubes, are increasing in the recent years, as a result of the demands of consumers to consume fresh, minimally processed vegetables, as part of healthier food habits (Castro et al., 2008). A variety of peppers which have intensive color, characteristical for the variety, and have a certain thickness of pericarp are used for freezing. According to the color of the peppers that are used for production, the frozen peppers can be red, green and colorful. Peppers are commonly frozen as slices ranging from 5 to 10 mm or as cubes 7 x 7 and 10 x 10 mm, without seeds (Marković et al., 1998). In general, after preparing the peppers in the factory, without blanching, they go directly for freezing, unless the buyer insists that the peppers shall be previously blanched. Blanching is performed in order to destroy living microorganisms and for inactivation of enzymes. To maintain the color of frozen products, the following considerations have great importance: blanching, rapid cooling, time of freezing and storage temperature, because changes of temperature during storage can cause discoloration. The most frequently applied process, which yields the best results, is the use of continuous tunnels, because in the beginning, the tunnel has fluidisation, which prevents the cut pieces from sticking together, i.e. achieves separation of the pieces, upon which, among other

things, relies the quality of the frozen products. The freezing in the tunnel is achieved by rapid freezing the peppers in temperatures of - 35 ºC or lower. When applying rapid deep freezing, microcrystalline structures are formed and do not damage the mechanical tissue of peppers. The water is frozen in its own natural state, with all of the substances that are found in the cell juice (Cvetkov, 1982). The frozen pepper as a finished product shall be properly labeled and transported to consumers at a temperature of -15 ºC or lower. After thawing, the food is not allowed to be re-frozen (Marković et al., 1998).

The influence of the freezing process on quality of the product is great. During freezing, some physical and chemical changes occur, such as drying of the product, which occurs as a result of sublimation of water, especially if the product is not properly packed. Then, ice macro crystals may occur and damage the plant tissue, as well as evaporate some of the aromatic substances whichis quite noticeable in the peppers, (Cvetkov, 1982). Chemical changes in frozen vegetables can be of enzymatic and non enzymatic nature, but at very low temperatures come to a reduction of the activity of enzymes. Chemical changes during freezing and during storage of frozen products are: denaturation of proteins, fat oxidation, enzymatic browning, loss of aroma and denaturation pigments and vitamins.

Frozen food is generally recognized as a safe food. (Barbosa-Canovas et al., 2005). In terms of safety of frozen products, it is directly depends on the quality of raw material before freezing process, hygienic practices, and standards between all steps of the manufacturing process, storage and distribution (Evans, 2008).

Material and methods

Samples

This paper studied industrial peppers of three varieties: *kurtovska kapija, palanechko chudo* and *horgosh*. The varieties *kurtovska kapija* and *palanechko chudo* originate from the Strumica region and are commonly used in the canned food industry, while the variety *horgosh* originates from the Demir Kapija region and it is spicy variety, which is mostly used for the production of spices. Peppers were harvested at full technological maturity, when the fruit achieved distinctive shape, size and get an intensive red colour. The research consisted of an analysis of quality parameters, nutrients, energy value, vitamin C and carotenoids on of fresh peppers as well as frozen peppers. Examinations were made at the laboratories for food quality control in the Institute of Public Health in Skopje, at the laboratory of the Department for processing fruits and vegetables, Faculty of Agricultural Sciences and Food in Skopje and at the laboratories of the Central Food Research Institute in Budapest, Hungary. Analyses were made by using standard laboratory methods (Vračar, 2001), equipment and standard chemical reagents. Chemicals and standards used for HPLC methods were with HPLC purity.

Technology of freezing

The technological process of freezing was performed industrially, at the factory "DS Foods", Kumanovo. Preparation of the peppers for freezing was carried out by manually sorting the peppers according to equalization in color and size, where the dimension of the peppers is particularly important and should be accounted for according to the needs of cutting machine. Then the peppers were washed, cut and the stalk and seeds were manually removed. The peppers were brought into a perforated drum, where a strong jet of water was used in order to completely remove the seeds and waste, after which, cleaned, sliced quarters of peppers were cut into certain dimensions as cube or

slices. The peppers passed through a horizontal movable strip with several ventilators to remove excess water. A universal continuous freezing tunnel was used to freeze the peppers, and ammonia was used as a cooling medium. The temperature of the freezing was - 35 ºC ± 1 ˚C or lower, and the tunnel had an air flow, so that the raw material was frozen for a period of 10 - 15 minutes, whereby it is important that at the center of the unit product, the temperature should be -15 ºC or lower (Marković et al., 1998). Frozen peppers, through an output dosimeter, were filled in cardboard boxes, with a PVC tool tray, from 10 to 12 kg, and were appropriate declared. The final products were lined up on a palette in closed containers and moved to the cooling chambers, at a temperature of - 20 to - 25 °C, where they were stored until delivery.

Morphological characteristics of fresh peppers

Morphological measurements were made on fresh peppers from varieties: *kurtovska kapija*, *palanecko chudo* and *horgosh*. For these measurements 30 fruits of peppers of each variety were taken and measured with the following parameters: weight, height, width, as well as the thickness of pericarp and also weight of cleaned out peppers. According to these data, percentages of the useful part of the pepper fruits for each variety of peppers were calculated.

Determination of quality

The quality was determined using the following parameters: total dry matter with gravimetric method, by drying the samples in an oven dryer at 105 ºC to constant mass; total acidity by applying of volumetric method, where as solution for titration was used 0.1 M solution of NaOH; ash was determined with reference, by incineration and burning of samples in a Muffle oven, on temperature of 550 °C.

Determination of nutritional value

To determine the nutritional value of fresh and frozen peppers, analyzes were made of the following chemical parameters: sugars by applying HPLC-method with RI-detector (internal method in Institute of Public Health); fats were assessed with extraction, according to the Soxhlet method; proteins were determined through the content of nitrogen, analyzed with the Kjeldahl method; cellulosa was determined by using gravimetric method after Scharrer - Kürschner. For calculation of the total energy value of fresh and frozen peppers, appropriate coefficients for each of the nutrients were used.

Determination of vitamin C and carotenoids

Vitamin C was determined by applying the volumetric method, where a solution of 0.1 N J_2 was used for titration. Determination of carotenoids had been done at the laboratory of the Central Food Research Institute in Budapest, Hungary, by applying of internal method for the extraction and determination. Carotenoids were determined by applying of liquid chromatography, with HPLC-method. Carotenoids were extracted with organic solvents, methanol and dichloromethane, while for chromatographic method was used a reverse-phase column, Vis detection were provided at wavelength of 473 nm, using gradient program. For quantification was used a standard β-carotene, whereby peaks of the samples were integrated and quantified in terms of surface peak of calibration standard.

Results and discussion

Determination of morphological properties of fresh peppers

Each variety of pepper is distinguished by special biological, morphological and production properties, as well as purposes for which they can be used (Jankulovski, 1997). The examinations of

morphological characteristics of fresh pepper fruits are important for determining their variety characteristics. During the breeding of the peppers, despite genotypic factors, influence on morphological characteristics also have environmental and conditions of cultivation. Genotypic factors are considered to have a dominant influence on diameter (50.53 %), weight (50.16 %) and the useful part (48.06 %) of fruits of pepper, while enviroment has a dominant influence of hight of peppers fruits (34. 31 %). It was determined that there is a difference in thickness of pericarp that is mainly due to genotypic differences (38.53 %) and their interaction with the environment (35.89 %) (Todorova, 2007). Peppers that are harvested in their technological maturity, and are characterized by fully formed fruit shape and appearance that is characteristic for the variety (Marković et al., 1998). According to size, fruits of peppers are grouped in: very large fruiting – weight more than 150 g; large fruiting 40 - 150 g; intermediate large fruiting of 10 - 40 g; minor fruiting 4 - 10 g and very small fruiting, with weight below 4 g (Jankulovski, 1997). The thickness of pericarp is a variety characteristic, and often depend on the conditions of cultivation. According thickness of pericarp fruits of peppers are divided into groups: very fleshy - over 6 mm thick of pericarp, fleshy from 4 - 6 mm, medium fleshy 2 - 4 mm, weakly fleshy below 1 mm thick pericarp (Jankulovski, 1997). The results of examined morphological characteristics of fresh peppers, for each variety of peppers, are presented in Table 1, where for each variety peppers are presented the following characteristics: weight (g), height (cm), width (cm), thickness of pericarp (mm), weight of a cleaned fruits of peppers (g) and a useful part of the peppers (%).

Table 1. Comparison of the morphological characteristics of the fresh peppers varieties: *kurtovska kapija, palanechko chudo* and *horgosh*

Average value with standard deviation of morphological parameters in peppers varieties	*kurtovska kapija*	*palanechko chudo*	*horgosh*
Weight (g)	102.44 ± 11.93	118.97 ± 15.06	54.48 ± 7.92
Height (cm)	15.15 ± 1.67	15.51 ± 0.92	15.03 ± 1.05
Width (cm)	5.36 ± 0.73	6.42 ± 0.49	4.36 ± 0.55
Thickness of pericarp (cm)	0.42 ± 0.07	0.44 ± 0.04	0.33 ± 0.06
Weight of a cleaned peppers (g)	84.35 ± 10.48	98.92 ± 10.47	44.06 ± 6.58
Useful part of the peppers (%)	82.30 ± 3.04	83.51 ± 2.69	80.84 ± 2.11

From the Table 1, can be seen that from examined varieties of fresh peppers, the variety *palanechko chudo* has the highest average values for: weight (g), width (cm), hight (cm) and thickness of pericarp (cm), while the variety *horgosh* is characterized with the lowest average values for weight (g), hight (cm), width (cm) and thickness of pericarp (cm). According to obtained results, it can be noticed that peppers fruits of all three varieties have large fruiting (40 - 150 g) (Jankulovski, 1997). The ratio of hight: width (H:D) is within the limits from 3:7 to 7:1, what indicate that all three varieties of peppers belongs to species (*Capsicum annuum ssp. Macrocarpum var. longum*) (Marković et al., 1998). The thickness of pericarp, in variety *kurtovska kapija* is 0.417 ± 0.07, and in *palanechko chudo* is 0.437 ± 0.04, which, according to Jankulovski (1997), belong to group of fleshy peppers. The peppers of variety *horgosh* have thick pericarp 0.329 ± 0.06, that according to Jankulovski (1997), belong in the middle fleshy peppers. The obtained results show that the highest

average of utilization of pepper fruits (%) have fruits from the variety *palanechko chudo* (83.509 ± 2.69), while the lowest have the pepper fruits of the variety *horgosh* (80.843 ± 2.11). The results of measurements for morphological properties were statistically elaborated for each of the examined varieties of peppers and for each of the examined parameters. The F-test was used and it was established that between varieties *kurtovska kapija* and *palanechko chudo* there was no statistically significant differences in relation to weight (P = 0.015) and height (P = 0.0009) of the peppers fruits. Between varieties *kurtovska kapija* and *horgosh* and also between *palanechko chudo* and *horgosh* there were statistically significant differences (P <0.05) in relation to weight thickness of pericarp and width of the peppers fruits.

Determining quality of fresh and frozen peppers

According to the Regulation on specific requirements relating to quick-frozen foodstuffs (Official Gazette No.32, 2006), the raw materials used in production of quick-frozen foodstuffs must be of good marketable quality and possess the necessary level of freshness. The quality of pepper varieties are evaluated according to: physical and sensory properties, physicochemical analysis and evaluation of the nutritional value (Pruthi, 2003). The quality of the fresh pepper fruits depends on: variety, time and manner of production, mineral nutrition of plant, breeding and protective measures, as well the time and method of harvest, etc. (Ilić et al., 2009).There are many factors which could affect the characteristics of final frozen vegetable, such as: type of product, variety, degree of maturity, the quality of the raw material, method of harvest, time from harvest to processing and treatments before freezing (Torreggiani et al., 2000). All of these factors and/or their combination, along with packaging and conditions of storage and during the distribution chain, have an effect on quality of frozen product (Evans, 2008). In peppers, water as a most typical ingredient is in a free condition, and one part is tied with proteins, carbohydrates and salts. Freezing temperature depends on the concentration of soluble matters. The freezing point is lower for the higher concentration of soluble matters (Veresh, 2004). Formation of ice crystals can cause disruption of frozen tissue which leads to release of enzymes and chemical substances that affect the quality of frozen food (Da-Wen, 2006). In Table 2 are presented results of analysis of individual chemical parameters, according what were determined the quality of fresh and frozen pepper varieties: *kurtovska kapija, palanechko chudo* and *horgosh*.

Table 2. Comparison of quality parameters among fresh and frozen peppers from varieties: *kurtovska kapija* (KK), *palanechko chudo* (PC) and *horgosh* (H)

Parameter for analysis	KK fresh	PC fresh	H fresh	KK frozen	PC frozen	H frozen
Water (%)	90.601 ± 0.146*	91.609 ± 0.107*	88.554 ± 0.124*	92.029 ± 0.178*	91.815 ± 0.175*	89.482 ± 0.168*
Total dry matter (%)	9.399 ± 0.146*	8.391 ± 0.107*	11.446 ± 0.124*	7.971 ± 0.178*	7.883 ± 0.175*	10.518 ± 0.168*
Ash (%)	0.464 ± 0.054*	0.516 ± 0.019*	0.671 ± 0.060*	0.415 ± 0.025*	0.375 ± 0.019*	0.577 ± 0.056*
Total acidity (%) (as citric acid)	0.372 ± 0.027*	0.396 ± 0.025*	0.315 ± 0.041*	0.251 ± 0.012*	0.197 ± 0.015*	0.239 ± 0.042*

*standard deviation

According to results in Table 2, it can be note that the variety *kurtovska kapija* has the highest content of water (%) in frozen pepper and the lowest content of ash (%) in fresh peppers. The variety *palanechko chudo* has the highest content of water (%) and total acidity, as citric acid (%) in fresh peppers, while the lowest content of total dry matter (%) in fresh peppers, ash (%) and total acidity, as citric acid (%), in frozen peppers. In the variety *horgosh* were determined the highest content of total dry matter (%) and ash (%), in fresh as well in frozen peppers, total dry matter (%), ash (%). Also, this variety has the lowest content of total acidity, as citric acid (%) and water (%) in fresh and water (%) in frozen peppers.

The obtained resalts were statistically elaborated, for all examinated varieties of fresh and frozen peppers, were calculated the mean values and standard deviation for each of tested parameters for quality. There were estimated: average value of water (%) in fresh and in frozen peppers; average value of total dry matter (%) in fresh and in frozen peppers; average value of ash (%) in fresh and in frozen peppers; average value for total acidity, as citric acid (%) in fresh and in frozen peppers.

According to obtained results, water content in the examined fresh peppers varieties corresponds to the values according to Somos (1984) where the water content in the fruit of pepper ranges from 82 – 92 % (Marković, 1998), and also according to Niketić-Aleksić et al. (1989), where fresh red pepper contains 90.7 % water. Obtained values for ash or mineral matters in examined samples are approximate in comparison with data from Niketić-Aleksić et al. (1989), where fresh red pepper contains 0.5% ash. Organic acids are weakly present in peppers, and as the most common are citric and malic acids, but their effect on taste of peppers and depends on their proportion with sugars (Jankulovski, 1997).

By comparing results of quality parameters among fresh and frozen peppers for all three varieties of peppers, it was noted that there was a decrease of dry matter, ash and total acids, which is due to a loss of water content along with soluble substances during thawing (Cvetkov, 1982).

After analysing the results for quality parameters of fresh and frozen peppers, it was established that during the freezing process, the percentage of water increases by (+) 0.225 % in the *palanechko chudo* and by (+) 1.576 % in *kurtovska kapija*, while the total dry matter is reduced by (-) 6.054% in *palanechko chudo* and (-) 15.193 % in *kurtovska gate*.

To determine changes of quality parameters in fresh peppers during freezing, statistical elaborations of results were made by applying the F-test. It was determined that between fresh and frozen varieties of peppers, *kurtovska kapija* and *palanechko chudo*, there were no statistically significant differences , compared to the average water content, total dry matter, ash and total acids, as citric acids. Small changes were due to changes in the structure of the cells when thawing, then it comes to losing their turgor, responsible for shape of tissue (Cvetkov, 1982).

Determining nutritional value of fresh and frozen peppers

The nutritional value of peppers is due to the presence of nutritional components: total carbohydrate (7.1 %), of which sugars (5.2 %) and cellulose (1.7 %), then protein (1.4 %) and fat (about 0.3 %) (Vracar, 2001).

By comparison of quality for examined fresh and frozen peppers, all three varieties had a reduction in dry matter after freezing. According to Cvetkov, (1982), by freezing and after the thawing, there is a loss of juice from the products together with other nutrients dissolved in the juice, such as: sugars, vitamins, mineral matter and organic acids. To estimate how big are changes of nutrients in varieties of peppers, *kurtovska kapija, palanechko chudo* and *horgosh* after freezing, the results

from examination are presented in a Table 3. It can be noted that content of total dry matter in fresh peppers are higher, than in frozen peppers.

The variety of pepper which stands out with the highest content of dry matter was *horgosh*, in fresh (11.446 %), also in frozen (10.218 %) peppers. As a result of this, the variety *horgosh* was characterized by the highest content of fructose (3.866 %) in frozen; glucose (3.393 %) in fresh and (2.917 %) in frozen; cellulose (1.821 %) in fresh and (1.805%) in frozen; protein (1.431 %) in fresh and (1.388 %) in frozen; fat (0.494 %) in fresh and (0.413 %) in frozen peppers. In fresh peppers, the the variety *kurtovska kapija* had the highest content of fructose (4.323 %).

Table 3. Comparison of nutrients among fresh and frozen peppers from varieties: *kurtovska kapija* (KK), *palanechko chudo* (PC) and *horgosh* (H)

Parameter for analysis	KK fresh	KK frozen	PC fresh	PC frozen	H fresh	H frozen
Total dry matter (%)	9.399	7.971	8.391	7.883	11.446	10.518
Fructose (%)	4.323	3.279	3.892	3.486	4.243	3.866
Glucose (%)	2.729	2.552	2.396	2.250	3.393	2.917
Cellulose (%)	1.026	0.976	0.992	0.982	1.821	1.805
Proteins (%)	0.983	0.922	0.876	0.851	1.431	1.388
Fats (%)	0.28	0.201	0.213	0.205	0.494	0.413
Vitamin C (mg/100g)	132.057	94.166	124.663	82.44	138.908	88.311
β – carotene (μg/g)	32.59	27.05	20.04	11.32	101.35	67.40
Total carotenoids (μg/g)	254.55	239.39	223.48	150.76	690.15	587.88

It was determined that the variety horgosh had the highest content of vitamin C (138.908 mg/100 g) in fresh peppers, compared to the variety *kurtovska kapija* in frozen peppers (94.166 mg/100 g). By using statistical calculation, it was found that the average value of vitamin C in fresh peppers was 131.876 ± 7.124 mg/100 g, while in frozen was 88.306 ± 5.863 mg/100 g. The content of vitamin C in peppers depends on: growing conditions, degree of maturity and etc. and it ranges from 200-400 mg/100 g, whereby it is more present in small fruiting peppers than in large fruiting ones. (Jankulovski, 1997). According to Vracar (2001), the content of vitamin C in red peppers is 204 mg/100 g.

The variety *palanechko chudo* had the lowest content of β-carotene (20.04 μg/g) and total carotenoids (223.48 μg/g) in fresh and also in frozen peppers, with β-carotene (11.32 μg/g) and total carotenoids (150. 76 μg/g). Fresh peppers from variety *horgosh* had the highest content 101.35 μg/g for β-carotene and 690.15 μg/g for total carotenoids, while in frozen were for β-carotene (67.4 μg/g) and total carotenoids (587.88 μg/g). Also, it was determined that the fresh peppers from variety *horgosh* had the highest share of β-carotene in total carotenoids content(14.685 %) and for frozen (11.465 %), while the lowest share of β-carotene in total carotenoids content was found in in fresh peppers from the variety *palanechko chudo* with (8.967 %), and in frozen was (7.508 %).

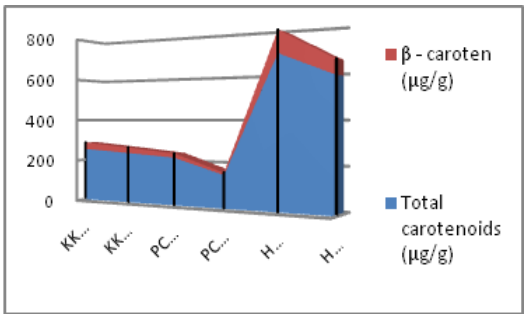


Figure 1. The share of β-carotene in the total amount of carotenoids.

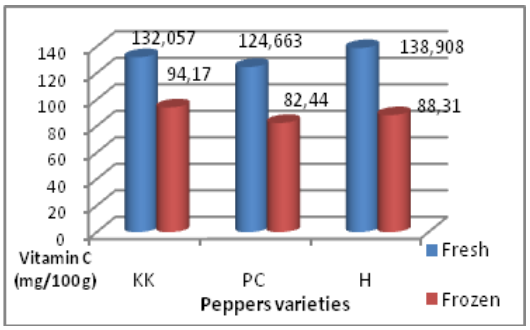


Figure 2. Vitamin C content in fresh and frozen peppers.

Differences in the content of colored matters in fruits of pepper are due to many factors, agricultural technique, maturity of fruit, and etc. In peppers there are certain colored matters: capsanthin about 70%, capsorubin 14 %, carotene approximately 6% zeaxanthin 5% cryptoxanthin and others around 5% (Jankulovski, 1997). According to Niketić-Aleksić et al. (1989), β - carotene is contained within the limits of 2.12 to 3.04 mg/100 g, while the content of total carotenoids is in the range from 15.99 to 16.35 mg/100 g. The data from FAO shown that the human body can utilize only 1/3 of the total the entered carotenoids (Niketić-Aleksić et al., 1989).

To determine differences between fresh and frozen peppers, as well as between each of the tested varieties of peppers, by applying statistical methods ANOVA, the obtained results were statistically elaborated. It was determined that differences in: total dry matter, water, ash, glucose, cellulose, proteins, fats, β-carotene and total carotenoids among fresh and frozen peppers between each of the varieties, and between the average value of total fresh and frozen peppers were determined statistically significant differences ($P < 0.05$). For the examined: total acidity, as citric acid, fructose, β-carotene and total carotenoids, between fresh and frozen peppers for each of the varieties, and between the average value of total fresh and frozen peppers were determined statistically significant differences ($P < 0.05$). For vitamin C, it was determined that the differences between fresh and frozen peppers are statistically significant ($P < 0.05$), while between each of the tested varieties of fresh and frozen peppers, there were no statistically significant differences ($P < 0,05$).

Differences that are determined in nutrients between fresh and frozen peppers are due to the chemical changes that are occurring during freezing, which can be of an enzymatic or non enzymatic nature. Then, there is a possibility of inversion of sucrose under enzyme activity of invertase, which is quite intense at a temperature of -12 to -16 °C, while vitamin C undergoes greater decomposition, especially when there is no previously treatment of blanching for inactivation ascorbase (Cvetkov, 1982). Chemical changes that occur during freezing and during storage of frozen vegetable products are particularly highlighted during thawing of product, when deformation occurs along with a change of the structure and a loss of juice with a part of soluble substances of the products (Cvetkov, 1982).

From the results of nutrients in peppers (total sugars, fats and proteins), nutritional or energy value for fresh and frozen peppers was calculated. According Vracar (2001) the energy value in fresh red peppers is 158 kJ. During calculation, the following coefficients were used which correspond to: 1 g fat to 38.9372 kJ, 1 g sugars to 17.1658 kJ and 1 g of protein to 17.1658 kJ. The results for the total energy value expressed in kilojoules (kJ) and kilo calories (kcal) are presented in Table 4.

According to these results, it can be noticed that the energy value is the lowest in the variety *palanechko chudo* 148.3 kJ (35.42 kcal), in fresh peppers and also in frozen peppers,137.91 kJ (32.94 kcal), while the highest energy value has the variety *horgosh* 206.13 kJ (49.24 kcal) in fresh and 187.33 kJ (44.74 kcal) in frozen peppers.

Table 4. Comparison of energy values of nutrients in fresh and frozen peppers for varieties: *kurtovska kapija* (KK), *palanechko chudo* (PC) and *horgosh* (H)

	KK fresh	KK frozen	PC fresh	PC frozen	H fresh	H frozen
Total sugars (%)	8.078	6.807	7.28	6.718	9.457	8.588
Energy value (κJ) (kcal)	138.67 33.12	116.85 27.91	124.97 29.85	115.32 27.54	162.34 38.77	147.42 35.21
Proteins (%)	0.983	0.922	0.876	0.851	1.431	1.388
Energy value (κJ) (kcal)	16.87 4.03	15.83 3.78	15.04 3.59	14.61 3.49	24.56 5.87	23.83 5.69
Fats (%)	0.28	0.201	0.213	0.205	0.494	0.413
Energy value (κJ) (kcal)	10.90 2.61	7.83 1.87	8.29 1.98	7.98 1.91	19.23 4.60	16.08 3.84
Total energy value (κJ) (kcal)	166.44 39.76	140.51 33.56	148.3 35.42	137.91 32.94	206.13 49.24	187.33 44.74

By applying statistical methods, the average energy values and standard deviation, for fresh and frozen peppers were calculated. In fresh peppers, the average energy value was 173.623 ± 29.58 kJ (42.33 ± 7.07 kcal), while the frozen peppers average energy value was 155.25 ± 27.81 kJ (37.08 ± 6.08 kcal).

Conclusions

Based on examinations made in this research and by evaluation of the obtained results, the following can be concluded:

Morphological characteristics - according to the weight of examined peppers, all three varieties: *horgosh, palanechko chudo* and *kurtovska kapija* are large fruiting, according to ratio of hight : width they belongs to specie *(Capsicum annuum ssp. Macrocarpum var. longum),* while according to tickness of pericarp, varieties *kurtovska kapija* and *palanechko chudo* are fleshy, while the variety *horgosh* belongs in medium fleshy peppers.

Quality of fresh and frozen peppers - according to results for quality of fresh peppers, it had been established that the examined varieties of peppers were with the necessary level of freshness, shape, color, and had featured with good marketable quality and can be used for the production of frozen peppers. In terms of the evaluated parameters of quality, it was determined that in average, between fresh and frozen peppers, there were insignificant differences, which were due to a change of structure of cells during thawing.

Nutritional value of fresh and frozen peppers - according to the survey, it was found that average value of each of examined nutrients did not significantly differentiate between fresh and frozen peppers. Significant differences among tested varieties were identified during the freezing of certain nutrients, such as dry matter, which consist of all the soluble nutrients, colored matters and vitamin

C. These differences of nutrients between all three varieties of peppers were due to the sort characteristics of peppers, environment, growing conditions, degree of maturity, and certain chemical changes during freezing and storage of frozen products. Variety *horgosh* had the highest content of dry matter, and therefore the highest energy value, in fresh and also in frozen peppers.
According to the conditions outlined by the Regulation for specific requirements relating to quick-frozen foodstuffs (Official gazette No.32, 2006), it had been established that frozen peppers were clean, healthy and free of impurities. Aroma, color and taste were inherent to the variety from which it were produced.

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ВЛИЈАНИЕ НА СМРЗНУВАЊЕТО ВРЗ НУТРИТИВНИОТ СОСТАВ КАЈ ОДДЕЛНИ СОРТИ ЦРВЕНИ ПИПЕРКИ

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Апстракт

Црвената пиперки во својот нутритивен состав има висока содржина на биолошко активни компоненти важни за човековото здравје. Високата содржина на витамин С и каротеноидите во пиперката се варијабилни во зависност од сортата, степенот на зрелост, применети агротехнички мерки и начинот на преработка. Смрзнувањето е доста применуван метод на конзервирање. Со смрзнувањето се запира или забавува развојот на микроорганизмите и ензиматските процеси. За смрзнување беа користени плодови од три сорти на пиперка, со изразена црвена боја: *куртовска капија, паланечко чудо* и *хоргош*. Замрзнувањето на пиперките беше изведено индустриски, како коцки 10 x 10 mm, во тунел за брзо длабоко смрзнување, на Т од околу – 34 ˚С ± 1 ˚С. Смрзнатите пиперки беа пакувани во соодветна амбалажа. Кај свежите и смрзнатите пиперки направена е анализира на нутритивниот состав: вкупни суви материи, шеќери со HPLC-RI, вкупни киселини, витамин С, вкупни каротеноиди, бета-каротен со HPLC-DAD, масти, протеини, целулоза и пепел. Сортата *хоргош*, како зачинска сорта, сè одликува со највисока содржина на суви материи 11,446 % во свежа и 10,518 % во замрзната состојба. Кај оваа сорта во однос на испитуваните пиперки утврдена е најголема содржина на биоактивни компоненти: витамин С (135,908 mg/100g) и вкупни каротеноиди (690,15 μg/g). Со споредба на анализираните нутритивни состојки, кај смрзнатите пиперки во однос на свежите забележано е намалување на содржината на вкупните суви материи, а со тоа и на шеќерите, протеините и мастите. Кај смрзнатите пиперки забележано е намалување на содржината на витаминот С, бета-каротен и вкупните каротеноиди.

Клучни зборови: црвени пиперки, смрзнување, нутритивен состав.

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THE QUALITY PROPERTIES OF RASPBERRY JAMS WITH DIFFERENT SWEETENERS

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Abstract
This research was made in order to determine and compare the quality properties of jams produced by using different sweeteners and two varieties of raspberry: cultivated and wild.
In order to determine differences in the quality properties of a cultivated and wild raspberry, analysis were made on the following parameters: total dry matter, soluble solids, ash, total acids, pH, sugars, vitamin C and proteins. In cultivated raspberry Willamette were established lower values for total dry mater 14.25% and soluble solids 8.60°Brix, comparing by the wild variety of raspberries where were obtained 15.10% total dry matter and 10°Brix of soluble solids. For preparing the jams in a traditional way were used different sweeteners: sucrose, fructose, sorbitol and Agave syrup. Of the finished product (jam) were determined the significant chemical parameters: total dry matters, soluble solids, ash, sugars, total acids, pH, vitamin C and proteins. The highest value of total dry matters was recorded in jam made from a wild raspberry with sucrose (49.96%), which reflected on the highest values for soluble solids (45.92°Brix) and total invert (37.30 %). The values of total acids in jams vary from 0.78 % to 0.81 %. On ready-made jams sensorial analyses were performed, which found that smell, taste, colour and consistency are acceptable. Microbiological examinations indicate that jams are microbiologically proper according to standards.
Key words: raspberry, quality properties, jams, sweeteners.

Introduction

The raspberry, with its biological and pomological properties, belongs to the group of the most prized and most important fruit species. Thanks to the great nutritional and technological value of the fruit, it is suitable for different types of domestic and industrial processing. There are several varieties of raspberries: red (Rubus idaeus L.), black (Rubus idaeus occidentalis L.) and purple (Rubus idaeus neglectus). The most common and economically important is the red raspberry (Veličković, 2007).
The raspberry fruitage has a pleasant, aromatic and refreshing taste and smell. It is rich in carbohydrates, organic acids, vitamins (vitamin C, B group vitamins, vitamin E and K), minerals (potassium, calcium, phosphorus, iron), dietary fibber, natural pigment (anthocyanins) and polyphenols, which make this fruit a protection from many diseases (Mitrev, 2006; Pichler, 2011).

Anthocyanins and polyphenols are powerful antioxidants that have anti-carcinogenic properties. After freezing or processing into jam fruit have maintained its properties (Levaj et al., 2010).
Raspberry can be processed into jam, stewed fruit, marmalade, syrup, wine, juice and other products. Jam is made by boiling fresh, frozen or chemically half-processed canned fruit by adding sugar, pectin and acid. The adequate of the jams requires a correct combination of each of these components. The main feature of this product is containing fruit pieces in an even gel substance, without separated the fruit juice (Lovrić, Piližota, 1994).
Jams are produced with a lower percentage of dry matter amounting to 30-50% comparable with the classic jams where the solids content ranges from 67-70%. These jams are prepared with a reduced amount of sucrose, or partial or complete replacement made with a suitable sweetener, using low-esterified pectines in the presence of calcium ions. Sweeteners act as preservatives and participate in maintaining the desired quality. (Tepić et al., 2001; Pavlović et al., 2003; Wolf, Schafer, 2009; Hui, 2006; Zhao, 2007).
Taking into consideration the findings of the importance of raspberry for human health and the possibility of processing fruits into jam by using different sweeteners (Pavlović, 2006; Tepić et al., 2001; Zhao, 2007), this paper shall analyze the pomological and chemical properties of two types of raspberry (cultivated and wild), followed by establishing the quality properties of jam produced using different sweeteners.

Material and methods

Two varieties of fresh raspberry fruits have been used as raw materials for jam production: the cultivated raspberry (Willamette) from the Krusevo region and the wild raspberry from the mountain region of Skopska Crna Gora. Before processing the fruit its pomological properties and chemical composition have estimated. Fifty fruits from each variety of raspberries have been used for determining the pomological properties. The weight of the fruits was measured with analytical balance, while the height and width of fruits were measured with a vernier scale. Standard analytical methods were used to determined chemical parameters: total dry matter by oven drying at 105 ^{o}C, content of total soluble solids by means of a refractometer, content of ash in a muffle furnace at 550 ^{o}C by gravimetric method, total acidity by titration of a 0.1 M solution of NaOH, pH value with a pH meter, sugars with the HPLC-RI method, vitamin C with an iodometric titration method and proteins with the Kjeldahl method.
The manufacture of dietary jams using traditional technological methods of processing was performed at the factory Vitalia Nikola Ltd. From each variety of raspberries, jams were produced using different sweeteners such as sucrose, fructose, sorbitol and Agave syrup. To achieve the desired texture during the production process, low-esterified pectin from the GENU pectin type LM 115AS by CPKelco with the addition of calcium ions in the form of calcium citrate and to provide the necessary acidity citric acid have been added.
The technological procedure comprises the following operations: washing and inspection, boiling by adding a suitable sweetener while stirring continuously, adding pectin, calcium citrate and acid, mixing, filling in jars and closing. The boiling was carried out in inox pressure cookers (steam release system). The percentage of dry matter during the production process has been controlled by a refractometer.

The chemical composition and microbiological safety of the produced jam has been tested, and its organoleptic features have been accessed. The chemical composition was estimated in the same way as it was done with fresh raspberry.

The sensory analysis was conducted in a scoring system, where the individual quality criteria (smell, taste, colour and consistency) were awarded with a different number of maximum points i.e. 2 points for the smell, 8 points for the taste, 4 points for colour and 6 points for consistency, the total sum amounting to 20 (Vračar, 2001; Tepić et al., 2001; Tepić et al., 2004).The microbiological tests have been made in order to confirm the microbiological safety of the produced jams.

Tests were made in the laboratory for processing fruits and vegetables at the Faculty of Agricultural Sciences and Food, Skopje, and some in the laboratories of the Institute of Public Health in Skopje.

Results and discussion

During processing, the fruit as a basic raw material must meet the requirements set by technological aspects, including physical and chemical properties, primarily because the quality of the finished product depends on the quality of the used raw materials (Niketić- Aleksić, 1994).

Fresh healthy fruits have been selected for this study, without major damage. The results obtained from the analysis of the pomological and chemical properties of the examined fruits of each fruits of both varieties of raspberries are given in Table 1. Evaluations of the pomological parameters (weight, height and width) determined that the fruits of wild raspberry are characterized by lower average weight (1.33 g) in comparison to the fruits of the cultivated raspberry Willamette (3.02 g). These results are in relation with the reference data, according to which the weight of the wild raspberry ranges from 1.1 to 1.6 g, while the weight of the highest quality varieties of red raspberry ranges from 3 to 6 g (Karaklajić -Stajić et al., 2006). Also, the values for the other fruit dimensions of the wild raspberries have smaller average values compared to the average size of the cultivated raspberry Willamette. From the results of the fruit measurements of the analysed Willamette variety it can be concluded that these data correspond to the data presented by Veličković et al. (2004), indicating that the fruit cv Willamette has measured value of the weight around 3.3 g, 2.0 cm in height and 1.8 cm in width. The results from chemical analysis compared for both varieties of raspberry have been showed in Table 1. According these results a higher total dry matter, soluble solids, ash, sucrose, fructose and glucose in the wild raspberry in comparison to the cultivated raspberry Willamette have been determined. The content of total acids in cultivated raspberry Willamette (0.98 %) is higher than the wild raspberry (0.41 %), which is related to the obtained pH values (2.16 or 2.4). The vitamin C content has been determined as 29.35 mg/100 g in cultivated raspberry Willamette and 25.39 mg/100 g in wild raspberry. The values obtained are higher than in the reference data for the presence of vitamin C in this kind of fruit (Niketić- Aleksić et al., 1989).

The difference in the calculated values is expected, taking into account that the chemical composition is specific for each variety and depends on climatic conditions, agro-technical measures, the degree of maturity and etc. (Niketić-Aleksić, 1994). According to the values of the studied parameters, the fruits of both varieties of raspberry correspond with the quality according to Regulation for fruits, vegetables and mushrooms (Off. Gazette No. 2 9/79 and 53/87). The results from analysis of the chemical properties of raspberry jams from both varieties by using different sweeteners have been presented in Table 2.

Table 1. Pomological and chemical composition of the different varieties of fresh raspberries tested

Analyzed parameters	Cultivated raspberry Willamette	Wild raspberry
Weight (g)	3.02	1.33
Height (cm)	1.84	1.21
Width (cm)	1.87	1.30
Total dry matter (%)	14.25	15.10
Soluble solids (°Brix)	8.60	10.00
Ash (%)	0.18	0.25
Total acidity (%) expressed as citric acid	0.98	0.41
pH	2.16	2.40
Vitamin C (mg/100 g)	29.35	25.39
Sucrose (%)	3.04	4.20
Fructose (%)	2.20	3.54
Glucose (%)	1.20	4.42
Proteins (%)	1.58	1.50

On the basis of these results it can be concluded that the total dry matter is in range from 37.81% in raspberry jam made from cultivated raspberry Willamette (4) to 49.96 % in jam made from wild raspberry (1). This is related to the content of soluble dry matter (35.07 °Brix to 45.92 °Brix), and it is in accordance with reference data (Pavlović, 2006).

Table 2. The chemical properties of jam from both raspberry varieties with different sweeteners

Sample	Willamette raspberry jam				Wild raspberry jam			
Sweetener	Sucrose (1)	Fructose (2)	Sorbitol (3)	Agave syrup (4)	Sucrose (1)	Fructose (2)	Sorbitol (3)	Agave syrup (4)
Total dry matter (%)	41.81	38.93	43.19	37.81	49.96	48.71	49.89	46.62
Soluble solids (°Brix)	38.13	35.67	41.96	35.07	45.92	45.83	45.03	43.20
Ash (%)	0.33	0.32	0.31	0.33	0.20	0.24	0.27	0.31
pH	3.20	3.10	3.00	3.10	3.10	3.20	3.00	3.00
Total acids (%)	0.80	0.81	0.78	0.80	0.79	0.81	0.79	0.79
Vitamin C (mg/100g)	22.05	22.28	22.65	22.83	21.04	20.92	20.08	20.67
Sucrose (%)	10.37	/	/	/	11.16	/	/	/
Glucose (%)	15.33	2.50	/	4.59	17.84	2.99	/	3.89
Fructose (%)	14.16	34.00	2.70	32.60	16.75	40.00	3.74	35.21
Sorbitol (%)	/	/	22.92	/	/	/	27.19	/
Total invert (%)	33.6	28.65	4.27	29.20	37.30	32.55	3.70	34.05
Proteins (%)	1.30	2.10	1.50	1.250	2.70	2.308	2.23	1.25

The comparison of the results, referring to the chemical properties, indicates higher values in the wild raspberry jam (1) compared to raspberry jam made of cultivated raspberry Willamette (1). Generally, it can be noted that there are higher values of total dry matter, soluble solids, sugars and

total invert in wild raspberry jams (1, 2, 3, 4) in comparison with the corresponding cultivated raspberry Willamette (1, 2, 3, 4). This is probably due to the higher content of total dry matter, soluble solids and sugars in fresh wild raspberry compared to the fresh cultivated Willamette.

The presence of sucrose in raspberry varieties of jams where the sweeteners used are fructose, sorbitol and Agave syrup, is negligible and it is a consequence of the inversion performed during thermal processing (Hui, 2006). The values of total acids in jams vary from 0.78 % to 0.81 % and the pH values vary from 3 to 3.2, consistent with the reference data (Hui, 2006; Niketić- Aleksić, 1994). The reference data indicates a high instability of vitamin C, especially in the presence of oxygen the fruit is thermally treated at a higher temperature, quickly oxidizing most of the vitamin C found in the product (Jašić, 2007). The lower values determined for the content of vitamin C were from 20.08 mg/100 g to 21.04 mg/100 g in wild raspberry jams and 22.05 mg/100 g to 22.83 mg/100 g in cultivated Willamette jams. These results were compared with the established values in fresh fruit (29.35 mg/100 g in cultivated raspberry Willamette and 25.39 mg/100 g in wild raspberry). According to Dauthy (1995) about 30 % of vitamin C found in the fresh fruit lost during the production of jam, that remains stable in the finished product during storage.

Jams contain 0.2 % to 0.33 % ash and 1.25 % to 2.7 % protein. According to the values of the studied parameters, jams meet the conditions prescribed in the Regulation for special security requirements of fruit jams, jellies, marmalades and sweetened chestnut purée (Off. Gazette of RM No. 3/2007).

The results from sensory analysis of the finished raspberry jam, from the two varieties with different sweeteners, are shown in Table 3. It can be noted that the cultivated raspberry Willamette jam with sorbitol has been gained the highest points (18.18) compared to the other jams obtained from the same variety. Wild raspberries jam with sucrose was rated with the highest scores: 1.9 for smell, 6.68 for taste, 3.58 for colour and 5.65 for consistency, resulting with the highest total of points (17.81) compared to the jams where other sweeteners have been used, derived from this variety of raspberry.

Out of all analyzed jams with a total of 18.18 points, cultivated raspberry jam with sorbitol is rated as the best. The worst quality is determined in the wild raspberry jam with Agave syrup (14.85) and wild raspberries jam with fructose (14.99). It can be noted that the cultivated raspberry jams, with a total number of points from 17.63 to 18.18, have better sensory properties compared to the wild raspberry jams, with a total of points from 14.85 to 17.81. From the microbiological analysis in all varieties of jams, it was estimated that the number of present microorganisms Staphylococcus aureus, Salmonella spp, Enterobacteriaceae, aerobic mesophilic bacteria, yeast and must, were within the acceptable limits according to the regulation on microbiological criteria for foodstuffs (Off. Gazette No. 78/2008).

Table 3. Sensory analysis of the jams manufactured from both varieties of raspberry with different sweeteners

Sample	Characteristic				Total points
	Smell	Taste	Colour	Consistency	
Willamette raspberry jam sucrose (1)	1.65	7.18	3.83	5.03	17.69
Willamette raspberry jam fructose (2)	1.83	7.28	3.43	5.23	17.77
Willamette raspberry jam sorbitol (3)	1.85	7.30	3.93	5.10	18.18
Willamette raspberry jam Agave syrup (4)	1.88	7.40	3.25	5.10	17.63
Wild raspberry jam sucrose (1)	1.90	6.68	3.58	5.65	17.81
Wild raspberry jam fructose (2)	1.48	5.48	2.83	5.20	14.99
Wild raspberry jam sorbitol (3)	1.75	6.03	2.85	5.20	15.83
Wild raspberry jam Agave syrup (4)	1.60	5.70	2.55	5.00	14.85

Conclusions

Results of this research indicated that the raspberry can be successfully processed into jam and that fructose, sorbitol and Agave syrup can be used as sweeteners, apart from sucrose.The cultivated raspberry Willamette and the wild raspberry possessed pomological and chemical properties which correspond to the prescribed regulations and are in accordance with the reference data. The differences in the obtained values of individual ingredients are a consequence of the genetic traits of the varieties, climate, soil and other conditions that affect the composition of the phase of growing and maturing of the fruits.

Based on the results of chemical and microbiological analysis of the ready-made raspberry jams from the two varieties with different sweeteners, we can conclude that they meet the requirements for food safety and quality. In the sensory evaluation of the ready-made jam, the cultivated Willamette raspberry jam with sorbitol is rated as the best (total 18.18 points), and the least points were awarded to the wild raspberry jam with Agave syrup (14.85) and wild raspberry jam with fructose (14.99). Overall, it can be concluded that cultivated Willamette raspberry jam have better sensory properties compared to the wild raspberry jams, because the cultivated Willamette jam scored higher total points (from 17.63 to 18.18) than the wild raspberry jam (from 14.85 to 17.81).

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КВАЛИТЕТНИ СВОЈСТВА НА ЏЕМОВИ ОД МАЛИНА СО РАЗЛИЧНИ ЗАСЛАДУВАЧИ

Љубица Каракашова, Викторија Стаматовска, Фросина Бабановска-Миленковска

Апстракт

Истражувањата се направени со цел да се утврдат и споредат квалитетните својства на џемови, добиени со преработка на култивирана и диворастечката малина, со примена на различни засладувачи. За да се утврдат разликите во квалитетните својства на култивирана и диворастечката малина направени се испитувања на следните параметри: вкупни и растворливи суви материи, пепел, вкупни киселини, pH, шеќери, витамин C и протеини. Констатирани се пониски вредности од 14,25 % за вкупните суви материи и за растворливите суви материи од 8,60°Brix, кај културираната малината Виламет (Willamette) во споредба со дивата малина каде се добиени 15,10% за вкупни и 10°Brix за растворливи суви материи. За подготовка на џем на традиционален начин беа користени различни засладувачи: сахароза, фруктоза, сорбитол и сируп од агава. Кај готовите производи (џем) беа утврдени следните значајни хемиски параметри: вкупни и растворливи суви материи, пепел, вкупни киселини, pH, засладувачи, витамин C и протеини. Најголема вредност на вкупните суви материи е забележана во џемот од дива малина каде е користена сахароза (49,96%), што се одразува и со највисока вредност за растворливи суви материи (45,92°Brix) и вкупниот инверт (37,30%). Вредностите на вкупните киселини во џемовите варира од 0,78% до 0,81%. На готовите џемови беше направена сензорска анализа со која е утврдено дека мирисот, вкусот, бојата и текстурата се прифатливи. Микробиолошките испитувања покажуваат дека џемовите се микробиолошки исправни согласно стандардите.

Клучни зборови: малина, квалитетни својства, џемови, засладувачи.

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COMPARISON OF QUALITY AND NUTRITIONAL COMPOSITION OF GREEN AND BLACK TABLE OLIVES

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Abstract
The aim of this research is to determine differences in the quality and nutritional value of two types of fermented table olives: green, elongated, variety Halkidiki, and black, naturally ripe olives, variety Amfissa. Fermented olives in the salt solution are packaged in jars and pasteurized. The quality is determined on examinations of pH, total acidity and salt. After determination of protein, fat, carbohydrates and fiber content, their energy values were calculated. Also, particular biologically active components like vitamin C, B_6, E and carotin were examined. According to the obtained results, it may concluded that the olives correspond to descriptions of types of olives, styles of processing, basic composition and quality that should be in accordance with standards. With green olives, pH is below max.4, total acidity is under max.0, 4 % and salt is above min. 5 %, while in black olives quality is prescribed only with salt, which is above the min. 7 %. With comparison of nutritional composition, there is no evidence of significant differences in content of nutritive components, so that energy value is about the same. Significantly higher content of vitamin C in green olives (22 mg/100 g) was found, in terms of black olives (13 mg/100 g), which is due to levels of maturity and applied technological procedure. Pasteurized olives also correspond to requirements regarding the content of additives, which vary in both ways of production. Analysis of contaminants and microbiological safety point out that the olives are in accordance to standards.
Key words: table olives, quality, nutrients, microbiology.

Introduction

Olive tree (Olea europaea L.) is one of the most important fruit trees in the Mediterranean Basin and is widespread through the entire region (Malheiro et. al., 2012). Table olives are currently the most popular agro-fermented product and are consumed and enjoyed throughout the entire world (Malheiro et. al., 2012; Marsilio, et.al., 2005). About 44% of world production emanates from Europe, the main producing countries being Spain, Greece, Italy and Portugal. The fruits have a soft texture with very delicate skin and pulp, so particular care must be taken during harvesting and processing. They are hand harvested from mid-September to mid-October when they have reached a yellowish-green surface colour. However, this variety is also used for the preparation of Spanish-style whole green olives (Marsilio, et.al., 2005).

Consumers perception of quality is improving and nowadays an increased seek for healthier products can be observed worldwide (Malheiro et. al., 2012). Mainly composed by monounsaturated fatty acids, table olives consumption can prevent and reduce the risk of

cardiovascular diseases (Kastorini et al. 2010). In addition, other minor constituents like tocopherols and phenolic compounds are responsible for antioxidant and antimicrobial properties (Sousa et al. 2006), protecting the organism from diseases in which free radicals and pathogenic microorganisms are involved, preventing also the body from certain kinds of cancer (Owen et al. 2004) and arthrosclerosis (Armstrong et al. 1997).

Phenolic compounds are of great importance for the olive fruit, being responsible for important characteristics and properties, such as color, taste and texture (Marsilio et al., 2001). Several phenolic compounds have been identified in table olives, including oleuropein and hydroxytyrosol, tyrosol (Briante et al., 2002), rutin, quercetin, as well as caffeic, vanillic and r- and q-coumaric acids, among others (Malheiro et. al., 2012). Olives phenolic composition, however, is highly variable in both quality and quantity, in the dependence of several factors: processing method (Romero et al., 2004), irrigation regimes (Patumi et al., 2002), cultivar, and maturation degree (Ryan et al., 1999).

According to the Trade Standard Applying to Table Olives (COI/OT/NC no. 1, 2004) table olives are defined as the product ‘‘prepared from the sound fruits of varieties of the cultivated olive tree (Olea europaea L.) that are chosen for their production of olives whose volume, shape, fleshto-tone ratio, fine flesh, taste, firmness and ease of detachment from the stone make them particularly suitable for processing’’.

Different kinds of table olives should be classified according to the ripeness stage of the fruit, trade preparation, styles and sizing. Table olives may or may not be size graded. Whole olives should be size graded according to the number of fruit in one kilogram or hectogram. When the unit is a kilogram, the size range is expressed in steps of 10 olives up to size 150/160, 20 from this up to size 200/220, and 30 up to size 370/400; above 400 per kilogram, the step are 50 olives. When the weight unit is the hectogram (not shown here), the range is expressed in steps of 1 olive up to size 15/16; 2 olives from this up to size 20/22, and 3 olives up to size 37/40; above 40 olives per hectogram, the steps are 5 olives (Luh, 2004). Table olives are classified, according to the Codex Standard for table olives (1987). in one of the following olive types, trade treatments and styles. There are three types of table olives: *green olives* obtained from fruits harvested during the ripening period, prior to colouring and when they have reached normal size. The colour of the fruit may vary from green to straw yellow; *olives turning colour* obtained from rose, wine-rose or brown-coloured fruits harvested when turning colour, before the stage of complete ripeness is attained and *black olives*, obtained from fruits harvested when fully ripe or slightly before full ripeness is reached. They may, according to production region and time of harvesting, be reddish black, violet black, deep violet, greenish black or deep chestnut not only on the skin but also through the flesh.

In term of trade treatments, *green olives* can be *treated green olives in brine*, treated in an alkaline lye and then packed in brine in which they undergo complete natural lactic fermentation (Sevillan style) or partial natural lactic fermentation. The preservation at a pH value within the limits specified in this standard for table olives not undergoing complete natural fermentation may be ensured by: sterilization or pasteurization, the addition of preservatives, refrigeration, treatment with nitrogen or carbon dioxide in treatments without brine. *Untreated green olives in brine,* these are placed directly in brine and preserved by natural fermentation. *Olives turning colour* can be *treated in brine*, obtained after alkaline treatment and preserved by natural fermentation: in brine, by heat treatment, in brine and by heat treatment and *untreated olives turning colour, in brine,* these are placed directly in brine and preserved by natural fermentation and ready for consumption. *Olives*

darkened by oxidation in brine are green olives or olives turning colour darkened by oxidation, whose bitterness has been removed by treatment in alkaline lye, which are packed in brine and preserved by heat sterilization. For black olives, more popular treatments is *black olives in brine*, these are firm, smooth and with a glossy skin. Owing to their preparation, they may present slight surface depressions. They can be: *treated black olives* obtained after alkaline treatment and preserved by natural fermentation through one or a combination of the following: in brine, by sterilization or pasteurization, by addition of a preservative and *untreated black olives*, these are placed directly in brine. They have a fruity flavour which is more marked than that of the treated black olives and they usually retain a slight bitter taste. They are preserved by natural fermentation through one or a combination of the following: in brine, by sterilization or pasteurization, by addition of a preservative. Olives may be offered in one of the following styles, according to type and trade treatment. The most used are: *whole olives*, which have their natural shape and from which the stone (pit) has not been removed. Without stem, whole olives from which the stem has been removed and with stem, whole olives retaining the stem; *stoned (pitted) olives*, from which the stone (pit) has been removed and which essentially retain their natural shape; *stuffed olives:* stoned (pitted) olives, stuffed either with one or more suitable ingredients (pimiento, onion, almonds, celery, anchovy, olive, orange or lemon peel, hazel-nut, capers, etc.) or pastes prepared therefrom etc.

The variety Halkidiki usually is used for the preparation of whole green olives. This variety "*Halkidiki*" is grown in Halkidiki, near Thessaloniki, Greece. Fruits are large, distinctively elongated end of lower part, inner lining is slightly bent, and the meaty part has no a good structure. This variety contains 120 - 140 fruits of olives per kilogram. Larger and more qualitative fruits of olives are used for production of Spanish-style green olives in brine, while the rest is used for extraction of oil.

The variety *Amphissa*, also known as Konservolia is one of most represented species in Greece and contributes around 80% in the production of olives in Greece. The fruits vary in shape, from round to oval form. They ripen in November, when the weight of the fruit can reach up to 10 gr. or 180-200 fruits per kilogram. The ratio between meat and inner lining is 8:1 and quantity of oil is from 22 to 25% of the total weight of olive fruit. From this variety can be produced green and black olives on top quality. Green olives are harvested from mid- September to mid- November and are suitable for production of Spanish-style of green olives. The rest of the fruits get ripen on trees, until they get from pink, purple to finally black color. This color is most suitable for the preparation of natural black olives in brine. This olive variety is highly regarded around the world, for the good characteristics of the fruit.

The processing method of fresh olives by treating the olives with dilute NaOH solution is due to eliminate their natural bitterness, followed by several washings with water to completely remove excess alkali. The olives are then placed in a solution of sodium chloride (brine), where spontaneous lactic fermentation takes place. During fermentation, weak acidification rates are often registered, because most of the sugars and nutrients are lost by the effect of the lye treatment and strong washing system used, so the pH and final lactic acidity are very often unsuitable for safe storage of the end-product (Marsilio, 2003). Another problem is the softening of the fruits due to cell rupture and separation during industrial processing, resulting in a dramatic texture loss as a consequence of the lye degradation and solubilization of pectic polymers from the cell wall and middle lamella (Marsilio et. al., 1996; Mafra et. al. 2001).

Sorted olives are packed carefully, often in glass jars in a definite pattern. Packed jars are then filled automatically with water or brine, then emptied to rinse of any adhering sediment. The jars are then filled with brine of 28 ° salometer. Some packers may acidify the brine with 0,2 to 0,5 % lactic acid if the olives are below the optimal acidity. Jars are then sealed in a capping machine. It is advantageous to pasteurize olives in jars by use hot brine 60 °C and then to pasteurized at 79 ° to 82 °C. This will prevent sedimentation from bacterial growth (Luh, 2004). The cooling should be performed after pasteurization in a certain time and then, jars of table olives are stored on appropriate place and conditions.

Material and methods

The researches in this article were made in order to determine differences in the quality and nutritional value of two types of table olives, green and black olives. As a raw material were used fermented table olives (Greek style): green, elongated, variety Halkidiki, and black, naturally ripe olives, variety Amfissa.

The production process was performed at plant for processing olives, Princip Komerc, in village Davidovo. In the production plant are located: calibrator, line for the production of pasteurized olives, production line for packaged olives in plastic packaging and new line for packaging olives with modified atmosphere. The fermented olives are purchased in barrels. The technological processing started by washing, selecting, calibration, then, preparing a brine, filling in jars with olives and brine, closing of jars, pasteurized and cooling. The neto-weight of table olives in jars is 230 or 440 g.

The analysis for quality control, nutritional composition and microbiological safety were performed at the laboratory for food quality control, at Institute for Public Health, Skopje. The quality control was estimate according to existing legislation, by examinations of pH, with pH-meter, total acidity by titrimetric method with 0,1 M solution of NaOH and salt by titrimetric method of Mohr.

Determination of nutrients were performed by application of physical and chemical methods, when the following parameters were analyzed: total dry matter by applying gravimetric method of drying in oven at T = 105 ° C to constant mass; proteins by Kjeldahl method; fats by using the Soxhlet method; sugars with HPLC-RI - liquid chromatography method with refractive index detector, dietry fiber by gravimetric method, the presence of vitamin C with iodometric method, and the presence of vitamin E, B_6 and caroten by using HPLC-DAD - liquid chromatography with Diode-Array Detection. According to obtained results for nutrients, were calculated the energy values for green and black table olives in jars.

Microbiological analysis were also made to estimate whether the table olives are microbiologically safe and in compliance to Regulation for specific requirements for food safety in terms of microbiological criteria (Official Gazette of R. Macedonia, No. 78/2008).

Results and discussion

Quality control of the green and black olives was made by comparison of obtained results to values that are prescribed in the national and international regulations (Codex Standard for table olives 66-1981. Rev.1-1987). During the processing of table olives controls were made on important conditions as, good quality of ingredients, good hygienic practice of ambient for production, equipment and personal, also on some parameters, as: pH and concentration of salt in brine, the temperature during processing brine, filling and closing of jars, temperature and time of

pasteurization and cooling. During processing of packed of table olives it is allowed, according to Codex Standard for table olives (1987), to use certain quantity of some additives, expressed as weight m/m of total weight of olives, including brine, like *antioxidants* (L-ascorbic acid – 0,2 g/kg); *acids* (citric, lactic and tartaric acids, for each max. 1,5%) and preservatives, as benzoic acid and its sodium and potassium salts (max. 1 g/kg, expressed as benzoic acid) or sorbic acid and its sodium and potassium salts (max. 0.5 g/kg, expressed as sorbic acid). The content of additives in table olives is also prescribed in national Regulation for additives what can be used for food processing (Official Gazette of R. Macedonia, No. 31/2012). It is also important for the final products to be properly labeled, respecting the requirements of the Regulation on food labeling (Official Gazette of R. Macedonia, No. 118/2005). To provide high level of protection the health of people and consumer interests in relation to food, it is necessary to apply the requirements according to Food Safety Law (Official Gazette of R. Macedonia, No. 31/2012), where the provisions of this Law shall be applied at all stages of production, processing and distribution of food.

In purpose to control the quality of table olives, packed in jars, analysis were made for following parameters: total dry matter, pH, NaCl and total acidity, as lactic acid. From obtained results of table olives analysis, green and black ones, shown that they do not contain any preservative.

Table 1. Comparison of quality parameters for black and green pasteurized table olives according to values in regulations

Parameters of quality	Green olives tasted	Green olives regulation	Black olives tested	Black olives regulation
Total dry matter	27,63%		30,04%	
pH	4,27	max 4.0	/	/
Total acids (as lactic acid)	0,51 %	min 0.4 %	/	/
NaCl	6,24 %	min 5.0 %	7,42 %	min 6 %

Table 2. Comparison of content for nutrients and antioxidants in green and black table olive

Nutrients in olives	Green olivs	Black olives
Proteins	1,3 g / 100 g	1,6 g / 100 g
Fats	12,5 g / 100 g	13,0 g / 100 g
Carbohydrates	7,0 g / 100 g	9,0 g / 100 g
- Sucrose	1,67 g / 100 g	1,21 g / 100 g
- Glucose	0,44 g / 100 g	0,25 g / 100 g
- Fructose	0,36 g / 100 g	0,2 g / 100 g
- Dietary Fiber	4,4 g / 100 g	5,0 g / 100 g
Vitamin C	22,0 mg / 100 g	13,0 mg / 100 g
Vitamin B_6	0,024 mg / 100 g	0,019 mg / 100 g
Karoten	180,0 µg / 100 g	167,0 µg / 100 g
Vitamin E	3,0 mg / 100 g	2,8 mg / 100 g

As a standard procedure after processing is a control of some sensorial properties and followed them for a certain period of time. It was notice that table olives in jars had fulfilled requirements: the brine was clean and transparent, free from abnormal odours or tastes and unauthorized foreign matter; It is important for green olives to have dark green, with lighter or darker shade of color, typical for green olives. Appearance of green olives: fruits of olives are quite soft, with stone, and have typical shape and color, submerged in a liquid with appropriate density. They have salty taste with pleasant proper aroma and pickled taste. Black olives are differ from the green one in color, what is from purple to black, with lighter or darker shade, and in specific aroma and taste. The size gradation of table olives is for green olives 121/140 and for black olives 161/180. In purpose to estimate energy value of green and black table olives, analysis were made for content of macro nutrients, as sugars (glucose, fructose and cellulose), fats and proteins, as well some bioactive components as: vitamin C, $B_{6,}$ what are hydrosoluble vitamins, vitamin E as a liposoluble vitamin and carotene what is natural pigment and also precursor of vitamin A.

Chemical composition and the share of each of the nutrients in olives are presented graphically in Figure 1. The biggest quantity in chemical composition belongs to the water, while in the dry matter, the largest share belongs to fats.Based on obtained results for macro nutrients, the energy values were calculated for green table olives 129 kcal / 539 кJ and for black table olives 130 kcal / 543кJ.

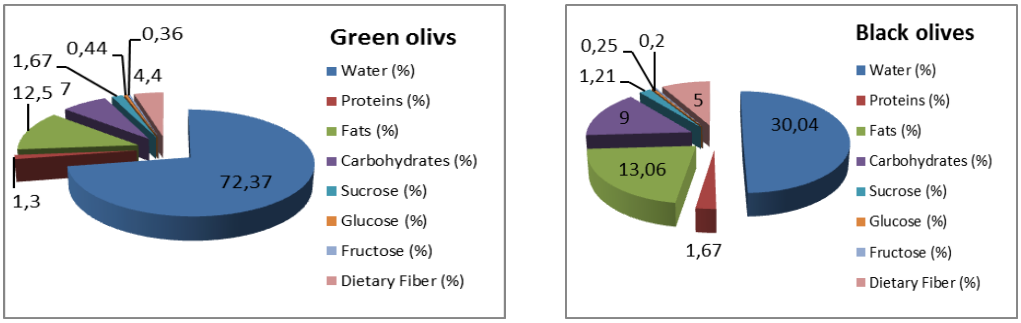


Figure 1. Chemical composition and the share of each of the macro nutrients in green and black table olives

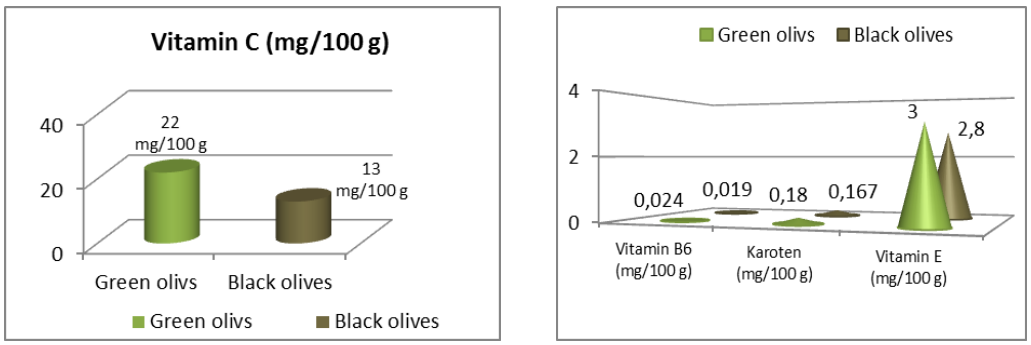


Figure 2. Content of bioactive components, vitamin C, B_6, E and carotene in green and black table olives

The microbiological testing was made to determine microbiological safety of black and green table olives packed in jars. According to Regulation for specific requirements for food safety in terms of microbiological criteria (Official Gazette R. Macedonia, No. 78/2008), were made analysis for presence on following microorganisms: Bacteria from Salmonella species (absence in 25 g), Staphylococcus coagulase positive (max. 100 cfu/g), Listeria monocytogenes (absence in 25 g), Esherichia coli (max. 1000 cfu/g), Clostridium perfringens (max. 100000 cfu/g). The obtained results shown that examined black and green table olives were microbiologically safe. Estimation of safety was also made by analysis of some contaminant what is required according to our national Regulation for general requirements for food safety (Official Gazette R. Macedonia, No. 118 / 2005). Estimation of safety was also made by analysis of some contaminant what is required according to our national Regulation for general requirements for food safety (Official Gazette No. 118 / 2005). There is no presence of Lead (Pb) (max. 1 mg / kg) and Tin (Sn) (max.250 mg / kg).

Conclusions

On differences in physicochemical properties of green table olives, variety Halkidiki, and black olives, variety Amfissa, despite of variety, many factors affecting on: the time of harvest, degree of maturity, treatment and condition due to fermentation process, processing after fermentation and packing.

The quality of table olives is determined on examinations of pH, total acidity and salt. For green olives, pH is below max.4, total acidity is under max.0, 4 % and salt is above min. 5 %, while in black olives quality is prescribed only with salt, which is above the min. 7 % (Codex Standard for table olives 66-1981. Rev.1-1987). Based on the examinations was established that the olives correspond to description of type of olives, size, style of processing, basic composition and quality what are in accordance with standards.

After determination: protein, fat, total carbohydrates and fiber, were calculated their energy values, for green 129 kcal / 539 κJ and for black table olives 130 kcal / 543 κJ.

It was found that green olives, variety Halkidiki, had higher content of vitamin C (22 mg/100 g), vitamin B_6 (0,024 mg /100 g), carotene (180 μg/100 g) and vitamin E (3,0 mg/100 g), in terms of black olives.

Pasteurized table olives also correspond to requirements regarding the content of additives, which vary in both ways of production. Analysis of contaminants and microbiological safety, point out that the olives are in accordance to standards.

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СПОРЕДБА НА КВАЛИТЕТ И НУТРИТИВЕН СОСТАВ КАЈ ЗЕЛЕНИ И ЦРНИ ТРПЕЗНИ МАСЛИНКИ

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Апстракт

Целта на ова истражување е да се утврдат разликите во квалитетот и нутритивниот состав кај два вида на ферментирани трпезни маслинки: зелени, долгнавести, сорта *халкидики* и црни, природно зрели маслинки, од сортата *амфиса*. Ферментираните маслинки во солен раствор се пакувани во тегли и пастеризирани. Квалитетот е утврден со определување на pH, вкупни киселини и натриум хлорид. По определување на содржината на протеини, масти, јаглени хидрати и целулоза, пресметана е нивната енергетска вредност. Воедно, се испитани и одделни биолошки активни компоненти, како витамин С, $Б_6$, Е и каротен. Според добиените резултати, може да се заклучи дека маслинките одговараат на описот на видот на маслинки, начинот на производство, основниот состав и квалитет кои треба да се во согласност на стандардите. Кај зелените маслинки, pH треба да е под max. 4, вкупните киселини да се под max. 0,4 % и содржината на сол да е над min. 5%, додека кај црните маслинки квалитетот е пропишан само со содржина на сол која треба да е над min. 7%, Со споредба на нутритивниот состав утврдено е дека не постојат значителни разлики во содржината на хранливите состојки, така што нивната енергетска вредност е приближно иста. Значително повисока содржина на витамин С е утврдена во зелените маслинки (22 mg/100 g), во однос на црните маслинки (13 mg/100 g), што се должи на степенот на зрелост и применетата технологија на производство. Пастеризираните маслинки воедно одговараат на барањата во однос на содржината на адитивите, кои се применуваат во двата начина на производство. Со анализа на контамиентите и испитување на микробиолошката исправност утврдено е дека маслинките се во согласност со стандардите.

Клучни зборови: трпезни маслинки, квалитет, хранливи состојки, микробиологија.

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THE APPLICABILITY OF THE FOODTEXTURE PUFF DEVICE FOR THE DETERMINATION OF THE RHEOLOGICAL PROPERTIES OF O/W EMULSIONS

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Abstract
The Food texture Puff Device (FPD) is a new device that yields contactless, fast, easy and non-destructive rheological measurements of food products. The instrument applies a controlled air pulse to the surface of a food product, while a laser distance sensor measures the deformation. This approach can be considered as an alternative method for more fundamental rheological properties like storage and loss module, viscosity, elasticity, especially for industrial applications. In the present work the FPD was evaluated on O/W emulsions. Eight commercial mayonnaise-type products were analyzed with the FPD, a Texture Analyser (spreadability rig) and the rheometer (storage and loss module from a frequency sweep). It was tested at three different selected temperatures with all instruments. The correlation between the results with the instruments was determined. The FPD was able to determine the firmness with a low standard deviation and good temperature sensitivity. In addition, it was shown that the maximum deformation created by the FPD was strongly correlated to the firmness of the emulsions as determined with the texture analyser, and to the storage module of the frequency sweep, determined with the rheometer. Therefore it was concluded that the FPD is well suited and applicable for measuring the firmness of o/w emulsions. It is a flexible instrument that is applicable in an industrial environment due to its real time analyses of rheological characteristics and its ease of use.
Key words: Food texture Puff Device, o/w emulsion, rheology, firmness.

Introduction

Quality is a concept that connects multiple options such as: uniform foodstuffs colour or crispy, fragrance that suits this product or raw materials from which it is made, etc. According to this, the quality of food or a product is very difficult to maintain and describe (Claes 2011). Fortunately, there are features that can be directly linked to the quality of the food, appropriate such characteristic is rheology. Rheologycal properties nag a clear picture of the characteristics of a substance. Rheologycal characteristics often largely based on complex measurement methods such as Bostwick konsistometer, sometimes giving the lack of necessary information. For companies and food production process which used testing different products would be useful to have a device, an instrument that operates on a simple and accurate way to describe rheology to these products. There rheometers are easy to operate and precise measurement, but have their own disadvantages. Some of the shortcomings is the design and method of managing of instruments, and the high cost of these

devices that cannot afford the smaller manufacturing companies for the food production. Another disadvantage is that already tested food can't be used again.

Foodtexture Puff Device (FPD) can be described as non destructive device that emits air at the surface of the sample for testing. At the same time FPD sends a laser beam on the surface of the sample with the laser lens and laser sensor measure distortion, wavy surface caused from air puffs.

This researching is part of big project, in mind has its performance test which can be applied in the food industry. Test project is divided into three research groups of foodstuffs. In the first group of food items and products with viscous properties as: foods with sugar, glucose syrup and fructose paste. The second group of products with yield properties such as oils, fats and chocolate. In the last group belong to products with high elastic properties as gluten flours and mixes with water. Past publicized scientific publications show that FPD can be used as a successful instrument in determining rheology in some of the above foods. The ultimate goal of the project is to make a good FPD practical guide that could be used in industry (Sofie Morren 2012).

This study take small part of the project and is focused on research and testing the applicability of the FPD to determine rheologycal properties of o/w emulsions. Specifically, this type of emulsion which is researched mayonnaise.

This instrument is used as an alternative method for rheological properties, while Rheometer Physica MCR 301 and Texture Analyser TA.XT.plus Stable Micro Systems have been used as reference instruments and methods for comparing the results obtained from the FPD.

Material and methods

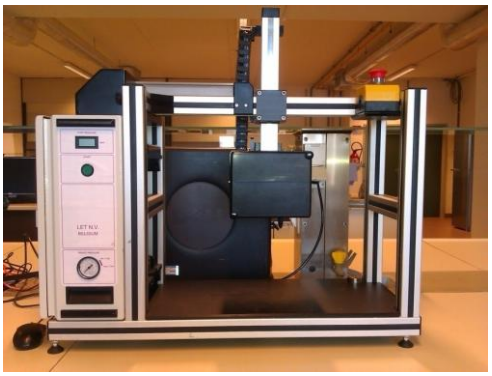
Eight commercial mayonnaise-type products were analyzed with the FPD, a Texture Analyser (spreadability rig) and the rheometer (storage and loss module from a frequency sweep). It was tested at three different selected temperatures with all instruments.

Foodtexture Puff Device (FPD)

FPD as an instrument for measuring the strength of the food products, without their destruction was first used by (Stanley E. Prussia 1994). These ways of measuring patented by them and are based on the use of injected air and light lens. Several characteristics are essential for productions of this invention: Measurements without contact, the sample is not destroying and is adjustable objects which have variable surface features. FPD actually injected controlled air puffs on the sample testing surface creating deformations that are observed by a laser sensor that measures the distance to the surface.

Vividly work FPD is shown below, and was first used for measuring the coagulation of milk by (F. R. Bamelis 2006).

Firmness is resistance, and is a key factor in determining the quality of food products. Customers choose the strength as a factor when choosing to buy. Information and data resulting from the changes of surface tested sample deformation was sent to personal computer where they are processed and presented in tables and graphics through special adapted software - Labview 5.3 National Instruments (F. R. Bamelis 2006).



Picture 1. Food texture Puff Device (FPD)

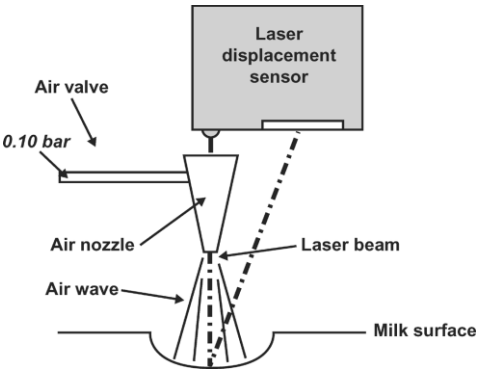


Figure 1. Measurement head of the Foodtexture Puff Device (F. R. Bamelis 2006)

Rheometer Physica MCR 301

This instrument, Rheometer Physica MCR 301, was used as a reference method to compare the results of the examination. Rate of shear test method was commonly found in the reference data. Spindle is tool who descends down to the head of Rheometer Physica MCR 301 on which was applied the testing sample. Plate on plate system was used, with a diameter of 25mm. Was used calibration option, zero GAP, 0 mm connecting surface between spindle and head of the instrument.



Picture 2. Reometer (Anton Paar Physica MCR 301) with spindle PP25



Picture 3. TA.XT2+ with Spreadability Rig

Was used two types of test: oscillatory and rotation test. From oscillatory test was measured storage and loss module from a frequency sweep and the rotation test was used for CSR (constant Rhear Rate) & SRR (Shear Rate Ramp) tests. With these two tests can be determined (γ, η, φ, $\dot{\gamma}$) (Germany 2006).

Texture Analyser TA.XT.plus

The (TA.XT.plus) Texture Analyser (Stable Micro Systems Ltd, Godalming, Surrey, UK), with the "TTC Spreadability Rig" (HDP/SR) attachment, was used as the reference analysis for the evaluation of the spreadability of the emulsions. This setup has previously been used to assess the

spreadability of table fats by (Glibowski 2008). The testing of the prepared samples repeat 5 times for each sample. For each test, cone tests are set special place in already centered base of 25mm. The male cone section ranges from the top down in a distance of 23mm with speed of 3mm / s, with penetration in tested mayonnaise, which is filled the female cone. The force required for penetration of the male part into the female part, pushing the mayonnaise on the outside, are registered on the computer monitor.

Data analysis

For all three instruments, the FPD, Rheometer Physica MCR 301 and the TA.XT2+, data treatment was performed in Office Excel 2007. All statistical tests were performed with SPSS. ANOVA tests were performed to differentiate between batches and curve estimation was used to correlate results from the FPD and the texture meter. Tests were decided on the 0.05 significance level, unless specified differently.

Results and discussion

The Food Texture Puff Device was tested for the applicability of o/w emulsion, mayonnaise. This research was part of a larger project, aiming to draw up a best practice guide for businesses on the FPD. In this study, the rheometer and texture analyzer as reference method.

Figure 2 relates the storage modulus from the rheometer with the force of the spreadability rig. It shows how the two "reference measurements" are related with each other. Figure 3 displays a significant correlation between result from the FPD and the Rheometer. On one curve is showed relates all samples at all temperatures. The correlation is described by a exponential function. Figure 4 displays a significant correlation between result from the FPD and the texture analyzer. On one curve is showed relates all samples at all temperatures.

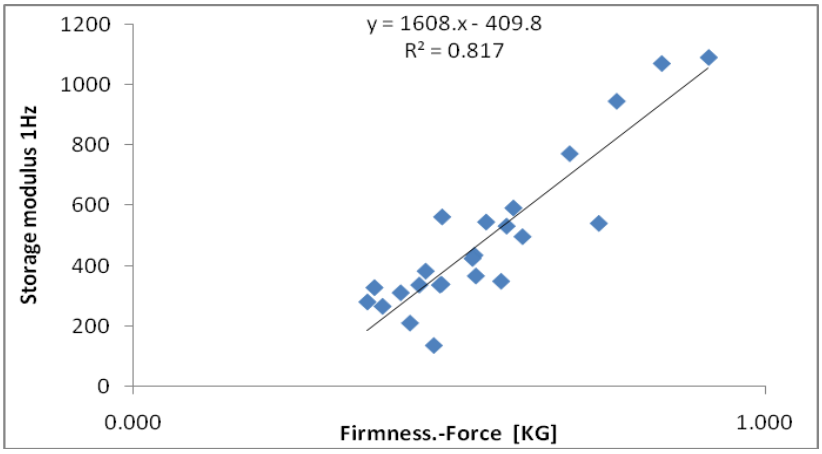


Figure 2. Linear correlation of the Storage modulus 1Hz to the Firmness

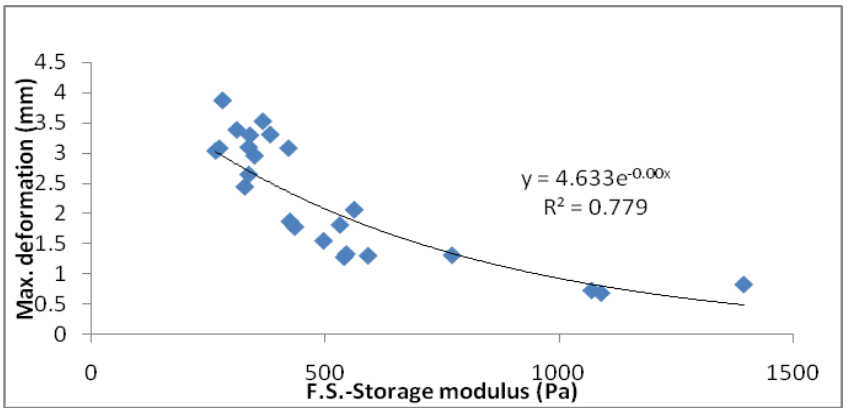


Figure 3. Exponential correlation of the maximum deformation to the Storage modulus

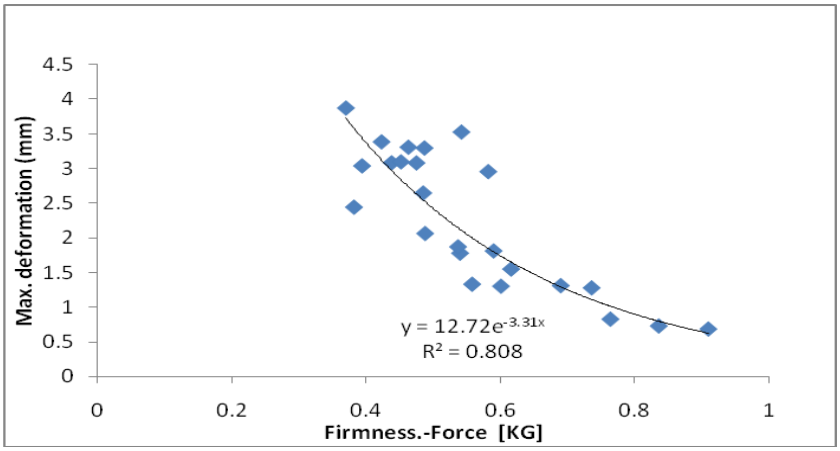


Figure 4. Exponential correlation of the maximum deformation to the Firmness

The combination of these three figures is important to illustrate the order magnitude of the standard deviations on the FPD measurements and that the FPD is capable to distinghuish different mayonaise samples.

The FPD is capable to study the influence of temperature, because for all mayonaise samples, the deformation at 7°C is lower than at 19°C (which is expected, because mayonaise is less firm at higher temperature). The deformations at 25°C are not always higher than at 19°C, but the difference in temperature is also rather small (only 6°C).

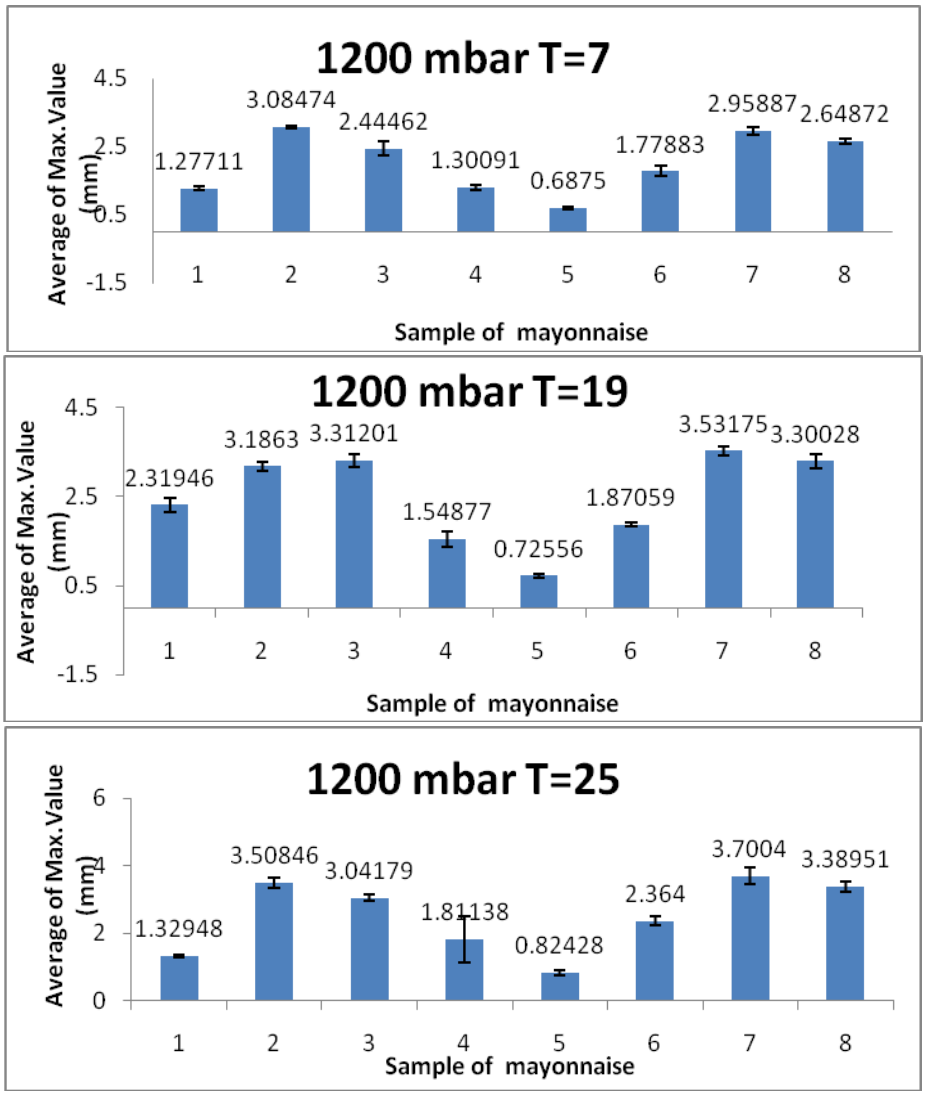


Figure 5. Maximum deformation (puff 1) for eight different batches of mayonnaises as measured with the FPD. The test displayed here were conducted at 7^0, 19^0, 25°C

Conclusions

In particular, the temperature effect on the viscosity was considered to be important rheological property of the oil or fat. The rheometer studied the temperature effect on the viscosity. The results showed, as in the literature, a viscosity decrease with increasing temperature. The first challenge of the study, the oils and fats perceptible for the FPD. The FPD is a good method and gave a wider range of the results than the rheometer.

The comparison of the FPD with a texture analyser revealed that the maximum deformation created by the FPD is strongly correlated to the firmness of the emulsions. The Foodtexture Puff device was capable of the same discriminating force as the texture analyser, when using the results solely by using the results of Puff's.

The use of the FPD by means of a guide best practice, delivers to a company has a simple method to gain insight into the rheology of O/W emulsions, especially mayonnaise. It is capable of accurate, in-depth measurements in a laboratory environment and has the flexibility and ease-of-use, required for measurements in a factory environment.

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ПРИМЕНЛИВОСТА НА АПАРАТОТ ЗА ИСПИТУВАЊЕ НА ТЕКСТУРА СО ДУВАЊЕ (FPD) ВО ОПРЕДЕЛУВАЊЕТО НА РЕОЛОШКИ КАРАКТЕРИСТИКИ НА O/W ЕМУЛЗИИ

Карастојанов Стефан, Моррен Софие, Клаес Јохан

Апстракт

Апаратот за испитување на текстурата со дување (FPD) претставува нов уред кој дава безконтактни, брзи, лесни и недеструктивни реолошки мерења на прехранбените производи. Инструментот користи контролиран воздушен пулс на површината на прехранбениот производ, додека ласерскиот сензор од далечина ја мери деформацијата. Овој пристап може да се смета за алтернативен метод на повеќе фундаментални реолошки својства, како: „storage module“ (G’- вредност, количество на енергијата потребна за да се изврши некоја деформација), “loss module” (G’’- вредност, претставува енергија на губење од примерокот кој се тестира), вискозитет и еластичност, особено за индустриска примена. Во презентираниот труд, за оценка на FPD се користени емулзии од масло во вода. Осум комерцијални производи од типот на мајонез се анализирани со FPD, анализатор на текстура (тест за мерење на размачкувањето) и реометар (G’и G’’од испитувањето со променлива фрекфренција. Тестирањето е направено на три различни температури со сите инструменти. Определена е корелацијата помеѓу резултатите со инструментите. FPD е во можност да ја определи цврстината со ниска стандардна девијација и добра температурна осетливост. Покрај тоа, се покажа дека максимална деформација создадена од страна на FPD е во силна корелација со цврстината на емулзиите како што е определено со анализаторот на текстура, и со “G’- вредност”, количество на енергијата потребна за да се изврши некоја деформација, утврдени со реометарот.Затоа е заклучено дека FPD е добро прилагоден и применливи за мерење на цврстината на емулзии од видот на масло во вода. Тоа е флексибилен инструмент, кој е применлив во индустриска средина, поради неговото реално време на анализа на реолошките својства, како и поради неговата едноставна употреба.

Клучни зборови: Апаратот за испитување на текстурата со дување (FPD), емулзија, реологија, цврстина.

UDC: 664.95:664.8.037.5
Review paper

FREEZING AND STORAGE OF THE FROZEN FISH

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Abstract
Freezing fish is essential, a widespread manner that provides the greatest conservation extending its sustainability without significant reduction in nutritional value and taste deterioration. Fish can be frozen in a number of ways: in the "stream" of cold air at a temperature of -38^0C to -42^0C or "block" freezer temperature records -42^0C. There is a possibility of freezing the fish in a solution of salt, glycerol and propylene glycol and agents with low boiling temperatures. Regardless of which procedure is used, it is essential that it provides a rapid decrease of fish temperature, especially in the zone of crystallization, and "down" to -18^0C or lower. During freezing and storage, biological, physical and chemical changes in fish occur. The main task when freezing fish is to reduce to a minimum the complex changes in the tissues of fish by providing optimum conditions of freezing. Frozen fish stored at a temperature no higher than -18^0C. Storage temperature changes greater than $\pm 0,5^0$C should be avoided, and in trade for a short time, greater than $+2^0$C.
Key words: fish, freezing, storage.

Introduction

With the growing earth population and improvement of the standard of living, particularly in the developing countries, there is a significant growth in the requirement for meat, especially for the meat from fish. The consumers have become more aware of the benefits from fish consumption and the possession of high quality fish. Our market offers live, fresh and frozen fish, as well as processed fish, mainly fish in cans, and rarely other products.

The most common and the most practical way of preserving fish meat is freezing. Freezing is an ancient technology for preserving foods (Archer, 2004), and it has been used for thousands of years because of high product quality (Persson and Londahl, 1993). It has its historical origins in China, where ice cellars were used to preserve the foods as early as 1000 BC. Later, the Greeks and Romans stored food in cellars in which snow had been compressed. Foods intended to be consumed while frozen date back to the 1500s when flavored ices were made in France by master ice makers (Lund, 2000). The ancient Eskimos and Indians, in certain cold areas, used to preserve the food by freezing it, in a way that the fish caught during the winter months was frozen and held frozen in the cold ambient air. (Ronsivalli and Baker II, 1981). Fish were purposely frozen in the United Sates in the mid-1800s using salt and ice to reduce the temperature of a pan on which the fish were placed (Enochian, 1968). The freezing of fish subsequently became an important industry and was boosted further by the advent of mechanical means of freezing.

Freezing of Fish

Freezing is one of the best and the most widely used preservation method for fish. Around 30% of all the fish and fish products, globally, are frozen before being sold on the market. Nevertheless, the eating quality of fresh fish is considered superior to that of frozen fish. It is, however, possible to produce frozen fish of high eating quality by freezing the fish quickly and subsequently storing it at low and stable temperatures. In this way, the physical and chemical processes causing the quality of the fish to deteriorate may be reduced (Nielsen and Jessen, 2007). The freezing process consists of freezing, frozen storage and thawing, each of which must be properly conducted to obtain optimum results when preserving foods (Fennema at al., 1973, quoted by Delego and Sun, 2001).

Freezing is a process by which, with taking the heat away, the temperature in the center of the body of the fish is being lowered from the initial temperature to -18°C or -20°C and lower, and most of the water contained in the fish tissue is being turned to ice. As a result of the freezing, unfavorable conditions are created for the action of the enzymes and development of the microorganisms, which in turn provides long-term storage of the fish. However, during the freezing and the storage of the fish, the properties of the tissue change, which leads to deterioration of the quality of the frozen fish in contrast to the fresh fish. During the freezing, biological and chemical changes are occurring in the fish. The biological changes involve discontinuing the microorganisms' ability to live, and part of them die in the process. The death of the microorganisms has been noticed to be at its maximum at temperatures between 0 and -5°C. (Быков, 1980; Витченко et al., 1981).

The basic physical process in the freezing of the fish is the converting of the water into ice. Different species of fish freeze at temperatures between -0.6°C and -2°C. The main part of the water in the fish (up to 75%) turns into ice on temperatures from -1°C to -5°C. While the temperature is decreasing, the formation of ice crystals is gradually decreasing, too. It is considered that virtually all the water becomes frozen at temperatures between -55°C and -65°C (Быков, 1980; Витченко at al., 1981). Around 76% of the unbound water freezes on -5°C, around 89% at -20°C and around 90% freezes at -30°C. The bound water in the tissue turns into ice on temperature of -65°C (Данев, 1999).

Fish muscle contains large amounts of water, often about 80%. When fish are frozen, the temperature in the center of the fish quickly falls to just below 0°C. At - 1°C, ice crystals start to form in the water, that is, the water changes from liquid to solid form. The degree to which this process affects the quality of the thawed fish depends on where in the fish muscle the ice crystals develop and on their size. Where crystals are formed and their size depend on whether the fish is frozen before (pre), during (in), or after (post) rigor mortis (stiffening after death), as well as on how speedy the freezing process is. In prerigor fish, the water is only inside the muscle cells, and when the fish is frozen, the ice crystals will therefore form inside the cells. The ice crystals will mainly be small. Large ice crystals will form only if the freezing process is slow (e.g., in still air above -18°C). In in-rigor and prerigor fish, a small amount of water, however, will be outside the cells and thus the speed of freezing becomes significant for the formation of ice crystals. If freezing is quick, small ice crystals will form both inside and outside the cells. However, if freezing is slow, ice crystals will first form outside the cells, resulting in an increase in the salt concentration. The higher concentration of salt outside the cells will extract more water from the cells and when this happens during freezing the ice crystals, which have already formed inside the cells, will grow in size rather than allowing for the formation of new ice crystals. In in-rigor and postrigor fish, the speed at which the fish are frozen can therefore determine how large the ice crystals are and where in the muscle

they form. This will range from many small ice crystals both inside and outside the cells, to only very few large ice crystals outside the cells (Nielsen and Jessen, 2007).

If the fish is frozen before rigor mortis, right after it was caught, fine crystals are starting to form in the cells, the deformation of the fish tissue is smaller, and the process is reversible to a significant degree. Through slow freezing, large crystals of ice form, the cells are injured, the histological structure of the tissue is damaged and the process is irreversible (Быков, 1980; Витченко at al., 1981). Through slow freezing, crystals of ice that reach 5 mm form in the muscles, and with rapid freezing the crystals are significantly smaller and reach dimensions from 0.005 mm to 0.1 mm (Данев, 1999). Fish contains about 60-80% by weight water depending on the species. The process of freezing converts most of water into ice (Johnston et al., 1994). Freezing occurs over a broad range of temperatures below −3°C. However, freezing is a stepwise process, and it is not until the temperature is lowered to −18°C that enough water is immobilized to effect a reasonable stabilization of product quality for to about 1 year. At higher temperatures, chemical reactions involving enzymes and oxygen will eventually degrade the product quality. At lower temperatures the product quality will remain high for many months and even years (Rinsivalli and Baker II, 1981).

The chemical processes on low temperatures are slow, but they don't stop, even in the frozen fish. In the process of freezing, glycogen and some phosphorus compounds decompose, and thus lactic and phosphorus acids are formed. These processes are intensively happening in a temperature interval of -2.5°C and 3.7°C. During freezing, the concentration of the dissolved matter in the water in the cells that is still not frozen, is increasing, which leads to an irreversible change in the proteins – denaturation. Denaturation of proteins is intensively happening on temperature of -1°C to -5°C. In order to ensure a maximally reversible process it is necessary to pass through this temperature zone quickly (Витченко et al., 1981). The changes in the frozen meat refer to the changes occurring in the proteins (denaturation of proteins) and the changes occurring in the lipids (oxidation of the lipids) (Tokur et al., 2006; Ali, 2011; Simeonidou, 1997). The denatured proteins are less soluble and have lesser ability for water retention. Around 25% of liquid can be "squeezed" out of the meat of the frozen fish. The denaturation of proteins is a slow, irreversible process, and it manifests itself after the defrosting through loss of the fluid ("drip"), change in the appearance, texture, smell and taste (Baltć et al., 2009). The main task in freezing the fish is to draw the complex of changes in the fish tissue to a minimum by providing optimal conditions of freezing (Витченко et al., 1981). The severity of the changes depends on the way of freezing (fast or slaw), the temperature, the time of storage, the way of defrosting, species of fish, the condition of the fish before freezing, etc. (Šoša, 1989; Ward et al., 2000; Sigurgisladottiri et al., 2000).

Methods of fish conservation by freezing

Fish can be frozen in the "stream" of cold air, in "block" freezers (between metal plates), appliances for quick freezing with water solution of salt and agents with low boiling point. Regardless which one of these procedures is used, the primary thing is that it provides fast reduction of the temperature, especially in the zone of crystallization, and to lower it to temperature of -18°C or lower. Freezing of fish with "stream" of cold air is used for whole (large) fish, which are hanged with their head down, as well as for smaller fish which are packed in cassettes (blocks) around 60 mm thick and 120 mm at most, for the smallest fish. During the freezing the temperature of the air is between -38°C and -42°C, and the air circulation is 300-1000 m/min. The freezing lasts for 4-5 hours, during which time the temperature in the fish reaches

between -18°C and -28°C depending on the freezing procedure and the thickness of the blocks. The freezing of fish in "block" freezers is a kind of freezing in which fish in the block is being frozen between two mobile metal plates. The plates are actually evaporators though which a cooling fluid continuously flows, and they can be in horizontal or vertical position. The temperature of the contact plates is -42°C (from -35°C to -45°C) (Baltć et al., 2009; Данев, 1999).

Fish can be frozen in an extremely cooled solution of salt (brine), in which the fish to be frozen is immersed or sprayed with such a solution. When a direct freezing is applied, a solution of table salt is used, and freezing without contact is needed the fish is packed in impermeable packaging and a calcium chloride solution is used. Liquid CO_2, liquid N, freon and other agents are used in the process of freezing with agents with low boiling point. The agents are put in devices with small dimensions and then the fish is placed. With the evaporation of the agents the temperature is greatly lowered and the fish freezes. The disadvantage of this method is that the freezing parameters are difficult to regulate (Данев, 1999).

Glazing and packing of frozen fish

The quality of the frozen fish is rapidly changing during the storage and distribution, unless it is appropriately protected from the effects of dehydration, oxidation physical damages and contamination with external agents. The surface of the fish can be protected with glazing, glazing and packaging or packing in a material that has the properties to completely fit (be completely attached to) the fish regardless of the shape of the block or of the fish. Materials with such properties (retraction) are present and they also possess good protective properties (impermeability of gas and liquid). The glazing is primarily used for fish in blocks and large packages, and on the other hand the packaging without glazing is used for small packages designed for the households. The glazing should be done immediately after freezing and the fish should be transferred into a storage chamber. Before the transfer it can be packed in a plastic or cardboard packages (Baltć et al., 2009). Glazing is a process of forming a thin layer of ice which will encompass the whole surface of the frozen fish (the block). It protects the lipids in the fish from oxidation and dehydration during the storage period. Drinking water on temperature of 1°C-2°C (not higher than +5°C) is used for glazing. Fish can be submerged in the water or sprayed with it. The glaze should cover the block of fish or the larger fish with an even layer and it should not be able to detach itself when affected by miner mechanical impacts. The glaze should be 0.4–0.6 mm thick, and have mass of 2%-4% from the mass of the fish. For reaching the necessary thickness of the glaze, double or triple dipping of the fish in water is required in duration of 2-3 sec. in intervals with pauses of 10-15 sec. between intervals. In order to speed up the process of icing in the water and allow a solid glaze to be formed, it is expedient to apply a stream of cold air to the fish. If more fatty fish are glazed, it is recommended that antioxidants are added to the water (0.2% solution of citric or ascorbic acid, 0.2% solution of sodium glutamate and others (Витченко et al., 1981).

Storage of frozen fish

Frozen fish is kept in storage chambers for frozen fish at the same temperature it was frozen to. The storage space is not used for the process of freezing, nor to further lower the temperature. If during the transfer, or from some other reasons, the fish is partly defrosted, it is frozen again according to the prescribed procedure, and then stored. The defrosted fish can be frozen again only if it is intended for finishing or processing (Baltć et al., 2009).

Changes in frozen fish during storage

During the storage microbiological, physical and chemical changes are occurring in the fish. At temperatures of -12°C the development of the microorganisms virtually stops (with an exception of some molds), which would mean that the microbiological changes in the frozen fish during the storage are negligible. But, it should be noted that the microorganisms endure lower temperatures better than higher temperatures. Therefore, during unfavorable storage conditions (contaminated air with microorganisms, high humidity of the air, significant initial contamination of the fish) molds start to appear on the fish. At temperature of -18°C, the microbiological spoiling of the fish is excluded, but certain physical and chemical changes are still happening in it, which have important influence on the quality indicators (Быков, 1980; Витченко et al., 1981).

The physical changes include shrinking, change of color and of the histological structure of the tissues. In the process of storage fish color can change as a consequence of the decomposition of the materials that give the color to the fish, and the growth of some strains of microorganism in those conditions. The color change and the change of the structure of the tissues are mutually connected. If there is a temperature fluctuation in the area with the frozen fish the fine ice crystals in the tissues of the fish turn into large crystals. As a result of the recrystallization the quality of fish deteriorates and a "shrinkage" appears. The degree of shrinkage of the frozen fish depends on the fish species, the temperature of the storage room, the humidity of the air in the chamber, type of packaging and the presence of the glaze on the fish surface. The average "shrinkage" during fish storage is 0.1–0.4% monthly. In the frozen and glazed fish there are not any losses determined during the first month of storage. During further storage of the frozen fish, chemical changes – oxidation of the lipids and denaturation of proteins, are also occurring (Быков, 1980; Витченко et al., 1981).

Storage regiment and shelf life of frozen fish

The storage regiment should provide maximum slowing down of the physical and the chemical changes in the fish and thus long term storage. The fatty fish should be stored at temperatures from -25°C to -30°C, and lean fish at temperatures from -18°C to -20°C. The temperature regiment should be constant, and the only allowed fluctuation is no more than ±1°C. During stocking and emptying of the storage chamber an increase in the air temperature of 3°C - 4°C is allowed. The relative humidity in the storage chamber of the frozen fish should be 94-98%. The strict consistency of the temperature and of the humidity is an essential condition for rational storage of the frozen fish (Быков, 1980; Витченко at al., 1981). A temperature of -25°C to -30°C for fatty fish and -20°C to -30°C for other fish and a relative air humidity of 90% to 95% is set for storage of the frozen fish before it arrives to the stores. Frozen or deep-frozen fish should not be stored more than six months (Lambaša-Belak, 2006). The air circulation during storage should be moderate and not higher than needed to maintain a constant temperature. In order to provide a more even circulation of the air in all the parts of the storage room a free space of 5 to 10 cm between the frozen fish and the walls i.e. ceiling or floor is necessary (Baltić et al., 2009).

Shelf life of food is defined as the maximum length of time a given product is fit for human consumption. For fish, shelf life is the time from when it is taken from the water until it is no longer fit to eat. Temperature and handling practices are the most important factors in determining the shelf life of all species of fish (Doyle, 1995). Under ideal circumstances (low and stable storage temperatures), some fish species may retain a fair eating quality for over a year. Shelf life can be assessed either in terms of Practical Storage Life (PSL) or High Quality Life (HQL). PSL is defined as the time the product can be in cold storage before it loses its characteristic properties or becomes

unsuitable for consumption. PSL is often determined between trade partners, and no legislative rules apply to this area. HQL is a target for how long the product can be in cold storage before taste panels are able to discern a clear difference from the original quality of the fish. HQL is normally two to three times shorter than PSL. PSL, moreover, is what is eventually declared on the product. The shelf life (PSL and HQL) of lean fish (e.g. cod fish), large fat fish (e.g. salmon) and small fatty fish (e.g. herring) is: at -18^0C for PSL – 7, 7, 5 months respectively, and for HQL – 3, 3, 2 months respectively. At -30^0C for PSL it is 12, 18, 10 months, and for HQL it is 6, 6, 5 months respectively (Nielsen and Jessen, 2007). Fatty fish, especially large fish like salmon, are more suitable for freezing than cod and at low temperatures may be suitable for consumption for up to 1.5 years (Sørensen et al., 1996). In Table 1 the shelf life for storage of some of the frozen fish and fish products is shown, according to different authors.

Fish Defrosting

Defrosting (thawing) is physically a reverse process of freezing (Быков, 1980; Haugland, 2002; Archer et al., 2008). Before it is used the frozen fish should be defrosted. The temperature of the frozen fish should reach -1°C or 0°C during defrosting. The quality of the defrosted fish is in correlation with all the previous processing: the quality of fish before freezing, the conditions and the time of storage of the frozen fish and the conditions involved in the defrosting. With defrosting it is impossible to renew the characteristics that the fish had in the process of treating until defrosting. However, it is necessary that the defrosting is conducted in a way that there are no further changes of the characteristics of the fish's meat.

It is acknowledged that the maximum amount of changes in the protein characteristics of the meat of the fish happen in the temperature zone of -1°C to 5°C during freezing and especially during defrosting. The faster this zone is passed through, both during freezing and defrosting, the less the properties of the meat of the fish change. This explains the necessity of rapid defrosting of fish (Быков, 1980). Still, it should not be too fast, because that also has negative influence on the product (Archer et al., 2008).

The initial increase of the temperature during defrosting is due to the presence of one layer of ice – ice glazing around the fish. The glazing has a higher heat transfer coefficient than the water and it melts rapidly in the early stages. As the glazing melts, the rate of defrosting slows down and a long process of defrosting follows, until the temperature of the fish reaches the ice melting point (-1°C). That is the period when any injury of the cells results in release of mobile ingredients and formation of drop by drop "drip" losses. There are not precisely determined rates of defrosting, since they depend on a lot of factors. The rate of defrosting gradually slows down with time, because the heat must travel from the surface through one layer of defrosted meat, which during time becomes thick. It is extremely important that the surface of the fish is not too warm during defrosting, since it can accelerate the spoilage. The control of the temperature during defrosting is critical, but there is not a definitely recommended temperature (Archer et al., 2008).

There are a lot of commercial methods for defrosting fish. The cold water remains the quickest and the best tool for fish defrosting. For thinner packages as individual fillets, the defrosting shouldn't last longer than 5 to 10 minutes. Another acceptable method of quick defrosting is the use of microwave oven. Slow defrosting in the refrigerator (overnight) is an acceptable practice, but an excessive loss of liquid which is drained from the meat, can occur when this process is used. Defrosting of fish at a room temperature or in hot water is not recommended (Stuiber, 2011).

Table 1. Frozen storage temperature and storage life for fish and fish products according to different authors

Product	Temperature (^{0}C)	Storage life (months)	Authors
Cod Herring	–30 –30	8 – 48 6 – 12	Berkel et al., 2004
Fat fish Lean fish Fish fillets	from –28 to –18 –20 from –28 to –23	8 12 6– 9	Scharnow, 1986
Fat fish glazed Lean fish fillets	–18, –24, –30 –18, –24, –30	5, 9, >12 9, 12, 24	Bykowski and Dutkiewicz, 1996
Fatty fish, sardines, salmon, ocean perch Lean fish, cod, haddock Flat fish, flounder, plaice, sole	–18, –25, –30 –18, –25, –30 –18, –25, –30	4, 8, 12 8, 18, 24 9, 18, 24	Johnston et al., 1994
Anadromus sturgeon glazed Freshwater sturgeon glazed Atlantic herring glazed Cod	–18, –25, –30 –18, –25, –30 –18, –30 –18, –30	7, 9, 12 6, 8, 10 3, 5 6, 9	Быков, 1980
Cod, frozen on boat Atlantic herring glazed Cod fillet	–18, –30 –18, –30 –18, –30	6, 9 6, 8 3, 8	Витченко et al., 1981
Headed and gutted fish Chinook salmon Chum salmon Coho salmon Pink salmon Sockeye salmon Pacific cod Alaska pollock Pacific halibut Pacific ocean perch Herrng Salmon shark	 –18, –29 –18, –29 –18, –29 –18, –29 –18, –29 –18, –29 –18, –29 –18, –29 –18, –29 –18, –29 –18, – 29	 8, 14 4, 8 6, 10 3, 6 7, 12 9, 18 8, 14 10, 20 8, 14 2, 6 9, 12	Kolbe and Kramer, 1993
Trout Cod fillet Ocean perch Mackeral Halibut	–12, –18, –23, –12, –18, –23 –12, –18, –23 –12, –18, –23 –12, –18, –23	110, 260, 300 days 90, 210, 300 days 120, 220, 300 days 50, 80, 110 days 170, 260, 350 days	Reid, 1998

It is important to determine the quality of the defrosted fish in order to evaluate the risk of consuming that fish. For assessment of the quality of the frozen fish, a large number of methods in different varieties are being researched: NIR- spectroscopy (Bøknæs et al., 2002), fluorescent

spectroscopy (Karoui et al., 2006), measurement of the dielectric properties in a microwave area (Kent et al., 2004; Kent et al., 2005). The obtained results are pointing towards a possibility of application of the dielectric properties in controlling the quality of the defrosted fish muscles.

Conclusions

Fish is an extremely perishable food item, susceptible to microbiological and biochemical processes, which deteriorate the quality, i.e. lead to change in the texture, color, taste and smell of the fish meat. Different procedures are used in order to preserve the quality of fish and to prolong the shelf life. Freezing is the most widely used method of fish preservation. The purpose of freezing is to lower the temperature of the fish and in that way to slow down the changes in the tissues to that degree that it virtually cannot be differentiated from the fresh fish when the product is defrosted, after being kept in the freezer. Around 30% of all fish and fish products, on a global level, are frozen before being sold on the market. However, the quality of the fresh fish for consumption is considered to be superior over the quality of the frozen fish. Nevertheless, it is possible to produce frozen fish with high nutritive quality if an appropriate care is provided in every step of the freezing, storage and defrosting procedures. In order to have a frozen fish with good quality the use of rapid freezing, immediately after fish is caught, followed by storage at low and stable temperatures and rapid defrosting is recommended.

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СМРЗНУВАЊЕ И СКЛАДИРАЊЕ НА СМРЗНАТА РИБА

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Апстракт

Смрзнувањето на рибата е основен, широко распространет начин на конзервирање, кој обезбедува најголемо продолжување на нејзината одржливост без значително намалување на хранливата вредност и влошување на вкусот. Рибата може да се смрзнува на повеќе начини: во „струја“ на ладен воздух при температура од -38^0C до -42^0C или во „блок“ замрзнувачи при температура на плочите од -42^0C. Постои можност за смрзнување на рибата во раствор од сол, глицерол и пропиленгликол и во агенси со ниски температури на вриење. Без оглед која постапка се користи, основно е таа да обезбедува брзо намалување на температурата на рибата, особено во зоната на кристализација, и да ја „спушти“ на -18^0C или пониска. При смрзнувањето и складирањето, во рибата настануваат биолошки, физички и хемиски промени. Основна задача при смрзнувањето на рибата е да се сведе до минимум комплексот на промени во ткивата на рибата по пат на обезбедување оптимални услови на смрзнување. Смрзнатата риба се складира при температура не повисока од -18^0C. Треба да се избегнуваат промени на температурата на складирање поголеми од $\pm 0,5^0$C, а во прометот, за кратко време, поголеми од $+2^0$C.

Клучни зборови: риба, смрзнување, складирање.

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INFLUENCE OF SERUM PROTEINS ON THE QUALITY, CHEMICAL AND BIOCHEMICAL PROPERTIES OF YOGURT

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Abstract
In order to determine the influence of serum proteins on the quality, chemical and biochemical properties of yogurt, two different starter cultures were applied: YF-L 811 (V1) and YC-381 (V2), as well as two inoculation temperatures: 35-37 °C (V1.1 and V2.1) and 41-43°C (V1.3 and V2.3), with and without the addition of serum protein powder (V1.2, V1.4 and V2.2 and V2.4). Cow milk from the same milk farm was used as a raw material, which was pasteurized at 85°C for 30 minutes. The storage lasted for fifteen days at 4°C, and the content of milk fats, ashes, proteins and dry material were analyzed on the first and 15th of the storage; and the lactose, the titration acidity and pH on the first, 5th, 10th, and 15th day. On the basis of the gathered date from the analysis it was determined that: Titration acidity significantly grows in all of the sub-variants, with the lowest acidity had V1.2 (28.61°SH to 45.34°SH), while the highest values shows V2.3 (38.50°SH to 52.59 °SH). V2 sub-variants had higher titration acidity for the duration of storage of the yogurt compared to V1, and the sub-variants with added whey powder had lower titration acidity. Active acidity has a declining trend, being higher among V2- sub-variants, and sub-variants with the addition of serum proteins appeared having a higher pH values. Lactose content significantly decreases from the first to the 15th day in all varieties of yogurt. On the first day, lactose ranged from 2.57 % (V1.4, V2.3 and V2.4) to 2.85 % (V2.1), and the 15th day of 0.17 % (V1.3, V2.3 and V2.4) to 0.34 % (V1.2). The addition of serum proteins did not influence the change in the content of lactose in yogurt. The addition of serum proteins in yogurt, led to a higher content of fat, protein, ash and dry matter in yogurt.
Key words: yogurt, temperature of fermentation, serum proteins, starter culture, storage.

Introduction

Fermented milk are products prepared from whole, partially or completely skimmed milk - not-homogenized or homogenized, pasteurized or sterilized milk, under the influence of specific bacteria (FIL-IDF, 1969, Kosikowski, 1984). Fermented milk products differ in taste, texture and durability, compared to the original raw materials. The definition of fermented milks is applied exclusively for liquid or semi-liquid dairy products, and does not apply to cheeses. Other than cow's milk in the production of fermented milk, sheep, goat, buffalo and mare milk can also be used, but a mixture of multiple types of milk can be used as well. Definition of fermented milk is accepted worldwide. (FIL-IDF, 1969, Kosikowski, 1984). Fermented dairy products are yogurt, stirred yogurt, fruit yogurt, kefir and fermented cheeses.

The term yogurt as a foodstuff, mean semi- liquid dairy product which is obtained by adding lactic acid bacteria such as (*Lactobacillus delbrueckii subsp.bulgaricus and Streptococcus thermophilus*), forming lactic and other acids that preserve the product, increase its durability and give it new characteristic organoleptic properties. During fermentation, a whole range of physicochemical changes occur to milk components: milk protein (casein) coagulates under the influence of acid, lactose under the influence of enzymes breaks down to glucose and galactose and to lactic acid; the taste and the smell of the product change as well. On a temperature from 42 to 45 ° C for a period of 2-4 hours, comes to the fermentation of milk, then the yogurt cools down so that its fermentation slows down, and the durability of the finished product extends. Yoghurt is rich in protein, calcium, vitamin B2 (riboflavin) and vitamin B12, and people who are lactose intolerant can freely consume yogurt because much of the lactose in the fermentation process turns into lactic acid.

Material and methods

The research for this paper was performed in the laboratories Faculty of Agricultural Sciences and Food in Skopje. As a research subject, different varieties of yogurt produced in the laboratory were used. As the basic raw material for research for this paper, the following was used: The sum of cow's milk from the same dairy farm, and as auxiliary raw materials were used: Two types of starter cultures as follows: YF L-811 and YC-381 and Serum proteins were the following chemical composition: Protein - 12.11%, Fat - 1.0%, Carbohydrate 69 62%.

In the survey, two basic variants were stated, based on the starter cultures used, then the sub-variants were made based on temperature of inoculation and addition of serum proteins. However, in the survey, eight sub-alternatives were stated:

V1-inoculated with YF L-811:

Sub-variants:

V 1.1- inoculation at a temperature of 35-37 º C.

V. 1.2 - Inoculation at a temperature of 35-37 º C + serum proteins

V. 1.3 - Inoculation at a temperature of 41-43 º C.

V. 1.4 - Inoculation at atemperature of 41-43 º C + serum protein

V2-inoculated with YC-381:

Sub-variants:

V 2.1 - Inoculation at a temperature of 35-37 º C.

V. 2.2 - Inoculation at a temperature of 35-37 º C + serum protein

V. 2.3 - Inoculation at a temperature of 41-43 º C.

V. 2.4 - Inoculation at atemperature of 41-43 º C + serum proteins

Method of operation

The chemical analysis includes examination of the essential ingredients in yogurt, according to the following methods: Determination of fat - Gerber method; Determination of protein - Kieldahl method; Determination of lactose - hloramin method T IDF / ISO / AOAC; Determination of ash - method according to the IDF / ISO / AOAC combustion at 550 ° C; Determination of dry matter according to the method of drying 105 ° C.

For assessment of biochemical changes in the yogurt, the following tests were conducted:

Titratable acidity - according to the method Soxhlet-Henkel modified by Moress; Active acidity - pH meter.

Results and discussion

Impact on titration acidity of yogurt (°SH)

Titration acidity in yogurt is an important indicator of the quality of yogurt. The obtained results, in terms of titration acidity in yogurt variants is given in Table 1.

In V1-sub-variants, titration acidity was ranging from 28,61 ° SH in V1.2 and to 33,25 ° SH in V1.3, in the first day of keeping. In Sub-variants, with the addition of serum proteins lower titration acidity (V1.2 and V1.4) was noticed.

In V2- Sub-variants, in the first day, the lowest titration acidity was noticed in V2.2 34,33 ° SH, and highest in V2.3 38,50 ° SH and in this variant, the addition of serum proteins lead to lower titration acidity. Comparatively, first day variants of V1 had lower titration acidity than the V2 variant.

Titration acidity in all variants, during the 15 days storage increases, but with different intensity. Namely, V1.1 titration acidity that in the first day was 28 91, to the 5th day, consequently increased to 23.6%, 10th dat to 14.9% and 15th day to 10.6% or for a period of 15 days, the acidity increased by 56.9% compared to the first day.

In V1.2, in which serum protein was added, the initial titration acidity was slightly smaller than V1.1 and amounted to 28,61 ° SH, and then there is an almost same pace of increase and on the 15th day it was 45,34 ° SH, or the growth in titration acidity is 55.5% higher compared to the first day. The largest increase in titration acidity is between the 1st and 5th day, 23.6% in V1.1 and 24.1% in V1.2. All V1 sub-alternatives show greatest decrease in titration acidity in the first 5 days of storage. On the other hand, V2-sub-variants statistics show significantly higher acidity compared to V1-sub-variants. In V2.1 titration acidity on the first day amounted to 34,59 ° SH, on the 5th day it increased by 12.0%, to 19.3% on the 10th day, and on the 15th day only 2.4% or a total of 38.7% compared to the first day. Added serum proteins in V2.2 slightly influenced acidity so that on the first day it was 34,33 ° SH, then to the 15th day it increased by 33.7% compared to the first day.

From the above it can be concluded that the sub-variants which have the addition of serum proteins (V1.2, V1.4, V2.2 and V2.4) have lower titration acidity than sub-variants with no added serum proteins, which is consistent to the tests by Chr-Hansen, (2006).

Table 1. Dynamics of the titration acidity of yogurt (°SH)

	1th day		5th day		10th day		15th day	
SH°	$\bar{x} \pm S_{\bar{x}}$	Cv	$\bar{x} \pm S_{\bar{x}}$	Cv	$\bar{x} \pm S_{\bar{x}}$	Cv	$\bar{x} \pm S_{\bar{x}}$	Cv
V 1.1	28,91±1,518	12,867	35,75±0,543	3,725	41,08±2,192	13,072	45,35±2,629	14,202
V 1.2	28,61±2,335	19,989	35,50±1,303	8,994	40,66±1,922	11,578	45,34±2,324	12,556
V 1.3	33,25±0,313	0,228	37,50±1,204	7,864	43,08±1,955	11,116	45,58±2,115	11,364
V 1.4	32,34±0,163	1,236	36,25±1,059	7,807	42,00±2,589	15,102	45,41±2,188	11,805
V 2.1	34,59±1,410	9,985	38,75±2,136	13,501	46,25±2,136	11,312	47,75±2,211	11,342
V 2.2	34,33±1,030	7,349	37,08±0,538	3,557	43,75±1,937	11,049	45,92±2,077	11,082
V 2.3	38,50±1,034	6,581	41,41±0,943	5,58	51,58±3,611	17,148	52,59±3,476	16,193
V 2.4	34,75±0,515	3,634	40,75±0,658	3,955	48,91±2,233	11,185	51,75±3,026	14,326

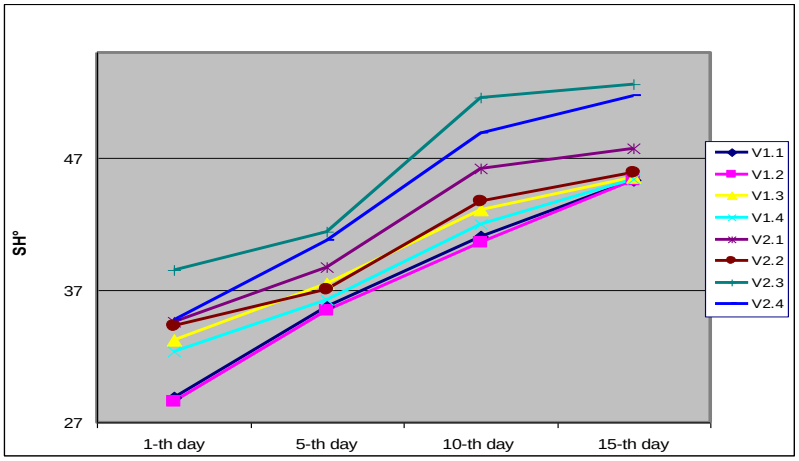


Figure 1. Dynamics of the titration acidity of yogurt

Impact on active acidity of yogurt (pH)

The change of the active acidity (pH) of yogurt, comes as a result of the milk-fermentation process in yogurt. The speed of reduction of the active acidity (pH), depends on the speed of development of the milk-fermentation process in yogurt. The high pH value is a reliable indicator that the yogurt contains more lactose.

In the first day, the lowest pH from V1-sub-variants was established in V1.3-4.54, and by the fifteenth day it amounted to 4.25, i.e. the active acidity was reduced by 0.29 pH units. The highest pH was observed in V1.2 and 4.66 which on the fifteenth day amounted to 4.33, i.e. was reduced a total of 0.33 pH units. Therefore, higher active acidity was stated in sub-variants with the addition of serum proteins.

In V2 variants, the lowest active acidity, the first day was observed in V2.3 and it was 4.34, and by the fifteenth day reached pH to 4.06, i.e. active acidity decreased by 0.28 pH units, while the highest value was V2.2 with 4.54, on the fifteenth day amounted to 4.17, that total was reduced by 0.37 pH units. And in V2-sub-variants supplement serum proteins influenced the higher pH in yoghurt. On the first day of storage yogurt, V2-sub-variants were lower pH compared with V1.

On the 5th day, the lowest pH value was determined in V1.3 and 4.37, and the highest in V1.2 and V1.4 and 4.46. V1-sub-variants with the addition of serum proteins (V1.2 and V1.4) showed higher pH. In V2-sub-variants 5 th day, the lowest value was determined in V2.3, with a pH of 4.18, while the highest value was V2.2, with a pH of 4.33. The added serum protein powder in V2-sub-variant on the fifth day led to higher pH. On the 5th day of storage, V2-sub-variants showed lower pH thanV1-sub-variants. On the 10th day, in V1-sub-variants the pH ranged from 4.30 in V1.3 to 4.39 in V1.2 and in V2-sub-variants, and it was from 4.13 in V2.3 to 4.25 in V2.2. Added serum protein powder stirred pH. On the 15th day, of the V1-sub-variants, the lowest active acidity was found in V1.3 with pH 4,25, and the highest in V1.2 and V1.4 with a pH of 4.33.

From the V2-sub-variants, the lowest active acidity on the 15th day was found in V2.3 with a pH of 4.06, and the highest was established in V2.1 and V2.2 and 4.17 pH units. The addition of serum proteins in the V2-sub-variant on the fifteenth day showed impact and led to higher pH in yogurt. Based on the above mentioned, it can be concluded that all the sub-alternatives of yogurt showed the greatest reduction of the active acidity on the 5th day of storage, which ranged from 3.7 to 5.3%,

then up to the 15th day pH decreases with lower intensity, i.e. from 1.2 to 1.9%. The overall reduction of the active acidity, for a period of 15 days in V1 variants ranged from 6.3% in V1.1 to 7.9% in V1.4 and in V2 from 6.5% in V2.3 to 8 1% in V2.2. It was found that V2-sub-variants with lower pH value of V1. Common to V1 and V2-sub-variants is that the added serum protein powder stirred pH, which is consistent with studies (Chr-Hansen, 2006) and is contrary with cocnclusion of (Cheng et al., 2003; Christopher et al., 2006 and Reddy et al., 2005), who found that the inclusion of serum proteins in yogurt leads to lower pH during storage. V2 sub-variants have lower pH than V1.

Table 2. Dynamics of pH in yoghurt

	1th day		5th day		10th day		15th day	
pH	$\bar{x} \pm S_{\bar{x}}$	Cv	$\bar{x} \pm S_{\bar{x}}$	Cv	$\bar{x} \pm S_{\bar{x}}$	Cv	$\bar{x} \pm S_{\bar{x}}$	Cv
V 1.1	4,58±0,032	1,746	4,41±0,024	1,36	4,34±0,024	1,359	4,29±0,023	1,305
V 1.2	4,66±0,019	1,008	4,46±0,005	0,269	4,39±0,009	0,501	4,33±0,012	0,692
V 1.3	4,54±0,027	1,475	4,37±0,024	1,395	4,30±0,017	0,953	4,25±0,011	0,658
V 1.4	4,56±0,040	2,149	4,46±0,019	1,076	4,34±0,022	1,29	4,33±0,015	0,877
V 2.1	4,53±0,049	2,671	4,29±0,043	2,494	4,24±0,025	1,438	4,17±0,028	1,603
V 2.2	4,54±0,046	2,511	4,33±0,033	1,893	4,25±0,036	2,07	4,17±0,044	2,613
V 2.3	4,34±0,069	3,917	4,18±0,043	2,559	4,13±0,035	2,106	4,06±0,038	2,29
V 2.4	4,45±0,033	1,82	4,27±0,015	0,894	4,21±0,015	0,902	4,13±0,008	0,46

From Figure 2 it can be seen that our conclusion coincides with the research findings by Kailasapathy et al. (1996), who showed that the pH is consistently higher in yogurt which has the addition of serum proteins, and does not coincide with (Cheng et al., 2003; Christopher et al., 2006; Reddy et al., 2005), who found that the inclusion of serum proteins in yogurt leads to lower pH during storage.

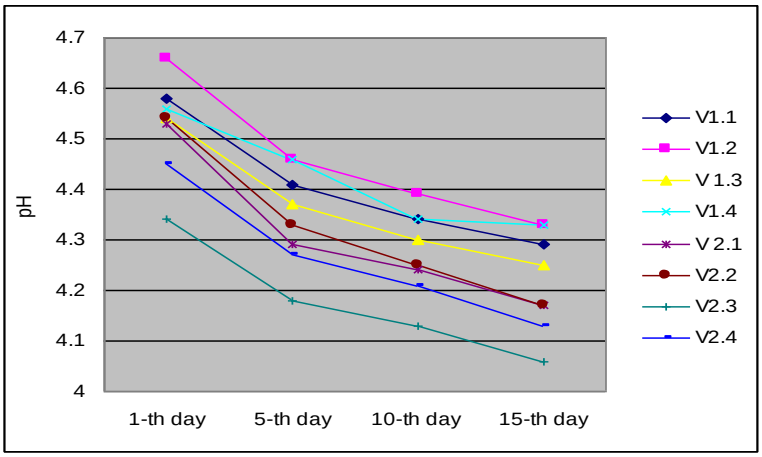


Figure 2. Dynamics of pH yogurt

Impact on lactose in yogurt

Lactose is a disaccharide that is composed of D-glucose and D-galactose. Hydrolysis of lactose depends on the enzyme concentration, temperature, pH and the presence of other ingredients. The presence of galactose is slowing down the action of enzymes, and thus hydrolysis of lactose. When fermentation takes place under the influence of homo-fermenting sour-milk bacteria, lactic acid develops from lactose. On the first day of storage of the yogurt, lactose content ranged from 2.57% in V1.4, V2.3 and V2.4 to 2.85%. in V2.1. It was found that on the first day of the addition of serum proteins, it did not affect the change of the amount of lactose in yogurt. You could say that V2-sub-variants with slightly lower lactose value of V1, which corresponds to the results obtained for the dynamics of acidity. In the fifth day of storage of yogurt, lactose content in V1-variants is reduced by 15.9 to 31.3% and ranged from 2.11% for V1.1 and V1.3 to 2.22% in V1. 2, while the V2 decrease was from 23.5 to 24, 5 and was in the range of 1.93% in V2.4 to 2.16% in V2.1. Appendix serum protein powder 5th day led to a higher content of lactose in yogurt only in V1.1. In addition, in most sub-alternatives of V2, lactose content was lower than V1. In the period from 5 to 10 days the storage continues the transformation of lactose into lactic acid and its reduction from 1.14% in V1.3 and V2.3 to 1.54% in V1.2. Sub-variants with the addition of serum proteins had a higher lactose content. Sub-variants V2 in most cases on the 10th day showed lactose content equal to those of V1. The largest decrease of lactose observed was in the period from the 10th to the 15th day when lactose percentage ranges from 0.17% in V1.3, V2.3 and V2.4 to 0.34% in V1.2. Moreover, the addition of serum proteins did not influence the increase of the content of lactose in V2.2 and V2.4. Sub-variants V2, on 15th day had lower or equal lactose content of sub-variants V1.

Table 3. Dynamics of lactose in yogurt

	1th day		5th day		10th day		15th day	
Lactose	$\bar{x} \pm S_{\bar{x}}$	Cv	$\bar{x} \pm S_{\bar{x}}$	Cv	$\bar{x} \pm S_{\bar{x}}$	Cv	$\bar{x} \pm S_{\bar{x}}$	Cv
V 1.1	2,68±0,035	3,246	2,11±0,096	11,232	1,42±0,094	16,338	0,28±0,036	32,285
V 1.2	2,79±0,035	3,143	2,22±0,639	7,049	1,54±0,124	19,746	0,34±0,002	1,5
V 1.3	2,62±0,035	3,347	2,11±0,037	4,402	1,14±0,035	7,692	0,17±0	0,0
V 1.4	2,57±0	0	2,16±0,073	8,365	1,25±0,094	18,576	0,23±0,037	40
V 2.1	2,85±0,035	3,077	2,16±0,073	8,365	1,42±0,094	16,338	0,28±0,036	32,285
V 2.2	2,68±0,035	3,272	2,05±0,063	7,634	1,48±0,094	15,689	0,23±0,037	40,391
V 2.3	2,57±0,062	5,914	1,94±0,096	12,221	1,14±0,035	7,692	0,17±0	0,0
V 2.4	2,57±0,124	11,832	1,93±0,071	9,093	1,25±0,035	7,016	0,17±0	0

Common to V1 and V2- sub-variants is that the addition of serum protein powder had no constant influence to the lactose content, although most sub-alternatives with the addition of serum protein powder showed a higher content of lactose. Sub-variants V2 in multiple iterations, with lower lactose content of V1- sub-variants while storage period of fifteen days led to a significant reduction of the lactose content. According to the above graph represented in chart 3, it can be concluded that the content of lactose during storage of yogurt steadily declines. Serum protein powder did not have a constant influence in sub-variants that were added (V1.2, V1.4, V2.2 and V2.4).

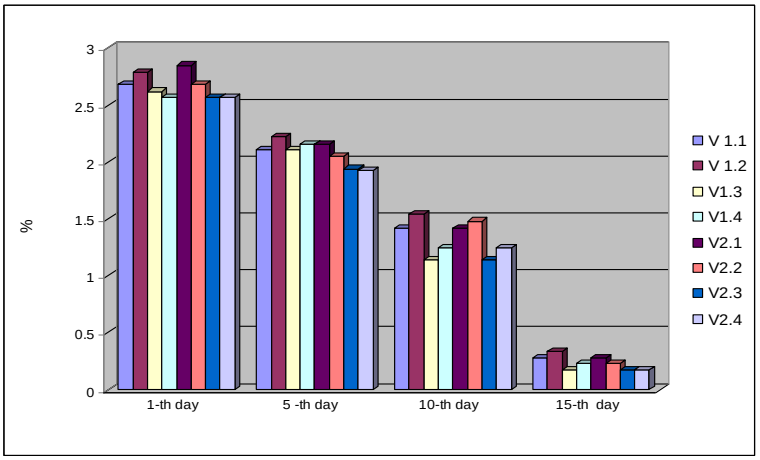


Figure 3. Dynamics of lactose in yogurt

Impact on fat, protein, ash and dry matter in yogurt

From these analyzes it was concluded that in sub-variants in which serum protein powder was added (V1.2, V1.4, V2.2 and V2.4) it was noticed a higher content of fat, protein, which was established research and authors Dave and Shah., (1998), as well as ash and dry matter in yogurt.

Conclusions

Based on the survey results, the following conclusions can be made:

By tracking the dynamics titration acidity, it was determined that it significantly grows from the first towards the 15th day in all the sub-alternatives. Lowest acidity had V1.2 (starting 28,61 °SH and end 45,34 °SH), while the highest values shows V2.3 (starting from 38,50 °SH and ultimate 52,59 °SH). V2 sub-variants had higher titration acidity throughout the storage of yogurt compared to V1 sub-variants, and sub-variants with the addition of serum proteins (V1.2, V1.4, V2.2 and V2.4), had lower titration acidity. It was found that the added serum protein powder has no statistically significant impact.

Active acidity has a declining trend, i.e. during storage it comes to increasing acidity, with biggest declining trend shown by V2 sub-variants as a result of the used starter culture. Lowest initial and final value had V2.3 (4.34 and 4.06). Highest initial value had V1.2 (4.66) and highest final V1.2 and V1.4 (4.33). According to the above we can conclude that the V2-sub-variant shows a lower pH during storage of yogurt, compared with V1 variant. Moreover in sub-variants that have the addition of serum proteins (V1.2, V1.4, V2.2, V2.4), pH has a higher value compared to those sub-alternatives not containing serum proteins. Serum protein powder supplement showed no major impact on statistical significant difference between sub-variants.

Lactose content significantly decreases from the first to the 15th day in all the variants of yogurt. Lowest percentage of lactose on the first day was noticed in V1.4, V2.3 and V2.4 (2.57%), and highest in V2.1 (2.85%), while the on 15th day, the lowest percentage of lactose was determined in V1.3, V2.3 and V2.4 (0.17%), and most lactose was found in V1.2 (0.34%). Added serum protein powder in sub-variants did not influence the change of the content of lactose in yogurt. The addition of serum proteins in yogurt led to a higher content of fat, protein, ash and dry matter in yogurt.

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ВЛИЈАНИЕ НА СЕРУМ ПРОТЕИНИ НА КВАЛИТЕТОТ, ХЕМИСКИТЕ И БИОХЕМИСКИТЕ СВОЈСТАВ НА ЈОГУРТОТ

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Апстракт

Со цел да се определи влијанието на серум протеините врз квалитетот, хемиските и биохемиските својства на јогуртот, во текот на истражувањето, се применети две различни стартер култури YF-L 811 (B1) и YC-381 (B2) и две температури на инокулација и тоа на 35-37°C (B1.1 и B2.1) и 41-43°C (B1.3 и B2.3), со и без додавање на серум протеини во прав (B1.2, B1.4 и B2.2 и B2.4). Како суровина е користено кравјо млеко, пастеризирано на температура од 85°C за време од 30 минути. Лагерувањето траеше 15 дена на температура од 4°C, при што содржината на млечната маст, пепелта, протеините и сувата материја се анализирани на 1-от и 15-от ден, а лактозата, титрацискатa и активната киселост на 1-от, 5-от ден, 10-от, и 15-от ден од лагерувањето на јогуртот. Врз основа на добиените резултати, од анализите е определено дека: Титрацискатa киселост значително расте кај сите подваријанти, при што најниска киселост има B1.2 (од 28,61°SH до 45,34°SH), додека највисоки вредности покажува B2.3 (од 38,50°SH до 52,59°SH). B2 подваријантите, имаат повисока титрациска киселост, за цело време на складирање на јогуртот, во однос B1, а подваријантите со додаток на серум протеини имаат пониска титрациска киселост. Активната киселост има опаѓачки тренд, при што е поголема кај B2 подваријантите, како резултат на употребената стартер култура, а подваријантите, со додаток на серум протеини, имаат повисока pH вредност. Содржината на лактоза значително опаѓа од првиот до 15-от ден кај сите видови на јогурт. Во првиот ден, содржината на лактозата е во граници од 2,57 % (B1.4, B2.3 и B2.4) до 2,85 %, (B2.1), а на 15-от ден од 0,17 % (B1.3, B2.3 и B2.4) до 0,34 % (B1.2). Додатокот на серум протеините не влијае врз промената на содржината на лактозата во јогуртот. Додатокот на серум протеини во јогуртот, доведе до повисока содржина на масти, протеини, пепел и сува материја кај јогуртот.

Клучни зборови: јогурт, температура на ферментација, серум протеини, стартер култури, складирање.

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DETERMINATION OF PHENOLIC COMPOUNDS AND ANTIOXIDANT AND ANTIMICROBIAL POTENTIALS OF SOME SERBIAN RED WINES

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Abstract
Wines contain a number of biologically active compounds and are subject of continual interest due to their beneficial effects on human health. The aim of this study was to determine the concentration of the phenolic compounds and antioxidant and antimicrobial activities of Vranac wines, produced from different Serbian wineries. The phenolic concentration was analyzed by high-performance liquid chromatographic (HPLC) method with photodiode array and fluorescence detection. The antioxidant activity was estimated by using 2,2`-diphenyl-1-picrylhydrazyl (DPPH) assay. Vranac wines were screened *in vitro* for antimicrobial activity using broth microdilution and disc agar diffusion techniques against six gram-positive and six-gram-negative bacterial strains.
Key words: Vranac wines, phenolic compounds, antioxidant activity, antimicrobial activity.

Introduction

The concentration of different phenolic compounds in grapes and their corresponding wines varies according to the morphological and agronomical characteristics of the grapevine cultural and the winemaking technique employed (Ginjon et al., 2011; Lachman et al., 2007; Villano et al., 2006). The wines contain a number of biologically active compounds and are subject of continual interest due to their beneficial effects on human health. Recent studies indicate that consuming small amounts of red wine on a regular basis reduces the risk of coronary heart disease and arteriosclerosis, and this medical quality is connected to the antioxidant properties of polyphenols (Braicu et al., 2011; Cliff et al., 2007; Cushnie et al., 2011; German et al., 2000; Papadopoulou et al., 2005; Pereira et al., 2009; Radovanović et al., 2009; Renaud et al., 1992).

In our earlier studies on Serbian red wines we showed that phenolic contents can be used to identify the biological properties of red wines (Radovanović et al., 2009). The phenolic fingerprint might be a useful tool for the classification of wines quality.

The enhancement of red wine biological properties may therefore have importance in a competitive market environment.

The aim of this study was to evaluate the relationship between phenolic profile and antioxidant and antimicrobial activities of Serbian Vranac wines, produced from Rubin Winery (Kruševac) and Vino Župa Winery (Aleksandrovac).

Material and methods

Chemicals and wines samples

Acetonitrile and formic acid (HPLC-grade) were obtained from Merck (Darmstadt, Germany); HPLC-grade methanol were purchased from Carlo Erba Reagent (Milan, Italy); gallic, caffeic, *p*-coumaric and ferullic acid, catechin, procyanidin B2, epicatechin, quercetin-3-glucoside, rutin, morin, quercetin, naringin, malvidin-3-glucoside and resveratrol were supplied from Sigma Chemical Co. (St. Louis, MO). The used reagents were of analytical quality. Serbian wines selected for this study were: red wine (Vranac1) from Rubin Winery (Kruševac) and red wine (Vranac 2) from Vino Župa Winery (Aleksandrovac), vintage 2009.

Microbial strains and inocula preparation

The antimicrobial activity of the wine samples was evaluated using laboratory control six species of multi-resistant entero bacteria strains obtained from the American Type Culture Collection. All these micro-organisms were gram-positive: *Clostridium perfringens* ATCC 19404, *Bacillus subtillis* ATCC 6633, *Staphylococcies aureus* ATCC 8538, *Listeria inocula* ATCC 13076, *Sarcina lutea* ATCC 9341 and *Micrococcus flavus* ATCC 40240, and gram-negative: *Escherichia coli ATCC 25922, Pseudomonas aeruginosa ATCC 9027, Salmonella enteritidis ATCC 13076, Shigella sonnei ATCC 25931, Klebsiella pneumonia ATCC 10031and Proteus vulgaris ATCC 8427.* The inocula of the bacterial strains were prepared from overnight broth cultures and suspensions were adjusted to 0.5 McFarland standard turbidity (corresponding to 107-108 CFU/ml, depending on genera - consensus standard by the NCCLS). The plate was incubated for 24 h at 37°C. All experiments were performed in triplicate.

High Performance Liquid Chromatography analysis (HPLC)

Phenolic compounds contents were determined by using HPLC, by direct injection of each wine sample into an Agilent 1200 chromatographic system - photodiode array detector (DAD) with radiofrequency identification tracking technology for flow cells and fluorescence detector for multiwavelength detection with online acquisition of excitation (Ex) and emission (Em) spectra, and a Chem-Station software. Elution was carried out in gradient mode using two solvent mixtures: (A) formic acid/water and (B) acetonitrile/formic acid/water. The elution profile was as follows: from 0 to 28 min, 0-10.0% B, from 28 to 35 min, 10-25% B, from 35 to 40 min, 25-50% B, from 40 to 45 min, 50-80% B, and for last 10 min again 0% B. Aliquots of 5 μL were injected into a 4.6×250 mm RPC-18 column (Zorbax Eclipse XDB-C18) with 5 μm particle size. The flow rate was 0.8 mL min^{-1}. The detection wavelengths were 280, 320, 360 nm for UV, and 275/322 nm ($\lambda_{Ex}/\lambda_{Em}$) for fluorescence-detection. Identification and quantification of various phenolic compounds were made by using calibration curves obtained with the standard solutions of pure phenolic compounds in the same conditions as the wine samples. The results are expressed in mg per L of sample (mg L^{-1}).

Antioxidant activity

Antioxidant activity of test wine samples was determined by using modified DPPH free radical scavenging method (Radovanović et al., 2010; Singleton et al., 1965). This antioxidant assay is based on the measurement of DPPH radical colour loss due to the changes in absorbance at 515 nm, caused by the reaction of DPPH radical with the test sample. The radical scavenging activity fifty (EC_{50} values) corresponding to the amount of samples necessary to decrease by 50% the amount of free radical DPPH was determined by plotting the scavenging activity against the sample concentration, and expressed as ml of wine sample per g of the DPPH-radical.

Antimicrobial activity

Disc agar diffusion method

Preliminary antimicrobial tests were carried out by disc diffusion method using 100 μL of bacterial suspension spread on Mueller-Hinton agar (MHA, Torlak, Serbia) in sterilized Petri dishes (90 mm in diameter). The discs (9 mm in diameter, HiMedia Laboratories Pvt. Limited) were impregnated with 50 μL of the test samples and placed on the inoculated agar (20 mL). The inoculated plates were incubated for 24 h at 37 ^{0}C. Reference antibiotics, Chloramphenicol (30 μg) and Streptomycin (30 μg) served as a positive control, while the solvent (water - 50 μL/disc) was used as a negative control. It was found that the solvent (water) showed no inhibitory activity. The diameters of inhibition zones produced by these extracts were then compared to standard antibiotics. All the tests were performed in triplicate. Antibacterial activity was evaluated by measuring the zone of inhibition (in mm) against the test bacterial strains. The values shown are the means from duplicate experiments performed for the six strains per species.

Micro-well dilution method

A broth microdilution method was used to determine the minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) according to the National Committee for Clinical Laboratory Standards (NCCLS, 2003). Two growth controls consisting of medium with water (negative control) and medium with Chloramphenicol and Streptomycin (positive control) were also included. The microbial growth was determined by absorbance at 620 nm using the universal micro plate reader (Thermo Lab systems, Multiskan EX, Software for Multiscan ver.2.6.). MIC was defined as the lowest concentration of wine samples at which microorganisms showed no visible growth. In order to determine MBC, broth was taken from each well without visible growth and inoculated on Mueller Hinton agar (MHA) for 24 h at 37 ^{0}C. The MBC is defined as the lowest concentration of the wine samples at which 99.9% of inoculated microorganisms were killed. The values shown are the means from duplicate experiments performed for the six strains per species.

Statistical analysis

Three analytical replicates were carried out on each sample wine. Measurements were averaged and results are given as mean ± standard deviation.

Results and discussion

Phenolic profile of grape and wine (determined by the relative proportions of the different phenolic compounds) is characteristic for each corresponding grape variety and wine. Moreover, concentrations of different phenolic compounds can vary significantly within grape cultivars according to environmental conditions. In addition, during the process of wine preparation, significant changes take place in the composition and content of phenolic compounds, as a result of fruit disintegration as well as wine fermentation and aging (Cliff et al., 2007; Ginjon et al., 2011; Lachman et al., 2007; Luiz, 2011; Mazza et al., 1999; Villano et al., 2006). Phenolic (gallic acid) and hydroxycinnamate acids (*t*-caftaric acid, *t*-coutaric acid, caffeic acid *p*-coumaric acid and ferullic acid) contents of tested Vranac wines are recorded at 280 and 320 nm. Flavan-3-ol contents: (+)-catechin, procyanidin B2 and (-)-epicatechin contents of tested wines are recorded by a fluorescence detector at 275/322 nm ($\lambda_{Ex}/\lambda_{Em}$).Then, flavonol and flavonol glucoside contents of tested wines: quercetin-3-glucoside, rutin, morin and quercetin are recorded at 360 nm, naringin at 320 nm and the anthocyanin and malvidin-3-glucosideis recorded at 520 nm.

All phenolic compounds, were identified by comparison of their retention times (from chromatograms recorded by fluorescence detection) and UV-VIS spectra with those of standards. The content of phenolic compounds for investigated Vranac wines determined by HPLC analysis are presented in Table 1.

Table 1. Content of phenolic compounds (mg L^{-1}) of tested Vranac wines determined by HPLC analysis

Phenolic compounds	Vranac 1	Vranac 2
Gallic acid	64.33 ± 0.67	47.53 ± 0.34
t-Caftaric acid	23.23 ± 0.97	7.56 ± 0.88
t-Coutaric acid	8.14 ± 0.98	1.83 ± 0.88
Caffeic acid	3.03 ± 0.55	2.95 ± 0.88
p-Coumaric acid	1.66 ± 0.55	1.59 ± 0.39
Ferulic acid	1.66 ± 0.55	1.59 ± 0.39
(+)-Catechin	27.61 ± 0.97	18.35 ± 0.76
Procyanidin B2	13.67 ± 0.47	13.22 ± 0.79
(-)-Epicatechin	12.37 ± 0.67	6.68 ± 1.01
Quercetin-3-gl.	5.36 ± 0.95	2.88 ± 0.57
Rutin	3.13 ± 0.84	0.15 ± 0.06
Morin	2.33 ± 0.92	1.82 ± 0.36
Quercetin	1.47 ± 0.82	1.12 ± 0.73
Naringin	3.05 ± 1.03	2.11 ± 0.46
Resveratrol	0.55 ± 0.02	0.41 ± 0.03
Malvidin-3-gl.	91.35 ± 0.33	53.98 ± 0.42

In these tested Vranac wines gallic acid content was predominant, which is in agreement with published data for a number of other wines (Cliff et al., 2007; Ginjon et al., 2011; Lachman et al., 2007; Luiz, 2011; Mazza et al., 1999; Papadopoloulou et al., 2005). Flavanol accumulation in wines results from enzymatic preparation, yeast fermentation and oxidative polymerization reactions. According to data shown in Table 1, the contents of (+)-catechin and quercetin-3-glucoside, also are predominant in investigated wines, which is in agreement with published data (Ginjon et al., 2011; Luiz, 2011; Radovanovic et al., 2010; Villano et al., 2006).

Table 2. Antimicrobial activity (in mm) and MIC/MBC against gram (-) and gram (+) bacteria of tested Vranac wines and referents antibiotics: streptomycin and tetracycline

Microorganisms	Vranac 1	Vranac 2	Streptomycin	Tetracyclin
Gram (-) bacteria				
Escherichia coli	17.8±0.3 250/250	12.8±0.5 250/250	16.0±0.4 16/16	23.2±0.2 3.8/7.5
Pseudomonas aeruginosa	15.2±0.3 250/250	12.6±0.6 125/125	23.0±0.7 8/8	20.8±0.5 7.5/7.5
Salmonella enteritidis	15.2±1.8 250/250	12.2±0.3 250/250	18.0±0.9 4/4	23.3±0.3 0.9/1.9
Shigella sonnei	16.5±0.9 250/250	13.7±0.6 250/250	19.0±3.0 nt	31.1±0.8 nt
Klebsiella pneumoniae	nt	12.1±0.2 250/250	nt	23.6±0.6 nt
Proteus vulgaris	13.5±1.8 125/125	12.1±0.2 125/125	nt	19.2±0.5 0.12/0.9
Gram (+) bacteria				
Clostridium perfringens	13.7±1.7 125/125	12.1±0.9 125/125	nt	29.0±0.7 0.9/0.9
Bacillus subtillis	15.8±0.1 250/250	13.5±0.5 250/250	nt	23.9±0.9 0.9/0.9
Staphylococcies aureus	17.0±2.1 125/125	14.2±0.7 125/125	nt	18.5±0.3 0.12/0.9
Listeria inocula	16.2±3.2 125/125	11.9±0.6 250/250	nt	20.0±0.2 0.46/0.9
Sarcina lutea	17.0±0.9 250/250	14.5±0.5 125/125	nt	23.6±0.7 0.06/0.06
Micrococcus flavus	17.0±0.8 250/250	12.3±0.6 125/125	nt	Nt 0.46/0.9

Conclusions

The concentrations of some phenolic compounds are very important for understanding biological potency of red wines. The high levels of phenolic compounds in the Vranac 1, produced from Rubin winery contribute to their high antioxidant and antimicrobial activities. The differences between investigated Vranac wines of Zupa vintage region can be ascribed to various winemaking techniques employed by Rubin and Vino Zupa wineries.

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ОПРЕДЕЛУВАЊЕ НА ФЕНОЛНИ СОЕДИНЕНИЈА И АНТИОКСИДАНС И АНТИМИКРОБЕН ПОТЕНЦИЈАЛИ НА НЕКОИ СРПСКИ ЦРВЕНИ ВИНА

Александра Н. Радовановиќ, Бранимир С. Јовановиќ, Блага Ц. Радовановиќ, Татјана Михајилов-Крстев

Апстракт

Винаta содржат бројни биолошки активни супстанци и се предмет на интерес заради нивните позитивни ефекти врз здравјето на луѓето. Целта на овој труд е да се определи концентрацијата на фенолните соединенија, антиоксиданси и антимикробна активност на виното Вранец, произведен од различни Српски винарии. Концентрацијата на феноли е анализирана со метод на високо-ефикасна течна хроматографија (HPLC) со фотодиодна флуоресцентна детекција. Антиоксидацискатa активност е проценета со користење на 2,2`-дифенил-1-пикрилхидразил (DPPH). Антимикробната активност на винаta Вранец кон шест Грам-позитивни и шест Грам-негативни бактерии беше прикажана in vitro со употреба на микродилуционен метод во бујон и диск-дифузионен метод на агар.

Клучни зборови: вина Вранец, фенолни соединенија, антиоксидациска активност, антимикробна активност.

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Original scientific paper

ESTIMATION OF DIETARY INTAKES OF PB, CD AND AS THROUGH CONSUMPTION OF MAJOR FOOD ITEMS OF SERBIAN MARKET BASKET

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Abstract
The aim of this study was to estimate the dietary intakes of three toxic heavy elements through consumption of daily doses of the main food items in the Serbian market basket like bread, meat, milk, vegetables, fruits, etc. The contents of lead (Pb), cadmium (Cd) and arsenic (As) were determined in different food samples by atomic absorption spectrometry with graphite furnace after the acid digestion in microwave unit. Samples were collected from supermarkets in Novi Sad, Serbia. The element intakes were calculated for average adult consumers based on consumption data of Serbian market basket. The relative shares of the estimated intakes of Pb, Cd and As with respect to the relevant provisional tolerable daily intakes were discussed and compared to the available literature data in order to point out the food items from the Serbian market with the highest potential for health risk through the dietary intake.
Key words: toxic elements, GFAAS, dietary intake.

Introduction

The presence of heavy elements in the environment and food chain represents a serious problem, which is recognized in most of the countries around the world. Many aspects related to food safety and quality control have attracted considerable consumer attention in recent years. Thus, it is imperative that the presence of heavy elements in foodstuffs be controlled in accordance with the defined maximum residue levels. The monitoring of the heavy element levels in food samples as well as the estimation of these food contaminants intake are essential for risk evaluation and investigation of possible contamination that would represent a health hazard. A risk of contamination of the food chain may arise when heavy elements accumulate in food at concentrations above the threshold levels believed to threaten the health of humans. A number of serious health problems can develop as a result of excessive uptake of dietary heavy elements.

The World Health Organization (WHO), through its Global Environment Monitoring System—Food Contamination Monitoring and Assessment Programme (GEMS/Food), is encouraging countries to undertake total diet studies as the most cost-effective method for assessing dietary exposure to chemical contaminants in the diet. Representative datasets on consumption of foods are combined with data on concentration in foods of the compounds of interest, to derive the average dietary exposure.

There have been scarce data on the chemical safety status of food products on the Serbian market. In fact, there is no comprehensive study dealing with levels of heavy elements in foodstuffs consumed in Serbia nor the detailed assessment of the dietary exposure of the Serbian population.

Thus, the main focus of this study was on getting data the presence of three toxic heavy elements (lead (Pb), cadmium (Cd), arsenic (As)) in major food items of the Serbian market basket providing more information for risk assessment valuable for both food producers and consumers through estimation of dietary intakes of these elements through consumption of the main food items in the Serbian market basket.

Materials and methods

Instrumentation

For analysis of heavy elements atomic absorption spectrometer with deuterium background correction, equipped with a graphite furnace (GFAAS) for electrothermal atomization (Varian AA240/GTA120, USA) was used. An automatic sampler was employed for injecting of the solution into the furnace. The assembly was operated from an interfaced computer running SpectrAA software.

Chemicals

For heavy element determination, concentrated 69% nitric acid (ccHNO_3) ("trace metals analysis" grade) and 30% hydrogen peroxide (H_2O_2) were both from J.T.Baker. All the plastic and glassware were cleaned by soaking in a 20% hydrochloric solution overnight; then in 20% nitric acid overnight and finally rinsed with Milli-Q water. The As, Cd and Pb stock standard solution (1000 μg/ml) were supplied by J.T.Baker. The working standard solutions of 1 μg/ml for each element were obtained by diluting stock solutions in 3% nitric acid. The calibration curve was prepered using the so-called bulk solution prepared by mixing the standard solutions and the subsequent dilution. Automix option of the GFAAS is applied enabling automatic preparation of the calibration standard. Paladium nitrate was used as modifier during analysis. Ultra-pure deionized water type Milli-Q with a specific resistivity of 18.2 MΩ/cm was used for preparation of the standard and the sample solutions.

Samples

In January, 2012, forty-five selected foodstuffs samples were collected randomly from different supermarkets within Novi Sad, the capitol of the Vojvodina Province, where the biggest producers of food in Serbia are located. Investigated foodstuffs were fruit (apple, prunes), vegatable (potato, onion, mushrooms), bread, cookies, chocolate, candy, oil, margarine, meat, milk, soft cheese and paprika (powder spice) contributing in the largest shares to the average market basket in Serbia. The samples were stored in their original packs at 4°C until analysis was carried out.

Method

Milestone Ethos One microwave with segmented rotor of high pressure (HPR-1000/10S) and internal temperature sensor (Milestone, Italy) was used for digestion of the samples. About 0.5 g of previously homogenised samples were weighted inside high-pressure Teflon (TFM) vessels and 7 ml of ccHNO_3 (69%) and 1 ml of H_2O_2 (30%) were added. The operational conditions and the heating program used were carried out according to the conditions recommended by the manufacturer. After cooling, digests were diluted with Milli-Q water to 25 ml glass flask and finally, transferred to previously acid-cleaned and labelled polypropylene vessel for further analysis. From each kind of food samples three digestions were prepared and analysed using three replicates. A blank digest was carried out in the same way in every batch of digest samples.

Appropriate quality assurance procedures and precautions were carried out to ensure the reliability of the results. Validation data (recoveries were in the range 66-132%; limits of detection (LOD) and

limits of quantification (LOQ) were than the LODs and LOQs required by EC (2007); linearty expressed as the regression coefficients was greater than 0.9950) indicated the suitability of the proposed method for determination of trace concentration of As, Cd and Pb.

Intake calculation

Calculation of the exposure of the Serbian population through consumption of investigated foodstuffs was based on the average daily portion of the selected foodstuffs and the average element concentrations found in this study, corrected for the recovery values.

Following equation was used for estimate the element intake:

$$\text{Estimate of element intake (μg/kg/day)} = \frac{[elements] * [foodstuffs\ consumption]}{[bw]}$$

where [element] is the concentration of element in (mg/kg) detected in foodstuffs adjusted for recovery, [foodstuffs consumption] is the amount of selected foodstuffs (kg) consumed per person per day, and [bw] is the body weight (kg).

The amounts of investigated foodstuffs used for calculation of the intakes were obtained according to the Serbian market basket (Statistical Office of the Republic of Serbia, 2011). The following investigated foodstuffs with average daily consumption figures per person were used (Statistical Office of the Republic of Serbia, 2011): apple (94.0 g), potato (143.0 g), onion (31.0 g), mushroom (5.7 g), oil (30.0 g), margarine (6.0 g), milk (145 ml), soft cheese (33.0 g), meat (102.2 g), bread (293.3 g), cookies (9.3 g), chocolate (2.2 g), candy (2.2 g), prunes (1.1 g), spice pepper (1.7 g). The average body weight (bw) of 70 kg for adults was used for calculating daily intakes per kg bw.

The estimated element intakes (in μg/kg/day) were than compared with the relevant provisional tolerable daily intakes (PTDI, μg/kg/day) set by Food and Agriculture Organization (FAO)/World Health Organization (WHO). The percentages of PTDIs through consumption of investigated foodstuffs were calculated:

$$\%PTDI = [\text{Estimate of foodstuffs intake}]/[PTDI] * 100$$

Results and discussion

Arsenic was detected only in samples of margarine and oil, but in concentrations below the maximum residue level of 0.1 mg/kg set by Serbian regulation. In other food items it was below the limit of detection.

The levels of Pb and Cd in selected foodstuffs are presented in Figure 1.

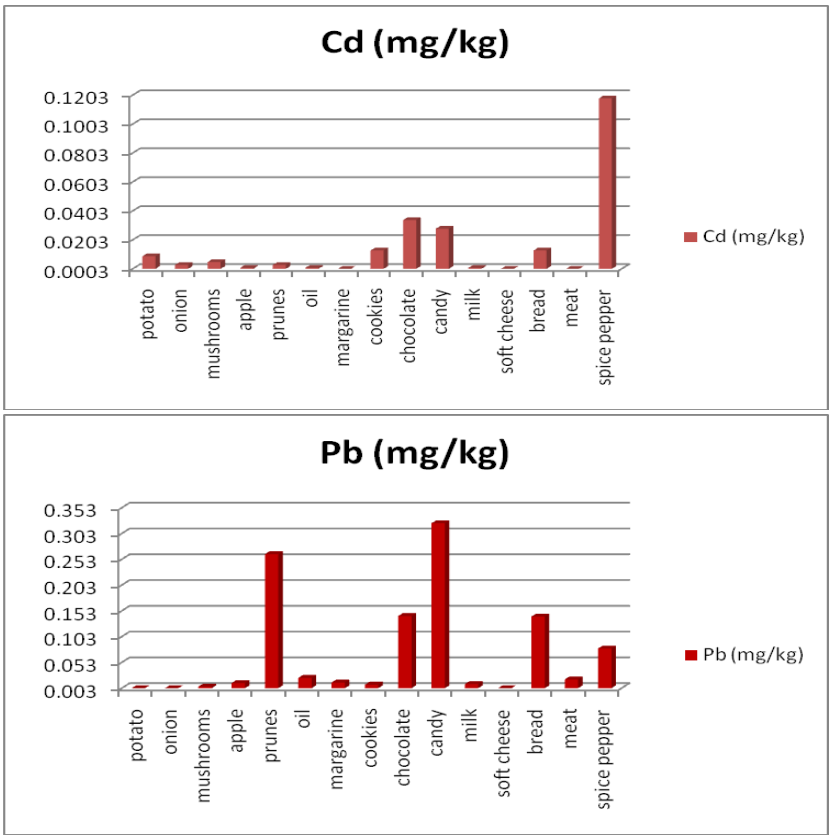


Figure 1. The content of cadmium and lead in different types of foodstuffs from the Serbian market basket (mg/kg).

The highest Cd content could be order as follows: paprika > candy > chocolate > bread > cookies = potatoes, followed by mushrooms, apple, whereas the lowest content was found in oil, milk and apple samples. The Cd levels quantified in analyzed foodstuffs were lower than maximum levels set by EU (EC, 2006) or Serbian regulations (No 28/2011). The Pb concentrations in majority of samples were very low being equal or lower than 0.035 mg/kg, except in the case of samples of bread, chocolate, prunes and candy for which the highest concetrations from 0.150 to 0.389 mg/kg were found. The lead levels in all investigated foodstuffs were found to be lower than maximum levels set by EU (1881/2006) or Serbian regulations (No. 28/11).

Intake of elements from food consumption is dependent element concentrations in food and amount of food consumed. The average levels of As, Cd and Pb were used in the intake calculation, since this methodology is internationally recognized to provide satisfactory estimates of long-term exposure, suitable for comparison with the respective Provisional Tolerable Weekly Intake (PTWI) set by Food and Agriculture Organization (FAO)/World Health Organization (FAO/WHO, 2007), which are also estimates based on long-term exposure. Tables 1 show the estimates of As, Cd and Pb intakes for the general Serbian adults through consumption of selected foodstuffs. The intake of each elements is expressed as a percentage of the PTDI proposed by the FAO/WHO (1988, 1999, 2005) to be 2.1 μg/kg/day for As, 1 μg/kg/day for Cd and 3.6 μg/kg/day for Pb. As can be seen from

Table 1, the intakes of As, Cd and Pb by adults through investigated foodstuffs consumption were generally estimated to be below the respective PTDIs.

Total intake of As through the selected foodstuffs was 11.64% of PTDI, and similar total intakes through the selected foodstuffs were estimated for Cd (9.45% of PTDI). The selected food commodities gave little contribution to As and Cd intake levels, when compared to PTDIs. However, higher total intake was estimated for Pb (22.17% of PTDI). The highest contribution to the total intakes of all three elements gave the bread due to its highest consumption rate. Moreover, in the case of Pb the significantly higher intake through bread was also a consequence of the markedly higher concentration found in this foodstuffs.

Few researchers have made some progress on the determination of heavy elements in different foodstuffs from „national market basket", (SCOOP, 2004; Leblanc *et al*., 2005; Becker *et al*., 2011). However, several factors have an impact on the validity of the intake estimation in different study and their comparison. The most important is different choices of analyzed food groups. Other confounding factors are differences in the sampling strategies, applied analytical methods, number of samples, calculation methodology.

According to the comprehensive SCOOP study, fish and other seafood are the main source of As; fruit, vegetables, cereals, meat and fish are the main sources of Cd; none of the most consumed foodstuffs throughout Member States (MSs) are generally high in Pb, however due to high consumption rates, fruits and vegetables accounted for about 42% of PTDI, and ready-to-eat food for about 20% of PTDI in the diet of the mean adult population.

Hence, comparison of intakes estimated in different studies should be used only approximately and with great caution.

Table 1. Average intakes of toxic elements through consumption of daily portions of the selected foodstuffs and the contribution to the PTDI for adults

Analyte	PTDI[a] (µg/kg/day)[b]	Intake for adults in µg/kg/day (in % of PTDI)															Total intake in µg/kg/day (in % of PTDI)
		potato	mushrooms	onion	apple	prunes	oil	margarine	cookies	chocolate	candy	meat	milk	soft cheese	bread	paprika	
As	2.1	0.041 (1.97)	0.002 (0.08)	0.024 (1.14)	0.02 (0.92)	0.002 (0.01)	0.01 (0.55)	0.004 (0.19)	0.002 (0.11)	0.0005 (0.02)	0.0005 (0.02)	0.021 (1.02)	0.05 (2.32)	0.007 (0.34)	0.06 (2.99)	0.0004 (0.02)	0.244 (11.64)
Cd	1.0	0.02 (1.53)	0.0005 (0.05)	0.0009 (0.09)	0.002 (0.22)	0.00007 (0.007)	0.0005 (0.05)	0.00001 (0.001)	0.002 (0.18)	0.001 (0.10)	0.0009 (0.09)	0.0002 (0.02)	0.002 (0.27)	0.00007 (0.007)	0.062 (6.18)	0.0024 (0.24)	0.0945 (9.45)
Pb	3.6	0.003 (0.08)	0.002 (0.05)	0.0007 (0.02)	0.02 (0.63)	0.005 (0.15)	0.009 (0.25)	0.0014 (0.03)	0.001 (0.04)	0.004 (0.12)	0.009 (0.27)	0.03 (0.87)	0.03 (0.78)	0.0007 (0.02)	0.68 (18.76)	0.003 (0.05)	0.80 (22.17)

[a]Provisional Tolerable Daily Intake (PTDI) has been calculated from Provisional Tolerable Weekly Intake (PTWI) set by Food and Agriculture Organization (FAO)/World Health Organization (WHO).

[b]A body weight (bw) of 70 kg was assumed for adults intake.

Conclusions

It could be concluded that, this is the most comprehensive study presenting the heavy element levels in foodstuffs frequently consumed by Serbian inhabitants. The study highlights the fact that levels of analyzed contaminants in investigated foodstuffs collected from the local markets in Novi Sad were in compliance with the current Serbian and EU legislation. It also emphasizes that there was no concern about intake of the heavy elements through different foodstuffs by adult consumers. Still, regular monitoring is essential, to prevent the excessive build-up in the food chain.

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ПРОЦЕНКА НА ВНЕСОТ НА Pb, Cd и As ПРЕКУ ИСХРАНАТА СО КОНЗУМИРАЊЕ НА ПОВАЖНИ ПРЕХРАНБЕНИ ПРОДУКТИ ОД КОШНИЦАТА НА СРПСКИОТ ПАЗАРОТ

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Апстракт

Целта на оваа студија е да се процени внесот на три токсични тешки елементи преку исхраната со конзумирање на дневни дози од главните прехранбени продукти од српскиот пазар како леб, месо, млеко, зеленчук, овошје, итн. Содржината на олово (Pb), кадмиум (Cd) и арсен (As) се определени во различни примероци од храна со атомска апсорпциска спектрометрија со графитна печка по варење во киселина во микробранова печка. Примероците се собрани од супермаркетите во Нови Сад, Србија. Внесот на елементите е пресметан за просечни возрасни потрошувачи врз основа на податоците за конзумирање од српскиот пазар. Релативното учество на проценетиот внес на Pb, Cd и As во однос на соодветниот привремен толеран дневен внес се дискутирани и споредени со податоците достапни во литературата со цел да се укаже на прехранбените продукти од српскиот пазар што се внесуваат преку исхраната со највисок потенцијален ризик по здравјето.

Клучни зборови: токсични елементи, GFAAS, додатоци во исхраната.

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COMPARATIVE ANALYSIS OF SELECTED TOXIC ELEMENTS IN FOOD SAMPLES FROM SPANISH AND SERBIAN MARKETS

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Abstract
A survey was carried out with the aim to comparatively assess the level of some toxic elements (As, Cd, and Pb) in food commodities collected from the Serbian and Spanish supermarkets. The following items were considered: milk, cheese, liquid yogurt, meat, sweets like cookies, chocolate, walnut, raisins, prunes, etc. The elements were extracted from their matrix by using nitric acid and hydrogen peroxide in a closed-vessel microwave digestion system for their subsequent detection by graphite furnace atomic absorption spectrometry (GFAAS). The method was validated by using a certified reference material and an in-house method. In majority of the samples, arsenic was not detected, while the highest levels of about 0.306-0.323 mg/kg were found for lead in candy samples from both countries. In general, the elements were present in the Serbian products in similar ranges as in the corresponding food items from the Spanish market. The results were compared with the maximum levels set by the European Commission and the Serbian regulation, and they were discussed in a light of the relevant data available in literature.
Key words: toxic elements, GFAAS, Serbian and Spanish food.

Introduction

The presence of heavy elements in the environment and food chain represents a serious problem, which is recognized in most of the countries around the world. Humans have traditionally been exposed to low concentrations of elements mainly via water and foods. In fact, food consumption has been identified as the major pathway of human exposure to toxic elements, compared with other ways of exposure such as inhalation and dermal contact. Arsenic (As), cadmium (Cd) and lead (Pb) are elements with highest toxic potential among those present in foods.

In this sense, there is need to obtain data on toxic heavy element levels in foods and determination of the element concentrations with high accuracy and precision has recently become a national challenge in many countries. Concerning the element occurrence in Serbian food there is scarce data available literature.

Thus, the main aim of the present study was to determine As, Cd and Pb concentration in food commodities collected from the Serbian market, as well as in the same or similar type of foodstuffs from Spain in order to comparatively assess the food safety status in Serbia.

Material and methods

Instrumentation

For analysis of heavy elements atomic absorption spectrometer with deuterium background correction, equipped with a graphite furnace (GFAAS) for electrothermal atomization (Varian AA240/GTA120, USA) was used. An automatic sampler was employed for injecting of the solution into the furnace. The assembly was operated from an interfaced computer running SpectrAA software.

Chemicals

For heavy element determination, concentrated 69 % nitric acid (ccHNO_3) ("trace metals analysis" grade) and 30 % hydrogen peroxide (H_2O_2) were both from J.T.Baker. All plastic and glassware were cleaned by soaking in a 20% hydrochloric solution overnight; then in 20 % nitric acid overnight and finally rinsed with Milli-Q water. The As, Cd and Pb stock standard solution (1000 μg/ml) were supplied by J.T.Baker. The working standard solutions of 1 μg/ml for each element were obtained by diluting stock solutions in 3 % nitric acid. The calibration curve was prepered using the so-called bulk solution prepared by mixing the standard solutions and the subsequent dilution. Automix option of the GFAAS is applied enabling automatic preparation of the calibration standard. Paladium nitrate was used as modifier during analysis. Ultra-pure deionized water type Milli-Q with a specific resistivity of 18.2 MΩ/cm was used for preparation of the standard and the sample solutions.

Samples

In 2012, 15 food items from supermarkets in Novi Sad, Serbia, and 14 food items from Barcelona, Spain were collected. The following food items were investigated: fruit, vegatable, bread, cookies, chocolate, candy, oil, margarine, meat, milk and dairy products, soft cheese and paprika. The samples were stored in their original packs at 4°C until analysis was carried out.

Sample preparation

Milestone Ethos One microwave with segmented rotor of high pressure (HPR-1000/10S) and internal temperature sensor (Milestone, Italy) was used for digestion of the samples. About 0.5 g of previously homogenised samples were weighted inside high-pressure Teflon (TFM) vessels and 7 ml of ccHNO_3 (69 %) and 1 ml of H_2O_2 (30 %) were added. The operational conditions and the heating program used were carried out according to the conditions recommended by the manufacturer. After cooling, digests were diluted with Milli-Q water to 25 ml glass flask and finally, transferred to previously acid-cleaned and labelled polypropylene vessel for further analysis. From each kind of food samples three digestions were prepared and analysed using three replicates. A blank digest was carried out in the same way in every batch of digest samples.

Method validation

Appropriate quality assurance procedures and precautions were carried out to ensure the reliability of the results. Firstly, the developed method was validated by in-house quality control procedure. Parameters taking into account were: instrumental linearity, limit of detection (LOD) and limit of quantification (LOQ), recovery, precision (repeatability as relative standard deviation (RSD) in %). Calibration curves were obtained with aqueous standards of the metals and the elements content were quantified by external calibration procedure except in the case of meat samples, when standard addition methods was applied. The regression coefficients obtained were all greater than 0.9950. The limit of detection (LOD) and limit of quantification (LOQ) were calculated as the mean blank signal plus three or ten times, respectively, its standard deviation. In all cases, LODs and LOQs were lower than LODs and LOQs established by European Union (EC, 2007). Validation of the

analytical method was carried out by determination of element recoveries from spiked samples. Different types of foodstuffs (potato, onion, mushrooms, apple, prunes, oil, margarine, cookies, chocolate, candy, milk etc.) were used for spiking at maxumum residul levels set by EC or Serbian regulation. All of the obtained recovery values were acceptable being in the range 66-132%. The certified reference material (CRM), wheat GBW 10011, was also used to check the bias of the method. The recovery of As, Cd and Pb regarding CRM were as follows: 113%, 100% and 96%, respectivily. Additionally, the accuracy of the method was checked by involvement in proficiency test (PT) for determination of Pb in chilli powder organized by FAPAS in July-August 2012. The recovery obtained in PT test was 80%.Thus, all validation data indicated the suitability of the proposed method for determination of trace concentration of As, Cd and Pb.

Results and discussion

The heavy elements not only affect the nutritive values of food items (i.e. milk, vegetables, fruits) but also have deleterious effect on human beings using food products. The average data on occurrence of As, Cd and Pb analyzed in selected foodstuffs samples collected from Serbian and Spanish supermarket together with maximum allowable concentrations set by the relevant Serbian (No. 28/11) and EC (1881/2006) regulations are given in Table 2. Samples with the element concentration between LOD and LOQ were considered to be positive and their levels were included in the statistical analysis. If element was below LOD in all of the samples, its average value is reported as "<LOD"; otherwise for calculation of the averages, quantities below LOD were considered as LOD/2. Arsenic is considered to be the most toxic to human health, which is the reason why this element was investigated in food items even though the maximum allowable concentration (MAC) has not been established yet by EU regulation. As shown in Table 1, arsenic was detected only in oily products (oil, margarin) from Serbian markets, and only in samples of candy from Spain. Determined level in later item was above the maximum residue level of 0.05 mg/kg set by Serbian regulation (No. 28/11). The results obtained for other food items were below limit of detection.

The highest Cd content of about 0.118 mg/kg was found in Serbian paprika spice and 0.103 mg/kg for Spanish candy, whereas the lowest content was found in apple, oil and milk samples collected from Serbian market. Comparative analysis of the Cd contents in the same type of the products from Serbia and Spain indicated similar levels, except in the case of candy samples (Table 1). Nevertheless all analyzed products were in compliance with EU or Serbian regulations regarding Cd.

Concerning Pb the highest average content was found in candy samples (0.323 mg/kg and 0.306 mg/kg) in Serbian and Spanish product, respectively, whereas the lowest Pb content of 0.005 mg/kg were in Spanish egg crème caramel. Significant differences in Pb levels between the same Serbian and Spanish products were observed for prunes and cookies samples. Nevertheless, levels obtained for Pb in food item from both countries were in line with maximum levels set by EU and Serbian regulations.

The results of the study for As, Cd and Pb have been compared with the European data collected in the scientific opinions of SCOOP 3.2.11 that is the keystone of European Union (EU) risk assessment regarding food and feed safety. Comparison with the relevant data for the same food items from the EU Member States, indicated that similar or lower levels were obtained for the Serbian and Spanish products, except in the case of the As content in Serbian oil samples and the level of Pb in Serbian bread and chocolate (Table 1).

Table 1. The content of arsenic, cadmium and lead in different types of foodstuffs from the Serbian and Spanish supermarket (mg/kg)

Analyte	Type	Average value[a] of Serbian products	Average value[a] of Spanish products	MAC[b], Serbian regulation (No. 28/11)	MAC[b], EU (1881/2006)	EU[c]
As	potato	<0.03		0.3		0.002
	onion	0.04		0.3		
	mushrooms	<0.03		0.3		0.09
	apple	<0.03		0.3		0.006-0.014
	prunes	<0.03	<0.03	0.5		<0.02
	rasines		<0.03	0.5		<0.02
	oil	0.03		0.1		0.003-0.005
	margarine	0.03		0.1		
	cookies	<0.03	<0.03	0.5		<0.1
	chocolate	<0.03	<0.03	0.5		0.0128
	candy	<0.03	0.09	0.05		0.005-0.0018
	milk	<0.03		0.1		<0.005-0.003
	yogurt		<0.03	0.1		
	jell		<0.03	0.1		
	egg creme caramel		<0.03	0.1		
	cream		<0.03	0.1		
	soft cheese	<0.03	<0.03	0.1		0.002-0.021
	bread	<0.03		0.5		0.005
	meat	<0.03	<0.03	0.1		0.003-0.023
	paprika (powder)	<0.03		5.0		
	walnuts		<0.03			
	peanuts		<0.03			
	sanflower seeds		<0.03			
Cd	potato	0.009		0.1	0.05	0.010-0.0686
	onion	0.003		0.1	0.05	0.002-0.1288
	mushrooms	0.005		0.2	0.2	0.016-0.081
	apple	0.001		0.05	0.05	0.0029-0.2025
	prunes	0.003	<0.0003	0.3		0.01
	rasines		<0.0003	0.3		0.01
	oil	0.001		-	-	0.006
	margarine	<0.0003		-		
	cookies	0.013	0.012	0.05	0.1	
	chocolate	0.034	0.034	0.2		
	candy	0.028	0.103	-		
	milk	0.001		0.01	-	0.0002-0.006
	yogurt		<0.0003	0.02		
	jell		<0.0003			
	egg creme caramel		<0.0003			
	cream		<0.0003			
	soft cheese	<0.0003	0.0003	0.1		0.003-0.034
	bread	0.013		0.05		0.0284-0.04
	meat	<0.0003	0.0042	0.05	0.05	0.001-0.051
	paprika (powder)	0.118				

	walnuts		0.003			0.198
	peanuts		0.069			0.198
	sanflower seeds		0.146			0.198
Pb	potato	<0.003		0.1	0.1	0.001-0.34
	onion	<0.003		0.1	0.1	
	mushrooms	0.006		0.3	0.3	0.016-0.026
	apple	0.013		0.1	0.1	0.029-0.64[d]
	prunes	0.263	0.065	3.0		0.61
	rasines		0.069	3.0		0.61
	oil	0.023		0.1	0.1	0.005-0.089
	margarine	0.014		0.1		
	cookies	0.010	0.097	0.4	0.2	
	chocolate	0.143	0.055	1.0		0.031
	candy	0.323	0.306	0.5		
	milk	0.011		0.02	0.02	0.004-0.05
	yogurt		0.039	0.4		
	jell		<0.003	0.4		
	egg creme caramel		0.005	0.4		
	cream		0.009	0.4		
	soft cheese	<0.003	0.008	1.0		0.031-0.058
	bread	0.142		0.40		<0.040-0.025
	meat	0.02	0.065	0.1	0.1	0.01-0.77
	paprika (powder)	0.08		-		
	walnuts		0.181			0.120
	peanuts		0.012			0.120
	sanflower seeds		0.068			0.120

[a]If the element content was below LOD in all the samples, its average value is reported as „<LOD“;otherwise for calculation of averages, quantities below LOD were considered as LOD/2.[b]Maximum allowable concentration; [c]Concentration range of mean levels of heavy elements in particular food item from different Member States; [d]fruits.

Conclusions

This study provides information on elements such as As, Cd and Pb, in food items collected from Serbian and Spanish markets. To the best of our knowledge, this is first time that food items from Serbian and Spanish markets were studied and compared. Generally, the results suggested that analysed food items are complied with current Serbian and EU legislation and that majority of samples contained similar levels of these three toxic elements.

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КОМПАРАТИВНА АНАЛИЗА НА ИЗБРАНИ ТОКСИЧНИ ЕЛЕМЕНТИ ВО ПРИМЕРОЦИ ОД ХРАНА ОД ШПАНСКИТЕ И СРПСКИТЕ ПАЗАРИ

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Апстракт

Истражувањето е спроведено со цел да се направи споредбена проценка на количеството на некои токсични елементи (As, Cd, и Pb) во прехранбени производи земени од српските и шпанските супермаркети. За таа цел се земени следниве продукти: млеко, сирење, течен јогурт, месо, слатки како колачиња, чоколадо, ореви, суво грозје, сливи, итн. Елементите се екстрахирани од нивната матрица со помош на азотна киселина и водород пероксид во затворен систем со микробраново печка, а потоа последователно се определени со помош на атомска апсорпциска спектрометрија со графитна печка (GFAAS). Методот за анализа е разработен и валидиран со користење на сертифициран референтен материјал. Во поголемиот дел од примероците не е детектиран арсен, додека највисоки концентрации од околу 0,306-0,323 mg/kg, се пронајдени за олово во примероци од бонбони од двете земји. Во производите со српско потекло, испитуваните елементи беа присутни во слични граници како и во соодветните прехранбени продукти од шпанскиот пазар. Резултатите се споредени со максималните количества утврдени од страна на Европската комисија и српската регулатива, а се дискутирани во согласност со релевантните податоци достапни во литературата.

Клучни зборови: токсични елементи, GFAAS, српска и шпанска храна.

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THE MICROBIOLOGICAL QUALITY DURING YOGHURT STORAGE

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Abstract
The aim of the research was to determine the microbiological characteristics of yogurt from three leading Macedonian milk-processing facilities supplied by retail centers, as changes that occur during storage of 20 days. Finished packaged products were stored at 4 and 8°C during 20 days, and analyzed on 1st, 10th, and 20th day. However, in three iterations the following parameters were analyzed: total number of bacteria and lactic acid bacteria, and then the presence of yeasts and pathogens. With the microbiological tests, the best quality on the first day was set in brand 1. Namely in this variant on the first day it didn't establish the presence of total number of bacteria, nor pathogens. After 20 days of storage at 4°C, the greatest changes in microbiological quality brand showed in brand 3 (V3) where it was determined constant large number of yeasts from 5 x 10^4 to 7.3 x 10^4 CFU/ml and total bacteria, followed by brand 2 (V2) where yeasts were in the range between 4,3 x 10^3 and 5,3 x 10^4 CFU/ml. Slightly smaller number of yeasts was determined in Brand 1 (V1) (2,5 x 10^2 2,5 x10^3 CF /ml,). All three variants showed an increased number of total bacteria. The products storage at 8°C had poorer microbiological quality. Yogurt which was the subject of analysis did not satisfy the requirements in terms of number of yeasts, with the exception of brand 1 (V1), and on the first day, which partially fulfilled the requirements.
Keywords: yogurt, quality, temperature, storage.

Introduction

Fermented dairy products are traditional products in Macedonia, present in milk-processing facilities, markets and our table and yogurt is one of the most consumed dairy products. Yoghurt implies to a product which is obtained by fermentation of pasteurized milk with appropriate lactic acid starter cultures. The technology is adjusted according to the traditional sour milk which as a fermented dairy product derives from these areas and in the sales is like liquid yogurt and yogurt. The quality and safety of yogurt can be defined with a large a number of criteria which include: microbiological, chemical, physical and nutritional characteristics. As a result of all this, the quality and safety can be determined by a number of tests of different degrees of objectivity, but all are aiming to determine that the product is:

- Safe for human consumption (especially in terms of microbiological and chemical pollution);
- In accordance with all legal requirements;
- Able to achieve the assigned shelf life without being spoiled;
- With high sensory standards.

Storage of the yogurt at temperatures lower than 10°C and maintaining these temperatures until the sale of the product, allows slowing down the microbiological and biochemical reactions that are

occurring in yogurt. Negative changes that may occur in the yogurt are as a result of non-compliance with the prescribed measures and rules for storage of the yogurt.

Material and methods

Studies were conducted on samples of yoghurt placed on the mark packed in carton boxes of 1litre, immediately after production. The survey included three yoghurts produced by different manufacturers (Brand 1, Brand 2 and Brand 3) that were stored for a period from 20 days at a temperature of 4°C (Brand 1-4, Brand 2-4 and Brand 3-4) and 8°C (Brand 1-8, Brand 2-8 and Brand 3-8). Microbiological tests were carried out in three repetitions. The samples were examined and analyzed in the Institute of Public Health - Bitola.

Microbiological methods were investigated by the following methods:

- Total Bacteria Count TBC - (MPA-agar) cultured 7 days at 28°C.
- Total *Coliform* bacteria – (ENDO-agar), detection of *Salmonella* appeared red colonies, while the detection of *Escherichia coli* appeared green colonies. The planted pad was incubated for 24-48 hours at a temperature of 35-37°C.
- Total number of *Lactic Acid Bacteria* - LAB. - MRS-agar under anaerobic conditions at a temperature of 37°C for a period of 24-48 hours.
- Total number of yeasts -SABURO- incubated 24-48 hours at a temperature of 37°C.

Results and discussion

In Table 1 are presents results for microbiological characteristics of yogurt from three leading Macedonian milk-processing facilities supplied by retail centers. All samples at the first day showed microbiological parameters in agreement with official standards regarding number of LAB and these entire presenting LAB counts higher than 10^7CFU/ml (Table 1). This is in correlation with Macedonian standards (Official gazette 96/2011) and Codex standard (CODEX STAN 243-2003).

According the results, pathogenic bacteria was not defined in the variants yogurts present on markets, except *E. coli* in Brand 2 and Brand 3 (from 5 to 80 CFU/ml in Brand 2 and from 18 to 40 CFU/ml in Brand 3). Coliforms detection or enumerating are often used as parameters for evaluating the yoghurt quality in different countries (Con et al., 1996; Nogueira et al., 1998; Tamine and Robinson, 2007). The obtained results are similar when compared to other studies in Lebanon (Al-Kadamany et al., 2003), and Portugal (Nogueira et al., 1998). However, there have been instances where much higher counts of coliform group were found in yoghurt samples, with frequency varying from 35 to 80% (Con et al., 1996). While, Massa (1996) did not noticed the presence of *Salmonella* in yogurt, but Rodrigues (2010) found *Coliform* bacteria with levels higher than 0.3 MPN/g in yogurt placed on Brazil's markets. Varga et al. (2007) in samples of yogurt did not noticed the presence of *Salmonlla* and *S. aureus*., and Okpalugo et al (2008) investigated dairy products on Nigeria market noticed the presence of *Coliform* bacteria as follows: *Enterococcus* spp. 4.2×10^3 and *E.coli* 1.2×10^2. According the results, yeasts were present at first day in all variants in range of $2x10^6$ to $2x10^7$CFU/ml.

During storage on different temperatures 4°C and 8°C, total number of bacteria in all brands gradually increased. Based on the results presented in Table 2 it can be concluded that the total number of bacteria in Brand 1 increased on the 10th day. Namely the 20th day the total number of microorganisms has increased $2x10^7$ CFU/ml. While in Brand 2 and Brand 3 total number of microorganisms is greater than Brand 2. Namely the 20th day the total number of microorganisms has increased from $2x10^6$ CFU/ml up to $2x10^7$ CFU/ml. (Brand 2), whereas in the Brand 3 total

number of bacteria is greatest and ranges $1x10^6$ CFU/ml. up to $8x10^7$ CFU/ml. Higher storage temperature increased total number of bacteria and it ranges from $2x10^6$ up to $2x10^7$ CFU/ml. (Brand 1), $2x10^7$ CFU/ml. (Brand 2) and $8x10^6$ up to $8x10^7$ CFU/ml. (Brand 3).

Table 1. Microbiological quality of different Brands of yogurt on Macedonian markets

Bacteria CFU/ml	Brand 1			Brand 2			Brand 3		
	Batch 1	Batch 2	Batch 3	Batch 1	Batch 2	Batch 3	Batch 1	Batch 2	Batch 3
TBC*[1]	$4x10^6$	$2x10^6$	$5x10^6$	$6x10^6$	$2x10^7$	$2x10^7$	$6x10^5$	$2x10^6$	$3x10^6$
LAB*[2]	$1x10^8$	$1x10^8$	$1x10^8$	$2x10^7$	$7x10^9$	$3x10^9$	$3x10^9$	$3x10^9$	$5x10^9$
Yeasts	$2x10^3$	$2x10^3$	$2x10^3$	$5x10^4$	$4x10^4$	$5x10^4$	$7x10^4$	$5x10^4$	$5x10^4$
E.coli	nd	nd	nd	5	80	20	18	40	20
Salmonella	nd	nd	nd	nd	nd	nd	nd	nd	nd
Shigela	nd	nd	nd	nd	nd	nd	nd	nd	nd
Staphylococcus	nd	nd	nd	nd	nd	nd	nd	nd	nd
S.piogenus	nd	nd	nd	nd	nd	nd	nd	nd	nd

*[1]TBC - Total Bacteria Count *[2] LAB – Lactic Acid Bacteria

All samples at the first day showed LAB counts higher than 10^7 CFU/ml. During storage period of 20 days LAB count decreased due to the accumulation of ambient lactic acid. Different temperature storage of yogurt no major changes in the total number of lactic acid bacteria. Their number varied in the interval from $5x10^7$up to $5x10^9$ CFU/ml. (Brand 1), $1x10^8$ up to $7x10^9$ CFU/ml. (Brand 3) and $3x10^9$ up to $7x10^9$ CFU/ml.

The yoghurt shelf-life can also interfere in the quality of this product. Associated to this, when yoghurt is kept in inappropriate conditions the LAB from starter cultures tends to increase their development provoking high acidity. and consequently the killing of themselves (Tamine and Robinson, 2007).

Table 2. Microbiological changes during Brand 1 yogurt storage at temperature of 4°C and 8°C for the period of 10 and 20 days

Bacteria CFU/ml	Brand 1											
	Batch 1				Batch 2				Batch 3			
	4°C		8°C		4°C		8°C		4°C		8°C	
	10 days	20 days	10 days	20 days	10 days	20 days	10 days	20 days	10 days	20 days	10 days	20 days
TBC	nd	$4x10^6$	$3x10^4$	$2x10^6$	Nd	$2x10^6$	$2x10^3$	$2x10^7$	nd	$5x10^6$	$2x10^3$	$2x10^6$
LAB	$1x10^8$	$1x10^8$	$5x10^7$	$1x10^8$	$1x10^8$	$1x10^8$	$3x10^9$	$1x10^8$	$1x10^8$	$1x10^8$	$5x10^9$	$1x10^8$
Yeasts	610	$2x10^3$	950	$2x10^3$	500	$2x10^3$	710	$2x10^3$	500	$2x10^3$	900	$2x10^4$

In the research of Rotar et al (2007) the lactic acid bacteria at the beginning of storage are moved in the range of 3.07 - 7.8 x 10^7, in the middle of expiration date of 1.5 - 7.5 x 10^6 and at the deadline of the durability of the yogurt from 3.9 x 10^3 to 2.6 x 10^4. The research of Rodrigues et al. (2009) the number of lactic acid bacteria was traveling at an interval of 5.81 - 9.67 x 10^8, while the number of lactic acid bacteria according to Michaela et al. (2007) was 1.5 - 7.8 x 10^7. Certain deviations were

defined, due to differences in the quality of the raw material and different technological line for the production of yogurt.

Table 3. Microbiological changes during Brand 2 yogurt storage at temperature of 4°C and 8°C for the period of 10 and 20 days

Bacteria CFU/ml	Brand 2											
	Batch 1				Batch 2				Batch 3			
	4°C		8°C		4°C		8°C		4°C		8°C	
	10 days	20 days	10 days	20 days	10 days	20 days	10 days	20 days	10 days	20 days	10 days	20 days
TBC	$1x10^6$	$2x10^6$	$9x10^6$	$2x10^7$	$2x10^6$	$6x10^6$	$2x10^6$	$2x10^7$	$1x10^6$	$2x10^7$	$7x10^6$	$2x10^7$
LAB	$4x10^9$	$3x10^9$	$6x10^9$	$1x10^9$	$3x10^9$	$7x10^9$	$4x10^9$	$7x10^9$	$3x10^6$	$3x10^6$	$5x10^9$	$1x10^8$
Yeasts	$1x10^4$	$5x10^4$	$4x10^4$	$5x10^4$	$2x10^4$	$4x10^4$	$1x10^4$	$8x10^4$	$1x10^4$	$5x10^4$	$5x10^4$	$9x10^4$

Yeasts as natural contaminant of yoghurt at the first day was in between $2x10^3$ in Brand 1 to $7x10^4$ in Brand 3. The total number of yeast in all variants gradually increased during the storage of 20 days but higher storage temperature significantly influence on increasing number. The highest total number of yeast were defined in Brand 3 ($7x10^4$), while Brand 1 ($2x10^3$) has the lowest number of yeasts in relation to the other two Brands.

Despite such arduous fencing, contamination owing to yeast is still one of the major limiting factors for shelf life and commercial value of yoghurt (Canganella *et al*., 1998). For instance under good manufacturing practices (GMP), the final product should contain not more than one yeast CFU/g at the time of production (Suriyarachchi & Fleet, 1981) in contrast to this, other studies extended this limit to less than or equal to 50 CFU (Li & Li, 1998). Different surveys of retail marketed yoghurt revealed that samples could exhibit counts more than 10^5 CFU (Rohm *et al*., 1990; AL-Tahiri, 2005).

Table 4. Microbiological changes during Brand 3 yogurt storage at temperature of 4°C and 8°C for the period of 10 and 20 days

CFU/ml	Brand 3											
	Batch 1				Batch 2				Batch 3			
	4°C		8°C		4°C		8°C		4°C		8°C	
	10 days	20 days	10 days	20 days	10 days	20 days	10 days	20 days	10 days	20 days	10 days	20 days
TBC	$1x10^6$	$6x10^5$	$3x10^6$	$8x10^7$	$1x10^7$	$2x10^6$	$2x10^6$	$8x10^6$	$2x10^6$	$3x10^6$	$3x10^6$	$8x10^7$
LAB	$8x10^8$	$3x10^9$	$1x10^8$	$1x10^9$	$4x10^8$	$7x10^9$	$1x10^8$	$1x10^9$	$4x10^8$	$5x10^9$	$1x10^8$	$1x10^9$
Yeasts	$1x10^5$	$7x10^5$	$4x10^3$	$1x10^4$	$1x10^4$	$5x10^4$	$6x10^3$	$6x10^3$	$1x10^4$	$5x10^4$	$6x10^3$	$8x10^3$

The spoilage of yogurts by yeasts is generally recognized by the development of yeasty offflavors, loss of texture quality due to gas production, and the swelling and eventual blowing off of the product container (Davis, 1974., Kroger, 1976.). When produced by "good manufacturing practice," yogurts should contain no greater than 1 yeast cell per g and, if correctly stored under refrigeration (5^oC), a product shelf life of 3 to 4 weeks may be expected (Davis, 1974). However, examination of yogurts randomly purchased at the Macedonian markets showed high number of yeasts which is partly in correlation with yogurts in United Kingdom and Canada where 25 to 30% of the samples

contain greater than 10^3 yeast cells per g. Some samples exhibited yeast counts as high as 10^5 cells per g (Kroger, 1976). The mean population of yeast varies from 4.5 x 10^1 CFU to 2.5 x 10^7 CFU having an average of 1.5 x 10^6 CFU were determinate in yoghurt sold in different localities of Karachi city (Khan, 2008). The averages of bacterial and yeast counts were significantly lower in contrast to the ranges reported by Zekai &Erdoğan (2003) but are comparable to the counts observed by Viljoen *et al*., (2003) and Rohm (1990). In contrast, AL-Tahiri (2005) observed 10^5 yeast CFU in locally marketed retail yoghurt which is in agreement with our observations. With good manufacturing practice, it is possible to obtain yogurts with a yeast count of less than 1 cell per g at the time of packaging. With proper refrigerated\ storage of the product, the yeast count should not exceed 10 cells per g after 3 to 7 days (Davis 1974). The yogurts examined in this study were all studied within 20 days of the date of manufacture, and none variant showed yeast counts less than 10 cells per g. which suggested an unsatisfactory degree of contamination during production. Moreover, inadequate refrigeration after packaging and during marketing probably encouraged yeast growth and accounted for those samples with yeast counts in the range of 10^4 to CFU/ml. This extent and level of yeast contamination are somewhat higher than those reported for yogurts in the United Kingdom (Kroger, 1976) and Canada (Arnott, et all.1974).

Conclusions

Based on the survey results obtained of yogurts placed on Macedonian market can be concluded following :

- All Brands at the first day showed microbiological parameters in agreement with official standards regarding number of LAB and all of these presenting LAB counts higher than 10^7 CFU/ml. During storage period of 20 days LAB count decreased due to the accumulation of ambient lactic acid.
- Total number of bacteria was not observed in Brand 1-4 in comparison with other variants, probably as a result of better quality raw milk. While the 10th and the 20th day of storage the total number of bacteria successively increased but with less dynamics in Brand 1 with respect to Brand 2 and Brand 3.
- Yeasts as natural contaminant of yoghurt at the first day was in between 500 in Brand 1 to $4x10^3$ in Brand 3. The total number of yeast in all variants gradually increased during the storage of 20 days, but higher storage temperature significantly influence on increasing number. The highest total number of yeast were defined in Brand 3 ($7x10^5$), while Brand 1 ($2x10^3$) has the lowest number of yeasts in relation to the other two Brands.
- *E. coli* were not present in Brand 1 but in Brand 2, and it was in range from 0 to 80 CFU/ml and in Brand from 3 to 100 GFU/ml.
- Recommended storage of the yogurt is at 4°C, and in exceptional cases up to 8°C.

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МИКРОБИОЛОШКИ КВАЛИТЕТ НА ЈОГУРТОТ ВО ТЕКОТ НА СКЛАДИРАЊЕТО

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Апстракт

Целта на истражувањето беше да се утврдат микробиолошките карактеристики на јогуртот од три водечки македонски млеко-преработувачки капацитети набавени од малопродажните центри, како промени кои настануваат во текот на складирањето од 20 дена. Готовите пакувани производи беа складирани на 4 и 8°C во текот на 20 дена, а анализите беа спроведувани на 1-от, 10-от, и 20-от ден. При тоа во три повторувања се анализирани следните параметри: вкупниот број на бактерии и млечно-кисели бактерии, а потоа присуството на квасци и патогени микроорганизми. Со микробиолошките испитувања најдобар квалитет на првиот ден беше утврден кај брендот 1. Имено кај оваа варијанта во првиот ден не беше утврдено присуство на вкупен број бактерии, ниту патогени микроорганизми. После 20 дена лагерување на 4°C, најголеми промени покажа бренд 3 (B3) каде беше утврдено константен голем број на габи од $5x10^4$ до $7,3x10^4$ CFU/ml и вкупни бактерии, потоа следи бренд 2 (B2) каде габите беа во границите од $4,3x10^3$ до $5,3x10^4$ CFU/ml. Нешто помал бројот на габи беше утврден кај Бренд 1 (B1) ($2,5x10^2$ до $2,5x10^3$ CFU/ml). Сите три варијантии покажаа зголемен број на вкупни бактерии. Производите лагерувани на 8°C имаа полош микробиолошки квалитет. Јогурт кој беше предмет на анализа не ги задоволи барањата во однос на бројот на квасци, со исклучок на брендот 1 (V1), и во првиот ден, кој делумно ги исполни барањата.

Клучни зборови: јогурт, квалитет, температура, чување.

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APPLICATION LEGALITY OF CODEX ALIMENTARIUS IN SERBIA

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Abstract
The paper deals with proving the illegality of introduction of Codex Alimentarius and from it developed HACCP system into the legislation of Republic of Serbia. In this paper, comparing methods of comparison of legal norms with Codex guidelines were used, which are in contradiction with the Constitution of the RS, Rotterdam and Stockholm Convention, several applicable laws, while products labeled with Codex Alimentarius and from it derived HACCP standard which is inconsistent with applicable law, illegally appear on Serbian market.
Key words: Codex Alimentarius, HACCP, healthy food, chemicals, legitimacy of law.

Introduction

Codex Alimentarius (http://www.codexalimentarius.org) is specialized international food organization which was founded in 1961 by UN Food and Agriculture Organization (UN FAO) and World Health Organization (WHO). The main objective with adopting similar standards and related documents (guidelines, codes of good practice, references, etc...) was to protect the health of consumers and ensure fair practices in food trade. The consequences of these provisions are breaking the current control standard in the area of food production in the world market; the quality and safety of food have been imperiled.

In the beginning of 2008, Institute for Standardization of Serbia, through which the cooperation of Serbia with the Codex Alimentarius Commission is performed, held the initial meeting for the establishment of a National Codex Committee. This committee aims to improve the country's participation in Codex overall activities. Ministry of Agriculture, Forestry and Water Management has developed in late 2010 The Draft Regulation on the establishment of the National Codex Committee of Serbia. As a draft, it was submitted for a review to all interested institutions and organizations in the country. Under current regulations in Serbia, there is no obligation of marking, because the law prohibited the use of GM seeds and foods containing GMOs or produced from GMOs. In the law of the Republic of Serbia (according to European legislation) the presence of GMOs in different products up to 0.9 percent is considered as unintended contamination, and so these products are considered unmodified in case of modifications that are allowed in Europe.

Serbia is a signatory to the Rotterdam (The Law on Ratification of the Rotterdam Convention, "Official Gazette of the Republic of Serbia - International Treaties" No. 38/2009) and Stockholm (Law on the Ratification of the Stockholm Convention, "Official Gazette of the Republic of Serbia - International Treaties", 1998) Convention. The Rotterdam Convention is an appropriate basis for establishing a system of chemicals management, as well as for the process of giving approval according to the prior information procedure for certain hazardous chemicals and pesticides in

international trade. The Stockholm Convention aims to protect health of people and the environment from persistent organic pollutants. Serbia, as a signatory, would have to abide to these conventions by its regulations in order to protect human health and the environment from potential harm and to contribute to the use of chemicals in a way that is environmentally sustainable, facilitating information exchange about their characteristics, taking care of the decision making process at the national level on import and export and by disseminating these decisions to Parties. (http://www.upravacarina.rs)

According to our comparative study we can conclude that the Codex Alimentarius Commission is contrary to these international conventions that have more power than national legislation, the Constitution of the RS, and laws in force in the Republic of Serbia. Therefore, the HACCP standard (Hazard Analysis Critical Control Points), derived from the provisions of the Codex Alimentarius, which in Serbia came into force on 11 June 2011, has no legal basis in domestic legislation. (Food Safety Law, "Official Gazette of the Republic of Serbia", No. 41/09).

What is actually the Codex Alimentarius?

With the set of rules for regulation of agriculture and food control from seed to final product, Codex Alimentarius Commission imposed new standards that are inconsistent with the Rotterdam and Stockholm conventions, the RS Constitution and domestic laws and that break all previous control standards in the production of food, additives and other food supplements.

The aforementioned Codex provides:

- mandatory provisions on the use of synthetic (recombinant) bovine growth hormone and antibiotics in all kinds of animals whose meat is intended for human consumption, so that all animals raised for food or milk will have to obtain Monsanto growth hormone and Monsanto antibiotics;
- the use of genetically modified seeds that are prohibited by law in Serbia (Law on Genetically Modified Organisms, "Official Gazette of RS" No. 41/2009 from 29th of May 2009);
- all kinds of food products must be radiated in order to last longer;
-the label of eco-products is not required to specify the ingredients of non-organic origin.
- vitamins, herbs (teas), useful minerals are prohibited in retail;
- more than 300 different additives (mostly synthetic) have been approved as safe; - from 12 banned herbicides as the most dangerous chemicals for the protection of agricultural products, Codex Alimentarius brings back seven substances on the allowed list, including DDT which is in our country (SFRY) prohibited from 1 January 1972.

The research results on the emersion of GM soy and corn, prohibited by law and allowed by the Codex Alimentarius

According to the data from the Customs Administration (http://www.upravacarina.rs) GM soybeans were first discovered on our fields in year 1998. In the year 2001, Ivana Dulić Marković, Minister of Agriculture, Forestry and Water Management RS has allowed the import of soybean meal from GM soybean. After that, in the year 2001, the agricultural inspection revealed in the area Čenej, near Novi Sad, seven hectares of "mutated" crops. It is a so-called "Roundup" soybean, resistant to total herbicide "Roundup". As previously stated, the GM soybean seeds were purchased at Novi Sad Najlon market and the market in Sremska Mitrovica, and were sold under a false name, as domestic sort "ravnica".

Otherwise, GM soybeans are found each year in our fields. During 2006, about 11 tons of genetically modified soy illegally entered the country. Owing to the inspection, the soy was seized before sowing. But, in spite of strict controls, in the year of 2005, genetically modified soy was

discovered in Mačva on 370 hectares of 270 manufacturers, and in Surčin area - on 55 hectares. The measure was to take that soy and under strict control take it to be processed to soybean meal, in order for that seed not to be found next year in the crops. The total of 7,800 tons of GM soybeans was retrieved from peasants at that time, about 2,500 tons of which in the area of Vojvodina. In 2008, the parcels with modified soybeans were discovered in Mačva, about 40 hectares, in the municipalities Šabac and Bogatić and in the area of Srem, about 30 hectares. In the year 2006, about 8,400 kilograms of GM soybeans were destroyed in a power plant "Nikola Tesla A", that were seized by the inspection in Mačva and Srem. The soy was kept for the new sowing and if it had been completed, with 82 hectares we would get new 300,000 kilograms of soybean.

According to the statement of the director of the Institute for Plant Protection, during the control over parcels under soybean in South Bačka District of Vojvodina, Serbia, in the year 2011, from the number of controlled parcels, 92% were under GM soybean, and in Banat 88% were under GM soybean.

From 16 May 2007, the MK Group became the exclusive importer of Monsanto sunflower seed, rapeseed and sorts of maize that were prohibited in some European countries and in particular, that were not examined, approved or registered in the Register of agricultural plants seed (Phytosanitary Border Inspection Certificate of import of Monsanto corn seed by MK Group). The parcels under corn, sunflower and rapeseed were never controlled by phytosanitary inspection.

During 2011 and 2012, the Monsanto Company has twice announced a competition for workers in Serbia which would sell Monsanto seeds and herbicides "at the level of Serbian farmers" with direct offers on the field, outside legal stream of seed sale.

Organochlorine insecticides

Pesticides are chemical substances intended for preventing, destroying or controlling pests, including vectors of human and animal diseases, unwanted species of plants (weeds) and species of zoogenic origin (insects, mites, snails, nematodes, rodents) that cause damage during growth, production, processing, storage, transportation of agricultures and food items etc. (Law on production and trade of toxic substances, "Official Gazette SFRY", No. 15/95, 28/96 and 2002 and "Official Gazette RS", No. 101/2005 – oth. law).

Pesticides from the group of organochlorine insecticides were prohibited in EU in the 1972. This group consists of DDT, dicofol, metoxychlor, lindane, HCH (mixture of isomers), aldrin, dieldrin, endrin, heptachlor, camphechlor, endosulfan and kelevan. Previously, they were widely applied in agriculture, forestry, veterinary medicine and communal hygiene. These compounds slowly break down in the body, they accumulate in unchanged form or in the metabolites form, especially in adipose tissue and internal organs (liver, brain, kidney, heart), and are excreted through breast milk and saliva, and eliminated in an unchanged form or transformed form through urine.

HACCP – Hazard Analysis Critical Control Points

HACCP is designed as a system that supports the principles of Codex Alimentarius Commission on food safety and it is based on analysis and control of potential biological/microbiological, chemical, allergenic and physical hazards to which all factors in the food production chain are exposed. That implies abiding by the standard operating procedures and guidelines that reduce risks to food safety.

The designers of HACCP system integrated with the ISO standards have designed it as a kind of deception and outstanding auxiliary means in implementation of the thorough industrial and technological espionage with the goal of overall globalization in all spheres of life including food as well. With their assumptions, principles and requirements they seek to establish, assess and control hazards that could affect food safety, with so called management system based on prevention.

Thereby, each employee is informed of what, how, when and why something must be done in order to prevent food risks, but also of his/her personal responsibility, so that the end user would consume healthy and safe food. The designers of HACCP system are consciously omitting two more important hazards that are current and, unfortunately, future pestilence of this planet, and are reflected in GMO food and radiological hazards associated with the food and food origin. The basic deception is reflected in the suppression of physical, chemical and biological hazards, where authors of this system are deceived assuming that the people is pretty much uniformed and they believe that any ordinary housewife DOESN'T KNOW that in the soup she is cooking must not fall any button, hair (physical hazard), that she must not over salt her lunch (chemical hazard) and that she must not use defective or unreviewed foods of animal origin (biological hazard).

Trivial examples were listed deliberately, to make it easier to understand the essence of the situation. Recently, risk of allergens was added to the list of HACCP hazards, it is undeniable, and, unfortunately, there are many children and adults whose organism is intolerant to certain foods. However, some organizations adhered to that danger and, for example, soybean that is useful and recommended for nutrition (unless it was GMO) is proclaimed to be allergen so that they could replace that soybean as a supplement in food production and favor hydrocolloids (additives) that are not in any way friends to our organism.

Table 1. Chemicals listed in the Rotterdam Convention (Official Gazette of Republic of Serbia – International Treatises, 1998)

2,4,5-T	Pesticide	Heptachlor	Pesticide
Aldrin	Pesticide	Hexachlorobenzene	Pesticide
Captaphol	Pesticide	Lindan	Pesticide
Chlordane	Pesticide	Mercury compounds, including inorganic mercury compounds, alkyl mercury compounds, alkyloxyalkyl and aryl mercury compounds	Pesticide
Chlordimeform	Pesticide	Pentachlorophenol	Pesticide
Chlorobenzilate	Pesticide	Methamidophos (soluble liquid formulation of the substance containing more than 600g of active ingredient per liter)	Pesticide dangerous formulations
DDT	Pesticide	Phosphamidon (soluble liquid formulation of the substance containing more than 1.000g of active ingredient per liter)	Pesticide dangerous formulations
Dieldrin	Pesticide	Methyl parathion (emulsifiable concentrate (EC) containing 19.5%, 40%, 50%, 60% of active ingredient and powder containing 1.5%, 2% and 3% of active ingredient)	Pesticide dangerous formulations
Dinoseb and dinoseb salts	Pesticide	Polychlorinated biphenyls (PCB)	Industrial
1,2-dibromoethane (EDB)	Pesticide	Polychlorinated terphenyls (PCT)	Industrial
Fluoroacetamide	Pesticide	Tris (2,3- dibrompropyl) phosphate	Industrial
HCH (mixture of isomers)	Pesticide		

Table 2. Aldrin and Dieldrin in Codex Alimentarius (http://www.codexalimentarius.org)

Commodity	Maximum Residue Limits (MRL)	Year of Adoption	EU or Serbia
Bulb vegetables	0.05 mg/kg	1997	
Cereal grains	0.02 mg/kg		
Citrus fruits	0.05 mg/kg	1997	
Eggs	0.1 mg/kg		
Fruiting vegetables, Cucurbits	0.1 mg/kg	1997	
Garden pea, Shelled (succulent seeds)	1 mg/kg		
Leafy vegetables	0.05 mg/kg	1997	
Legume vegetables	0.05 mg/kg	1997	
Meat (from mammals other than marine mammals)	0.2 mg/kg		
Milks	0.006 mg/kg		
Pome fruits	0.05 mg/kg	1997	
Poultry meat	0.2 mg/kg	1997	
Pulses	0.05 mg/kg	1997	
Root and tuber vegetables	0.1 mg/kg	1997	

Table 3. DDT in Codex Alimentarius (insecticide) (http://www.codexalimentarius.org)

Commodity	Maximum Residue Limits (MRL)	Year of Adoption
Carrot	0.2 mg/kg	1997
Cereal grains	0.1 mg/kg	
Eggs	0.1 mg/kg	1997
Meat (from mammals other than marine mammals)	5 mg/kg	2001
Milks	0.02 mg/kg	1997
Poultry meat	0.3 mg/kg	2003

Table 4. Dicofol in Codex Alimentarius (http://www.codexalimentarius.org)

Commodity	Maximum Residue Limits (MRL)	Year of Adoption
Beans (dry)	0.1 mg/kg	1995
Cattle meat	3 mg/kg	1997
Cattle, Edible offal of	1 mg/kg	1997
Cherries	5 mg/kg	1997
Citrus fruits	5 mg/kg	1997
Common bean (pods or immature seeds)	2 mg/kg	1997
Cotton seed	0.1 mg/kg	1995
Cotton seed oil, Crude	0.5 mg/kg	1997
Cotton seed oil, Edible	0.5 mg/kg	1997
Cucumber	0.5 mg/kg	1995
Eggs	0.05 mg/kg	1995
Grapes	5 mg/kg	1997
Hops, Dry	50 mg/kg	1995
Melons, except watermelon	0.2 mg/kg	1995
Milks	0.1 mg/kg	1999
Peach	5 mg/kg	1997
Pecan	0.01 mg/kg	1995

Peppers	1 mg/kg	1995
Peppers Chili, dried	10 mg/kg	2006
Plums (including prunes)	1 mg/kg	1997
Poultry meat	0.1 mg/kg	1997
Poultry, Edible offal of	0.05 mg/kg	1995
Prunes	3 mg/kg	1997
Squash, summer	1 mg/kg	1995
Tea, Green, Black (black, fermented and dried)	50 mg/kg	1997
Walnuts	0.01 mg/kg	1995

Table 5. Endrin in Codex Alimentarius (http://www.codexalimentarius.org)

Commodity	Maximum Residue Limits (MRL)	Year of Adoption
Fruiting vegetables, Cucurbits	0.05 mg/kg	1997
Poultry meat	0.1 mg/kg	1997

Table 6. Endosulfan in Codex Alimentarius (http://www.codexalimentarius.org)

Commodity	Maximum Residue Limits (MRL)	Year of Adoption
Avocado	0.5 mg/kg	2007
Cacao beans	0.2 mg/kg	2007
Coffee beans	0.2 mg/kg	2007
Cotton seed	0.3 mg/kg	2007
Cucumber	1 mg/kg	2007
Custard apple	0.5 mg/kg	2007
Egg plant	0.1 mg/kg	2007
Eggs	0.03 mg/kg	2007
Hazelnuts	0.02 mg/kg	2007
Kidney of cattle, goats, pigs and sheep	0.03 mg/kg	2007
Litchi	2 mg/kg	2007
Liver of cattle, goats, pigs & sheep	0.1 mg/kg	2007
Macadamia nuts	0.02 mg/kg	2007
Mango	0.5 mg/kg	2007
Meat (from mammals other than marine mammals)	0.2 mg/kg	2007
Melons, except watermelon	2 mg/kg	2007
Milk fats	0.1 mg/kg	2007
Milks	0.01 mg/kg	2007
Papaya	0.5 mg/kg	2007
Persimmon, American	2 mg/kg	2007
Potato	0.05 mg/kg	2007
Poultry meat	0.03 mg/kg	2007
Poultry, Edible offal of	0.03 mg/kg	2007
Soya bean (dry)	1 mg/kg	2007
Soya bean oil, Crude	2 mg/kg	2007
Squash, summer	0.5 mg/kg	2007
Sweet potato	0.05 mg/kg	2007
Tea, Green, Black (black, fermented and dried)	10 mg/kg	2011
Tomato	0.5 mg/kg	2003

Table 7. Lindane in Codex Alimentarius (http://www.codexalimentarius.org)

Commodity	Maximum Residue Limits (MRL)	Year of Adoption
Barley	0.01 mg/kg	2004
Edible offal (mammalian)	0.01 mg/kg	2004
Eggs	0.01 mg/kg	2004
Maize	0.01 mg/kg	2004
Meat (from mammals other than marine mammals)	0.1 mg/kg	2004
Milks	0.01 mg/kg	2004
Oats	0.01 mg/kg	2004
Poultry meat	0.05 mg/kg	2004
Poultry, Edible offal of	0.01 mg/kg	2004
Rye	0.01 mg/kg	2004
Sorghum	0.01 mg/kg	2004
Straw and fodder (dry) of cereal grains	0.01 mg/kg	2004
Sweet corn (kernels)	0.01 mg/kg	2004
Wheat	0.01 mg/kg	2004

Table 8. Veterinary Drugs in Foods

Codex Alimentarius Commission		
Updated as at the 34th Session of the Codex Alimentarius Commission (July 2011)		
Veterinary Drugs in Foods		
Abamectin	Gentamicin	Albendazole
Imidocarb	Avylamycin	Isometamidium
Azaperone	Ivermectin	Benzylpenicillin/Procaine benzyl penicillin
Levamisole	Carazolol	Lincomycin
Ceftiofur	Melengestrol acetate	Chlortetracycline/ Oxytetracycline/Tetracycline
Monensin	Clenbuterol	Moxidectin
Closantel	Narasin	Colistin
Neomycin	Cyfluthrin	Nicarbazin
Cyhalothrin	Phoxim	Cypermethrin and alpha-cypermethrin
Spiramycin	Dicyclanil	Spectinomycin
Pirlimycin	Danofloxacin	Porcine somatotropin
Dihydrostreptomycin/Streptomycin	Progesterone	Dexamethasone
Deltamethrin	Sarafloxacin	Diclazuril
Diminazene	Testosterone	Doramectin
Thiabendazole	Eprinomectin	Tilmicosin
Erythromycin	Trenbolone acetate	Estradiol-17beta
Sulfadimidine	Trichlorfon (Metrifonate)	Febantel/Fenbendazole
Oxfendazole	Triclabendazole	Fluazuron
Tylosin	Flubendazole	Zeranol

Table 9. List of emulgators harmful to human health

E 102 - dangerous	E 171 - suspicious	E 241 - suspicious
E 103 - banned	E 173 - suspicious	E 250 - affecting heart pressure
E 104 - suspicious	E 180 - suspicious	E 251 - affecting heart pressure
E 105 - banned	E 210 - cancerogenous	E 311 - causing rash
E 110 - dangerous	E 211 - cancerogenous	E 312 - causing rash
E 111 - banned	E 212 - cancerogenous	E 320 - cholesterol
E 120 - dangerous	E 213 - cancerogenous	E 322 - gastric disturbances
E 121 - banned	E 215 - cancerogenous	E 339 - gastric disturbances
E 122 - suspicious	E 216 - cancerogenous	E 340 - gastric disturbances
E 123 - very dangerous	E 217 - cancerogenous	E 341 - gastric disturbances
E 124 - dangerous	E 221 - intestine disorders	E 407 - gastric disturbances
E 125 - banned	E 222 - intestine disorders	E 450 - gastric disturbances
E 126 - banned	E 223 - intestine disorders	E 461 - gastric disturbances
E 127 - dangerous	E 224 - intestine disorders	E 462 - gastric disturbances
E 130 - banned	E 226 - skin damaging	E 463 - gastric disturbances
E 131 - cancerogenous	E 231 - harmful for skin	E 465 - gastric disturbances
E 142 - cancerogenous	E 232 - harmful for skin	E 466 - gastric disturbances

Trivial examples were listed deliberately, to make it easier to understand the essence of the situation. Recently, risk of allergens was added to the list of HACCP hazards, it is undeniable, and, unfortunately, there are many children and adults whose organism is intolerant to certain foods. However, some organizations adhered to that danger and, for example, soybean that is useful and recommended for nutrition (unless it was GMO) is proclaimed to be allergen so that they could replace that soybean as a supplement in food production and favor hydrocolloids (additives) that are not in any way friends to our organism. On the other hand, the Codex Alimentarius, from which HACCP system is derived, for the human use recommends the use of GMO and products made from it, recombinant synthetic bovine growth hormone, the residues of antibiotics and the most dangerous pesticides in the animal meat which were legally prohibited in Serbia long time ago, as well as the toxic food additives. In this way, food that is loaded with all mentioned hazards from the previous paragraph, is not possible to be detained from the import if it has the label of HACCP standard. The evidence for the above statement is a response from the Ministry of Agriculture, Forestry and Water Management to the question of whether the imported meat is checked at the border for the presence of GMO, which are prohibited by law in Serbia, the answer was as follows: "Control of animal nutrition, when it comes to GMO animal food, is performed during the animal breed on the farms in the country of origin". Testing for the presence of recombinant synthetic bovine growth hormone, antibiotics and residues "is performed in accordance with applicable regulations of Republic of Serbia/EU" (Reply of the Ministry of Agriculture, Forestry and Water Management number 011-00-17/2012-05, 2012), where it was allowed contrary to the law of Republic of Serbia.

Conclusions

Based on the above stated, one can clearly conclude that Codex Alimentarius, as well as from it derived HACCP system, are contrary to the Rotterdam and Stockholm Convention, RS Constitution (Constitution of Republic of Serbia), and several laws on force, such as the Law on Ratification of the Rotterdam Convention (Law on Ratification of the Rotterdam Convention, "Official Gazette RS - International Treaties" No. 38/2009), Law on Ratification of the Stockholm Convention (Law on Ratification of the Stockholm Convention, "Official Gazette of the Republic of Serbia - International Treaties", 1998), The Food Safety Act (Official Gazette of the Republic of Serbia, No. 41/09), Law on Agricultural Land ("Official Gazette RS" No. 62 / 2006), The Law on Environmental Protection ("Official Gazette RS" No. 135/2004), Health Care Law ("Official Gazette RS" No. 107/05), Law on Genetically Modified Organisms ("Official Gazette RS" No. 41/2009).

With consistent application of national laws and regulations, if the regulative is based on traditional values, of course, the need for introducing and completing the demands and rules of unconstitutional and illegal Codex Alimentarius and mentioned standards can be excluded. They have, as already mentioned, one completely different role in the food production system and in nutrition system. That system excludes balanced and safe nutrition and as we can witness, leads this planet with human population to unconditional downfall.

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Certificate of the border phytosanitary inspection for import of Monsanto corn seeds by MK Group.

ПРИМЕНА НА ЗАКОНИТОСТА НА CODEX ALIMENTARIUS ВО СРБИЈА

Ана Перениќ, Радован Кривокапиќ, Никола Алексиќ

Апстракт

Овој труд се занимава со докажување на нелегалноста на воведувањето на Codex Alimentarius и од него развиениот HACCP-систем во законодавството на Република Србија. Имено, во овој труд се користени методи за споредба на правните норми со препорачаниот Кодекс, кои се во спротивност со Уставот на РС, Ротердам и Стокхолмската конвенција, неколку применливи закони, додека производите означени со Codex Alimentarius и од него произлезениот HACCP - стандард кој не е во согласност со применливиот закон, илегално се појавува на српскиот пазар.

Клучни зборови: Кодекс Алиментариус, HACCP, здрава храна, хемикалии, законитост.

SECTION 9: AGRICULTURAL ECONOMICS

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Original scientific paper

THE DEVELOPMENT OF THE AGRICULTURE AND THE VILLAGE IN INDEPENDENT MACEDONIA

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Abstract
As part of the economy in Macedonia, the agriculture could have and should have (it was expected) to contribute for the development of the overall economy. There are well relevant indicators for agriculture from which it is concluded that it has given a certain contribution in the overall economy such as: real value of increased GDP, increased export, increased crop per unit capacity etc. However, the key indicators point to unsatisfying realization where the most important are: decreased basic production capacities, an increase of import rather than the increase of export especially for food and others. The comparison among the key indicators for the development of agriculture is made through natural and financial data, by previous comparison of the production capacities, their usage, the change of the production structure and comparison of the crop according to published official data. This paper analyses the socio – economic processes in the Macedonian village and the assumptions and limitations for preservation of the valid agricultural household – analysis of the basic features of the life of the village population, as a significant segment in the lifestyle of the contemporary village. This paper should encourage a creation of model for development and realization of the agricultural policy in Macedonia.
Key words: agriculture, development, export, village, farm.

Introduction

After twenty years of independent Macedonia, it is very common that there is a need for analysis of the past road and estimation for the comparative indicators for the movement of the Macedonian economy. In the context of such analysis, we think that the agriculture as its important segment deserves to be thoroughly perceived of the past twenty year road not only as a proof for vitality with positive movements, but as a way to understand the mistakes and the negative indicators so that we „can learn from our mistake “ and to realize better results in the future. Macedonian agriculture still has a relatively high participation in the GDP of the country (almost 10%), and that is why it deserves to be more present in the future and to be supported in any was so that it can face the upcoming challenges in the production of safe, economic and competitive food and goods, as well as to provide a higher standard of the agriculturalists.

Aim of the paper-The aim of this paper is to trace the key aspects in the development of the agriculture and the village throughout the key indicators, beginning with the movement of the

disposable capacities, the way of usage of the agricultural capacity, the structure of the prevalent productions, the movement of the overall production, the movement of the value of the export and the import, as well as the financial results through the economic accounts in the last five years. These aims are realized by implementation of the indicators in the road of development monitoring a twenty years period through 5 five years data at the level of the country. It was not our aim to analyse the agricultural policy, because it was reflected in the results, but we will point out that for these 20 years it was improper for the problem about the village.

Material and methods

The method is based on the view and the comparison of the official statistical indicators as well as our calculations. As a base year we use 1991, when Macedonia is becoming an independent, and then we monitor the movement of the indicators for every 5 years like in 1996, then in 2001, then again in 2006 and the last year is 2011. The table display and the graphic display are applied for the more important data so that the movements of the development stage can be clearly viewed.

Results and discussion

The production capacities with which the Macedonian agriculture had at its disposal are: relatively limited scope of agricultural and cultivated land which permanently decrease (table 1), so in 2011, the agricultural land is decreased by 175.000 ha, and the cultivated land by 153.000 ha, which should seriously worry us, and more because there not almost any actions taken for protection especially for the cultivated land located in the most fertile areas for the competitive production. The livestock fund expressed in the numbers of the livestock unit in the last 10 years is decreased by the number of 27.000, for which the import of livestock products is increased, and especially meat. The importance of irrigation for the Macedonian agriculture is well known, but instead of an increased irrigated areas (as an indicator for development), in the last years it reached only 34% of the built irrigation systems before 1991 (127.000 ha), and 64% from the irrigated ones in 1991. The number of tractors is continually growing, but the decrease of the cultivated land led to the fact that today one physical tractor cultivates only 7,3 ha, and because of this the tractor is not effective. The number of the individual agricultural holdings, but the companies as well, continues to grow which has led to a smaller farm size of land, and thus in 2011 in a production subject on average there is only 2,7 ha agricultural land.

Cultivated land by category of use, in accordance with its decrease, the arable land and the gardens, the orchards and the vineyards were decreased, and the area with meadows was increased (table 2). Such structure of the usage of the cultivated land, points to the fact that in 1991 in the Macedonian agriculture the intensive systems had a bigger participation, that is, the orchards and the vineyards with share of 8,8%, meadows 8,1%, while in 2011, the orchards and vineyards participated with 6,8%, and meadows with 11,9%.

Table 1. Major production capacities

Indicator (‘000)	1991	1996	2001	2006	2011
Agricultural land (ha)	1.295	1.291	1.244	1.226	1.120
Cultivated land (ha)	664	658	612	537	511
Pastures (ha)	629	632	630	688	608
Number of livestock (no.)	325	337	305	286	278
Tractors (no.)	46	54	61	66	70
Irrigated area (no.)	67	52	48	21	43
Individual agricultural holdings (no.)	163	168	159	178	192
Agricultural companies and cooperatives (no.)	211	191	160	128	297

Table 2. Cultivated land by category of use (in 000 ha)

Indicator	1991	1996	2001	2006	2011
Arable land and gardens	552	554	512	439	415
Orchards	23	20	17	13	14
Vineyards	35	29	28	26	21
Meadows	54	55	55	60	61

The usage of the arable land and the gardens, in accordance with their overall constant decrease from 1991 to 2011 is manifested with a decrease of the areas of all groups of crops (table 3). The cereals have the highest participation which from 42,9% in 1991 fell down to 39,3%, and the sowed areas with wheat in the same period were decreased by 31,2%. However, the sowed areas with industrial crops from 1991 to 2011 are decreased by 125%, as a result for which there is no more sugar beet production, there is a minimum representation of the sunflower, and only the tobacco remains within a stable scale of areas. The areas with vegetable crops from 61.000 ha have decreased to 51.000 ha in 2011. These two groups of crops are considered as a national advantage, because they traditionally use the Mediterranean influence of the climate in Macedonia at best. The maintenance of the forage crops is positive at the level from 34 to 39.000 ha. The most negative is the maintenance of the fallow and the uncultivated arable land at a high level of areas with several times bigger scope of sowed areas of the industrial, vegetable and fodder crops, and with the participation of 33% from arable land and gardens and 27,0% from the cultivated areas (in 2011). This scope of arable land and gardens as well as a high participation of fallow and uncultivated arable land must seriously concern us. The insistence for an increase of the areas of any group because of the increased production is reflected on decrease in other groups, and as can be seen they are with a limited scope. The increase in the production of the current crops as well as an eventual broadening of the range is possible just by providing conditions for activation of a part of the uncultivated arable land (it is considered that around 50% from it can still be activated), but also faster implementation of new varieties, higher technologies and increase in the scope of the irrigated areas.

The area of the major annual crops has a similar tendency, the same as the groups of cereals, industrial, fodder and vegetable crops. From the nine chosen annual crops (table 4), it can be seen that the areas with wheat, are decreased by 39,1% in 2011 in comparison to 1991, and in the last 5 years by 21,1%.

Table 3. Arable land and gardens by category of use (in 000 ha)

Indicator	1991	1996	2001	2006	2011
Cereals	237	222	220	290	163
Industrial crops	63	40	31	23	28
Vegetable crops	61	61	56	51	51
Fodder crops	36	39	36	34	35
Fallow and uncultivated arable land	163	194	169	140	138

It is obvious that with such scope of areas (78 thousand ha) with wheat, we will be more dependable from the import, if the crop is not greatly increased by implementation of high quality certified seeds and an appropriate technology, because the horizontal extension of production (the areas) lead to decrease in the areas with other also very important crops for the Macedonian agricultural complex. The same referees to the sunflower whose scope of areas in 2011 is smaller for nearly 5 times in comparison to 1991. The areas with rice, the decrease in the analyzed period is nearly 50%, with the corn by 33%, whereas with the vegetables, the tobacco, the alfalfa and the fodder maize, the scope of the areas is maintained throughout the whole period nearly at the same level.

Table 4. Area of the major annual crops (in 000 ha)

Indicator	1991	1996	2001	2006	2011
Wheat	113	118	115	98	78
Corn	43	42	33	32	29
Rice	9	4	2	3	5
Tobacco	18	19	20	17	20
Sunflower	29	16	6	4	6
Tomatoes	9	9	6	6	6
Peppers	9	9	7	8	9
Alfalfa	19	20	19	18	19
Fodder maize	2	2	3	2	2

The orchards in relation to the scope of certain types (table 5) are presented with the number of fruit-bearing trees (in accordance with the official statistics). As can be seen, with all fruit types the number of fruit-bearing trees decreased in the analysed period, except the number of the apples trees increase by 65,7%. This increase led to the fact that in 2011 with over 57% of the total amount of all types of fruit-bearing trees, made the apple trees to participate (Statistical Yearbook 2012). This has led to difficult selling of apples, and has led to deficiency of the domestic market and import of pears, peaches, apricots, walnuts, and berry fruits. Unfortunately this is a result of inappropriate financial support of the fruit types.

The vineyards, as it was shown in table 2 from 35.000 ha in 1991 continually decreased so in 2011 there are only 21.000 ha. A serious problem in the viticulture is the inadequate presence of the species (wine grapes, table grapes) but the grape variety as well. Unfortunately, the financial support in viticulture was inappropriate, with insufficient support of the table grapes in a time when the wine varieties were not required due to serious problems in the global market of wine, and wine grape varieties was supported with higher amounts, which had reflection on the overall price policy.

Livestock, poultry and beehives in relation to its capacity is represented through the breeding number of the cattle, sheep and pigs and the total amount of poultry and beehives (table 6).

Table 5. Number of fruit-bearing trees (in 000 no.)

Indicator	1991	1996	2001	2006	2011
Apples	2.593	2.515	3.203	3.803	4.281
Pears	1.091	707	649	417	361
Plums	1.515	1.470	1.472	1.348	1.489
Sour cherries	1.326	771	758	765	606
Apricots	536	286	189	145	140
Peaches	776	490	511	435	413
Walnuts	164	160	167	163	162

It is well known that sheep breeding is considered as a priority in the livestock sub-sector because of the particularly appropriate conditions presented with vast and quality pastures, but as well as with the tradition of the Macedonian sheep breading. However the strong migration village – city, as well as the inappropriate policy of many years, has led to a constant decrease of the number of sheep which are only 33,6% of the total number of the ewes for breeding 20 years ago. With the total number of sheep (767.000 in 2011), not even 20% of the pastures are used, which Macedonia has at its disposal. The number of the cows and heifers in calf is maintained at nearly the same level in the last five years as well as in 1991, but from 1996 to 2011 the number was bigger for ten thousand of heads. The number of the sows and first farrow sows had a similar tendency, while the number of poultry is constantly decreased, and today it is only 42,6% compared to the one in 1991.

Table 6. Number of livestock, poultry and beehives (in 000 no.)

Indicator	1991	1996	2001	2006	2011
Cows and heifers in calf	164	176	174	164	164
Ewes for breeding	1.623	1.233	897	859	545
Sows and first farrow sows	23	29	27	28	24
Poultry	4.562	3.361	2.750	2.585	1.944
Beehives	77	68	67	68	65

The overall production of the most important products mainly corresponds to the trends of the capacities, which indicates that the decreased areas of certain crops and the number of livestock heads mainly is not compensated with the increased production per unit capacity. A relatively small number of agricultural products are with an increased production in the last years in relation to 1991, and those are the alfalfa, apples, cow milk and honey (tab. 7).

Table 7. Production of major products (in 000 tons)

Indicator	1991	1996	2001	2006	2011
Wheat	341	269	246	393	256
Corn	135	117	141	147	126
Rice	38	22	9	14	27
Tobacco	25	15	23	25	26
Sunflower	37	21	5	6	8
Tomatoes	169	146	126	142	166
Watermelon	152	116	130	130	127
Alfalfa	114	107	104	126	129
Apples	48	65	38	96	125
Grapes	264	215	230	254	235
Cow milk (mil.litres)	119	134	201	295	376
Meat total	35	28	26	28	22
Eggs (mil.no.)	574	435	395	331	196
Honey (tons)	918	1.352	928	868	1.105

The economic accounts with prices from the previous year according to official statistics in the last five years (from 2006 to 2010) point to significant trends in the Macedonian agriculture, despite the fact that it is not in accordance with the analyzed period. The value of the crop output is increased by 3,6%, and of the animal output by 25,8% (table 8). This difference does not derive from the big differences of the crop and animal output, here it is a result of a various increase of prices (according to the methodology applied "quantity x price"). The value of the crop and animal output– the agricultural goods output from 2006 to 2010 is increased by 8,6%. The value of the services in agriculture is increased, while the value of the "secondary" activities is with a decreased value, but the value of the "subsidies of agricultural products" is increased by 313% and as a result of that, the value of the agriculture as an "industry" is increased by over 12,9%. The gross value added in the last 5 years was constantly increasing and in 2011 it is higher from the one in 2006 by 29,4% as a net value added, because in the value of consumption of fixed capital there was not any significant increase.

The export of agricultural products is an especially significant indicator through which we can see the participation of the sector in the international division of the labour on the one hand, and on the other, as a possibility for our products (fruit, vegetable, tobacco, sheep products, grapes and wine), which exceed the domestic expenditure to be exported and to prove their competitive ability. In the first 10 years after the independence of Macedonia the value of the export was increased by several times, but in 2001 was decreased by 35% (due to the war conflict) in relation to 1996. In 2006 the export was increased by 99% compared to 2001, and in the last 5 years (from 2006 to 2011) by 60%, when the value of the export in 2011 exceeds half a million dollars for 126 million (table 9). The structure of the overall value of the export has changed very interestingly, namely while in 1991 the value of the exported food participated with 44,5%, and the tobacco with 49%, in 2011 the export value of food participates with 59,6%, and the tobacco with 24,5%. The participation of the beverages was increased for more than double. While the value of the export of the food in the last

years is increased by 484%, the value of the overall export is increased by 337,8%, which is appreciated as a positive trend, and especially the high participation of the value of food in the overall export in 2011 by nearly 60%.

Table 8. Changes in the economic accounts in the last 5 years (million denars)

Indicator	2006	2007	2008	2009	2010
1.Crop output	49.460	46.293	47.613	50.079	51.259
2. Animal output	14.356	15.721	18.448	21.719	18.058
3. Agricultural goods output (1+2)	63.816	61.954	66.061	71.798	69.317
4. Agricultural services output	171	259	248	201	361
5. Agricultural output (3+4)	63.987	62.213	63.309	71.998	69.678
6. Non-agricultural secondary activities	1.479	1.462	1.070	925	1.325
7. Subsidies on products	977	901	1.693	3.339	4.214
8. Output of the agricultural "industry" (5+6+7)	66.443	64.576	69.072	76.262	75.217
9. Total intermediate consumption	34.372	31.831	34.936	34.926	33.719
10.Gross value added (8-9)	32.071	32.745	34.136	41.336	41.498
11. Consumption of fixed capital	2.637	2.669	3.017	3.184	3.425
12.Net value added	29.434	30.076	31.119	38.152	38.073

The import of the agricultural products is characterized mainly with a higher total value from the export, and that is especially expressed with the food (table 10). While, in the export of food dominate the value of fruit, vegetable and other processing, in the import of food dominate the meat, the maize, the milk, the edible oil and the sugar. In the years from 1991 to 2001 the import grew, then it decreases in 2001, but in 2006 the value is increased by 83,5%.

Table 9. Value of the export according to Standard International Trade Classification – SITC

Indicator ('000.000 $)	1991	1996	2001	2006	2011
Food	63,6	95,4	65,3	191,8	373,2
Beverages	7,8	40,4	46,5	80,3	81,5
Tobacco and processing	70,1	114,5	75,0	111,7	153,5
Other	1,5	7,5	9,8	7,4	17,8
Total	143,0	257,8	196,6	391,2	626,0

The high increase continued so in 2011 in relation to 2006 it is increased by 94,3%, which value (in 2011) reaches over 800 million dollars. Thus the high value of the import exceeded the overall export for over 190 million dollars, that is, the coverage is 76,6%. The participation of the value of food in the overall import in 2011 is 82,3% (in export 59,6%). The imported food by the value dominates in the whole 20 year period (1991-71,2%, 1996 – 83,2%, 2001 – 84,8%, 2006 – 87,9%). Despite the relatively high non-coverage of the import with the export, what is more concerning is the higher trend of the import than the export. Namely, from 2006 to 2011 the export is increased by 60%, and the import by 94,3%. This shows that we did not have a competitive production for export and also insufficient production for substitution for imported products for the domestic market.

Table 10. Value of import according to the Standard International Trade Classification – SITC

Indicator (‘000.000 $)	1991	1996	2001	2006	2011
Food	124,3	218,2	194,1	396,6	672,0
Beverages	11,5	3,8	4,7	18,2	38,8
Tobacco and processing	32,3	13,6	13,4	13,9	30,1
Other	6,1	26,4	16,7	18,5	75,6
Total	174,2	262,0	228,9	420,2	816,5

Unequal social and economic development of the village. The current economic, social and agricultural policy in Republic of Macedonia has positive reflection to the development of the bigger villages and those closer to the cities and on the villages which are well connected with traffic with the city environment, as well as in the villages where economical and infrastructural facilities are built. On the other hand, the population in the hilly and mountains villages and in the economical and social provincial areas, because of improper road communication and deprived basic infrastructure (communal, social activities) permanently migrate and leave their village.

The village population and especially the young population is still not satisfied with the services of certain life areas in the country. This especially refers to the services in: education, health care, local self government and the culture. The level of dissatisfaction from the services of the institutions of the system rises with the rising of the altitude and the distance from the villages and the municipality centres.

The unfavourable age structure of the village population. The migration movements contribute to flowing of the young and hard-working population and the demographic ageing of the village. These migratory movements greatly led to growth of the regional difference in the age structure of the village population. Namely, the population in the village areas of the municipalities Demir Hisar, Kratovo and Resen in 2002 is in a deep demographic old age. In one third of the municipalities in Macedonia, the village population is in a demographic old age (Berovo, Bitola, Gevgelija, Kavadarci, Kocani, Kriva Palanka, Ohrid, Prilep, Probistip, Sv. Nikole I Stip), and the municipalities Skopje, Gostivar, Debar, Struga and Tetovo are characterized with a young village population.

The unfavourable age structure in relation to the average at the state level (10.9%) is noticed in the villages in the Pelagonia Region (18,8%), Eastern region (15,5%), Vardar region (12,9%) and Northeastern region (12,7%) according to the census in 2002.

The extended poverty with the village population. In Republic of Macedonia the village population is facing with small incomes and unsolved basic infrastructural needs of the village community. The income of the village households are at e low level and insecure. The agriculture still has a dominant part in the village economy. In the countryside, 38,4% of the children from 0-17 years live under the official boundary of poverty (situation in 2011). Among the most poor households are the households in the hill and mountain areas. The serious economic and social problems are retained and cause decrease in the real life standard of the population which affects the development of the children. The decrease in the life standard does not have an equal influence on the way of life of the different social categories. So for example, with some, the possibility for realization of the purchasing power is limited, with the others, which are in a great number it is necessarily decreased to an already minimal financial resources for food, clothes, education of the children etc.. In that

sense, their dissatisfaction from the effects of the economical transition is not in the same nature and with the same intensity and does not cause an equal willingness for a change of the situation in a certain direction.

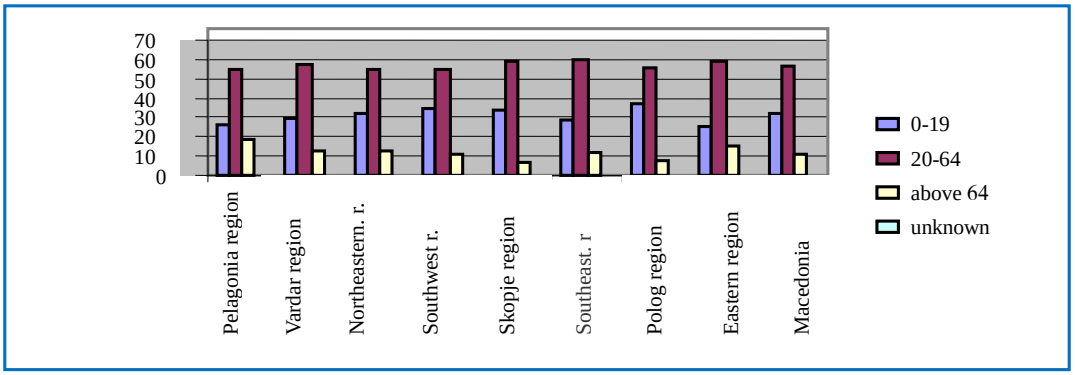


Figure 1. Age structure of the village population by regions

Conclusions

The development in the Macedonian agriculture after the independence of the country is unquestionable, however it is not sufficiently high enough having in mind the natural conditions, the locality, the tradition and the relatively stable macro-economical conditions and the relatively free market. The decrease in the key production factors such as agricultural and especially the cultivated land, then the number of livestock, the decrease in the irrigated areas, the perennial cops, and others, had a strong reflection which is shown in the stagnation of some elements of the development. Despite the increase of the extensive usage of the cultivated land (12% of natural meadows), the percentage of the uncultivated land is also high (27% of cultivated land). Despite the big deficiency of the domestic offer of cereals (especially wheat and maize), the areas with cereals in 20 years are decreased by 42%. In the orchards there is a discontinuity and a decline of the number of fruit – bearing trees at the stone fruit and pears, and the apple orchards are in a strong growth whose crop is already facing problems in the market. The situation with the viticulture is similar where the table varieties of grape are neglected and the wine varieties are forced with unreasonably high financial support. Inappropriate relation towards sheep breeding and the pastures led to the decrease in the number of sheep. While the number of cattle breeding and pig-breeding is at the same level as 20 years ago, the poultry farming is significantly in a decrease. The movement of the overall production with the 15 most important productions is a result of the used capacities, and because of this only 4 products have an increased production in 2011 in relation to 1991. According to the economic accounts, in the last 6 years the crop output has a relatively small increase despite the little increase in the production, while with the animal output, the increase is much higher, as a result of a higher growth of the prices in this period. The value of the export and import in the last 20 years is greatly increased, more with the import than with the export, and in 2011, the value of the export and import reached 1,44 billion dollars which is 4,5 times more than the one in 1991. And yet, one of the main aims of the future agricultural policy must be growth in the production by implementing highly productive varieties and species (because there are limited possibilities for

horizontal expansion unless the unused arable land is activated) and high technology, together with a higher degree of finalization of the primary production.

Directions of action for the development of the village*:* The major participation of the non-agricultural economy in the village community will contribute for the economic and social demographic stability of the village. The agriculture and the village population in the modern village community are closely related to the other activities and occupations outside and also inside the household itself. That is why today every isolated approach and solution of problems in the village does not give successful results.

The integral development of the village community, where it is referred to the overall economic, social and cultural progress of the rural areas and the community, has proven to be a successful model for revival and progress of the village communities in Western Europe.

Such a concept of development requires special conditions and not only in maximization of the economic sizes (profit) but also optimization of the natural and human resources. This approach implies multi-sectoral, and not mono-sectoral development (agriculture) as it was until now in Republic of Macedonia. The village needs a development of the infrastructure as a prerequisite for a lively economic, social and cultural development, which will provide a better life standard for the population. A special attention should be turned to the development of the small enterprises in the rural communities and areas where there are unused capacities and human resources. Measures for integration or re-integration of population in the hills or mountains and the socially provincial areas by investment for development of infrastructural objects, credits for returners in the village, tax relief etc. has to be taken.

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РАЗВОЈОТ НА ЗЕМЈОДЕЛСТВОТО И СЕЛАТА ВО НЕЗАВИСНА МАКЕДОНИЈА

Борис Анакиев, Јорде Јакимовски, Марија Ѓошева – Ковачевиќ

Апстракт

Како дел од стопанството на Македонија, земјоделството можеше и требаше (се очекуваше) да има важен придонес во развојот на вкупната економија. Има сосема релевантни показатели за земјоделството од кои се заклучува дека дало определен придонес во вкупната економија како што се: реална вредност на зголемен БДП, зголемен извоз, зголемени приноси по единица капацитет и сл. Меѓутоа важни индикатори укажуваат на незадоволителни остварувања од кои најважни се: намалени основни производни капацитети, повисок пораст на увозот од порастот на извозот особено на храна и друго. Споредбата помеѓу поважните показатели за развојот на земјоделството е направена преку натурални и финансиски податоци, со претходна споредба на производните капацитети, нивното користење, промената на производната структура и споредба на приносите според објавени официјални податоци. Трудот ги анализира и социоекономските процеси во македонското село и претпоставките и ограничувањата за одржување на валидно фармерско домаќинство-анализа на основните белези на животот на селското население, како значаен сегмент за начинот на живеење на современото село. Трудот треба да поттикне создавање на модел за развој и спроведување на аграрната политика во Македонија.

Клучни зборови: земјоделство, развој, извоз, село, фарма.

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Original scientific paper

ECONOMIC ANALYSIS OF APPLE PRODUCTION IN MACEDONIA: THE CASE OF PELAGONIA REGION

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Abstract
Apple production in the Republic of Macedonia holds the greatest importance among all fruit crops in terms of export value, production quantity and area of land under apple trees. The favorable climatic conditions and the long-established tradition of growing apples offer huge potential for the development of this branch of fruit growing. Low productivity levels and high production costs of apple put major limitations to the competitiveness on domestic and foreign markets, mainly due to inadequate and obsolete cultivation practices and technologies applied. The research addresses the economic performance of family agricultural holdings. For the purposes of the analysis, a filed study has been conducted on 39 apple holdings in Pelagonia region for the production years 2009 and 2010.Besides the standard performance indicators, the following social and economic factors affecting the apple producers performance have been analyzed: area of land, farmers' age, gender issue, apple varieties and land location. The methods of descriptive statistics and empirical methods of data analysis were used to process data. The findings demonstrate that apple trees are produces on small areas, with very high plant protection costs and seasonal work force. Farms' economic success depends on the apple variety as well as the location of the orchards. Farmer's/manager's age correlates poorly with the farm's success, whereas farms with greater economic size are more successful in apple production.
Key words: apple producers, economic analysis, Pelagonia region, performance indicators.

Introduction

Fruit production is of considerable importance to the Macedonian economy. According to the latest Agricultural Census (SSO, 2007), orchards encompass area of 11,264 ha, out of which apple orchards take 38%, plums 19%, peaches 13%, sour cherries 12% and the rest belongs to other fruits. The area under orchards in the individual farms sector increased from 11,756 ha in 2007 to 12,903 ha in 2010, whereas the orchards' area at business entities has decreased from 1,644 ha in 2007 to 1,029 ha in 2010 (SSO, 2008 - 2011). The production of apples, in the period from 2004 to 2011, in average amounts to 118,000 tons. The production itself had an upward trend with a 32% increase, hence from 82,414 tons in 2004 to 124,552 tons in 2011; the number of fruit-bearing trees in 2011 reached 4.3 million, which is a 16% increase when compared to 2004 (SSO, 2012). Within the fruit sub-sector, apple production is with highest perspective and significance in our country and is

spread on total agricultural area of 4,113 ha. Apples are net-export product generating an average annual inflow of 9.3 million euro for the period 2004 to 2011 година (SSO, www).

The highest concentration of apple plantations is in the region of the great lakes at about 700 m above sea level; this area is situated in the geographical regions of Pelagonia and South-West as determined by the State Statistical Office (SSO), and comprises 3.352 ha or 79% of the total area under apples (SSO, Ag Census, 2007). The focus of this study is the production of apples in the Pelagionia region where the respective share is 67%, i.e. it concentrates on the municipalities of Resen (with 2.567 ha, 99% of total area under fruit orchards) and Bitola (135 ha or 54% of total area under fruit orchards).

The aim of this paper is to conduct an economic analysis of the performance of the individual apple producers, in the Pelagionan region as the biggest apple production region in the Republic of Macedonia. The paper is structured into several chapters; following the introduction is the material and methods chapter, the presentation of the results and the discussion, and the conclusions are given in the end along with some recommendations for improvement of the economic performance of the apple producers.

Material and methods

This research is based on primary and secondary source of data. The target group are the individual agricultural holdings (family farms) that according to the Agricultural Census data operate on 94% of the total area under apples. The survey refers to the production years of 2009 and 2012; it includes data from 39 individual agricultural holdings. To facilitate the data collection, a questionnaire was designed and a field survey was conducted. Additionally, many farmers were interviewed individually with an additional set of questions mainly covering the issues of farms assets and investments. Apple production experts were also consulted during this process. Following the initial data processing, a panel discussion was organized with relevant participants from the sub-sector: apple producers, researchers and scholars, processors, producers of plant material, преработувачи, advisors and extension agents. Data from the official statistics as well as results from previous studies were used as secondary sources.

In order to determine the sample size, a calculation of the maximum allowed error threshold was calculated, which represents half of the length of the appropriate confidence interval i.e. margin of error. Higher level of the margin of error will mean smaller sample, and vice versa. Factor in the determination of the upper limit of error level is the sample variation, or the standard variation (Delova Jolevska, 2008).

The determination of the sample size depends upon three factors: confidence level, upper error limit and the variability of the statistical mass expressed through the variance (Risteski, 1999). The interaction of these three factors is expressed as follows:

$$E = Za/2 * \frac{\delta}{\sqrt{n}}$$

The optimal sample size is calculated according to the following formula (Delova Jolevska, 2008, Risteski, 1999):

$$n = \frac{N * Z_{\frac{\alpha}{2}}^{2} * \sigma^2}{Z_{\frac{\alpha}{2}}^{2} * \sigma^2 + \left(\frac{E}{2}\right)^2 * (N-1)}$$

where as:
E = maximum margin of error
Z = standardized normal value corresponding to the confidence level
1-α = error risk
σ = standard deviation of the statistical mass
n = optimal sample size
N = sample size

The confidence level for the determination of our sample was set at 0.90, meaning that 90% of the mean of the sample will be in the interval of 1.64 standard deviations to the arithmetic mean of the statistical mass. The calculated optimal size of the sample was 37, and the survey was done at 39 farms.

In order to determine the economic performance of the farmers, standard performance indicators are used. The output/input value coefficient demonstrates the production efficiency (PE) or the productivity in the larger sense and is calculated as a ratio between the total value of the production output (OV) and the value of the total inputs (IV). Alternatively, it can be calculated in the reverse order i.e. input value over output value. The formula used in this paper is as follows:

PE = OV/IP

The apple production is recognized as efficient if this coefficient is higher than 1, i.e. when the total value of outputs is higher than the total value of inputs. In order to determine the level of economic effectiveness of the farms, a calculation of the rate of profitability (RP) is applied, expressed as ratio of the farm profit (FP) over the total output value (OV):

RP = (FP/OV) x 100 (%)

Higher rates indicate higher profitability.

The cost of production of apples is also calculated, as a ratio of the total costs i.e. input value (IV) over the total quantity of product (PQ), and it is expressed in Macedonian denars per kg:

COP=IV/PQ

The survey included collection of data concerning the labor; it enabled a calculation of the labor productivity indicator as an important aspect of the farm economic analysis. The labor productivity (LP) is determined as a ration between the total value of output (OV) and the total cost of the labor input (LI):

LP = OV/LI

The labor compensation is a sum of the costs of hired labor and also the cost of family labor in terms of opportunity cost. The labor unit equals the annual workload of one person i.e. the Annual Work Unit (European Commission, Farm Definitions 2005) and is equivalent of 275 workdays or 2200 labor hours. In order to systemize the output and inputs in apple production adequate analytical enterprise budgets were constructed, contacting both the variable and fixed production costs.

Standards methods of the descriptive statistics were used for the sample analysis and the analysis of the performance indicators; mean (M_x), standard deviation (SD) and coefficient of variation (CV). Lower values of the coefficient of variation, as a relative measure of dispersion, indicate lower deviation in the sample from the arithmetic mean, and vice versa (Risteski, 1999).

Results and discussion

Description of the sample

The farm survey and individual interviews gave ground to describe the typical features of apple farms in the Pelagonia region.

In general, apple farms are characterized with high specialization in the Resen municipality, while in the Bitola municipality farms are usually of mixed character.

The total area of the included family farms in the survey is 84.22 ha. In average, an apple farm has 2.2 ha ov apple orchards, and this per farm area in the sample ranges from 0.1 ha to 8 ha. Farms are larger in the Resen municipality with an average of 2.5 ha, compared to the farms in Bitola municipality with 1.5 ha (Figure 1). The farms are highly fragmented, with 4 to 10 land parcels per holding.

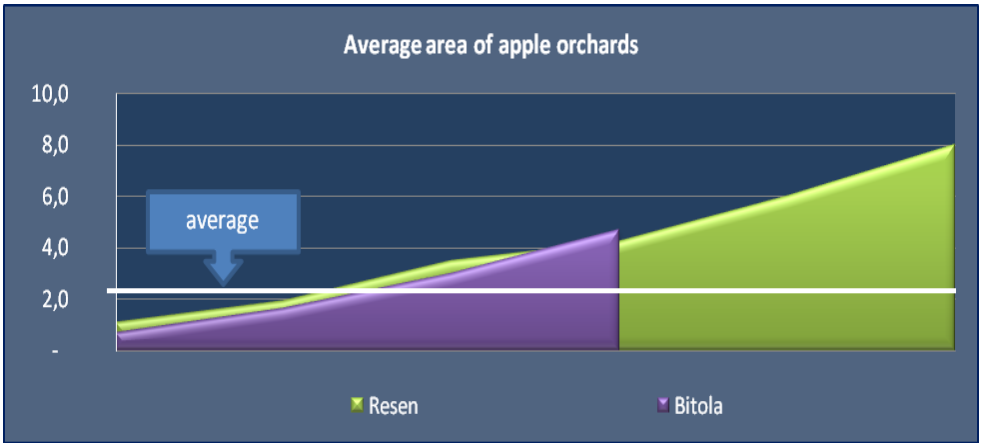


Figure 1. Average area of apple orchards, in ha per municipality

In term of farm assets, the survey showed that apple farms have obsolete machinery (17 years average). Almost all farms have some storage space, which are not always in good shape, and only few farms in the survey had cooling rooms, however, without controlled atmosphere. The average age of the apple orchards is 12 years. The irrigation technology is relatively advances and almost 70% of the sample farms are irrigated with dripping system.

According to the survey and the questions regarding the variety structure, the variety Ajdared is represented on 60% of the area, followed by the Golden Delicious with 13% of the area, and with Red Delicious and Muco taking 8% each. In Bitola municipality, the most common variety is Golden Delicious with 33%, Ajdared with 25%, followed by Granny Smith and Red Delicious varieties with 18% and 11%, respectively. In Bitola municipality only a small portion of the apples sells as industrial, compared with Resen region and therefore has a higher average producer prices

by 40%. Unlike the Bitola, in Resen the most typical variety is Ajdared with 68% of the total surveyed area.

The research revealed that out of the total surveyed farms, there is only one woman farm holder. This indicates a low level of gender equality in terms of ownership, i.e. the holder of the agricultural economy, but the involvement of women in production, especially labor in harvesting as a family, is a highly prevalent and an average of 33% of the total family labor. In terms of farm size in ha which is owned by farmers, farm holders by age 40 possess only 28% of the total area in the survey. By this age, the effects of learning by doing are the highest (Liu and Zhuang, 2000 in Passel and Huylenbroeck, 2007). Most of the total area, with 40%, is owned by farmers aged 48 to 54. According to the research of O'Neill *et al* (2001) in the United Kingdom, the efficiency of the farm lead by managers over the age of 48 years is negatively correlated.

Farm performance indicators

The analysis of the economic results is presented on hectare basis, on order to obtain more comparable averages.

According to the average budgets per unit area, it was determined that the fixed costs range from a minimum of 32,708 MKD/ha to a maximum of 220,213 MKD/ha, with an average of 91,713 MKD/ha. The coefficient of variation as deviation from the mean is 48.8%. The variable cost have expectedly lower coefficient of variation of 37.9%, and the values are in the interval of 42,718 MKD/ha to 322,962 MKD/ha with an average of MKD 155,154/ha. The average total cost to produce 1 ha of apples, on average amounted to MKD 246,867/ha, but if the costs for family labor are added up, the average total costs reach MKD 312,297/ha (see Figure 2). The family annual work unit, required for 1 ha of apple orchards, averages 0.5. The coefficient of variation is very high, amounting to 74.8% due to the different degree of utilization of family labor. In the entire sample, the farm of size of 0.1 ha of apple orchard, that does not use any seasonal labor, utilizes annually 0.2 AWU (around 880 hours) or 2.2 AWU if calculated on a hectare basis, which is indicative of very low productivity of family labor due to the smaller area.

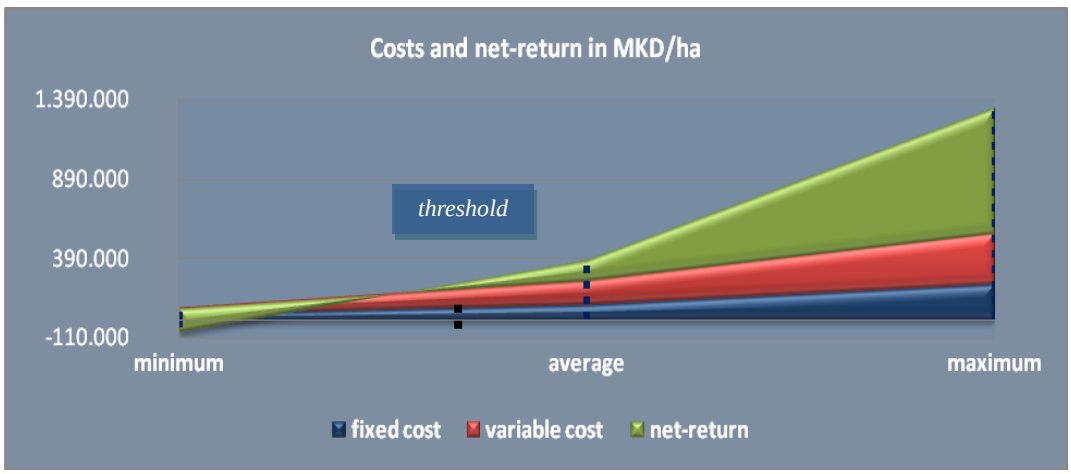


Figure 2. Costs and net return per ha

Yields per unit area range from 10,732 kg/ha to 66,250 kg/ha with an average of 31,715 kg/ha and standard deviation of 11,120 kg/ha (see Figure 4). Average yields are relatively low, when

compared with yields in France, Italy and Chile ranging from 50,000 kg/ha to 60,000 kg/ha. With regard to the farming systems with different tree densities, predictably highest yields are realized at orchards with the highest density of 1500 to 2499 trees/ha i.e. intensive plantations (see Figure 4). The trend is positive and consistent with the increase in the number of trees.

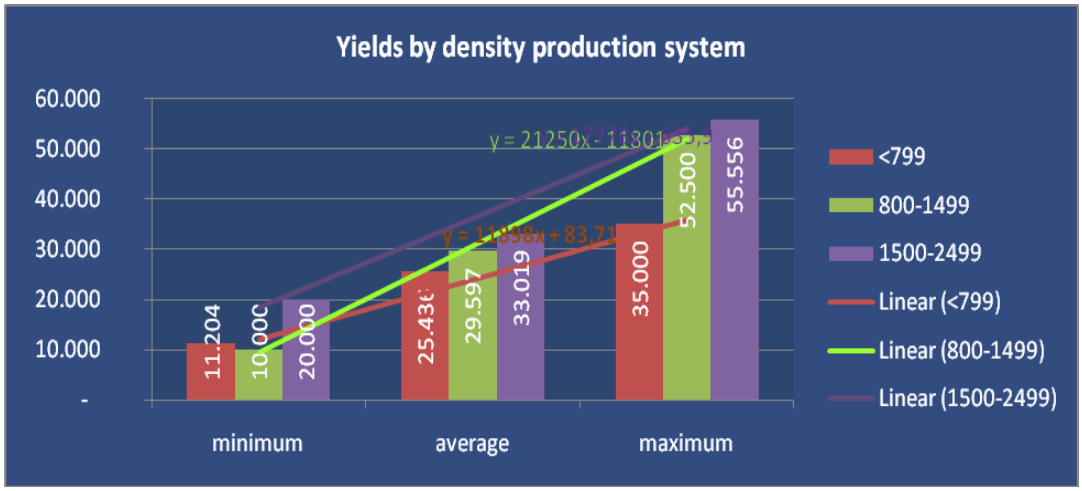


Figure 3. Yields by density production system.

The average value of the gross margin of apple plantations amounts to 291,268 MKD/ha, with a high coefficient of variation of 76.2%, which indicates a large deviation from the mean. In the structure of total revenue, 35% is the share of variable costs and 65% is the share of gross margin (see Figure 4), which is generally a good indicator and indicates the ability of farms to cover fixed costs and to accumulate profits.

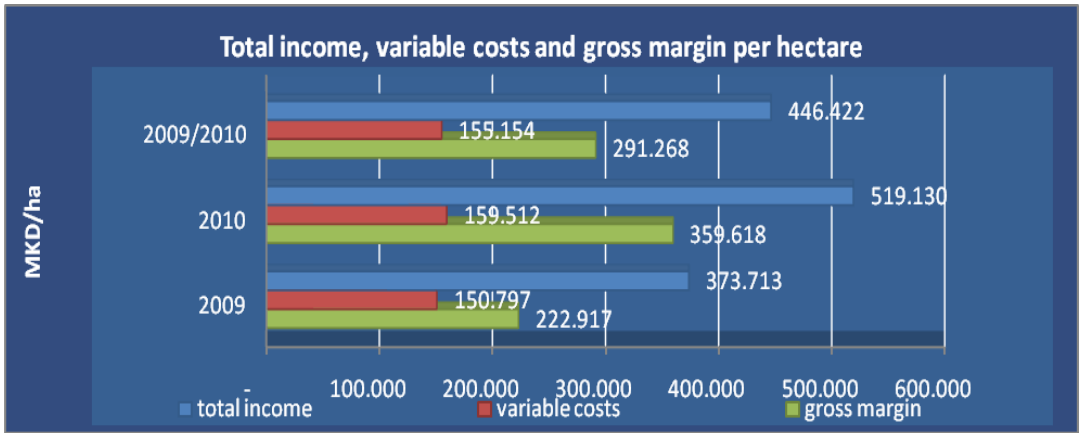


Figure 4. Total income, variable costs and gross margin per hectare

With the inclusion of the fixed costs, we get the financial result as the sum which remains on the farm and has average of 199,555 MKD/ha. The maximum value reaches 907,974 MKD/ha, but there are also a number of farms with very low profitability where the net profit is at a break-even

level i.e. the difference between total costs and total revenues is negligible. These family farms are in most cases dealing with other activities and the production of apples is on a very small area. Family labor, which occurs as the opportunity cost, in practice rarely is calculated as a real cost, but when included as cost in the calculations, it significantly affects the results; in farms with low margin, with the inclusion of family labor as cost, the net margin becomes negative, reaching -148,980 MKD/ha or -139,613 MKD/farm (see Figure 5).

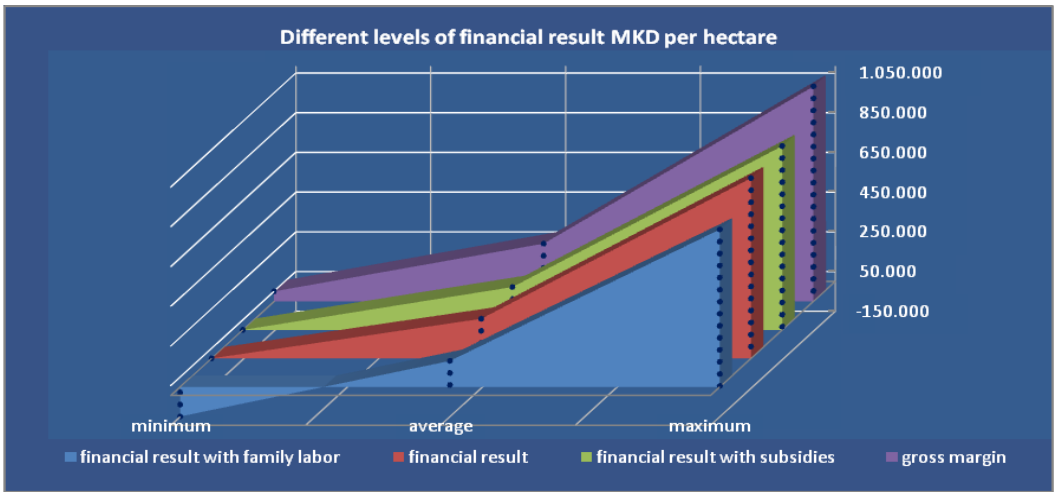


Figure 5. Different levels of financial result per hectare

The average cost of production at variable costs level amounts 5.1 MKD/kg of apple, while the full cost of production including both variable and fixed costs is higher by 36% and it reaches 8.1 MKD/kg. With the addition of family labor, i.e. its valorisation as opportunity cost, the average cost sums up to 10.3 MKD/kg. The weighted average purchase (producer) price is 14.9 MKD/kg, in which the cost of production including the family labor participates with 69%. Figure 6 gives visible representation of the in cost of production at different cost inclusionn levels.

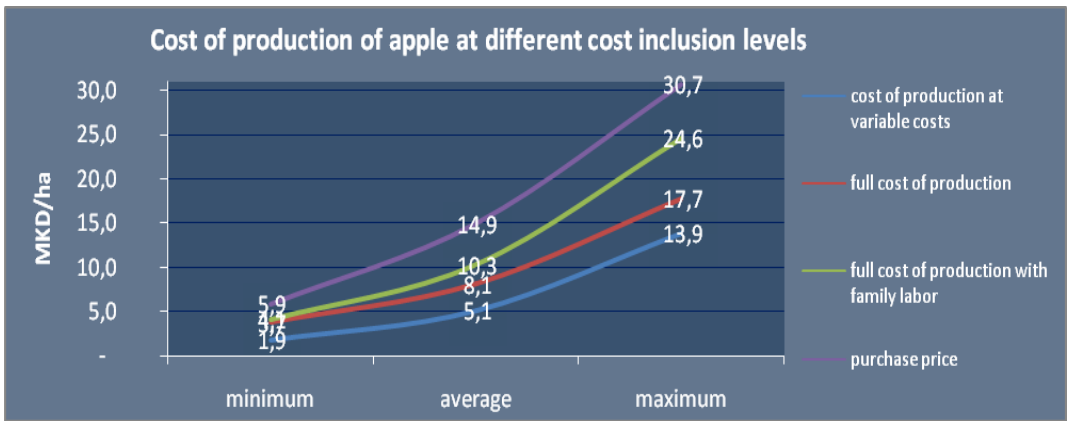


Figure 6. Cost of production of apple at different cost inclusion levels in MKD/ha

The average economic efficiency of production in output - input value terms has a coefficient if 1.9. The lowest value in the sample is 1 representing farms that have a value of production equal to the amount of costs incurred, while the highest coefficient is 4.3. Subsidies do not have a significant impact on increasing the average value of the coefficient, but only cause a slight increase in the maximum.

The level of economic effectiveness, determined by the rate of profitability, is 43.4%. The coefficient of variation is 176%, which indicates huge difference in the degree of profitability among farms.

Table 1. Performance indicators of apple producers

Indicator	Year	No of farms	Area	M_x	Max	Min	SD	CV
Production efficiency (output value/ input value)	2009	39	78.1	1.6	4.1	1.0	0.8	50
	2010	39	78.1	2.1	4.3	1.0	0.9	41
	2009 /2010	39	78.1	1.9	4.3	1.0	0.9	47
Production efficiency, incl. subsidies (output value/ input value)	2009	39	78.1	1.6	4.1	1.0	0.8	50
	2010	39	78.1	2.3	4.5	1.1	0.9	39
	2009 /2010	39	78.1	1.9	4.5	1.0	0.9	47
Profitability rate (%)	2009	39	78.1	36.1	317.4	0.01	67.0	185
	2010	39	78.1	50.7	406.9	0.5	83.9	165
	2009 /2010	39	78.1	43.4	406.9	0.01	76.2	176

Based on the data concerning costs, yields and income (taking into account the area with apple plantations), an average analytical budget was constructed for the two studied regions for years 2009 and 2010. The analytical calculation gives a clear overview of the cost structure. The largest share of the total costs represented by 25.6% is due to plant protection, or 41% of total variable costs, followed by the depreciation of the machinery with 17% of the total cost or 46% of the total fixed costs (both cost items in total occupy 43% of the total costs). It is also important to stress the seasonal labor costs which amounted to 11.2% of the total costs; this is indication of the labor intensiveness of apple production (see Table 2). Accounting for 8.1% of the total cost is for fuel for machinery.

Table 2. Apple enterprise budget, average by location for 2009/2010 per hectare in MKD

	Resen average	Bitola average	Resen/Bitola average	Total
No. of farms (total)	27	12	39	39
Farm area (total)	62.2	15.9	78.1	78.1
Yield/ha	32,423	30,120	31,715	
Purchase (producer) price	12,3	20,5	14,8	
Income/ha	398,959	617,853	470,337	
	Resen average	Bitola average	Resen/Bitola average	Cost Structure
1.Variable costs/ha	153,116	159,741	156,428	62.6%
Manure	1,056	1,504	1,280	0.5%
Fertilizer	12,171	15,066	13,619	5.5%
Plant protection	66,726	60,946	63,836	25.6%
Machinery fuel	13,718	26,678	20,198	8.1%
Irrigation fuel and irrigation fee	6,198	10,830	8,514	3.4%
Packaging	15,034	16,769	15,901	6.4%
Hired labor	31,701	24,361	28,031	11.2%
Storage at third party	925	1,033	979	0.4%
Maintenance and repair	3,971	2,350	3,161	1.3%
Soil analysis	231	205	218	0.1%
Other costs	1,385	0	692	0.3%
2. Fixed costs/ha	89,239	97,280	93,260	37.4%
Depreciation of machinery	32,852	52,043	42,447	17.0%
Depreciation of buildings	22,253	16,803	19,528	7.8%
Depreciation of apple plantation	16,988	7,055	12,021	4.8%
Taxes, gross salaries, fees	16,928	19,688	18,308	7.3%
Other fixed costs	218	1,692	955	0.4%
Total costs (1+2)	242,354	257,022	249,688	100.0%
Total income – total costs	156,605	360,832	220,650	
Cost of production at variable costs per kg	4.7	5.3	4.9	
Cost of production at total costs per kg	7.5	8.5	7.9	

Conclusions

The favorable climatic and soil conditions, as well as a long tradition of growing apples, provide huge potential for the development of this sub-sector in our country. There is still lack of investments; the variety structure needs to be changed in line with the consumer demand, and change is needed in terms of up to date practices and technologies for growing apples.

The low productivity and high cost of production of apples emerge as major constraints to competitiveness in domestic and world markets, mainly because of inadequate and old fashioned cultivation practices, and reduced levels of application of inputs and technologies.

The research aimed to determine the performance operations of individual farms which are engaged in production of apples. The survey was limited to the Pelagonia region, where the apple production is the largest in the country. Overall, the findings reveal that the total income out of apple production on the individual farms can cover the production costs and accumulate profit. Exception is made by the findings when family labor is included as opportunity cost hence causing some farms to have negative financial results. The average yields are still relatively small (around 32 tons/ha) and could be increased. According these findings, the high-intensity way of cultivation is a prerequisite for increasing the competitiveness of the sector, due to higher yields per unit area and lower costs in the regular fruit bearing, as compared with other systems. Of the total area surveyed, the high-intensity farming is represented only by 1%.

Apple producers need to improve the production management and technology through education and information, with special emphasis on reducing costs and improving the quality of product. The plant protection should be well balanced and new methods could lead to decreasing the costs. Also, the cost of labor is high with share of 11.2%, without the involvement of family labor, which can be reduced by using farming systems that require less labor investment, especially in the cutting phase and harvesting, such as the super intensive systems.

From the findings of the performance and the social demographic aspects, younger farmers need to be more involved in managing the farm.

Farmers do not keep regular records, which further complicates the management of the farm. Not being aware of the farm performance does not allow making timely decisions and adjustments in the farm management. Therefore, it is a strong recommendation to farmers that want to operate commercially and successfully to maintain and improve the agricultural holding by keeping records.

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ЕКОНОМСКА АНАЛИЗА НА ПРОИЗВОДСТВОТО НА ЈАБОЛКА ВО МАКЕДОНИЈА: ПРИМЕР ОД ПЕЛАГОНИСКИ РЕГИОН

Марија Ѓошева Ковачевиќ, Александра Мартиновска Стојческа

Апстракт

Производството на јаболка во Република Македонија, има најголемо значење од сите овошни култури, земајќи ги предвид извозната вредност, производството и површините со јаболкови насади. Поволните климатски услови, како и долгата традиција за одгледување на јаболка, овозможуваат голем потенцијал за развој на оваа овоштарска гранка. Ниското ниво на продуктивност и високите цени на производството, на јаболка, се јавуваат како главни ограничувања за конкурентност на домашниот и светските пазари, главно поради неадекватни и застарени култивациски практики и применети технологии. Истражувањето го адресира економскиот успех на работењето на семејните земјоделски стопанства. За целите на анализата, спроведено е теренско истражување на 39 фарми од Битолскиот и Ресенскиот регион кои се занимаваат со производство на јаболка, за производната 2009 и 2010 година. Покрај стандардните индикатори на успех, како социјални и економски фактори, кои се анализирани како влијаат на успехот на работењето на производителите на јаболка, земени се предвид големината на површините, возраста на фармерот, сортите на јаболка и локацијата на земјоделските стопанства. За обработка на податоците, користени се методите на дескриптивната статистика, како и емпириските методи на анализа на податоците. Наодите од анализите покажуваат дека јаболката се произведуваат на мали површини, со многу високи трошоци на заштита и сезонска работна сила. Економскиот успех на фармите зависи од сортната структура како и применетите технологии за одгледување на јаболковите насади. Возраста на фармерот – менаџер има низок степен на корелација со успехот на работењето на фармите, додека, пак, фармите со поголема економска големина имаат поголема успешност во одгледувањето на јаболковите насади.

Клучни зборови: производители на јаболка, економска анализа, пелагониски регион, показатели за оцена на успехот.

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Original scientific paper

AGRICULTURAL E-COMMERCE IN TURKEY

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Abstract
Electronic commerce has been growing rapidly in recent years. Definition of trading has renamed and marketing field has changed. Industrial society transform into informational society so that marketing replaced with electronic commerce. Turkey has a big agricultural potential. Agricultural e-commerce in Turkey is observed in this study.
Key words: Agriculture, E-commerce, Turkey.

Introduction

Needs of people are endless. To satisfy these needs, new things are developed in every single day. These developments are not common in the agricultural marketing. In recent years, developments in communication and technologies have created radical changes in marketing. The inception of these changes is the E-Commerce (Electronic Commerce) comes a great deal, as it has recorded significant success in volume of sales at real time. E-Commerce is simply to buy and to sell goods and services using the online platform. At the same time manufacturers are making real online sales cutting off the burden of many intermediaries in the marketing chain. Despite the proliferation, e-commerce in the field of agricultural development is very slow, due to the characteristics of agricultural products and the literacy level of agricultural producers. Agricultural E-commerce has not recorded significant progress as highlighted earlier but it has great potentials for marketing agricultural products in Turkey. It is expected that the importance of the agricultural e-commerce will increase with the help of developed technology and access which is prevalent among Turkish farmers. In this study, understanding that internet is an important indicator for the success of e-commerce in agriculture, and the attendant increase in its usage within Turkish farmers some of whom does high exports and imports the Turkish agriculture is a potential case to study the weaknesses and strengths of e-commerce in agriculture and also as a model to test the validity of such venture.

Material and methods

In this study, literature search was conducted besides thesis and essays, international and national resources, statics (TUIK) and internet resources was used.

Results and discussion

Definition of Electronic Commerce, Elements and Kinds of Electronic Commerce
What is Electronic Commerce (e-commerce)?
Trade is defined as the purchase or sale of goods and services. If this process happens electronically on the Internet, it turns into e-commerce. E-commerce is defined in various ways due to the multi-

faceted concept. OECD defines E-commerce as individuals and institutions related to all commercial transactions over computer networks. Apart from OECD, ECOM defines e-commerce as design of products, manufacture of products, presentation of products and all commercial actions till the customer receive the product. So E-commerce businesses, households, individuals, public or companies, institutions and organizations purchasing a property over computer networks is defined as the E-commerce (ETTK, 1998:5).

Importance of E-commerce

Increase in the supply of goods and services, on a global scale makes it difficult for the competition in the business world. Businessmen change their way of working and organizations for adapting to it, so they remove the barriers between company-customer-supplier by using the internet and e-commerce to (KANAT et all., 2002).

E-commerce provides the opportunity for small and medium-sized enterprises to enter new markets and it increases competitiveness. E–commerce increase selling and buying process, decrease cost of marketing and also it helps to communicate between the buyer and the seller. Because of increasing the exchange of information, it helps to increase the efficiency of business processes (TÜFEKÇİ, 2003).

E-commerce, both in the process of payment and fulfillment of the commitment have its own unique features. Consumers' concerns about security of e-commerce on the internet have decreased. The best indicator of this is the increase in the volume of e-commerce in recent years.

Elements of E-Commerce

Any product or service is sold generally in the web page. In the e-commerce generally the credit card is used because cash isn't accepted. To do this, the credit card number must be provided. There are a lot of payment methods to ensure the safety of this number between the seller and the bank.

In E-commerce, delivery is usually provided with an independent logistics firm. Ordered or purchased the product is delivered to the recipient by shipping companies. To transfer software, text and data from computer to computer, the mechanisms of downloading files are used as a tool.

There are some similarities between classical marketing and electronic marketing. These similarities are accepting the return products, fulfilling the warranty and etc.

Customer Support system which customers pay more attention is an important element in an electronic environment. The questions frequently asked about the product pages, e-mail and electronic forms are part of this system. (KANAT et all., 2002).

Basic Tools of E-Commerce

Telephone, fax, television, electronic payment and money transfer systems, electronic data interchange systems (EDI) and the internet are the basic tools of E-commerce. Among them the internet, the most effective in terms of internet e-commerce, is considered to be the most important tool. Because the production of a service, advertisement, purchase intake, payment and delivery can be made only online. Internet is preferred in the e-commerce sector. Because it has an opportunity to transmit audio, a video and a written text quickly in the same time and these processes are cheap on the internet (ÖZDEMİR, 2012).

Kinds of E-Commerce

According to The Activities of E-Commerce - Electronic commerce is divided into two groups according to activities. Indirect e-commerce and direct e-commerce.

Indirect E-Commerce - Indirect e-commerce, electronic ordering of goods with traditional ways (e.g., mail service and commercial couriers) is in the form of the realization of the physical delivery.

Indirect e-commerce depends on external factors such as transportation system, monetary system, customs system. (KANAT et all., 2002).

Direct E-commerce - Direct e-commerce, non-physical goods and services (computer programs, entertainment and cultural content, audio-visual works, which also provides information on various topics, services, consulting services, etc.) orders, payment and delivery is carried out on-line. Direct e-commerce which can be completed beyond the geographical boundaries is an electronical process (KANAT et all., 2002).

According to Sides of Electronic Commerce

E-commerce From Business to Consumer - Business to business services, e-commerce functionality for the consumer, business and trade relations and transactions between the clients are conducted on the web. The aim is to sell goods and services to target groups. As a result of rapid developments in technology, the "Virtual Store" companies started to sell the product like PC, car, pizza, and book etc. directly to the consumer with applications in electronic form on the Internet. Companies like Dell, Amazon.com, eBay, are examples of these services (KANAT et all., 2002).

E-commerce From Business to Business - It is the form of e-commerce which is the most common. The purpose of e-commerce from business to business is defined as giving orders to supplier firms electronically; paying bills cost of the products (ÖZDEMİR, 2012).

E-Commerce From Business To People - The most important examples of e-commerce from business to people are public tenders which are published online. With the aim of supporting the spread of e-commerce payment of taxes, customs procedures are carried in the virtual world (KANAT et all., 2002).

E-Commerce From Person to Public - The applications like driver's license, passport applications, social security, contributions and tax payments can be formed in the virtual environment with the e-commerce from person to public.

E-commercial in Turkey

The volume of e-commerce, that was mentioned previously, has grown rapidly in recent years. As shown in the volume of e-commerce in Turkey in the graphic 1, according to the previous year, recording a 50% increase in nominal and inflation-adjusted figures are 36% of the volume of real growth in 2011. Although there is not the same rate in 2012, in August the total e-commerce volume increase of 36% according to the previous year it is estimated that it will be around 31 billion Turkish Liras.

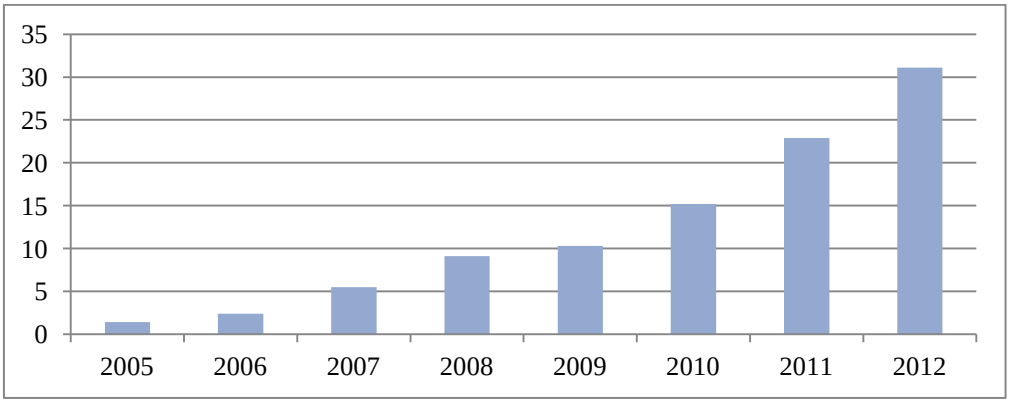


Figure 1. Volume of E-commercial by years

Source: The statistic of The Interbank Card Center in Turkey, 2012

In spite of the annual growth rate of the volume of e-commerce, in the Graphic 2 it is seen that there are some fluctuations, outputs and reductions in some months. Monthly fluctuations have had same trend since 2009. As a result, in case the data containing the same shopping categories continue with the same calculation methods decrease which started in August seems to continue in September, October and November.

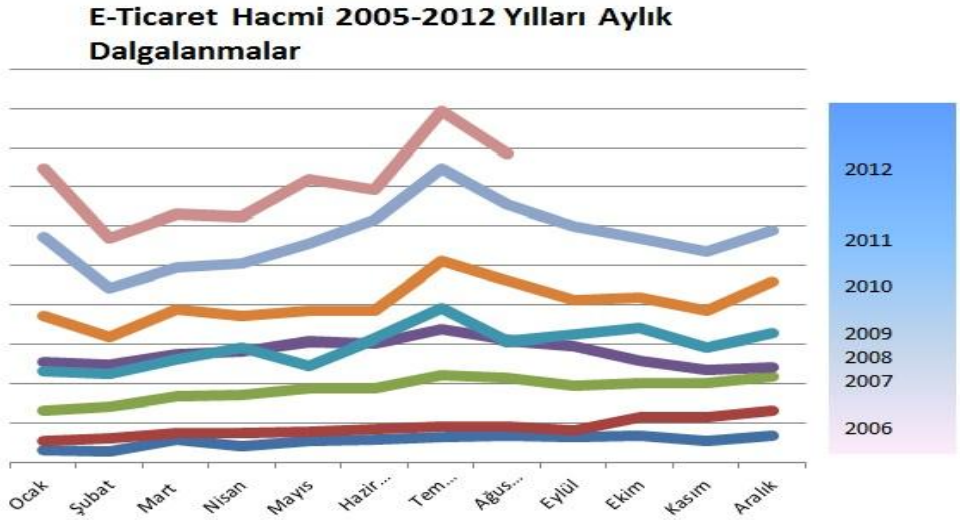


Figure 2. The volume of e-commerce monthly fluctuations in 2005-2012
Source: The statistic of The Interbank Card Center in Turkey, 2012

Potential of Agricultural E-Commerce in Turkey

E-commerce is not only for the production and the service sector, but also for the agricultural sector in terms of knowledge and market position, as well as offering new resources. For Internet can be said that the application both agricultural producers and agro-based companies operating in industries located in the most important of the benefits of e-commerce. Apart from this, of course, a wide variety of internet supply chains for agricultural products, the creation of a new improved agriculture, transport sector, the development and activation of the agricultural information easy, cheap and fast way to access will continue to be the most effective tool.

E-commerce applications in the agricultural sector, especially in European countries and the United States have developed rapidly. According to do 2000's statics, one of every 25 agricultural farms in the United States uses internet to products to market and provide input. Again, in 1999, trade in agricultural products on the internet while 4% in 2004, this rate increased to 12%. Turkish agricultural sector, protect the important position in international markets and trade in agricultural products sourced to adapt to the conditions of competition, information technology must keep up with the rapidly growing information technologies. These harmonies in any area related to agriculture, especially in the marketing of new products in markets that have the potential demand are required to perform.

Numerous manufacturer of agricultural inputs, the main distribution channels, resellers and millions of agro-based industry with a large number of the manufacturer and also quite large, but scattered in the agricultural sector, which has a structure not allow for an efficient supply chain, the others that

weak ties between buyers and sellers, and in which commercial relationship, so buyers often give up the e-commerce vendors. For all this, as well as agricultural production is seasonal, and the decisions of national or international agricultural policies, depending on the fluctuations in the quantity and efficiency of production may lead to instability.

The design of the traditional nor the farmers nor the retailers and wholesalers with input providers as equal parties have not been trading partner. Another problem is in terms of the results from an examination the development process of e-commerce enterprises and enterprises in other sectors in the agricultural sector. Looking at the process of this development is that sales of agricultural enterprises over the internet is limited compared to other businesses, in other words, directly to the final consumers of agricultural producers, retailers and agricultural product processing enterprises than in other sectors, companies have reached a degree of limited. All this, as well as due to the traditional structures of agricultural holdings, capacity (capital, labor, or expert) in designing for the web site to open is not at the same level as other businesses. In short, farmers cannot do the same things when they are offline in contrast to online. In this context, the scope of e-commerce as a customer to identify the farmers would be more realistic. Despite all these disadvantages, the global economic and technological changes in the agricultural sector are inevitable reflections. Without limitation of time and space, with the development of online virtual market can be said that e-commerce will create a revolution in agriculture. Firms in the agricultural sector between the fields of electronic commerce can benefit from input sales, marketing information, the output sales, service support and management tools support (Alüftekin and Gülçubuk, 2012).

Conclusions

With the development of electronic commerce in the world of technology is evolving. Development of electronic commerce not only with the increase of the amount of purchases made in electronic, but also understood that the increase in the diversity of shopping. Especially in countries with a high potential for agricultural production, a number of agricultural products is expected to increase the importance of exchange of e-commerce.

In E-commerce, Small and medium can enter the marketing easily. This situation creates a positive impact on increasing competition. E-commerce between the producer and the consumer in a way they tried lowering effect of decreases.

A rapid increase in the volume of e-commerce in Turkey over the years is shown. Given Turkey's current agricultural production potential of trade in agricultural products is expected that the increase in electronic commerce. Turkey's current agricultural production potential is concerned, however, trade in agricultural products is expected that the increase in e-commerce trade in agricultural products and agricultural enterprises have their own unique features are available because of some problems in the development of e-commerce in agriculture. Despite these issues in the agricultural sector in Turkey between manufacturers and retailers, consumers, intermediaries, which will establish a direct connection to the development of e-commerce applications, will lead to fundamental changes in the agricultural sector. For these reasons, agricultural producers and consumers to adopt e-commerce applications, to work towards the implementation of a fast are recommended.

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ЗЕМЈОДЕЛСКА Е-ТРГОВИЈА ВО ТУРЦИЈА

Илајда Појраз, Бурак Озторнаци

Апстракт
Електронската трговија рапидно расте во последните години. Дефиницијата за трговија е преименувана и областа на маркетинг е променето. Индустриското општество е трансформирано во информациско општество со што маркетингот е заменет со електронска трговија. Турција има голем земјоделски потенцијал. Земјоделската е-трговија во Турција е анализирана во оваа студија.
Клучни зборови: Земјоделство, Е-трговија, Турција.

UDC: 338.439.4:664.12(560)
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THE HISTORICAL DEVELOPMENT OF SUGAR SECTOR IN TURKEY

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Abstract
Sugar sector is an important sector for all countries in the World. And Turkey is an important export country. But Turkey has started to lose the role of export since 2000. This study analyses the production of sugar sector in Turkey with historical point of view, in order to understand the reasons of this change.
Key words: Sugar Production, Sugar Beet, Turkey Sugar Sector.

Introduction

Sugar is produced by various products but generally by sugarcane and sugar beet. World sugar futures prices are determined by sugarcane which constituted 82% of the sugar produced in the world and is low cost which has a dominant position in trade. Because of the climate, instead of sugar cane which is a cheap raw material, sugar beet which is a strategic product, is produced in Turkey and Europe. Sugar beet hasn't opportunity to compete with sugarcane in the export markets. So sugar beet is produced by intending not trade but also self-sufficiency. Although Turkey is self-sufficient as far as sugar production is concerned, in some years there have been an obligation for importation. Although the Turkish population has increased approximately %1.5 per year, the fluctuations observed in an abroad regarding sugar consumption (Konyali, 2001). Therefore, the agricultural policies applied by state concerning sugar production need to be re-assessed and in the historical process, the sector of the sugar which has changes should be presented. This study tries to observe the development of sugar beet production and sector in Turkey. Especially in Turkey, through the post-1980 neo-liberal economic policies, examination of the radical changes in the sugar industry are useful for countries experiencing similar processes.

Material and methods

The production, the consumption, the import, the export and effective policies of sugar and sugar beet are examined in this study. In these context national and international researches, theses, editions and articles are observed. The effects of policies formed in sugar sector are observed with the macro variables in the period of the historical development. Secondary data is used in the study. This data is obtained from Turkey Statistical Institute, FAO, The Word Bank, institutions and organizations.

Results and discussion

General State of Sugar Sector in the World

Production and Consumption in the World

Sugar cane, sugar beet and starch-based sugar which are obtained from starch- containing plants are three sources for sugar in the world. But sugar is produced by sugar cane around the world.

According to the FAO's data, approximately 80% of sugar is produced by sugar cane and 20% of sugar by beet. Starch-based sugar's production is low the world. Sugar is produced in almost all the countries because it is a strategic product. The source which the countries choose to produce sugar is about these countries' geographical location and climatic conditions. Sugar production by sugar cane is common. Because production by sugar cane is cheaper and sometimes sugar production by sugar beet isn't convenient for all countries.

In the world, sugar is produced by sugar cane in 73 countries and by sugar beet in 43 countries. The sugar cane which can be grown in tropical and sub-tropical regions is used for sugar especially in Brazil, in Mexico, in India, in Thailand and in Austria. Because of the climatic condition, beet is grown in the majority of European countries, in Russia and in Turkey. Besides, both sugar cane and sugar beet are grown in USA, Japan and China (Şeker-İş Sendikası, 2011).

Table 1. World Sugar Balance

World sugar balance october / september (thousand tons, white sugar equivalent)				
Period	Production	Consumption	Import	Export
2003/04	130.871	132.892	40.946	41.478
2004/05	129.537	135.062	44.273	44.328
2005/06	138.151	140.132	44.508	44.322
2006/07	152.917	143.927	44.884	45.075
2007/08	153.747	147.847	44.295	44.393
2008/09	140.283	151.021	46.063	46.064
2009/10	147.663	153.258	48.661	48.639
2010/11	155.439	154.255	46.143	46.632

Source: T.Ş.F.A.Ş 2010 Market Report

In the period between 2003 and 2010, the production is wavy. The reason of the recession between 2008 and 2009 can be climatic condition. When the consumption of the sugar is observed, it can be seen that in some years the consumption of sugar is more than the production of sugar. So it can be explained with stock. In almost all countries, sugar is stocked because it is a strategic product.

Brazil is a country which produces sugar the most. India, China, USA, Germany and France follow Brazil in the production. It has been stated before that the sugar is produced by sugar beet in the countries, the members of the EU and in Turkey. The data about sugar beet production is given in the tableau 3.

Table 2. The Main Sugar Producing Countries in the World (Beet+Cane) (Thousand Tons)

The main sugar producing countries in the world (beet+cane) (thousand tons)							
Period	Usa	Argentina	Australia	Germany	Belgium	Brazil	China
2002/03	7.601	1.733	5.609	4.393	1.107	23.652	11.611
2003/04	7.847	1.920	5.314	3.907	1.118	26.359	10.894
2004/05	7.145	1.857	5.528	4.803	1.078	28.266	9.864
2005/06	6.714	2.217	5.397	4.627	999	27.815	9.581
2006/07	7.661	2.459	4.731	3.606	856	32.495	13.038
2007/08	7.394	2.204	4.635	4.295	1.008	32.984	16.131
2008/09	6.833	2.449	4.601	3.560	787	34.755	13.513
2009/10	7.210	2.256	4.525	4.310	889	35.365	11.672
2010/11	7.560	2.470	4.600	3.625	750	39.950	12.750

Source: Pankobirlik‘s data base, http://www.pankobirlik.com.tr/Dosyalar/Resim/Istatistikler/d4.jpg.

Table 3. World Sugar Beet Planting Area and Production Quantities

In 2010 world sugar beet planting area and production quantities (ha, tones)		
Countries	Planting area	Production
France	383.479	31.874.800
United States of America	467.858	29.060.800
Germany	367.000	23.858.400
Russian Federation	923.800	22.255.900
Turkey	328.651	17.942.100
Ukraine	492.000	13.749.000
China	219.000	9.296.000
United Kingdom	118.000	6.527.000

Source: FAO, 2012

Seen the sugar beet sown area and the production, Turkey is a country which has an important part in the sowing area and the production.

Import and Export in the World

As white sugar equivalent, about 50 million tons of sugar place in the foreign trade. In the period of 2009 /10, the ten countries which have the most export and import and the amounts of export and import are given in the table 4.

Brazil is the leader country in both production and export. It has a big part in the world sugar export. EU, India and USA take the first place in the import.

Table 4. The Ten Countries Which has the Most Export and Import in The World

In the world, the exporting and importing countries, 2009/2010 (Thousand Tons, White sugar equivalent)			
Exporting countries	Amount	Importing countries	Amount
Brazil	24.173	EU	3.422
Thailand	5.083	India	3.404
Australia	3.413	USA	2.277
EU	1.863	Russia	2.259
Guatemala	1.633	Indonesia	2.240
United Arab Emirates	1.569	United Arab Emirates	1.730
Colombia	902	China	1.610
South Africa	754	Algeria	1.440
Switzerland	727	Iran	1.403
Cuba	566	Canada	1.380

Source: The Future of Sugar, Şeker-iş Sendikası, 2011

Sugar Prices in the World

Supply and demand determine the sugar prices in the world. Speculation, oil and commodity prices, energy policy, exchange rate changes, interest rates, trade policies and agreements preference, inflation, political and financial turmoil, countries' economic situations are also important for determining the sugar prices. If the produced sugar's amount is lower than the demand, stocked sugar amount decreases. So this causes higher prices. The opposite of this event causes lower prices (T.Ş.F.A.Ş Market Report, 2011).

Table 5. White Sugar Prices in the World 2002-2010

Years	Fob european ports us $ / ton london stock exchange
2002	228,26
2003	213,75
2004	212,37
2005	275,61
2006	358,50
2007	321,40
2008	394,00
2009	485,46
2010	549,90

Source: http://www.pankobirlik.com.tr/Dosyalar/Resim/Istatistikler/d16.jpg. F.O Licht GmbH-2011

The cause of the permanent higher prices can be the policies which have been applied for 2001. But the policies aren't only factor which effect to prices. In the table 5, in 2009 and in 2010, it is seen that world sugar prices are very high. In these years, negative climatic conditions in Brazil which is the biggest producer in the world cause high sugar prices (Şeker-iş Sendikası, 2011).

Sugar Policies in the World

Food safety of sugar is provided by the government because sugar is an important nutrient and it has a floating price structure. But although sugar is an important nutrient, it isn't a basic nutrient like

rice, corn and grain. The governments apply to the sugar the same policies which they apply to these nutrients. These polices interventions guide the sugar markets. These interventions affect the global and local sugar prices, incomes and investment decisions. Sugar markets are out of the commercial arrangements GATT in Uruguay Negotiation (Bozdağ, 2007). Sugar policies of the development countries affect the developing countries. China, EU and USA's interventions to the world sugar trade effect international prices. A small part of other producer countries can protect the effects of those global markets. From OECD's (Organization for Economic Co-operation and Development) industrialized countries, only Australia opened its tariffs to the world in 1995. The policies and the target of the developing countries are different from these of the development countries. For example, Brazil tries to encourage raw materials' (sugar cane) production of the ethanol by restricting the export of the sugar. In many developing countries, the governments work as a public organization to save their sugar industries. In these countries sugar policies are formed to provide self- sufficient about the sugar. The countries like China and India pay the input subsidies directly from the state budgets (Larson and Borrell, 2001) (Bozdağ, 2007). So each country's sugar policies are observed on the basis of that country.

The Historical Development of Sugar Sector In Turkey

The Emergence of Sugar Sector and Policies Which Organize This Sector

The production of sugar in Turkey started in 19th century but in this study, the sugar sector is observed the sugar sector since the founding of The Republic of Turkey. Because the first sugar factory was set up after the declaration of Republic in 1923. In 1929, in the result of Big Crisis, The Young Turkish Republic did its first attack of industrialization. In this period, the industrialization is run by the state and "the three white" (flour, sugar and cotton) is focused on being produced in the country. The production of the sugar in the four factories since 1950, is enlarged with the development policy according to the agricultural sector and between 1951 and 1956, eleven new sugar factories were opened. This process has continued so far. With the growing population the number of the sugar factories has increased and also the more than thirty factories have been set in the sugar industry. As soon as the number of the factories increases, the production of sugar beet becomes widespread. So Türkşeker which is a state institution is set in 1935. Türkşeker is responsible for the costing of the production, the sales, the foreign trade and the by-product of the sugar which is produced by sugar beet. Each factory, which has just opened, support new cooperatives where farmers grow the sugar beet and sell this product to this new factory, operate. In 1972 Sugar Beet Growers Cooperative Central Union (Pankobirlik) was set by collecting these cooperatives.

Table 6. The number of the Sugar Factories in Turkey by Years

The Number of the Sugar Factories in Turkey by Years	
Years	The Number of the Sugar Factories
1930	4
1940-1960	15
1980-2000	30
2009-2010	33

Source: The Future of Sugar, Şeker-iş Sendikası, 2011

Since the establishment of sugar factories, the most important political change had been in 1980.

Since 1980, privatization has been started in 1980 in Turkey. The first step of the privatization of the sugar factories is taken with IMF's program which was put into effect in 1998. Dated 12.09.1999, for 17th Stand-By Arrangement in the letter of intent which is given to IMF, it is stipulated that sugar factories will be target to work with commercial purposes and treasury support will be withdrawn from Agricultural Sales Cooperatives Unions in which there is Pankobirlik. About one year later, in 18.12.2000 dated of the letter of intent which was given to IMF two months before the crisis in February 2001 privatization was determined as clear target (ÖNAL, 2010). IMF's program ended with the biggest economic crisis of Turkey's history in February, in 2001. But the privatization policies have continued in sugar sector. Privatization of all sugar factories were predicted in the program called "Transition to Strong Economy" which was prepared by the Finance Minister of that period, Kemal Derviş. With this program;

- In the first time in Turkey, the production of the starch-based sugar which is % 10 of the total sugar quota was allowed and the authority was given to the council of minister about 50% increase and decrease of this amount. (act 1),
- Business administrators who operate sugar factories, manufacturers and their representatives connected to an agreement about the purchase prices of sugar beet and the prices of sugar was released (act 5),
- An Institution of Sugar was set to organize the production of sugar and there was a group who were 7 people and some of them were private sector representatives in this institution (act 8),
- This Institution of Sugar has the authority about the total sugar production quota and the determination of the sharing this quota among the factories (act 9).

Nowadays the privatization of sugar factories haven't completed yet, it has continued. Although the privatizations in the sugar sector are postponed in Turkey, the domestic market has been still changing. With the cause of the quota of the sugar beet's production, the production of the sugar beet after 2001 is lower than before 2001. Besides of the quota of sugar beet's production since 2001; the convenience of the starch-based sweeteners was the factor which reduced the productions of sugar beet and sugar (Şeker-İş Sendikası, 2011).

The Production and the Consumption in Turkey

It is stated that both the production of sugar beet and sugar in Turkey has a very important part in the world. But the sugar beet sowing area and sugar production are observed by years, it is seen that the sector is affected by the policies.

When the table 7 is observed, it is seen that Turkey hasn't certain stability about the production and the yield of the sugar beet but the sowing area of the sugar beet has decreased in years because of the negative effects of "The Sugar Law". Although the planting area of the sugar beet has decreased, the yield hasn't decreased in the same rate. Yield tends to increase in spite of the yield fluctuations. These fluctuations affect the amount of the import and export.

Table 7. Sowing Area, Production and Yield of Sugar Beet in Turkey by Years

Sowing Area, Production and Yield of the Sugar Beet in Turkey by Years			
Years	Sowing Area (da)	Production(ton)	Yield (kg/da)
1998	5.044.930	22.282.539	4,448
1999	4.232.340	17.102.326	4.121
2000	4.100.230	18.821.033	4.611
2001	3.587.630	12.632.522	3.542
2002	3.724.680	16.523.166	4.444
2003	3.153.030	12.622.934	4.014
2004	3.153.440	13.517.241	4.290
2005	3.358.120	15.181.247	4.524
2006	3.256.995	14.452.162	4.464
2007	3.002.421	12.414.715	4.154
2008	3.219.806	15.488.332	4.829
2009	3.244.428	17.274.674	5.332
2010	3.291.669	17.942.112	5.459
2011	2.972.648	16.126.489	5.488

Source: TUIK, 2012

Import and Export in Turkey

The policies of the import and export in Turkey are determined with the rules of The World Trade Organization like all products. Besides these policies, the production of sugar and the fluctuations of the foreign exchange markets determine the import or export of sugar. With the policies which are formed through Market Access Commitments, in the export of sugar, the rate of %150 is determined for the import protection. And this rate was reduced by %10 in 2004. The rate of %135 for tariff has been given for the import of sugar since 2004. By years, the export and import of sugar beet is given in the table 8. The most important thing is that the export of the sugar beet has reduced since 2001. The import in the sugar industry doesn't mean that sugar sector is insufficient. The export of sugar in the industry consists of sugar which isn't produced in the sector or is special and is produced with a certain amount. But with the policies which is formed in the sugar sector it can be seen that Turkey has started to lose its characteristic of export in the table 8.

Table 8. The Export and Import of Sugar in Turkey by Years

The Export and Import of Sugar in Turkey By Years		
Years	Export (Thousands Tons)	Import (Thousand Tons)
2000	560.7	2.4
2001	858.8	0.6
2002	123.5	1.2
2003	188.1	0.7
2004	133.4	0.6
2005	8.1	3.9
2006	125.6	7.4
2007	38.5	4.2
2008	5.4	4.3
2009	5.1	4.3
2010	77.1	4.2

Source: The Future of Sugar, Şeker-iş Sendikası, 2011

The Prices of Sugar in Turkey

Turkey is an appropriate country for illegal sugar. Because while the prices of sugar are 370-400 $/ton, the prices of sugar are 950 $/ ton in Turkey. The world sugar prices are determined by the sugar which is produced by sugar cane. The price of this sugar is low because the cost of sugar which is produced by sugar cane is low. In USA and EU like in Turkey, the prices of sugar which is produced by sugar beet, are higher than the prices in the world market (Tuğcu; 2009). In the years, it is seen that sugar prices have increased on a current basis with The Sugar Law since 2001 when the privatization has been increased in the table 9.

Table 9. The Prices of Sugar in Turkey by Years

The Prices of Sugar in Turkey by Years	
Years	Prices(TL/kg)
2002/03	1,26
2003/04	1,43
2004/05	1,56
2005/06	1,45
2006/07	1,51
2007/08	1,62
2008/09	1,72
2009/10	1,78
2010/11	1,79

Source: Annual Report, 2012

Conclusions

The sugar sector is a strategic sector for all countries. Many countries want to product sugar as long as the climatic conditions are appropriate. The sugar is produced by sugarcane and sugar beet in the world. Although the production of sugar beet is more expensive, the countries (EU, Russia etc.) where the climatic conditions are appropriate for sugar beet prefer producing sugar by sugar beet to importing the sugar, because the development countries and the developing countries don't want to be dependent on other countries for sugar. Many countries' sugar polices are generally formed for these countries' self-sufficient. In this context, the public organizations which organize the sugar sector have an important effect.

Turkey has advantages for production of sugar beet due to climatic conditions. And these advantages have been developed with the investments in the sugar sector since the establishment of Turkish Republic. Because of these reasons, Turkey is a country which has been exported sugar so far. But Turkey has started to lose the role of export since 2000 when the effects of neo-liberal policies started to be formed in 1980s. The world sugar prices have intended to increase and The Middle East Countries like Turkeys neighbor Iran have entered in the biggest importing countries in recent years but decreasing the export in Turkey is an important loss.

The advantages of the sugar sector in Turkey are lost in the historical development because of the effects of neo-liberal policies. With this reason, the sugar policies which are specific to Turkey should be formed with the developments in the region and in the world. To evaluate current production potential, the reconstruction of the infrastructure which allows the export is so advantage for Turkey's economy.

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ИСТОРИСКИ РАЗВОЈ НА СЕКТОРОТ ЗА ПРОИЗВОДСТВО НА ШЕЌЕР ВО ТУРЦИЈА

Бурак Озторнаци, Пурен Везироглу

Апстракт

Секторот за производство на шеќер е важен за сите земји во светот. И Турција е важна земја извозник. Но Турција започна да ја губи улогата на извозник од 2000 година. Оваа студија го анализира производството на секторот за шеќер во Турција од историски аспект, за да се разберат причините за овие промени.

Клучни зборови: производство на шеќер, шеќерна репка, сектор за производство на шеќер во Турција.

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Review Article

FOOD INSECURITY AND OBESITY; TURKEY AT A GLANCE

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Abstract
Obesity is arguably a worldwide threat due to the attention the subject has received in the last decade. Rates of food insecurity have arisen and thus a link made between both food insecurity and obesity. The impact of cheap, accessible high energy food is often strongly argued in explaining these trends.
Keywords: Obesity, Food, insecurity, Turkey.

Introduction

Obesity prevalence has been rising in the world recently. Factors such as age, gender, education level and nutritional habits, characterize obesity as a disease. Diabetes, cardiovascular diseases obesity are generally named non-communicable diseases. Obesity is both resulting and causing these diseases. Prevalence frequency of those kinds of diseases is high in low and middle income countries. The incidence of these diseases is rising significantly in the Eastern Mediterranean Region. It is estimated that the regional burden of disease attributable to non communicable diseases will rise to 60% by 2020. The national income projected to be lost due to non communicable diseases such as heart disease, stroke, obesity diabetes in the Region (WHO, 2010). In China, India both under nutrition and over nutrition are increasing; this is related to growing inequalities in income and access to food (Seidell, 2006).

It seems obvious that obesity rates are related to the higher prices of health foods. This situation requires regulation and revision about the obesity prevention politics. Nutrient dense foods such as meats, fish, vegetables and fruits cost more. We can say that there is an inverse relationship between nutrient dense foods and their costs. Energy dense foods which cost low are tasty. Food additives mostly used by industrial food manufacturers, these additives enhances flavor, blend and balance total perception of other tastes. Efforts have focused on removing the offending foods from the consumers reach. Fear of toxic food environment has led to proposed taxes on fats and sweets to both discourage consumption and promote alternative healthy diets, regulating the sale of competitive foods limiting, access to vending machines (Drewnowski and Darmon, 2005).

Major public health issue related to nutrition. In addition overweight children are much more likely to become obese adults and to suffer adverse consequences associated with excess weight including decreased work productivity increased health care costs disability and premature death.

Previous studies have suggested a link between obesity and food insecurity. Possible explanations include the fact that high-fat, high-calorie food products cost less than healthful food. In addition,

food insecure households may experience disrupted eating patterns (feast or famine) that can have metabolic consequences (Martin, and Ferris, 2007).

Food Insecurity

Food insecurity is a situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life. It may be caused by the unavailability of food, insufficient purchasing power, inappropriate distribution, or inadequate use of food at the household level. Food insecurity, poor conditions of health and sanitation, and inappropriate care and feeding practices are the major causes of poor nutritional status. Food insecurity may be chronic, seasonal or transitory (FIVIMS, 2012).

Food insecurity has been defined as in access by all people, at all times to enough food for an active healthy life. We can define food security accessing healthy and adequate food at needed time. Therefore, the right to food cannot only be regarded as a means to achieve food security, but must be seen as a wider, more encompassing, and distinct objective in itself. Realizing the right to food should; furthermore, be part and parcel of rights-based approaches to development that aim to implement all human rights obligations which States have committed themselves to under human rights law (Mechlem, 2004). It is frequent in both developed and developing countries, affecting from 5% to 25% of the general population (Dastgiri et al., 2011).

A common conceptual framework of food security includes availability, access, and utilization as the 3 main dimensions that describe this condition. Typically, food availability describes the supply of food to a region or community, and food access refers to the ability of an individual or household to acquire food, either through market purchase or own production. Utilization describes the process of converting food to nutrients, which can be affected by gastrointestinal and other infections, common in places where sanitation is compromised. Low-income individuals, who often have difficult access to fresh fruits and vegetables, consume less of these foods and are more likely to be overweight than others. Neighborhood environments may contribute to this problem by providing insufficient availability of low-energy nutritious foods and excess availability of energy-dense snack foods. Shelf space has a promotional effect and large quantities of certain types of foods in neighborhood stores may affect social norms about what is acceptable to eat (Rose, 2010).

However, psychosocial factors, including maternal mental and physical health status, domestic violence, parental cooking and financial skills, parental education level, and familial social networks, also play roles in food insecurity (Bauer et al., 2012). The neighborhood food environment, broadly speaking, is also an underlying determinant of access in the sense that it affects the cost of purchasing an adequate diet. In neighborhoods without supermarkets, residents likely face higher prices for many healthy foods, because small stores typically charge more for items such as fresh produce (Rose,2010).

Obesity

Defining overweight and obesity is done by the two main types: adult obesity and childhood obesity. Diagnosing a person with obesity Body Mass Index is used. Body Mass Index (BMI) is a calculated number from a person's weight and height. BMI is an indicator for overweight and obesity. An adult who has a BMI between 25 and 29.9 is considered overweight, 30 or higher is considered obese (CDC, 2012).

There are various factors affecting obesity prevalence. Genetic factors play a lead role. Nonetheless, intake of unhealthy foods triggers rise of obesity prevalence. Genetic disorders influence may decrease with the help of healthy foods. Evidences suggest that food insecurity contributes obesity.

For this reason various factors may cause obesity but intake of healthy foods can change the path. Some illnesses and environment may lead to obesity or weight gain. Drugs such as steroids and some antidepressants may also cause weight gain (CDC, 2012). Some illnesses causes obesity on the other hand obesity causes illnesses, coronary heart disease, type 2 diabetes, hypertension, cancers etc.

More than 35% of U.S. men and women were obese in 2009–2010. There was no significant difference in prevalence between men and women at any age. In 2009–2010, 16.9% of U.S. children and adolescents were obese. The prevalence of obesity was higher among boys than girls.18.6% of boys and 15.0% of girls were obese (Flegal et al., 2012).

Morland et al. Inagami et al. have suggested that the availability of chain grocers is associated with fruit and vegetable intake and that limited access to chain grocers may be positively correlated with BMI (Chen et al., 2010). A number of these earlier studies documented that easier access to supermarkets, measured in a number of different ways, was associated with food consumption, particularly improved fruit or vegetable intakes or overall diet quality Supermarket access has also been shown to be negatively associated with obesity whereas easy access to convenience stores has been positively associated with obesity (Rose et al., 2010). As a result, disadvantaged residential neighborhoods are left with limited geographical access to food retailers, specifically those retailers that carry healthy and affordable foods.

Prevention

Centers for disease control and prevention organizes various obesity prevention programs. Including increasing physical activity in the community program, increasing the consumption of Fruits and Vegetables, Breastfeeding interventions, guides for local governments for reducing and prevent obesity, early assessment programs and policies to prevent childhood obesity (CDC,2012).

Programs like “Let’s move, family plans raising for health children, healthy meals resource system etc. are helping to prevent obesity and help individuals to be aware of obesity epidemic (USDA, 2012).

Obesity Economics

Obesity affects country economics directly or indirectly. Diagnose and treatment expenses are directly affects countries economy. Loss of work productivity and illnesses that obesity cause increases health expenses significantly. The cost of diagnosis and treatment of diseases named direct costs. Two methods have been used to calculate the direct costs of obesity:

- The fraction of incidence of diseases attributable to obesity multiplied by the costs of these diseases – total direct costs are the sum of these costs.
- The fraction of use of medical care attributable to obesity (e.g. excess consultations with general practitioners and medical specialists, excess hospitalization, excess medication) – total direct costs are the sum of these costs (Seidell, 2006).

Indirect costs are including loss of productivity, premature death and disability. These kinds of costs are complex to analyze economically. These costs are measurable; on the other hand some kind of costs affects individuals socially, mentally and physically.

Turkey at a glance

Every five years "Turkey Demographic and Health Survey (TDHS)" study is performed in Turkey. It can be seen from the results that obesity is increasing among female population. According to the results of the researches, overweight prevalence in15-49 age group women (BMI = 25-29.9 kg/m2) in1998, 2003 and 2008 was found as 33.4%, 34.2%and 34.4% respectively and the obesity

prevalence (BMI 30 kg/ m2) in 1998, 2003 and 2008 was found as 18.8%, 22.7% and 23.9% respectively. According to these results, obesity prevalence among females has been increasing 5.1% during the last ten years.

Diet quality of Turkish people differs according to regions, socio-economical status. Diet quality is a function of social class. We can say income is major determiner of diet quality. Turkish people's main food is bread and other grains. 44% of daily calorie intake is derived from bread only and 58% from bread and other grains. In years, the consumption of bread, milk-yoghurt, meat and meat products, fresh fruits and vegetables have decreased and but the consumption of legumes, egg and sugar increased. Although the amount of fat didn't differ significantly, more vegetable oil is used .In the last years in Turkey it was seen that fast food is the most preferred nutrition style especially among the children and adolescents in the urban areas. Fast food nutrition has high energy, rich unsaturated fatty acids and salt contents but poor in fiber, vitamin A and C and calcium contents so this type of nutrition leads to inadequate and unbalanced nutrition and increases the risk of chronic diseases such as obesity.

Though Turkey is currently on track to meet MDG 1c (halving 1990 rates of child underweight by 2015), it has seen a recent increase in adult obesity. Low-birth weight infants and stunted children may be at greater risk of chronic diseases such as diabetes and heart disease than children who start out well-nourished.To fight with obesity Turkey has established "Obesity Prevention and Control Program (2010 – 2014)". This program also related with food insecurity which is a cause and effect of obesity. Control program targets determining economical precautions within the budget possibilities by giving priority to the regions not developed socio-economically to improve the attainability of finding safe food which forms the basis for adequate and balanced diet in the country as a whole.

Conclusions

Preventing obesity and food insecurity is complex issue. Furthermore, government and individuals need to cooperate fighting with these issues. Multiple sectors including agriculture, education, health need to be involved and nutritious diets should have been accessible to all. First of all there is need to have strong evidence for policy. That can be possible by drawing together existing scientific information on the relationship between diet, physical activity and non communicable diseases and knowledge about interventions. Secondly, informing decision- makers and stakeholders of the problem about determinants, interventions and policy. Stakeholders need to agree on their roles and implementing a global strategy. Tailored policies and interventions for countries needed.

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НЕСИГУРНОСТ ЗА ХРАНА И ДЕБЕЛИНА: ПОГЛЕД НА ТУРЦИЈА

Пурен Везироглу, Бурак Озторнаци

Апстракт
Дебелината е голем проблем во светски рамки. Тоа се потврдува и со вниманието кое оваа проблематика го добива во текот на декадата што изминува. Како што растеше несигурноста за храна се создаде поврзаност помеѓу несигурност за храна и дебелината. Влијанието на евтината и достапна храна со високи енергетски својства, често се смета за одговорна за овие трендови.
Клучни зборови: Дебелина, храна, несигурност, Турција.

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Expert paper

ORGANIC FARMING - OPPORTUNITIES AND CHALLENGES FOR SUSTAINABLE RURAL DEVELOPMENT IN SERBIA

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Abstract
The organic production system dominant economic principles were brought into the best possible compliance with environmental requirements. This production is based on the rational use of natural resources, renewable energy, and conservation of the natural diversity of flora and fauna and the environment. It contributes to the biological balance of the soil-plant-animal. Most area under organic production in the world, is located in Australia, 12,1 million hectares, or 33% of the total area under organic production, followed by Europe with 10 million hectares or 27%, Latin America with 8,4 million hectares, or 23%. Much smaller role play Asia with 2,8 million acres, or 7%, North America with 2,8 million hectares or 7% and Africa with only 1,1 million acres, or 3%. In recent years, with the aim of improving organic production, the competent state authorities in Serbia have adopted a series of measures to legally regulate the sector, promote and implement effective control system. Despite numerous advantages for development, it should be noted that this system is suitable for the production of certain areas of our rural areas where the fragmentation of landholdings expressed. It is the main goal of this paper is to assess the potential for organic production incentives and opportunities of development of other economic activities in order to revitalize the village and the sustainability of rural Serbia. Basic economic and environmental determinants are defined using SWOT analysis.
Key words: organic products, rural areas, sustainable development.

Introduction

Relations between agriculture and nature are increasingly directed towards mutual development on an ongoing basis. Systems and methods of agricultural production that are contrary to the usual - traditional or conventional production, known as alternative, ecological, biological or organic farming (Kovacevic et al., 2005). Based on the rational use of natural resources, renewable energy, conzervation of the natural diversity of flora and fauna and the environment. It contributes to the biological balance of the soil-plant-animal. In fact, the organic production system dominant economic principles were brought into the best possible compliance with environmental requirements (Sredojević e*t al.*, 2000, Sredojević 2002). In recent years, with the aim of improving organic production, the competent state authorities in Serbia have adopted a series of measures to legally regulate the sector, promote and implement effective control system. Despite numerous advantages for development, it should be noted that this system is suitable for the production of

certain areas of our rural areas where the fragmentation of landholdings expressed. It is the main goal of this paper is to assess the potential for organic production incentives and opportunities of development of other economic activities in order to revitalize the village and the sustainability of rural Serbia. Basic economic and environmental determinants are defined using SWOT analysis.

Material and methods

For any research in this paper used the data of statistical records in Serbia, and publications evidanije FIBL's, then records of the Ministry of Agriculture, Forestry and Water Management of Serbia, sites of major institutions, manufacturers and distributors of organic food sources of domestic and foreign magazines and other publications, and by anecdotal evidence from the field in practice. In analyzing the dates are utilizing statistical parameters and methods, as well as a SWOT analysis. Results are expressed and value and interpreted through relevant economic indicators.

Results and discussion

Condition and performance development of organic farming in the world and the EU

According to economic indicators, today organic production is becoming increasingly important. Its significance can speak with several aspects: protection of natural resources from pollution, preservation of biodiversity, and increase long-term maintenance of soil fertility, protection of consumers, the possibility of sustainable socio-economic development of rural areas and others. The emergence of new products and services, the purchasing power of consumers, the competitiveness of the market participants and other factors have more influence on the profitability of this production, their effects on the rates and determine the position of the market. That is why more and more talk about: the quality of the final product, the quality of coverage of the entire process of production and environmental quality. Organic agriculture in the last decade was a lot of fast-growing, while the share of land under organic production continues to rise in many countries. Areas under this form of production in the world amount to more than 37 million hectares (http://www.organic-world.net/yearbook-2012). Looking across the continents, according FIBL data from 2012, the bridge area under organic production in the world, is located in Australia, 12.1 million hectares (Australia and over 12 million hectares and New Zealand with 124,463 ha), or 33% of the total area under organic production, followed by Europe with 10 million hectares or 27%, Latin America with 8.4 million hectares, or 23%. Much smaller role play Asia with 2.8 million acres, or 7%, North America with 2.8 million hectares or 7% and Africa with only 1.1 million acres, or 3% (http://www.fibl.org / en.html). With more than 56% of the population living in rural areas (91% of the territory), rural development policy is an area that is vital to the EU. Strengthening of EU rural development policy is, therefore, an important priority for the EU. The policy provides the highest standard of environmental protection in agriculture and forestry as well as other, similar, activities.

The current policy of the EU is based on the following principles: multi-functionality of agriculture, multi-sectoral and integrated approach to the rural economy, diversification of activities, creating new sources of income in rural areas, expansion of employment opportunities, protection of resources in rural areas, decentralization, partnership at local and regional level, transparency in creating and managing development programs. EU Common Agricultural Policy (Common Agricultural Policy, the so-called. CAP) has undergone a series of reforms, which is the role of organic farming in the rural development of agricultural production became increasingly important.

Also, more importance is given to the mechanisms of financial support to organic farming, which are part of the EU rural development policy (Council Regulation 1698/2005). All funding for organic production were made possible through the three priorities of rural development, where organic farming meets all the requirements necessary for this kind of help.

The first priorities are: competitiveness, investment in farms during the conversion, training, investment in processing and marketing.

The second priorities are: payments to agriculture and environment measures (payments per unit area of organic production).

The third priorities are: invest in quality of life and economic diversification (eg, opening stores of organic products in rural areas). The main sources of funding for pre-accession countries in the period 2007-2013, relating to rural development, are the funds from the IPA (Instrument for Pre-Accession Assistance). IPA consists of five components: institutional development, regional and cross-border cooperation, regional development, human resource and Rural Development (IPARD). All the above mentioned components can use the candidate countries, and only the first two components are intended to potential candidates. Development of organic farming can contribute to clusters as "geographically concentrated groups of interconnected companies and institutions of certain activities." The formation of clusters is more, both narrower and broader, goals. Broader goals include: increasing the competitiveness, support to small and medium-sized enterprises, a policy of regional economic development and others. Among the immediate targets of concern include a group of companies, associations, business bodies, education, technology and knowledge transfer, exchange, competition, partnership enterprises and social infrastructure. The success of clusters depends on the ability of its members to develop mutual trust, are functioning together, forge partnerships, collaborate and use the options on offer. Clusters provide insight into vulnerability, as well as the ability to overcome them. Through the process of conducting business, manufacturers should be aware of the importance of continuous improvement, the use of new knowledge and technologies, increasing productivity and quality, the introduction of EU standards, the conquest of new markets. Cluster initiatives promoting innovative activities and enhance the quality of the work is based on a shared partnership.

The European Union has recognized the need for new investments in rural development dynamics in order to improve the efficiency of rural policy. In addition to primary agricultural production, the importance of which in rural areas is increasingly declining, opportunities for new activities, service sector etc. Maybe in the future urban exodus appears to rural areas. The village is offers the possibility of organizing a variety of production and living room permanent and occasionally enjoy the natural beauty and landscapes. These are the main trends in the development of rural Europe in the future. Rural development planning, in essence, is a process, which is based on research, which aims to optimize its potential contribution to economic prosperity and quality of human nature /environment. It performed on several levels in accordance with the character of economic activity with particularly important question of finding a balance between different levels of organization. Rural development has also a number of specific features - creating a balance between supply and demand, or total capacity (physical and other) in order to minimize conflict and the exploitation of natural solid foundation for the development of the economy, without degrading the environment. One of the basic prerequisites for successful planning and management of sustainable rural development is the active involvement of village communities and local people in the process. This

involvement is necessary because the natural environment is an important factor in the overall quality of life in rural areas.

The focus is primarily the relationship between the public and private sectors, and between the government and bodies, on the one hand, enterprises and other organizations that are directly and indirectly involved in rural development, on the other hand. The goals may be different: diversification of production, increasing employment, restoring traditional houses and buildings and others. Creating the necessary conditions to meet the needs, demands and desires of visitors. It is understood that rural development should lead, on the one hand, an increase in employment related to the provision of products and services for tourists and, on the other hand, to provide additional revenue for existing employees based on seasonal employment.

Organic production sector in Serbia

The fact to which attention should be paid is to develop organic production lot viewed from the aspect of European integration that Serbia wishes. Development of the sector of organic production in Serbia began in the 90s of the last century. Terra's Association in Subotica brought together producers, advisors, peoples from science and practice.The primary department at the Open University in Subotica. This association is actively working to promote organic farming in accordance with the standards of IFOAM and already in 1992 became a member of the foundation. Due to difficult economic and political circumstances and only after the political change after 2000 years, the low on Organic Agriculture and established the first certification bodies. It was later amendments and new laws and in accordance with EU standards. This law and regulations in detail, all issues related to organic production methods, control and certification, processing, storage, transportation, marketing and labeling of organic products. Compliance with standards prescribed by law and the conditions of production, processing, storage, transporting and labeling of organic products is under the supervision of the state government.

To steer their farms to organic production methods, farmers are required to indicate in advance the potential risks and opportunities for their avoidance or mitigation. Among a number of risks, in terms of economic viability and incentives for organic production, it is important to be quite realistic estimate: Will the current level of sales prices resulting products will be able to make up for lost benefits resulting from reduced production volume? Will the level of demand for organic products obtained can provide the appropriate level of profit? Whether and to what extent their fast forwarding to the organic production method enabled agricultural policy incentives, additional subsidies and the like? Therefore, it is necessary to draw up before the manufacturing process planning kalkuacija cost per unit of a planned product. In essence, it is necessary to plan the production cost per unit of yield: material - seed, fertilizer, etc.; Work mechanization, labor workers, insurance premiums, interest, contributions, etc. Based on findings of the cost, can provide an answer to the question: What is the lowest selling price of the finished product which is, in terms of producers, organic farming would be economically viable? As long as the cost is lower than the sales price, production is acceptable. What is the difference, the sooner the production is carried out with greater economic success. However, as the selling price of a product will be higher than the cost depends on competitiveness, supply, demand, parity, etc.

Association and the creation of an association of producers are also of great importance for efficient organic production. Benefits are as follows: savings in procurement of raw materials and production; savings in transport; savings in storage of goods; easier placement of goods in the market; favored in obtaining grants and borrowing. In this sector, in this day and age are active in

Serbia following associations: National Association of Serbia Organica, www.serbiaorganica.org; Green Network of Vojvodina, www.zelenamreza.org; Terras, www.terras.org.rs; Assocaition for Biodynamic production, www.biodinamika.org; NGO Natura Balkanika www.balkanika-crd.org; Organic www.organskasrbija.org.rs Serbia; Centers for Organic production in Selenca, Valjevo, Svilajnac and Leskovac, www.organiccentar.rs. Also, today in Serbia has more organization authorized to issue certificates or resertifikata for organic products, "SGS - Beograd" Ltd., "Evrocert" doo, "Bioagricert" doo, "Ecocert Balkans" doo, "Jugoinspekt Belgrade", "e Suolo salute the Balkans "," PANCERT ", Novi Sad;" Organic Control System ", Subotica.

Necessary for Serbia is, guided experience of developing countries, the application of the cluster concept to overcome the problems that led to the decline of the domestic product and national income, and that to successfully cope with international competition.

Specifics of the regions in Serbia and possibilities for organic farming

There are plenty of strong arguments in favor of creating the conditions for greater representation of organic agricultural production in Serbia. The country has natural resources, both in the plains and in mountainous areas, which can meet the requirements for the establishment of long-term organic agriculture. Then, there are social reasons that are reflected in the steadily rising unemployment, increasing poverty, migration to cities, etc.. Introduction of organic farming in Serbia, too, is a long-term requirement for the production of valuable biological products in the function of protecting human health and environmental protection as well. Looking at the specifics, and sorted according to altitude (from the lowlands to the highlands), given the generally characteristics of individual queen of Serbia.

The first region includes Vojvodina and Macva. This region is home to more than 1.5 million people, or about 37% of the total population of rural Serbia. This is a region with a well-developed economy, good infrastructure and povezanan with large centers - Belgrade and Novi Sad. Because of this, appealing to the younger population of the population coming from remote areas, and the age structure is more favorable compared to other rural regions. Although, as a result, employment in the tertiary sector is high, about a third of the employed population still works in agriculture. About one-third of households in Serbia, whose size greater than 10 ha, is located in this region. Organic food production in this region has been present since the early 90's.

The second region includes parts of central Serbia, Sumadija, part Mačve and Stig. About 15% of the total population in Serbia is living in the territory. Despite the fact that the average population density is better than in other rural areas, the problem is the high rate of population aging. Compared with Vojvodina, the region is characterized by a larger number of mixed farms and fewer non-farm households. In this area are more present holdings to 3 hectares and quite a small number of farms of over 10 ha. Representation of primary production is about 33% and was lower compared to other rural areas of central Serbia. The agricultural production is dominated by production of vegetables, fruits and livestock. In addition to agriculture, an important role is chemical and food processing, machinery, and textile industries.

Agricultural land covers 64% of the total territory, and although the relationship between labor and capital less favorable than in Vojvodina, the productivity is higher than in other rural areas of central Serbia. About 60% of arable land is used for the production of corn, which is almost entirely used for livestock feed. About 24% of cattle and as many as 30% of the total production of sheep production in Serbia are take place in this region. Engaged in cattle breeding and dealing with

smaller farms, for which the revenue from the sale of milk, the main or only ordinary income households.

Given that the total area under orchards in Serbia represented the region at 30%, traditionally a significant part of its revenue from the production of fruits and grapes. And the food industry is well developed in the structure is dominated by slaughterhouses, factories for processing fruits and vegetables, mills and dairies. From ukupng number of farms oriented to organic production in Serbia (317), in the region of more than 160, and this number is steadily increasing. This rural area is increasingly gaining in importance.

The third region includes the east, south and west and Serbia with 42% of the total territory of Serbia is the most rural region, and is generally characterized by abandoned land potential, shortages of labor, unorganized market and lack of services for specific regions. This area has 20% of the population of Serbia, but the average population density is the lowest compared to other rural areas. Every third resident adults have not completed primary education, the employment rate of the most disadvantaged in the country, and more than 35% of the employed population working in the primary sector, particularly in agriculture and mining. Realized gross domestic product per capita is only 53% of the national gross domestic product, and given the high share of primary sector, the region formed nearly 19% of GDP primary sector of Serbia. However, the national domestic product of the secondary sector, the region is represented by only 10%. Agricultural areas make up 55% of the territory, but low productivity due to modest investment holdings and equipment.

The specificity of this region has a high percentage of unused land, especially in the southeastern part of, and the reasons are unfavorable age structure of the population, lack of adequate machinery, unavailability of land and poor soil quality. Besides wheat, the major vegetable production and whose are growing raspberries in the forefront Zlatibor District, which deviates from the average in the region and cattle breeding, and the Raška district is the largest sheep growers in the country. Although the region has the greatest potential for tourism in Serbia, where some destinations like Zlatibor, Kopaonik, the Vrnjačke Spa or Guče make up over 60% of the turnover of the national tourism infrastructure problems unsolved, cause continuous depopulation of the region, its economic marginalization and a rural poverty. This is particularly pronounced in southeastern Serbia. Therefore, it is necessary to develop some other activity outside the primary agricultural production in order to execute the revitalization of the village.

Courts of the districts under certain angle, intersected, rivers and streams, with special relief, climate, vegetation, flora and fauna. This contains the largest forest, water and mineral resources. The dominant production in this area is farming. Transport and road networks are poorly developed in addition to the small goods, and limited retail market. A special feature of this area is the depopulation of villages, where almost all the municipalities affected by depopulation. Leaving the mountainous areas is still in progress. Given that within the zone are mostly natural beauty and areas suitable for winter sports, this area is very suitable for tourism development. In addition, we offer rural areas poljorivredno market - food, fruit, wood products, industry and handicrafts, these are the places for vacation, tourism and life.

Production of organic products and rural development has theirs causal relationships. They are, on the one hand demonstrate that the micro scale at the company level. On the other hand they have a general macroeconomic and social dimension.

The results of their relationships are reflected through: increased production of safe products, more appropriate land use and the risk of its excessive overutilization; employment of labor;

rehabilitation, recovery and development of rural tourism, changing traditional concepts and others. Organic production as a factor in the rural economy, making a significant contribution to the development of other related activities and that the details given SWOT analysis in Table 1.

Table 1. SWOT analysis of organic production aimed at the sustainability of rural Serbia

Strength	*Weakneses*	*Opportunities*	*Threaths*
Favorable natural resources for organic production	Under-representation of organic production	Rational use of natural resources and environmental protection	Lack of legal measures for the conservation of natural resources
Favorable conditions for the development of rural tourism	Insufficient infrastructure development	It provides the opportunity for revitalization	Unstable social conditions for the attraction of tourists
The tradition of environmental origin of specific products	Insufficient accumulation of organic agriculture	Development of secondary activities in the country	Unsure organic product placement
High unemployment and relatively cheap labor force in the country	Indifference to work in agriculture	Reducing social tensions	Labour shortages in the countryside
A large number of experts	Lack of employment in the profession	Better linking local communities	Lack of marketing education
Increasing organic products asortmana	The decline in purchasing power in the country	Exports of organic products and new markets	Further decline in the purchasing power of consumers in the country
The interest of foreign investor	Failure to comply with legal regulations	Compliance with the standards of developed countries	Investment risk and uncertainty of return
Made the National Action plan	Insufficient investment in ancillary activities-tourism, sports and others	Promote local and regional infrastructure	Gaps in control of funding priorities
Solving the existential problem of young people	Lack of financial support fo the development of organic farming	Making plans for development in certain regions of Serbia	The adverse sex structure in the countryside-the devaluation of the family
Organization of training for the production, processing and distribution of orga products	Unfavorable strategies of local communities to financ priority activities	Raising environmental awareness in the population diet	Depopularizacija villages and distrust of the political agenda

Serbia has the natural potential for producing organic food. Stages of production and sales of organic products require specific handling - detection of needs, ideas (new knowledge, development production plans, technical implementation, and product launches). How much will be a manufacturer, local communities or the entire state to deal with organic production is a question that is hard to answer. At the level of the narrower or wider region, it is a matter of strategy development, and at the producer level - individual or association of manufacturers, it is a matter of business decisions.

Support measures for organic production in Serbia

According to the Ministry of Agriculture, in Serbia there are 153 registered farms that hold organic production and 164 farms that are in conversion or total of 317 oriented to organic production. Support policies are implemented through several types of incentives: direct, structural and market. Direct incentives include: bonuses, incentives for production, regression and support non-commercial farms. Market incentives are: incentives for export, storage and loans. Structural incentives are a form of incentive that includes measures of rural development, improvement and protection of agricultural land quality and extent of institutional support. All the above forms of incentives could be determined under different conditions and in different degrees, depending on whether you are the regions with difficult working conditions in agriculture.

The right to use the incentives under the conditions defined herein have farms that are registered farms, local governments, local communities and other forms of local governments, and other persons and organizations in accordance with the law. Family farms are the main form of organization of agricultural production. Depending on its economic strength may be commercial or non-commercial. The local governments in Serbia are mainly active assistance of the Office for the village and / or the Office of the aid to farmers in different organizational forms. In most cases, the local government there is an office that helps the development of agriculture and rural areas, and it is usually employed by one person. The offices are mainly employed professionals with a university degree (agricultural engineers, veterinarians, etc.). Fundamental observation is that the one employed in the field of rural development / agriculture is not possible to make significant progress in rural development or agriculture. Following the adoption of the Law on Agriculture and Rural Development, local governments have begun with the establishment of local funds for the development of agriculture, which generally have some measure of support to rural development. Most local governments in Serbia have strategic development plans in which agriculture is recognized or rural development as a priority. However, the main problem of existing strategic plans that are not fully developed and do not have plans of action and are therefore unenforceable. In most cases there is no monitoring and evaluation of existing plans.

At the proposal of the Ministry of Agriculture, Trade, Forestry and Water Management, the Serbian government adopted a decree on the use of financial incentives to support the development of organic farming in 2012 current year

http://www.mpt.gov.rs/?lang=lat&menu_id=7). The right to use the stimulus fund has individuals-the registered holders of domestic commercial agricultural farms, companies, cooperatives, contract manufacturers (persons with whom the producers involved in organic production have concluded a cooperation agreement) and educational - educational institutions. Requests for use of stimulus funds submitted to the Ministry of Agriculture, Trade, Forestry and Water Management - Directorate for Agrarian Payments. In the case of delivery or confirmation of inaccurate information, the beneficiary loses the status of active and passive status acquired the farm in accordance with the law, the obligation to repay the amount received stimulus funds that are accounted for, legal interest.

This decree stipulates the conditions and manner of use of financial incentives to support the development of organic production. Incentive funds are used to support the development of organic farming systems, including: agricultural, vegetable and fruit and wine, which is done indoors (in greenhouses), regardless of the surface of the interior space, as well as open space for farming and vegetable production area must be at least 0.2 hectares, and for fruit and grape production area of at

least 0.3 hectares, as well as support the development of organic livestock production. The right to use stimulus funds, under the conditions laid down in this Regulation, has: a physical person - holder of the domestic commercial agricultural holdings; company, agricultural cooperatives, contract manufacturers, educational institutions of learning. Under contract manufacturers in terms of these regulations, shall be a person with whom the manufacturer, which is engaged in organic production for the needs of organic, concluded a cooperation agreement, which performs a similar type of organic production, and the production units, the area of collector are in the same geographic area. A person who is registered in the Register of Agricultural Holdings in accordance with the Regulations on the manner and conditions of registration and management of a Farm, has the right to the use of financial incentives, if the reported data on agricultural crops on agricultural land that relate to the current year, the type of and number of animals and farms where animals are kept or bred in accordance with the Rules of the authorized control organization concluded an agreement on control and certification of organic production, which is valid in the current year, that is not the same size raises funds for reimbursement of materials for agricultural and vegetable production on the basis of the Regulation on the conditions and manner of use of funds for reimbursement of materials for crop and vegetable production in the same year, was settled due to its obligations under the regulations governing the development of measures to boost agricultural production in the case of a lease of agricultural land has contract with a natural or legal person, the land owned by the state with the ministry responsible for agriculture until at least three years over the next three years on the cadastral parcels where organic farming is done for you to exercise the right incentives, applied organic production methods in accordance with the law governing organic production.

Applicants who have a manufacturing plant located in conversion eligible for incentives to support the development of organic farming in the amount of: 36,000 RSD/ha for crop production (cereals, industrial crops, medicinal and aromatic plants); 50,400 RSD/ha for vegetable production; 64,800 RSD/ha for fruit and grape production. The total amount of incentives by the applicant can not be more than 1,200,000 RSD. Applicants who are certified to produce organic plant or a plant production which was completed conversion period and are in the process of issuing certificates eligible for incentives to support the development of organic farming in the amount of: 30,000 RSD/ha for crop production (cereals, industrial crops, medicinal and aromatic plants); 42,000 RSD/ha for vegetable production; 54,000 RSD/ha for fruit and grape production. The total amount of incentives per applicant of such requests can not be more than 1,000,000 RSD.

Applicants who have livestock production, which is in the conversion eligible for incentives to support the development of organic farming in the amount of 21,600 RSD per head of cattle (for at least 4 animals); 7,200 RSD per head of sheep (at least 10 animals); 720 RSD per head of poultry (at least 100 individuals); 2,800 RSD per hive (for at least 30 hives). The total amount of incentives per applicant of such requests can not be more than 1,200,000 RSD. Applicants who are certified for organic livestock products and livestock production have been completed by the conversion period and are in the process of issuing certificates eligible for incentives to support the development of organic farming in the amount of: 18.000 RSD per head of cattle (at least 4 animals); 6,000 RSD per head of sheep (for at least 10 animals); 600 RSD per head of poultry (at least 100 individuals); 2,400 RSD per hive (for at least 30 hives). The total amount of incentives per applicant of such requests cannot be more than 1,000,000 RSD.

The possibility of directing our agriculture to sustainable development systems must be viewed as

part of the transition to a market economy in relation to technical, technological and economic power of the state. In this sense, the construction of such systems need to set priorities, primarily at the state, but also at the regional level, with the difference in quality and greater variety of agricultural products. The expansions of organic farming contribute to the modern understanding of ecology and its importance in our lives. To achieve this, we need to be working on developing environmental awareness through education of staff whose will be in future work on improving agricultural production.

Conclusions

Organic production in Serbia is more popular and economically significant, and thanks potentials that are primarily reflected in the fragmented and owned land that is not contaminated with harmful material this type of agriculture can contribute significantly to the development of rural areas, and thus agriculture in general. This is why organic farming, as one of the priorities of agricultural development and an integral part of the strategy for rural and agricultural development in the Republic of Serbia. The unfavorable general picture of agricultural production in our country is influenced by many factors, the most significant being a small farm area, high production costs, "svaštarenje" lack of information about the market, and therefore inconsistency choice of plant species for cultivation and demand, lack of quality standards disorganization and manufacturers. In addition, our manufacturers procure our raw materials at unfavorable prices, which could affect the final price of the product and their lack of competitiveness in the market. Since few of them organized in associations, self-producer who comes out on the market can not have a continuity of supply of goods, their quantity, and sometimes quality that requires large retailers and processors. Accepted criteria for assessing the effects of organic products are: originality, value added, return on investment, fit with existing activities, creativity and innovation, increased market share, projected cash flow and profitability. Organic food production in all developed countries is booming. In our country it will develop in the future, regardless of whether and how much the state support. Development of organic pproizvodnje should contribute to the optimal use of natural resources, increase local production and improve the overall status of the population in rural areas. Long-term, organic farming could contribute to closing the gap between rich and poor regions, as well as in achieving stability in production.

Note: The paper is part of the research projects number: 46009 - Promotion and development of hygienic and technological processes in the production of foods of animal origin in order to obtain high-quality and safe products competitive on the world market and the 179028 - Rural labor markets and rural economy of Serbia - the diversification of income and poverty reduction;46006: "Sustainable agriculture and rural development accomplishing the strategic objectives of the Republic of Serbia within the Danube region, "an integral and Interdisciplinary Research funded by the Ministry of Education and Science of the Republic of Serbia, in period 2011-2014.

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ОРГАНСКО ПРОИЗВОДСТВО - МОЖНОСТИ И ПРЕДИЗВИЦИ ЗА ОДРЖЛИВ РУРАЛЕН РАЗВОЈ ВО СРБИЈА

Зорица Средојевиќ, Наташа Кљајиќ, Небојша Новковиќ

Апстракт
Доминантните економски принципи на органскиот производствен систем беа донесени во најдобра можна согласност со еколошките барања. Ова производство се базира на рационална употреба на природни ресурси, обновлива енергија и зачувување на природната разновидност на флора и фауна во животната средина. Тоа придонесува за биолошки баланс на почва-растенија-животни. Најголемата област под органско производство во светот е лоцирана во Австралија, 12,1 милиони хектари или 33% од вкупната област под органско производство, следена од Европа со 10 милиони хектари или 27%, Јужна Америка со 8,4 милиони хектари или 23%. Доста помала улога има Азија со 2,8 милиони хектари или 7%, Северна Америка со 2,8 милиони хектари или 7% и Африка со околу 1,1 милиони хектари или 3%. Во последните години, со цел да се подобри органското производство, надлежните државни ргани во Србија имаат усвоено серија мерки за легално да го регулираат секторот и да промовираат и имплементираат ефикасен систем на контрола. И покрај бројните предности за развој, треба да се напомене дека овој систем е соодветен за производство во одредени области во нашите рурални области кадешто има изразена раситнетост на земјиштето на фармите. Тоа е и главната цел на овој труд да го процени потенцијалот на иницијативите за органско производство и можностите за развој на други економски активности за да се ревитализираат селата и одржливоста на рурална Србија. Основните економски и еколошки детерминанти се дефинирани со употреба на SWOT анализа.
Клучни зборови: органско производство, рурални области, одржлив развој.

UDC: 631.15(497.7)"2005/2011"
Original scientific paper

PERFORMANCE INDICATORS OF MACEDONIAN AGRICULTURE

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Abstract
The aim of this paper is to analyze the state and performances of Macedonian farms, through relevant indicators from available sources. A combination of available sources was used in order to assess the development of the Macedonian agriculture set at medium-run time span, from 2005 to 2011. The agricultural sector is important in the Macedonian economy, both in terms of value and employment of the rural workforce. The utilized agricultural area follows the decreasing trend, from 546 thousand hectares in 2005 to 511 thousand hectares in 2011, but this decline was somewhat amortized by the generally increasing trend in yields. The farm stucture is composed of a large number of mostly small family farms and small number of agricultural companies. Most of the value of agricultural production is created at family farms; sector value of agricultural production reached 76 billion denars in 2010. The net entrepreneurial income in real terms kept a slow, but steady upward trend. The number of farms with a farm gross margin of less than 100 thousand denars has decreased in the FMS farm sample, an annual survey, from 33% in 2005 to 23% in 2011, whereas the number of farms with farm gross margin over million denars increased over time, to about 10% of the sample. The output versus specific inputs ratio is positive on average farm level in the FMS sample in all regions, farm types and economic size groups; the gross margin coverage ratio in the average farm situation in 2011 indicates that 47% of the income is used to cover the specific costs.
Key words: Macedonian farms, indicators, economic performance, development.

Introduction

Agriculture is the third largest sector in the Macedonian economy in terms of participation in the national Gross Domestic Product (GDP), with around 10% share, or 15% share if the processing industry is added. Additionally, this sector is important as major employer of the workforce, and also provides social cushion for majority of the rural population; the agricultural sector (including hunting, forestry and fisheries) employed 121 thousand persons or 18.43% of the employed population in 2011 (SSO, 2012).

The Macedonian farm structure is composed of family farms and agricultural enterprises; the Agricultural Census in 2007 (SSO, Ag. Census, 2012) recorded a total of 192,675 farms, out of which 192,378 family farms and 297 are registered as agricultural enterprises. Family farms use 55.8% of the total agricultural area (or 91.5% of the utilized area), while agricultural enterprises and cooperatives use 44.2 % of agricultural land (or 8.5% of the utilized area) (SSO, 2011). Pastures account for about half of the agricultural land with around 600 thousand hectares; pastures are

mostly owned by the state and agricultural enterprises are the biggest users. The average size of family farms is approximately 1.47 hectares; Macedonian farms are highly fragmented and the largest group cultivates less than 0.5 hectares. This structure contributes to the ineffective use of agricultural land (MAFWE, 2012).

The objective of this paper is to analyze the state and performances of Macedonian agriculture, in the medium-run period through available indicators. Following the introduction, the applied method is described. The results are presented and discussed subsequently, and the conclusions are drawn in the end.

Material and methods

A combination of available sources was used in order to assess the development of the Macedonian agriculture in the short-run, both in physical and economic terms. The major source of data was the State Statistical Office that provided annual data regarding production and technical figures; the Economic Accounts in Agriculture – EAA were used as a major source indicating the value of agricultural production; the structure and typology of farms was drawn from the Farm Structure Survey - FSS; and finally the economic performance of farms was assessed through the data from the Farm Monitoring System – FMS, Farm Monitoring System, an annual survey conducted in line with FADN methodology, carried out by the National Extension Agency.

The period subjected to analyses was set at medium-run time span, depending on the data availability (2006-2010 EAA, 2011 FSS, 2005-2011 FMS).

Standard analytical methods are applied, with index numbers theory and descriptive statistics where applicable. For micro-economic data i.e. determination of the gross income of Macedonian farms the gross margin method was applied, calculated as the difference between the farm output and specific costs. The concentration of farms in terms of land and gross margin was estimated using the Gini and Herfindahl coefficient.

Results and discussion

Physical and technical indicators of agricultural production

Out of the total country area of 2,571 thousand hectares, the share of agricultural land has noted a fall from 1,229 thousand hectares (or 47.8%) in 2005, down to 1,014 thousand hectares (or 39.4%) in 2009, hence recuperating slowly to 1,120 thousand hectares (or 43.6%) in 2011. The utilized agricultural area follows the decreasing trend, from 546 thousand hectares in 2005 to 511 thousand hectares in 2011 (SSO, 2011). Similar pattern is followed by the arable area, which takes up to 80% of the agricultural area, decreasing from 448 thousand hectares in 2005 to 415 thousand hectares in 2011 (*ibid*). The area under pastures shows significant variability in size over the years; the largest noted area under pastures in the referential period was in 2006 with 687 thousand hectares, while in 2009 only 500 thousand hectares were recorded by SSO (Table 1).

The fall in utilized agricultural area is most evident in the case of cereals; over the years from 2005 to 2011, the area under cereals has decreased by 20% (Table 2). For some cereal crops, such as wheat, the fall is even more drastic, up to 30% (Figure 2, left). Wheat, however, is still by far the most significant crop in the country, covering 78.9 thousand hectares in 2011, followed by barley with 42.5 and maize with 29.4 thousand hectares in 2011. The area under vineyard also had a sharp decline, by 20% from 2005 to 2011; though many old plantations have been renewed. The situation with vegetable crops is relatively stable; areas under cabbage increased most significantly in the past period (Figure 1).

Table 1. Structure of agricultural area (in thousand hectares)

Indicator	2005	2006	2007	2008	2009	2010	2011
Agricultural area	1,229	1,225	1,077	1,064	1,014	1,121	1,120
% of total area (2,571 th. ha)	47.8	47.6	41.9	41.4	39.4	43.6	43.6
Utilized agricultural area	546	537	526	521	513	509	511
Arable area (annual crops)	448	439	431	424	420	415	415
Orchards	13	13	13	14	14	14	14
Vineyards	26	25	23	22	21	21	21
Meadows	59	60	59	61	58	59	61
Pastures	682	687	550	542	500	611	608
Wet lands and fish ponds	1	1	1	1	1	1	1

Source: SSO, 2006-2012

Table 2. Area under the most important crops (in thousand hectares)

Crops	2005	2006	2007	2008	2009	2010	2011	Index 2011 (2005=100)
Wheat	108.9	99.1	92.0	86.9	88.3	79.9	78.6	72.2
Barley	50.7	48.3	48.4	48.8	48.8	43.0	42.5	83.9
Maize	33.6	31.9	31.1	31.6	32.7	28.6	29.4	87.5
Vineyards	25.0	24.3	21.3	21.8	20.0	20.0	20.2	80.5
Tobacco	18.5	17.5	17.2	17.1	17.8	20.3	19.7	106.5
Alfalfa	17.8	18.2	19.4	18.8	19.6	19.4	19.1	107.1
Potato	13.5	13.6	14.0	13.8	13.9	13.4	13.7	101.5
Pepper	8.1	8.3	8.3	8.2	8.4	8.5	8.5	104.0
Watermelon	6.5	6.5	6.2	6.2	6.0	5.7	5.8	89.2
Tomato	5.7	5.6	5.4	5.3	5.7	5.7	5.6	98.3
Cabbage	3.5	3.6	4.0	4.1	4.5	4.7	4.6	130.8

Source: SSO, 2006-2012

The decline in agricultural area was somewhat amortized by the generally increasing trend in land productivity; the yields of most crops per unit of area increased over the period 2005 to 2011. This increase is particularly notable in the vegetable sub-sector (Figure 1, left) and grapes, which all followed an upward trend. The yields of cereals increased at a slower pace since 2005, following a sharp fall in 2007, while tobacco and alfalfa generally had lower yield levels (Figure 1, right).

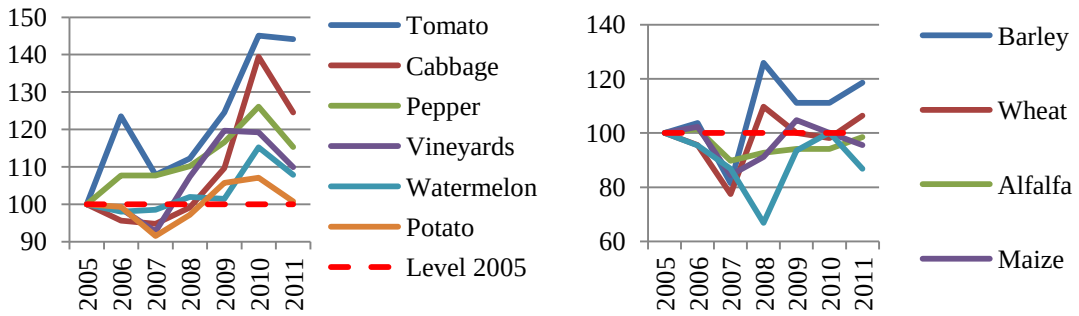


Figure 1. Base index (2005=100) of crop yields; vegetable and grapes (left), cereals, industrial and fodder crops (right)

The per head yields of milk per dairy cows noted an upward trend, from 2,254 liters in 2005 to 2,866 liters in 2011, with peak in 2009 with 3,004 liters. The trend is opposite in sheep milk production; since most of the sheep are of domestic or mixed breed, the milk productivity is low, and reached the minimum 51,2 liters per ewe in 2011 (Table 3); sheep are bred extensively and lamb meat production is most important. The highest milk production was noted in 2008, with around 438 million liters; cow milk production is dominant, encompassing around 86% of the total production, followed by sheep and goat milk.

Table 3. Milk yields (in liter per head)

Milk yield	2005	2006	2007	2008	2009	2010	2011	Index 2011 (2005=100)
Per milking cow (l)	2,254	2,497	2,880	2,835	3,004	2,787	2,866	127.2
Per ewe (l)	58.5	64.0	66.2	68.0	68.9	59.9	51.2	87.5

Source: SSO, 2006-2012

The number of animal heads has sharply decreased according to the official statistics when it comes to sheep and poultry, from 1.2 million heads of sheep in 2005 to 766 thousand heads in 2011 i.e. almost a 40% drop (Figure 2, right) ; cattle numbers remained relatively stable with around 265 thousand heads, while the biggest increase was in pig heads, from 169 thousand heads in 2005 to 197 thousand heads in 2011.

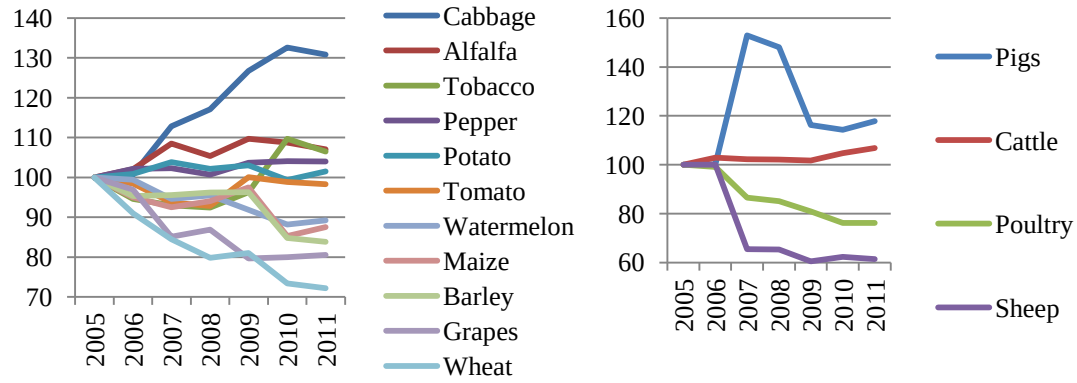


Figure 2. Base index (2005=100) of area under crops (left) and number of livestock heads (right)

Farm structure

The farm structure in the country is notably dual, composed of family farms or indivudial agricultural holdings, on one side, and agricultural companies, on the other side. The family farms take up to 86.9% of the value of agricultural production (SSO, FSS, 2011). Most of the farms in the country or 58.2% are classified in the class of very small farms, with less than 2000 euro standard output (Figure 3, right), according to the Farm Structure Survey based on Agricultural Census data (SSO, 2011).

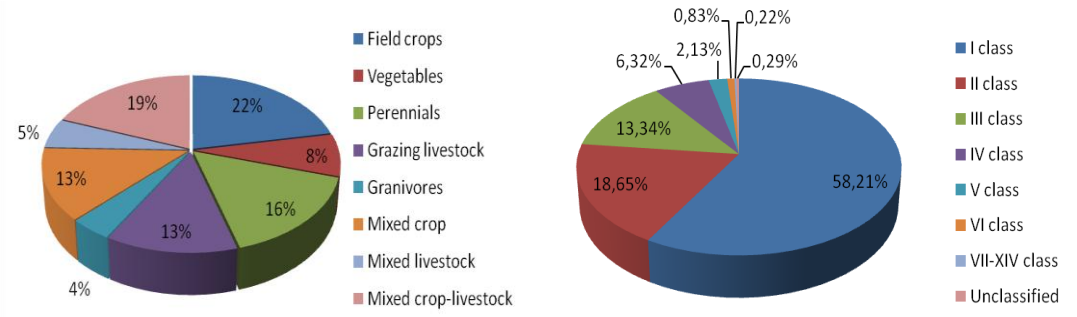


Figure 3. Structure of farms accroding to their type (left) and economic size (right), Farm Structure Survey (SSO, 2011)

Mixed farming (crop, livestock or both) is important in the country, being a distinctive feature of more than one-third of Macedonian farms (Figure 3, left). Farms with dominating field crops production (producing cereals, industrial crops such as tobacco, fodder crops etc) take up 22% of the total number of farms, followed with 16% of farms with perennial crops (vineyards and orchards), 13% of farms with grazing livestock, 8% of vegetable farms etc. However, in terms of standard production value, Mixed farms create 40% of the standard output in agriculture, followed by the grazing livestock farms (21%) and vegetable farms 14%. Cereals farms, although accounting for one-fifth of the farms, create only 7% of the value.

Value of agricultural production

The value of agricultural production has slowly increased in terms of currents prices in the period 2006 to 2010 reaching 76 billion denars in 2010 (SSO, 2012). Crop production is traditionally occupying from 70 to 80 percent of the total value. Vegetables have the most significant share, with a significant increase of 30.9% in 2009 to 36.4% in 2010. Other important crop enterprises are fruits, industrial crops, cereals and fodder crops, as important base for the animal husbandry. Milk takes up to a half of the livestock sector value, followed by cattle, pigs, poultry and eggs, sheep and goat.

The value of agricultural production in 2010 increased by 10% compared to the previous 2009 and the average value of production in the period from 2006 to 2008, when analyzed in at current prices (Table 4). The highest increase in relative terms occurs in agricultural services (+48%) and subsidies on production (+30% for production subsides, and +37% for total subsidies). Generally, the value of crop production has increased by 10% compared to the previous year. Reduction observed in funds employed (-16%) and paid wages (-22%). Subsidies take a share of 12.8% in the entrepreneurial income in 2010, which is the highest share so far. In terms of value, the subsidies amounted 4.5 billion denars in 2010, a 46.1% increase as compared to the previous 2009; the subsidies accounted only for 0.3% in the period from 2006 to 2008 and practically were insignificant in the preceding period.

Table 4. Agricultural production value, in current prices

Mllion denars	Average (2006 – 2008)	2009	2010	2010 (2009=100)
Production value	69,869	69,543	76,447	110
Crop production	49,645	47,077	52,412	111
Livestock production	18,595	17,943	17,927	100
Subsidies on products	1,246	3,349	4,367	130
Services and other	1,628	1,173	1,741	148
Total intermediary consumption	35,617	32,259	35,146	109
Gross value added	34,251	37,283	41,300	111
Depreciation	2,888	3,194	3,550	111
Net value added	31,363	34,089	37,750	111
Taxes on production	65	56	59	105
Other subsidies	88	101	138	137
Income from production factors	31,386	34,134	37,829	111
Employee compensation	1,930	2,531	2,137	84
Rents	/	124	97	78
Interest balance	/	-264	-327	124
Entrepreneurial income	29,352	31,216	35,269	113
Subsidies/entrepreneurial income (%)	0.3	11.1	12.8	116

Source: SSO (EAA), 2012; Eurostat, www; own calculations

However, when analyzed at previous year prices, taking into consideration the real changes, increase is noted in 2008 and 2009, though the value of agricultural production, as well as gross and net added value, is at same level in 2010 as compared to the prices of 2009 (Figure 4).
The total labour factor income showed increase in 2009 and 2010, after the fall in the previous two years. The average engaged labor in the sector for the period 2006 to 2010 was 119 thousand annual work units (AWU), being highest in 2008 with 130 thousand annual work units. Paid labor force participation accounts for about half of the engaged population and increases over the last years (from 44% in 2006 to 52% in 2010).

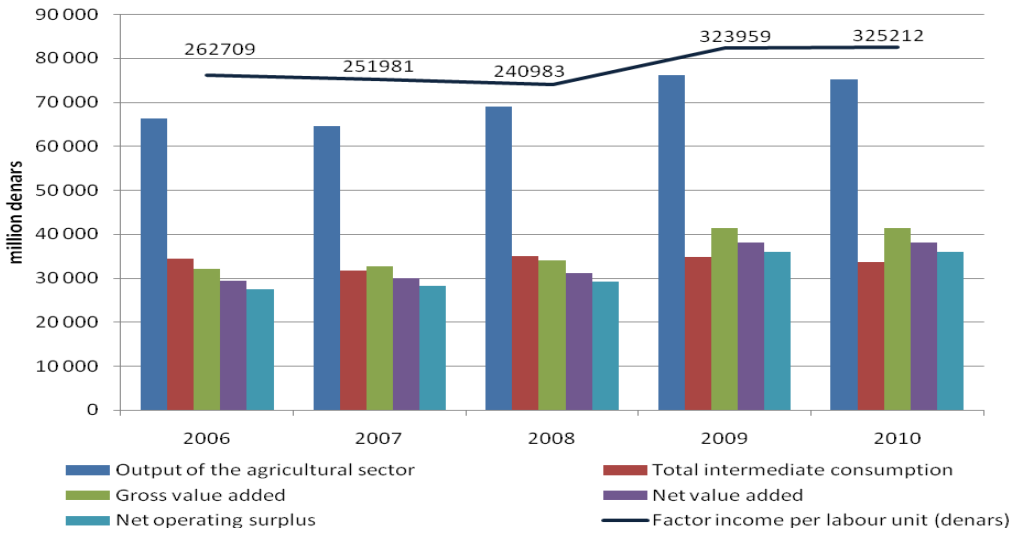


Figure 4. Agricultural production value, previous year prices
Source: SSO (EAA), 2012

The indicator of income of the production factors per annual working unit in real terms has increased in the period from 2005 to 2010 by 16%, or more notably by 50% in the case of unpaid family labor (Figure 5). The net entrepreneurial income kept a slow, but steady upward trend.

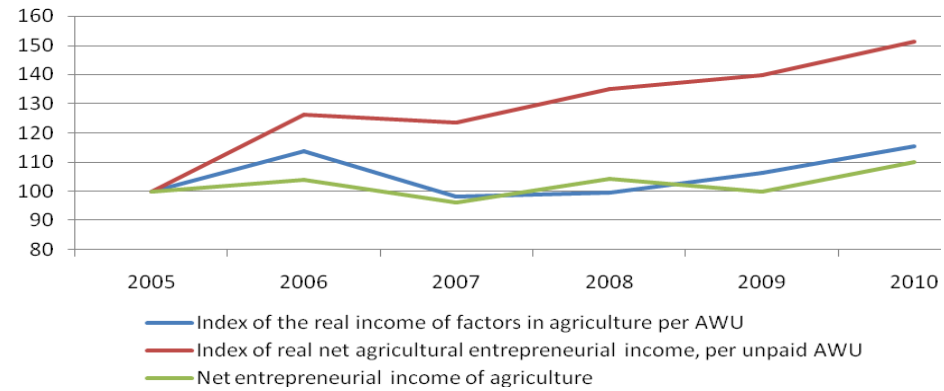


Figure 5. Indicators of real agricultural income, 2005=100
Source: Eurostat, www, 2012

Gross margins at family farms: The case of FMS sample farms

The Farm Monitoring System at NEA collects data from a sample of 400-600 farms concerning the farm output and inputs. Due to data availability constraint, it was possible to calculate the farm return on the level of the farm gross margin.

The number of farms with a farm gross margin of less than 100 thousand denars has decreased in the farm sample, from 33% in 2005 to 23% in 2011 (Figure 6). The values are taken in nominal terms. Cumulatively, around 50% of the farms had a farm gross margin lower than 200 thousand denars, though this figure has lowered to 42% in 2011. The number of farms with farm gross margin over million denars increases over time, to about 10% of the sample.

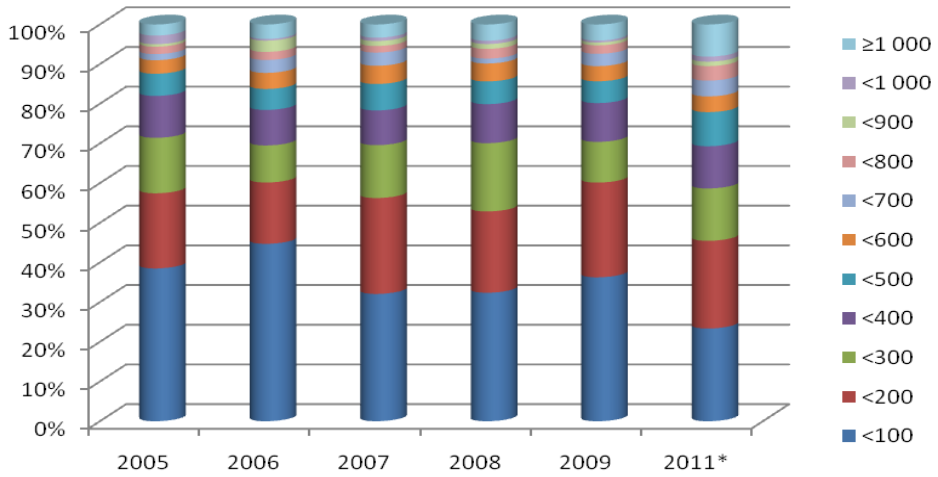


Figure 6. Number of FMS farms in terms of GM per farm in thousand denars
* Preliminary FMS processed results, FASF, 2012

In terms of concentration of the land among the farms in the FMS sample, it showed an unequal distribution, especially on the upper right corner of the distribution plot. In 2005, 70% of the farms used 30% of the land, i.e. 90% of the farms used 55-56% of the land with a Gini coefficient of 0.56. The situation is almost identical in 2011. The gross margin was medium concentrated; 70% of the farms produced 30% of the GM in 2005, or 33% of the GM in 2011, while 90% of the farms produced 58% in 2005, or 63% in 2011, with a Gini decreasing from 0.56 to 0.51 in 2011. The Herfindahl index indicates highly competitive environment. According to the analyzed FMS data, the average farm gross margin in the sample in the period 2005 to 2009 was 264 thousand denars, whereas it has increased to 366 thousand denars in the survey of 2011. Highest per farm gross margins occurred in Bitola and Skopje regions, and lowest in Strumica and Tetovo farms (Figure 7, left). However, when analysed on per hectare basis, Strumica farms have the highest value, due to the high concentration of vegetable cash crops. The gross margins are ranging from around 80 thousand denars at the farms in the class of less than 1 ESU, to about 1.7 million denars at the farms with over 16 ESU (Figure7, right). Analyzed on per hectare basis, the farms had average 85 thousand denars GM/ha in the period 2005 to 2009, and 137 thousand denars GM/ha in 2011.

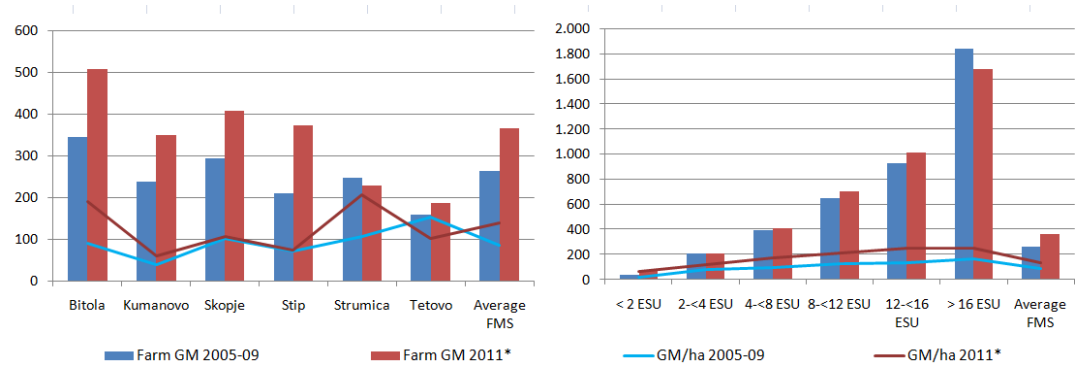


Figure 7. Farm Gross Margins at FMS farms, per region (left) and per economic class (right) in thousand denars

* Preliminary FMS processed results, FASF, 2012

** Note: ESU stands for European size unit, equivalent of 1200 euro GM

Production efficiency and gross margin coverage ratio

The income/cost ratio as production efficiency indicates whether the farm can cover the incurred, specific costs (in this case without the fixed costs, due to data completeness constraint) by the income from the production, and values over 1 are required. These ratios are positive on average level in the FMS sample in all regions, farm types and economic size groups (Table 5 and 6). The gross margin coverage ratio in the average farm situation in 2011 indicates that 47% of the income is used to cover the specific costs, meaning that the remainder is to cover the fixed costs and to compensate the family labor through the net family income.

Table 5. Output/specific input and GM ratios per average farm by region and economic size, 2011

Region	O/I ratio	GM ratio	Econ.size*	O/I ratio	GM ratio
Bitola	2,32	43%	VSF1	1,55	64%
Skopje	1,98	51%	VSF2	2,00	50%
Stip	1,89	53%	SF	2,42	41%
Kumanovo	2,22	45%	MLF1	2,13	47%
Tetovo	2,02	49%	MLF2	2,12	47%
Strumica	2,71	37%	MHF	2,43	41%
Average	2,13	47%	Average	2,13	47%

*Economic size classification: VSF (very small farm), SF (small farm), MLF (medium-low farm), MHF (medium-high farm)

Table 6. Output/specific input and GM ratios per average farm by farm type, 2011

Type	O/I ratio	GM ratio	Type	O/I ratio	GM ratio
Mixed cropping	2,65	38%	Specialist granivores	1,27	79%
Mixed crops — livestock	2,16	46%	Specialist grazing livestock	1,85	54%
Mixed livestock holdings	1,99	50%	Specialist permanent crops	2,99	33%
Specialist field crops	2,95	34%	Specialist horticulture	2,58	39%

Conclusions

The agricultural sector is important in the Macedonian economy, both in terms of value and employment of the rural workforce. In the period 2005 to 2011, the utilized agricultural area followed a decreasing trend, but at the same time the yields of most farm enterprises were generally improved, although they are still far from the EU levels. The sector, in general, noted a slow but steady growth overall and in farm performance terms. Conducting sector analysis must be based on relevant sources that provide coherent and continuous time series. Recently, there is an increasing availability of agriculture related surveys and data, which can be used for analysis of the agricultural sector. Most of these reports are prepared in accordance to the Eurostat methodology, which makes them suitable for comparative researches. Using appropriate information and analytical tools enables measuring the performance of the sector. Moreover, it provides ground for creation and evaluation of future policies.

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ПОКАЗАТЕЛИ ЗА ОЦЕНА НА УСПЕХОТ НА МАКЕДОНСКОТО ЗЕМЈОДЕЛСТВО

Александра Мартиновска Стојческа, Драги Димитриевски, Ивана Јанеска Стаменковска

Апстракт

Целта на овој труд е анализа на состојбата и перформансите на македонските фарми, преку пресметување на релевантни индикатори од соодветни извори. Со цел да се процени развојот на македонското земјоделство, анализирано на среден рок од 2005 до 2011 година, беше користена комбинација од различни извори. Земјоделскиот сектор е особено значаен за македонската економија, како од аспект на вредноста така и од аспект на вработеноста на руралната работна сила. Искористената земјоделска површина следи еден опаѓачки тренд, од 546 илјади хектари во 2005 година на 511 илјади хектари во 2011 година, но овој пад беше на некој начин амортизиран со генерално растечкиот тренд на приноси. Структурата на фармите главно е составена од голем број на мали семејни фарми и мал број на земјоделски претпријатија. Најголем дел од вредноста на земјоделското производство е креиран од семејните фарми; вредноста на земјоделското производство во 2010 година достигна 76 милијарди денари. Нето претприемачкиот доход во реални бројки бележеше бавен но скромен нагорен трнд. Бројот на фарми со бруто маржа по фарма помала од 100 илјади денари, беше намален во примерокот на ФМС,што претставува годишна анкета, од 33% во 2005 година на 23% во 2011 година, додека пак бројот на фарми, опфатени во примерокот, со бруто маржа поголема од милион денари се зголеми за 10% во анализираниот период. Односот помеѓу аутпуот и специфичните инпути е позитивен, анализиран на просечно ниво на фарма во рамките на примерокот на ФМС, и тоа во сите региони, сите типови на фарма и групи на економски големина; показателот за покритие со бруто маржа, пресметан на ниво на просечна фарма, во 2011 година индицира дека 47 % од приходот е искористен за покривање на специфичните трошоци.

Клучни зборови: Македонски фарми, показатели, економски перформанси, развој.

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Review Article

THE USE OF GEOGRAPHICAL INDICATIONS – OPPORTUNITY FOR GAINING COMPETITIVE ADVANTAGE OF AGRI-FOOD PRODUCTS

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Abstract
The aim of this paper is (a) to provide an overview of the use of geographical indications (GIs) in the Republic of Macedonia and some countries in the world and (b) to emphasize the possibility of increasing the competitiveness of the agri-food products by protection of GIs. The paper is based on qualitative and quantitative aproach. With the qualitative, we present domestic and international system of protection. The approach also includes description of GIs as a tool for increasing competitiveness of agri-food products. Quantitative approach includes review of the competitiveness of the wine sub-sector of the three countries of the European Union (EU) and the Republic of Macedonia, calculated by Balassa index. The results show that the legal framework of the system for protection of GIs varies in different countries, which is actually considered as weaknesses of the system. In some countries this system is well developed and reaches high market value of the products protected with GIs. In other countries the system of protection is relatively new. In Republic of Macedonia, the laws and regulations that cover this topic are generally harmonized with EU legislations. So far, four agricultural products are internationally protected with GIs, in accordance with Lisbon Agreement. There is also an ongoing activity for nationwide protection of few agri-food products, through the system of protection enforced by the Ministry of Agriculture, Forestry and Water Economy. Besides these, the Republic of Macedonia has traditional agri-food products that have potential and should be protected with GIs. Here, the use and protection of GIs will put emphasis on the competitive advantages that products possess and their opportunity to create competitive position and enter on niche markets.
Key words: geographical indications, agri-food products, competitiveness.

Introduction

Macedonia is a small country with many challenges in the agricultural sector in terms of low level of industrialization, low income, small farms, low educational level of the farmers, *etc*. At the same time, Macedonian export of agri-food products is mainly directed on regional markets, where their competitiveness is endangered as a result of lack of quality standards and increased competition from other countries. In fact, this seriosly concern the future development of the sector and targeting of other non-traditional markets, which have stricter standards in regards to the requirements related to food standards and consumer safety (Dimovski *et al.*,2012).

Macedonian fruits and vegetables are traditionally exported in Ex Yugoslavian countries. Unfortunately, their competitive position is changing. These markets are opening for products from other countries and in the last few years, there is also a trend of change in the consumers' habits (Dimovski *et al.*, 2012). Increased domestic production on these markets and increased number of competitors will have serious impact on the Macedonian domestic primary production. Dimovski *et al.*, (2012), consider this as big challenge, since Macedonian production is not fully ready for EU markets especially regarding the post-harvest handling and packaging practices. Processed fruit and vegetable products are mainly exported in EU and neighboring markets.

In this sector, the constructive trading regime between Macedonia and the EU, and further liberalization especially as a result of CEFTA agreement should even more enhance the competitive position of the processed fruit and vegetable products (Risteski, 2008). In more recent studies, one of the key strategies to increase the competitiveness of agri-food products is the quality and presented information about the quality. Agri-food products labeled with geographical indications (GIs) are good example of this. Menapace and Moschini (2011) explain that GIs present information about the origin of the product and indirectly the quality, by constraining the moral hazard behavior of the producers, reducing the costs of building reputation and leading to lower equilibrium prices and welfare gains. In the past period there is an increased trend of consumers' interest for the origin of the product, especially if it is associated with specific characteristics and local "know-how" in a certain area. GIs are part of the industrial property system of protection, which also includes patents, trademark and industrial design. In 1992, the European Union approved two categories (Protected designation of origin - PDO and Protected Geographical Indication - PGI) of GIs, in order to promote the food quality and rural development. In Macedonian agricultural sector, PDO and PGI are regulated with the Law on quality of agricultural products. The Law defines "designation of origin" as a name of a region, a specific place or, in exceptional cases, a country, used to indicate the agricultural or food products whose quality or characteristics are produced under specific natural or human factors in specified geographical area. "Geographical indication" is the name of the region, a specific place or, in exceptional cases, a country used to indicate the agricultural or food products whose production and / or processing and / or preparation take place in this geographical area. The main difference between GIs and other industrial property rights is that GIs are collective right that could be used by many producers in particular region, if they fulfill the legal requirements or the "code of practice". These collective rights can be used as a tool for producers to maintain their competitiveness, in a way that guarantees certain standards of the products. Here, quality, reputation or other characteristics are attributed to their particular geographic origin. There are different types of GIs, regulated with different international agreements and laws, where only few enable GIs protection. For instance, Paris convention of 1883 is one of the earlier historic treaties to mention the international protection of GIs as "indications of source or appellations of origin". However, it does not really define indications of source or appellations of origin and is not explicit about the form of protection (Giovannucci *et al.*, 2009). Madrid Agreement of 1891 concerns the repression of false and deceptive indications of source and Madrid Protocol of 1989 concerns the international registration of trademarks, collective marks and certification marks. Lisbon Agreement of 1958 facilitates the international protection of appellations of origin (AOs) through a single notification and registration procedure.

TRIPS agreement of 1994 protects GIs (PDO and PGI) and enables higher protection for wines and spirits and lower for all other goods. As a result of the minimum protection of non-alcohol products,

other bilateral or regional agreements will be important and could serve to make possible more specific protection of broader categories of products (Sylvander and Allaire, 2007). Nowadays, World Intellectual Property Organization (WIPO) is the international governmental body that is most involved with the issues of GIs. It offers information and training on several aspects of GIs that have to do with law and trade. Considering GIs and the theoretical framework, frequently used theories are theory of competitiveness and model of reputation. With regard to the competitiveness, Giovannucci *et al*., (2009) state that GIs are a potentially unique form of competitive advantage, even for smallholders, build on unique tradition and special agro-ecological endowments. This means that they protect the products in a way that the quality, reputation or other characteristics are attributed to their geographic origin, thus providing information on the potential consumer that the product has specific attributes (Polenak *et al*, 2004). Moreover, GIs could directly influence the increased competitiveness and reputation of the products, originated from the region (Idris, 2004). As a competitive tool, GIs could lead to higher differentiation of the products and positioning on niche markets. Bagal and Vittori (2011) indicate that GIs enable producers of commodities to export *i.e.* high-quality agricultural products. Many authors researched this topic, but unfortunately in Macedonia, GIs are less researched than other IP rights and consequently there is a lack of comparable research in the field of economics of GIs.

Material and methods

Material

The material for the research is based on primary and secondary data collection and semi-structured interviews with relevant persons. Data regarding GIs was gathered from the Ministry of agriculture, forestry and water economy, State office of industrial property, European Commission and WIPO database. In general, the period of research is 2004-2012, but in the calculation of Balassa index, due to the lack of data availability, the period is up to 2008. Information regarding wine export and import value was gathered from State Statistical Office of Republic of Macedonia and FAO.

Method

The paper includes qualitative and quantitative approach. The qualitative approach is based on flexible research method, where GIs were related to the competitiveness of agri-food products and the national and international system of protection was presented. The quantitative method includes preview of the competitiveness, calculated with Balassa index. Revealed comparative advantage RCA (Balassa index) is defined as export share of a product of the total exports of a country, divided by the world's export share of this product. In this paper, Balassa index measures the intensity of wine trade specialization of a country within the world. If it takes a value less than 1, this implies that the country is not specialized in exporting the product.

$$RCA = \frac{\frac{x_{c,p}}{NX_c}}{\frac{wx_p}{WX}}$$

, $x_{c,p}$ - wine export value of a county, NX_c - total export value of agricultural production wx_p - total world export of wine, WX - total world export value of agricultural production

Results and discussion

When GIs are legally registered they take different forms such as Appellation of origin, Denomination of origin, PDO, PGI, and marks (Giovannucci *et al*., 2009).These distinctive signs for collective use are protected with different international agreements: Collective marks – Madrid System; Certification marks - Madrid System; Geographical indications – TRIPS, Appellations of origin – Lisbon Agreements, Indications of source – Paris Convention and Madrid Agreement (Not GIs).The system of GIs protection varies in different counties. For some countries this system is relatively new, while for other is quite developed. There are 110 countries, including the 27 Member States of the European Union (EU), with specific GI laws in place. Outside the EU, only 22 of the other 83 countries have established registers and officially listed Geographical Indications. This is where Macedonia belongs which legislation is in compliance with EU. Australia, Canada, Japan, United States, parts of Africa and a number of Arab countries, do not have specific GI protection laws, but they protect GIs through certification marks, collective marks or trademarks.

The differences in the countries' legislation are considered as weaknesses of the system. For instance, some PGIs in EU are actually collective marks in US, protected with the trademark law.

Generally, there are more than 10,000 legally protected GIs, which generate an estimated sales value of over 50 billion dollars (Giovannucci *et al*., 2009). About 90% of GIs come from the OECD countries while in more than 160 other countries very few GIs have been developed.

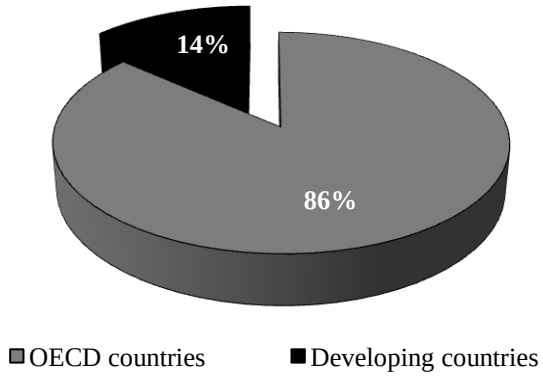


Figure 1. Participation of GIs protection among countries
Source: Giovannucci *et al*., (2009)

There are 905 registrations and 800 in force for protection of Gis in compliance with Lisbon Agreement. Table 1 present number of GIs protected in many countries according this agreement.

Most of the protected products in EU refer to wines and spirits, and the number of registered agricultural and food products have an increasing trend. As a result of the EU enlargement, the number of applications for the protection of agricultural and food products has increased. According to the European Commission, the number of protected designations of origin which are entered in the register is 505. The number of protected geographical indications is 465, and the number of products with traditional specialty guaranteed is 30. There are only 11 non-EU products with protected status.

The main countries in terms of value of PDO/PGI production are Italy (33% of the total), Germany (25%), France (17%) and the United Kingdom (8%). Next come Spain with 833 million euro (6%), Greece with 606 million euro (4%) and Austria with 123 million euro (1%) (European Commision, 2010). In Republic of Macedonia, in 2002 GIs were regulated as industrial property right. In the past two years, an institutional change has been made. Until 2010, GIs were protected by the Macedonian State Office of Industrial Property. In 2010, the State Office of Industrial Property of Republic of Macedonia internationally protected four agri-food products with geographical indications, in compliance with Lisbon Agreement for the Protection of Appellations of Origin: "Kochani rice" (under number 897), "Krivopalanecki honey" (under number 895), "Macedonian ajvar" (under number 894) and "Disan" (under number 896). From 2011, Ministry of agriculture, forestry and water economy (MAFWE) took the responsibility for protection of PDO and PGI of agri-food products. According to the suggestions from the European Commission, and in regards to the Law on quality of agricultural products, MAFWE adopted a number of by-laws and rulebooks that define the overall procedure in compliance with EU Commission Regulations.

Table 1. Number of protected GIs according Lisbon Agreement

Country	Number
France	508
Czech Rep.	76
Bulgaria	51
Italy	31
Hungary	28
Georgia	20
Cuba	19
Mexico	14
Peru	8
Algeria	7
Portugal	7
Tunisia	7
DPR of Korea	6
Slovakia	6
Macedonia	4
Serbia	3
Montenegro	2
Costa Rica	1
Israel	1
Moldova	1

Source: WIPO, 2012

These legal and institutional changes require restarting the process from its beginning, but now taking into consideration the PDO and PGI protection on national level. In December 2011, MAFWE carried out a procedure for selection of national symbols for agricultural farm products and foodstuffs with protected designation of origin and protected geographical indication. The

symbols were legalized and published in 2012 (Picture 1&2). By adopting all by-laws in 2012, the national system of PDO and PGI protection was established.



Figure 2 Macedonian logo for PDO
Source: MAFWE, 2012



Figure 3 Macedonian logo for PGI

Moreover, MAFWE initiated a national protection of PDO or PGI for eleven potential products. Unfortunately, only two of the proposed products, fulfill the basic requirements and could be further protected with PDO and PGI (IQS, 2012).

Wines and spirits protection

Wines and spirits are protected separately from other agri-food products with different GIs laws and regulations. In Macedonia, these products are protected under the Law of wine. MAFWE initiate a protection of "Stanusina" wine, made from local indigenous grape variety. Even though the procedure has not been started yet, producers expressed high interest for PDO/PGI registration (IQS, 2012).In a meantime, FAO and European Bank for Reconstruction and Development also initiated a support of Macedonian wine producers in developing GIs for the Vardar River Valley, further used as a name for the PGI (Wines of Macedonia, 2012). This protection shall include 8 wine districts. As other agricultural and food products, wines can also be protected with different forms of GIs. Table 2 shows the number of protected wines in different countries, including some of the neighboring countries of Republic of Macedonia. Unfortunately, our country still has no protection register in the European Commission E-Bacchus database. It confirms the fact that we need to act as soon as possible and it is obvious that the neighboring countries pay more attention to this issue. This is necessary in order to maintain the competitive position of domestic wine, because the main export markets for bottled wines are our neighboring and Balkan countries. In addition, we have presented the competitiveness of the wine sub-sector in Macedonia, France, Bulgaria and Slovenia, calculated with Balassa index.

Table 2. Wines protected with GIs

Wines protected with PDO	
European Union	1310
USA	1
Brazil	1
Wines protected with PGI	
European Union	570
Wines with Geographical Indications	
South Africa	153
Australia	78
Chile	61
Switzerland	37
Albania	36
Republic of Serbia	29
Georgia	18
Montenegro	9
Bosnia and Herzegovina	7
Canada	7
Wines protected with a name of origin	
USA	696

Source: European Commission, 2012

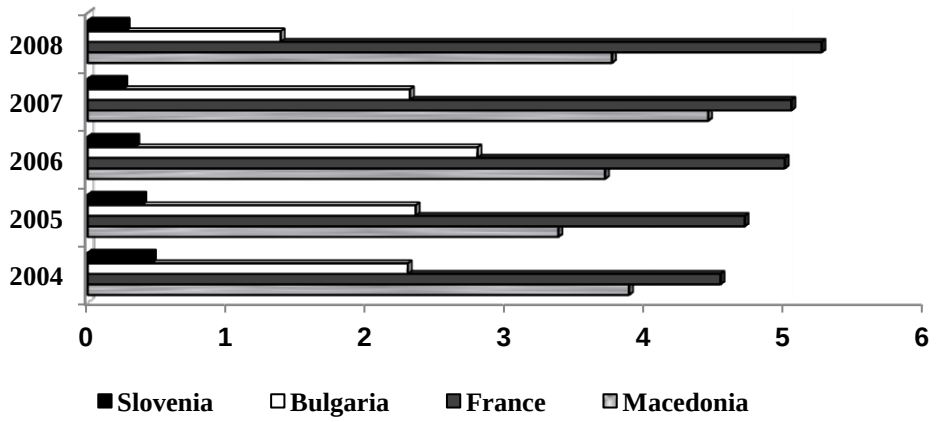


Figure 4.Balassa index
Source: Nacka M.,2011

The high value of the index of Macedonia, arise from the high export value of wine. However, if we consider that bottled wine participates with small percentage of total exports (around 13%), it can be said that high value is a result of export of bulk wine. It is difficult to discuss about competitive GIs protected wine of Macedonia, with major export of bulk wine. In this regard, significantly important is the use of GIs, trademarks or industrial design. As Polenak *et al*., (2004) stated, they protect the products in a way that the quality, reputation or other characteristics are attributed to their

geographic origin, thus providing information on the potential consumer that the product has specific attributes. GIs, particularly PDO and PGI could be a strong marketing strategy and quality assurance sign, if are labeled on the final package of the product. Even though, there is an opportunity for bottling wine in another country, producers should consider the possibility of performing this activity domestically. Here, GIs protection should be perceived as a long term investment with sustainable results, where the traceability of the process and quality control would be easily monitored.

Conclusions

Maintenance of the competitiveness of agri-food products on the traditional markets and improving the reputation is currently most important part regarding Macedonian exported agri-food products. Their competitiveness is endangered as a result of lack of quality standards and value added production of the competition.

In this regard, GIs could enable a unique form of competitive advantage build on tradition and special agro-ecological endowments. Consequently, it confirms the permanent quality and could be used as a quality certification tool. Even though the process of protection is lengthy, it shall effect in long-term and sustainable results.

GIs protection present a powerful tool for promotion, that send a clear message to the consumer, but it must be supported by strong marketing strategy. As export-oriented, Macedonian wine producers must follow recognized international system of quality assurance in order to create a competitive position and enter on niche markets. Based on GIs protection and territory, a collective marketing which will include well-defined promotional strategy (visual identity, wine tourism, and international recognition), is necessary for successful export of Macedonian wines and re-positioning in higher price segments.

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УПОТРЕБА НА ГЕОГРАФСКИТЕ ОЗНАКИ - МОЖНОСТ ЗА СТЕКНУВАЊЕ НА КОНКУРЕНТСКА ПРЕДНОСТ НА ЗЕМЈОДЕЛСКО-ПРЕХРАНБЕНИТЕ ПРОИЗВОДИ

Марина Нацка, Ненад Георгиев, Васко Хаџиевски

Апстракт

Целта на ова истражување е (а) да се даде преглед наупотребата на географските ознаки (ГО) во Република Македонија и одредени земји во светот и (б) да се нагласи можноста за зголемување на конкурентноста на земјоделско-прехранбените производи преку заштита на ГО. Трудот се базира на квалитативен и квантитативенметод. Квалитативниот метод опфаќа приказ на домашниот и меѓународниот систем на заштита. Пристапот опфаќа и опис на ГО како алатка за зголемување на конкурентоста на земјоделско-прехранбени производи. Квантитативниот метод вклучува преглед на конкурентноста на винскиот под-сектор на три земји членки на Европската Унија (ЕУ) и Република Македонија, пресметана преку Баласа индекс. Резултатите покажуваат дека правната рамка на систем на заштита на ГО се разликува во одделни земји, што претставува недостаток на системот. Во некои земји е овој систем е многу развиен и овозможува постигнување на висока пазарната вредност на производите заштитени со ГО. Во останати земји овој систем на заштита е релативно нов или недоволно развиен. Во Република Македонија, законите и подзаконските акти кои ја опфаќаат оваа тематика се генерално хармонизирани со легислативите на ЕУ. Досега меѓународно се заштитени четири земјоделски производи со ГО, според Лисабонскиот договор. Во тек е заштита на неколку земјоделско-прехранбени производи на национално ниво преку системот на заштита спроведен од Министертвото за земјиделство, шумарство и водостопанство. Покрај овие, Република Македонија поседува традиционални земјоделско-прехранбени производи кои имаат потенцијал и треба да бидат заштитени со ГО, со што ќе се овозможи потенцирање на предности што ги поседуваат производите и можност за конкурентен настап на диференцирани пазарите.

Клучни зборови: географски ознаки, земјоделско-прехранбени производи, конкурентност.

UDC: 332.1(497.7)
Original scientific paper

ANALYSIS OF THE ORGANIZATIONAL POTENTIAL IN THE REPUBLIC OF MACEDONIA FOR ESTABLISHMENT OF RURAL DEVELOPMENT NETWORK

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Abstract
The Republic of Macedonia is strategically oriented to establish sustainable development of rural areas, to make optimal use of national resources in terms of protection of nature and environment, to increase the quality and competitiveness of agricultural products and to strengthen the rural economy. In that way, rural development policy aims to improve the existing living and working conditions of the population that lives in rural areas by establishment of different forms of associations that will act to achieve changes and common interests. Therefore, the aim of the survey is to analyse the capacity and structure of organizations in the Republic of Macedonia that work in the field of rural development and to evaluate the possibility of their networking and further cooperation. The data are obtained by previously developed questionnaire, submitted to different organisations that work in the field of rural development. Deductive research approach which includes qualitative method of descriptive analysis is used to relate the capacity of existing organisations with the possibility for establishment of rural development network. The analysis of variance (ANOVA) is used to estimate the significance of the organisational potential for establishment of National rural development network. The results show that networking of organisations in the country can start on the voluntary basis by the initiative of the civil associations that work and have many years of experience in the field of rural development. This follow the "bottom-up" approach established in many European countries, and emphasise the need for participation of private sector and public institutions in rural development network.
Key words: networking, organisations in the Republic of Macedonia, rural development.

Introduction

The Republic of Macedonia has 84 municipalities from which 49 are located in the rural areas while 10 are located in the capital city of Skopje. According to the Official Gazette in the Republic of Macedonia (134/07) rural areas are geographical areas with relatively small number of residents and specific socio-economic characteristics. More than 73% of the total areas in the country are poorly populated (with less than 50 residents/km^2) while the remaining areas are overpopulated with more than 100 residents/km^2. The crisis and modern trends that mark the beginning of the 21st century creates serious challenges for the rural areas and its population. They are consequence of many factors: exponential growth of rural population, the increase in world consumption, excessive growth of carbon dioxide and other greenhouse gas emission, and the alarm enlarge of the dead species.

The rural population with 43% represent a large part of the total population in the country which is characterised with significantly high age structure, educational problems, unemployment, trend of poverty and migration in the big cities (MAFWE, 2007). 99% of the rural population work in the private family holdings with an average size of 1.62ha. 58% of the holdings have annual revenues to 2000€ while more than a half of the agricultural workers which are members of the holdings are unpaid (MAFWE 2012).

To avoid and solve the existing problems in the rural areas, the Republic of Macedonia developed a strategy by which it is oriented to establish sustainable development by optimal use of national resources in terms of protection of nature and environment, to increase the quality and competitiveness of agricultural products and to strengthen the rural economy. By this the country adjusts to the Brundtland Report where in 1987 EU countries defined the sustainability concept as development that satisfy the present generations needs without destroying the opportunities and needs of the future generations. Their analysis confirms that the basis for rural development is the concept of sustainability. It highlights the three basic sustainability components: the environment, economy and society, by which increase the life quality and promote different economic activities. In that way, rural development policy aims to improve the existing living and working conditions of the population that lives in rural areas by establishment of different forms of associations that will act to achieve changes and common interests (MAFWE, 2007). Here, very important is to form networks between organisations and rural population that will act in the field of rural development. This leads to the aim of this study, which is to analyse the capacity and structure of organizations in the Republic of Macedonia that work in the field of rural development and to evaluate the possibility for their networking and further cooperation. In that way, the purpose of this paper is to give an overview of the current situation of organisations that are working in the field of rural development.

Material and methods

Networking theory

The need for formulation of rural development networks is expressed at the European movements meeting held in the Swedish Rural Parliament in 2004. In this meeting the rural development network is defined as cooperation between people who work together to achieve some changes in the rural areas. In that way, the concept of rural network developed on a national level represents a system of tools and services intended for three local groups: Non-Governmental Organisations (NGOs), business associations and Governmental institutions. Their cooperation is a cycle where they exchange the knowledge and information in order to establish economic development of rural areas. From here, networking allows achievement of: sustainable rural areas, appropriate management with the environment and natural resources, innovative approaches for development of rural infrastructure, and participation of the residents and institution in the decision making processes (ECOVAST, 2006).

According to the theory, networking is a “bottom-up” approach developed on a voluntary basis. The explanation is that networking represents a triangle where the activities start at the bottom level and end at the top of the triangle. From here, the networking process starts as cooperation between associations that work in the field of rural development. Then, cooperation between the business sector and Governmental institutions is established. This allows easier exchange of information between public and private institutions and civil associations. At the end, institutionalised networks

previously formed on a voluntary basis become Governmental obligation to bring positive results for rural development from social and economic aspect (MARD, 2010; RDSU, 2009).

Following EU principals, the Republic of Macedonia is supposed to established National rural development network as cooperation between the Government and civil associations. Furthermore, the Government should take a leading position to establish the network as Institution for rural development. According to the legislatives and rural development strategy (MAFWE, 2007), the country should also provide a financial support for continuing with the networking activities. However, the good practises show that the best for civil associations is to provide managerial activities since they are the most familiar with problems of the rural population and situation in the rural areas.

Research method

To analyse the present situation in the Republic of Macedonia and the capacities of organisations, the paper is based on deductive research approach. The research starts by making interviews with managers of different organisations that work in the field of rural development and collecting the data by previously prepared questionnaire to get the required information. The information received by the questionnaire should give clear picture of the capacity of organisations that work on regional and local level, but also their willingness and need to participate in such national rural development network. To meet the requirements of the survey, the questions are separated in two groups. The first part of questions is regarding the organisations by itself (their capacity and structure) and the second group of questions gives information regarding the organisational activities and their willingness to participate in the networking. The method consists of two approaches. In the first one, the collected data are analysed by using qualitative approach in order to make descriptive analysis of the organisational capacity in the relation with the possibility for their networking. According to the "bottom-up" theory, the organisational capacities are qualitatively introduced by emphasis the need for establishment of rural development network in the country.

The second approach is performed to estimate the significance of the organisational potential for establishment of National rural development network by the analysis of variance (ANOVA). In that way, a statistical regression analysis is chosen to determinate the correlation between one dependent and six independent variables. The approach consists of multiple linear regressions and correlation model analysed in SPSS computer programme. Moreover, dependent variable describes organisational willingness and potential to participate in the rural development network, while for the independent variables are chosen: the budget of the projects, number of employees and volunteers who work in the surveyed organisations, organisational activities, their working field and organisational type. The regression model is estimated by using the following formula:

$$Y_i = \beta_0 + \beta_1 TYP + \beta_2 ACT + \beta_3 FIEL + \beta_4 EMP + \beta_5 VOL + \beta_6 BUD + \varepsilon_i$$

Here, Y_i is the dependent variable, β_0, β_1 ... β_6 are coefficients, TYE, ACT, FIEL, EMP, VOL and BUD are the independent variables, while ε_i is the stochastic part or standard error that represent the effects of other factors which are not included in the analysis (Risteski and Tevdovski, 2010).

Results and discussion

Descriptive analysis

The questionnaire was answered by 100 organisations that operate in the field of rural development.

Their profile explains different organisation structure. From all contacted organisations, only 5 are Governmental institutions including agencies, ministries and academic institutions. Also, 69% are registered as Non-Governmental organisations and civil associations, 7% are advisory and training organisations and the remaining 7% represent all other types of organisations. Organisational structure is given in Figure 1.

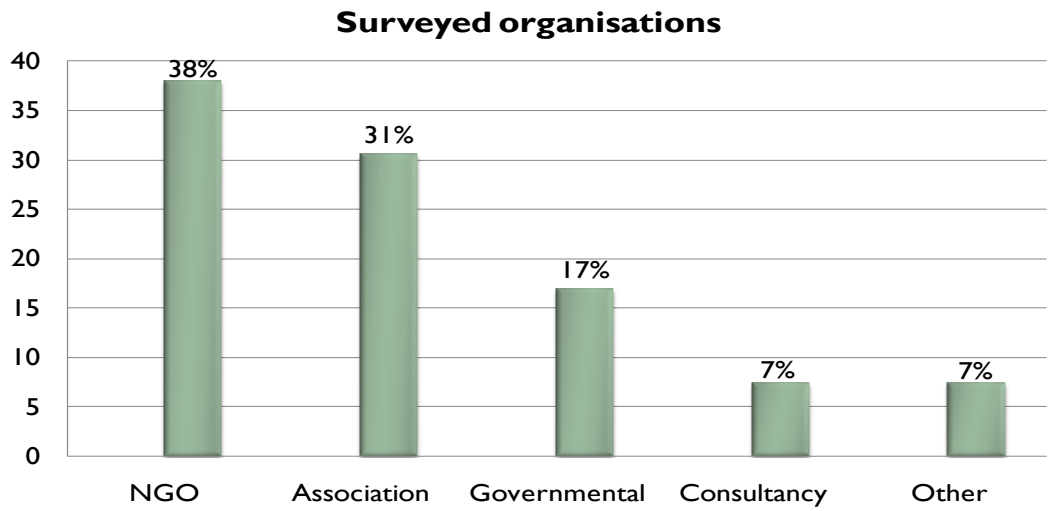


Figure 1. Structure of the surveyed organisations (n=100)

According to the results, 89% of the contacted organisations are located in four regions: in the East region works 30% of the organisations, 22% in both regions of Skopje and Pelagonija and 16% of organisations are located in the South-East region.

Furthermore, the information obtained by the fulfilled questionnaires explains the capacity of the existing organisations, their working field and their preparedness, but also need and willingness actively to participate in the network for rural development.

Considering the organisational working field, 44% work in the field of environment and ecology, 15% in the field of rural and alternative tourism and 13% in the field of sustainable development. The other organisations work in the field of agriculture, cultural heritage and healthy food. The organisational expertise is 85% for protection of the environment, 81% for rural development and 62% for training and consultancy services. According to the analysis, organisational capacities regarding employees, organisational members and volunteers depend on the organisational activities and size. Indeed, there are big organisations with many employees that include volunteers in their activities. Smaller organisations have fewer employees, and some of them do not provide volunteer activities. The descriptive statistic of the important variables analysed in the survey is given in Tab.1.

Even all organisations provide different projects, 76% of them have more than 3 realised and ongoing projects in the last three years. Unfortunately, only 24% of the projects last more than one year, while all other projects are provided in a maximum period of 24 mounts. Here, the important is that 64% of the projects are financed with the amount of more than 5000 €.

Table 1. Descriptive statistic of the surveyed variables (n=100)

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Type	100	1	5	2	2.83
Activity	100	1	6	3	3.53
Field	100	1	3	2	0.60
Employees	100	2	1,800	130	324
Volunteers	100	1	40	9	10
Budget	100	10,500	76,437,000	8,473,541	18,541,094

The analysis show that 96% of the organizations are positive for establishment of rural development network and 91% wants actively to participate in it. The remaining organisations are not decided whether the establishment of national rural development network is important for further rural development and agricultural sustainability.

Analysis of variance

In this study the sample is represented by the surveyed organisations. The results explain which variables are statistically significant for organisational willingness and potential to participate in the national rural development network. With a purpose to estimate the nature of the regression model and correlation between factors all six variables that influence on the dependent variable are analysed by the multiple linear regression and correlation model. The results show 65% variations of the dependent variable caused by the independent variables common influence which indicates that the regression is satisfactory. Hence, the influence of other factors that are not included in the regression is 35%. The estimates of standard error shows 40% unexplained variability. The summery of the regression analysis is given in Table 2.

Table 2. Summary of the regression analysis (n=100)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.442	.653	.543	.40081

The analysis of variance tests the significance between differences of the variability of randomly selected samples. According to the results presented in Table 3, the residual part presents random variability and influence of other factors which are not included in the analysis. Due to its relativity, the residual approach is better measure than standards error, which explains that almost 15% of other factors influence on the regression. However, the estimates show strong statistical significance of 0.002 on the organisational positive assessment for establishment of rural development network.

Table 3. Analysis of variance (ANOVA)

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	3.620	6	.603	3.756	.002
Residual	14.940	93	.161		
Total	18.560	99			

The value of the regression parameters is presented in Table 4. Hence, the number of employees and volunteers is of great significance for increasing the organisational potential for establishment of rural development network. The level of significance is 0.05 which indicate 5% allowed error due to the other influencing factors.

Correlation analysis is used to estimate significance between each variable included in the model. The results considered different significant levels of correlation. In that way, they present a correlation with significance at the 0.01 and 0.05 levels. Indeed, there are three correlations with the 0.01 level of significance established between the type of organisation and its provided activities, the activities and the available budget for successfully providing all organisational obligations, and the number of employees and the output that describes the organisational potential for establishment of rural development network. On the other side, correlation with significance at the 0.05 level is considered between the type of organisation and its operational field, and between the output and the number of volunteers. The correlation analysis is shown below in Table 5.

Table 4. Value of the regression parameters

Model	Unstandardised Coefficients		Standardised Coefficients	t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	2.684	.144		18.699	.000	2.399	2.969
Type	-.031	.044	-.080	-.698	.487	-.119	.057
Activity	.120	.067	.286	1.791	.077	-.013	.254
Field	.114	.070	.160	1.630	.106	-.025	.252
Employees	-.005	.002	-.314	-3.327	.001	-.008	-.002
Volunteers	.000	.000	-.226	-2.397	.019	.000	.000
Budget	-1.430E-9	.000	-.160	-1.100	.274	.000	.000

Table 5 Correlation between the selected variables

		Type	Activity	Field	Emplo.	Volunt.	Budget	Output
Type	Pearson Correlation	1	.469**	.218*	-.105	.028	.153	.091
	Sig. (2-tailed)		.000	.029	.300	.780	.130	.366
	N	100	100	100	100	100	100	100
Activity	Pearson Correlation	.469**	1	.121	-.014	.014	.719**	.154
	Sig. (2-tailed)	.000		.231	.893	.890	.000	.126
	N	100	100	100	100	100	100	100
Field	Pearson Correlation	.218*	.121	1	.082	-.039	.186	.130
	Sig. (2-tailed)	.029	.231		.417	.702	.064	.197
	N	100	100	100	100	100	100	100
Emplo.	Pearson Correlation	-.105	-.014	.082	1	.023	.060	-.311**
	Sig. (2-tailed)	.300	.893	.417		.823	.552	.002
	N	100	100	100	100	100	100	100
Volunt.	Pearson Correlation	.028	.014	-.039	.023	1	-.092	-.223*
	Sig. (2-tailed)	.780	.890	.702	.823		.364	.026
	N	100	100	100	100	100	100	100
Budget	Pearson Correlation	.153	.719**	.186	.060	-.092	1	.065
	Sig. (2-tailed)	.130	.000	.064	.552	.364		.519
	N	100	100	100	100	100	100	100
Output	Pearson Correlation	.091	.154	.130	-.311**	-.223*	.065	1
	Sig. (2-tailed)	.366	.126	.197	.002	.026	.519	
	N	100	100	100	100	100	100	100

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Conclusions

In the results and discussion part the analysis of variance and correlation show that the organisational potential for establishment of rural development network strongly depends on several influencing factors. Moreover, the correlation between some factors is highly significant for increasing the organisational potential. Due to the significance of the current variables, the results show that the analysed organisations have a potential to work in the field of rural development and they can actively participate in the national rural development network. The biggest influences on organisational potentials have the number of employees and volunteers that are working in the analysed organisations. According to the results, the biggest part of the organisations has appropriate capacities and many years of experience in realisation of the ongoing project activities in the field of rural development. They share the need for establishment of National rural

development network and show willingness to participate in its activities. Hence, networking of organisations in the country can start on the voluntary basis by the initiative of the civil associations that work and have many years of experience in the field of rural development. This follow the "bottom-up" approach established in many European countries, and emphasise the need for participation of private sector and public institutions in rural development network.

Actualisation of the rural development approach and increased obligations leads for establishment of National rural development network in the Republic of Macedonia to represent a need and obligation at the same time. It will allow easier cooperation of all participants for realisation of the activities planned in the National Agricultural and Rural Development Strategy. Even if there are already set up conditions for establishment of rural development network, some parts of this process can still be improved. In that way, there are few possible useful practices:

- Building local partnerships and increasing their capacities by knowledge development and mobilising local potentials can bring significant positive results.
- The promotion of private-public partnership including strategy development can focus on innovative approaches in the rural development sector.
- The initiatives for development of rural areas can lead to connecting new people and organisations by applying innovative research, practices and entrepreneurship.
- On-line communication can increase the knowledge and experience for good agricultural practices and innovations for rural development.
- A strategy for better management in the rural areas can increase their economic and social behaviour.

The general conclusion is that the organisations in the Republic of Macedonia fulfil the necessary requirement for successful realisation of the activities in the field of rural development and recognise the need for network establishment. In that way, the basis for establishment of National rural development network exists, nut additional plans for the form and way of establishment should be developed by the Governmental organisations since they are more influencing legislative bodies in the country.

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АНАЛИЗА НА ПОТЕНЦИЈАЛОТ НА ОРГАНИЗАЦИИТЕ ВО РЕПУБЛИКА МАКЕДОНИЈА ЗА ВОСПОСТАВУВАЊЕ НА МРЕЖА ЗА РУРАЛЕН РАЗВОЈ

Марина Петровска, Јован Аждерски

Апстракт

Република Македонија е стратешки ориентирана да воспостави одржлив развој во руралните области, да овозможи оптимално користење на природните ресурси во поглед на заштита на природата и животната средина, да го зголеми квалитетот и конкурентноста на земјоделските производи и да ја зајакне руралната економија. На тој начин, политиката за рурален развој има за цел да ги подобри постоечките услови за живот и работа на населението кое живее во руралните области преку воспоставување на различни форми на здруженија кои ќе дејствуваат за да се постигнат промени и заеднички интерес. Затоа, целта на студијата е да направи анализа на капацитетот и структурата на организациите во Република Македонија кои работат во областа на рурален развој и да ја оцени можноста за нивно здружување и понатамошна соработка. Податоците се добиени од предходно изработен прашалник, доставен до различни организации кои работат во областа на рурален развој. Употребен е дедуктивен истражувачки пристап кој вклучува квантитативен метод на описна анализа за да го спореди капацитетот на постоечките организации со можноста за воспоставување на мрежа за рурален развој. За да се пресмета значајноста на потенцијалот на организациите за воспоставување на Национална мрежа за рурален развој направена е анализа на варијанса (АНОВА). Резултатите покажаа дека вмрежувањето на организациите во земјата може да започне на волонтерска база преку иницијатива на граѓанските здруженија кои работат и имаат многу години искуство во областа на рурален развој. Ова го следи пристапот „оддолу-нагоре“ (“bottom-up“) воспоставен во многу европски земји и ја истакнува потребата за учество на приватниот сектор и државните институции во мрежата за рурален развој.

Клучни зборови: вмрежување, организации во Република Македонија, рурален развој.

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THE PERFORMANCE OF THE MACEDONIAN FRUIT AND VEGETABLE PROCESSING INDUSTRY

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Abstract
The aim of this paper is to determine the performance of the Macedonian fruit and vegetable processing industry during the period 2007-2011. Furthermore, this research has several specific aims: (1) prepare an up-to-date data base of the fruit and vegetable processors in Macedonia (2) research and analyze the production figures and export performances of the fruit and vegetables processing industry; (3) draw adequate conclusions and recommendations in regards to performances of the industry. The majority of the processing companies are classified as micro or small sized companies (86% in 2010 and 88% in 2011). There are no large scale enterprises in the F&V processing industry, due to the seasonal character of the production, which in return only provides an opportunity for seasonal employment. The predominant business activity of the processing industry is vegetable processing, canning in particular, while fruit processing accounts for only 10% of the processing activities. From the production figures it can be concluded that the industry in its development phase. The increased demand for the Macedonian processed goods by the foreign buyers, and domestic market growth are the main factors for improved performances of the industry. Pepper based products (roasted peppers, ajvar, lutenica, frozen pepper stripes) are dominant in the industry product portfolio. The companies are still facing capacity underutilization, mainly due to difficult access to finance (lack of working capita), and still disorganized demand and supply of the raw materials. EU and regional markets are the main export destination for Macedonian processed products. Germany (17%), Serbia (15%) and Croatia (9.5%) are the top 3 export destinations, encompassing in total 42% of the total value of exported processed products in 2011. Bosnia and Herzegovina, Slovenia, Montenegro and Kosovo additionally contributed with 22.5% in the total export value of processed products in 2011. Production under private labels dominates over own brand production and sales, particularly for EU countries. Currently, the industry is building its export strategy primarily on competitive prices, rather than supply of value added products.
Key words: processing of fruits and vegetables, exporting, export markets, product portfolio, competitive prices.

Introduction

The food processing industry is an important sector for the Macedonian economy. This sector contributed with about 3% in the national gross production in 2010 (SSO, 2011). In the beginning of 2012, the food processing industry had about 18,190 employees (excluding the employees in the

beverages and tobacco production and processing), which represents about 3% of all employments in the country (648,200 at the beginning of 2012). The food processing industry is in the group of processing industries, which provides the largest number of employments in the country (130,025 at the beginning of 2012). Within the processing industries, the food processing industry is on the second place according to the number of employments in this sector, right after the sector for production and processing of textiles.

Table 1: GDP and participation of Food and Beverages industry in the GDP (in million denars)

Production of Food Products and Beverages	2006	2007	2008	2009	2010
Gross Output	27,026	30,001	38,392	34,897	41,516
Intermediate Consumption	19,275	20,756	25,982	22,017	28,713
Gross Value Added	7,750	9,245	12,410	12,881	12,803
Taxes and customs duties	9	6	6	6	6
Compensation of employees	4,974	3,729	4,075	4,777	6,262
Gross Operating Surplus	2,768	5,510	8,328	8,098	6,535
Depreciation	1,782	2,076	2,101	2,207	2,573
Net Operating Surplus	986	3,434	6,227	5,892	3,962
Number of employees and self-employed	13,748	13,812	14,973	15,504	17,739
GDP	2006	2007	2008	2009	2010
Total Gross Value Added	276,324	313,478	357,450	358,945	381,148
Taxes on Products	44,741	52,426	56,723	54,935	57,331
- Subsidies on products	-1,006	-915	-2,445	-3,146	-4,367
GDP	320,059	364,989	411,728	410,734	434,112
% Production of Food Products and Beverages in Total Value Added	2.4%	2.5%	3.0%	3.1%	2.9%

Source: Own Analysis, SSO, MAKSTAT Database

The Fruit and Vegetables (F&V) processing sector consists of about 50 processing companies, that employ about 1,200 permanent employees and between 3 and 4,000 seasonal workers. On average, the industry buys about 60,000 tons of fresh fruits and vegetables, annually, for further processing (MAFWE, 2012).

Material and methods

The empirical approach consisted of surveying the fruit and vegetable processing companies in Macedonia during the period May - June 2012. All registered processing capacities were included in the survey (census method), and direct face-to face interviewing technique was utilized (Leader & Kyritsis, 1990). For the purpose of this research a semi-structured questionnaire was developed, tested on 3 companies, fine tuned and deployed. Data related to export performances of the industry was obtained from the state statistical office and additionally specific product groups were extracted and analyzed. The survey encompassed 49 fruit and vegetable (F&V) processing capacities in the

country, out of which only two companies (small scale processors) declined to participate and to provide the requested details. Another 6 companies could not complete the questionnaire due to the fact that they did not perform any processing activity in 2011 (due to various reasons, but mainly because of renovation of processing facilities, installation of new equipment etc.). Hence, the results and the analysis elaborated in this document are based on the answers obtained from 41 active F&V processing companies (unless otherwise stated). Due to the very high response rate of, all the details stated in the report are relevant and statistically correct. The period analyzed in this paper is 2007 – 2011 and analytical models applied are standard, including index numbers where applicable.

The results of the survey were analyzed by using descriptive statistics, while key findings were presented in tabular and graph forms. The research was channelled through MAP, and was financially supported by USAID's AgBiz Program.

Results and discussion

Raw materials supply

The F&V processing industry is highly dependent on domestic production and supply of agricultural products. High import tariffs and complicated procedures for imports of fresh produce for processing purposes leaves the industry to rely almost exclusively on arrangements with private farmers, enterprises and cooperatives involved in primary production and intermediaries – traders that supply the industry. Contract farming is still not applied efficiently as mechanism that regulates the production and supply of raw materials to the industry. Hence, around 40 % of the raw materials needed by the industry are contracted and delivered by the producers/traders (the same as in 2010), while the bulk of the raw materials are obtained on ad hoc basis typically just before or during high processing season.

According to the survey, the industry purchased more raw materials in 2011 in comparison to 2010. In 2011, the industry purchased 70.1 thousand tons of raw materials in total or 1.0% more than in 2010. In comparison to 2007, 22% more fruits and vegetables were acquired by the industry in 2011 (Table 1).

Red pepper is the most important raw material for the processing industry. The quantities of red pepper purchased by the processing capacities in 2011 represented nearly 54% of the overall raw material volume, and increased by 31% compared to 2007. The buyout of industrial tomatoes, beet root, eggplant and plums also increased in 2011 compared to 2007, while quantities of industrial apples and carrots decreased by 67% and 73% compared to 2007.

Overall, the industry purchased 65.3 thousand tons of vegetables (or 93%) and 4.7 thousand tons of fruits (or 7%) for processing purposes in 2011, out of which 27 thousand tons of fresh produce directly from the individual farmers (or 38.5%), while 30.7 thousand tons were supplied by the traders/consolidators (or 43.8%). Agricultural cooperatives supplied the industry with only 0.4 thousand tons or 0.6%, while the remaining 12 thousand tons of fresh F&V (or 17.1%) were provided by agricultural enterprises. This means that more than 80% of the raw materials are supplied by small scale farmers directly or through the traders and hence, processors are faced with product uniformity issues, varietal differences, production practices applied, traceability of the raw materials etc., which ultimately affects their productivity and overall performance.

Table 2. Purchase of raw materials by the industry 2007 – 2011 (in thousand tons)

Raw materials	2007	2008	2009	2010	2011	Index 2011/ 2007 =100
Red pepper	28.6	34.5	29.7	32.9	37.6	131
White pepper	1.2	1.0	1.0	1.2	1.1	92
Gamba	1.7	1.1	0.7	1.6	1.6	94
Chili peppers	2.1	1.7	2.0	2.1	1.5	71
Gherkins	3.6	3.8	2.7	3.5	4.3	119
Beetroot	1.8	2.6	2.7	1.5	2.4	133
Eggplant	2.6	3.2	3.2	3.0	3.2	123
Cabbage	2.3	5.9	2.9	2.5	2.1	91
Carrots	1.1	1.2	0.9	0.3	0.3	27
Industrial tomatoes	1.2	5.0	4.9	8.4	6.2	517
Onions	1.0	2.0	1.4	1.3	0.6	60
Sour cherries	3.6	4.8	3.2	2.4	3.3	92
Plums	0.3	0.8	0.9	1.6	0.7	233
Industrial apples	0.9	0.9	1.7	1.5	0.3	33
Others	5.5	6.30	9.2	5.6	4.9	89
Total	57.5	74.8	67.1	69.4	70.1	122

Production of processed F&V products

The industry in 2007 and 2008 showed a continuous increase in production, mainly due to the increased demand for the Macedonian processed goods by the foreign buyers, and domestic market growth resulting from strong penetration of the retail chains and changes in the lifestyle of the population (buying processed products rather than preparing homemade preserves). However, in 2009 the output was reduced due to the effects of the global financial crisis while in 2010 industry again showed an increase in production. This trend continued in 2011 - the industry's output increased by 5.2 thousand tons or by 10.9% in comparison to 2010 mainly as a result of improved marketing and sales practices of the producers, increased demand by international markets and additional governmental support to the farmers that cooperate with the industry.

The processing industry is involved in production of canned, frozen and dried F&V. The canning component dominates in production structure and increased in volume by 24% in 2011 compared to 2007. The production of frozen F&V products in 2011 was similar to the one from 2007 - +2% in 2011 while dried products showed negative trend and contributed with only 0.1% in total output of the industry in 2011 compared to 0.5% in 2007 (Table 3).

Table 3. Production of processed F&V products by the industry 2007 – 2011 (in thousand tons)

Category	2007	2008	2009	2010	2011	Index 2011/ 2007 =100
Canning	32.7	39.8	39.6	38.2	40.4	124
Freezing	12.2	14.0	6.2	9.3	12.4	102
Drying	0.2	0.4	0.2	0.2	0.1	41
Total	45.1	54.2	46.0	47.7	52.9	117

According to the individual product analysis, industrial ajvar was mostly produced by the industry, (individually contributing with 18% to the overall 2011), followed by processed gherkins, roasted pepper, homemade ajvar, beetroot, frozen pepper, etc. The quantities of homemade ajvar produced in 2011 outrun the volume of the same product produced in 2007 by 72%. Frozen peppers in terms of quantity faced sharp increase in production (8.9 thousand tons produced in 2011 compared to 5.3 thousand tons in 2010). Overall speaking, pepper based products were the most dominant and contributed with 55% in the overall production of processed products in 2011. Also, the production of ketchup significantly increased from 1.4 thousand tons in 2007 to 2.9 thousand tons in 2011due to the increased production of industrial tomatoes in the country. In regards to the processed fruit products, frozen sour cherries remain the most important item for the industry and the overall production is stabile over the analyzed period. Other products, such as lutenica, bleached peppers and chili peppers faced small decrease in 2011 compared to 2007. The highest production of processed products was registered in 2008 with 54.2 thousand tons of finished goods (table 4).

Table 4. Production of individual processed products 2007 – 2011 (in thousand tons)

Product name	2007	2008	2009	2010	2011	Index 2011/ 2007 =100
Industrial ajvar	7.6	10.1	10.4	10.4	9.5	125
Homemade ajvar	1.8	2.6	2.2	2.1	3.1	172
Lutenica	1.0	0.9	0.9	0.9	0.8	80
Roasted pepper	2.7	2.2	3.2	3.1	3.9	144
Bleached pepper	1.4	2	1.9	1.2	1.3	93
Chilli peppers	2.3	1.9	1.9	2.4	1.6	70
Gherkins	5.0	5	3.9	4.8	5.4	108
Beetroot	1.9	2.5	3.3	2	2.8	147
Ketchup	1.4	1.8	2.3	2.1	2.9	207
Mixed salads	1.1	1.8	1.3	1.1	0.8	73
Frozen sour cherries	1.6	2.3	1.3	1.4	1.6	100
Frozen pepper	7.6	8	2.8	5.3	8.9	117
Other	9.7	13.1	10.6	10.9	10.3	106
Total	45.1	54.2	46	47.7	52.9	117

Trade with processed F&V products

The processing industry of the RM has strong export orientation. Macedonian processed products, according to industry members, currently enjoy positive reputation among the food importers from the region and EU, as well. As a result, there is a positive trend for increase of exported quantities. Very favorable trading regime between Macedonia and the EU, and further liberalization especially as a result of CEFTA agreement should even more enhance the competitive position of the processed fruit and vegetable products. In 2007 the total volume of exported good was 29.5 thousand tons, while in 2011 the volume increased by 33% and amounted to 39.2 thousand tons. Domestic sale of processed products is also increasing, contributing to the overall performance of the industry. For example, a domestic sale in 2007 was 7.9 thousand tons in 2007 and 9.0 thousand tons in 2011 or + 14% (table 5).

Table 5. Export and domestic sales of processed products 2007 – 2011 (in thousand tons)

Year	Export	Domestic sales	Total sales	Index 2011/ 2007 =100
2007	29.5	7.9	37.4	100
2008	32.0	8.5	40.5	108
2009	32.2	8.6	40.8	109
2010	39.0	8.2	47.2	126
2011	39.2	9.0	48.2	129

Macedonian processing companies predominately export processed vegetable products. In 2011 processed vegetables contributed with 81.5% in volume and 79.3% in value of the overall exports of processed products. The EU and neighboring markets are the main export destinations for domestically produced processed products. Exports to the EU market contributed with 54.8% in volume (compared to 52.5% in 2010) and 49.9% in value (compared to 46.1% in 2010) of the overall export of processed products from Macedonia. In total, exports to the EU in 2011 increased by 2.3% in volume and 3.8% in value compared to 2010. Serbian market was the second biggest (14.1% in volume and 15.1% in value from the total exports in 2011). Exports to Montenegro considerably increased in 2011 in comparison to 2010. Overall regional exports of processed products in 2011 (to Serbia, Croatia, Bosnia and Herzegovina, Montenegro and Kosovo) contributed with 38.6% in volume and 41.4% in value of the overall exports of Macedonian processed F&V. Overseas markets (particularly Australia and USA) due to large communities of immigrants from Macedonia but also from other Balkan countries are also very important export destinations (Figure 1).

The Macedonian processed products have relatively low export value. The average value of exported processed vegetables in 2007 was 0.90 Euro/kg, while in 2011 the average value was 1.05 Euro/kg, or + 17%. For processed fruit products the average value of exported goods in 2011 was 1.20 Euro/kg and the value increased by 34.8% compared to average value from 2007 (table 6). This categorizes the processed goods as “commodity” rather than products with added value.

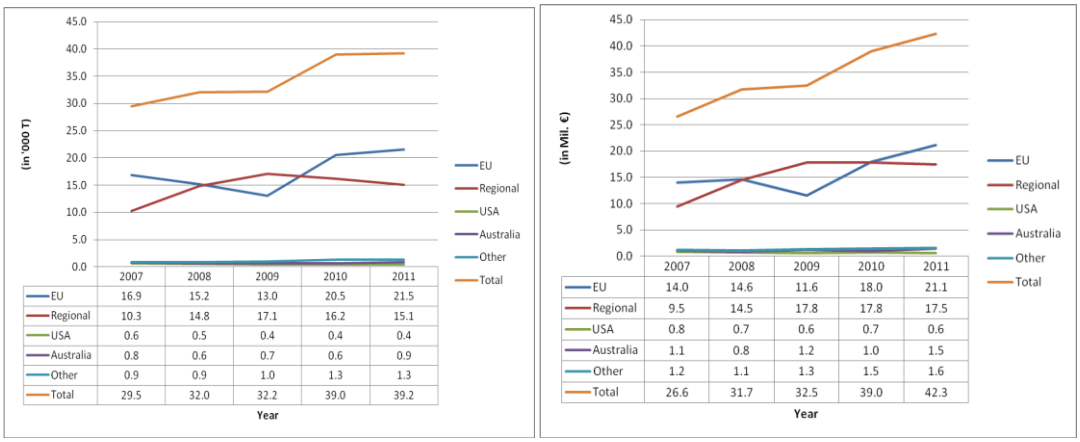


Figure 1. Export volume (left) and export value (right) of processed products 2007 - 2011

Table 6. Export and domestic sales of processed products 2007 – 2011 (in thousand tons)

Exports 2007 – 2011	2007	2008	2009	2010	2011	Index 2011/ 2007 =100
Export of processed vegetables (in '000 tons)	23.37	25.20	27.17	30.12	31.95	136.7
Export of Processed Vegetables (in Mil.Euro)	21.08	24.82	27.54	29.91	33.55	159.2
Average value of exported processed vegetables (Euro/kg.)	0.90	0.98	1.01	1.00	1.05	116.7
Export of processed fruits (in '000 tons)	6.22	6.84	5.13	8.96	7.28	117.1
Export of processed fruits (in Mil.Euro)	5.55	6.92	5.04	9.15	8.78	158.2
Average value of exported processed fruits (Euro/kg.)	0.89	1.01	0.98	1.02	1.20	134.8

Conclusions

The fruit and vegetable processing industry consists of predominantly macro and small enterprises. The predominant business activity of the processing industry is vegetable processing, canning in particular, while fruit processing accounts for only 10% of the processing activities.

The industry showed an increase in 2007 and 2008, but due to the global economic crisis, the industry slowed down in 2009 but quickly recovered in 2010 and 2011. From the production figures it can be concluded that the industry in its development phase. The increased demand for the Macedonian processed goods by the foreign buyers, and domestic market growth are the main factors for improved performances of the industry.

Pepper based products (roasted peppers, ajvar, lutenica, frozen pepper stripes) are dominant in the industry product portfolio. The companies are still facing capacity underutilization, mainly due to

difficult access to finance (lack of working capital), and still disorganized demand and supply of the raw materials. The supply chain structure shows that traders are still the dominant suppliers of fresh raw materials for the industry, while the number of direct purchases from the individual suppliers is also on the rise, mainly due to considerable efforts for deployment of contract farming model, and additional subsides directed to farmers that deliver their produce to the industry. The domestic processing industry is export oriented. The export in 2011, compared to 2007 increased by almost 60%. Very favorable trading regime between Macedonia and the EU, and further liberalization especially as a result of CEFTA agreement should even more enhance the competitive position of the processed fruit and vegetable products.

Due to its continuation, this model can be applied to other agribusiness related industries (or sub-sectors). The analysis and key findings could also serve as starting point in preparation of a longer term development strategy and Sector Export Marketing Plan for the F&V processing industry. This analysis could be expanded by adding financial analysis of the industry in order more relevant data to be gathered and analyzed.

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ОЦЕНА НА УСПЕХОТ НА МАКЕДОНСКАТА ПРЕРАБОТУВАЧКА ИНДУСТРИЈА НА ОВОШЈЕ И ЗЕЛЕНЧУК

Сашо Ристески

Апстракт

Целта на овој труд е да се утврди ефикасноста на македонското преработувачката индустрија за овошје и зеленчук во периодот 2007-2011 година. Ова истражување има неколку специфични цели: (1) да се подготви обновена база на податоци за овошје и зеленчук во Македонија (2) да се истражува и анализира производството и извозот на преработувачката индустрија на овошје и зеленчук; (3) да се подготват соодветни заклучоци и препораки во однос на перформансите на оваа индустрија. Мнозинството на преработувачки компании се класифицирани како микро или мали компании (86% во 2010 и 88% во 2011 година). Нема големи претпријатија во преработувачката индустрија на овошје и зеленчук, што се должи на сезонскиот карактер на производството, и што за возврат дава можност само за сезонското вработување. Доминантна дејност на преработувачката индустрија е преработката на зеленчук, особено конзервирање, додека на преработка на овошје отпаѓа само 10% од преработувачките активности. Од производството низ бројки може да се заклучи дека оваа индустрија е во својата развојна фаза. Зголемената побарувачка за македонските преработки од страна на странските купувачи, и порастот на домашниот пазар се главните фактори за подобрување на перформансите на оваа индустрија. производите од пиперка (печени пиперки, ајвар, лутеница, замрзната пиперка ленти) се доминантни во портфолио на производи во индустријата. Компаниите се уште се соочуваат со нецелосно искористе капацитет, што главно се должи на тежок пристап до финансии (недостаток на работни глава на жител), а сепак неорганизирана побарувачката и понудата на суровини. ЕУ и регионалните пазари се главните извозни дестинации за македонските преработени производи. Германија (17%), Србија (15%) и Хрватска (9,5%) се првите 3 извозни дестинации, опфаќајќи вкупно 42% од вкупната вредност на извезени преработени производи во 2011 година. Босна и Херцеговина, Словенија, Црна Гора и Косово дополнително придонесоа со 22,5% во вкупната вредност на извозот на преработени производи во 2011 година. Производството под приватни марки доминира над производството и продажбата на сопствен бренд, особено за земјите на ЕУ. Во моментов, индустријата е во изградба на својата извозна стратегија главно врз конкурентни цени, наместо врз понуда на производи со додадена вредност.

Клучни зборови: преработка, овошје и зеленчук, извоз, извозни пазари, портфолио на производи, конкурентни цени.

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TRENDS DEVELOPMENT IN THE PRODUCTION OF PLUMS IN THE REPUBLIC OF SERBIA

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Abstract
Plum is fruit is a widespread fruit species throughout the world and Europe, but also in Serbia. Plum is a fruit species moderate continental climate, which is on the territory of Serbia adapt to different conditions. Leading the fruit species in Serbia as well managed and well born in the mountainous area, relatively easy to reproduce and quite rapidly enters the cropping. It is very adaptable and succeeding even at over 1000 m above sea level (grown on the slopes of Javor and Kopaonik at a height over 1250 m). Because of the importance of plum in fruit production in Serbia, the main goal of the research is to analysis the state and basic trends in plum production in the world, Europe and the Republic of Serbia in the period 2002-2011. Analyzed are area, number of trees, yields per hectare and production of plum.
Key words: plum, trends development, Republic of Serbia.

Introduction

Pomiculture as a field in the plant growing production is characterized with a line of comparative advantages in terms of the remaining branches of agriculture. The edible parts, i.e. the juicy parts of the annual and perennial plants which are used fresh or processed are considered to be fruit. The biological –dietetic value of the fruit is determined with the presence of a larger quantity of vitamins, mineral maters and dietary minerals, enzymes, organic acids, natural antioxidants, phytochemical compounds, fibers, essential oils and other ingredients (Mihajlović Dragana, 2007). The production of fruit and fruit products can come from very profitable activities, especially when the export of fruit and fruit products are in question. The purpose of the fruit production is not just to produce, but to produce the specific product which can be placed on the market under the favorable conditions.

Pomiculture is of great significance for our country, and also there are excellent natural conditions for growing almost all kinds of fruit. Fruit grows well on relatively steep ground in favorable climate conditions. Well grown fruits give great yields per surface unit (Šoškić, 2008).

The economic development of the plum is determined by its utilization value, the representation in the pomiculture and the total agricultural production, the participation in the foreign trade, the necessary work force in the production, processing and the trade of plums, as well as the yield of this type of fruit of the sustainable development and the protection of the environment (Milić and Radojević, 2003).

The plum is a leading type of fruit in the structure of the fruit production in Serbia, as well as in the number of fruit giving trees (share 56,98%), and in the realized production as well (share 45,53%). The second and third place in the structure of the fruit production belongs to the apples and sour cherries, respectively (Lukać, Bulatović, 2004). However, although the plum is a prevailing type of fruit in Serbia and has a great economic significance, one type is grown the most – damson plum (Požegača).

Serbia which was a leader in the production of the "blue queen", the popular name of the plum with decades, can no longer hold this title. The European countries, such as Germany, France and Romania, are winning the game and so from the first place, Serbia has come down to number four, which is also uncertain since the Turkish plum producers are seriously competing for that place (Stojić, 2008). This author points out that the plum had a similar fate on the world market were, production wise, in its better days it was a match even for America.

The fruit of the plum is rich in potassium and reduces the blood pressure. The vitamins, enzymes and growth hormones have a significant, dietetic and therapeutic value. The anthocyanins can provide the human body with the appropriate protection from radioactive radiation and are significant antioxidants (Mišić, 2006).

Material and methods

For the analysis of the condition and the movements of the more significant characteristics of the plum production in the world, Europe and Serbia, the published data (web-sites) of the FAO organization and the Statistical Office of the Republic of Serbia (www.fao.org and www.stat.gov.sr) were used. At the same time, data from other sources were used which are listed in the part of the Bibliography.

For the processing of the statistical data, a table and graphic analysis and descriptive statistics was used for: the relative indicators of the occurrences, the average value, the change rate, the coefficient of variations.

The method of operation is adjusted to the purpose of the research, so that the surfaces, the number of the fruit trees and the production of the plum are arranged by years in tables, in order to visually understand the dynamics of the observed occurrences in the production with greater clarity.

Results and discussion

Characteristics of the capacities for the production of plums in the world

With the long term evolution in the various eco-environments, the plum has acquired a high degree of adjustment and a wide range of distribution, especially in the northern hemisphere (between 40º and 60º northern latitude). The leading place of the plum in the fruit production of Serbia can be explained with its wide range of distribution and the moderate demands from the land, the relatively moderate demands in terms of the applied agro techniques and the opportunities to grow on higher altitudes. However, in spite of the great economic significance in the production of plums of Serbia, there are still low yields and unsatisfactory economic results (Milić et al, 2009).

According to the average for the period of 2002-2006 there were total of 56.120.000 plum trees in Serbia, of which 52.230.000 were fruit giving trees. The average production was 448.960 tons a year, with an average yield of 8 kg per tree (Šoškić, 2008).

In the period 2008-2010, the world areas planted with plums were amounting to 2,5 million ha in average (table 1). Asia with its average area of 1,8 million hectares and Europe with its average area

of 5,5 million hectares have a share of 71,99%, or 22,23% in the total areas planted with plums in the world. According to this, the above-mentioned continents have a share of 94, 92% in the total areas under plums in the world. The share of the other continents extends within the interval of 0,15% (Oceania) to 1,85% (Africa).

Table 1. Areas under plums in the world, for the period 2008-2010

Region	Areas (ha) Year			Average 2008-2010	Structure (world =100%)
	2008	2009	2010		
World	2480995	2501982	2488374	2490450	100,00
Africa	43359	45065	49819	46081	1,85
North America	3967	38361	37684	26671	1,07
South America	36214	42233	42511	40319	1,62
Asia	1767489	1779521	1831946	1792985	71,99
Europe	574713	578648	507814	553725	22,23
Oceania	4401	3543	3430	3791	0,15

Source: www.fao.org

The average yield of plums in the world within the examined period (2008-2010) was amounting to 4.321 kg/ha (table 2). North America is the region with the highest average yield per unit area (13.376 kg/ha), followed by South America with its average yield of 11.373 kg/ha. The average yield of plums per unit area in Europe is amounting to 5.025 kg/ha.

Table 2. Yields of plums in the world for the period 2008-2010

Region	Yield (kg/ha) Year			Average
	2008	2009	2010	
World	4.167	4.375	4.420	4.321
Africa	6.316	6.611	6.291	6.406
North America	12.502	14.886	12.740	13.376
South America	11.108	11.566	11.444	11.373
Asia	3.646	3.698	3.744	3.696
Europe	4.572	5.047	5.456	5.025
Oceania	5.476	5.112	5.102	5.230

Source: www.fao.org

The average production of plums in the world in the period 2008-2010 was amounting to 10,8 million tons (table 3). Having known that the largest areas under plums are located in Asia and Europe, the largest production should be expected from these two continents. Asia with its average production of 6,6 million tons holds the first place, with share of 61,59% in the total world production of plums. The second place belongs to Europe with realized average production of 1,9 million tons, or a share of 17,71% in the total world production of plums. These are followed by North America (4,79%), South America (4,26%), Africa (2,74%) and Oceania (0,18%).

Table 3. Production of plums in the world for the period 2008-2010

Region	Production (t)			Average 2008-2010	Structure world=100%
	2008	2009	2010		
Worlds	10338754	10945579	10998227	10760853	100,00
Africa	273855	297943	313432	295076	2,74
North America	495525	571051	480094	515556	4,79
South America	402282	488448	486474	459068	4,26
Asia	6444479	6580565	6859259	6628101	61,59
Europe	27854	2920227	2770496	1906192	17,71
Oceania	24100	18113	17500	19904	0,18

Source: www.fao.org

China is leading plum-producing country in the world with a production of 3,2 million tons, representing a share of 30,06% in the total world production of plums (table 4). Serbia is the largest European producer of plums, with average production of 337.421 tons and share of 3,14 % in the total world production of plums. USA, Iran, Romania, Turkey, Spain, Italy, India, Russia and Chile are also important producers.

Table 4. Largest producers of plums in the world for the period 2008-2010

Countries	Production (t)			Average 2008-2010	Structure world=100%
	2008	2009	2010		
China	3116919	3206374	3380169	3234487	30,06
Serbia	362099	395436	254728	337421	3,14
USA	294239	339228	285090	306185	2,85
Romania	192802	191753	192257	192270	1,79
Iran	160613	160613	160613	160613	1,49
Turkey	148108	146674	143705	146162	1,36
Chile	139643	176643	177836	164707	1,53
Spain	118699	135943	114579	123073	1,14
India	113368	117503	140896	123922	1,15
Italy	109778	112969	123827	115525	1,07

Source: www.fao.org

Plum- producing tendencies in the world

The average areas under plums in the world in the examined period (2001-2010) were amounting to 2,3 million hectares, with variations throughout the analyzed years of 2 million hectares in 2007 up to 2,5 million hectares in 2002 (table 5). Europe with its average area of 489.258 hectares, has a share of 23,17%, in the total areas under plums in the world. Global increase of the areas under plums has been noticed in the world (change rate of 2,1%), as well as in Europe (change rate of 15,1% per year).

Table 5. Trends at the areas planted with plums in the world, in the period 2001-2010

Indicators	Area (ha)	
	World	Europe
Average	2.310.559	489.258
min.	2.053.685	431.593
max.	2.501.982	607.977
Change rate (%)	2,1	15,1
Variation coefficient (%)	6,7	33,28

Source: www.fao.org

In the examined period (2001-2010) the average yield per unit area in the world was amounting to 4.279 kg/ha (table 6). Variation coefficient is 4,44%. The average yield of plums in the world has been increased with a change rate of 0,45% per year, while the average change rate in Europe reaches even 8,5%.

Table 6. Trends at the yields of plums in the world, in the period 2001-2010

Indicator	Yield (kg/ha)	
	World	Europe
Average	4.279	4.897
min.	3.982	4.271
max.	4.513	5.698
Change rate (%)	0,45	8,5
Variation coefficient (%)	4,44	9,44

Source: www.fao.org

For the 2001-2010 period, the realized world plum production amounted to 9,8 million tons on average, with variation according to analyzed years from 8,5 million tons in 2002 to approximately 11 million tons in 2009 (table 7). The world plum production increases according to a 2,6% change rate, while in Europe there is a 2,1% change rate. The growing trend of the world plum production increase is the result of the increase of surface areas and yields per unit capacity.

Table 7.Variation of the world plum production in the 2001-2010 period

Indicators	Production (t)	
	World	Europe
Average	9.897.218	2.632.443
min.	8.473.770	1.856.892
max.	10.998.227	3.049.759
Change rate (%)	2,6	2,1
Variation coefficient (%)	8,70	12,42

Source: www.fao.org

Characteristics of plum capacities in Serbia

The number of fruit giving plum trees in Serbia amounted to 41,9 million for the observed period (2001-2010) on average, with variation according to analyzed years from 42,3 million in 2002 to 40,8 million in 2011 (table 8). With its 2,6 million fruit giving plum trees, Vojvodina has a share of 6,23% in the total number of fruit giving plum trees in Serbia. There is a decrease of the number of fruit giving plum trees in Serbia with an average change rate of – 0,43% annually. There is a decrease of the number of fruit giving plum trees in Serbia as a whole (change rate – 1,42%) as well as according to observed regions.

Table 8. Variation of fruit giving plum trees in Serbia in the 2002-2011 period

Period	Indicators	Serbia	Central Serbia	Vojvodina
2002-2011	Average (000)	41909	39295	2614
	min.	40822	38192	2545
	max.	42582	39950	2648
	Change rate (%)	-0,43	-0,48	0,32
	Variation coefficient (%)	1,42	1,55	1,19

Source: www.stat.gov.rs

For the 2002-2011 period, the yield per tree in Serbia amounted to 12 kg/st (table 9). The average yield of plums shows a tendency of growth per 8,04% change rate.

Table 9. Variation of the plum yields in Serbia in the 2002-2011 period

Period	Indicators	Serbia	Central Serbia	Vojvodina
2002-2011	Average (000)	12,0	11,6	17,1
	min.	4,0	4,0	6,0
	max.	16,0	16,0	22,0
	Change rate (%)	8,04	8,48	8,15
	Variation coefficient (%)	32,39	33,56	25,03

Source: www.stat.gov.rs

There was average plum production in Serbia in the amount of 514.886 t for the 2002-2011 period (table 10). With the production of 40.678,5 t Vojvodina has a share of 7,9% in the total plum production in Serbia. There is an increase of the average plum production in Serbia as a whole (change rate 6,76%), as well as according to observed regions (Central Serbia 6,70% and Vojvodina 7,55%).

Table 10. Variation of the plum production in Serbia in the 2002-2011 period

Period	Indicators	Serbia	Central Serbia	Vojvodina
2002-2011	Average (000)	514886	469667,5	40678,5
	min.	197486	180726	16760
	max.	680566	635872	56856
	Change rate (%)	6,76	6,70	7,55
	Variation coefficient (%)	30,5	31,55	24,26

Source: www.stat.gov.rs

The plum production situation is a consequence of the general situation in agriculture and promiculture production in Serbia. Due to its exposure to great influence of the instable market (domestic and foreign) and the variation of the climate conditions, this production went through its rises and falls (Tomić and associates, 2006).

According to Milošević and Petrović (200), the Kolubar and Nish County are characterized with extensive production of plums, while the area around Valjevo and parts of Šumadija are characterized with intensive production. Noted authors also indicate parameters that characterize the production in hill and mountain areas:

- Inappropriate varieties and soils,
- Low and variable yield followed by low quality of the plum fruits,
- Old, tired and biologically worn out plum plantations and
- Irrational use of plum fruits.

Milić and associates (2001) stress that only the intensive plum production is economically justified. Therefore the production should be intensified in the following period and the producers should be "persuaded" that with high investments per unit surface optimum financial results and high profitability may be achieved.

Many authors proposed measures for revival and promotion of the plum production in Serbia (Milošević and Petrović 2000), (Petrović and Milošević 1995), (Vlahović and associates 2001) etc. Some of the proposed measures by the mentioned authors are the following:

- planting new intensive plantations with varieties which according to the realized yields, size and quality of the fruits may provide lucrativeness of the investment, on one hand, and satisfaction of the requests of the foreign market on the other,
- promotion of the plum growing technology, above all, by improvement of the protection level against diseases and pests,
- more efficient efforts in the elimination of the negative consequences provoked by the sharka,
- preparation of long- term national programme for plum production and processing which implies division of the Republic into zones and micro- zones appropriate for growing of certain plum varieties. Financial support by the state community for planting of new intensive plantations with varieties of high quality which have high potential of fertility and sharka resilience is necessary, as well as crediting of the current production,
- introduction of the marketing concept,

- on a macroeconomic level it is necessary to undertake several vital measures in the agricultural policy, in order to provide long- term stabilization of the production and a high level offer and to provide economic security of the producers.

Conclusions

The plum is a widely spread fruit variety in the world and Europe, but in Serbia as well. The plum is a fruit variety which grows in a humid continental climate that in Serbia has adjusted to different conditions. It is highly adaptable and can grow even on 1000 m above the sea level (it is grown on the meadows of Javor and Kopaonik on a height of over 1250 m above the sea level). The terrains between 200 and 750 m above the sea level are most suitable for the mostly spread plum varieties in our country (damson plum (Požegača), Stanley and Čačanska Rodna).

On average for the period 2008-2010 the plum plantations in the world occupied 2, 5 mil ha. Asia, with average surface of 1, 8 mil.ha and Europe with average surface of 553.725 ha participate with 71, 99%, i.e. 22, 23% in the total plum plantations in the world. In the researched period the average plum yield was 4.321 kg/ha. North America is the region with the biggest average yield per unit surface with 13.376 kg/ha, and second is South America with average yield of 11.373 kg/ha. The average plum yield per unit surface in Europe is 5.025 kg/ha. Having in regard that Europe and Asia have the biggest plum plantations it should be expected that these two continents will provide the biggest production. Asia, with average production of 6, 6 million tons is on the first place participating with 61, 59 % in the total world plum production. Europe is second with realized average production of 1, 9 million tons i.e. participating with 17, 71% in the total world plum production.

On average for the research period (2001-2010) the plum plantations grow in the world in general (change rate 2, 1%), and in Europe (change rate 15, 1% annually). The realized world plum production was 9, 8 million tons and it tends to grow with an average change rate of 2, 6%. The growing trend of the plum production increase in the world is a result of the growth of the surfaces and the yields per unit capacity.

On average for the researched period (2001-2010) the number of Plum trees in Serbia was 41, 9 million. Vojvodina, with 2, 6 million of the total number of plum fruit giving trees participates with 6, 23% of the total number of fruit giving trees in Serbia. The number of plum fruit giving trees is decreasing, in Serbia in general (change rate -043%) and according to analyzed periods. The average plum yield in Serbia was 12.00 kg/st (table 9). The average plum yield tends to grow per change rate of 8, 04 %. In Vojvodina the average yield was 17, 1 kg/st and it tends towards increase per average annual change rate (8, 15%). The average plum production in Serbia was 514.886 t, with expressive increase trend (change rate 6, 76 %).

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ТЕНДЕНЦИЈА НА ДВИЖЕЊЕ НА ПРОИЗВОДСТВОТО НА СЛИВИ ВО РЕПУБЛИКА СРБИЈА

Дејан Томашевиќ, Ристе Еленов, Душан Милиќ

Апстракт
Сливата е многу распространет вид на овошје во светот и во Европа, но и во Србија. Сливата е вид на овошје на умерено континенталната клима која на просторите на Србија се прилагодила на различни услови. Таа е водечки вид на овошје во Србија бидејќи одлично успева и добро раѓа во ридско-планинскиот простор, релативно лесно се размножува и доста брзо започнува да раѓа. Многу е адаптивна и успева дури и на преку 1000 m надморска висина (се одгледува на падините на Јавор и Копаоник, на висина од преку 1250 m). Поради значењето на сливата во производството на овошје во Србија, основната цел на истражувањето е согледување на состојбата и на основните трендови на движењето на производството на сливите во светот, Европа и Република Србија во периодот 2002-2011 година. Анализирани се површините, бројот на родните стебла, пронисите по хектар и остварено производство на сливите.
Клучни зборови: слива, тенденција на движењата, Република Србија.

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STRATEGIC APPROACH TO THE STUDY OF INTERDEPENDENCE OF PRICE AND QUALITY OF WINE – CROATIAN EXPERIENCE

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Abstract
One of the main strategic points within wine marketing is the establishment of interdependence of quality and price, especially for new products. The paper will start with theoretical approach to wine quality and wine price separately and will discuss the interdependence of quality and price of wine which represents the assumption for strategic approach to this problem for wine producers and wine dealers. Results of indicative research conducted in The Republic of Croatia which were gained by probing of individual questioning with the aim of defining the importance of quality and price when buying wine are shown within the scientific research. In the end, managerial implications based on experience of Croatian wine producers and wine dealers are shown.
Keywords: wine price, wine quality, wine marketing, interdependence of quality and price of wine.

Introduction

Quality is considered to be one of the significant elements of non-price competition in the markets of developed market economies. It presents established level of characteristics of a product which effectiveness and/or usefulness is described. When quality is concerned, regardless of the fact whether it is discussed about production operation, commercial or any other business, it is necessary to define the following:

a) approximately maximal, average and minimal level of quality of the product;
b) the amount in which price and quality of the product are synchronized;
c) the amount of customers' sensitivity to the change of level of quality of the products and the amount of changes of product demand.

First, this paper will try to give answer to the second question. However, strategies concerning wine quality can be established based on the preceding paper. Particular quality and price position in relation to the competition wine products can be presupposed highlighting the identification of customers needs, i.e. wine consumers needs, then (positive and negative) changes in customers needs and quality of level of the direct competition. This process needs to be studied dynamically, hence in longer period of time as well.

Wine quality

Recent quality definitions are getting significantly closer to the fundamental marketing settings. For example, quality is defined as a measure that shows the amount in which a product is synchronized

with customers' needs, wishes and expectations (Bovée, C. L. and Thill, 1992); optimal quality is defined as the level of quality in which best brings into balance customers' satisfaction and manufacturers' cost. Unfortunately, Croatian wine manufacturers pay more attention to quantity, in the production and market segment, and not to quality in any of its aspects. Generally, it is possible to discuss quality and quantity increase of the particular wine manufacturer. It is possible to measure quantity increase by looking at production, sale, number of employees increase indicators and certain financial increase indicators as well. It is possible to introduce quality increase in two ways: by introducing new wine brands and/or increase of wine quality in general terms; it can be the result of the overall increase in the quality of wine manufacturer's business on all organizational levels. Wine manufacturer's quality increase is based on the quality increase programme elaborate. It must be based on manufacturer's attitude to carry out the quality policy which is based on the following:

1. proportional high quality of wine
2. the necessity of constant level of wine quality
3. constant pursuit of increasing wine quality.

It is important to know that the introduction of wine manufacturers' quality elaborate will have a long term effect. Unfortunately, it is usually the case that wine manufacturers understand the role of quality only in case when they try to capture new and especially foreign market by selling wine they made, i.e. with the existing level of (low-) quality. Moreover one must be aware that medium-size wine manufacturers (producing 100 to 250 thousand bottles of wine a year) are a synonym for Croatian wine of high quality (Ladašić, 2006), which isn't necessarily true. The quality of wine cannot be based on the quantity. Apart from the characteristics of the quality, the quality can be recognised by all the other elements of marketing mix. It is common that high quality is followed by high wine product price, selective or exclusive distribution and highly professional but not so usual promotion. These characteristics are within manufacturer's scope of work. Apart from the characteristics mentioned, there are two promotional activities that are not within manufacturer's scope of work but which are equally present in a positive way- publicity and "word-of-mouth" advertising.

Moreover, objective and subjective quality elements should be differentiated. On the one hand, it is about technical-technological and other similar quality standards, while, on the other hand, it is about immeasurable quality standards which are judged by customers (wine consumers); these standards are different for every consumer and are, for example, wine taste. Generally, wine consumers' satisfaction should be the result of both elements, even though there is real possibility that subjective quality will overcome objective (low-) quality. This is the case with notorious wine brands which objective quality is not wholly or at least sufficiently overdrawn.

Wine quality is undoubtedly the result of the place where grapes for the wine production are grown. Place of growth is with the process of production, grape species and elements of physical environment (climate, insolation, soil, vegetation, water supply, micro flora and fauna and the like) of extremely important. All these elements together are called *terroir* and it is easiest to define it as taste of locality. According to the mentioned *terroir* should presuppose its uniqueness, particularity, origin, durability and personality. It is obvious that *terroir* understanding moves from objective to subjective category and should definitely be used for marketing. What is more, geographical wine origin and thus *terroir* is sometimes legally protected (example of Champaign and Rizling) (Hall, 2008).

Quality is an essential part of material and immaterial elements of wine which is an integral product. Quality of each particular element should be equally on the same level because wine consumer's dissatisfaction can be influenced by only one low-quality product. This can automatically lead to consumers' dissatisfaction of the whole product because the product is seen as whole. It can be shown in the following way:

$$KPP_1 \approx KPP_2 \approx KPP_3 \approx KPP_4 \approx KPP_5 \approx KPP_6 \approx KPP_{n.}$$

KPP stand for partial product quality regardless of its material or immaterial nature. Hence, the quality of wine as an integral product has to be understood as the function of quality of its partial elements where the quality of each partial element has to be at least equal and the level should be proportionally high. Only in this case it is possible to talk about integral quality of such product. When wine is concerned, cork, for instance, can be of low quality; while opening a bottle with such cork, the cork will break into peaces, crumble and contaminate wine which is being poured into a glass. The situation described will make a negative impression of the whole wine.

To maintain and improve his image which is related to quality, it is of great importance for wine manufacturer to put a lot of effort into realizing one of the following variants:

a) minimalistic variant: to maintain constantly achieved level of quality under condition that the quality is seen as relatively satisfactory; middle variant: to have the tendency of constant improvement of general level of quality; maximalist variant: to have the tendency of constant wine production with the highest possible level of quality (top-quality), i.e. to become and keep the position of market leader when wine quality is concerned.

When products are being repeatedly used, and it is the case with wine, the quality has to fulfil certain additional conditions which mostly affect usage and create consumers loyalty to certain products in the end. It can be concluded that quality is presupposed to be in close relation to wine origin, i.e. its tenderer. Wine style and character are presupposed by its quality and both of them define further consumers' segmentation and (non-)existence of loyalty in the same quality group. In other words, wine consumers who have experienced certain wine quality will continue with the purchase of that particular wine regardless of the higher price. At the same time, wine promotion cost should be in inverse proportion to the quality improvement cost. Hence, high quality wine should be sold with no or minimal promotion. On the other hand, bigger promotions are required for wine of low quality, especially in marketing and personal sale field. In the process one should be aware that according to Wine law (NN 96/2003) wine with controlled geographical origin and fruit wine are allowed to be advertised.

ISO 9000 norms were introduced in order to establish quality standards and for wine manufacturers to obey. These norms present simple and logical demands, elements and guidelines. Above all, these norms apply to the standardization of offer, purchase and testing of all actions included in the process of wine production, its sales activities and wine serving. ISO 9001 managing system is even more demanding than ISO 9000 system because it consists of developmental component as well. Croatian wine producers obey ISO 9001 system norms and HACCP (integrated food control system concerning all process fazes of its production and distribution). Some of the producers obey ISO 14001 (environment managing system) and ISO 18001 (health and safety at work managing system) norms. On the whole, wine producers who obey quality managing standards have top product in the end. However, after wine category is gained and wine is in the market conducting quality control on

national level is most important. In other words, there are serious doubts whether high quality and low-quality wine are mixed.

In the end, it is necessary to highlight that achieving and maintaining proportionally high level of quality can mostly be the result of the following marketing performance:

– creating suitable image wine and its producer,

– improving competitive position in the wine market and precise wine differentiation in the market since raising of the quality level presupposes added value of wine,

– achieving higher wine price,

– rationalization of promotional activities, since unpaid promotional forms are increasing (publicity and "word-of-mouth" advertising),

– general decrease of marketing cost,

– increase of repeated purchase and customers' loyalty etc.

Wine price

Price system directly determines functioning of the whole economic mechanism. On the other hand, price system directly influences making decisions about price even though as a rule price should be the result of economical acts, especially market rules. However, in Croatia it is normally not the case. As a result there is a fact that price is not considered to be significant variable of marketing mix by domestic wine producers; it is primarily considered to be mean of achieving (more) reasonable financial results without changes within production factors and business politics. Even though this fact was also affected by general state of disorder in the market in the time of former country it is obvious that we are pretty far away from perception that price as an element of marketing mix is of extremely significant importance for wine producers' business decision making, decisions of strategic and tacticful importance; everything mentioned is the result of the present situation which is reflected in the environment as well as present situation among wine producers. This also means that wine price has to be congruent to fundamental features and characteristics of particular wine, hence to closely suit its quality, design, packaging… and to realistically present achieved wine manufacturer's work productivity through wine price. Difference among sale price, i.e. valorised market price, and the cost should present realized income earned from wine sale. To sum up, effective combination of price and quality results in suitable strategic position and higher income.

Due to the facts mentioned above wine price is often seen as critical variable within marketing decision making since established price mostly and in large amount affects realization of established marketing goals, i.e. generally speaking fulfilling wine consumers' needs and achieving wine producers' suitable income. Hence making decisions about wine price has to be based on the following principles:

a) wine price has to be acceptable for wine customers
b) wine price has to ensure wine producer's future business
c) wine price has to ensure wine producer's sale increase, i.e. increase in the field of market share
d) wine price has to be competitive in the wine market
e) wine price has to function as stabilization in the wine market
f) wine price has to maintain suitable rate of profit.

On the other hand, price establishing factors are numerous and diverse. However, key factors are market factors, especially the following:

1) faze in the cycle of wine
2) price elasticity within wine demand
3) wine price among competition
4) style and habit of purchase of wine consumers
5) wine price differentiation
6) economic policy measures in the wine price field
7) manufacturer's image and tradition and vineyard position
8) consumers' buying power.

Due to the lack of space for giving explanation for every single of the mentioned factors, in the following part we will generally mention that there are four methods in wine price establishing: (Wagner 2007)

1) Method based on production cost

This is the oldest and the simplest method. Within this method wine price is based on the price of a tonne of grapes. There is a rule in the consistent American practice that the price of a tonne of grapes is divided by 100. According to this, if the price of a tonne of grapes is 2000$/tonne the price of the bottle is 20$. However, this method is old-fashioned and is hardly ever used except in the small vineries.

2) Method of price defining by experts

It is usually based on "blind" tasting of large number of mutually competitive samples of wine (8 to 12 wine samples) by wine experts, retailers and experts alike, four to eight of them in the total. These testers are expected to make a list of tasted wine samples which in the end gives the ranking chart of the wine samples tasted. If wine of a tasted vinery is in the first third of the chart it can be accepted to be in the highest price bracket because it is competitive by its quality as well. There is a problem when this method is concerned and it deals with subjectivity of the tasters, particularly in the process of their recruitment. It is also possible to make a jury of wine consumers who will make the chart instead of the experts motioned above.

3) Price defining method on the strategy-consumers lines.

Within this method the first thing to do is to define the strategy by which wine is to be directed in the particular segment of the market, i.e. to particular competitive market niche. Then, a survey of potential wine consumers of the particular market segment, i.e. market niche, is being conducted in the market and special events can be organized so that survey can have a promotional effect. In any case received feedback is authentic because they are result of true opinion of wine consumers in the market.

4) Method which combines all the methods mentioned above.

No matter which of the methods is used to define price, final decision about wine price has to be made. With this price wine producer will come out in the market by being aware that the price is synchronized with other elements of marketing mix and prices of competitive wine.

Interrelation of wine quality and price

Defining interrelation of wine quality and price is one of the crucial strategic issues within wine marketing, especially for new products, i.e. for new wine brands. Successful strategic defining and then managing interrelation of wine quality and price can result in competitive advantage of particular wine manufacturer. Dynamically observing, in defining this interrelation, generally there are three following variants:

1) One comes out in the market with balanced interrelation of quality and price, i.e. their interrelation is tried to put into balance in the best possible way according to the "value for money" principle. It is expected that quality level in every aspect has suitable price as well; however this cannot be expected in a real situation.
2) One comes out in the market with higher quality in relation to price to draw attention and when it is done the price is slowly increasing till it reaches "value for money" level.
3) One comes out in the market with lower price in relation to quality level to draw attention and when it is done the quality level is gradually increasing till it reaches "value for money" level. It is about specific penetrating price variants which are used to enter a market no matter how tough the competition is.

The problem in relation to the previous question is what really "value for money" is. Furthermore, isn't "more value for less money" present with wine consumers. Namely, the fact is that quality in general, and wine quality in particular, is a subjective category with distinction to price, which is an objective category, understood by wine consumers. That is, quality perception is different from customer to customer, while price is a given category and customers can(not) accept it only in terms of their buying power and life standard. Generally, wine consumers should react positively to the change of the quality level in a way that they recognise it in the first case and then show readiness to pay higher price for reached higher quality level. In order to achieve this investment in the increasing quality level should be directed to those elements of quality that are recognisable to an average wine consumer.

Apart from the above mentioned, it is quite hard to observe simultaneously both wine quality and price. That is, the problem is that wine consumer can actually judge wine only after it was tasted, even though quality elements don't necessarily be in relation to wine itself; it can include its packaging, label and other visual components of wine as a product and especially wine brand image, its origin, *terroire*, quality category (top quality, superior quality…), wine style and character and other immaterial elements of quality. Wine price can be the result of long wine production tradition and established image, for example French wine have higher prices than wine of other European, and New world wine producers, wine producers within the same quality level. However, decisions about wine quality are mostly made by coincidence (mutually with wine consumption, for example in restaurants and on wine roads), and is even more frequent as an element of post-purchase satisfaction of wine consumers who, after they taste certain wine, can judge about interrelation of wine quality and price. It should be noticeable that this kind of judging is subjective and this can be concluded from the above. In this sense it should be known that if suitable judgement is made about quality and price relation, wine consumer's loyalty toward certain wine brand will arise. This kind of loyalty can be maintained despite reasonable wine price increase. That is, it is important to know that loyal consumers are willing to pay more and stay loyal to wine producer that meets their needs and won't take risks by going to other producer with lower price.

Conjoint analysismakes the defining of interrelations between quality features and service price and their effect on the total product usefulness possible and idea acquired in this way is used for forming your own product offer and price policy. Using this model presupposes the possibility of one feature being compensated by another (trade off). In this way it is possible to determine whether wine consumer prefers qualitative or price elements of the product. In the case in which quality has greater impact in relation to price it is possible for prices to increase and consequently net usefulness decreasing would be possible to compensate with quality level rising etc. (Benazić, 2006)

Interrelation of price and quality can be shown through so-called hedonistic price function which is actually regressive equation which brings close product price and product's characteristics which means that, apart from the rest, individual maximal wine customer's readiness to pay for particular wine quality element can be shown. Achieved price function can then help to define direction and intensity of quality feature change impact on wine price change. Equally, investment profitability of wine quality increase can be defined by additional analysis made by wine producers. Namely, investment profitability of quality increase exists only in the case when wine consumers are willing to pay more for increased quality. Moat authors think believe that competitive advantage is based on perceived added value used is determined by customer's conditions in relation to product price. Hence, wine producers can move in the direction of increasing added value and/or price implicating differentiation and effectiveness, i.e. cost.

In the following text we will try to prove everything mentioned so far by results of indicative personal questioning probing research (Kristić, 2012) conducted last year in the part of Osijek-Baranya County among 476 respondents, members of student population, with the aim of defining importance of quality and price when buying wine. That is, to see the whole picture of wine market and define the preferences of younger population, aimed respondent group was introduced to pre-graduate and graduate students of Osijek University. One should be aware that Osijek-Baranya County where Osijek University is situated represents proportionally significant wine-growing district (Belje, Đakovo, Erdut and Feričanci wine are widely known) and the results given in the following text can be explained. On the other hand, young people definitely don't represent the segment which characterises the biggest wine consumption but it shouldn't be forgotten that young population is the group which create its attitudes, opinions and preferences at the end of this period. Big, if not the biggest effort should be made to direct the promotion of creating wine consumption culture to this very group of people. The specimen was deliberate and included 476 respondents from Osijek-Baranya County. There were 46,01% of men and 53,99% of women among the respondents. In the beginning, the surprising results of the conducted survey show that 88,58% of male respondents and 82,88% of female respondents consume wine while 81,28% of male respondents and 55,25% of female respondents consume beer which contradicts general opinion that most of the young people consume beer in larger amount than wine. This also shows that adequate marketing effort, this prospective market segment, should be held as extremely important in managing marketing strategies. In the context of this work and the conducted survey we were mostly interested in the answers of the respondents who consume wine and answers concerning their attitude towards wine quality and price. Respondents' answers are shown in five grades on Likert scale, and the results are shown in the table 1.

Table 1. Respondents' attitudes towards wine quality and price

Variable	Number of respondents*	Arithmetic mean	Median	Mode	Standard deviation	Coefficient of variation
Wine quality	407	3,65	4,00	4,00	0,85	23,22
Wine price	407	3,84	4,00	4,00	0,88	23,00

*The percentage was calculated on the basis of 407 respondents who said that consume wine.

It is noticeable that respondents evaluated importance of wine quality with an average appraisal of 3,66 and wine price with 3,84 which means that wine quality and price are of great and inasmuch

equal importance. Considering the amount of money the respondents are willing to pay for a bottle of wine for their own consumption in retail shops, the following answer distribution was reached (table 2).

Table 2. Respondents' attitudes on the reasonable amount of money given for their own wine consumption in a retail store

Price bracket (in kn)	<25	26-50	51-75	76-60	>100	Total
Number of respondents	95	160	83	41	28	407
Relative share (in %)	23,34	39,32	20,39	10,07	6,88	100

Note: 1kn = 0,135 €

It is obvious that respondents prefer wine from lower price bracket which is reasonable in relation to their buying power. In this connection respondents' sex is slightly significant (female respondents prefer lower price bracket a bit more than male respondents), but respondents' origin is of no importance (city, suburb, country), neither is the number of family members, but normally there is monthly household income dependence which is just proportional. In relation to the amount of money that the respondents pay for their own wine consumption in a café/bar/restaurant the following answer distribution was reached (table 3).

Table 3. Respondents' attitudes on the amount of money paid for their own wine consumption bought in a café/bar/restaurant

Price bracket (in kn)	<50	51-100	101-150	151-200	>200	Total
Number of respondents	159	168	55	18	7	407
Relative share (in %)	39,07	41,28	13,51	4,42	1,72	100

Note: 1kn = 0,135 €

Table 3 shows that even though price brackets are not reasonably equal to price brackets in table 2 respondents in this case as well prefer wine from lower price bracket which is again reasonable with regard to their current buying power. Respondents gave interesting answers to the question what makes them consume wine more often. The distribution of answers is shown in table 4. That is, with this control question of a kind of it was indirectly meant to define wine price significance to wine consumption. It is obvious the biggest possible incentive is cheaper but quality wine, hence reasonable “value for money” variant. That is, respondents are not particularly interested in new wine types even though they are perhaps of higher quality and this means that they would like to consume current (quality) wine at lower price.

It is obvious, as it was defined in the text above, that the most important factors of consumption are wine quality and price, especially if wine aroma and smell are accepted as elements of quality which they truly are. It is interesting that survey conducted by Centre for market study GfK from Zagreb which was conducted in July 2012 (http://trazilica.tportal.hr) which includes nationally representative specimen for Republic of Croatia also shows that today most of Croatian citizens pay attention to and values “price and quality proportion” (even 39% of the total number of the respondents) when buying products of mass consumption and service. “Quality in the first place is important for 22,5% of the Croatian respondents; “health”, i.e. “the amount in which product or

service is good for my health" is highlighted by 17% of Croatian citizens. With regard to the current recession and crisis in Croatia it is interesting that "price" factor is in the fourth place with only 8,3%.

Table 4. Respondents according to possible incentive for often wine consumption

Possible incentive	New wine type	Cheaper quality wine	Better promotional actions	Wine testing	1+1 bonus promotion	Nothing	Total
Number of respondents	24	158	34	49	75	67	407
Relative share (in %)	5,90	38,83	8,35	12,03	18,43	16,46	100

The questionnaire uses one control question which was meant to define indirectly price significance within wine consumption and the following distribution of answers was reached (table 5).

Table 5. The most important factors for wine consumption

Factor	Number of respondents	Relative share (in%)
Design and packaging	70	17,20
Quality	264	64,86
Reasonable price	280	68,80
Brand	56	13,76
Percentage of alcohol	70	17,20
Manufacturer (wine origin)	106	26,04
Recommendation of a friend	114	28,01
Aroma and smell	232	57,00
Croatian product	92	22,60
Famous advertising campaign	9	2,21
Product tradition	90	22,11

Even though the results given refer to indicative survey, since representative specimen is not included, especially in spatial and demographic sense, one can come to certain conclusions which sufficiently confirm attitudes given in the theoretical part of this paper. Naturally, it would be extremely good to conduct an overall survey in the whole Croatian Republic and by using representative specimen, especially in relation to demographic and socio-economic characteristics of wine consumers, and using more subtlety statistic methods such as conjoint analysis which was discussed before and which demand serious financial means for operating such survey. In any case, results of such survey would be very useful for further development and implementation and eventual strategy of wine development correction in Croatian Republic.

Managerial implications

Despite centuries-old tradition of wine production, Croatia is only in the last few decades going back to vineyards in search of quality in order to have a product which will at any time decently represent the country it comes from. Focus on the large quantitive production is replaced with the focus on the quality, from vineyard to visually qualitative introduction of the final product in the market outlet. Croatian market in the recession prefers cheaper private brands and unpacked wine and this is the fact that all Croatian wine producers fight, it is however more obvious with large wine manufacturers it is this reason that wine image is always connected to person of the manufacturer himself. This personality is harder to present with large wine manufacturers contrary to small wine manufacturers whose wine are always connected to the person of the owner it is one of the key reasons that this wine easily achieve the image of exclusiveness and alignment in the premium class. On the other hand, large manufacturers are forced to continually promote their wine and convincing consumers in their quality and individuality with great effort. Export market (out-of-region market is referred) don't consider Croatia as wine country, little it is known Croatian historical wine heritage and such market is not in the position to perceive Croatian unique wine regions in a way they are perceived in Croatia.

Insurance of quality raw material and quality in the wine cellar is just the beginning of a long way which leads to recognisability and acceptance by more demanding but rational consumers. Connecting name and product which evokes time when final product quality was not in the main focus was, for example, the main motive for product rebranding start by one of the large Croatian manufacturers. This process is pretty time and money consuming because it demands great involvement of financial and human resources. The process is developed through three key-fazes:

1) Research - research, collecting and analysing sequence of data and information
2) Imagination - process of brand strategy defining and the story which will be a framework of all marketing activities that relate to the brand
3) Narration - sharing brand story with all sides that are interested in it and their inclusion in the brand story.

We will briefly present how it appears in reality in the example of Vina Laguna (Laguna Wine). Identity of Vina Laguna is based on the icon which was created for it and named "Spirit of Istria"- inspired by legends about magical Istrian land, and especially legend about magical beings who built the ancient town of Pula during the night. The icon presents ease of Istria which is reflected in wine, air and Istrian way of life. Each bottle of Vina Laguna, within all price brackets has its icon on it and it has a different interpretation of depending on the price bracket it relates to. Each etiquette has the same brand story text "The lightness of being Istria". The icon and the story are integrated in all marketing activities of Vina Laguna, from in-store to the Internet, from advertising to experience in vineyard. Campaign bearer is Malvazija in the selected series which transparent bottle reflects ease in colour as well as character. New brand identity led the way to brand optimization - products with higher quality are produced which quality is now reflected through better visual presentation which tells the unique brand story through all price brackets. Within first five months of campaign- rebranding all new Vina Laguna were listed in all sales formats, and the total sale was increased for 20% in relation to the previous year (the increase is particularly noticeable in the highest price brackets - Selected and Premium category). It is necessary to highlight that parallel with rebranding, redefining of price policy to higher level followed.

Conclusions

We tried to answer the question to what amount product price is synchronized with its quality in this paper. We also tried to confirm that with the increase of quality level value for the consumers is increased at the same time and profitability for wine manufacturers is increased as well. Everything mentioned leads to conclusion that value creating is the frame for interrelation of quality and price synchronisation and the frame to overall activities with the aim development of interest of consumers and of manufacturers and all the other sides which are interested. This paper considers strategic approach to interrelation of wine quality and price in Croatia experience. The results show that interrelation of wine quality and price positioning affects the growing strategy of wine producing; especially quality increasing system which gives excellent results to employers, manufacturers and wine consumers as well. This doesn't mean that wine consumer is interested in every aspect of higher quality; he is interested in that aspect of quality which fulfils his clearly defined needs and wishes. Gained experience of Croatian manufacturers confirm that continuous tendency to increase quality level is profitable in long period because it achieves satisfaction of wine consumers who have the perception of it and manufacturer's suitable profit achieving creates security for future business, increases the volume of sale and market share as well which finally results in long term market competitiveness. In the end, with the aim of successful wine manufacturer strategy positioning conducting and achieving their competitive advantage it is necessary to include all resources to form and conduct basic wine manufacturer's competitive strategies.

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СТРАТЕШКИ ПРИСТАП КОН ИСТРАЖУВАЊЕ НА МЕЃУСЕБНАТА ЗАВИСНОСТ НА ЦЕНАТА И КВАЛИТЕТОТ НА ВИНОТО - ИСКУСТВОТО ВО ХРВАТСКА

Марцел Мелер, Ђуро Хорват, Јелена Крстиќ

Апстракт

Една од главните стратешки точки во рамките на маркетингот на виното е воспоставување на меѓусебна зависност на квалитетот и цената, особено за нови производи. Трудот започнува со теоретски пристап кон квалитетот на виното и цената на виното одделно, потоа се зима предвид меѓусебната зависност на квалитетот и цената на вино што ја претставува претпоставката за стратешки пристап кон овој проблем за производителите и диструбутерите на вино. Резултатите од индикативното истражување спроведено во Република Хрватска кои добиени од поединечно испрашување со цел дефинирање на важноста на квалитетот и цената при купување вино, се прикажани во рамките на научното истражување. На крајот, прикажани се менаџерски импликации врз основа на искуството на хрватски производители и дистрибутери на вино.

Клучни зборови: цена, квалитет, маркетинг на вино, меѓузависност на квалитетот и цената на вино.

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EXPORT OF FRUIT AND FRUIT PRODUCTS FROM THE REPUBLIC OF SERBIA

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Abstract
The aim of this research is to analyze the main characteristics of changes in exports of fruit and fruit products from the Republic of Serbia. The task is also to review the changes and to identify factors which determine the movement of realized exports. The authors point out the main problems and suggest the necessary measures that will increase the volume of production and exports of fruits, i.e. the possible directions of development for this very important branch of agriculture for the Republic of Serbia. Growth and change in the structure of production is the basis for the increase in fruit exports. The strategic goal of the Republic of Serbia should be the production of high-quality fresh fruit and processed products and increase the competitiveness in the international market. The marketing concept of legal entities should be to obtain a dominant position in the production concept, processing and export, in order to meet the needs of foreign markets and obtain an adequate (high) profit for the producers.
Key words: fruit, fruit processed products, exports, Serbia.

Introduction

Pomiculture as an important field of the plant growing production is characterized with some comparative advantages in terms of the remaining branches of agriculture, meaning that a greater amount of attention will need to be paid to pomiculture in the future. The production of fruit and fruit products can be a very profitable activity, especially when the export of fruit and fruit products is in question. But in this aspect it is necessary to undertake significant measures in the direction of intensifying the fruit growing production, as well as the modernization and specialization of the processing capacities (Milić and Radojević, 2003). The fruit growing production has a great development perspective due to the favorable natural conditions for growing of all continental types of fruit and due to the greater demand of fruit and fruit products on the domestic and worldwide market. About 60% of the total agricultural deficit of the rich countries in Europe and North America come from the deficit of fruit and vegetables.

Material and methods

The aim of this research is to analyze the main characteristics of exports of fresh and processed fruit in the Republic of Serbia for 2000-2001. The research is based on the data available, with the application of the method „desk research“. The basic data have been undertaken form the Statistical

Office of the Republic of Serbia in Belgrade. The most significant characteristics are presented in tables, and have been processed with the standard statistical methods.

Results and discussion

Export of fruit and fruit products from the Republic of Serbia

The average export of fruit and fruit products in the time period researched (2010-2011) was a little over 200 million dollars. Good export results have been achieved with a significant trend of growth of the export (growth rate of 17% annually). In 2010 the production of fruit in the Republic of Serbia achieved over a million tons (1,3 million tons), and the total value of the export of fruit and fruit products amounted to 316 million dollars. In terms of value, the largest share in the export belongs to the frozen (73%) in terms of fresh fruit (26%). The lowest share belongs to dried fruit (1%).

The favorable results of Serbia in the foreign trade of fruit and fruit products have been realized due to the suitability in the preferential status on the market of the countries from the European Union, the realized liberalization in the exchange with the countries from the Western Balkans (CEFTA) and the market conditions, which are still maintained on the world market (www.akter.co.rs).

Table 1. Export of fresh fruit from the Republic of Serbia (2010-2011)

Fruit	Amount (tons)	Value (000$)
Apples	107.967	46.433
Plums	22.359	14.715
Peaches	8.284	5.631
Nectarines	5.272	3.471
Sour cherries	4.270	2.822
Apricots	3.188	1.757
Cherries	2.848	4.848
Strawberries	1.484	2.408
Total	155.672	82.085

Source: Customs Administration of the Republic of Serbia, 2012

The export of fresh fruit is a little over 155 thousand tons, which amounts to over 82 million dollars (2010). In the amount structure of the fresh fruit export of the Republic of Serbia, apples dominate with 68% share; plums come second; peaches; and then nectarines (table 1). Although the crops were not realized to the maximum, the notable results in the export of apples were accomplished, among other things, due to the supplies which were kept in the ULO (Ultra Low Oxygen) refrigerators. In the Republic of Serbia there are quite a lot of standard refrigerators, but there are only 13 ULO. These results have proven that the number of ULO refrigerators needs to be increased in our country in order to keep and observe the continuity of the export. The greatest export was realized with the Russian Federation and in the countries of the CEFTA region. The greatest part of the export of plums is being realized in the Ukraine, Moldavia, Belarus, and the Russian Federation.

One of the basic problems which occur in order to achieve a greater export of fresh fruit is is the fact that in our country there are very few “real” producers with large production. They are mainly producers which produce relatively small amounts of fruit for their own purposes and retail markets.

Without more significant producers having a larger and continuous production, and putting the accent on the high quality, more serious export of fresh fruit cannot be expected.

Table 2. Export of frozen fruit from the Republic of Serbia (2010-2011)

Fruit	Quantity (tons)	Value (000$)
Sour Cherry Rolend	28.556	33.538
Raspberry Rolend	26.303	95.416
Raspberry Gritz	22.649	43.566
Blackberry Rolend	18.521	16.935
Raspberry Blok	5.701	8.006
Raspberry Bruh	6.774	9.828
Raspberry Original	2.498	7.366
Strawberry frozen	2.433	3.733
Other frozen fruit	19.033	15.154
Total	110.947	233.542

Source: Customs Administration of the Republic of Serbia, 2012

The export of the frozen fruit slightly exceeds 110 thousand of tons, which is amounting to 233 million dollars (table 2). In the structure of the export of frozen fruit, the raspberry has a dominant position with the amount of 164.2 million dollars, or with a share of 70% in the export value. Largest export was realized to the countries of the European Union (Sweden, Great Britain, Germany, France and Belgium). Largest export of the frozen sour cherries was realized in Netherlands, Italy, France, Germany and Austria. It is obvious that the countries of the European Union dominate in the export structure.

Serbia exports around four thousand tons of prunes at annual level, and has a potential to place up to 10 thousand tons on the foreign market. The prunes are mostly exported in the Russian federation, followed by Bulgaria, Croatia, USA, but there are new potential markets such as the Near East, India and the former republics of the Soviet Union. The profitability from the export of dried fruits is up to ten times higher than the profitability from the fresh and frozen fruit. In 2010, Serbia exported a total of 4.590 tons of dried fruit and realized profit of 14 million dollars, where the major part of the export consisted of prunes. In addition, 34 tons of dried apples, 43.4 tons of dried peaches, 12.8 tons of dried apricots and 3.4 tons of dried pears were exported. Serbia has quality fruits of apples for drying, and its share in the production and export can be increased for at least ten times. The dried apricot and raspberry have very important potentials.

The realized export results were influenced by heterogeneous factors: the scope and the quality of the production, the constant lack of finances, the undefined relationships in the reproduction chain, the numerous problems related to the purchase and processing of the fruits and similar. Despite the abovementioned, external factors influenced as well, but mostly the measures of the agricultural protectionism, including the economic policy and the economic regime with their numerous means (customs tariff, bans, contingents, subsidies and other measures) protecting the market of the developed countries (Vlahović and Tomić, 2003).

The market of the European Union is a demanding market, especially concerning the product quality. The consumers from the EU countries are prepared to pay higher price for the required

quality. There is a trend of constant increase in the demand of products of organic origin, which is based on natural factors in the growing, without presence of chemicals and mineral fertilizers, grown in ecologically stable conditions. Republic of Serbia still encounters numerous problems in the production of fruit and quality fruit products. In addition to the undisputable natural conditions for growing of all types of continental fruits, it needs to make a division into fruit areas, to struggle towards the required assortment, towards highest product quality, towards promotion of the organization in all phases of this activity, beginning from the stem plants, establishing orchards, production of fruit, harvesting, storage and placement. The prices are an important item in all of this, and they must be competitive with the quality since the profitability of the production greatly depends on them. Republic of Serbia could start producing fruits according to the principles of the organic production on remarkable areas, which should enable a safe placement and satisfactory price in the highly developed EU countries. Significantly higher budget amounts should be allocated in this direction, along with the finances which could be provided by particular local self-government units that see their chance of development in the promotion of this type of production. Good preparation and appropriate marketing strategy need to be carried out for a successful fruit export. The planning and realization of the fruit export must begin from the primary production, via an appropriately organized logistics, and at the end, the marketing (agroekonomija.wordpress.com).

One of the significant measures for development of the fruit production and export is the signing of the Agreement between the Ministry of Agriculture of the Republic of Serbia and the Kingdom of Denmark (2012). The agreement for implementation of the Programme for support of the private fruit and berries sector in Southern Serbia foresees investments in the total amount of nine million euro. The government of Denmark shall grant 5.35 million euro for the Programme, the government of Serbia shall grant 3.3 million euro, and the local self-governments shall have to invest 300.000 euro. This assistance shall be used by the agricultural producers of five districts –Pčinja, Jablanica, Toplica, Nišava and Pirot district. The farmers shall receive non-refundable assistance for growing of berry plants with advanced techniques, purchasing of equipment and refrigerators, and training shall be organized as well. The Agreement shall promote the production and shall raise the competition of the Serbian producers.

Denmark already imports significant amounts of fruits from Serbia, while the export of processed products should be increased. The purpose of the Agreement is to promote the production and processing of fresh fruits and fruit products in the underdeveloped regions of Serbia, to promote their export and placement on the foreign market, to realize higher incomes for the local population and to open new work posts. The application of the Programme for support is planned for the period from 2012 to 2014. The Stabilization and Association Agreement and the Interim Trade Agreement as its segment, were signed in 2007, and the same regulate the internal trade issues. The Agreements have been signed in 2008 in Brussels. The Assembly of the Republic Of Serbia has ratified both agreements in 2008. From February 1st 2009 Serbia has unilaterally applied the Interim Trade Agreement. In 2009 the Council of the European Union has adopted a decision that the European Union shall start a bilateral application of the Interim Trade Agreement on temporary basis, and Interim Trade Agreement officially entered into force on February 1st 2010, while the ratification of the Stabilization and Association Agreement of the EU member states commenced in the second half of 2010. Two most important responsibilities that the Republic of Serbia undertook by the signing of the Stabilization and Association Agreement and Interim Trade Agreement are the establishment of a free trade zone and harmonization of the Serbian legislation with legislation of

the EU within the transitional period of six years. The Agreement creates a free trade zone between Serbia and the EU within a transitional period of six years. The responsibility of Serbia shall be composed of gradual abolishment of the EU origin goods import customs duties within the transitive period. On the other hand, the European Union confirms the free access of goods from Serbia to the European Union markets (www.merr.gov.rs).

With Article 11 from Interim Trade Agreement, for the fruit for which in the Joint Customs Tariff of the EU a special customs fee shall be envisaged ad valorem, during export from Serbia, from the day of entering into force of the Agreement, a special customs rate shall be applied, while the import of the other tariff positions shall be free, respecting the strict standards in the field of the sanitary safety, traceability and quality. Serbia may offer a product which does not carry any health risk but the production is with uncompetitive price and quality. In order to change that, it is necessary for the producers to increase the level of incomes and to decrease the costs and to improve the quality of the produce packaging. The export potential of the Serbian agriculture for many years was based on the fruit, more precisely the berries or even more precisely the raspberry. The berries participated with 63.7% in the entire export and the raspberry alone was 57.8% from the value of this group of goods. Observed by tariff positions, bigger export, besides the Roland, Gritz and Bruh raspberry, the coreless sour cherry and the Roland bramble achieved bigger export (Tomić and associates, 2010).

Having in regard that the fruit production in Serbia has been export directed, its liberalization shall expressly have a positive impact, because it will initiate significant changes in the sector which will reflect with increased competition i.e. keeping the old or obtaining new markets. That means that the liberalization may potentially improve the fruit sector in Serbia. Such scenario depends on the reforms in the sector that need to cover: knowledge improvement, embracement of new technologies, establishment of more efficient intellectual rights protection system, in order to facilitate the implementation of new varieties, the organization of production groups (clusters) and the unification of the offer, creation of conditions for implementation of the standards, the investing in storage rooms, refrigerators and mastering the fruit storing technology and the investing in the processing capacities. A great portion of the producers, who have not changed the approach toward the orcharding, will have to adjust to the changes or transfer in some other sector. The prices of the fruit in Serbia are lower that the prices in the EU, but higher than the prices in the neighboring countries. The liberalization shall not have a significant impact on the prices, but the consumers shall have a better quality and regular supply for the same price (www.agrobiznis.net).

The inclusion in the international market and the placement of the fruit from the Republic of Serbia is conditioned by many factors such as: the quality, the price, the assortment, the competitiveness, the currency regime as well as some quantity and quality limitations and the signed agreements. The export of fruit from our country is not limited by the quality, namely the quality of our fruit (ex. the raspberry, the plum etc.) is highly appreciated at the European strict market. In the strategy for export of agricultural and alimentary products from the Republic of Serbia, the fruit should have a dominant position. In the following period significant changes will occur in the fruit sector and they will cover in particular (www.ledib.org):

- Opening of the borders, by signing the Stabilization and Association Agreement and the membership in the WTO, which provokes even bigger contest on the fruit market and a need for increasing the price competitiveness for the respective product,

- Increased requirements and demands for the quality competitive products, where that quality has been certified- integral production, organic production, protection of the origin name, protection of the origin symbols etc.,
- More strict standards in the production and sale of the fruit, especially export related (in the European Union, as well as in the other countries), but also in the home market. Increased production traceability requirements (registry, plant passports, standards etc.),
- Increased need for embracement of new technologies in the production process because they change fast and it creates a need for acquisition of new knowledge to adjust to,
- Increased investments in the agriculture, the rural areas and by that in the fruit sector through various programmes of the central government and also by utilization of the EU structural funds- mostly the IPARD fund.

Analyzing the agricultural export in Serbia and observing the export incentives which the Government defined in its Decrees for utilization of the subvention funds for the producers of agricultural and alimentary products for the researched period, it can be concluded that the fruit and the fruit products are most significant goods from the export assortment in the agriculture of the Republic of Serbia.

Having in regard the fact that the aim is total market liberalization and abolishment of the customs duties and levies, the subventions are a good stimulation measure which may be applied as long as the EU approximation process allows that. That is significant support for the domestic production and processing of fruit and fruit products. The export stimulations for the fruit are not high- they vary from seven to ten percent but are useful, as they should increase the competitiveness of the domestic products at the European market.

It is necessary to have consistency and harmonization in the production so that the Republic of Serbia can realize permanent export of fruit and fruit products with permanent increase. In other words, it is necessary for our country to have high quality products, to increase the domestic production, to perform continuous control over those products, which is harmonized with the export standards, in order to achieve significant export of these products. It is necessary for the domestic internationally oriented enterprises to abandon the external trade approach as soon as possible and to introduce the marketing concept in order to become holders of the international business activities. Unfortunately, many of the economical entities which are involved in the production and processing of fruit in Serbia have not embraced the marketing concept in the international operation. That means that for the purpose of creation of an optimal international marketing MIX, only the basic elements (product, price, distribution and advertising paths) are at disposal. Simultaneously, they are not in a situation to perform a research on the foreign market, which is a basic precondition for efficiency and effectiveness for the international operation. The marketing concept of operation of the economical entities should have a dominant place in the planning of the production and the export in order to satisfy the needs of the foreign market and to realize appropriate profit. It is necessary to unify the export programme in a single product trademark „Serbian Fruits" or „Fruits of Serbia" or similar stressing the high quality and the sanitary safe character. The orcharding is definitely not only a standardized technology and a selected variety, but also organization of the fruiterers who sell some variety within the standard for agreed quality for a higher price at the domestic and global world market (www.vocarstvo.com).

The increase of competitiveness and agro-industrial products from Serbia can be based on the following activities of the business entity (modified Cvijanović and associates, 2008).

- Leading an active policy and continually promoting product quality by observing the standards of importer countries (introducing and certifying a food quality and safety system and observing all health and sanitary standards). These standards refer to the biochemical characteristics, external appearance (fruit mass, color, diameter) and the presence of harmful materials (nitrates and heavy metals, pesticide residuals, phytohormones). The case is primarily ISO for agricultural production and HACCP in the processing industry. These standards were produced as consumers' reaction to the occurrence of sanitary unsafe food and from the fear of introduction of genetically modified food. GLOBALGAP is a standard that covers the main aspects of production, such as land management, growing crops and gathering. Also, it deals with the issues regarding pollution, treatment of labor force and protection of the environment. It monitors production from harvest (it analyzes the origin of seeds and history of the land), through growing (it monitors the use of herbicides, pesticides and fertilizers – quantity, type, quality, place and manner of application) irrigation and gathering (the hygiene level and manner of storage), up to packing, transport and display of products on store shelves (Presnall and cap., 2003). Many authors support integral fruit production in order to increase export. This represents a strategic path for pomiculture development in developed countries, as well as in our country in future. The integral concept is based on the application of a combination of genetic, agronomical, biotechnical and chemical methods in an economically acceptable system of production, which provides fruit quality, preservation of the environment and human health (Keserović, 2005).
- It is necessary for the producers to dedicate themselves to the production of quality fruit varieties that will be processed in accordance with modern technologies in order to achieve maximal marketing supported placement of products with high nutritive value.
- Addition of new properties of the present products, in accordance with the demands, wishes and needs of the consumers in separate market segments – grafted dry fruit, processings on the basis of frozen fruit, and similar.
- Creation of "new" products that are demanded by the foreign market, primarily in the field of organic food and/or biologically valuable food.
- Creation of a brand in order to gain the trust of foreign consumers in the fruit that is produced in the Republic of Serbia.
- Reduction of production costs in order to achieve more favorable prices in the international market.
- Definition of adequate strategies for placement in separate market segments – EU market, market of the CEFTA region countries, Russian Federation market.

Price competitiveness is no longer a defining export advantage, but quality factors have shown to be significantly defining: design, packaging, safety and speed of delivery, trademark ("*brand*"), ability to meet the specific demands of the consumers regarding usage, services in the course of and after purchasing, warranty deadlines and observance of contractual obligations during export, the issue of patents, introduction and use, permanent advertisement in the media, representation of our country's trade interests and building a positive image of the company products and promotion of the national identity (Presnall and cap., 2003). The basic steps that always lead to increase of competitiveness of the export products are the following (Paraušić and cop., 2007): increase of production productivity and restructuring of the export offer, promotion of the business and market ambience, application of innovative marketing strategies and initiation of cluster associations and the like. For export oriented development of the processing industry there must be significant and stable raw material

base, i.e. production of quality fruit. Constant expansion of the assortment based on fruit. Search of new solutions in the fruit production and processing technology. Application of modern standards in production and processing is one of the basic determinations regarding export of fruit and processings from Serbia is the constant quality improvement. The increase of competitiveness on the international market must be based on quality, not price. At present, the quality and satisfaction that the buyers will have during use is increasingly more important. Fruit products must also have modern and attractive design, i.e. high quality packaging. It is necessary for the product to be adjusted to the conditions on the defined market, i.e. the wishes, demands, needs and habits of the consumers.

Conclusions

Fruit and fruit products have a dominant place in the structure of agricultural – alimentary products from the Republic of Serbia. Main obstacles for more dynamic export of Serbian fruit and fruit products are: inappropriate varieties and quality of plant propagating material, insufficient knowledge of foreign markets as well as lack of knowledge of the new production technologies that prolong the production season. The problems related to product export are inappropriate quality and design of the packaging, limited number of varieties, large number of small producers with un-harmonized fruit production technology and instability of export markets. During the monitored time period significant export results were realized. Export of fruits and products in the value of over 200 million dollars was realized, as well as there was also a trend of significant increase. Fruit production reached over one million tons (1.3 million tons) in the Republic of Serbia in 2010 and the total value of the fruit and fruit processings export amounted to 316 million dollars. In terms of value, frozen fruit had the largest export share of 73% in relation to fresh fruit (26%). Dry fruit had the lowest share of 1%. Export should be the instigator for increase of the total national production and industrial processing of fruit. Producers must be connected in specialized professional associations in order to increase production and export. Their goal would also be higher quality production since solely quality can help achieve a better result, especially on the international market. There is a significant opportunity for export of the fruit produced in the integral production system, i.e. sanitary safe food, for which there is a significant demand on the international market. The marketing concept of operation of the business entities must acquire dominant place in the planning of production and export, in order to satisfy the needs of the foreign market and to realize appropriate profit.

Acknolegment

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ИЗВОЗ НА ОВОШЈЕ И ПРОИЗВОДИ ОД ОВОШЈЕ ОД РЕПУБЛИКА СРБИЈА

Бранислав Влаховиќ, Ристе Еленов, Душан Милиќ

Апстракт
Целта на истражувањето е да се согледаат основните карактеристики на движењето на извозот на овошје и производите од овошје од Република Србија. Исто така, задача е да се квантифицираат настанатите промени и да се утврдат факторите кои го детерминираа реализираното движење на извозот. Авторите укажуваат на основните проблеми и даваат предлози за неопходни мерки кои ќе влијаат врз зголемување на обемот на производството и извозот на овошје, односно на можните насоки за развој на оваа, за Република Србија многу значајна гранка на земјоделството. Порастот и промената на структурата на производството претставуваат основа за зголемување на извозот на овошје. Стратешката цел на Република Србија треба да биде производство на квалитетно свежо овошје и производи од овошје и зголемување на конкурентноста на меѓународниот пазар. Маркетинг концептот на работење на стопанските субјекти треба да добие доминантно место во конципирањето на производството, преработката и извозот, за да се задоволат потребите на странскиот пазар и да се оствари соодветен (висок) профит за производителот.
Клучни зборови: овошје, производи од овошје, извоз, Србија.

SECTION 10: PLANT PROTECTION - PHYTOMEDICINE

UDC:632.651.532:632.9
Original scientific paper

ISOLATE MX-95 OF APHANOCLADIUM ALBUM IN THE CONTROL OF COMBINED ATTACKS OF SOIL BORNE PLANT PATHOGENS AND ROOT-KNOT NEMATODES

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Abstract
Two experiments were carried out to verify the efficacy of *Aphanocladium album*, isolate MX-95, against *Pyrenochaeta lycopersici* and *Verticillium dahliae* in combination, each of them, with *Meloidogyne incognita*. Treatments were applied in each trial by the sub-irrigation system. In the first trial, on tomato, treatments were *A.album* isolate MX-95 applied before and after transplant at 5 l/plot ($1x10^7$ CFU/ml) and metham-Na (1,000 l c.p./ha). The second trial was carried out on eggplant and treatments were *A. album* isolate MX-95 at 7.2 l/plot (2×10^7 CFU/ml) applied 7 days before transplant and 15 days after transplant, azoxystrobin (20 l/ha) and fosthiazate (30 Kg/ha). In both trials an untreated control was considered. *A.album* isolate MX-95 reduced severity of symptoms of corky root on tomato roots and the indexes of wilting and vascular discoloration, caused by *V. dahliae* on eggplants in comparison to the untreated control. Also root gall index and soil nematode population density were significantly reduced in both trials.
Keywords: Biological control agent, corky root, Verticillium-wilt.

Introduction

Several studies on the interaction between soilborne plant pathogens and plant parasitic nematodes have been conducted (Ciccarese *et al*., 2001a; Lamberti *et al*., 2001; Gallo *et al*., 2011; Ciccarese *et al*., 2012). During the last decade, severe corky root and *Verticillium*-wilt symptoms, caused by *Pyrenochaeta lycopersici* Schneider *et* Gerlach and *Verticillium dahliae* Kleb., respectively, have frequently been found in association with *Meloidogyne* spp. attacks (Polizzi *et al*., 2004; Ciccarese *et al*., 2012). Generally, control of these pests was based on chemical treatments. The use of pesticides on agricultural crops recently has been deeply restricted and revised by the European Legislation that has focused the attention on human and animal health and enviromental safety. Plant protection from insects, fungi, bacteria, nematodes and other pests should rely on alternative control methods that are enviromentally sound and economically convenient at the same time. Antagonistic microrganisms may represent a potential alternative to the use of pesticides in agriculture as biological control of plant disease and plant parasitic nematodes. Recently an isolate of the fungus *Aphanocladium album* (Preuss) W. Gams, signed as MX-95, has shown appreciable effects in the biological control of powdery mildew, on tomato, squash and cucumber caused by

Oidium lycopersici L. Kiss and *Sphaerotheca fusca* Blumer, respectively (Ciccarese *et al*., 2001b). *A. album* is able to produce hydrolytic enzymes especially chitinase (Kunze *et al*., 1992) responsible of a total or partial degradation of cell walls of numerous plant pests (Ciccarese *et al*., 2003).
Therefore, to verify the possibility of the use of the chitinolytic activity of *A. album* isolate MX-95 also in the soil-borne plant pathogens and plant parasitic nematode biological control, two experiments were carried out on tomato, in a plastic house infested by *P. lycopersici* and *M. incognita*, and on eggplant in an open field infested by the same root-knot nematode and by *V. dahliae*.

Material and methods

First trial

A plastic house at Leverano (province of Lecce, Apulia Region, southern Italy) with a soil heavily infested by *P. lycopersici* and *M. incognita* was selected. The soil was deeply ploughed, rotaveted and subdivided in 96 m^2 plots, spaced 1 m apart, and distributed according to a randomized block design with four replications per treatment. To allow the different treatments a sub-irrigation system (depth 0.2 m) was performed in each plot by PVC drip lines (Ø 1.6 cm) equipped with water emitters (flow rate 4 l/h) every 0.3 m.
Treatments were: a) isolate MX-95 of *A. album* (5 l/plot as a conidial suspension at 1 x 10^7 CFU/ml) applied two times; b) metham-Na (1,000 l p.c./ha) and c) an untreated control. In each plot, one-month old tomato seedlings (cv. Luisa) were transplanted in 3 coupled rows spaced 1 m each other and with 0.8 m between the rows of the same coupled row. Plants were spaced 0.3 m along the row. *A. album* and metham-Na were applied one month before transplant.
A. album treatment, at the same concentration, was repeated one month after transplant. The fungus was reared *in vitro* on PDA Petri dishes incubated in dark conditions at 24 °C for 1 week. To allow the dispersion of hygroscopic conidia, the mycelium was homogenized in sterile water with a tensioactive. The concentration of the inoculum was determined and diluted to obtain 1 x 10^7 CFU/ml standard conidial suspension. The conidial suspension was applied at the rate of 5 l/plot. To avaid the block of the irrigation system a filter was set at the beginning of the sub irrigation system. During the growing season plants received the usual cultural practices. Tomatoes were harvested six times and the total marketable yield calculated. In each plot, plants from the central coupled row were uprooted to estimate the severity of corky root on main and secondary roots and root gall index (RGI). Severity of corky root on main and secondary roots was estimated according to a 0-5 scale (0 = root healthy; 1 = 1-10% affected root surface (a.r.s.); 2 = 11-25% a.r.s.; 3 = 26-50% a.r.s.; 4 = 51-75% a.r.s. and 5 = >76 % a.r.s.). RGI was estimated also according to a 0-5 scale (0 = no galls and 5 root system completely deformed by large and numerous galls) (Lamberti, 1971). Nematodes were extracted from soil samples of each plot processing 500 ml soil sub-sample with the Coolen's method (Coolen, 1979).

Second trial

The second trial was carried out at Valenzano (province of Bari, Apulia region, southern Italy) in open field condition on eggplant (cv. Dalia). The soil was naturally infested by the soil-borne plant pathogen *V. dahliae* and the root-knot nematode *M. incognita*. Treatments were: a) *A. album* isolate MX-95; b) the nematicide fosthiazate (30 Kg/ha) and the fungicide Azoxystrobin (20l/ha) both applied at transplant and c) an untreated control. *A. album* was applied 1 week before transplant and

15 after transplant at the rate of 0.4 l/plant (2 x 10^7 CFU/ml). At the end of the crop cycle Verticillium-wilt index, vascular discolaration and root gall index (RGI) caused by the nematode attack were recorded. Wilting index was assessed according to a 0 – 5 scale (0 = health plant; 1 = yellowing of basal leaves; 2 = diffuse yellowing; 3 = wilting; 4 = diffuse wilting and 5 = dead plant. Stem of each plant was transversely cut 3 cm above the soil level and the severity of vascular discoloration (% area affected) was recorded according to a 0-4 scale (0 = no vascular discoloration; 1 = 1-10% vascular discoloration (vd); 2 = 11-50% vd; 3 = 51-75% vd; 4 = >75% vd). Nematode attack on the eggplant roots was evaluated according to a 0-5 scale (0= no galls and 5 = root completely deformed by the presence of numerous large galls. Nematodes were extracted from soil samples of each plot processing 500 ml soil sub-sample with the Coolen's method (Coolen, 1979).
Data from both trials were subjected to analysis of variance and means compared Duncan's Multiple Range Test using the software Plot It vers. 3.02.

Results and discussion

First trial

Tomato marketable yield was significantly increased by Methan-Na treatment in comparison to untreated control. No statistical difference was observed between *A. album* isolate MX-95 treatment and the other thesis (metham-Na and untreated control) (Fig. 1). In addition, methan-Na treatment significantly decreased severity of corky root either on main and secondary roots, RGI and final nematode population density because of the development of methylisothiocyanate (Figs. 2, 3 and 4). The nematode soil population density and root gall index were also significantly suppressed by *A. album* isolate MX-95 (P=0,05) (Fig. 4).
Number and application time of the chitinolytic fungus can be the cause of the reduction of RGI. Infact, *A.album* isolate MX-95 was applied two times: 1 month before transplanting and 1 month later. So in this way the fungus had the possibility to develop its maximum enzymatic chitinolytic activity protecting the seedlings from nematode attack at transplant. The second application, during the crop cycle, served as post transplant protection. The severity of corky root on secondary roots was not reduced by *A. album* treatment in comparison to untreated control, whereas it was effective on main root with a significant reduction of symptoms (Fig. 2).
The experiments revealed significant and positive correlations between root gall index and the severity of corky root on main ($y = 0.42 + 0.34\ x$; $r^2 = 0.975$) or secondary root ($y = 3.15 – 0.36/x^2$; $r^2 = 0.893$). Therefore, it seems that an increase of the nematode attack increases also the severity of the corky root. Probably the trofic activity of the second juvenile stage of *Meloidogyne* on tomato roots through the mechanical action of the stylet favours *P. lycopersici* infection and penetration.
Metham-Na should be recommended for the control of simultaneous attaks of *P. lycopersici* and *M. incognita*. For this chemical and also for biological control agent application through the sub irrigation technique would results more beneficial than with any other methods of distribution. Infact, in this way it is possible to reduce production costs because of the repeated use of the irrigation system in several cultural practices (irrigation, fertilization and crop protection).

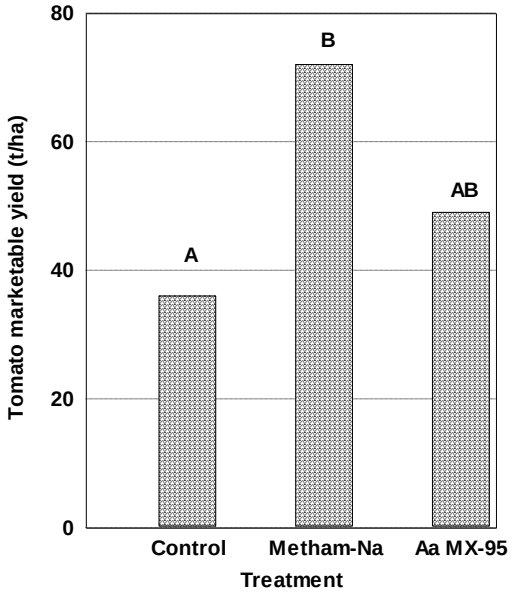


Figure 1. Effect of the chitinolytic fungus *A. album* isolate MX-95 and methan-Na treatments on tomato marketable yield (cv. Luisa) in a plastic house infested by *Pyrenochaeta lycopersici* and *Meloidogyne incognita*.

Data flanked in each column by the same letters are not statistically different according to Duncan's Multiple Range Test (P=0.01)

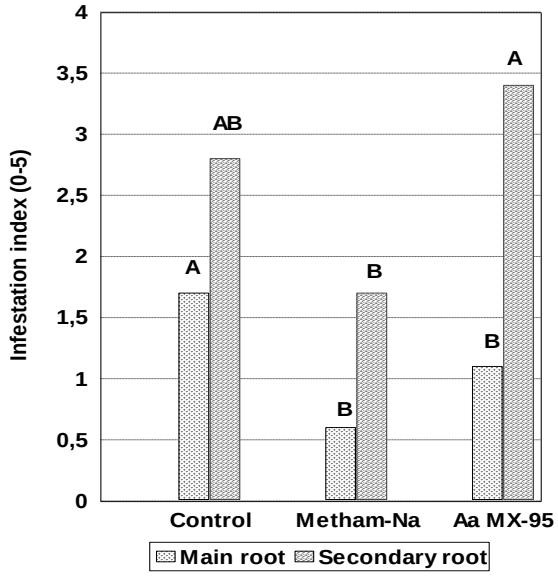


Figure 2. Effect of the chitinolytic fungus *A. album* isolate MX-95 and methan-Na treatments on symptoms of *Pyrenochaeta lycopersici* attack on tomato roots (cv. Luisa) in a plastic-house. For each parameter (main or secondary root) data flanked in each column by the same letter are not statistically different according to Duncan's Multiple Range Test (P=0.01)

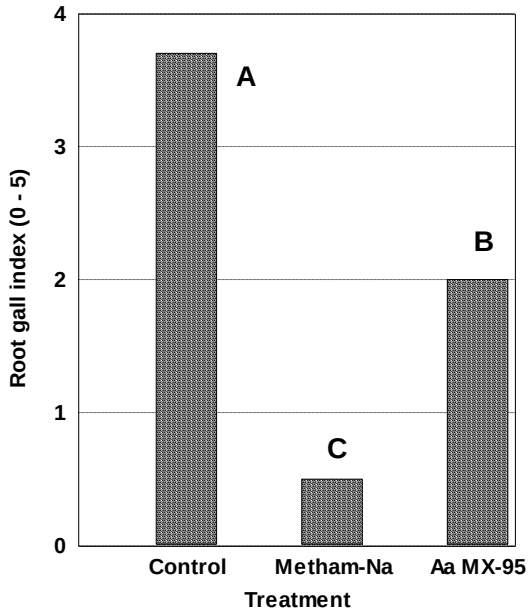


Figure 3. Effect of the chitinolytic fungus *A. album* isolate MX-95 and methan-Na treatments on root gall index caused by *Meloidogyne incognita* on tomato roots (cv. Luisa) in a plastic-house.
Data flanked in each column by the same letter are not statistically different according to Duncan's Multiple Range Test (P=0.01)

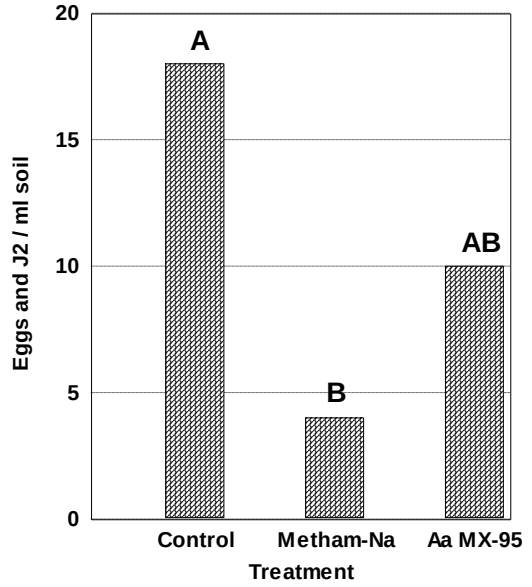


Figure 4. Effect of the chitinolytic fungus *A. album* isolate MX-95 and methan-Na treatments on final *Meloidogyne incognita* population density (*Pf*). Data flanked in each column by the same letters are not statistically different according to Duncan's Multiple Range Test (P=0.01)

Second trial

Treatments with the fungicide (azoxystrobin) and nematicide (fosthiazate) and with the isolate MX-95 of *A. album* significantly increased eggplant yield in comparison to the untreated control. No statistical difference was observed between the chemical treatment and the use of the biological control agent (Fig. 5).

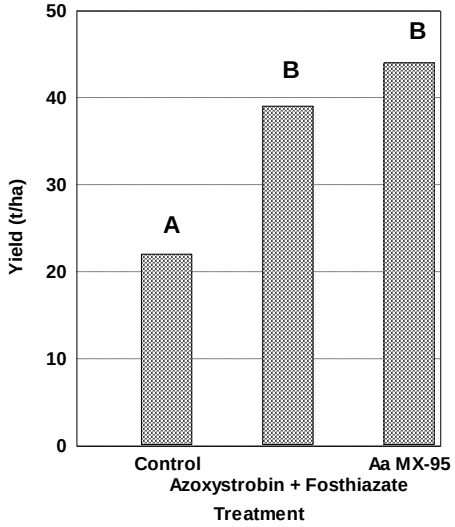


Figure 5. Effect of *A. album* isolate MX-95 and azoxystrobin and fosthiazate treatments on yield of eggplant (cv. Dalia) affected by *Verticillium dahliae* and *Meloidogyne incognita*.
Data flanked in each column by the same letters are not statistically different according to Duncan's Multiple Range Test (P=0.01)

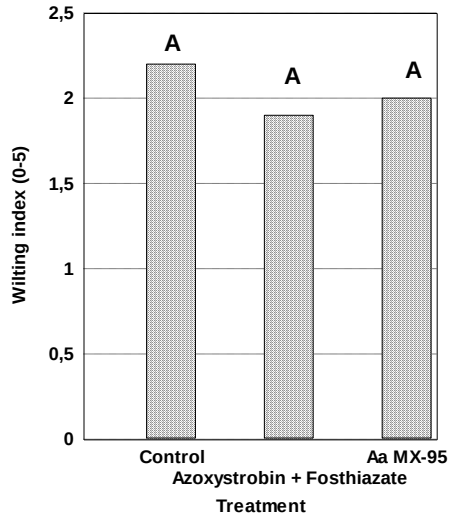


Figure 6. Effect of *A. album* isolate MX-95 and azoxystrobin and fosthiazate treatments on wilting index of eggplant (cv. Dalia) affected by a combined attack of *Verticillium dahliae* and *Meloidogyne incognita*. Data flanked in each column by the same letters are not statistically different according to Duncan's Multiple Range Test (P=0.01)

At the end of the crop cycle no statistical differences were observed in the wilting index between the untreated and treated plants (Fig. 6). The index of vascular discoloration was significantly reduced in plant treated with chemicals and with isolate MX-95 of *A. album* in comparison to untreated control (Fig. 7).

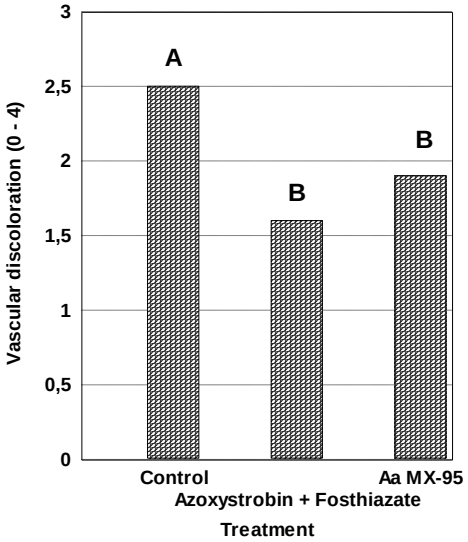


Figure 7. Effect of *A. album* isolate MX-95 and azoxystrobin and fosthiazate treatments on vascular discoloration of eggplant (cv. Dalia) affected by a combined attack of *Verticillium dahliae* and *Meloidogyne incognita*. Data flanked in each column by the same letters are not statistically different according to Duncan's Multiple Range Test (P=0.05)

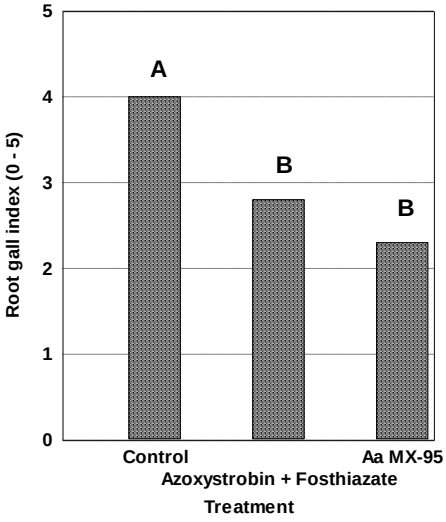


Figure 8. Effect of *A. album* isolate MX-95 and azoxystrobin and fosthiazate treatments on root gall index of eggplant (cv. Dalia) affected by a combined attack of *Verticillium dahliae* and *Meloidogyne incognita*.
Data flanked in each column by the same letters are not statistically different according to Duncan's Multiple Range Test (P=0.05)

RGI observed on the roots of untreated plants was significantly higher than that observed on *A. album* MX-95 and Fosthiazate and Azoxystrobin treated plants (Fig. 8).
Data flanked in each column by the same letters are not statistically different according to Duncan's Multiple Range Test (P=0.05)
From results of the two experiments the repeated use of the chitinolytic fungus *A. album*, isolate MX-95, seems to be reasonably possible for soil borne plant pathogens and nematode biological control.
The main aim of *A. album* isolate MX-95 use should be a progressive reduction of infestation level under the tolerance limit of the target nematode species also reducing soil borne pathogens attacks (Sasanelli, 1994).

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КОНТРОЛА НА ПОЧВЕНИТЕ ПАРАЗИТИ И КОРЕНОВИТЕ НЕМАТОДИ СО ПРИМЕНА НА ИЗОЛАТОТ МХ-95 ОД *APHANOCLADIUM ALBUM*

Сашанели, Н., Цикаресе, А., Гало, М., Ренчо, М., Папајова, И., Цикаресе Ф.

Апстракт

Двата експеримента се извршени да се потврди ефикасноста на *Aphanocladium album*, изолиран МХ-95, против *Pyrenochaeta lycopersici* и *Verticillium dahlia* во комбинација, секој од нив со *Meloidogyne incognita*. Третманите беа применувани во секој опит со под-системот за наводнување. Во првиот експеримент на домати, третирани беа *A.album* изолиран МХ-95 аплициран пред и после расадување на 5 l/ површина ($1x10^7$ CFU/ml) и metham-Na (1,000 l с.р./ha). Вториот експеримент беше спроведен на модриот патлиџан и третманите беа *A. album* изолиран МХ-95 на 7.2 l/површина ($2 x 10^7$ CFU/ml) аплициран 7 дена пред расадување и 15 дена после расадувањето, azoxystrobin (20 l/ha) и fosthiazate (30 Kg/ha). Во двете испитувања нетретирана котрола се разгледуваа. *A.album* изолиран МХ-95 ја намалува сериозноста на симптомите на испакнат корен на доматот и индексот на овенување и васкуларната промена на бојата, предизвикана од *V. dahliae* на модриот патлиџан и во споредба со нетретираната контрола. Исто така индексот на галите и густината на почвените нематоди беа значително намалени во двете испитувања.

Клучни зборови: биолошки контролен агенс, плутест корен, Verticillium-wilt.

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Original scientific paper

INTENSITY OF M. GRAMINICOLA ATTACK ON VARIOUS WHEAT CULTIVARS GROWN AT PSEUDOGLEY

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Abstract
This paper gives the results concerning resistance of fifteen winter wheat cultivars to attack of *Mycosphaerella graminicola*, the causal agent of septoria leaf blotch. Climate of Serbia is very favorable for appearing and development of this parasite, so it is considered as one of very harmful pathogens. The investigation has been carried out during 2011/12, in the conditions of natural infection, at the experimental field of Agricultural School in Kraljevo. The trial was set at pseudogley soil type. Experimental plots were 50 m long and 2 m wide. Attack intensity was assessed during the first decade of June, according to the scale of Geshele (1978), by determining infection severity from 0-100%. Majority of the studied cultivars (Ljiljana, Rusija, Biljana, Etida, Gordana, Zvezdana and Arija) showed attack intensity of 30%, which was 46.6% of the total cultivars number. Two of the observed cultivars (13.3%) had 10% of leaf area under septoria blotches. Rapsodija was the most susceptible cultivar with infection intensity of 50%.
Key words: *M. graminicola*, wheat, cultivars, susceptibility, pseudogley.

Introduction

Wheat (*Triticum aestivum* L) is the most important field crop, grown on a large part of arable land throughout the world. Grain yield of wheat is affected by many factors, and among them are parasites, causal agents of various plant diseases, so it is necessary to observe their presence and intensity every year. Septoria leaf blotch (*Mycosphaerella graminicola*) is a disease which can appear during whole vegetation. Under suitable conditions, primary infection happens early, and symptoms of the disease can be seen after emergence of second wheat leaf. The attack causes necrosis and wilting of affected plant tissue, which is often attached to soil surface (Telečki and Jevtić, 2009). This parasite is nowadays regarded as the most influential one in global wheat production, causing main wheat disease in many regions throughout the world (Eyal et al., 1985). Greater damage appears in favorable weather conditions, when the disease can be spread from lower to upper leaves. Wilting of heavily attacked leaves reduces assimilation surface, decreasing grain yield and quality. Wiese (1987) stated that the disease is registered in about 50 countries. Leroux et al. (2007) and Stammler et al. (2008) pointed out to *M. graminicola* as one of the most dangerous parasites in Northern Europe, and Garcia et al. (1992) stated the same for cereal belt of USA. Grain yield loss caused by *M. graminicola* in Western Europe usually is between 30 and 50% (Royle et al., 1986).

Climate of Serbia is very favorable for appearing and development of this parasite, so it is considered as one of very harmful pathogens. Presence of this disease in many locations of Serbia has been reported by Arsenijević (1965), Kostić and Smiljaković (1966), Ivanović et al. (2001). Gudžić et al. (2012) observed that in 2011, on pseudogley soil type, the average infection intensity in ten cultivars amounted 27%. Kalentić et al. (2006) found that in 2006 intensity of septoria leaf blotch attack was higher in winter genotypes, in regard to the spring ones. Proper choice of suitable cultivars plays an important role within integrated plant protection measures. Consequently, this study has been aimed to establish intensity of the pathogen's attack on some winter wheat cultivars grown on pseudogley soil type.

Material and methods

The investigation has been carried out during 2011/12, in the conditions of natural infection, at the experimental field of Agricultural School in Kraljevo. Local coordinates of the location were the following: latitude 43º 42', longitude 20° 42', altitude 215 m. The trial was set at pseudogley soil type. Dugalić (1998) reported this soil as having very bad physical properties and extremely acid soil reaction (pH<4.5). It had low content of humus (about 2.18%) and available phosphorus (7.0-8.0 mg 100^{-1} g of soil). Supplies of available potassium were moderate (13.0-18.0 mg 100^{-1} g of soil), and the amount of total nitrogen was satisfying. The following cultivars were studied: Renesansa, NSR-5, Natalija, Ljiljana, Simonida, Rapsodija, Dragana, Rusija, Biljana, Pesma, Etida, Gordana, Pobeda, Zvezdana and Arija. Sowing was done by seeding machine. Experimental plots were 50 m long and 2 m wide. Fertilization was done by NPK fertilizer 15:15:15 in the dose of 281 kg ha^{-1}. Additional nitrogen fertilization was applied in the stage of tillering with 242 kg ha^{-1} of CAN. The rest of applied production technology was standard.

Intensity of attack by the fungus *Mycosphaerella graminicola* was observed during the first decade of June 2012. Attack intensity was assessed according to the scale of Geshele (1978), by determining infection severity from 0-100%.

Results and discussion

Results of the study have shown the average attack intensity in 2012 was 30.6 % (table 1). Cultivars Natalija and Simonida had 10% of leaf area covered by blotches of the parasite *M. graminicola*. Attack intensity in the cultivar Renesansa was 20%. The most of cultivars (Ljiljana, Rusija, Biljana, Etida, Gordana, Zvezdana and Arija) suffered attack intensity of 30%, and 46.6% of the all studied cultivars belonged to this group. Attack intensity in the cultivars NS rana-5, Dragana, Pesma and Pobeda was 40%, with 18.3% of the cultivars in this group. Rapsodija was the most susceptible cultivar with infection intensity of 50%.

M. graminicola is a pathogen which represents a problem for wheat production. In addition to favorable weather conditions, growing susceptible cultivars and large amount of inoculum from previous vegetations also have a positive effect on this pathogen's development (Kalentić et al., 2006). Breeding and growing resistant cultivars is very important for wheat protection from the causal agent of septoria leaf blotch. Palmer and Skinner (2002) stated that commercial cultivars did not express adequate resistance to this parasite. Jerković et al. (2005) found differences among cultivars regarding resistance to the most dangerous causal agents.

Analysis of the obtained results revealed the highest resistance shown by cultivars Natalija and Simonida, which also had a series of desirable traits. During the observed year, cultivar Renesansa expressed a satisfying resistance to *M. graminicola*. Such behavior of the cultivar has been reported by Gudžić et al. (2011), which is in accordance with the results of our investigation.

Table 1. Intensity of *Mycosphaerella graminicola* attack to wheat cultivars

No	Cultivar	Intensity
1.	Renesansa	20
2.	NS rana 5	40
3.	Natalija	10
4.	Ljiljana	30
5.	Simonida	10
6.	Rapsodija	50
7.	Dragana	40
8.	Rusija	30
9.	Biljana	30
10.	Pesma	40
11.	Etida	30
12.	Gordana	30
13.	Pobeda	40
14.	Zvezdana	30
15.	Aria	30
Average		30.6

Conclusions

On the basis of previously published studies and the presented results, the following conclusion can be drawn out:

Mycosphaerella graminicola is one of common and harmful parasites of wheat in Serbia.

This investigation results showed that the average infection intensity was 30.6%.

Good resistance to *M. graminicola* was shown by the cultivars Natalija and Simonida. Rapsodija was the most susceptible cultivar, with infection intensity of 50%. Breeding and growing resistant cultivars is very important for wheat protection from the causal agent of septoria leaf blotch. In addition to growing resistant cultivars, a special attention ought to be paid to agrotechnical and chemical measures.

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ИНТЕНЗИТЕТ НА НАПАД ОД *M. GRAMINICOLA* КАЈ РАЗЛИЧНИ СОРТИ ПЧЕНИЦА ОДГЛЕДУВАНА НА ПСЕВДОГЛЕЈ

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Апстракт

Овој труд ги дава резултатите во врска со отпорноста на петнаесет зимски сорти на пченица нападнати од *Mycosphaerella graminicola,* како последица од септориозна лисна дамкавост. Климата во Србија е многу поволна за појавување и развој на овој паразит, така што се сметаат за едни од многу штетни патогени. Испитувањата се спроведуваа во текот на 2011/12, во услови на природна инфекција, на експерименталната област на Земјоделското училиште во Краљево. Експериментот беше поставен на псеудоглејна тип на почва. Експерименталните парцели беа 50 метри во должина и 2 метри широчина. Интензитетот на нападот беше оценет во првата декада на Јуни, според скалата на Geshele (1978), детерминирање на инфекција со интензитед од 0 – 100%. Мнозинството од студираните култури (Ljiljana, Rusija, Biljana, Etida, Gordana, Zvezdana и Arija) покажаа надад со интензитет од 30%, кој беше 46,6% од вкупниот број на сорти. Две од набљудуваните сорти (13.3%) имаа 10% на лисната површина од септориозна лисна дамкавост. Rapsodija беше многу подложна сорта на инфекција со интензитет од 50%.

Клучни зборови: *M. graminicola*, пченица, сорти, осетливост, псевдоглеј.

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Original scientific paper

ANTIFUNGAL ACTIVITY OF ESSENTIAL OILS TO PLANT PATHOGENIC FUNGI *ALTERNARIA SOLANI* SORAUER AND *FUSARIUM GRAMINEARUM* SCHWABE

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Abstract
Eleven essential oils were assayed for inhibitory and lethal activity against *Alternaria solani* Sorauer and *Fusarium graminearum* Schwabe. Fungal pathogens were isolated from diseased plants in Serbia. Early blight of tomato, caused by *A. solani* is an important and widely distributed disease, and *F. graminearum* is the causal agent of Fusarium head blight of small grain cereals in fields worldwide. Essential oils were provided by the „Dr Josif Pančić“ Institute for Medical Plant Research in Belgrade, Serbia. Isolates of pathogenic fungi were exposed to the volatile phase of the oils, and then ventilated in order to determine if the effect of the oils was lethal to the pathogens. Five essential oils inhibited growth of *A. solani*: anise (*Illicum verum* Hooker fil.), peppermint (*Mentha piperita* L.), wintergreen (*Gaultheria procumbens* L.), lemongrass (*Cymbopogon flexuosus* L. Stapf) and origanum (*Origanum vulgare* L.). These oils were also lethal to the tomato pathogen, except the wintergreen having only suppresive effect. Pathogen *F. graminearum* was susceptible to four oils: anise, wintergreen, lemongrass and origanum, and they all exhibited fungicidal effect to the fungus. The strongest antifungal activity of natural compounds tested was shown by origanum, followed by lemongrass oil. Origanum oil was lethal to both pathogens at concentrations of 0.02 µl ml^{-1} of air. Lemongrass oil showed fungicidal effect to *A. solani* at 0.02 µl ml^{-1} and to *F. graminearum* at 0.04 µl ml^{-1} of air. Essential oils of rosemary (*Rosemarinus officinalis* L.), eucaliptus (*Eucalyptus globulus* Labill.), pineneedle (*Pinus syilvestris* L.), turpentine (*Pinus pinaster* Ait.) and lavander (*Lavendula angustifolia* Mill.) did not show significant antifungal effects to investigated pathogens.
Key words: essential oils, antifungal activity, *Alternaria solani*, *Fusarium graminearum*.

Introduction

Alternaria solani Sorauer causes two types of disease on tomato plants: early blight and collar rot. Early blight, which defoliates mature plants and contributers to major economic losses for growers, is considered a more serious disease than collar rot. Collar rot is primarily a seedborn disease carried to the field on tomato transplants. Collar rot symptoms are dark, sunken stem lesions near the soil line (Moore and Thomas, 1943). Early blight lesions on tomato leaves are typically surrounded by chlorotic regions that are less extensive in nonvascular tissue than in vascular tissue, indicating that *A. solani* toxins are translocated systemically and may be responsible for the lesions observed (Pound and Stahmann, 1951). Stepanović *et al*. (2007) tested sensitivity of *A. solani*

isolated from Serbia to fungicide formulations, finding that pyraclostrobin, prochloraz, difenoconalzol, iprodione and famoxadone exhibited the highest toxicity, mancozeb and chlorothalonil lower and copper oxychloride the poorest.

Fusarium head blight, or scab, can be a devastating disease on all classes of wheat and barley. Among the species of Fusarium causing scab, *Fusarium graminearum* Schwabe is the predomenimant pathogen. Wheat and barley are highly susceptible to infection when the crop is in flowering to soft dough stages and when weather includes frequent precipitation and high humidity. Multiple symptoms occur: reduced yields discolored and shriveled kernels, depressed seed weights, and reduced seed quality and vigor. The mycotoxin deoxynivelanol (DON, commonly known as vomitoxin) also can be produced by *F. graminearum* on infected grain. Grain contaminated with DON is often unsuitable for flour, cereals, or malt and is also toxic as feed for nonruminant animals (McMullen *et al*., 1997). In recent years, Fusarium head blight has reemerged worldwide as a disease of economic importance. In Serbia, fusarium head blight has been a growing problem over the past three decades. The highest frequency and intensity of up to 67.2% was detected in 2005 for *F. graminearum*, followed by *F. poae* (up to 20.4%) (Lević *et al*., 2008). The fungicides widely used in Serbia for controlling fusarium head blight, leaf rust, septoria leaf blotch, and powdery mildew are: mancozeb, carbendazim, carbendazim + cyproconazole, captan, chlorothalonil, epoxyconazole + thiophanate-methyl, carbendazim + flusilazole, trifloxystrobin + cyproconazole, tebuconazole + triadimenol + spiroxamine, prochloraz + tebuconazole, prochloraz + propiconazole (Savčić-Petrić and Sekulić, 2007; Balaž *et al*., 2008). Various plant essential oils and their components have been tested against pathogenic fungy on cultivated plants. They have demonstrated strong antifungal effects. It is apparent that essential oils should be considered as alternative preharvest natural fungicides. Natural plant-derived fungicides should provide a wide variety of compounds as alternatives to synthetic fungicides, safe for both human health and the environment (Daferera *et al*., 2003). There are few reports about strong activity of essential oils to *A. solani* (Zygadlo *et al*. 1994), Zygadlo and Grow (1995), Özcan *et al*. (2000), Abou-Jawdan *et al*. (2002) Cakir *et al*. (2004) (Mishra *et al*., 2009) and to *F. graminearum* (Agnioni *et al*., 2004; Velluti *et al*. 2004a; 2004b; Singh *et al*., 2005).

Material and methods

Test organisms

Isolates of *Fusarium graminearum* ZE and *Alternaria solani* SV-2 representing isolates identified 2005 and 2006, respectively, during the survey in farms in Serbia, were chosen for this study.

Test substances

Twenty two essential oils of plants were provided by the Dr. Josif Pančić Institute for Medical Plant Research in Belgrade, Serbia. including: *Rosemarinus officinalis* PO124476 (Rosemary Oil Ph. Eur. 50); *Illicum verum* S0100154 (Anise Oil Ph. Eur. 50); *Mentha piperita* P0123884 (Peppermint Oil Ph. Eur. 50); *Eucalyptus globulus* S0100321 (80/85% Eucalyptus Oil Ph. Eur. 50); *Gaultheria procumbens* P0117394 (HAB 2005 Winergreen Oil Ph. Eur. 50); *Pinus silvestris* P0124319 (Pineneedle Oil Ph. Eur. 50); *Citrus limon* P0119551 (Lemon Oil Ph. Eur. 50); *Cymbopogon flexuosus* P0120241 Lemongrass Oil Ph. Eur. 50); *Origanum vulgare* P0125062 (Origanum Oil Ph. Eur. 50); *Pinus pinaster* P0125332 (Turpentine Oil Ph. Eur. 50); *Lavendula angustifolia* P0123527 (Lavander Oil Ph. Eur. 50); *Origanum vulgare* P0125412 (Origanum Oil nat. id.); *Rosmarinus*

officinalis, Xherdo Co., Albania; *Lavandula angustifolia*, Agroherbal, Albania; *Rosmarinus officinallis* 1, Agroherbal, Ablania; *Rosmarinus officinalis* No-41, Agroherbal, Albania; Pinus pinaster 2, Agroherbal, Albania; *Pinus nigra*, Agroherbal, Albania; *Mentha piperita* No 41/A, Agroherbal, Albania; *Salvia officinalis* Sage, Xherdo Co., Albania; *Abies alba* (Aetheroleoum abietis albie), Xherdo Co., Albania; *Juniperus oxycedrus* (Aethoeroleoum juniperi oxycedri), Xherdo Co., Albania.

Inoculum preparation

The fungal pathogens *F. graminearum* and *A. solani* were prepared as a conidial suspension (approximately 10^6 conidia ml^{-1}). The isolates were initially grown for 14 days on PDA plates. Conidia were harvested by flooding the plates with 10 ml of sterile distilled water and Tween 20 (v/v 0.01%) followed by filtration through double layer of cheesecloth.

Toxicity of the essential oils to fungal pathogens in vitro

Antifungal activity was tested on PDA medium in glass Petri plates (R=90 mm) inoculated with the investigated strains by pipetting 20 µl of the conidial suspension into the well cut at the centre of the plate (R=10 mm). The isolate was exposed to the volatile phase of essential oils for seven days at 20°C. The oils were applied as a drop onto the inner side of the plate covers at concentrations of 0.02, 0.04, 0.08, 0.16 and 0.32 µl m^{-1} of the air inside the Petri plates by using a micropipette. Bottom of the plates were immediately placed on the covers. The plates were left up-side-down and sealed by parafilm to prevent gas exchange with the outside environment. Inhibition of the mycelial growth was estimated four days after the treatment by measuring the radial growth of the isolate treated with different concentrations of the oils and compared to the control. Seven days after the treatment, the plates were observed for the initial mycelial growth without measuring. Concentrations of an oil which completely inhibited the mycelial growth after seven-day-exposure at 20ºC were considered to be fungistatic and the lowest of these concentrations was determined as Minimum Inhibitory Concentration (MIC). Afterwards, the plates were opened and ventilated in a laminar flow hood for 30 min in order to remove volatiles and determine fungicidal effect. The concentrations of the oil were considered as fungicidal if the microbial growth had not been observed seven days after the ventilation. The lowest concentration with fungicidal effect was defined as Minimum Fungicidal Concentration (MFC). Four replicates per treatment were used and the experiment was repeated twice.

Results and discussion

The growth of the isolates was surveyed using 22 essential oils applied in the range of 0.02-0.32 µl ml^{-1}. Thirteen oils did not show either inhibitory or lethal effect to two fungal isolates at tested concentrations (Table 1).

A growth inhibition of tested pathogens after two days was achieved by five oils: *Illicum verum* S0100154, *Gaultheria procumbens* P0117394, *Cymbopogon flexuosus* P0120241, *Origanum vulgare* P0125062 and *O. vulgare* P0125412. Species *A. solani* was more sensitive than *F. graminearum*. Its growth was fully inhibited by nine essential oils, two oils at 0.02, one at 0.08, three at 0.16 and three at 0.32 µl ml^{-1}. Five oils completely inhibited growth of *F. graminearum*: two oils at 0.02, one at 0.08, two at 0.16 and none at 0.32 µl ml^{-1} air after two-day exposure. Essential oils *Cymbopogon flexuosus* P0120241 and *Origanum vulgare* P0125062 exhibited the highest inhibitory effect to both isolates tested, having MIC values of 0.02 µl ml^{-1}. High toxicity

was also shown by *Illicum verum* S0100154, *Gaultheria procumbens* P0117394 and *Origanum vulgare* P0125412 with MIC of 0.08 or 0.16 µl ml^{-1} varied depending on the pathogen. Oils *Rosmarinus officinallis* 1, Agroherbal, Ablania; *Rosmarinus officinalis* No-41, Agroherbal, Albania; and *Salvia officinalis*, Xherdo Co., Albania, inhibited *A. solani* at 0.32 µl ml^{-1} air, and without any effect on *F. graminearum* below 0.32 µg ml^{-1}. The most toxic was oil *Origanum vulgare* P0125062 with MBC value of 0.02 to both pathogens, and *Cymbopogon flexuosus* P0120241 with 0.02 to *A. solani* and 0.04 µg ml^{-1} to *F. graminearum*. High toxicity was also obtained by *Origanum vulgare* P0125412, having MBC of 0.08 to *F. graminearum* and 0.16 µg ml^{-1} to *A. solani*. Following toxicity was recorded by *Mentha piperita* P0123884 with MBC of 0.16 µg ml^{-1} to *A. solani*, *Gaultheria procumbens* P0117394 with MBC of 0.32 µg ml^{-1} to *F. graminearum*. The oil *Illicum verum* S0100154 also was highly toxic with MBC of 0.32 µg ml^{-1} to both pathogens.

Results obtained four days after oil application confirmed that the oils varied in their fungicidal effect to *A. solani* and *F. graminearum*. The highest lethal effect was shown by *Cymbopogon flexuosus* P0120241 and *Origanum vulgare* P0125062 to *A. solani*, having MBC value of 0.02 µg ml^{-1}, followed by *Mentha piperita* P0123884 and *Origanum vulgare* P0125412 with MBC of 0.16 µg ml^{-1} and *Illicum verum* S0100154 with MBC of 0.32 µg ml^{-1}. Lethal oils to *F. graminearum* were *Origanum vulgare* P0125062 (MBC=0.02 µg ml^{-1}), *Cymbopogon flexuosus* P0120241 (MBC=0.04 µg ml^{-1}), and *Illicum verum* S0100154 and *Gautheria procumbens* P0117394 (MBC=0.32 µg ml^{-1}). The results indicated that nine oils showed inhibitory effect to *A. solani* and five to *F. graminearum*. Different five oils were lethal to the both pathogens, two of them at 0.02 µg ml^{-1} to *A. solani* and one to *F. graminearum*. *F. graminearum* was less sensitive than *A. solani*. Seventeen oils did not exhibit neither inhibition nor fungicidal activity to *F. graminearum*, and 13 oils were without activity against the *A. solani*.

Among the 22 essential oils analyzed, those of *Illicum verum* S0100154, *Mentha piperita* P0123884, *Gaultheria procumbens* P0117394, *Cymbopogon flexuosus* P0120241, *Origanum vulgare* P0125062 and *O. vulgare* P0125412 expressed the strongest antifungal activity to both of the investigated pathogenic fungi. Only four oils, *Illicum verum* S0100154, *Gaultheria procumbens* P0117394, *Cymbopogon flexuosus* P0120241, *Origanum vulgare* P0125062 and *O. vulgare* P0125412 exhibited fungicidal effect to both isolates tested. The strongest inhibitory and lethal effect to *A. solani* and *F. graminearum* was displayed by *Cymbopogon flexuosus* P0120241 and *Origanum vulgare* P0125062. Oils *Origanum vulgare* P0125062 and *Cymbopogon flexuosus* P0120241 were the most toxic to both isolates.

Antifungal effect of oregano, peppermint and sage oils, from other plant species than used in this study were confirmed in reports of Abou-Jawdan *et al*. (2002), with wild marjoram (*Origanum syriacum*), peppermint (*Mentha longifolia*) and sage (*Salvia fruticosa*), having high activity against *A. solani*. Özcan *et al*. (2000) showed that sage had weak activity, whilst wild thyme and oregano were active against *A. solani*. Zygadlo and Grow (1995) confirmed that essential oils of *Salvia gilliess*, inhibited mycelial growth of *A. solani*.

Contrary to ours findings, inductive effect of Sardinian *Rosmarinus officinalis* L. on the growth of *F. graminearum* was observed (Agnioni *et al*., 2004). Results of our tests about inhibitory effects of oregano and lemongrass to *F. graminearum* were consistent with reports of Velluti *et al*. (2004a; 2004b). Although the cost-effectiveness of oil application must be taken into account, this study justifies further research on practical use of essential oils for the control of plant pathogenic fungi.

Table 1. Toxicity of the essential oils to tested pathogenic fungi.

Essential oils	Effective concentrations of the essential oils (µl/ml of air)			
	Alternaria solani		*Fusarium graminearum*	
	MIC[1]	MFC[2]	MIC[1]	MFC[2]
Rosemary Oil Ph. Eur. 50 (*Rosemarinus officinalis* PO124476)	>0.32	>0.32	>0.32	>0.32
Anise Oil Ph. Eur. 50 (*Illicum verum* S0100154)	0.08	0.32	0.16	0.32
Peppermint Oil Ph. Eur. 50 (*Mentha piperita* P0123884)	0.16	0.16	>0.32	>0.32
Eucalyptus Oil Ph. Eur. 50 (*Eucalyptus globulus* S0100321)	>0.32	>0.32	>0.32	>0.32
Wintergreen Oil Ph. Eur. 50 (*Gaultheria procumbens* P0117394)	0.16	>0.32	0.16	0.32
Pineneedle Oil Ph. Eur. 50 (*Pinus silvestris* P0124319)	>0.32	>0.32	>0.32	>0.32
Lemon Oil Ph. Eur. 50 (*Citrus limon* P0119551)	>0.32	>0.32	>0.32	>0.32
Lemongrass Oil Ph. Eur. 50 (*Cymbopogon flexuosus* P0120241)	0.02	0.02	0.02	0.04
Origanum Oil Ph. Eur. 50 (*Origanum vulgare* P0125062)	0.02	0.02	0.02	0.02
Turpentine Oil Ph. Eur. 50 (*Pinus pinaster* P0125332)	>0.32	>0.32	>0.32	>0.32
Lavender Oil Ph. Eur. 50 (*Lavendula angustifolia* P0123527)	>0.32	>0.32	>0.32	>0.32
Origanim Oil nat. id. (*Origanum vulgare* P0125412)	0.16	0.16	0.08	0.08
Rosemary Oil (*Rosmarinus officinalis;* Xherdo Co., Albania)	>0.32	>0.32	>0.32	>0.32
Lavender Oil (*Lavandula angustifolia*; Agroherbal, Albania)	>0.32	>0.32	>0.32	>0.32
Rosemary Oil (*Rosmarinus officinallis* 1; Agroherbal, Ablania)	0.32	>0.32	>0.32	>0.32
Rosemary Oil (*Rosmarinus officinalis* No-41; Agroherbal, Albania,)	0.32	>0.32	>0.32	>0.32
Turpentine Oil (*Pinus pinaster* 2 Agroherbal, Albania)	>0.32	>0.32	>0.32	>0.32
Black pine Oil (*Pinus nigra*; Agroherbal, Albania)	>0.32	>0.32	>0.32	>0.32
Peppermint Oil (*Mentha piperita* No 41/A; Agroherbal, Albania,)	>0.32	>0.32	>0.32	>0.32
Sage Oil (*Salvia officinalis*; Xherdo Co., Albania)	0.32	>0.32	>0.32	>0.32
Silver fir Oil (*Abies alba*; Xherdo Co., Albania)	>0.32	>0.32	>0.32	>0.32
Cade juniper Oil (*Juniperus oxycedrus*; Xherdo Co., Albania)	>0.32	>0.32	>0.32	>0.32

[1]Minimum Inhibitory Concentration

[2]Minimum Lethal Concentration

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ФУНГИЦИДНА АКТИВНОСТ НА ЕСЕНЦИЈАЛНИ МАСЛА ВРЗ ФИТОПАТОГЕНИТЕ ГАБИ *ALTERNARIA SOLANI* SORAUER И *FUSARIUM GRAMINEARUM* SCHWABE

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Апстракт

Единаесет есенцијални масла беа испитувани за инхибиторна и смртиносна активност врз *Alternaria solani* Sorauer и *Fusarium graminearum* Schwabe. Габните патогени беа изолирани од заболените растенија во Србија. Рано гниење на доматот, предизвикан од *A. Solani* е важна и широко распостранета болест, и *F. Graminearum* е причински агент на фузариозно гниење на житните култури низ целиот свет. Есенцијалните масла беа обезбедени од „Dr Josif Pančić“ Институт за Истражување на Медицински Растенија во Белград, Србија. Изолатите од патогените габи беа изложени на испарливата фаза на масла, и потоа се проветрени со цел да се потврди дали ефектот на маслата е смртоносен за патогенот. Пете есенцијални масла се инхибитори на порастот на *A. solani*: anise (*Illicum verum* Hooker fil.), peppermint (*Mentha piperita* L.), wintergreen (*Gaultheria procumbens* L.), lemongrass (*Cymbopogon flexuosus* L. Stapf) и origanum (*Origanum vulgare* L.). Овие масла исто така покажаа смртност на патогенот на доматот, освен wintergreen има само спречувачки ефект. Патогенот *F. Graminearum* беше подложен на четири масла: anise, wintergreen, lemongrass и origanum, сите тие се изложени на фунгицидниот ефект на габата. Најсилните антигабни активности од природните состојки што се тестираа беше прикажан од страна на origanum, проследен со lemongrass масло. Origanum маслото беше смртоносен за двата патогена во концентрација од 0.02 µl ml-1 во воздух. Lemongrass маслото покажа фунгициден ефект на *A. Solani* со 0.02 µl ml^{-1} и на *F. graminearum* со 0.04 µl ml^{-1} во воздух. Есенцијалните масла од рузмарин (*Rosemarinus officinalis* L.), еукалиптус (*Eucalyptus globulus* Labill.), pineneedle (*Pinus syilvestris* L.), turpentine (*Pinus pinaster* Ait.) и lavander (*Lavendula angustifolia* Mill.) не покажуваат значителни антигабни ефекти на испитуваните патогени.

Клучни зборови: есенцијални масла, фунгицидна активност, *Alternaria solani*, *Fusarium graminearum*.

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Original scientific paper

NEMATICIDAL EFFECT OF CHESTNUT TANNIN SOLUTIONS ON POTATO CYST AND ROOT-KNOT NEMATODES

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Abstract
Two glasshouse pot experiments were carried out to evaluate the effect of chestnut tannins in the control of the potato cyst nematode *Globodera rostochiensis* patotype Ro1 and the root-knot nematode *Meloidogyne javanica*. Doses of 100, 250 and 450 g/m^2 of tannins in aqueous solutions were applied to the soil at transplant or at transplant and two weeks later to verify their effect on nematode control. In both experiments tannin treatments were compared to untreated controls. Cysts were extracted from dried soil using the Fenwich can. Root-knot nematodes were extracted from roots by the Hussey and Barker's method using 1% NaOCl aqueous solution and from soil processing 500 ml soil by the Coolen's method. Data were subjected to analysis of variance and means compared by Least Significant Difference's test. Significant reductions of *G. rostochiensis* number of cyst/100 g soil and eggs and juveniles/g soil and eggs and juveniles/g root and total *M. javanica* population density were observed in association with decreased reproduction rates.
Key words: *Globodera rostochiensis*, *Meloidogyne javanica*, nematode control.

Introduction

Plant parasitic nematodes are important pests of many horticultural crops in the world. They can be highly specialized or they can attack a large number of plants belonging to numerous botanical families because of their polyphagy. Among the most dangerous pathogenic plant parasitic nematodes there are the cyst forming nematode *Globodera rostochiensis*, a specific parasite of potatoes and the root-knot nematode *Meloidogyne javanica*, ables to attack more than 770 agricultural plants also in higher altitudes and warms climates. Because of the development of these nematodes is related to the rizosphera and they can grow also inside plant root tissues, their control during growing season is difficult. The large restriction and revision of the use of pesticides on agricultural crops according to the last European Legislation (Reg. CE 299/2008 and 1107/2009) forced to find new environmental, human and animal health safety methods for plant protection against these pests. From many years the research on low environmental impact alternatives to chemicals has received a strong impulse with a wide range of options, including the use of natural plant products (Sasanelli & D'Addabbo, 1992; Hewlett *et al.* 1997; Chen *et al.* 1997; Renčo *et al*. 2011; Caboni *et al*., 2012; Cavoski *et al.*, 2012).

Plant derivatives are a rich source of pharmaceuticals, pesticides and immune allergens containing important biomolecules with biological activities such as glycosides, tannins and phytosterols

(Upadhyay, 2011). In particular, tannins, secondary plant polyphenols, were found to have nematicidal properties against gastrointestinal nematodes in ruminants (Hoste *et al*. 2006). Their physical and chemical properties can change according to the plants, parts of the plants and the season in which they are produced (Waterman, 1999; Waghorn & McNabb, 2003). Moreover, tannins protect several plants against herbivores (Feeny, 1976) and they are toxic to a wide range of fungi, bacteria and yeasts (Scalbert 1991). Hovewer, studies on the effect of the tannins on plant parasitic nematodes are few (Mian & Rodríguez-Kábana 1982; Hewlett *et al.* 1997; Chen *et al.* 1997).

Threfore, two pot experiments in glasshouse were carried out to evaluate the potential use of chestnut tannins in the control of the potato cyst nematode *Globodera rostochiensis* and the root-knot nematode *Meloidogyne javanica*.

Material and methods

Trial on Globodera rostochiensis (Ro1)

The tested chesnut tannin were provided by Agrostar s.r.l. (Cavriago, RE, Italy), extracted by vapour from chestnut wood without chemical solvents in powder form after dehydration. The population of *Globodera rostochiensis* (Woll.) Behrens pathotype Ro1, was obtained from an infested soil at Avezzano (province of L'Aquila, Italy).

The cysts were collected by Fenwick can from dried soil. Then the extracted cysts were thoroughly mixed into 2.9 kg steam sterilised sandy soil. Five 10 g soil samples were taken from this inoculum and the cysts were extracted, counted and their egg content estimated. Appropriate amounts (100 g) of the inoculum were then thoroughly mixed with steam sterilised soil (3,900 g) in each clay pot to give an initial nematode population density of 5 eggs and juveniles/g soil. After inoculation, in each clay pot one potato tuber (cv. Désirée) was sown.

Three tannin treatments at different concentrations were considered: 1) 100 g/m^2; 2) 250 g/m^2 and 3) 450 g/m^2, applied at sowing or at sowing and two weeks later, with a total of six tannin treatments. Tannins were applied as aqueous solutions (400 ml/pot), calibrated on the holding capacity of the soil. Nematode infested and untreated soil was used as control. The pots were arranged on beaches in a glasshouse at 20 $\pm$ 2 °C according to a randomized block design with four replicates for each treatment. Three months later, at the end of the experiment, potato plants were uprooted and nematological parameters estimated. Soil from each pot was mixed thoroughly and then a soil sample was collected and air dried. Cysts were extracted by Fenwick can from 200 g soil sub-sample. Cysts separated from debries and soil particles were crushed (Seinhorst & Den Ouden, 1966) and their egg content estimated.

Trial on Meloidogyne javanica

The population of *M. javanica* (Treub) Chitwood was obtained from Torchiarolo (Province of Brindisi, southern Italy) from infested tomato roots (*Solanum lycopersicum* L.). *M. javanica* was reared for two months on tomato cv. Rutgers in a glasshouse at 25 ± 2 °C. When large mature egg masses were formed, tomato roots were finely chopped and eggs and juveniles were quantified by processing 10 root samples of 5 g each with 1 % aqueous solution of NaOCl (Hussey & Barker, 1973). The roots were then thoroughly mixed with 3 kg of steam sterilised sandy soil (pH 7.2; sand > 99 %; silt < 1 %; clay < 1 % and organic matter = 0.75 %) and used as inoculum.

Appropriate amounts of this inoculum were then thoroughly mixed with steam sterilised sandy soil contained in clay pots (1,000 ml) to give an initial nematode population density of 5 eggs and juveniles/ml soil (*Pi*). Tannins were applied as described in the previous trial on *G. rostochiensis*. After treatments were performed, in each pot a one-month-old tomato seedling cv. S. Marzano was transplanted.

Pots were arranged on benches in a glasshouse at 25 ± 2 °C according to a randomized block design with 10 replicates per treatment.

At the end of the experiment, two months later, tomato plants were uprooted to evaluate nematological parameters. Root gall index (RGI) was estimated according to a 0 – 5 scale, where 0 = no galls; 1 = 1 – 2 galls; 2 = 3 – 10 galls; 3 = 11 – 30 galls; 4 = 31 – 100 galls and 5 > 100 galls (Taylor & Sasser, 1978). Soil nematode population density in each pot was determined by processing 500 ml soil by the Coolen's method (Coolen, 1979). Numbers of *M. javanica* eggs and second stage juveniles in roots were assessed by cutting up each root system into small pieces and further comminuting them in a blender, containing 1 % aqueous solution of NaOCl for 20 sec (Marull & Pinochet, 1991; Sasanelli *et al*., 1997). The water suspension was then sieved through a 250 µm pore sieve put over a 5 µm pore sieve. Nematodes and root debris gathered on the 5 µm pore sieve were further processed by centrifuging at 2,000 rpm for five min in 400 ml of a magnesium sulphate solution of 1.16 specific gravity. Then eggs and juveniles in the water suspension were sieved through the 5 µm pore sieve, sprayed with tap water to wash away the magnesium sulphate solution and collected in about 30 – 40 ml water in plastic labelled bottles. Nematodes in water suspension were then counted by a microscope and final nematode population density (*Pf*) in each pot calculated summing nematodes recovered from soil and roots. *M. javanica* reproduction rate *r* was expressed as ratio between final and initial population density (*Pf*/*Pi*). Data from both experiments were subjected to analysis of variance (ANOVA) and means compared by Least Significant Difference's test. All statistical analysis was performed using the PlotIT program.

Results and discussion

In the literature, there are only few studies where the impact of tannins application on plant parasitic nematodes population development were investigated, however the investigations on tannins as suppressant of gastrointestinal nematodes, bacteria and diseases prevailing (O´Donovan & Brooker, 2001; Paolini *et al.*, 2003; Nguyen *et al.*, 2005).

Results showed that number of cysts/100 g soil, number of eggs and second stage juveniles/g soil and reproduction rate (*r = Pf*/*Pi*) of the potato cyst nematode *G. rostochiensis* were significantly reduced by all tannin treatments (100, 250 and 450 g/m^2) in comparison to the untreated control (Fig 1). The highest reduction of these parameters was recorded in soil treated with tannin at dose of 450 g/m^2 applied at sowing and at sowing and 2 weeks later, although this treatment was not significantly different from that applied twice at 250 g/m^2. Tannin treatments at different doses did not significantly affect number of eggs/cyst (Fig 1C).

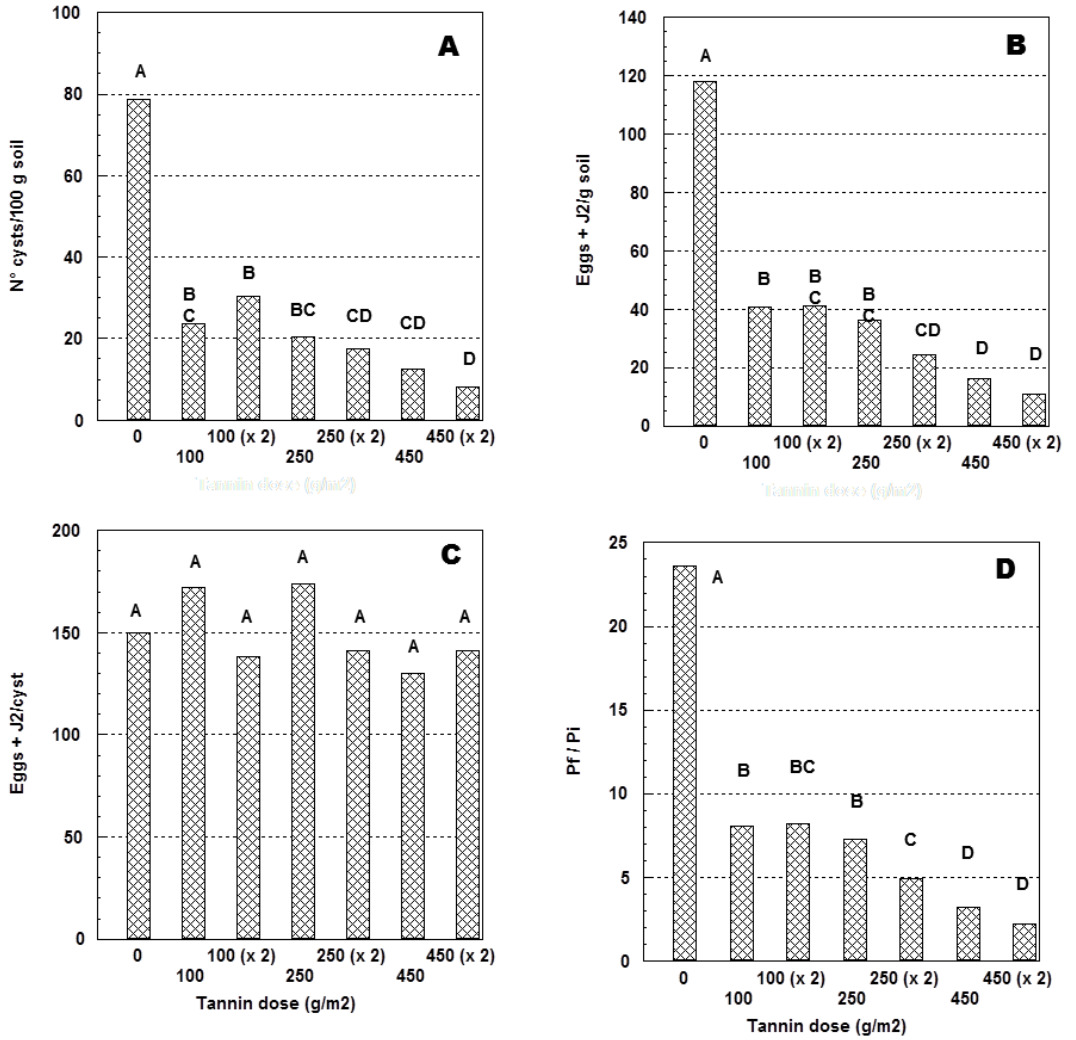


Figure 1. Effect of chesnut tannin at different doses applied at sowing and at sowing and two weeks later on nematological parameters induced by the potato cyst nematode *Globodera rostochiensis* on potato (cv. Désirée). A) N. of cysts/100 g soil; B) eggs and J2/g soil; C) eggs and J2/cyst and D) reproduction ratio *Pf/Pi*. Columns flanked by the same letter are not statistically different according to LSD's test (P=0.01).

No significant differences, in all nematological parameters, were found between the tannin applications at sowing and at sowing and 2 weeks later for all the three tested concentrations (100, 250 and 450 g/m^2) (Fig 1). Similarly to results obtained with the potato cyst nematode, in the pot experiment with *M. javanica* all tannin doses (100, 250 and 450 g/m^2) reduced number of eggs and juveniles/g root, the final population/ml soil and reproduction rate of the root-knot nematode *M. javanica* in comparison to infested and untreated control (Fig 2).

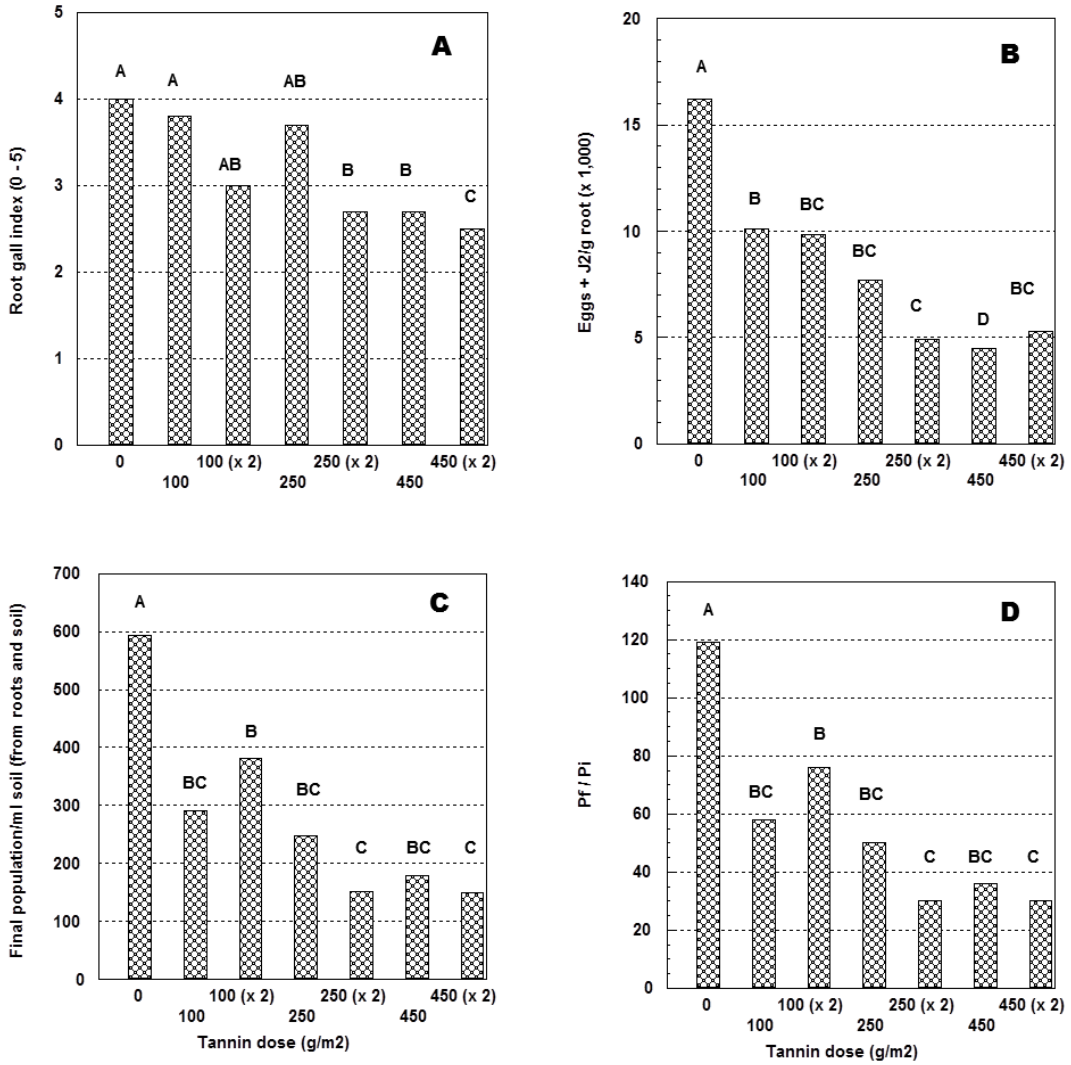


Figure 2. Effect of chesnut tannin at different doses applied at transplant and at transplant and two weeks later on nematological parameters induced by the root-knot nematode *Meloidogyne javanica* on tomato (cv. S. Marzano). A) Root gall index; B) eggs and J2/g root; C) final population/ml soil and D) reproduction ratio *Pf/P*. Columns flanked by the same letter are not statistically different according to LSD's test (P=0.01).

In particular, a significant reduction of RGI was obtained by the use of tannins at 250 g/m^2 applied two times, at transplant and two weeks later, demonstrating the protective and positive effect of repeated treatments (Fig 2, A). However, the lowest dose (100 g/m^2) of tannin was not sufficient to contain the initial nematode attack on the roots.

Results from our pot experiments with the two different type of endoparasitic nematode species, the potato cyst nematode *G. rostochiensis* and the root-knot nematode *M. javanica*, confirm results obtained in previous studies. Mian and Rodríguez-Kábana (1982) found the reduction of

Meloidogyne arenaria (Neal) Chitw. on squash in field after tannic acid treatments and Tylor and Murant (1966) found less number of *Longidorus elongatus* (de Man) Thorne & Swanger in soil treated with two powdered tannin extracts derived from mimosa (*Acacia mollisima* Willd.) and quebracho (*Schinopsis lorentzii* (Griseb.) Engl.). *L. elongatus* is a virus vector of plant and it was found that soil borne viruses were previously suppressed by the addition of tannins to the soil (Cadman & Harrison, 1960). Because of these viruses are not free in the soil but they are transmitted by *L. elongatus*, Tylor and Murant (1966) outlined that plant virus protection was obtained through the control of the virus vector and not because of the effect of the tannin directly on viruses.

On the contrary, Hewlett *et al.* (1999) found that tannic acid extracted from tara (*Caesalpinia spinosa* Mol. Ktz.) was an attractant for the *M. arenaria* and *M. incognita*, whereas it was abhorrent for *Radopholus similis* (Cobb) Thorne and had no effect on *Heterodera glycines* Ichinohe.

On the base of results from these two pot experiments the use of chestnut tannin seems to be a promising method for the control of the potato cyst and root-knot nematodes in sustainable agriculture. Because of the tannins are present in all higher plants, additional studies are suggested to investigate the effect of different tannins on different plant parasitic nematode species as well as on beneficial, soil free living nematodes.

Acknowledgement

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НЕМАТИЦИДЕН ЕФЕКТ НА ТАНИНИ ОД КОСТЕНОТ ВРЗ КОМПИРОВАТА ЦИСТА И КОРЕНОВИТЕ НЕМАТОДИ

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Апстракт

На два стакленика беа извршени експерименти со цел да се оцени ефектот на танинот од костенот во контрола на компировата цисна нематода *Globodera rostochiensis* патотип Ro1 и корено-јазолски нематоди *Meloidogyne javanica*. Дози од 100, 250 и 450 g/m^2 од танин во водни раствори беа применети на почвата на пресадување или пресадување и две недели подоцна да се потврди ефектот од контрола на нематодата. И во двата експерименти танинскиот третман беше спореден со нетретирани контроли. Цистите беа естрахирани со користење на Fenwich can. Корено-јазолските нематоди беа естрахирани од коренот со Hussey и Barker's метод користејќи 1% NaOCl воден раствор и со обработка на почва 500 ml почва од страна на Coolen's метод. Податоците беја изложени на анализа на варијансата и начин во споредба со најмалку значителна разлика на тест. Значително намалување на *G. rostochiensis* број на цисти/100 g почва и јајца и младите/ g, почва и јајца и младите /g на корен и вкупна популација на *M. javanica* каде се забележани во соработка со намалени репродукциски стапки.

Клучни зборови: *Globodera rostochiensis*, *Meloidogyne javanica*, контрола на нематоди.

UDC: 632.76-567(497.115)
631.24(497.115)
Original scientific paper

INVESTIGATION OF THE PRESENCE OF THE MOST IMPORTANT WHEAT GRAIN PEST FROM THE ORDER COLEOPTERA IN SOME PROCESSING MILLS IN KOSOVO

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Abstract
The purpose of this study was to identify the most common pest species affecting wheat grain during storage in three electric processing mills in Kosovo. During the year of 2011 and 2012, grain samples were taken from the processing mills located in three different locations of Kosova (Podujevë, Sekiraqë and Bajqinë). The obtained results showed that wheat weevil is the most prevalent pest of the wheat grain in processing mills in Kosovo. Of the total collected pests in the above three processing mills (1522), wheat weevil (*Sitophilus granarius*) takes part with 875 individuals (57%), rice weevil (*Sitophilus oryzae*) 380 (25%), lesser grain borer (*Rhyzopertha dominica*) with 199 individuals (13%) and flour beetle (*Tribolium* spp.) with 68 individuals (5%). The highest number of the grain pests was found in processing mill located in Bajqina (744 individuals), whereas the lowest one in Sekiraqa (328 individuals). According to the analysis of variance (ANOVA) there were found statistically significant differences with regard to pest species found in three electrical mills in different locations.
Key words: Grain pest, Storage, Electric processing mills, Granary weevil, ANOVA.

Introduction

Human beings for centuries has collected, stored and preserved agricultural products. So archaeologists have determined that food storage started back to the Neolithic period (about 8000 years BC), when man began the cultivation of plants and animals.

The storage fauna investigation was subjekt to many authors, thus in Georgia (Voast, 2009), Croatia (Korunić, 1990), etc. Storage pests were investigated also in Kosov by different authors. Thus, according to some authors (Pireva & Musa, 2003) in different grain strage and mills it was identified and investigated in detal lesser grain borer (*Rhizoperta dominica*), while according to Pireva (1990) in different storage and mills in Kosovo were found 32 species from the order Coleoptera and three from the order Lepidoptera. Given that storage conditions are more favorable compared to outdoor condition the multiplication of pests in storage is faster. Thus, as for the pest species *Oryzaephilus surinamensis* and *O. Mercator*, a pair of mature individuals (imago) within 150 days can provide up to 1 million offspring, while the other pest species, *Sitophilus granarius*, some couples formed hundreds of thousands of descendants (Maceljski, 1999). In this manner a very small infestation within a very short period of time will provide a large number of pests which endanger the entire wheat grain stored in storage. In large infestation of some siloses, feed factories

etc. have been found in some cases more than 2816 insects / 1 kg of wheat sample. In 1 kg of cereales grain were found over 29 species of insects, whereas in other cases in 1 kg of waste wheat grain during aspiration found over 100 species of insects (Maceljski, 1999). According to some authors (Korunić, 1990), in wheat grain storages there are shown to be present different types of pests most of whom are from the order Coleoptera (over 100 species), Lepidoptera order (more than 10 species) and mites (33 species).

The goal of our investigation has been the determination of the pests from the order Coleoptera, in some electrical procesing mills in our country.

Material and methods

Our investigations were conducted during the years 2011- 2012 in the Podujevo region. For this purpose, samples were taken at three electricall processing mills (Bajqinë, Sekiraqa and Podujevë). Grain samples were taken according to standard methods for investigation of the storage pests. In each investigated processing mill were taken three samples, each weighing about 1 kg. The samples consisted of wheat grain collected in different places in mills, usually in sievse, corners etc. Samples for analysis were taken once a week from each processing mill. In this case, all the insects collected were taken and placed in plastic bags, were equipped with the all relevant informations (date of sampling, sample number, the name of the mill, etc.). Later on such a samples were brought to the laboratory for plant protection of the Phytosanitary Corporation "Sara & Meti" in Pristina, for identification and description of the different pest species, with the aid of different entomological keys (Lea Schmidt, 1970). The obtained results were processed statistically using MSTAT-C computer program from University of Michigenit.

Results and discussion

During the two-years of the investigations with regard to the presence of different pest species in wheat grain stored in three processing mills in region of Podujeva (Podujevë, Sekiraqa and Bajqinë) there were found these pests: wheat weevil (*Sitophilus granarius*), rice weevil (*Sitophilus oryzae*), lesser grain borer (*Rhizopertha dominic*a) and flour beetle (*Tribolium* spp.). The level of appearance of differenet grain pests in investigated processing mills was very diferent (Table 1).The obtained results after the two-years of investigations of wheat grain pests in some electric processing mills in Podujevo municipality (Podujevo, Sekiraqa and Bajqinë) showed that wheat weevil (*Sitophillus granarius*) is the most prevalent pest species, while there were also present other pest species, by far with the lowest number (Graph 1). From the total collected pests in the above mentioned mills (1522), wheat weevil takes part with 875 individuals (57%), rice weevil 380 (25%), lesser grain borer with 199 individuals (13%) and flour beetle 68 individuals (5%). Our results are nearly the same as the results reporter by other authors, where it has been shown that the first two pests (*S. granarius* and *S. oryzae*) are the mos present species during storage of wheat grain in siloses and proccesing mills (Pireva, 1990; Korunić, 1990; Musa & Carli, 2004).

The frequency of appearance of different pests of wheat grain stored in different processing mills under ivestigations has been different (Graph 2). Of the total number of pest species found in the wheat grain stored in different processing mills it was shown that there are differences among investigated mills, with regard to the presence of these pests.

Table 1. Frequency of the wheat grain pests in different mills (2011-2012)

Processing Mill	Pest	Sampling										Total
		1	2	3	4	5	6	7	8	9	10	
Podujevë	*S. granarius*	14	9	23	1	52	33	19	83	43	6	283
	S. oryzae	6	7	8	5	20	12	9	23	11	4	105
	Rh. dominica	5	0	8	4	0	1	1	11	8	4	42
	Tribolium spp.	0	3	0	2	5	0	3	4	0	3	20
Sekiraqë	*S. granarius*	1	17	14	12	9	39	34	15	24	5	170
	S. oryzae	0	4	6	12	7	11	13	18	17	3	91
	Rh. dominica	0	0	1	2	1	4	7	11	2	8	36
	Tribolium spp.	1	1	4	4	2	6	9	0	3	1	31
Bajqinë	*S. granarius*	19	22	49	51	31	28	54	21	105	42	422
	S.oryzae	6	11	33	12	15	18	25	19	33	12	184
	Rh. dominica	0	0	15	28	12	9	3	16	5	33	121
	Tribolium spp.	0	5	1	3	0	0	2	5	0	1	17

Legend: the values represents the sum of the imagos collected from three working samples

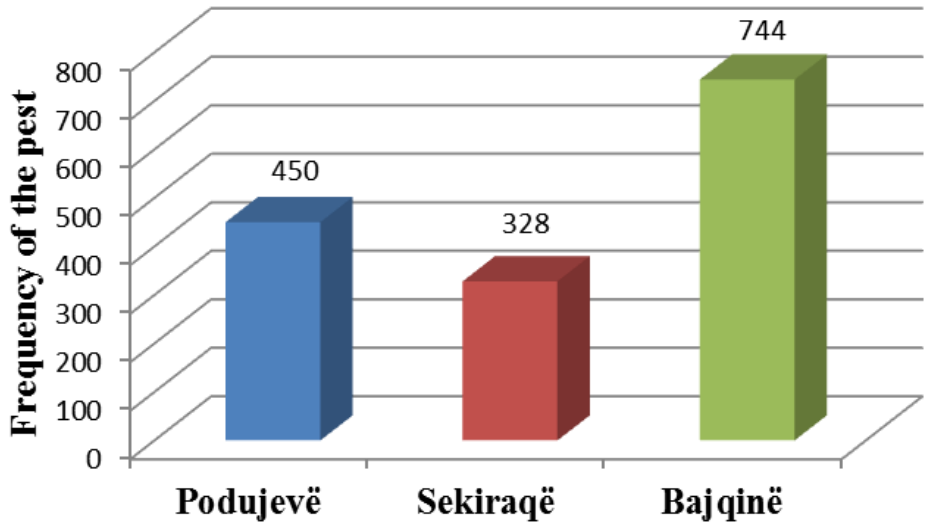


Figure 1. Pest proportion from the total identified in all pocesing mills

With regard to this, the processing mill located in Bajqina has been the most affected, with total of 744 individuals found or 48.88%, mill in Podujevo with 450 or 29.57%, while the least affected was processing mill in Sekiraqa, with 328 individuals or 21.55%, (Graph 3).

The table of analyses of variance and LSD tests shows that different levels of statistical significant differences were found with regard to the number of pests identified in different processing mills, where samples were taken. In this regard, the results of our investigations are nearly the same as those reported by other authors (Kolektiv Autora, 1972).

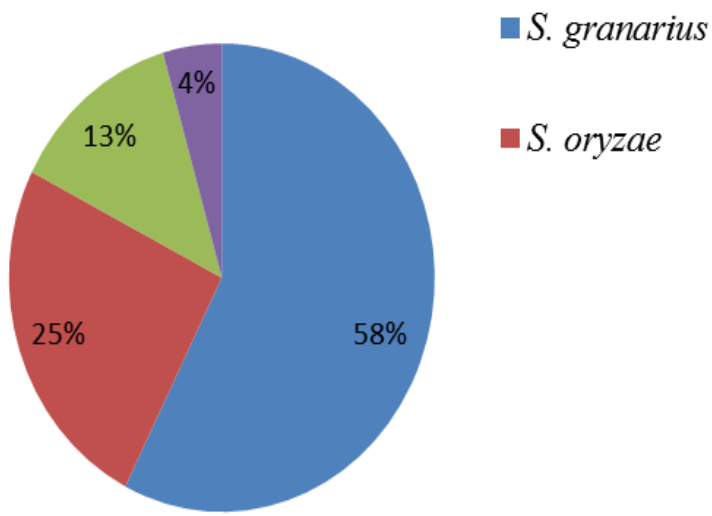


Figure 2. Frequency of the pest by proccesing mills

The highest number of pests, as the average of the total, was found in processing mill located in Bajqina (18.60) and the lowest one in Sekiraqa (8.20). On the other side in processing mill located in Podujevo the average number of pests from the total has been somewhere in between (11.25). In this context we can say that processing mill located in Bajqina has been the most affected by these pests, while the mill located in Sekiraqa has been the least one affected by various grain pests.
Statistically significant differences of different levels were found with regard to pest species as well (Factor B). The highest value (29.17) was found to wheat weevil (*S. granarius*) and lowest one (2.27) to flour beetle (*Tribolium* spp). According to the analyses of variance, it was shown that there are statistically significant differences of different levels among wheat grain pests found (Table 2).

Table 2. Frequency of wheat grain pests, (ANOVA)

Processing mill (A)	Pest (B)				Average (A)
	S.oryzae	*S.granarius*	*Rh.dominica*	*Tribolium* spp.	
Podujevë	28.30	10.50	4.20	2.00	11.25
Sekiraqë	17.00	9.10	3.60	3.10	8.20**
Bajqinë	42.20**	18.40	12.10	1.70**	18.60**
Average (B)	29.17**	12.67	6.63	2.27**	Interaction A x B

Factor		A	B	A x B	B x A
LSD	1%	8.7768	7.3722	14.2483	12.7690
	5 %	6.4072	5.6006	10.6304	9.7005

Regarding to the interactions of the factors, locality and pest species (A x B), also were found different levels of statistical significant differences as it is shown in table 2.
In connection with the appearance of grain pests, various authors have reported results that are approximately in line with the results of our investigations (Maceljski, 1999; Pireva, 1990; Radonjic Jelena 1990).

Conclusions

Based on the two-year investigations, with regard to the spread of different pests species from the order Coleoptera in the wheat grain stored in three electric proccesing mills of Podujevo Municipality (Podujevo, Sekiraqa and Bajqinë), we can conclude that:
Different pest species from the order Coleoptera are widespread in these mills, causing huge losses of wheat grain during it's storage. The obtained results indicates that wheat weevil (*S. granarius*) is the most prevalent pest species from the order *Coleoptera* in wheat grain in storage. From this order there were found also other pest species in wheat samples, rice weevil (S. oryzae), lesser grain borer (*Rh. dominica*) and flour beetle (*Tribolium* spp.) but by far in less number.
The dynamics of the appearance of certain types of grain pests has been various in all investigated processing mils, where the highest number of these pests were found in Bajqinë, then Podujevë and the lowest one in Sekiraqa.
Through the analyses of variante and LSD tests, highly significant statistical differences were found between the pest species found (factor B), locations where processing mills were located (factor A) and interaction between these factors (locality x pest).
Based on the number of the pest found in all investigated processing mills it can be said that there is a neccesserry to undertake protective measures to keep these pests under control starting from preventive to curative ones.

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УТВРДУВАЊЕ НА ПРИСУСТВОТО НА НАЈЗНАЧАЈНИТЕ ШТЕТНИЦИ НА ПЧЕНИЧНОТО ЗРНО ОД РЕДОТ COLEOPTERA ВО НЕКОИ МЛИНОВИ ВО КОСОВО

Гурнер Мурати, Фадил Муса, Скендер Рамадани

Апстракт

Целта на овие истражувања беше да се идентификуваат најчестите штетни инсекти на зрната од пченица при нејзиното складирање во три електрични млинови во Косово. Во текот на 2011 и 2012 година, беа земани примероци од пченични зрна во испитуваните електрични млинови сместени на 3 различни локации во Косово. Добиените резултати покажуваат дека најзастапен штетник е житниот жижак. Од вкупниот број на собрани штетници во трите испитувани млинови (1522), житниот жижак (*Sitophilus granarius*) беше застапен со 875 единки (57%), оризовиот жижак (*Sitophilus oryzae*) со 380 (25%), *Rhyzopertha dominica* со 199 единки (13%) и *Tribolium* spp. со 68 единки (5%). Најголем број на штетници беше утврден во млинот лоциран во Бајкина (744 единки), а најмал во Секирака (328 единки). Со анализа на варијанса (ANOVA) утврдени беа статитистички значајни разлики во однос на штетните видови на инсекти во трите испитувани млинови.

Клучни зборови: штетници на зрна, складирање, електрични млинови, ANOVA.

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Original scientific paper

THE MOST COMMON HARMFUL AND USEFUL ORGANISMS FOUND IN GRAIN CROPS IN LESKOVAC

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Abstract
The aim of this research is to monitor plant development and register any emergence of harmful and useful organisms in each separate research facility. The research took place in 2011 and 2012 in the research area of Agricultural High School in Leskovac. The following standard entomological methods were used to determine the prevalence and number of insects: visual examination of plants (every 7-10 days during the whole vegetation period) so as to determine the presence of pests; examination of above-ground plant organs (ears and leaves) and determination of the intensity of pest attack; hand reaping as an additional measure for determination of pest presence and density; laboratorical treatment, taxidermy and making a herbarium out of collected materials. The research results show that the following pests are the most common: aphids *(Aphididae)*, cereal leaf beetle (*Lema melanopus*) and scarab beetles (*Anisoplia spp*.). The most common diseases are the following: leaf rust (in 2011) and *Fusarium spp.* (in 2012). Significant presence of some sorts of ladybirds (Coccinellidae) and green lacewings (Chrysopidae) has been registered too.
Key words: grain crops, harmful and useful organisms, monitoring, Leskovac.

Introduction

Crop production is based on modern principles of creating high-quality food sources and providing healthy food products. Crop production can be brought to a higher extent by modernization of the production process. That is achieved by using high-yield crops, adequate fertilization (Tmušić et al., 2012) and pesticides in accordance with the integral (Ančev et Lazarevska, 2000) and organic principles of production . The increase in wheat crop area imposes the need for monoculture which, as a result, leads to specific conditions, high density of cultivated plants and the presence of various harmful organisms. The newly-arizen conditions in agrobiocenosis are suitable for the emergence of various harmful (disease, pests and weeds) and useful organisms (Lazarevska, 1998). Observing the presence, development and ratio of both useful and harmful organisms, taking notice of any faults in normal production process and establishing the extent of harmfulness that certain organisms might have are all part of monitoring system in plant protection. (Nikolić et al., 2012).

Apart from the modernization of production process, the changes in agrobiocenosis are caused by the climate as an environmental factor highly prone to change. Global warming, the phenomenon established by the end of the 20th and the beginning of the 21st century, has a significant influence on normal crop production process and plant protection as it changes the ratio of plants and harmful organisms. As a result, it is necessary to monitor the number of harmful organisms (Čamprag, 2000;

Petrović-Obradović, 2003) and disease-causing agents (Gudžić et al., 2009) in grain crops, as well as all accompanying changes in climatic factors (temperature, precipitation, humidity).
The aim of this research is to monitor plant development, take notice of any emergance of both harmful and useful organisms and the comparison of their emergence in spring and winter crops.

Material and methods

Microexperiment on spring crops (done on 19/04/2011) had 7 genotypes (Vojvoda, Smaragd, Jadran, Slavuj, Rajac, Lovcen and Vranac). Microexperiment on winter crops (done on 18/11/2012) had 8 types (Zemunska Rosa, Aleksandra, Srma, Janja, Zenit, Nirvana, Cipovka, 34/D-durum). The standard entomological methods (Group of authors, 1983) were used to determine the number and the spread of insects. Visual plant examinations were carried out during the whole vegetation period, every 7-10 days, depending on the meteorological conditions and the need for establishing the presence of disease-causing agents and insects (both harmful and useful). This method was also used for establishing the presence of rodents. Examination of aboveground plant parts (ears and leaves) was done to establish the presence of leaf lice. After the ear development stage in plant growth, 100 ears of each type were examined to determine the attack intensity of aphis population on the ears. The attack intensity was graded on the scale from 0 to 4. (Banks): 0 - no pests; 1 - very mild infection (individual plants or small colonies); 2 - mild infection (small number of pest colonies can be found on plants); 3 - infection of medium intensity (aphis can be found widely, several big or incoherent colonies); 4 - infection of high intensity (aphis can be found in large numbers, plant organs are densely covered with coherent colonies).
Aphids infection of medium intensity is calculated when the total sum of graded ears is divided by the number of analysed ears (Group of authors, 1983). Hand reaping was used as an additional measure for establishing the presence of predatory fauna in the period of high plant density. Laboratorical treatment (taxidermy and making a herbarium out of collected materials) was done continuously during the entire research period.

Results and discussion

The research results show that the following pests are the most common: aphids *(Aphididae)*, cereal leaf beetle (*Lema melanopus*) and scarab beetles (*Anisoplia spp*.). The most common diseases are the following: leaf rust (in 2011) and *Fusarium spp.* (in 2012). Significant presence of some sorts of ladybirds (Coccinellidae) and green lacewings (Chrysopidae) has been registered too.
The attack intensity of aphids (Figure 1.) on spring crops was determined three times in 2011 (on June, 19th, July, 5th and July, 18th). The attack intensity of aphids on winter crops was determined three times in 2012 (on May, 28th, June, 11th and June, 29th) (Table 1.). Aphids infection of medium intensity during the mentioned research period is shown in the Table 2. During the research period, it was determined that meteorological conditions such as drought and high temperatures were partucularly suitable for the development of leaf lice. In both research years, there was one treatment done to diminish the aphids population.



Figure 1. Aphids colony on ear and leaf

Table 2. Aphids infection of medium intensity in grain crops

	Visual examination		
2011.	June, 19th	July, 5th	July, 18thv
Spring crops	0,42	1,14	1,85
2012.	May, 28th	June, 11th	June, 29th
Winter crops	0,13	1,00	1,37

The predatory activity of natural enemies from the ladybird Family Coccinellidae and the green lacewing Family Chrysopidae was established during the research period.

- Family Coccinellidae (ladybird):
Coccinella septempunctata L. (Figure 2.)
Adalia bipunctata L.
Hippodamia variegata Goeze
Propylea quatouredecimpunctata L.
Calvia quatourdecimpunctata L.
- Family Chrysopidae (green lacewing):
Chrysopa perla L.
Chrysopa carnea Steph.

All those predatory natural enemies that were taken notice of during the reseach period fed primarily on aphis. They play a significant role in reduction of aphis population and dicrease in the extent of inflicted damage. Therefore, it is of extreme importance to take care and preserve the already-existing predatory species in the agrobiocenosis under research.

Table 1. Aphids infection of genotypes (scale from 0 to 4)

2011.	Visual examination		
Genotypes	June, 19th	July, 5th	July, 18thv
Vojvoda	0	1	1
Smaragd	1	2	2
Jadran	1	2	3
Slavuj	1	1	2
Rajac	0	1	2
Lovcen	0	0	1
Vranac	0	1	2
2012.	Visual examination		
Genotypes	May, 28th	June, 11th	June, 29th
Zemunska Rosa	0	1	1
Aleksandra	0	0	2
Srma	0	1	2
Janja	0	1	1
Zenit	1	2	2
Nirvana	0	1	1
Cipovka	0	1	1
34/D-durum	0	1	1

Cereal leaf beetle (*Lema melanopus* L.) is one of most significant small grain pests. (Čamprag, 2000). Its presence was established in the research area during the research period, but not in numbers large enough to require a special treatment. The first emergence of imaga on the newly-formed leaves of spring crops was established on 10/05/2011. The first emergence in winter crops was establised on 23/04/2012. The first signs of damage caused by larvae of cereal leaf beetles were established on 21/06/2011 and 24/05/2012. Larvae feed on the leaf area causing the leaf to skeletonize, leaving only the lower leaf epidermis (Figure 3.)

The damaged leaves are strikingly yellow and white, whereas the larvae are covered in mucus. The extent of larva damage was higher in spring crops in 2011 in comparison to the larva damage of winter crops in 2012. The preference of this pest for spring crops was pointed out by other authors too. (Group of authors, 1983; Čamprag, 2000).

Sporadic emergence of scarab beetles (*Anisoplia spp*.) was established during the research period. In 2011, larger numbers of *A. austriaca* Hrbst., *A. agricola* Poda and *A. segetum* Hbst .were present in winter crops.

Drought in summer 2011 was suitable for the emergence and spread of rodents, causing minor attacks on winter crops on the outskirts of the research area. (13/07/2011).

In 2011, the emergence of leaf rust (*Puccinia triticina* Ericsson) and stem rust (*Puccinia graminis* Persoon) were established in spring crops, especially in the oats types of Slavuj and Rajac. Orange pustules on leaves were first established on 17/06/2011 and the most intense attack was on 05/07/2011. In 2012, leaf rust has been present in traces in some sorts of winter crops (Figure 4).



Figure 2. *Coccinella septempunctata* L. on ear



Figure 3. Damaged leaves from *Lema melanopus* L.



Figure 4. Leaf rust (*Puccinia sp.*) on leaves

In 2012, fusariosis of wheat ears (*Fusarium graminearum*) was established in the blossoming stage (on 08/06/2012), after a long-lasting period of rain and higher humidity. The characteristic symptoms of this disease are the emergence of "white ears" with poorly developed seed and dying out of the ear above the infected area.

The results are a part of the research project called: "The examination of genetic basis for the improvement of growth and yield of small grains under different environmental conditions" (TP 31092) funded by the Ministry of Science and Technological Development of the Republic of Serbia. The research is going to be continued in the forecoming period.

Conclusions

Modernized production process, monoculture and environmental conditions can result in dense plant growth and emergence of various harmful organisms in grain crops.

The research results show that the most commonly-present pests were: aphids (Aphididae), cereal leaf beetles (*Lema melanopus*), scarab beetles (*Anisoplia spp*.) and rodents. Natural enemies from the Family of ladybirds (Coccinellidae) and the Family of green lacewings (Chrysopidae) play an important role in the reduction of aphis population.

The most commonly present diseases were leaf rust (*Puccinia triticina*) in 2011 and furiosis of wheat ears (*Fusarium graminearum*) in 2012.

The presence of harmful and useful organisms in spring and winter crops is almost identical, with small differences pertaining to the beginning of insect emergence and different attack intensity. The diferences in attack intensity are related to the developmental stages of plants and are under the influence of meteorological conditions.

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НАЈЧЕСТИ ШТЕТНИ И КОРИСНИ ОРГАНИЗМИ КАЈ ЖИТНИТЕ КУЛТУРИ ВО ЛЕСКОВАЦ

Катерина Николиќ, Надица Тмушиќ, Славиша Гуџиќ

Апстракт

Целта на ова истражување беше преку мониторинг на развојот на растенијата да се детектира појавата на штетни и корисни инсекти во секој испитуван објект. Истражувањата беа извршени во текот на 2011 и 2012 година во истражувачките полиња на Земјоделското Средно Училиште во Лесковац. Во испитувањата беа вклучени стандарни ентомолошки методи за утврдување на застапеноста и бројот на инсекти и тоа: визуелен преглед на растенијата (секои 7-10 дена) за да се утврди присуството на штетните организми; преглед на надземните делови од растенијата и утврдување на интензитет на напад; лабораториски третмани, таксидермија и правење на хербариум од колектираниот материјал. Резултатите покажуваат дека најчести штетни инсекти се следните: растителните вошки *(Aphididae)*, житната пијавица (*Lema melanopus*) и *Anisoplia spp*. Најчести болести кај житариците се: лисната рѓа (во 2011) и *Fusarium spp.* (во 2012). Значајно присуство на некои видови бубамари (Coccinellidae) и златици (Chrysopidae) беа регистрирани исто така.

Клучни зборови: житни култури, штетни и корисни организми, мониторинг, Лесковац.

SECTION 11: AGRICULTURAL MACHINERY

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Original scientific paper

EXPLOITATION EXAMINATION OF MACHINERY FOR HARVESTING CHAMOMILE IN TWO PHASES

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Abstract
The paper covered the exploitation trials for collection chamomile in two phases where drawn collection combine the inflorescence has been used and the line of machines for mowing and gathering stalk of chamomile. Tests were carried out on 48 hectares in the area of the municipality Rankovci drawn combine manufactured by Prima Novi Sad, for the first time applied to cultivated diploid variety chamomile without irrigation in conditions of Macedonia. Exploitation examination covered the quality of work and exploitation parameters of harvest machinery and the obtained results are of great importance for Macedonian agricultural production for the first time.
Key words: Exploitation, combine, harvesting, chamomile.

Introduction

Development of medicinal and aromatic plants in the world has seen steady growth and cultivated land increases, because this kind of plants are of great importance for industrial processing needs of pharmaceutical, medical and cosmetic industry. Progress is seen as a result of the improvement of structures of various agricultural machines, and their working proces is performed almost completely mechanized by introducing modern production technology for our farmers greatly facilitates work processes with increased cost and increased accuracy in work .Progress notes and the fact that the world's factories, and even the smaller manufacturers of this type of machinery, constantly perfecting machines for individual work processes in terms of quality and economy makes it possible to obtain high productivity in the work, but also to increase the area of these plants. Here in Macedonia have a long tradition of individual cultivation of medicinal and aromatic plants, only certain areas and several individual small firms that are engaged in this activity. For now, the possibilities are used about 1% of all domains. Few years ago, we show interest in increasing the surface and parallel to it and the need for introduction of new machinery in the cultivation of these crops.

Material and methods

Exploring were performed in a production conditions in the Republic of Macedonia, in the municipality of Rankovce an area of 40 hectares in the fields with diploid varieties of chamomile, sowing was carried out in the autumn, in optimal term with proper agrotechnical measures, in October 2011. For collecting the vintage was engaged drag harvester with tractor type and model VB 2002 manufactured in the factory receives in Novi Sad (Pajić M. et al 2005), collecting

inflorescence of chamomilla. Collecting stems of the chamomilla was done with the other line on the machine: Disc mower, Rotary rakes and Balers. This way of production of chamomila has been certificated as organic production.

Subject of examination

As an immediate goal and the reason for this exploration, was to be examined exploitation research in the locations and the quality of the machine work on the lines in the vintage of chamomile, including all terms in Republic Macedonia. Certainly, obtained results are reason to these machines gradually to affirm which will lead to an increase on the surface of producing the various types of medicinal and aromatic plants.

Methods and technique of examination

During the exploration, methodology and technique work was divided into two parts. In the first part were investigated exploitative features towed combine harvesting inflorescence, with quality work. The second part was examined line machines to collect the stems.Exploitation characteristics Combine that throughout the tests was drawn tractor IMT 539, were recorded all default parameters measured in production conditions with five repetitions, where you can see what kind of results obtained in manufacturing conditions. Quality of work performed recording the condition of the crop in terms of number of plants per m^2 their height, weight, number of flowers in different locations of the parcel with 5 samples taken at random blog system gave real situation he mean by parameter. Weeds are also exploring, their number representation, which gives an indication of the work combine as exploitation features and quality of work.

Quality of work were examined number selected socvetija completely and incompletely collected fallen country other. Loss of mass in the stem and flower were also measured, because the purpose of the investigation was set with any loss at optimal regulation combines, to give satisfactory result, because all measurements and tests were performed at the optimum speed of movement of 3,4 km / h, which is defined as the most appropriate speed in the working conditions for all measurements and parameters.

After collecting inflorescences was used line of machines for collecting stems. Rotary mower with rotary therefore, rotary rakes, pick up-press (balers) were three types of machines that perform the collection of stems.On this tree tipes od mashines, were examined exploitation features with productivity at work the entire surface.

Results and discussion

I-Phase on harvesting

All results obtained by measurements carried out directly in the field, during the execution of working process, and some samples have been measured in the laboratory DOOEL "Coro Company" from Skopje, which was also the carrier of all activities. The entire plantation was seeding in October 2011, with a properly executed agro-technical measures, quality seeds, but in dry conditions.And later, after seeding in the next two months, without rainfall, it contributed some plants about 20% before winter, to germinate, but in this phase they are not ready for winter, with above-ground part and root system, other plants were germinate in the spring and crop at certain places there was sufficient density, certain places where the plant had increased moisture from chamomile were rare. Our plantation was ready until the end of May, and we had diverse plants as per number of plants per square meter at their height, and number of inflorescences per plant.

Table 1. Condition of the crop before harvest

Number of plants per m^2	Weight g/m^2	Number of weeds per m^2	Height weeds cm	Height chamomile cm	Number of inflorescences per m^2
92	246	24	10-42	18-34	1730

Harvest was carried out a total of 5 days, in the period from June 20 to 26, with towed combine attached on tractor IMT 539. During the work we noticed that combines requires a tractor with greater pulling power, but at that point we didn't have tractor 539 satisfactorily serve the Combine, which had a working grip of 2 meters, fitted with it's technical features. During this harvesting,we didn't have any problem with combine, because chamomila plant's were rare, and the cuting inflorescences as easy. (Brkić et al., 1998). The average work speed was 3,4 km / h (Table 2), and it was notice that the entire surface, aggregate was moving at a constant speed, because the surface was well-prepared, no bumps which created favorable conditions for the operation of the combine. From the Table 1, it is evident that the samples taken average per square meter, we have a green mass of 246 grams, which shows that the number of plants per square meter 98, that all the plants were not equally developed, or at the very measurements we noticed that some plants had about 20 inflorescences, and some 200. The unequal development of the plants had no impact on the quality and exploitative features combine his device properly collected florescence at the average speed unnoticed congestion pickup device.

During the work the organization was set up in terms of spillage coffin with agegatot had many empty movement, because drying was carried out in solar energy dryers, set in several places of the parcel. Therefore, aggregate showed result koenficient beneficial effect of 0.78 for 8 hours of working time and production of 0.53 acres per hour.

Table 3 shows the results of the quality of work with measurements at different locations of the parcel with several iterations.

Table 2. Displaying exploitation features combine Prima

Working width (m)	Working speed (km/h)	Coefficient of efficiency Production	Production (ha/h)	Production for 8 h
2	3,4	0,78	0,53	4,4

During the work the organization was set up in terms of spillage coffin with agegatot had many empty movement, because drying was carried out in solar energy dryers, set in several places of the parcel. Therefore, aggregate showed result koenficient beneficial effect of 0.78 for 8 hours of working time and production of 0.53 acres per hour. Table 3 shows the results of the quality of work with measurements at different locations of the parcel with several iterations.

Table 3. Quality work combines Prima

Fallen florescences		Other uncollected florescences plant		Uncollected florescences m^2	
number	%	number	%	number	%
4	0,23	132	7,6	14	0,80

During the work as well as the tests themselves noticed, that the combines header collect all florescences with height greater than 9 cm from the ground. From the table we see that uncollected florescences per square meter average of 14 numbers of measurements, and the knowledge that it is not florescences that appliance and fell to the ground but florescences that their height is under 9 inches and the header does not embarked or florescences that of a minor branch had fallen to the ground, but the percentage of the total number of florescences in the table is 0.80. During the tests, we noticed that fallen florescences on the ground that the average amount 4 or percentages 0.23, it was generally not properly shaped florescences, which have a very low specific mass and even appeared in the last days of work a particular place parcel which were half dry. Collection device probably has accepted disassociated, but additionally were dropped because as we have mentioned, about 60% were dehydrated.

If we analyze the data in Table 3 for quality work we can see that the total loss Combine during exploitation average is 1.03%, which is quite satisfying and losses methodological eksplataciono tolerant. From the results of Table 3 shows that per square meter found 132 florescences that biologically are not shaped like florescences as previously mentioned for the dry autumn period phenophase plant were mixed in the spring, so probably the florescences that appeared in later period covered by dry days were unable to fully form less humidity, the device could not affect collection. The number of 132 numbers or 7.6% of this category of florescences should not be neglected, where these florescences are not placed in the figure shown in Table 1 for the total number of florescences per square meter before collecting harvest. It is quite normal because of the trials themselves conclude that these are florescences that can not be taken under any category, as a loss Combine.

II-Phase on harvesting steam of chamomile

After collecting the florescences, therefore perform collection stems as a second stage (phase). First machines that we use was rotary mower which exploitation characteristics are shown in Table 4. Rotary mower has given us very good results, that the plant chamomile do not have a very high density, and stems were completely dry, with the mower worked in second gear fast, and the table shows that the working speed has been 5,8 km / h.Stems-quarter was very weak and we were forced to apply sun rotary rakes which two three-quarter merge in one swath. We did this in the next day, because the harvest period, temperature that day reach up to 38^0C, and harvested the next day it was completely dry, and thus got the improved exploitation features rotary rakes and balers and economy in operation. The results are shown in Table 4.

Table 4. Exploitation characteristics

Type of machine	Working width	Work speed	Coefficient of efficiency Production	Production ha/h	Production for 8 h	Trees dry mass per hectare
Disc mower	2	5,8	0,75	0,87	6,9	670 kg/ha
Rotary rakes	4,5	6,1	0,75	2,05	16,4	
Balers	4,5	6,0	0,75	2,02	16,1	

Conclusions

From the exploitation parameters and the quality of work we can conclude that combine for harvesting chamomole, manufactured by the company EURO PRIMA, (Chamomile harvester VB2002) in terms of R. of Macedonia gives satisfactory results. Of course, these trials were important to us from a scientific and application point of view, but it is important for manufacturers of medicinal and aromatic plants as sign, that the problem of collecting chamomile is already solved with quality machines which precision and tolerance limits loss to collect the florescences and stem can be seen from the displayed results. It gives us the occasion of this culture affects a growing number of areas in the Republic of Macedonia, but gives occasion to bring new machines with new technical solutions that work process or the overall production technology will perform better and more economical.

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РЕЗУЛТАТИ ОД ЕКСПЛОАТАЦИОНИТЕ ИСПИТУВАЊА НА МАШИНИТЕ ЗА ДВОФАЗНО СОБИРАЊЕ НА КАМИЛИЦА

Цанев Иле

Апстракт

Во трудот се опфатени експлоатационите испитувања за двофазно собирање на камилицата при што употребен е влечен комбајн за собирање на цветот, а потоа линија на машини за косење и собирање на дршката од камилицата. Испитувањата се вршени на површина од 48 хектари во реонот на општина Ранковци со влечен комбајн произведен од Прима Нови Сад кој во услови на Македонија за прв пат го применуваме на култивирана диплоидна сорта на камилица, без наводнување. Од експлоатационите испитување опфатени се квалитетот на работа и експлоатационите параметри на машините во двофазна берба при што добиените резултати се од исклучително значение, бидејќи за прв пат во Македонија се употребува оваа линија на машини.

Клучни зборови: Експлоатација, комбајн, жетва, камилица.