TECHNOLOGICAL CHARACTERISTICS OF SOME NEW PROKUPAC CLONES

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Abstract
The research carried out in experimental vineyard-collection at Faculty of Agriculture experimental field Radmilovac, which is located at GPS coordinates N 44º 45' 21" and E 20º 34' 53". Experimental vineyard is located at southeast part of Belgrade, at an altitude of 130 m and covers southern exposure. It belongs to Šumadijsko-velikomoravski vineyard area, Belgrade sub-region and Grocka vineyard region. Rows were extending in southeast-northwest direction with line spacing of 3 m and 1 m between vines in row. In experiment tested clones were under codes 40/2, 42/1, 43/1 and 43/3. From technological characteristics in paper is presented data related to weight of biomas discarded in pruning, yield, mechanical composition of berries and cluster, structural indicators of berries and bunches and qualitative parameters-sugar and acid content. The biggest mass of pruning shoots was determiner at clone 40/2 (1.008 kg/vine). The highest yield is recorded at clone 42/1 (7.1 kg/grapevine) and the smallest for clone 43/1 (3.6 kg/vine). Maximum cluster mass was recorded at clone 43/1 (276 g), whereas for clone 40/2 was determined the largest weight of berries meat (254 g) and the biggest seeds number per 100 berries (208). Clones 42/1 and 43/1 are characterized with the highest recorded skin weight of 100 berries (10 and 23 g/100 berry). Same trend was recorded for percent of stem, skin and seed in cluster. Clone 42/1 had the lowest percent of meat in berry (88.21%). According to sugar content were founded the highest level for clones 42/1 (24.1%) and 40/2 (22.4%). Same trend of variation is determined for acid content in grape juice.

Keywords: technological characteristics, berry, grape, clone, Prokupac.

Introduction

In recent years, great attention has been give to cultivation and conservation of autochtonous varieties. Prokupac is an Serbian autochtonous red wine variety. Vineyards raised with the Prokupac variety, which is also known as Rskavac, Kameničarka, Crnka and Niševka, is mostly spread throughout southern and central parts of Serbia, also in Macedonia (Skopsko crno) and Bulgaria (Zarcin). Prokupac it is characterized with big yielding capacity. Bunch could be classified as medium large, cylindrical or conical in shape, medium compact, berries are round or slightly oval with dark blue epidermis. Prokupac wine is refreshing and nicely red colored (Avramov and Zunic 2001, Zunic, 2010). First information about Prokupac breeding date from the fourteenth century (Zirojević, 1964). By clonal selection were separate 42 clones with different morphological and technological characteristics, 11 were recognized by Ministry of Agriculture as a technologically better clones compared to the standard variety and they are expanding into further production. (Markovic et al. 2013a). Clonal selection is important tool for grapevine genetic selection. In grape clonal selection main aims of selection are bigger cluster, excellent yield, bigger percent of berry skin, better grape quality express through sugar and acid content, stronger wine aroma and coloration, as well as genetic resistance to main pests and diseases. Clones from one grape variety can produce wines with different organoleptic characteristics, aromatic profile and phenolic content. Content of phenolic acids, stilbenes, flavonols, dihydroflavonols, anthocyanins, flavanol monomers (catechins) and flavanol polymers-proanthocyanidins can be affected directly by mechanical grape composition (Zivkovic et al. 2016). The objective of this study was to represent the yield, morphological and quality variability among clones of the autochthonous variety Prokupac.

Material and methods

The research carried out in experimental vineyard-collection at Faculty of Agriculture experimental field Radmilovac, which is located at GPS coordinates N 44º 45' 21" and E 20º 34' 53". Experimental vineyard is located at southeast part of Belgrade, at an altitude of 130 m and covers southern exposure. It belongs to Šumadijsko-velikomoravski vineyard area, Belgrade sub-region and Grocka vineyard region. Rows were extending in southeast-northwest direction with line spacing of 3 m and 1 m between vines in row. In experiment tested clones were under codes 40/2, 42/1, 43/1 and 43/3. From technological characteristics in paper is presented data related to weight of biomass discarded in pruning, yield, mechanical composition of berries and cluster, structural indicators of berries and bunches and qualitative parameters-sugar and acid content. Vegetative potential was determined by measuring of shoot mass during pruning. The obtained results give a clearer picture of real vegetative potential of vine. Ravaz's index is derived from ratio of grape yield to grape weight. For the *Vitis vinifera* L. Ravaz index can have values in range from 4-15, and this range is large but necessary because there is a different vine balance depending on training system and number of buds left during pruning. When is index values less than optimal, it indicates a small yield with a higher mass, if the value is above the upper, then is reverse. The yield per trunk is determined in technological grapes maturity by measuring of total clusters mass on scale type CAS-SHOLEX SHRE-122. The mechanical composition of the grapes and berries represents a varietal characteristic. The elements of the mechanical composition are subject to deviations under influence of ecological factors under which variety is cultivated. The mechanical composition of clusters and berries is characterized by the weight-ratio of certain elements, where elements of cluster composition are: cluster stem and berries, and elements of composition of berries are: berries skin, mezocarp and seeds. By values of mechanical composition of clusters and berries it is shown quality of grapes which has a special scientific and practical relationship. Practical significance is reflected in determination of percent of individual berries components, in particular berries skin and the mezzogarpa, which are main elements of quality of future wine. For purposes of testing mechanical composition of berries and clusters were selected five vines from which was harvested five representative clusters which are subjected. After clusters selecting it was measured their individual weight, length and width after which was carefully separate each berry from cluster stem without meat rest. With measuring on analytical balance was determined cluster mass, mass of all beres on cluster and cluster stem weight. Berries number was determined by counting. After that was selected 100 berries from which was separated epidermis and seeds. The seeds and epidermis mass was measured on an analytical balance. Seeds number was determined by counting. Other parameters were obtained by computation. The grapes quality was expressed through sugar content in grape which was examined by Oeshle mostwage and values were determined using Dujardin-Salleron tables. Total acid content was determined by titration method with n/4 NaOH.

Results and discussion

On basis of results obtained by measuring of cutting shoot mass it can be concluded that the largest average mass was recorded at clone 40/2 (1.008 kg/ vine), while the lowest value was observed at clone 43/1 (0.335 kg/vine). The higher average shoot mass for clone 40/2 indicates strong vigor versus clone 43/1, which had a smaller shoot mass, consequently, a lese vigor. The results are shown in table 1.

Table 1. Shoot mass removed by pruning

Clon	Shoot mass				
	Vine 1	Vine 2	Vine 3	Vine 4	Average
40/2	0.840	1.135	1.130	0.930	1.008
42/1	0.370	0.795	0.715	0.565	0.611
43/1	0.250	0.400	0.285	0.322	0.335
43/3	0.265	0.400	0.505	0.910	0.520

Ratio between yield and average shoot mass was calculated as Ravaz index. The highest index value was recorded for clone 43/1 (10.74), and the lowest for clone 40/2 (4.86). Other two clones were with approximately same values (10.19 and 10.74). High index values can be explained through lower yield and high values of the average shot weight. Shoot mass and vigor also can be affected to different rootstock (Markovic et al. 2012). The results are shown in table 2.

Table 2. Ravaz index

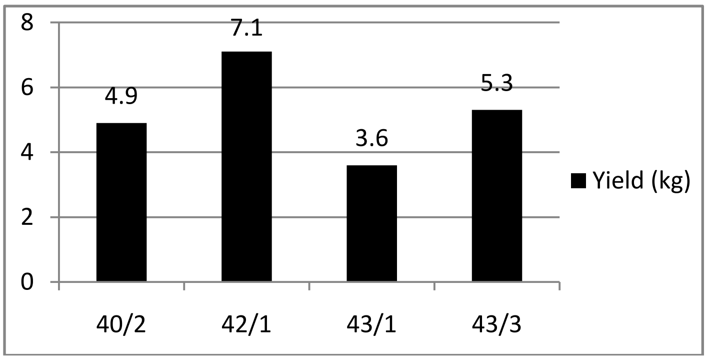
Clon	Yield per vine (kg)	Average shoot mass per vine (kg)	Ravaz index
40/2	4.9	1.008	4.86
42/1	7.1	0.611	11.62
43/1	3.6	0.335	10.74
43/3	5.3	0.520	10.19

Grapes yield depending of clone varied from 3.6 to 7.1 kg/vine. The highest yield, i.e. the highest grape mass per vine, was determined for clone 42/1, while average yield per hectare at planting density of 3333 vine per hectare for this clone was 23664 kg. Clon 43/1 had the lowest average grape weight per vine, which was 3.6 kg, ratio of average yield per hectare was 11998 kg. Clones 40/2 and 43/3 had approximately same yield values-4.9 and 5.3 kg, or 16331 and 17664 kg/hectare. Results are according to Markovic and Atanackovic (2013a).

Table 3. Grape yield of Prokupac clones

Clon	Yield per vine (kg)	Yield per ha (kg)
40/2	4.9	16331
42/1	7.1	23664
43/1	3.6	11998
43/3	5.3	17664

Existing differences between clones by yield/vine are shown in graph 1.



Graph 1. Yield per vine

The average clusters and berries mass of tested Prokupac clones varied from clones to clones. By study is founded that the largest cluster mass had a clone 43/1 (276 g), while the lowest was recorded for clone 43/3 (223 g). Clones 42/1 and 43/1 had same berries number in cluster (115), while the smallest number of berries were found for clone 43/3 (103). The results of measurements showed that clone 43/1 had the biggest berries mass (266 g) and the smallest 43/3 (213 g).
On the other hand, analysis of indicators of the mechanical composition and structure of berry resulted following results. The maximum weight of 100 berries was determined for clone 40/2 and was 269 g. The smallest mass was determined for clone 43/3 and was 231 g. By study was found that the largest mass of berries skin of 100 berry had clone 42/1 (23 g), while the smallest mass was

recorded for clones 40/2 and 43/3 (9 g). The weight of seeds in 100 berries varied in range from 6-7 g, so the highest mass was determined for clones 42/1 and 43/1 with 7 g, while a slightly smaller mass was recorded for clones 40/2 and 43/3 and it was 6 g. Clone 40/2 had the highest seeds number (208), while clone 43/3 had the smallest seeds number (159). Other two clones had approximately same seeds number (190 and 197). Relationship between seeds and berries skin is important parameter that can define quality of future wine, however, their given aromatic and color matter, as well as most tannins which are concentrated in these berries parts (Zivkovic et al. 2016). The results of mechanical composition of berries are shown in table 5.

Table 4. Indicators of mechanical composition and cluster structure

Clon	Cluste structure				Indicator of weight composition
	Cluster mass (g)	Berries number in cluster	Berries mass (g)	Cluster stem mass (g)	
40/2	243	106	233	10	23.3
42/1	254	115	247	7	35.2
43/1	276	115	266	10	26.6
43/3	223	103	213	10	21.3

Table 5. Mechanical composition and berries structure

Clon	Berries structure				
	100 berries mass (g)	Skin mass of 100 berries (g)	Seed mass of 100 berries (g)	Mesocarp mass of 100 berries (g)	Seed number in 100 berries
40/2	269	9	6	254	208
42/1	252	23	7	222	197
43/1	240	10	7	223	190
43/3	231	9	6	216	176

Clone 43/3 (4.48%) was allocated according to percent of stem in cluster. The highest value for percent of berries in cluster was determined for clone 42/1 and was 97.24%. For same parameter the lowest value was recorded for two clones 40/2 and 43/3-95.51% and 95.88%. Percent of berry skin is important parameter and indicator of oenological potential of variety, especially considering that many phenolic compounds are concentrated in berry skin. Clone which has the largest percent of berry skin in cluster is 42/1 (10.5%), which is significantly higher than other clones. The lowest participation berry skin in cluster was determined for clone 43/10 (4.10%). Based on study of seeds participation in cluster it can be concluded that value of seed content was approximately same for all examined clones. Clone with the largest mesocarp content in cluster was 43/1 with 89.45%, while clone with the lowest mesocarp content in cluster 42/1 was 83.78%. By study was found that the highest percent of solid residue was found for clone 42/1 and amounted to 16.22% and clones 40/2 and 43/1 had approximately similar values of solid residual (10.55% and 10.80%). By detailed study, clone with the highest values of structural indicator was 43/1 (8.47), and the lowest value of structural indicator is determined for clone 42/1 (5.16). Results of mechanical composition and cluster structure indicators are shown in table 6.

Table 6. Indicator of mechanical composition and cluster structure

Clon	Cluster structure						
	% of cluster stem	% of berries in cluster	% of berries skin in cluster	% of seed in cluster	% of mesocarp in cluster	% of solid residue	Structure indicator
40/2	4.11	95.88	3.94	2.74	89.19	10.80	8.25
42/1	2.75	97.24	10.50	2.96	83.78	16.22	5.16
43/1	3.62	96.37	4.10	2.82	89.45	10.55	8.47
43/3	4.48	95.51	4.30	2.55	88.65	11.34	7.81

By testing of mechanical composition and berry structure following results were obtained. Clone 42/1 was allocated on basis of the largest percent of berries skin (9.20%), but also the smallest mesocarp percent in berry (8.21%) and values for indicator of berry weight. Clone 43/1 was caracterised by the highest percent of seeds in berry (2.82%) and the minimum value for berry indicator (41.66). Clone 43/3 characterized itself with the smallest percent of berries skin (4.04%) and percent of seeds in berry (2.39%), but also the highest values for participation of mesocarp in berry (93.57%), berries indicator (46.18) and indicator of berry weight (23.17). Markovic et al. (2013 b) and Markovic and Atanackovic (2013 c) in research founded same results. The results are shown in table 7.

Table 7. Indicator of mechanical composition and berries structure

Clon	*Berries structure*				
	% of berries skin	*% of seed*	*% of mesocarp*	*Berries indicator*	*Indicator of berry weight*
40/2	*4.29*	*2.68*	*93.03*	*43.62*	*21.64*
42/1	*9.20*	*2.59*	*88.21*	*45.27*	*13.26*
43/1	*4.11*	*2.82*	*93.07*	*41.66*	*22.67*
43/3	*4.04*	*2.39*	*93.57*	*46.18*	*23.17*

Fact is that Prokupac as vine variety with strong oenological potential which is important parameter that can be monitored through sugar and total acids content in the grapes and through their relationship via glycoacidometric index. During alcoholic fermentation, biochemical processes take place, there is a series of physical and chemical changes which resulting wine production. Wine contains a large number of compounds that together contribute to overall quality, depending on the percentage of sugar and acid in the berry. Matthews et al. (2005) refers that grape and wine quality can be affected by berries size and yield. In table 8 are showed sugar content expressed in percent and total acid content expressed in g/l and values of glycoacidometric index are also shown.

Table 8. Sugar and total acid content and glycoacidometric index

Clon	Sugar content (%)	Total acid content (g/l)	Glycoacidometric index
40/2	22.4	6.7	3.34
42/1	24.1	6.9	3.49
43/1	20.0	6.7	2.98
43/3	17.6	6.0	2.93

The highest sugar percent was recorded for clone 42/1 (24.1%), while the lowest value for same parameter was recorded for 43/3 (17.6%). The highest total acid content was found for clone 42/1 (6.9 g/l), which is correlated with extremely low sugar content for this clone. The smallest total acid content was recorded for clone 43/3 (6.0 g/l). While the clones 40/2 and 43/1 had same total acid content in must (6.7 g/l). Values for glycoacidometric index varied in the range from 2.93-3.49. The lowest value is determined for clone 43/3 and the highest is determined for clone 42/1. Results was according to Markovic et al. (2013 b).

Conclusions

After research following conclusions can be made: the highest average shoot mass recorded for clone 40/2 which indicat strong vigor of this clone, whereas clone 43/1 had the lowest value for this parameter; the highest yield was recorded for clone 42/1, while the lowest yield was recorded for clone 43/1. Clones 40/2 and 43/3 did not differ significantly in for yield values; Based on analysis of mechanical composition of clusters and berries and calculated parameters can concluded: the maximum 100 berries weight was recorded for clone 40/2 and the smallest berries mass was determined for clone 43/3. The largest skin mass of 100 berries, mass of seeds in 100 berries and the largest percent of skin in cluster had clone 42/1. Slightly smaller seed mass in 100 berries was recorded for clones 40/2 and 43/3. Clone 40/2 had the highest seed number, while clone 43/3 had the smallest number of seeds. According to percent of cluster stem clone 43/3 was singled out. Clone 43/1 had the highest percent of mesocarp in the cluster. According to qualitative parameters expressed through sugar content in grape juice clones 40/2 and 42/1 were singled out. The highest acid content was founded for clone 42/1, which is correlated with low sugar content of this clone. Values of glycoacidometric index varied in the range of 2.93-3.49.

Acknowledgements

This paper was realized as a part of the project (TR 31063): Application of new genotypes and technological innovation in fruit and grape production financed by the Ministry of Education and Science of the Republic of Serbia within the framework of the technological project research for the period 2011-2017.

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