

‘Čačanska Rodna’ – plum cultivar for spirit production

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Abstract. During the five year period, technological characteristics of fully ripen fruits of ‘Čačanska Rodna’, ‘Stanley’ and ‘Požegača’ grown in the same locality were comparatively studied, as well as the chemical composition and sensory characteristics of plum spirits obtained by their processing. The plums were processed traditionally, which included fruit crushing (without stone removing), spontaneous fermentation of the mash and double distillation in alembic. All examined characteristics of fruits and monovarietal plum spirits varied significantly depending on the year of the harvest, and their ranges of variation during the five-year period were shown accordingly. The possibilities of using cultivar ‘Čačanska Rodna’ for production of plum spirit according to the traditional procedure in comparison with the parent cultivars have been considered.

Key words: plum, ‘Čačanska Rodna’, plum spirit, chemical composition, sensory characteristics

Introduction

Changes in the assortment of plums intended for plum spirit production are slow and rare. Production of plum spirit is mainly based on old cultivars whose suitability for this purpose has been proven by several-decades and even century old practice. This is due to, among other, quite conservative attitude of consumers (accustomed to consuming plum spirits of traditional sensory characteristics) and spirit producers (well acquainted with technological characteristics of standard cultivars). However, changes in the plum assortment in Serbia, conditioned by various factors, are steady and dynamic (Mišić & Ranković, 2002). Therefore, some new cultivars recommended for various purpo-

ses have been introduced into production. In order to determine the suitability of a newly created or newly introduced cultivar for spirit production, it is necessary to conduct a several-year comparative study of the respective cultivar and standard cultivars under controlled conditions (Stojanovska & Janda, 1986).

The suitability of a plum cultivar for spirit production cannot be determined solely on the basis of the characteristics of the fruit. However, based on the content of individual components of the mechanical and chemical composition of the fruit, it is possible to estimate potential yield of spirit, as well as potential contents of some components (methanol, HCN, benzaldehyde) important for spirit quality (Popović et al., 2006a). The real yields of plum spirit, as well as its

chemical composition and sensory characteristics depend not only on the cultivar but also on the technological process of production (Nikićević *et al.*, 2018).

The spread of ‘Čačanska Rodna’ cultivar (obtained from a cross ‘Stanley’ × ‘Požegača’ at Fruit Research Institute, Čačak) in Serbian orchards in the last quarter of the century has been evident. At the same time, the prevalence of ‘Požegača’, which is considered a cultivar for the production of top quality plum spirit, decreased during this period, and the prevalence of ‘Stanley’, a cultivar for the production of spirit of only moderate quality, increased. In the last 20 years, ‘Čačanska Rodna’ has been studied more intensively as a raw material for spirit production. The impacts of the following factors on the quality of plum spirit obtained from ‘Čačanska Rodna’ have been studied: 1) pre-harvest factors, such as pruning intensity (Popović *et al.*, 2008b) and locality (Popović *et al.*, 2013); 2) degree of ripeness at the harvest (Popović, 2014); 3) method of plum processing (Popović *et al.*, 2007; 2009a; Urošević, 2015). The quality of plum spirit obtained from ‘Čačanska Rodna’ was compared with the quality of plum spirit obtained from other plum cultivars for spirit production, but only through short-term, one-year or two-year studies (Popović *et al.*, 2006b; 2009b; 2012; 2019; Vyviurska *et al.*, 2017). However, there are no several-year studies, which examined the effect of the harvest year on the plum spirit characteristics, i.e. content of components prescribed by regulations and sensory characteristics.

Cultivars ‘Čačanska Rodna’, ‘Stanley’ and ‘Požegača’ account for more than 50% of the plum assortment in Serbia. Nevertheless, the largest share of plums is processed into spirit in rural households traditionally, by double distillation of spontaneously fermented plum mash with stones. Thus, the aim of the study was to determine the ranges of technological characteristics of fruits and quality parameters of spirits produced in the traditional way from these three cultivars during the five-year period.

Material and Methods

Fully ripe plum fruits (at the stage of technological maturity for spirit production) of ‘Čačanska Rodna’, ‘Stanley’ and ‘Požegača’ were harvested at Preljinsko brdo in five years (from the beginning, middle and end

of the first decade of the 2000). The common agrotechnical measures, including hard pruning of the cultivars ‘Čačanska Rodna’ and ‘Stanley’, recommended for their intensive cultivation (Oparnica *et al.*, 2000; Mitrović *et al.*, 2001), were applied in the orchard.

The following mechanical characteristics of fruits were determined: fruit and stone mass (using Mettler technical scales), and stone ratio. For physical and chemical analyses of fruits, the following methods described by Trajković *et al.* (1983) were used: content of soluble solids (SSC) (refractometric – by manual refractometer 3828 Carl Zeiss), content of total sugars, directly reducing sugars and sucrose (method by Luff-Schoorl), content of total acids (by neutralization with 0.1 M NaOH, with phenolphthalein), pH value (potentiometric – by pH meter MA 5705 Iskra), contents of pectinic acid, pectic acid, protopectins and total pectins (carbazole method). The total sugar/acid ratio was calculated.

Plum spirits were produced in a traditional way, which included: 1) manually crushing of fruits; 2) spontaneous alcoholic fermentation of 20 kg of crushed fruit (with stones) at a temperature of about 20°C. For fermentation (in three replicates), polyethylene vessels with a volume of 30 litres were used. During fermentation, the surface of the mash was in constant contact with air (traditional fermentation in open vessels). Termination of the reduction of soluble solids content in the fermentation mash was an indicator of the completed alcoholic fermentation; 3) double distillation in a 25-liter copper pot still (alembic), heated by a gas burner. The first distillation (distillation of the fermented plum mash) was conducted immediately after finished alcoholic fermentation, whereby the first distillate (with an ethanol content of about 28 vol%) was obtained. Second distillation, redistillation of the first distillate, was done in order to separate the following fractions: the head (1%), heart (with an ethanol content of about 60 vol%) and tail. Only the heart (middle fraction) was used for further analyses.

The contents of methanol, HCN, total extract and volatile substances in plum spirits were determined using official methods (Službeni list SFRJ, 70/87). Volatile substances were shown according to the latest legislation (Official Journal of the European Union, 39/08; Službeni glasnik RS, 92/15) as the sum of the content of following compounds: higher alcohols, esters, total acids, total aldehydes, furfural and benzal-

dehyde. The content of total volatile substances reduced by the content of total acids is also shown.

For sensory analysis, the content of ethanol in the middle fraction of the distillate was reduced by deionized water from 60 vol% to 45 vol%. An expert commission of 5 members evaluated 4 parameters of plum quality using Buxbaum's sensory analysis method: colour (maximum 1 point), clearness (maximum 2 points), odour (maximum 7 points) and taste (maximum 10 points). The maximum number of points that one spirit could get was 20.

Statistical analysis was performed using the statistical software package Statistica 7 (StatSoft Inc., Tulsa, OK, USA). Minimum (Min) and maximum (Max) values, median (Me), mean value (Mx) and standard deviation (SD) were given for all examined characteristics of fruits, fermenting mash and plum spirit during the five-year period.

Results and Discussion

Plums intended for processing into spirit were, as commonly, harvested at the stage of the full maturity. The date of reaching full maturity of fruits in the same locality, depending on the year of harvest (Tab. 1), differed up to 18 days ('Čačanska Rodna'), 24 days ('Stanley') and 23 days ('Požegača'). In the observed five-year period, the average dates of reaching full maturity were 05. 09. – 'Čačanska Rodna', 07. 09. – 'Stanley' and 18. 09. – 'Požegača'. Except for 'Čačan-

ska Rodna', this was significantly later than the moments of reaching optimal maturity for fresh consumption, which, based on many years of research in the Čačak region, were on average 05. 09. – 'Čačanska Rodna', 27. 08. – 'Stanley' and 04. 09. – 'Požegača' (Ogašanović, 1985), i.e. 11. 09. – 'Požegača' (Stančević, 1988).

Based on our five-year results (Tab. 1) and the classification given by Milatović (2019), 'Čačanska Rodna', 'Stanley' and 'Požegača' are considered as cultivars with medium-sized, large and small fruit, respectively. This is significant if these cultivars of combined utilization properties are used for fresh consumption, or for the production of frozen and dried plums. For the production of spirit, however, the stone ratio is much more important, particularly if the plums are processed into spirit in a traditional way, without removing the stones. Accordingly, it is more convenient to process cultivars with a lower stone ratio, because the resulting spirits will contain fewer undesirable components such as HCN and ethylcarbamate and have a less pronounced stone-like aroma (Paunović & Nikićević, 1988; Popović *et al.*, 2019). Due to five-year average stone ratio of 4.15% and 4.36% for 'Čačanska Rodna' and 'Požegača', respectively, these cultivars can be considered more suitable for the production of spirit (Tab. 1) than 'Stanley' (average stone ratio in fruits of this cultivar during five-year period was 5.55%). These results are in accordance with classification given by Milatović (2019), who placed 'Čačanska Rodna' and 'Požegača' in a group of cultivars

Tab. 1. Harvest dates and fruit mechanical characteristics of plum cultivars 'Čačanska Rodna' (ČR), 'Stanley' (ST) and 'Požegača' (PO) during 5 years

Tab. 1. *Datumi berbe i mehaničke karakteristike plodova sorata šljive Čačanska rodna (ČR), Stanley (ST) i Požegača (PO) tokom 5 godina*

Characteristics <i>Karakteristike</i>	Cultivar <i>Sorta</i>	Min <i>Min</i>	Max <i>Max</i>	Me <i>Me</i>	Mx <i>Mx</i>	SD <i>SD</i>
Harvest date <i>Datum berbe</i>	ČR	28. 08.	14. 09.	02. 09.	05. 09.	7.54
	ST	28. 08.	20. 09.	04. 09.	07. 09.	9.20
	PO	06. 09.	28. 09.	11. 09.	18. 09.	9.98
Fruit weight <i>Masa ploda</i>	ČR	32.67	36.32	34.37	34.72	1.32
	ST	33.47	46.28	34.68	37.53	5.44
(g)	PO	17.34	20.17	19.33	18.87	1.41
Stone weight <i>Masa koštice</i>	ČR	1.35	1.58	1.36	1.43	0.10
	ST	1.72	2.46	1.95	2.05	0.30
(g)	PO	0.78	0.88	0.86	0.84	0.04
Stone ratio <i>Udeo koštice</i>	ČR	3.72	4.78	3.96	4.15	0.46
	ST	4.97	5.83	5.72	5.55	0.35
(%)	PO	3.90	4.71	4.36	4.36	0.30

with medium stone ratio (between 4.01 and 5.50%), whilst ‘Stanley’ is categorized as a cultivar with a large stone ratio (>5.51%).

The chemical characteristics of plum fruits are shown in Table 2. Because of high soluble solids contents, all examined cultivars were suitable for various processing methods. The highest content of total su-

gars was found in the fruits of ‘Čačanska Rodna’ (average 14.28%), which was in accordance with our previous results (Popović *et al.*, 2006a; 2008a). Thus, high yields of spirit could be obtained by processing fruits of ‘Čačanska Rodna’. Based on the content of total acids and sugar/acid ratio, ‘Čačanska Rodna’ and its parents were, according to Mitrović *et al.* (2016),

Tab. 2. Fruit chemical composition of plum cultivars ‘Čačanska Rodna’ (ČR), ‘Stanley’ (ST) and ‘Požegača’ (PO) during 5 years
Tab. 2. Hemijski sastav plodova sorata šljive Čačanska rodna (ČR), Stanley (ST) i Požegača (PO) tokom 5 godina

Characteristics <i>Karakteristike</i>	Cultivar <i>Sorta</i>	Min <i>Min</i>	Max <i>Max</i>	Me <i>Me</i>	Mx <i>Mx</i>	SD <i>SD</i>
SSC*	ČR	20.00	25.10	21.00	21.90	2.02
RSM	ST	16.50	18.50	17.90	17.76	0.75
(%)	PO	18.40	22.00	19.90	20.04	1.48
Total sugars	ČR	12.75	15.05	14.45	14.28	0.89
<i>Ukupni šećeri</i>	ST	11.76	13.95	13.20	12.93	0.83
(%)	PO	11.00	13.95	12.71	12.48	1.21
Invert sugars	ČR	6.70	9.65	8.22	7.96	1.25
<i>Invertni šećeri</i>	ST	4.71	8.35	7.23	6.83	1.36
(%)	PO	5.83	9.10	7.60	7.57	1.23
Sucrose	ČR	4.56	7.57	5.75	6.01	1.11
<i>Saharoza</i>	ST	5.01	7.42	5.56	5.80	0.94
(%)	PO	3.70	5.41	4.61	4.66	0.72
Total acids	ČR	0.65	1.02	0.73	0.77	0.15
<i>Ukupne kiseline</i>	ST	0.56	0.87	0.76	0.72	0.12
(%)	PO	0.52	0.81	0.61	0.62	0.11
pH	ČR	3.44	3.85	3.75	3.69	0.17
<i>pH</i>	ST	3.56	3.80	3.66	3.66	0.10
	PO	3.72	4.02	3.79	3.83	0.12
Sugar/acid ratio	ČR	14.75	22.62	18.77	19.04	3.17
<i>Odnos</i>	ST	13.52	24.91	16.92	18.43	4.35
<i>šećer/kiseline</i>	PO	17.22	24.44	20.00	20.37	2.72
Pectinic acid	ČR	181.50	362.50	211.25	240.30	73.06
<i>Pektininska kiselina</i>	ST	205.00	395.00	273.50	272.05	77.31
(mg AGA/100 g fruit)	PO	211.00	293.75	272.50	261.65	35.33
Pectic acid	ČR	8.50	33.00	18.17	19.03	8.83
<i>Pektinska kiselina</i>	ST	12.67	32.25	17.25	20.10	7.44
(mg AGA/100 g fruit)	PO	33.75	93.00	35.75	50.50	25.23
Protopectine	ČR	302.00	390.91	309.25	330.83	37.67
<i>Protopektin</i>	ST	156.74	390.50	280.00	295.85	93.65
(mg AGA/100 g fruit)	PO	147.99	454.50	294.00	312.80	115.89
Total pectins	ČR	390.90	683.25	535.50	536.38	106.60
<i>Ukupni pektini</i>	ST	453.61	696.25	602.75	588.01	108.16
(mg AGA/100 g fruit)	PO	531.51	730.75	609.50	624.95	94.30

*SSC – Soluble solid content/RSM – *Rastvorljiva suva materija*

classified into the group of cultivars with pleasant sourish, i.e. sweet-sour harmonious flavour. These characteristics are of great importance for fresh fruits consumption and production of prunes. However, for spirit production, pH value of the fruit is of greater importance since fermentation purity depends on it (Nikićević *et al.*, 2018). The fruits of all three examined cultivars had much higher pH values than pH 3.0, considered limit value for exhibiting metabolic activity of undesirable bacteria during spontaneous alcoholic fermentation of fruit mash. With regard to the content of total pectin substances and certain pectin fractions, a resemblance between cultivars ‘Čačanska Rodna’ and ‘Stanley’ was observed, while the fruits of ‘Požeगाča’ had somewhat different content of these components. ‘Požeगाča’ had the highest content of total pectin and according to the results of our previous study; this cultivar therefore gives spirit with a potentially highest content of methanol (Popović *et al.*, 2006a). Among the analyzed characteristics of fruits, the year of harvest had the greatest influence on the variation of the content of total acids (about 1.5 times) and total pectin (1.4–1.8 times) in all three examined plum varieties.

The duration of spontaneous alcoholic fermentation of the mashes from crushed plum fruits with stones lasted, depending on the cultivar and year, between 9 and 20 days (Tab. 3). The average duration of fermentation was 12 days (‘Čačanska Rodna’), 10 days (‘Stanley’) and 14 days (‘Požeगाča’). Various species and strains of yeasts and bacteria participate in spontaneous fermentation of plum mash (Rašić, 1954; Satora & Tuszyński, 2005), so differences in the duration of fermentation of mashes, obtained in the same way, are most likely due to fine diversity in the mash microflora of certain plum cultivars in different years.

The chemical characteristics of the produced plum spirits are shown in Table 4. All plum spirits obtained during the five-year study, from the fruits of

‘Čačanska Rodna’ and its parents (‘Stanley’ and ‘Požeगाča’), complied with the requirements of Serbian and EU legislation regarding methanol content (max 12 g/l a.a.), HCN (max 70 mg/l a.a.) and total volatile substances (min 2000 mg/l a.a.). It had been determined that the content of all analysed components of monovarietal plum spirits was strongly influenced by the year of the production. This could be seen in a wide range of variations (Tab. 4) of the content of these ingredients, whose limits are shown as the minimum and maximum contents during the observed five years of harvest. In plum spirits produced in the same way and from the same plum cultivar, the methanol content varied, depending on the year of harvest, up to 1.5 (‘Čačanska Rodna’ and ‘Požeगाča’) – 2 times (‘Stanley’), HCN content 5.5 (‘Stanley’) – 8.5 times (‘Požeगाča’), benzaldehyde about 2.5 (‘Požeगाča’) – 5.5 times (‘Stanley’), furfural even by 2.5 (‘Požeगाča’) – 213 times (‘Stanley’), higher alcohols by 1.5 (‘Čačanska Rodna’) – 2 times (‘Stanley’), esters for about 2 (‘Čačanska Rodna’) – 3 times (‘Stanley’ and ‘Požeगाča’), acid for about 2 (‘Čačanska Rodna’) – 6 times (‘Požeगाča’) and aldehydes for about 2.5 (‘Čačanska Rodna’) – 6 times (‘Požeगाča’).

The contents of methanol, HCN, benzaldehyde, furfural and higher alcohols in fruit spirits depend to a large extent on the composition of raw material (Pau-nović & Bulatović, 1978; Nikićević *et al.*, 2018). In order to explain such large variations of these plum spirit ingredients, which are conditioned by the year of harvest, it is necessary to perform more subtle fruit analyses, which should include determination of the degree of esterification of pectin, activity of pectolytic enzymes, content of pentoses in polysaccharides, contents and profile of nitrogen compounds.

The plum spirits obtained from ‘Čačanska Rodna’ and ‘Stanley’ contained similar average methanol contents, while those obtained from ‘Požeगाča’ had

Tab. 3. Duration of plum mashes fermentation (‘Čačanska Rodna’ – ČR, ‘Stanley’ – ST, ‘Požeगाča’ – PO) during 5 years
Tab. 3. Trajanje fermentacije kljukova šljive (Čačanska rodna – ČR, Stanley – ST, Požeगाča – PO) tokom 5 godina

Characteristics <i>Karakteristike</i>	Cultivar <i>Sorta</i>	Min <i>Min</i>	Max <i>Max</i>	Me <i>Me</i>	Mx <i>Mx</i>	SD <i>SD</i>
Duration of fermentation <i>Trajanje fermentacije</i> (days/dani)	ČR	10	14	12	12	2.5
	ST	9	11	10	10	1.0
	PO	11	20	11	14	4.0

Tab. 4. Chemical composition and sensory evaluation of plum brandies from cultivars 'Čačanska Rodna' (ČR), 'Stanley' (ST) and 'Požeगाča' (PO)
 Tab. 4. Hemijski sastav i senzorna ocena šljivovica sorata Čačanska Rodna (ČR), Stanley (ST) i Požeगाča (PO)

Characteristics <i>Karakteristike</i>	Cultivar <i>Sorta</i>	Min <i>Min</i>	Max <i>Max</i>	Me <i>Me</i>	Mx <i>Mx</i>	SD <i>SD</i>
Metanol <i>Methanol</i> (g/l a.a.)	ČR	4.83	7.55	7.34	6.48	1.37
	ST	4.72	9.45	4.83	6.47	2.34
	PO	5.60	9.37	7.71	7.43	1.41
HCN <i>HCN</i> (mg/l a.a.)	ČR	0.96	6.34	2.41	2.79	2.22
	ST	0.99	5.45	3.92	3.42	1.90
	PO	0.85	7.11	1.21	3.18	3.01
Higher alcohols <i>Viši alkoholi</i> (mg/l a.a.)	ČR	1178.85	1666.40	1323.08	1385.95	185.20
	ST	915.00	1880.77	1337.00	1390.53	384.37
	PO	1021.15	1442.60	1406.00	1335.49	176.75
Esters <i>Esters</i> (mg/l a.a.)	ČR	618.74	1237.00	1173.33	1006.23	284.65
	ST	859.40	2577.21	1011.85	1327.87	718.30
	PO	846.83	2672.59	2088.80	1771.07	760.22
Total acids <i>Ukupne kiseline</i> (mg/l a.a.)	ČR	455.36	952.23	711.71	740.73	194.83
	ST	327.64	1469.08	549.00	795.23	489.06
	PO	242.13	1416.35	892.45	826.63	490.38
Total aldehydes <i>Ukupni aldehidi</i> (mg/l a.a.)	ČR	53.58	133.85	60.59	84.24	37.75
	ST	44.62	113.60	81.68	78.92	31.57
	PO	44.65	272.16	103.90	122.55	88.77
Furfural <i>Furfural</i> (mg/l a.a.)	ČR	4.45	58.50	23.59	27.59	22.98
	ST	0.16	34.10	12.68	15.36	12.90
	PO	11.48	27.76	20.42	19.55	7.55
Benzaldehyde <i>Benzaldehid</i> (mg/l a.a.)	ČR	15.00	65.50	34.90	34.98	19.44
	ST	12.50	70.70	27.40	39.22	25.72
	PO	20.78	47.80	28.50	32.82	12.97
Volatile substances <i>Ispaljive supstance</i> (mg/l a.a.)	ČR	2998.38	3551.65	3179.61	3238.38	206.23
	ST	2892.76	5110.71	3282.06	3634.53	891.69
	PO	2551.75	5616.62	4100.81	4099.63	1127.97
Vol. sub. – Total acids <i>Isp. sup. – Ukupne kiseline</i> (mg/l a.a.)	ČR	2227.38	2660.65	2542.99	2497.65	167.24
	ST	2343.76	3641.63	2651.08	2839.30	498.14
	PO	2255.63	4461.06	3664.55	3273.00	960.32
Total extract <i>Ukupni ekstrakt</i> (g/l)	ČR	0.010	0.032	0.018	0.018	0.008
	ST	0.012	0.022	0.012	0.015	0.004
	PO	0.009	0.033	0.019	0.018	0.010
Sensory assesment <i>Senzorna ocena</i> (points/poena)	ČR	17.11	18.01	17.43	17.52	0.38
	ST	16.70	17.88	17.22	17.22	0.45
	PO	17.47	18.10	17.88	17.84	0.27

slightly more this undesirable ingredient. This is in line with our previous studies on the influence of the chemical composition of fruits of different plum cultivars on the potential methanol content in plum spirits (Popović et al., 2006a).

The average HCN content in the produced mono-variatal plum spirits was correlated with the stone ratio. The highest HCN was found in plum spirits obtained from 'Stanley', whose fruits had the largest stone ratio, and the lowest one in spirits of 'Čačanska Rod-

na', the cultivar with the smallest stone ratio. Similar results for the HCN content in spirits of these three cultivars were found by Janda *et al.* (1987). The contents of benzaldehyde in the produced spirits were significantly below the concentration of 100 mg/l a.a., above which a negative effect on the flavour of spirit occurs (excessively pronounced stone-like aroma).

The highest average content of furfural was detected in plum spirit obtained from 'Čačanska Rodna', which was most likely related to the amount and share of pentoses in the pectin substances and hemicellulose of the fruit. Vyviurska *et al.* (2017) found that the content of heterocyclic aldehydes (furfural and 5-methylfurfural) was very high in plum spirits obtained from 'Čačanska Rodna'.

Cultivars 'Čačanska Rodna', 'Požegača' and 'Stanley' differ in the content of individual and total amino acids in the fruit (Ogašanović, 1985). According to Hernandez-Orte *et al.* (2002), varietal differences in the amino acid profile of grapes strongly influence the occurrence of differences in the composition of important aromatic components (especially higher alcohols, but also some esters and volatile acids) of monovarietal wines. Since 1-propanol, which is significantly present in certain monovarietal plum spirits, does not give a coloured reaction with the reagent *p*-dimethylaminobenzaldehyde, it cannot be determined by the official spectrophotometric method used for analyses of higher alcohols. Thus, it is not possible to talk about the influence of the cultivar on differences in higher alcohol content of plum spirits obtained from 'Čačanska Rodna' and its parents, because their average contents are very similar. The conclusion about the existence of differences in the content of total and individual higher alcohols in monovarietal plum spirits can be made using more sophisticated gas chromatographic methods (Popović *et al.*, 2019). According to the authors, plum spirits obtained from 'Čačanska Rodna' contain more 3-methyl-1-butanol and 2-phenylethanol than plum spirits produced in the same way from 'Stanley' and 'Požegača'. Therefore, the aromatic profile of plum spirit obtained from 'Čačanska Rodna', according to Vyviurska *et al.* (2017), was characterized by a more pronounced flavour of 'fusel alcohols', and a less pronounced flavour of plum compared to plum spirits from other cultivars.

Variation in the content of esters, acids and aldehydes in plum spirits, depending on the cultivar and year of production, is most likely due to the occur-

rence of fine differences in the composition of the epiphytic microflora of yeasts and bacteria involved in spontaneous fermentation of mash. By comparing the composition of several monovarietal peach spirits, Panunović & Bulatović (1979) determined that spirits containing more total esters and total acids also had more total aldehydes. Similar was determined in the examined monovarietal plum spirits, i.e. the average contents of total acids, total esters and total aldehydes were the lowest in the plum spirit obtained from 'Čačanska Rodna', and the highest in the plum spirit obtained from 'Požegača'. These results are in line with the results obtained by gas chromatographic analysis of plum spirit from these three plum cultivars (Popović *et al.*, 2019). According to the cited authors spirits obtained from 'Čačanska Rodna' contained less ethyl acetate and acetaldehyde compared with the spirits produced from 'Stanley' and 'Požegača'. The aforementioned compounds are the most common components in total esters and total aldehydes analysed in spirit drinks.

Out of 15 analysed plum spirits, only three received a gold medal, i.e. they had a grade = 18.01 (one plum spirit obtained from 'Čačanska Rodna' = 18.01 points and two plum spirits of 'Požegača' = 18.08 and 18.10 points) (Tab. 4). All other plum spirits received between 16.01 and 18.00 points, classifying them into the group of spirits awarded by a silver medal. The sensory evaluation of the produced monovarietal plum spirits varied depending on the year of production. The largest variation was found in plum spirits obtained from 'Stanley' and amounted to 1.18 points (between 16.70 and 17.88), and slightly less in 'Čačanska Rodna' plum spirits (0.90 points, i.e. between 17.11 and 18.01), whereas the least in the case of plum spirits of 'Požegača' (0.63 points, i.e. between 17.47 and 18.10). As it is the case in the production of premium wines or cognacs, the year of harvest also has a strong influence on the sensory quality of plum spirit. During the five-year study of plum spirits produced in the traditional way, the plum spirit obtained from 'Požegača' was in three years rated higher than the plum spirit obtained from the other two cultivars, and in two years the plum spirit obtained from 'Čačanska Rodna' was rated the best (data not shown). In four years, plum spirits obtained from 'Stanley' were assessed lower than plum spirits obtained from the other two studied cultivars, and only in one year the plum spirit obtained

from this cultivar had higher rank than the plum spirit obtained from 'Čačanska Rodna'. Average sensory evaluations of monovarietal plum spirits for five-year period have shown that the best sensory quality was obtained by processing fruits of 'Požegača' (average score 17.84), followed by 'Čačanska Rodna' (average score 17.52) and 'Stanley' (average score 17.22). This confirms the statement of Nikićević *et al.* (2018) that 'Požegača' is a cultivar for the production of top quality plum spirits; 'Stanley' gives spirit of lower, average quality, whereas 'Čačanska Rodna' gives spirit of good quality.

Conclusion

The five-year study showed that, depending on the year of harvest, the contents of total acids and pectic substances in the fruits of 'Čačanska Rodna', 'Požegača' and 'Stanley' grown in the same locality significantly varied, as well as the contents of all examined quality parameters (methanol, HCN, higher alcohols, esters, total acids, total aldehydes, furfural, benzaldehyde, total extract) and sensory ranks of the produced monovarietal plum spirits. The chemical composition of all obtained monovarietal plum spirits complied with the requirements of legal regulations. Based on sensory evaluation, it can be concluded that by traditional way of processing fruits of examined cultivars, different quality of plum spirit were obtained. With an average rating for the five-year period of 17.52 points, spirit obtained from the cultivar 'Čačanska Rodna' could be considered as the good quality one. On the other side, 'Stanley' gave spirit of medium, average quality (average rating 17.22 points), whilst 'Požegača' was a cultivar for obtaining traditional high quality spirits (average rating 17.84 points).

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ČAČANSKA RODNA – SORTA ŠLJIVE ZA PROIZVODNJU RAKIJE**Branko Popović^{1*}, Ninoslav Nikićević², Vele Tešević³, Ivan Urošević⁴, Olga Mitrović¹, Nemanja Miletić⁵, Nebojša Milošević¹**¹*Institut za voćarstvo, Kralja Petra I 9, 32000 Čačak, Republika Srbija*²*Univerzitet u Beogradu, Poljoprivredni fakultet, Nemanjina 6, 11080 Beograd, Republika Srbija*³*Univerzitet u Beogradu, Hemijski fakultet, Studentski trg 12–16, 11000 Beograd, Republika Srbija*⁴*TOK Ltd., Ilije Čalića 2, 11000 Beograd, Republika Srbija*⁵*Univerzitet u Kragujevcu, Agronomski fakultet, Cara Dušana 34, 32000 Čačak, Republika Srbija***E-mail: bpopovic@institut-cacak.org***Rezime**

Prikazani su rezultati petogodišnjih ispitivanja tehnoloških karakteristika potpuno zrelih plodova sorte Čačanska rodna i njenih roditelja (Stanley i Požegača), kao i hemijski sastav i senzorne karakteristike dobijenih sortnih šljivovica. Šljive su prerađene na tradicionalan način (muljanje plodova bez odvajanja koštica, spontana fermentacija i dvostruka destilacija). Za ispitivane osobine plodova, kljuka i šljivovica, u toku petogodišnjeg perioda, prikazane su minimalne i maksimalne vrednosti, medijana, srednja vrednost i standardna devijacija. Datum dostizanja pune zrelosti plodova razlikovao se, zavisno od godine berbe, i do 18 dana (Čačanska rodna), 24 dana (Stanley) i 23 dana (Požegača). Za proizvodnju rakije na tradicionalan način pogodnije su sorte Čačanska rodna i Požegača, koje su imale manji udeo koštice u plodu (3,72–4,78%), nego sorta Stanley koja se odlikuje velikim udalom koštice (4,97–5,83%). Plodovi sorte Čačanska rodna sadržali su najviše ukupnih šećera (prosek 14,28%), što ih čini dobrom sirovinom za dobijanje visokih prinosa rakije. Plodovi sve tri sorte imali su pH vrednost veću od pH 3,0. Sorte Čačanska rodna i Stanley sadržale su manje ukupnih pektinskih materija i pojedinih frakcija pektina nego Požegača, koja zbog toga može da da rakiju sa potencijalno najvećim sadržajem metanola. Godina berbe je najizraženije uticala na variranje sadržaja ukupnih kiselina (oko 1,5 puta) i ukupnih pektinskih materija (1,4–1,8 puta) u plodovima sve tri sorte. Prosečna dužina alkoholne fermentacije iznosila je 12 dana (Čačanska rodna), 10 dana (Stanley) i 14 dana (Požegača). Sve šljivovice su zadovoljavale zahteve zakonske regulative. Na sadržaje analiziranih komponenata monosortnih šljivovica značajno je uticala godina proizvodnje. Sadržaj metanola se razlikovao, u zavisnosti od godine berbe 1,5 (Čačanska rodna

i Požegača) – 2 puta (Stanley), sadržaj HCN 5,5 (Stanley) – 8,5 puta (Požegača), benzaldehida oko 2,5 (Požegača) – 5,5 puta (Stanley), furfurala čak za 2,5 (Požegača) – 213 puta (Stanley), viših alkohola za 1,5 (Čačanska rodna) – 2 puta (Stanley), estara za oko 2 (Čačanska rodna) – 3 puta (Stanley i PO), kiselina 2 (Čačanska rodna) – 6 puta (Požegača) i aldehida 2,5 (Čačanska rodna) – 6 puta (Požegača). Šljivovice sorte Čačanska rodna i Stanley sadržale su slične prosečne sadržaje metanola, dok je šljivovica od sorte Požegača sadržala nešto više ovog nepoželjnog sastojka. Prosečan sadržaj HCN u šljivovicama bio je u korelaciji sa udalom koštice u plodu. Koncentracije benzaldehida u rakijama bile su znatno niže od 100 mg/l a.a., što je granica iznad koje on negativno utiče na aromu rakije. Šljivovica sorte Čačanska rodna sadržala je najviše furfurala. Analiza viših alkohola spektrofotometrijskim metodom pokazala je da sorta ne utiče na pojavu razlika u sadržaju ovih komponenata u šljivovicama. Prosečni sadržaji ukupnih kiselina, ukupnih estara i ukupnih aldehida bili su najmanji u šljivovici sorte Čačanska rodna, a najveći u šljivovici sorte Požegača. Prosečne senzorne ocene sortnih rakija za petogodišnji period pokazuju da je najbolji senzorni kvalitet šljivovica sorte Požegača (prosečna ocena 17,84), a za njom slede sorte Čačanska rodna (prosečna ocena 17,52) i Stanley (prosečna ocena 17,22). Na osnovu senzornih ocena šljivovica proizvedenih na tradicionalan način, Požegača se može smatrati sortom za proizvodnju šljivovice vrhunskog kvaliteta, Stanley za sortu od koje se dobija rakija slabijeg, prosečnog kvaliteta, a Čačanska rodna sortom za dobijanje kvalitetne rakije, mada se, u zavisnosti od godine berbe, mogu javiti i izuzeci.

Ključne reči: šljiva, Čačanska rodna, šljivovica, hemijski sastav, senzorne karakteristike