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ORIGINAL PAPER

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EVALUATION OF SERBIAN PLUM CULTIVARS UNDER THE AGRO-ECOLOGICAL CONDITIONS OF THE TROYAN MOUNTAIN REGION

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ABSTRACT

Background. The biological and economic qualities (including morphological, biochemical and sensory properties) of Serbian plum cultivars are of interest for fruit production in the European Union countries. Studying their agro-biological and pomological properties can assist farmers in making informed choices. The research aims to characterise the Serbian plum cultivars 'Čačanska Rana', 'Čačanska Lepotica', 'Čačanska Najbolja', 'Čačanska Rodna' and 'Valjevka', as well as the local cultivar 'Kyustendilska'. 'Stanley' was included as a control, and the study focuses on both biological and economic qualities under the agro-ecological conditions of the Troyan Mountain region.

Material and methods. The study was conducted in an experimental plantation of the Research Institute of Mountain Stockbreeding and Agriculture (RIMSA), Troyan (42°53′N 24°43′E, altitude 420 m) from 2020 to 2022. Reproductive, biochemical and colour parameters were analysed.

Results. The study established that the cultivars 'Čačanska Rana' and 'Čačanska Najbolja' produced the largest fruits, weighing 46–48 g, with relatively large stones, comprising 4–4.5% of the fruit's weight. The fruit skin of all cultivars was characterised by a dark blue colour with shades of purple, blue, and dark blue. Among the cultivars, the 'Stanley' had the hardest skin, while 'Čačanska Najbolja' had the softest. Similarly, the fruit flesh was the firmest in 'Stanley' and 'Čačanska Lepotica'. Yields depended entirely on changes in climatic conditions by year. The cultivar 'Čačanska Rodna' is noted for its high content of soluble solids, polyphenols and anthocyanins, as well as a relatively high sugar content and a low acidity. These attributes make it suitable both for fresh consumption and processing. The cultivar 'Čačanska Najbolja' is characterised by high sugar and acid content along with very low levels of soluble solids. Its taste is described as well-balanced and very pleasant.

Conclusion. All studied cultivars are well-suited for cultivation under the conditions of the Troyan Mountain region. They produce large, flavourful fruits with a rich biochemical composition and are highly recommended for inclusion in plum growers' assortment.

Keywords: biological properties, fruits, mountain region Troyan, *P. domestica* L.

INTRODUCTION

In 2022, plums and prunes accounted for the largest share of fruit production in Bulgaria, followed by cherries and apples, accounting for 25%, 24% and 21% of total production, respectively. Among newly established plantations in the 2021/2022 economic year, stone fruits dominated, comprising 52%, while

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shell species accounted for 20%, and pome and berry species made up 14%. Within the stone fruit category, plums and prunes had the largest share at 43%, followed by cherries at 27% (Agrostatistics, 2022).

Native plum cultivars are local, primitive or vernacular genotypes that are spontaneously and permanently present in a particular area. However, changes in the structure of the plum assortment are evident: the dominance of autochthonous cultivars is decreasing, while cultivars with combined qualities, such as 'Čačanska Lepotica' and 'Čačanska Rodna', and 'Stanley' are gradually taking the lead. Despite some shortcomings, 'Stanley' remains one of the dominant cultivars in plantations in both Serbia (Tomić et al., 2019) and Bulgaria.

In a study of native plum cultivars in Serbia, Milošević et al. (2010) classified the fruits as extremely small, with sizes ranging from 6.79 g to 36.62 g, and stone weights from 0.14 g to 1.95 g. The fruit shape is predominantly rounded, with skin colours varying from amber to dark blue and light yellow flesh. The fruits are well-suited for processing, particularly into plum brandy, as well as for fresh and dried consumption. While native plum cultivars have limitations for improving large-scale production in Serbia, they serve as an exceptional source of germplasm and a valuable genetic base for breeding, especially through clonal selection.

Plum breeding work at the Fruit Research Institute, Čačak, has been ongoing since its establishment in 1946 and has led to the development of significant European plum (*Prunus domestica* L.) cultivars. Well-known varieties, such as 'Čačanska Lepotica', 'Čačanska Rodna', 'Čačanska Najbolja' and 'Čačanska Rana' are widely grown in commercial orchards and used as parent varieties in various breeding programmes (Milošević et al., 2021).

The results of a study by Milosevic (2000) showed that the standard 'Požegaca' had a higher fruiting potential, leading to greater yields of smaller fruits per tree and per hectare, compared to the selected variant, which produced fewer but larger fruits. In this context, the research by Mondeshka (1970) on the 'Kyustendilska' cultivar—a representative of the domestic plum species with genotypes originating from Bulgaria, included in the present study—was also relevant.

Milatović et al. (2021) studied the growth and productivity characteristics of ten European plum cultivars from Serbian and German breeding programmes in the Belgrade area over a three-year period (2013–2015). The study found that yield correlated with fruit weight ($r = 0.47$*). Similarly, Glišić et al. (2016) investigated the growth vigour, yield and fruit weight of five plum cultivars grafted onto myrobalan rootstock (*Prunus cerasifera* Ehrh.) over the second to sixth growing seasons in the Čačak region (Serbia), using a 4 × 2 m planting scheme. The cumulative yield ranged from the lowest in 'Čačanska Rana' (30.75 kg tree^{-1}) to the highest in 'Čačanska Rodna' (66.36 kg tree^{-1}). The average fruit weight reflected the specific traits of each cultivar, ranging from 27.4 g for 'Čačanska Rodna' to 51.8 g for 'Čačanska Rana'.

In a separate study, Glišić et al. (2021) evaluated plum cultivars and hybrids based on key physical, biochemical, and sensory characteristics (attractiveness, taste, aroma, and consistency) compared to the standard cultivar 'Čačanska Lepotica'. The results revealed significant differences among the plum genotypes across all evaluated traits. The oldest Serbian cultivars in the new orchards are 'Čačanska Rodna', 'Čacanska Lepotica' and 'Čačanska Rana' (Milatović et al., 2018).

As a result of cooperation with the Fruit Research Institute, Čačak, some Serbian cultivars have been introduced at the Research Institute of Fruit Growing, Pitesti, Romania. The results obtained in the Pitesti region for the period 2018–2020 showed that the ripening period of Serbian plum cultivars varied from the beginning of July ('Boranka') to the end of August ('Mildora' and 'Čačanska Rodna'). High-yielding cultivars noted during this period included 'Čačanska Lepotica', 'Čačanska Najbolja', 'Mildora' and 'Valerija' (over 15 kg tree^{-1} in the 5th year after planting). 'Čačanska Rodna', 'Mildora' and 'Valjevka' had a high dry matter content (above 18°Brix). Except for 'Valerija' and 'Čačanska Rodna', all other cultivars were tolerant to Plum Pox Virus (PPV). Most of the introduced Serbian cultivars performed very well under Romanian climatic conditions, but the most widespread was 'Čačanska Lepotica' (Butac, 2021).

Due to the significant damage caused by the spread of PPV in Hungarian plum orchards, Molnár (2016) studied high-yielding plum cultivars from Germany, Serbia ('Čačanska Rodna'), and Romania with better resistance to PPV. The study observed growth characteristics, flowering and harvest times, yield potential

and PPV resistance in commercial plum orchards and gene bank collections starting in 2006. These cultivars have become widely distributed in recent years, making their evaluation under industrial production conditions increasingly important.

Based on the chemical composition of fresh and dried plums, Mitrović et al. (2020) concluded that the fruits of 'Čačanska Rodna' are suitable for drying regardless of the climatic conditions during the summer period, and that processing the fruits with soluble substance content above 18% results in the desired sweet-sour taste of prunes.

The aim of the present study was to characterise Serbian plum cultivars based on their morphological, biochemical, and sensory properties under the agro-ecological conditions of the central Old Mountain region.

MATERIAL AND METHODS

The study was conducted during the period 2020–2022 in an experimental plantation in Troyan (42°53′N 24°43′E, altitude 420 m). Climatic factors were monitored using a weather station located on the territory of the Research Institute of Mountain Stockbreeding and Agriculture (RIMSA), Troyan. The Serbian plum cultivars 'Čačanska Rana', 'Čačanska Lepotica', 'Čačanska Najbolja', 'Čačanska Rodna', and 'Valjevka' were included. The local cultivar 'Kyustendilska' and the cultivar 'Stanley' were used as controls. The orchard was established on light grey forest soil and grown under non-irrigated conditions, with tillage between the rows. The trees were in full bearing, and Mirobolan seedlings were used as rootstocks. The planting distance was 5 × 4 m.

A detailed description of the cultivars included in this study is provided in the book *Fruit Cultivars Developed at Fruit Research Institute, Čačak (1946–2016)* (Lukić et al., 2016). Their properties, along with those of the control cultivars, are summarised in Table 1.

The following parameters were studied:

1. Morphometric properties of fruits

Using standard morphological methodology, the following parameters were determined: fruit and stone weight (g), share of stone (%), fruit dimensions (length, width, and thickness) and stalk size (mm).

2. Yield per tree (kg/tree^{-1})

Yield was determined by weighing the fruits from each tree (3 trees in 3 replicates).

Table 1. General biological characteristics of the studied cultivars

Cultivar	Origin	Harvest date	Skin colour	Purpose
'Čačanska Rana'	'Wangenheims Fruhzwetsche' × 'Požegača'	early (the third decade of June to the first decade of July)	purple blue	dessert plum
'Čačanska Lepotica'	'Wangenheims Fruhzwetsche' × 'Požegača'	mid-early (the third decade of July to the first decade of August)	dark blue	combined traits
'Čačanska Najbolja'	'Wangenheims Fruhzwetsche' × 'Požegača'	mid-early, (the end of the second-beginning of the third decade of August	dark blue to black	a high-quality dessert cultivar, for freezing, for drying and producing brandy
'Čačanska Rodna'	'Stanley' × 'Požegača'	late (the middle of the third decade of August to the middle of September)	reddish blue	combined traits
'Valjevka'	'Prune d'Agen 707' × 'Stanley'	late (the end of the third decade of August to the end of the first decade of September)	attractive blue	for drying and producing brandy
'Stanley'	'Agen' × 'Grand Duke'	late (during the third decade of August)	deep blue	combined traits
'Kustendilska'	*P. domestica*	late (the middle of September)	blue	for drying and producing brandy

3. Physical properties of fruits

Firmness of fruit flesh (kg/cm^2) was measured with a digital penetrometer FHT-15 (3.5 mm) on both sides of 25 randomly selected fruits. The fruit skin was removed prior to measurement.

4. Biochemical composition of fruits at ripening stage

Soluble solids content (%): Measured refractometrically with a refractometer (RHB-32, range 0.0–32.0% Brix).

Content of sugars (total, invert and sucrose, %): Determined using the Schoorl and Regenbogen method (Donchev et al., 2000)

Content of organic acids (malic, citric,%): Determined by titration with 0.1N NaOH (Donchev et al., 2000).

Content of vitamin C (mg/%): Measured using the Tilman method (Donchev et al., 2000).

Content of tanning substances (%): Measured using the Levental method (Donchev et al., 2000).

Content of anthocyanins (mg/%): Determined according to the method of Fuleki et al. (1968).

Content of total polyphenols (mg/g): Measured using the method of Singleton and Rossi (1965).

5. Colour parameters of fruits

Both the fruit skin and fruit flesh were analysed using an SC-30 Colorimeter. Colour differences were assessed by the CIE Lab method, which measured the following coordinates:

L (colour brightness): Ranges from $L = 0$ (black) to $L = 100$ (white).

a (red-green balance) Positive values indicate red, while negative values indicate green

b (yellow-blue balance) Positive values indicate yellow, while negative values indicate blue. The colour tone or dominant wavelength was represented by the a/b ratio.

STATISTICAL ANALYSIS

Statistical data processing was performed using ANOVA (Excel 2019). Treatments were considered significantly different at the $p = 0.05$ level. The analyses were performed in three replications, and the results are expressed as means ±standard error.

RESULTS AND DISCUSSION

Climatic and agro-ecological factors are crucial for the growth, development and fruit-bearing of fruit species. The Serbian plum cultivars tested found the conditions in the central Old Mountain region suitable for cultivation and regular fruiting.

Average monthly temperatures for the study years showed significantly higher values for the winter months of November, December, January and February, compared to the baseline for the 30-year period (Fig. 1). After the rest period, a temperature increase

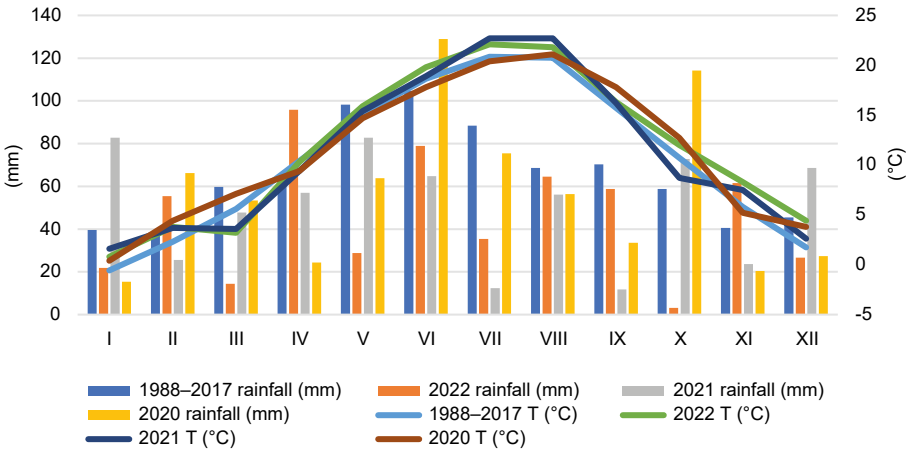

Fig. 1. Average monthly temperature and total monthly rainfall for the study period 2020–2022 and average for a 30-year (1988–2017) base period

above 5°C is necessary for the onset of plant vegetation. This was only true for March 2020. In 2021 and 2022, the average temperature for March was 3.2–3.6°C, lower than the baseline period's 5.6°C. Thus, a warm winter and cool March delayed the phenophase of tree flowering in spring. Moderate amounts of precipitation were recorded for the winter period (Fig. 1). The largest amounts of precipitation were measured in May and June, when average monthly temperatures were close to the baseline. The year 2021 was characterised by very hot months in July and August (over 2°C warmer than the standard value), with the lowest amounts of precipitation (12 mm in August and 11.8 mm in September). The total vegetation rainfall for 2021 was a record low of 286 mm.

The early and medium-early ripening cultivars 'Čačanska Rana' and 'Čačanska Najbolja' produced the largest fruits. The fruit weight varied from 46 g to 55 g for 'Čačanska Rana', while 'Čačanska Najbolja' had an average weight of approximately 48 g (Table 2). The cultivar 'Stanley' showed variation in fruit weight: in the first year of the study it was 37 g; in the second year (2021), it increased to 39.42 g; and in the third year (2022) it slightly decreased to 35.76 g. The cultivar 'Kyustendilska' had the smallest fruits, weighing 15–16 g throughout the study period. The large-fruited cultivars also had larger stones, with the relative share of stone ranging from 4% to 4.5% in the first and third years. In the extremely dry year of 2021, the stone size increased significantly, reaching 5.2% to 5.6%.

In the case of small-fruited cultivars, a high percentage of stone relative to the fruit mass was observed, particularly in 'Čačanska Rodna' (6.8%) (Table 2). In 2022, larger fruits were recorded in the large-fruited

Table 2. Morphological indicators of fruits (2020–2022)

Cultivar	Fruit weight, g	Stone weight, g	Share of stone, %	Fruit dimensions, mm			Fruit stalk length, mm
				Length	Width	Thickness	
1	2	3	4	5	6	7	8
2020							
Čačanska Rana	50.00	2.20	4.00	50.21	39.26	38.94	11.00
Čačanska Lepotica	38.00	1.60	4.20	42.09	38.37	36.51	9.50
Čačanska Najbolia	48.42	2.50	5.20	47.76	40.90	41.82	13.17
Čačanska Rodna	31.83	1.30	4.10	44.94	36.49	33.69	15.05
Valevka	24.24	1.30	5.40	43.98	31.23	31.88	11.57
Stanley	37.35	2.20	5.90	48.83	36.38	36.43	16.66
Kustendilska	16.00	0.50	3.10	36.06	27.87	26.81	12.93
2021							
Čačanska Rana	46.44	2.40	5.20	50.51	39.06	38.34	10.97
Čačanska Lepotica	35.10	1.90	5.40	43.42	37.61	37.33	7.62
Čačanska Najbolia	48.10	2.70	5.60	48.83	42.17	40.18	10.38
Čačanska Rodna	17.70	1.20	6.80	38.11	30.01	26.73	14.27
Valevka	28.90	1.60	5.50	48.18	32.93	32.46	13.18
Stanley	39.42	2.47	6.30	52.15	38.57	35.54	12.85
Kustendilska	15.40	0.60	3.90	35.50	27.20	26.51	11.85

Table 2 – cont.

1	2	3	4	5	6	7	8
				2022			
Čačanska Rana	55.30	2.25	4.10	49.93	39.71	42.84	11.21
Čačanska Lepotica	38.57	1.81	4.70	43.73	40.42	37.66	14.56
Čačanska Najbolia	46.94	2.12	4.50	48.27	41.42	39.75	20.25
Čačanska Rodna	33.25	1.35	4.10	46.08	36.64	33.10	16.61
Valevka	19.83	1.19	6.00	40.61	30.30	29.13	15.75
Stanley	35.76	2.14	6.00	48.32	36.03	34.97	24.00
Kustendilska	15.04	0.92	6.10	34.97	28.00	26.47	16.18
LSD 0.05	*5.03*	*0.25*		*2.52*	*2.06*	*2.04*	*2.01*

cultivars, likely due to the smaller number of fruits reaching harvesting maturity, while smaller fruits were observed in the small-fruited cultivars ('Čačanska Rodna', 'Valjevka' and 'Kyustendilska') as a result of high summer temperatures and a lack of precipitation. During this period, the highest percentage of stone relative to fruit mass was recorded (6.0–6.1%), with the 'Stanley' cultivar consistently showing a percentage of around 6%. Fruit size is genetically determined by the cultivar, and this trend was observed consistently across all years of the study (Table 2).

For Hungarian conditions, Molnár (2016) reports fruit sizes for 'Čačanska Rodna' (length: 44.20–41.45 mm; width: 34.63–30.46 mm; thickness: 31.75–26.96 mm) similar to those observed under our conditions in 2020 and 2022. In 2021, however, significantly smaller fruits were recorded due to drought. According to Serbian researchers (Lukić et al., 2016), the fruit sizes of all cultivars in our study are consistent with the averages for the 3-year period. For the 'Valjevka' cultivar, slightly larger fruit sizes were observed in our study during the dry year of 2021 compared to those reported by the Serbian researchers.

In the first year of the study, with a very high yield, the cultivars 'Čačanska Rana', 'Čačanska Najbolja', and 'Čačanska Rodna' stood out. However, in the following years severe drought and exhaustion from the previous harvest led to 'Čačanska Rana' and 'Čačanska Najbolja' recording the lowest yields (4–10 kg tree^{-1}). In contrast, yields exceeding 25 kg tree^{-1} were obtained from 'Čačanska Lepotica' and 'Čačanska Rodna', similar to those of 'Stanley' and 'Kyustendilska'. In the third year (2022), yields were insignificant due to late spring frosts that caused freezing of the tie. On average, over the study period (2020–2023), yields of 15 kg to 20 kg tree^{-1} were recorded, with 'Čačanska Rodna' achieving the highest average yield of 21 kg tree^{-1} (Fig. 2). A similar trend was reported by Glišić (2016), where cumulative yields were lowest for 'Čačanska Rana' (30.75 kg tree^{-1}), slightly higher in 'Čačanska Najbolja', 'Čačanska Lepotica' and 'Stanley' (43.86, 60.37 and 73.40 kg tree$^{-1,}$ respectively), and highest for 'Čačanska Rodna' (66.36 kg tree^{-1}).

The biochemical composition of the fruits (Table 3) represents the average for the study period. The highest content of soluble solids was observed in the cultivar 'Čačanska Rodna' (21.5%), followed by 'Stanley' and 'Kyustendilska' (19%). The earlier-ripening cultivar 'Čačanska Rana' had a lower content of 15.3%. 'Stanley', 'Valjevka', and 'Kyustendilska' contained between 18 and 20%. These results are consistent with a study by Pešaković et al. (2020), which evaluated the effects of biofertiliser and chemical fertiliser on 'Čačanska Lepotica' and 'Stanley' plum cultivars.

Total sugars ranged from 5.85% in 'Čačanska Lepotica' to 14.15% in 'Čačanska Najbolja'. The 'Kyustendilska' cultivar occupied an intermediate position (7.70%), with no sucrose content reported. In 2021, the total sugars showed a 2:1 invert sugar to sucrose ratio, indicating relatively low sucrose content, which

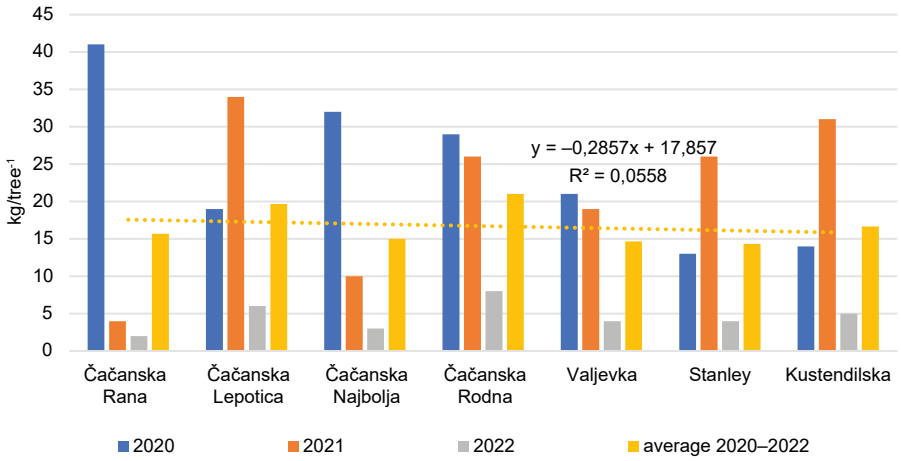

Fig. 2. Yield (kg tree^{-1}) (2020-2022)

Table 3. Biochemical composition of fresh plum fruits

	Soluble solids brix %	Total sugars %	Inverted sugars %	Sucrose %	Acids %	Vit. C mg/%	Gluco--acidimet-ric index	Tannins %	Total poly-phenols mg/g	Antho-cyanins mg/%
Čačanska Rana	15.30	9.40	6.85	2.42	0.76	10.56	12.37	0.11	46.31	23.06
Čačanska Lepotica	15.60	5.85	4.05	1.71	0.80	17.60	7.31	0.10	173.18	3.06
Čačanska Najbolja	15.50	14.15	9.05	4.85	0.80	15.84	17.69	0.10	163.74	4.68
Čačanska Rodna	21.50	9.55	5.70	3.66	0.60	12.32	15.92	0.17	621.73	15.32
Valjevka	16.70	9.20	5.70	3.33	0.87	14.08	10.57	0.19	228.49	5.32
Stanley	19.00	10.90	5.38	5.27	0.67	21.12	16.27	0.17	281.96	3.71
Kustendilska	18.90	7.70	7.70	-	0.80	17.60	9.63	0.17	280.82	17.58
av	*17.21*	*9.54*	*6.35*	*3.54*	*0.76*	*15.59*		*0.14*	*256.60*	*10.39*
std	*2.73*	*2.59*	*1.66*	*1.37*	*0.09*	*3.58*		*0.04*	*180.34*	*8.10*
CV%	*15.86*	*27.16*	*26.08*	*38.67*	*12.12*	*22.98*		*24.93*	*70.28*	*77.91*

justifies the inclusion of these fruits in the nutritional diets of diabetics. A similar ratio was observed in 'Čačanska Lepotica'. The acid content of the fresh fruit of most cultivars was around 0.80%. According to Glisic (2021), the acid content in 'Čačanska Lepotica' was approximately 1%. Using these data on total sugars and acids, we calculated a gluco-acidimetric coefficient. For values around 18-20, it is assumed that the ratio between sugars and acids is balanced, and the taste of the fruit is pleasant. In our study, 'Čačanska Najbolja' and 'Stanley' cultivars showed coefficients of 17.69 and 16.27, respectively, while the rest showed a lower coefficient due to their low sugar content.

Vitamin C content was also assessed, with the highest levels found in 'Stanley' (21.12%). Tannin content ranged from 0.10 to 0.19%, while anthocyanins and polyphenols were also measured. The highest content of polyphenols was recorded in 'Čačanska

Table 4. Colour parameters and firmness(kg/cm^2) of fresh plum fruits

	Fruit skin					Fruit flesh				
	L	*a*	*b*	*a/b*	firmness kg/cm^2	*L*	*a*	*b*	*a/b*	firmness kg/cm^2
Čačanska Rana	28.56	3.01	–1.66	–1.81	4.96	40.62	–3.38	21.09	–0.16	1.00
Čačanska Lepotica	30.31	8.42	1.76	4.79	12.32	49.03	–9.59	31.29	–0.31	5.26
Čačanska Najbolja	34.31	8.98	–4.55	–1.97	4.32	47.24	–4.64	29.95	–0.16	2.34
Čačanska Rodna	29.37	5.45	2.27	2.40	6.84	48.34	–4.3	31.54	–0.13	1.14
Valjevka	32.70	2.67	–1.62	–1.64	12.34	37.25	–2.38	28.31	–0.08	1.62
Stanley	31.54	1.89	–1.01	–1.88	14.08	41.28	–7.84	33.33	–0.24	5.22
Kustendilska	31.95	5.00	0.42	11.95	12.08	29.72	–5.53	23.15	–0.24	1.62

Rodna' fruits (612.73 mg/g), followed by 'Stanley' and 'Kyustendilska' (280 mg/g each), and 'Valjevka' (230 mg/g).

In addition to their importance in fruit flavour formation, acids are significant from the perspective of fruit processing because they affect the gelling properties of pectin. Acids are fruit components that are less sensitive to changes during processing and storage than other components, such as pigments and aroma compounds. This relative stability offers a practical advantage for using the organic acid profile as an index of authenticity in fruit products. Moreover, organic acids are used in the pharmaceutical industry as antioxidants, preservatives, acidulants and drug absorption modifiers (Tomić et al., 2019).

Colour parameters of fresh plum fruits were assessed once during the research period (2022) (Table 4). The skin of the fruit was characterised by a dark blue colour with shades of purple, blue and dark blue. The highest value for skin colour brightness (L = 34.31) was found in the cultivar 'Čačanska Najbolja', followed by 'Valjevka' (32.70). In 'Čačanska Najbolja', the red colour tone dominated (a = 8.42) with blue ($–b$ = –4.55), while in 'Čačanska Lepotica', the red (a = 8.98) and yellow (b = 1.76) tones were more pronounced.

For the flesh of the fruit, the greatest brightness (L = 49.03) was found in 'Čačanska Lepotica', with the green and yellow colour tones of (a = –9.59; b = 31.29). A higher value for the yellow colour tone was observed in the flesh of the 'Stanley' cultivar (b = 33.33). The skin of the 'Stanley' cultivar was the hardest (14.08 kg/cm^2), while the skin of 'Čačanska Najbolja' was the softest (4.32 kg/cm^2). For the flesh, it was the hardest in 'Stanley' and 'Čačanska Lepotica' (5.22 kg/cm^2 and 5.26 kg/cm^2, respectively).

CONCLUSIONS

Fruiting, biochemical composition and pomological characteristics of fresh plum fruits from Serbian plum cultivars were evaluated under the climatic conditions of the central Old Mountain region. The cultivars 'Čačanska Rana' and 'Čačanska Najbolja' produced the largest fruits (46–48 g). The large-fruited cultivars also had a large stone, the relative share of which was 4–4.5% in the first and third years. However, this share increased significantly (5.2–5.6%) in response to the exceptional drought in 2021.

The cultivar 'Čačanska Rodna' is notable for its high content of soluble solids, polyphenols, anthocyanins, and sugars, combined with a low acid content. Conversely, 'Čačanska Najbolja' stands out for its high sugar and acid content but very low levels of soluble solids.

The fruit skins of all cultivars were characterised by a dark blue colour and shades of purple, blue, and dark blue. The skin was hardest on the 'Stanley' cultivar and softest in 'Čačanska Najbolja', while the flesh was the hardest in 'Stanley' and 'Čačanska Lepotica'.

All studied cultivars demonstrated suitability for cultivation under the conditions of the Troyan region

(central Old Mountain), yielding large and flavourful fruits with a rich biochemical composition. These cultivars can confidently be recommended for inclusion in the assortment of plum growers.

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DECLARATIONS

Data statement

All data supporting this study has been included in this manuscript.

Ethical Approval

Not applicable.

Competing Interests

The authors declare that they have no conflicts of interest.

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REFERENCES

Agrostatistics (2022). Available from: https://www.mzh.government.bg/bg/statistika-i-analizi/izsledvane-rastenievadstvo /danni/

Butac, M., Plopa, C., Chivu, M. Mareși, E. (2021). Behaviour of Serbian plum cultivars under Romanian ecological conditions. Acta Hortic., 1322, 103–108 https://doi.org/10.17660/ActaHortic.2021.1322.16

Donchev, H., Zlateva, D., Pashova, S. (2000). Commodity science of food products. Part II. Varna: University Press Varna University of Economics.

Fuleki, T., Francis, F. J. (1968). Quantitative Methods for Anthocyanins 1. Extraction and Determination of Total Anthocyanin in Cranberries. J. Food Sci., 33(1), 72–77. https://doi.org/10.1111/j.1365-2621.1968.tb00887.x

Glišić, I. P., Milošević, T., Glišić, I. S., Ilić, R., Paunović, G., Milošević, N. (2016). Tree vigour and yield of plum grown under high density planting system. Acta Hortic.,1139, 131–136. https://doi.org/10.17660/ActaHortic.2016.1139.23

Glišić, I. S., Milatović, D. P., Milošević, N. T., Marić S. A., Lukić, M. M., Popović, B. T. (2021). Physicochemical and sensory characteristics of promising plum (*Prunus domestica* L.) genotypes bred at Fruit Research Institute, Cacak. Acta Sci. Pol. Hortorum Cultus, 20 (2), 23–32. https://doi.org/10.24326/asphc.2021.2.3

Lukić, M., Pešaković, M., Marić, S., Glišić, I., Milosević, N., …, Kandić, M. (2016). Fruit cultivars developed at Fruit Research Institute, Čačak (1946–2016). Čačak: Fruit Res. Institute.

Milatović, D., Durovic, D., Zec, G., Boskov, D., Radovic, M. (2018). Evaluation of Medium Early Plum Cultivars in The Region of Belgrade (Serbia). Proceedings of the IX International Agricultural Symposium "Agrosym", 612–618

Milatović, D., Đurović, D., Zec, G., Boškov, Đ. (2021). Evaluation of growth and productivity of some European plum cultivars. Acta Hortic., 1308, 229–234 https://doi.org/10.17660/ActaHortic.2021.1308.32

Milošević, T., Milošević, N., Mratinić, E. (2010). Morphogenic Variability of some autochthonous plum cultivars in Western Serbia. Brazil. Arch. Biol. Technol., 6, 1293–1297. https://doi.org/10.1590/S1516-89132010000600005

Milosevic, T. (2000). Bearing Potential of Standard and Selected Pozegaca. Acta Hortic., 536, 369–374 https://doi.org/10.17660/ActaHortic.2000.536.43

Milošević, N., Glišić, I. S., Đorđević, M., Radičević, S., Jevremović, D. (2021). An overview of plum breeding at Fruit Research Institute, Čačak. Acta Hortic., 1322, 7–12 https://doi.org/10.17660/ActaHortic.2021.1322.2

Minkov, P., Popski, G., Stefanova, B. (2021). Basic Physico-Chemical Parameters of the Fruits of Some Plum Cultivars, Related to their Suitability for Fresh Consumption and Processing. Scientific Papers. Series B. Horticulture, Vol. LXV(1), 162–168 https://horticulturejournal.usamv.ro/index.php/scientific-papers/issues?id=946

Mitrović, O., Popović, B., Glišić, I., Korićanac, A., Leposavić, A., Jevremović, D., Miletić, N. (2020). Čačanska Rodna-a plum cultivar for drying. J. Pomol., 54, 207–208, 15–24. https://www.casopisnvd.rs/pojedinacni-brojevi/54_207-208

Molnár, Á.M., Ladányi, M., Kovács, S. (2016). Evaluation of the production traits and fruit quality of German plum cultivars. Acta Univ. Agricult. Silv. Mendelianae Brunensis, 64(1), 109–114. DOI: 10.11118/actaun201664010109

Mondeshka, P. (1970). Study of the influence of Biomin on the reproductive manifestations of Kyustendilska blue plum. Sofia: Anniversary Collection of Scientific Works of the Academy of Agricultural Sciences, 39–48.

Pešaković, M., Glišić, I., Tomić, J., Karaklajić Stajić, Ž., Rilak, B., Mandić, L., Đukić, D. (2020). Evaluation of innovative and environmentally safe growing practice suitable for sustainable management of plum orchards. Acta Agricult. Serbica, 25 (49), 77–82. https://doi.org/10.5937/AASer2049077P

Singleton, V., Rossi, J. (1965). Colorimetry of Total Phenolics with Phosphomolybdic-Phosphotungstic Acid Reagents. Am. J. Enol. Vitic., 16, 144–158. https://doi.org/10.5344/ajev.1965.16.3.144

Tomić, J., Štampar, F., Glišić, I., Jakopič, J. (2019). Phytochemical assessment of plum (*Prunus domestica* L.) cultivars selected in Serbia. Food Chem., 299, 125113. https://doi.org/10.1016/j.foodchem.2019.125113