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PHYSİCOCHEMİCAL AND SENSORY CHARACTERİSTİCS OF PROMİSİNG PLUM (*Prunus domestica* L.) GENOTYPES BRED AT FRUİT RESEARCH INSTİTUTE, ČAČAK

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ABSTRACT

Five plum hybrids (38/62/70, IV/63/81, 32/21/87, 34/41/87 and 22/17/87) and newly released cultivar 'Nada', obtained by planned hybridisation and singled out within breeding programme at Fruit Research Institute, Čačak, were assessed for the main physical (fruit and stone weight and flesh percentage), chemical (soluble solids content, total and inverted sugars content, sucrose content, total acids content, pH value of fruit juice, ratio of soluble solids and total acids content and ratio of total sugars and total acids content) and sensorial (attractiveness, taste, aroma and consistency) traits compared with the standard cultivar 'Čačanska Lepotica'. Results showed that the studied plum genotypes differed significantly in all of the assessed traits. Regarding the physical features, the best results were shown by hybrid 38/62/70, which had the highest fruit weight (56.92 g) and flesh percentage (96.91%), as well as by the new cultivar 'Nada', for which a larger fruit was observed in comparison to the standard (45.54 g and 42.24 g, respectively). Also, 'Nada' had better sensorial properties such as attractiveness, taste, aroma and consistency in relation to the other promising hybrids and the standard cultivar. From the aspect of all the studied sensorial characteristics, in addition to 'Nada', only hybrid 38/62/70 was aligned with the standard cultivar. Out of the studied genotypes, late ripening hybrid 22/17/87 had the best values of parameters of fruit chemical composition such as the soluble solids content (17.01%), total and inverted sugars contents (12.31% and 8.96%, respectively). The highest sucrose content (3.39%), pH value of fruit juice (3.51), as well as the highest ratio between soluble solids and total acids content (43.72) and ratio between total sugars and total acids content (32.58) were found in cultivar 'Nada'. The highest total acids content (1.42%) was recorded in hybrid 32/21/87. Compared to 'Čačanska Lepotica', the same or better results in terms of the fruit chemical composition were determined in cultivar 'Nada' and hybrids 34/41/87 and 22/17/87. The study revealed existence of significant correlations between individual studied parameters of the fruit physical, chemical and sensorial properties.

Key words: European plum, hybrid, fruit, physical, chemical and sensorial traits

INTRODUCTION

The breeding programme of European plum (*Prunus domestica* L.) at the Fruit Research Institute, Čačak was started in the middle of the last century [Paunovic et al. 1968]. The initial breeding objectives were defined taking into consideration the fact that the plum production at the time lacked cultivars with large fruits of good quality. Since 1980s, due to the rapid spread of *Plum pox virus* – PPV [Ranković et

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al. 1995], which causes enormous economic losses in production reducing both yield and fruit marketability [Cambra et al. 2006], resistance to this pathogen was included among the most important breeding goals [Ranković et al. 1994]. The major aims of the modern plum breeding programme at the Institute can be summarized as follows: improving fruit size, fruit quality and storability; increasing disease resistance (Sharka virus and causal agents of red leaf spot, leaf rust and brown rot); extending the ripening period (especially very early to early or late to very late ripening time); improving self-fertility, precocity and productivity; improving growth features (reduced vigour, moderately dense and open crown); suitability of fruit for different purposes (fresh consumption, drying, juice, jam, brandy, freezing) [Lukić et al. 2016]. So far, 17 plum cultivars have been named and released, and a large number of promising genotypes are currently under intense evaluation.

Hybridisation has been used to develop most of plum cultivars, and along with the clonal selection, it remains the dominant method. Breeding of European plum is a long-term process, which is constrained by its long reproductive cycle with long juvenile phase, complex reproductive biology and high degree of heterozygosity. Since the hexaploid genome hinders heredity analysis, there are not yet molecular markers available for agronomic traits in this species, which could be applied in breeding programmes [Decroocq et al. 2011]. The fruit quality is a complex phenomenon, conditioned by the appearance and the flavour (taste and aroma). The fruit attractiveness will determine the first opinion of consumers, but the flavour will provide their preference and a repeat purchase. Therefore, the challenge for breeders is to provide attractive fruits with the desired flavour [Callahan 2003]. Attractiveness is usually based on the fruit size, shape and skin colour, while flavour represents a combination of the fruit chemical composition and aroma [Neumüller 2011]. In addition to the aforementioned fruit characteristics that determine the market requirements and consumer demands for the cultivar, there are many features such as productivity, vigour and resistance or tolerance to the biotic and abiotic factors that influence the acceptability of cultivars by the growers. Since PPV tolerant or resistant genotypes often lack satisfactory fruit quality, they are usually crossed with cultivars which are characterised by large sized, specially coloured and exceptionally tasty fruits in order to improve their quality [Neumüller et al. 2010].

This research focused on physical, chemical and sensorial characteristics of six promising plum genotypes developed at the Fruit Research Institute, Čačak. In order to determine how the studied parameters can affect each other, the correlations between them were also established. Our previous studies revealed that these promising genotypes are partially self-compatible or self-compatible [Glišić et al. 2017a], tolerant to PPV and causal agents of economically the most important fungal diseases [Glišić et al. 2017b], with high cropping potential and medium to strong vigour [Glišić et al. 2016]. The results obtained in this work along with the results of previous research will enable the final selection of genotypes with the best combination of desired properties, aiming to be recommended for commercial planting as well as for using as parents in future breeding programmes.

MATERIAL AND METHODS

Plant material. The study was conducted in an experimental plum orchard at the Ljubić facility of the Fruit Research Institute, Čačak (43°53'N, 20°20'E, 250 m above the sea level), during three years (2009–2011). The experiment included five promising hybrids (hybrids: 38/62/70, IV/63/81, 32/21/87, 34/41/87 and 22/17/87) and a newly released cultivar 'Nada' (Tab. 1). The 'Čačanska Lepotica', as one of the most widely grown plum cultivar, not only in the Republic of Serbia, but in many other European countries as well [Glišić et al. 2018], was used as the control. All the studied genotypes were grafted on Myrobalan (*Prunus cerasifera* Ehrh.) seedlings.

The orchard was established in spring 2002 with standard one-year-old nursery trees planted at the 6 m × 5 m distance (333 trees per ha), using randomised five-block design that was replicated three times (15 trees per genotype). Standard cultural practices except irrigation were used. The trees were trained as pyramidal crowns.

Fruit sample. For the period of three growing seasons, 25 randomly selected fruits from all sides of each tree of each genotype in three replications were collected and used for determination of physical and

chemical characteristics. A sample of 200 fruits was used for sensorial evaluation. The plum genotypes were hand-picked at the commercial maturity stage during the period between end of July and beginning of September (Tab. 1).

Physical characteristics. Fruit (FW) and stone (SW) weight were taken using technical scale Adventurer Pro AV812M (Ohaus Corporation, Switzerland) and expressed in grams (g). Flesh percentage (FP) was calculated as the ratio of the weight of the edible portion of the fruit to the total fruit mass (expressed in %).

Chemical characteristics. The following parameters were investigated: soluble solids content – SSC, total sugars content – TS, inverted sugars content – IS, sucrose content – SC, total acids content – TA, pH value of fruit juice – pH, ratio of soluble solids and total acids content – SSC/TA, ratio of total sugars and total acids content – TS/TA. The SSC (%) was determined by a binocular refractometer (Carl Zeiss, Germany) and pH by a CyberScan 510 pH-meter (Nijkerk, Netherlands). For determination of the TS (%), IS (%) and SC (%) Luff-Schoorl method [Egan et al. 1981] was used. The TA (%) were expressed as malic acids and determined by titration with 0.1 N NaOH up to pH 8.1, using phenolphthalein as an indicator. The SSC/TA and TS/TA were calculated.

Sensorial characteristics. Fruit sensorial properties such as attractiveness (FA), taste (FT), aroma (AF) and consistency (FC) were assessed by positive scoring by five panellists according to the Fruit utility assessment guidelines specified by the Regulations of the Ministry of Agriculture Forestry and Water Management of the Republic of Serbia. The panellists' responses were recorded using a 6-point scale for FA, 8-point scale for FT, 2-point scale for AF and 4-point scale for FC.

Statistical data analysis. The variance analysis (ANOVA) was used for establishing the impact of genotype on the analysed physical, chemical and sensorial characteristics of fruits. In cases where the *F*-test ($P \leq 0.05$) was significant, differences between arithmetic means were evaluated using the least significance difference (LSD) test with the significance threshold set at $P \leq 0.05$. Relationships between the analysed physical, chemical and sensorial characteristics of fruits were determined by Pearson's correlation coefficients using a significance threshold of $P \leq 0.05$. Statistical analyses were performed using SPSS statistical software package, Version 8.0 for Windows (SPSS Inc., Chicago, IL).

Table 1. Pedigree and mean harvest date of promising plum genotypes

Genotypes	Parentage	Harvest date
Hybrid 38/62/70	Hall × California Blue	29 July
Hybrid IV/63/81	Large Sugar Prune × Scoldus	08 August
Hybrid 32/21/87	Stanley × Scoldus	12 August
Nada	Stanley × Scoldus	20 August
Hybrid 34/41/87	Valjevka × Čačanska Lepotica	29 August
Hybrid 22/17/87	Čačanska Najbolja × Zelta Boutilcovidna	02 September
Čačanska Lepotica	Wangenheims Fruhzwetsche × Požegača	31 July

RESULTS

Physical characteristics. The studied plum genotypes differed significantly in terms of FW, SW and FP (Tab. 2). In addition, the significant positive correlations between the FW and SW ($r = 0.59$), as well as between FW and FP ($r = 0.86$) were determined (Tab. 5).

The FW and FP were the highest in the hybrid 38/62/72 (56.92 g and 96.91%, resp.) and the lowest in the hybrid 34/41/87 (25.10 g and 94.30%, resp.).

Table 2. Physical fruit characteristics of promising plum genotypes

Genotypes	FW (g)	SW (g)	FP (%)
Hybrid 38/62/70	56.92 ±2.87 a	1.76 ±0.03 a	96.91 ±0.19 a
Hybrid IV/63/81	31.98 ±0.65 e	1.36 ±0.05 e	95.75 ±0.07 c
Hybrid 32/21/87	35.11 ±1.71 d	1.62 ±0.01 c	95.38 ±0.23 d
Nada	45.54 ±0.29 b	1.68 ±0.03 b	96.57 ±0.04 b
Hybrid 34/41/87	25.10 ±0.89 g	1.43 ±0.03 d	94.30 ±0.42 e
Hybrid 22/17/87	26.96 ±0.68 f	1.46 ±0.02 d	94.58 ±0.18 e
Čačanska Lepotica	42.24 ±0.69 c	1.34 ±0.04 e	96.75 ±0.06 b

The table contains the average values of the studied parameters for three years ± a standard error
The various lowercase letters in respective columns indicate significant differences at $P \leq 0.05$ according to the LSD test

Table 3. Chemical fruit characteristics of promising plum genotypes

Genotypes	SSC (%)	TS (%)	IS (%)	SC (%)	TA (%)	pH
Hybrid 38/62/70	11.39 ±0.44 g	8.26 ±0.33 e	5.77 ±0.24 e	2.36 ±0.09 d	1.03 ±0.04 b	2.88 ±0.01 e
Hybrid IV/63/81	12.62 ±0.65 f	10.12 ±0.48 d	7.21 ±0.37 cd	2.76 ±0.13 c	1.06 ±0.02 b	2.90 ±0.03 e
Hybrid 32/21/87	14.27 ±0.52 d	10.26 ±0.44 d	6.99 ±0.16 d	3.10 ±0.29 b	1.42 ±0.05 a	2.78 ±0.05 f
Nada	14.73 ±0.28 c	11.42 ±0.21 b	7.85 ±0.26 b	3.39 ±0.36 a	0.35 ±0.02 e	3.51 ±0.03 a
Hybrid 34/41/87	16.49 ±3.21 b	10.81 ±1.07 c	7.55 ±0.87 bc	3.10 ±0.64 b	0.77 ±0.05 d	3.06 ±0.15 c
Hybrid 22/17/87	17.01 ±0.96 a	12.31 ±0.49 a	8.96 ±0.28 a	3.18 ±0.22 b	0.97 ±0.04 c	3.18 ±0.04 b
Čačanska Lepotica	13.97 ±0.70 e	10.84 ±0.59 c	7.61 ±0.29 bc	3.06 ±0.42 bc	0.97 ±0.03 c	2.94 ±0.02 d

The table contains the average values of the studied parameters for three years ± a standard error
The various lowercase letters in respective columns indicate significant differences at $P \leq 0.05$ according to the LSD test

Two genotypes (hybrid 38/62/70 and cultivar 'Nada') had higher FW than the control cultivar 'Čačanska Lepotica'. The smallest stone was found in the control cultivar (1.34 g) and hybrid IV/63/81 (1.36 g). The biggest stone was found in hybrid 38/62/70 (1.76 g).

Chemical characteristics. Hybrid 22/17/87 had the highest average values of SSC (17.01%), TS (12.31%) and IS (8.96%), while the highest SC was found in cultivar 'Nada' (3.39%). The lowest values of these parameters were determined in hybrid 38/62/70 (11.39%; 8.26%; 5.77%; 2.36%, resp.). Hybrid 32/21/87 is distinguished by the highest TA (1.42%) and the lowest pH (2.78), SSC/TA (10.25) and TS/TA (7.38). Cultivar 'Nada' had the lowest TA (0.35%) and the highest pH (3.51), SSC/TA (43.72) and TS/TA (32.58). In terms of the studied parameters of the fruit chemical composition, cultivar 'Nada' and hybrids 34/41/87 and 22/17/87 were at the same level or higher than the control cultivar.

Significant differences between the assessed genotypes with respect to all studied parameters of chemical fruit characteristics were found (Tab. 3 and Fig. 1). Significant negative correlations between the studied parameters of physical and chemical fruit characteristics were found (Tab. 5). The FW and FP had significant negative effect on SCC ($r = –0.51$ and $r = –0.63$, resp.), TS ($r = –0.48$ and $r = –0.46$, resp.) and IS ($r = –0.56$ and $r = –0.52$, resp.), while SW exhib-

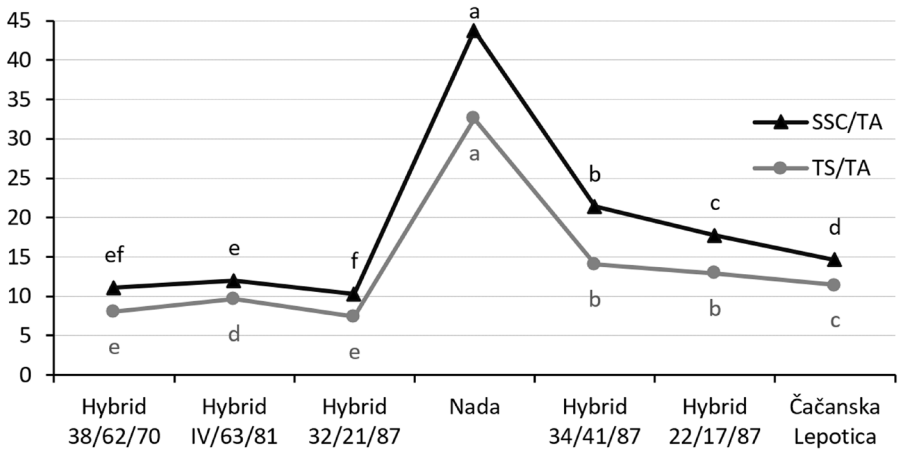

Fig. 1. Soluble solids content and total acids ratio (SSC/TA), total sugars content and total acids ratio (TS/TA) of promising plum genotypes (The various lowercase letters indicate significant differences at $P \leq 0.05$ according to the LSD test)

Table 4. Sensorial characteristics of promising plum genotypes (average scores of five panellists)

Genotypes	FA (0-6)	FT (0-8)	AF (0-2)	FC (0-4)
Hybrid 38/62/70	4.87 ±0.11 b	6.08 ±0.24 ab	1.10 ±0.08 bc	3.67 ±0.08 a
Hybrid IV/63/81	4.01 ±0.19 c	4.79 ±0.23 c	0.99 ±0.05 c	3.10 ±0.15 c
Hybrid 32/21/87	4.05 ±0.15 c	3.58 ±0.11 d	1.11 ±0.03 bc	2.38 ±0.06 d
Nada	5.36 ±0.11 a	6.22 ±0.05 a	1.31 ±0.03 a	3.69 ±0.08 a
Hybrid 34/41/87	4.18 ±0.05 c	5.88 ±0.06 b	1.14 ±0.02 b	3.64 ±0.05 a
Hybrid 22/17/87	4.01 ±0.13 c	4.86 ±0.06 c	1.18 ±0.03 ab	3.05 ±0.02 c
Čačanska Lepotica	4.87 ±0.09 b	6.21 ±0.37 a	1.15 ±0.11 b	3.37 ±0.14 b

The table contains the average values of the studied parameters for three years ± a standard error
The various lowercase letters in respective columns indicate significant differences at $P \leq 0.05$ according to the LSD test

ited a negative impact on IS (r = –0.45). Additionally, the correlations between the individual parameters of the chemical composition of the fruits were determined. The SSC had significant positive impact on TS (r = 0.89), IS (r = 0.79), SC (r = 0.72) and pH (r = 0.47). TS positively correlated with IS (r = 0.89), SC (r = 0.79) and pH (r = 0.58), likewise IS with SC (r = 0.44) and pH (r = 0.54), as well as SC with pH (r = 0.44). On the other hand, a significant negative impact of TA on pH (r = –0.87), SSC/TA (r = –0.88) and TS/TA (r = –0.89) was determined.

Sensorial characteristics. There were significant effects of genotype on sensorial characteristics of fruits (Tab. 4). Cultivar 'Nada' was characterized by the most attractive fruits (5.36) with the best taste (6.22), aroma (1.31), and consistency (3.69). The lowest scores of these parameters, except AF, were obtained in hybrid 32/21/87. Hybrid IV/63/81 had the lowest AF. In terms of sensorial characteristics of fruits, in addition to cultivar 'Nada' only hybrid 38/62/70 was in line with the standard.

The results presented in Table 5 indicate that there are significant correlations between individual parameters of physical and sensorial characteristics, between individual chemical and sensorial characteristics, as well as between certain individual sensorial characteristics of fruits. The FW and FP had a significant positive impact on FA (r = 0.63 and r = 0.60, resp.), while

Table 5. Correlation matrix for the studied physical, chemical and sensorial characteristics

	FW	SW	FP	SSC	TS	IS	SC	TA	pH	SSC/TA	TS/TA	FA	FT	AF	FC
FW	1														
SW	0.59*	1													
FP	0,86*	0.20	1												
SSC	–0.51*	–0.18	–0.63*	1											
TS	–0.48*	–0.27	–0.46*	0.89*	1										
IS	–0.56*	–0.45*	–0.52*	0.79*	0.89*	1									
SC	–0.19	0.06	–0.23	0.72*	0.79*	0.44*	1								
TA	–0.09	–0.09	–0.10	–0.17	–0.28	–0.27	–0.19	1							
pH	–0.05	0.14	–0.10	0.47*	0.58*	0.54*	0.44*	–0.87*	1						
SSC/TA	0.06	0.22	–0.01	0.35	0.42	0.40	0.33	–0.88*	0.93*	1					
TS/TA	0.10	0.21	–0.08	0.28	0.41	0.38	0.32	–0.89*	0.92*	0.99*	1				
FA	0.63*	0.28	0.60*	–0.06	0.05	–0.07	0.29	–0.39	0.45*	0.49*	0.52*	1			
FT	0.43	0.04	0.42	0.15	0.20	0.11	0.25	–0.63*	0.45*	0.45*	0.45*	0.63*	1		
AF	0.27	1.14	0.14	0.21	0.19	0.18	0.14	0.33	0.43	0.43	0.42	0.55*	0.26	1	
FC	0.30	0.12	0.30	0.11	0.06	0.02	0.15	–0.67*	0.42	0.42	0.42	0.48*	0.90*	0.23	1

* The asterisk indicates significant correlation at the 0.05 probability level by Pearson's correlation coefficients

TA significantly negatively affected FT (r = –0.63) and FC (r = –0.67). The positive significant correlation was found between pH and FT (r = 0.44), SSC/TA and FT (r = 0.45), as well as between TS/TA and FT (r = 0.45). Moreover, correlation analysis pointed to a significant positive correlation between FA and all other studied sensorial properties of the fruits – FT, AF and FC (r = 0.63, r = 0.55 and r = 0.48, resp.), as well as between FT and FC (r = 0.90).

DISCUSSION

Improving fruit size and quality according to growers' and consumers' demands is the main breeding goal because if the fruit is not of acceptable quality it will not be a commercial success [Callahan 2003]. The fruit weight is a quantitative hereditary trait [da Silva Linge et al. 2015] whose improvement is difficult to achieve in plum and prune progenies, so that a very small number of hybrids in this respect surpasses the parents [Paunović et al. 1968]. Taking into account the statements of Mišić [1996] regarding the fruit size as well as the results obtained in present study, hybrids IV/63/81, 32/21/87, 34/41/87 and 22/17/87 represent genotypes of medium large fruits, while hybrid 38/62/70 and cultivar 'Nada' are genotypes of large fruits that in this respect outperform the standard. Since the hybrid 38/62/70 was obtained from the cross 'Hall' × 'California Blue' (Tab. 1), the result of its fruit weight was consistent with those of Mišić's [2002], who reported that the cultivar 'California Blue' is a donor of a large fruit. The positive influence of the cultivar 'Stanley' on the fruit weight of hybrid progeny observed by Mišić [2002] and Jakubowski and Lewandowska [2004] was confirmed in cultivar 'Nada', but not in the hybrid 32/21/87. However, for the cultivar 'Čačanska Najbolja', our results were consistent with those of Milošević and Milošević [2011], but not with those of Blazek and Vávra [2007], who reported the positive impact of this cultivar on the fruit size of hybrid progeny. Also, results of our study did not show a positive influence of cultivar 'Čačanska Lepotica' on the fruit size of its offspring. The SW is considered to be a stable and genotype specific feature in *Prunus domestica* L. [Sarigu et al. 2017], showing a significant degree of positive correlation with the

FW [Milošević and Milošević 2012a], as confirmed by the results of this study. Additionally, the results of our study indicate a significant positive correlation between the FW and FP. A positive correlation between the FW and FP in apricot genotypes was previously published by Asma and Ozturk [2005].

The high fruit quality and good flavour are associated with a high content of soluble solids, which according to Neumüller [2011] vary in the European plum genotypes within the range of 12–32%. Given that ≥12.0% SSC is a limit value for the acceptability of a plum genotype by consumers [Crisosto et al. 2004, 2007], only hybrid 38/62/70 did not meet this criterion. Considering the fact that in late ripening plum genotypes the SCC should be more than 17% [Neumüller 2011], hybrid 22/17/87 can be singled out in this respect. In addition, with regard to SCC, better results than in standard cultivar were found in hybrids 32/21/87 and 34/41/87, as well as in the cultivar 'Nada'. The obtained results for TS in all promising genotypes were consistent with the findings of Mišić [1996], who reported that plum flesh contained 7.00–17.74% of TS. The sugars (TS, IS and SC) are a genotype specific feature [Meredith et al. 1992], which also depends on the maturity stage of the fruit, pedo-climatic factors and orchard management [Milošević and Milošević 2012b]. The best results regarding the TS, IS and SC in our study were recorded in hybrid 22/17/87 and cultivar 'Nada'. This study revealed that FW significantly negatively correlated with SSC, TS and IS which points to difficulties in developing new plum cultivars of large fruit and better fruit quality. Mratinić et al. [2010] previously described negative correlation between FW and SSC, FW and TS, as well as between FW and IS in some apricot genotypes; however, these correlations were not significant. Significant positive correlations between the SCC and sugar content (TS, IS and SC) was observed in our work and this was expected considering the fact that sugars make 65–91% of the content of soluble solids as reported by Kader et al. [1982] for clingstone peaches. Similar results were stated by Bozhkova [2014] for plum, as well as Mratinić et al. [2010] and Caliskan et al. [2012] for apricot. Beside the SSC and TS, TA is another key parameter of taste and fruit quality of the plum [Crisosto et al. 2004, 2007]. The same authors reported that the relations between the mentioned parameters (SC/TA and TS/TA) are more reliable indicators of a genotype acceptability by consumers. So far, research has shown that these are genetically controlled parameters [Dirlewanger et al. 2004], which vary considerably among plum genotypes [Milošević and Milošević 2012b] and depend on the degree of fruit maturity [Usenik et al. 2008], as well as on the climatic conditions [Bozhkova 2014]. According to Vangdal [1985], European plum genotypes have good fruit quality if they are characterized by the values of the SSC/TA in the interval between 12 and 24, therefore hybrids 34/41/87 and 22/17/87 can be singled out as best in this regard. Cultivar 'Nada' was characterized by the higher values of the abovementioned parameter in comparison to the range indicated by Vangdal [1985], as a result of the low content of total acids. Similar results were reported by Družić et al. [2007] for the German plum cultivar 'Elena'. Results obtained in the present study showed no relationship between SSC and SSC/TA, as reported previously by Mratinić et al. [2010], but a significant negative correlation was observed between TA and SSC/TA. Additionally, the same relations were found between TA and TS/TA, as well as between TA and pH. These results indicated the tendency of genotypes with higher TA content to have smaller SS/TA and TS/TA ratios, and lower pH. The pH showed a significant positive correlation versus SSC/TA or TS/TA, in a way that higher pH generally meant a lower TA.

Fruit quality is a combination of physical and chemical properties evaluated by consumers based on the observation of the attractiveness, taste, aroma and firmness [Abbott 1999]. In the final assessment of the cultivar acceptance, besides fruit quality, the subjective opinion of the taster is of a great importance [Shewfelt 1999]. Therefore, Müller et al. [2003] reported that measuring, describing and comparing organoleptic characteristics is more difficult compared to determining the chemical composition and nutritional value of the fruits. Abbott [1999] pointed out that instruments for measuring of quality-related traits are relevant for research and for inspection, while only people can judge quality. Regarding the appearance of fruit in the Central European countries, the advantage is given to plum cultivars of large fruits, elliptical shape, blue skin colour with intense bloom [Neumüller 2011]. According to abovementioned, the correlation

analysis in our research showed a significant positive effect of FW on the FA. Also, fruits of the cultivar 'Nada' which are large, elliptical and symmetrical, dark blue skinned with heavy silvery bloom [Glišić et al. 2015] were considered the most attractive. The newly realised cultivar in this respect achieved significantly better results than 'Čačanska Lepotica'. Beside the standard cultivar, the best flavour of fruit was also revealed in cultivar 'Nada' and hybrid 38/62/70. Generally, our results showed the positive correlation between SSC/TA and FT, and between TS/TA and FT, as well as negative correlations between TA and FT. It is important to point that hybrid 38/62/70 in contrast to cultivar 'Nada' was not characterized by the high values of SSC/TA and TS/TA, nor by the low value of TA. The obtained results are in accordance with results of Crisosto et al. [2004], who reported that there are no clear relationships between the acceptability of a cultivar by the consumers and the values of mentioned parameters that can be generally used, but rather that acceptability is a specific feature of each genotype and must be individually studied. In terms of aroma, better results compared to standard were obtained for cultivar 'Nada' and hybrid 22/17/87. With regard to the consistency, which is according to Neumüller [2011] an important feature for the fresh market, hybrids 38/62/70 and 34/41/87 and the cultivar 'Nada' showed the best results. In addition, 'Nada' has been recommended for drying, since this cultivar is characterised by a dark skin colour, typical of prunes in general, high levels of phenolic components and a favourable plum/prune ratio, which is a good indicator for the cost-efficiency of industrial prune production [Mitrović et al. 2019].

Generally, the obtained results indicate that the genotype is a key factor of fruit quality. On the base of our data for physical and sensorial properties of the fruit, hybrid 38/62/70 and cultivar 'Nada' can be selected as the best, while hybrid 22/17/87 was characterized by the best fruit chemical properties. The correlation coefficients between the evaluated parameters suggested that the change of one trait causes changes in a greater number of others. Neumüller et al. [2012] also pointed out that all factors which have an impact on fruit quality should be combined in order to obtain successful strategy for improving quality of plums.

CONSLUSION

The results of the three years' study of the major pomological (physical, chemical and sensorial) properties of six promising plum genotypes developed at the Fruit Research Institute, Čačak, could be outlined as follows:

– hybrid 38/62/70 and cultivar 'Nada' had the highest fruit weight and flesh percentage;

– hybrid 22/17/87 had the highest content of soluble solids, total and inverted sugars, while cultivar 'Nada' had the highest sucrose content, ratio between soluble solids and total acids contents, as well as between total sugars and total acids contents;

– hybrid 38/62/70 and cultivar 'Nada' characterized by the best score of fruit attractiveness, taste and consistency, while the best aroma of fruit was typical of cultivar 'Nada' and hybrid 22/17/87.

Based on the abovementioned, beside newly released cultivar 'Nada', the hybrids 38/62/70 and 22/17/87 have been singled out as an elite material which deserve to be included in the release procedure. Namely, owing to the values of parameters which were determined in this study, as well as the results of our previous research, 'Nada' can be recommended for further promotion and commercial growing, as a cultivar suitable for fresh marketing and processing; hybrid 38/62/70 for fresh use and hybrid 22/17/87 can be suitable for processing, whereas more detailed analysis should be carried out in future studies in order to define processing purposes. Apart from introducing into the release procedure and production, the selected cultivar and hybrids are an important source of genetic variability and extend the list of genotypes that can be used as parents within future breeding programmes, since the hybridisation remains the most important tool for improving quality of plum fruit.

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