Promising Cornelian Cherry (*Cornus mas* L.) Genotypes from Natural Population in Serbia

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Summary

Serbia is a rich in Cornelian cherry (*Cornus mas* L.) populations that grow naturally in a variety of locations. At Faculty of Agriculture in Novi Sad, an intensive breeding program on this fruit species started in 2006. The paper reviews morphometric characteristics of 16 Cornelian cherry genotypes collected on the territory of the Vojvodina Province and Mačva region in 2008 and 2009, which were found to be superior in terms of fruit size and quality. On average for the two years, the genotype PPC1 had the highest fruit length (27.79 mm), fruit width (18.97 mm), fruit weight (6.61 g), mesocarp weight (5.86 g) and the flesh to stone ratio (88.46%). The genotype Žuti had the longest fruit. The effect of year of growing was statistically significant for all studied traits, except for fruit width and fruit shape index. Fruit weight, economically the most important characteristic, ranged in the interval from 2.25 to 6.61 g, with a large number of genotypes having the fruit weight over 3 g. All of the tested genotypes had satisfactory flesh to stone ratio, from 79.00% (CPC9) to 88.46% (PPC1). The highest variability was detected for mesocarp weight (36.48%) and fruit weight (33.19%) in 2009, while flesh to stone ratio was the most stable characteristic in both test years (CV = 3.84 and 4.09% in 2008 and 2009, respectively). The genotype SKC had highest contents of soluble matter (32.37%), total sugars (25.38%) and reducing sugars (23.67%). Fruits of the genotype KC2 had highest contents of vitamin C (39.22 mg/100 g fruit) and total acids (3.60%). Selection Apatinski rani had the highest content of anthocyanins (109.36 mg/100 g fruit). Depending on the genotype, protein content ranged from 1.43 to 2.71%, and tannin content from 0.65% to 1.31%.

Key words

chemical content, *Cornus mas* L., genotype, morphometric properties, selection

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Introduction

Consumers worldwide are showing an increased interest in high-quality natural fruits, such as those of the Cornelian cherry. Until recently, the Cornelian cherry has been considered exclusively as a medicinal and decorative species. Only in recent decades have breeding programs aimed at the development of large fruit and high-yielding trees been launched in several countries. Most of these programs have been sucessful (Hricovsky, 1984; Pirc, 1990; Korać et al., 1996; Güleryüz et al., 1998; Pirlak et al., 2003; Demir and Kalyoncu, 2003; Klimenko, 2004; Ninić Todorović et al., 2005; Brindza, 2006; Bijelić et al., 2007b; Bijelić et al., 2008a).

Serbia is rich in Cornelian cherry populations and has excellent conditions for Cornelian cherry growing and a reintroduction and expansion of this neglected fruit species and exploitation of its high potential for organic production would bring large economic benefits (Bijelić, 2008; Bijelić et al., 2009). Plants develop from spontaneous seedlings of wild forms and these genotypes vary considerably in time of maturity, fruit size, color, shape and taste and the nutrient value of fruits. Because of their diversity, Cornelian cherry (*Cornus mas* L.) genotypes as self-reproducing wild fruit species have a significant genetic potential for use in breeding programs (Ercisli, 2004). Collection, study and preservation of genetic variability of the Cornelian cherry and its cultivation would enrich the existing gene fund of cultivated fruit trees. In these parts, the Cornelian cherry is mostly found in deciduous oak forests. Regarding the geological substrate, the Cornelian cherry shows high adaptation, although it grows best on medium-deep limestone soils, rich in nutritive elements and humus. Individual Cornelian cherry trees can be found up to the altitude of 1300 m.

The Cornelian cherry is a rare plant species that can be grown without application of chemicals and have good yield potential even under modest agrotehnical conditions. The Cornelian cherry may have diverse applications in medicine. In Turkey, the Cornelian cherry is used for its antioxidant, antiallergenic, antimicrobial and antihistamine properties (Celik et al., 2006). Evidently, in some Asian countries the Cornelian cherry is the main ingredient of herbal preparations used in the treatment of diabetes (Jia et al., 2003; Jayaprakasam et al., 2005).

At the stage of technological maturity, the Cornelian cherry acquires a sweet-sour taste, so it can be consumed fresh or in the form of various processed products. Particularly popular is the so-called stirred Cornelian cherry jam, which is made in our laboratory, and also by local housewives, without cooking and additives but with some sugar or honey (Bijelić, 2009). These home made cornelian cherry products have short shelf life and they should be relatively soon consumed. Cornelian cherry jam is particularly interesting for diabetics. Also, the Cornelian cherry is suitable for hedges, anti-erosion protection and as greenery in urban areas, as it tolerates high levels of air pollution.

The Cornelian cherry wood is strong and resilient and it can be used in carpentry. It is also an important honey plant because it blooms early in the spring (Bijelić et al., 2008b), providing valuable nectar and pollen at the time when there are very few blooming plants available to foraging bees.

In spite of a wide applicability of Cornelian cherry fruits and a growing interest of fruit growers, the presence of the Cornelian cherry in our country is still negligible. It is found mainly in home gardens and extensively grown mixed orchards. The biggest problem is associated with Cornelian cherry harvest, because these wild forest fruits frequently grow on inaccessible terrain. This problem could be successfully solved by selecting superior genotypes and growing them in plantation orchards. In the Vojvodina Province, several attempts at Cornelian cherry selection were made at the Faculty of Agriculture in Novi Sad before the 1990s. Three selections were developed that were distinguished for fruit size and weight, and their processing period was considerably extended since these selections mature over a period of two months (Korać et al., 1996).

A new program of Cornelian cherry selection was started at the Department for Pomology, Viticulture, Horticulture and Landscape Architecture in 2006 (Bijelić et al., 2007a; Bijelić et al., 2009; Gološin et al., 2009). The objectives of this program were: 1) to multiply the previously selected genotypes, 2) to identify new genotypes interesting for further selection and growing, and 3) the establishment of a collection and an experimental Cornelian cherry orchard, first facilities of that kind in this region. The ultimate goals were standardization of Cornelian cherry varieties and their introduction into intensive commercial fruit production. The aim of this study was the selection of promising cornelian cherry genotypes from the population that would be recommended for the cultivation in gardens and plantations.

Materials and methods

A collecting trip was conducted on the territory of the Vojvodina Province and Mačva region, where Cornelian cherry trees are frequent in the natural population of tress, both in different locations and on different geological substrates. In recent years, over three hundred Cornelian cherry trees have been registered and monitored during all phenophases of their growth and development. The objects of this paper are 16 genotypes from this group, those which on average showed best morphometric characteristics. Fruits of the studied genotypes were picked at the stage of full maturity. Fifty-fruit samples per genotype were measured for morphometric characteristics such as fruit length and width, fruit weight and stone weight. Shape index was calculated as the of fruit length/width ratio. Flesh to stone ratio was calculated as a relationship between fruit weight and mesocarp weight multiplied by 100 and expressed in percentage. The morphometric measurements were made using precision analytical scale and digital micrometers.

In 2008, after separation from the stone, the mesocarp was analyzed for total soluble dry matter (TSC), total acids, total and reducing sugars, vitamin C, proteins, anthocyanins, tannins and Ca-pectates following the methodology published by Vračar (2001).

The data obtained for morphometric properties of the fruit were processed by a two-factorial analysis of variance ANOVA in the statistical program STATISTICA 9.1 (Statsoft, 2010). The data for the chemical composition of the mesocarp of the analyzed genotypes were processed by the one-way analysis of variance in the same statistical program.

The significance of differences of the means for the analyzed characteristics was tested by Duncan's multiple range test at 0.01% significance. In order to determine the variability of the

characteristics, coefficient of variation (CV), as a most reliable indicator of the relative dispersion of data, was calculated for each of them.

Results

Morphometric characteristics of the 16 selected genotypes of Cornelian cherry (*Cornus mas* L.), examined in the course of two years, and the average value of the investigated characteristics, are given in Tables 1 and 2.

The tested genotypes had a significantly higher average fruit length (21.87 mm) in 2008 compared with 2009, while no significant differences could be found between the years for the values of fruit width and fruit shape index (Table 1). Genotype as a factor showed high variability during the investigation period in all measured characteristics. The genotype PPC1 showed the highest fruit length and width (27.79 mm and 18.97 mm, respectively), on average for both years. Fruits of the genotype APC9 had the

Table 1. Fruit length and width and fruit shape index of the tested Cornelian cherry genotypes from Serbia

Genotype	Fruit length (mm)			Fruit width (mm)			Shape index		
	2008	2009	Average	2008	2009	Average	2008	2009	Average
APC9	18.06 st	17.79 t	17.93 J	12.97 m	12.43 n	12.70 J	1.95 gh	2.06 fg	2.00 E
CPC9	21.71 jkl	19.24 op	20.47 G	13.54 l	12.41 n	12.98 J	2.59 a	2.42 bc	2.50 A
CPC16	19.18 op	18.80 pr	18.99 I	17.23 c	17.27 c	17.25 B	1.24 m	1.19 m	1.21 I
KC1	23.27 gh	21.55 klm	22.41 E	17.32 c	16.39 e	16.86 C	1.81 ijk	1.73 k	1.77 G
KC2	20.99 m	21.80 jk	21.39 F	15.44 fg	17.17 c	16.31 E	1.86 hij	1.62 l	1.74 G
SKC	24.04 ef	23.72 fg	23.88 C	15.38 fgh	15.55 f	15.47 F	2.47 ab	2.33 c	2.40 B
Apatinski rani	24.90 d	21.10 lm	23.00 D	16.14 e	13.57 l	14.85 H	2.39 bc	2.43 bc	2.41 B
Bačka	22.07 jk	22.33 ij	22.20 E	16.59 de	16.44 e	16.52 DE	1.78 ijk	1.85 hij	1.82 FG
CA1	20.29 n	19.32 op	19.80 H	14.90 hij	15.32 fgh	15.11 GH	1.87 hij	1.60 l	1.74 G
R1	24.51 de	25.58 c	25.05 B	16.57 de	16.90 cd	16.73 CD	2.20 de	2.31 cd	2.26 C
Žuti	22.92 hi	22.86 hi	22.89 D	14.54 jk	14.47 jk	14.51 I	2.49 ab	2.50 ab	2.50 A
PPC1	27.24 b	28.35 a	27.79 A	18.37 b	19.57 a	18.97 A	2.21 de	2.13 ef	2.17 D
KDC1	20.30 n	20.06 n	20.18 GH	15.37 fgh	15.13 fghi	15.25 FG	1.75 jk	1.77 ijk	1.76 G
KDC3	19.02 opr	18.49 rs	18.76 I	15.36 fgh	15.04 ghi	15.20 FG	1.54 l	1.52 l	1.53 H
KIC1	19.97 n	19.63 no	19.80 H	14.67 ijk	14.33 k	14.50 I	1.86 hij	1.89 hi	1.88 F
KKC1	21.45 klm	21.04 lm	21.24 F	15.36 fgh	15.06 fghi	15.21 FG	1.95 gh	1.96 gh	1.96 E
Max	31.39	33.71		20.11	21.88		3.36	3.18	
Min	15.01	15.96		11.30	11.21		0.92	1.02	
Average	21.87 A	21.35 B		15.61 A	15.44 A		2.00 A	1.96 A	
SD	2.69	2.94		1.60	1.96		0.42	0.43	
CV (%)	12.32	13.79		10.27	12.69		20.78	21.74	

Values with different lower-case letters for tested years are significantly different according to Duncan's multiple range test at $p < 0.01$;
Average values with different capital letters are significantly different according to Duncan's multiple range test at $p < 0.01$.

Table 2. Weights of fruit, stone and mesocarp and flesh to stone ratio of the tested Cornelian cherry genotypes from Serbia

Genotype	Fruit weight (g)			Stone weight (g)			Flesh weight (g)			Flesh/stone ratio (%)		
	2008	2009	Average	2008	2009	Average	2008	2009	Average	2008	2009	Average
APC9	2.40 p	2.09 r	2.25 J	0.41 m	0.39 m	0.40 K	1.99 o	1.70 p	1.85 K	82.90 hi	81.34 jk	82.12 F
CPC9	2.84 o	2.10 r	2.47 I	0.56 ghi	0.46 l	0.51 HI	2.28 n	1.64 r	1.96 K	79.95 mno	78.04 p	79.00 H
CPC16	4.10 efg	3.85 ghi	3.97 D	0.58 fg	0.53 hij	0.55 FG	3.53 ef	3.32 fgh	3.42 CD	85.94 d	86.15 cd	86.05 C
KC1	4.61 d	3.81 hij	4.21 C	0.71 c	0.61 ef	0.66 D	3.90 d	3.20 ghi	3.55 C	84.54 f	83.98 fg	84.26 E
KC2	3.46 klm	4.10 efg	3.78 E	0.52 ijk	0.59 fg	0.55 FG	2.95 jk	3.51 ef	3.23 EF	84.82 ef	85.57 de	85.19 D
SKC	4.08 efgh	4.01 efgh	4.05 CD	0.85 a	0.82 b	0.83 A	3.24 ghi	3.19 ghi	3.21 EF	79.23 o	79.53 no	79.38 H
Apatinski rani	4.29 e	2.75 o	3.52 FG	0.56 ghi	0.52 ijk	0.54 G	3.74 de	2.22 n	2.98 GH	87.00 bc	80.71 klm	83.85 E
Bačka	4.06 efgh	4.05 efgh	4.06 CD	0.72 c	0.72 c	0.72 C	3.34 fg	3.34 fg	3.34 DE	82.19 j	82.21 ij	82.21 F
CA1	3.32 klm	3.49 lmn	3.41 GH	0.65 d	0.58 fg	0.62 E	2.67 lm	2.91 jkl	2.79 IJ	80.23 lmn	83.21 gh	81.72 F
R1	4.14 ef	4.85 c	4.50 B	0.51 jk	0.59 fg	0.55 G	3.63 e	4.27 c	3.95 B	87.61 b	87.84 b	87.73 B
Žuti	3.46 klm	3.26 mn	3.36 GH	0.66 d	0.63 de	0.65 D	2.80 klm	2.62 m	2.71 J	80.88 kl	80.33 lmn	80.61 G
PPC1	6.03 b	7.19 a	6.61 A	0.73 c	0.78 b	0.76 B	5.31 b	6.40 a	5.86 A	87.85 b	89.07 a	88.46 A
KDC1	4.09 efgh	3.94 fghi	4.02 D	0.58 fg	0.57 fgh	0.58 F	3.50 ef	3.37 fg	3.44 CD	85.69 de	85.53 de	85.61 CD
KDC3	3.56 jkl	3.24 mn	3.40 GH	0.48 kl	0.45 l	0.47 J	3.07 hij	2.79 klm	2.93 HI	86.41 cd	85.95 d	86.18 C
KIC1	3.38 lmn	3.15 n	3.27 H	0.52 ijk	0.53 hij	0.53 GH	2.86 klm	2.62 m	2.74 J	84.47 f	83.05 hi	83.76 E
KKC1	3.72 ijk	3.48 klm	3.60 F	0.51 jk	0.48 kl	0.50 I	3.21 ghi	3.00 ijk	3.10 FG	86.24 cd	86.04 d	86.14 C
Max	7.93	8.72		1.03	0.97		7.07	7.84		89.86	90.08	
Min	1.83	1.52		0.30	0.32		1.40	1.20		69.48	74.15	
Average	3.85 A	3.71 B		0.60 A	0.58 B		3.25 A	3.13 B		84.12 A	83.66 B	
SD	0.92	1.23		0.13	0.13		0.85	1.14		3.23	3.42	
CV (%)	24.03	33.19		22.29	22.92		26.18	36.48		3.84	4.09	

Values with different lower-case letters for tested years are significantly different according to Duncan's multiple range test at $p < 0.01$;
Average values with different capital letters are significantly different according to Duncan's multiple range test at $p < 0.01$.

Table 3. Some chemical characteristics of the mesocarp in the Cornelian cherry genotypes selected in Serbia, 2008

Genotype	Fruit weight (g)			Stone weight (g)			Flesh weight (g)			Flesh/stone ratio (%)		
	2008	2009	Average	2008	2009	Average	2008	2009	Average	2008	2009	Average
APC9	2.40 p	2.09 r	2.25 J	0.41 m	0.39 m	0.40 K	1.99 o	1.70 p	1.85 K	82.90 hi	81.34 jk	82.12 F
CPC9	2.84 o	2.10 r	2.47 I	0.56 ghi	0.46 l	0.51 HI	2.28 n	1.64 r	1.96 K	79.95 mno	78.04 p	79.00 H
CPC16	4.10 efg	3.85 ghi	3.97 D	0.58 fg	0.53 hij	0.55 FG	3.53 ef	3.32 fgh	3.42 CD	85.94 d	86.15 cd	86.05 C
KC1	4.61 d	3.81 hij	4.21 C	0.71 c	0.61 ef	0.66 D	3.90 d	3.20 ghi	3.55 C	84.54 f	83.98 fg	84.26 E
KC2	3.46 klm	4.10 efg	3.78 E	0.52 ijk	0.59 fg	0.55 FG	2.95 jk	3.51 ef	3.23 EF	84.82 ef	85.57 de	85.19 D
SKC	4.08 efgh	4.01 efgh	4.05 CD	0.85 a	0.82 b	0.83 A	3.24 ghi	3.19 ghi	3.21 EF	79.23 o	79.53 no	79.38 H
Apatinski rani	4.29 e	2.75 o	3.52 FG	0.56 ghi	0.52 ijk	0.54 G	3.74 de	2.22 n	2.98 GH	87.00 bc	80.71 klm	83.85 E
Bačka	4.06 efgh	4.05 efgh	4.06 CD	0.72 c	0.72 c	0.72 C	3.34 fg	3.34 fg	3.34 DE	82.19 j	82.21 ij	82.21 F
CA1	3.32 klm	3.49 lmn	3.41 GH	0.65 d	0.58 fg	0.62 E	2.67 lm	2.91 jkl	2.79 IJ	80.23 lmn	83.21 gh	81.72 F
R1	4.14 ef	4.85 c	4.50 B	0.51 jk	0.59 fg	0.55 G	3.63 e	4.27 c	3.95 B	87.61 b	87.84 b	87.73 B
Žuti	3.46 klm	3.26 mn	3.36 GH	0.66 d	0.63 de	0.65 D	2.80 klm	2.62 m	2.71 J	80.88 kl	80.33 lmn	80.61 G
PPC1	6.03 b	7.19 a	6.61 A	0.73 c	0.78 b	0.76 B	5.31 b	6.40 a	5.86 A	87.85 b	89.07 a	88.46 A
KDC1	4.09 efgh	3.94 fghi	4.02 D	0.58 fg	0.57 fgh	0.58 F	3.50 ef	3.37 fg	3.44 CD	85.69 de	85.53 de	85.61 CD
KDC3	3.56 jkl	3.24 mn	3.40 GH	0.48 kl	0.45 l	0.47 J	3.07 hij	2.79 klm	2.93 HI	86.41 cd	85.95 d	86.18 C
KIC1	3.38 lmn	3.15 n	3.27 H	0.52 ijk	0.53 hij	0.53 GH	2.86 klm	2.62 m	2.74 J	84.47 f	83.05 hi	83.76 E
KKC1	3.72 ijk	3.48 klm	3.60 F	0.51 jk	0.48 kl	0.50 I	3.21 ghi	3.00 ijk	3.10 FG	86.24 cd	86.04 d	86.14 C
Max	7.93	8.72		1.03	0.97		7.07	7.84		89.86	90.08	
Min	1.83	1.52		0.30	0.32		1.40	1.20		69.48	74.15	
Average	3.85 A	3.71 B		0.60 A	0.58 B		3.25 A	3.13 B		84.12 A	83.66 B	
SD	0.92	1.23		0.13	0.13		0.85	1.14		3.23	3.42	
CV (%)	24.03	33.19		22.29	22.92		26.18	36.48		3.84	4.09	

Values with different lower-case letters for tested years are significantly different according to Duncan's multiple range test at $p < 0.01$;
Average values with different capital letters are significantly different according to Duncan's multiple range test at $p < 0.01$.

lowest average values of fruit length and width (17.93 mm and 12.70 mm, respectively). There was no significant difference in the fruit width of the genotype APC9 and the genotype CPC9 (12.98 mm). Longest fruits, i.e., highest values of the fruit shape index (2.50) were exhibited by the genotypes Žuti and CPC9. The lowest coefficient of variation was found for fruit width in 2008 (10.27%), while the highest coefficient was found for the fruit shape index in 2009 (21.74%).

On average for all genotypes tested (Table 2) fruit weight (3.85 g); stone weight (0.60 g); mesocarp weight (3.25 g), and the flesh to stone ratio (84.12%) were higher in 2008 than in 2009. The genotype PPC1 had the highest values of both fruit (6.03 g and 7.19 g in 2008 and 2009, respectively) and mesocarp weights (5.31 g and 6.40 g in 2008 and 2009, respectively). This genotype also had the highest average value of fruit weight for the studied period (6.61 g). The average flesh to stone ratio in PPC1 fruits (88.46%) was highly significant in relation to the other genotypes. Also, PPC1 had the highest values of the flesh to stone ratio in both years (89.86% and 90.08%). With the exception of CPC9 and SKC, all genotypes had a very high flesh to stone ratios, over 80%. In both years of the study, the flesh to stone ratio was the most stable characteristic, with variation coefficients of 3.84% and 4.09%. The highest variations were recorded for mesocarp weight in 2009 (36.48%) and fruit weight in 2008 (33.19%).

Table 3 shows the chemical composition of the mesocarp of the Cornelian cherry fruits analyzed in 2008. The genotype SKC was distinguished for the highest contents of soluble dry matter content (32.37%), total (25.38%) and reducing sugars (23.67%) and the content of Ca-pectates (2.44%). The highest content of total acids (3.60%) and vitamin C (39.22 mg/100g fruit) was recorded in KC2; the highest protein content (2.71%) was found in CPC9 and the highest anthocyanin content in fruit mesocarp (109.36 mg/100 g fruit) was recorded in the genotype Apatinski rani. The highest average variation was recorded in the content of Ca-pectates (CV = 44.65%). High variation coefficients were also registered for anthocyanin and protein contents (35.91% and 33.63%, respectively). The lowest variation was found for the content of soluble dry solids (16.51%).

Discussion

The obtained values of fruit length and width of the Cornelian cherry genotypes from Serbia are in agreement with results of earlier authors who also had recorded high variability of fruit characteristics that depended primarily on the genotype but also on environmetal factors (Güleryüz et al., 1998; Demir and Kalyoncu, 2003; Brindza, 2006). The average fruit weight of the tested genotypes (2.47 g) were in the range reported by previous authors, but considering the tested genotypes and study years, the fruits of our selections were much larger (up to 7.19 g in PPC1) compared with prevously published results (Güleryüz et al., 1998; Pirlak et al., 2003; Demir and Kalyoncu, 2003). The Cornelian cherry selection should be primarily focused on larger fruit weight, a characteristic that has the highest direct correlation with mesocarp weight (Bijelić et al., 2007b; Karadeniz, 2000). Depending on the genotype and study year, the average flesh to stone ratio ranged in the interval from 78.04% (CPC9) to 89.07% (PPC1), which is in agreement with previous studies of the Cornelian cherry population in Serbia (Bijelić et al., 2007a; Bijelić et al., 2010). Suitability of the studied characteristics for further selection depends on their variability. Highest average variations in morphometric characteristics among the genotypes, expressed through the coefficient of variation (Tables 1 and 2), were found for mesocarp weight (CV = 36.48%) and fruit weight (CV = 36.91%) in 2009, while the flesh to stone ratio (3.84% and 4.09%) was the most stable characteristic, as found in earlier studies of the Cornelian cherry population in the Vojvodina Province (Bijelić et al., 2007a).

The quality of fruits intended for fresh consumption or processing is expressed through the contents of fruit sugars, acids, vitamins, and mineral, aromatic, pectic and other substances (Vračar, 2001). The highest TSC content (32.37%) was registered in the genotype SKC. This value was significantly higher than those reported by Jaćimović (2006), Demir (2002) and Tural (2008), although some genotypes from Vojvodina had the soluble dry matter content in fruits even over 48% (unpublished data). The average total acid content was 2.68%, the highest being found in KC2 and CPC16 (3.60% and 3.59%, respectively). The ratio between dry matter content and total acids determines fruit taste. According to Pirlak et al. (2003), this ratio ranges between 3.0 and 9.2. Kalkisim and Odabas (1994) reported for their material that this ratio ranged from 8.3 to 9.1, which is in accordance with our results. The total sugar content ranged on average from 13.90% (APC9) to 25.38% (SKC) and even more (Bijelić et al., in press) that is significantly higher in comparison with genotypes from the Slovak Republic (6.5 to 15.5%) (Brindza, 2006), Montenegro (8.72 to 18.67%) (Jaćimović, 2006) and Russia (5.4 to 13.5%) (Dudukal and Rudenko, 1984). Demir (2002) reported a significantly lower content of total sugars in the fruit compared with our results. The nutritive and medicinal properties of the Cornelian cherry result from balanced contents of sucrose, tannin, pectin, organic acids, carotenoids, anthocyanins, vitamins C and E, resins, flavonoids, etc (Brindza, 2006). Natural remedies made from Cornelian cherry leaves, flowers and fruits, either fresh or dry, had been used in the traditional medicine for the prevention and treatment of numerous ailments. Fruit and vegetables are valuable sources of natural antioxidants that provide protection from harmful free radicals. Vitamin C is a powerful antioxidant that stimulates the functioning of all cells. On average, all Cornelian cherry genotypes had the vitamin C content around 22.44 mg/100 g fruit. The highest content (39.22 mg/100 g fruit) was recorded in KC2, which was significantly higher than in any other of the examined genotypes. Pirlak et al. (2003) claimed that the Turkish Cornelian cherries have much higher levels of this vitamin (35.6-106.3 mg/100 g fruit). The Cornelian cherry varieties from Ukraine, with the exception of the variety Bilda (28.9 mg/100 g fruit), showed high contents of vitamin C (Klimenko, 1990), while the genotypes from Slovakia had a slightly lower content of this vitamin (Brindza, 2006). The largest variation in the chemical composition of the mesocarp was observed for the content of Ca-pectates (CV = 44.65%), which was highest in SKC (2.44%), while the average value for all investigated genotypes was 1.66%. Pectic substances are an important component of human diet, because they prevent, mitigate or eliminate stomach problems. These substances are contained in considerable amounts in Cornelian cherry fruits. According to Burmistrov (1994), the tannins content ranges from 0.6 to 14%. In the tested fruits, tannins ranged from 0.65% (KDC1) to 1.31% (CA1). The various bright colors (red, blue and purple) of fruits, vegetables and flowers come from anthocyanins, main constituents of fruits and vegetables which are used as dietary polyphenols. Anthocyanins contained in fruits tend to reduce coronary diseases and are also used for antidiabetic purposes (Jayaprakasam et al., 2005). Cornelian cherry fruits are characterized by a significant content of colored substances. The average content of anthocyanins in the tested fruits amounted to 70.06 mg/100g fruit, the highest being found in the selection Apatinski rani (109.36 mg/100g fruit). Tural (2008) and Pantelidis et al. (2007) reported significantly higher values.

Conclusion

Based on the results of the conducted study, it was concluded that the area of the Vojvodina Province and Mačva region in Serbia abounds in Cornelian cherry populations whose fruits differ considerably in morphological and chemical characteristics, and on that account they are of great importance for breeding programs. Also, the selected genotypes showed to be suitable for cultivation, and their fruits can be used for both fresh consumption and industrial processing.

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