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Fruit Nutritional Value of Cornelian Cherry Genotypes (*Cornus mas* L.) Selected in the Vojvodina Province

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Abstract: This paper reviews results of some morphometric properties and chemical analyses of natural populations of the Cornelian cherry collected in the Vojvodina Province in 2008. Purpose of this study was the selection of the best genotypes for future breeding program until the final goal and that is standardizing Cornelian cherry cultivars. Chemical content has been found to depend on the genotype. Total sugar content in fruits ranged from 11.77% (CPC16) to 41.62% (BPC7), vitamin C from 17.15 mg/100 g (APC8) to 42.30 mg/100 g of fresh fruit (APC2), Ca pectat from 0.17% (APC6) to 2.52% (KC1) and anthocyanin from 22.65 mg/100 g (APC4) to 96.30 mg/100 g of fresh fruit (BPC1). Cornelian cherry fruits have an especially high content of minerals compared with other fruit species: the potassium content (in ppm) ranges from 2330 (APC6) to 11487 (APC4), the calcium content from 33.80 (APC6) to 1307.70 (BPC1), the sodium content from 22.82 (BPC8) to 273.48 (APC8), the magnesium content from 10.20 (APC6) to 372.80 (APC8) and the iron content from 2.38 (KC2) to 14.40 (APC8). The balanced content of nutrients, a wide range of food products made from the Cornelian cherry and an extremely high nutritional value make this fruit species a highly recommendable food item, especially if it comes from organic production.

Key words: Cornelian cherry, selections, chemical properties, nutritional value.

1. Introduction

The cult of trees dates back in our folk tradition from pagan times. Various kinds of trees had played important roles in Christian holidays celebrating the spring equinox and they had been used for health preservation and disease prevention and treatment. Use of medicinal herbs has a long history in the treatment of many diseases. For centuries, herbs were the only medicine or source of medical substances [1]. Many herbs are found in our natural flora and most of them can be used either as food or medicine.

One of the self-multiplying wild plants that can be used as food and medicine is the Cornelian cherry, which folk tradition takes as a symbol of health, spiritual firmness, stamina and longevity. The Cornelian cherry had been used since ancient times as a cure for many diseases in the form of teas, balms, healing creams, but also as a delicacy.

The Cornelian cherry is a rare plant species that will preserve its natural form without application of chemicals and it is capable of fruit bearing under modest agrotechnical conditions. Our country has extraordinarily favorable conditions for Cornelian cherry growing and a reintroduction and expansion of this neglected fruit species and exploitation of its huge potential for organic production would bring large economic benefits [2, 3]. Numerous studies have indicated a high tolerance of the Cornelian cherry to diseases and pests. There is a local saying “healthy as the Cornelian cherry ‘which corresponds to the English saying’ fit as a fiddle.” This feature is quite important in the light of the current campaign for more intensive production of safe food. Considering its natural advantages, the Cornelian cherry definitely takes an important place in organic fruit production. In addition to being a valuable food item, the

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Cornelian cherry may have large applications in medicine and cosmetics. In Turkey, the Cornelian cherry is used for its antioxidant, antiallergenic, antimicrobial and antihistamine properties [4]. It has been reported that in some Asian countries the Cornelian cherry is the main ingredient of herbal preparations used in the treatment of diabetes [5, 6].

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: marinated, as seasoning for meat and fish, wine, brandy, jam, marmalade, candied, compote, syrup, fruit juice, fruit yogurts, etc. Fresh of processed fruits of the Cornelian cherry can be safely recommended as food for children and persons with impaired health. It is important to emphasize that Cornelian cherry-containing products do not need additives and heat treatment, so that a full content of nutrients, especially those sensitive to heat treatment, remains preserved in the 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 [7]. Cornelian cherry jam is particularly interesting for diabetics because it is prepared with a minimum amount of sugar.

In addition to the above, 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 and wood turning industry. There are claims that the Old Romans had made spear handles out of Cornelian cherry wood. Homer's "Odyssey" mentions that the Trojan horse had been made of Cornelian cherry wood [8]. The Cornelian cherry is also an important honey plant because it blooms early in the spring [9].

The aim of this research is selection of best cornelian cherry genotypes on the basis of morphometric and chemical characteristics of fruits for their further breeding and introduction of intensive fruit growing.

2. Materials and Methods

For the purpose of further selection, several hundred Cornelian cherry genotypes from different locations in the Vojvodina Province have been labeled and investigated. This paper presents morphometric characteristics (fruit weight, flesh/stone ratio) and chemical composition of fruit mesocarp of 25 of these genotypes. Mature fruits of these genotypes were selected in the course of July and August 2008. Samples consisting of 50 fruits per genotype were measured for morphometric characteristics and then, on the basis of the proportion of mesocarp weight to total fruit weight, the fruit flesh/stone ratio (%) was calculated. After stone extraxtion, the mesocarp underwent a chemical analysis for the following parameters: total dry matter-TSC, soluble dry matter-SSC, total acids, total and reducing sugars, and contents of sucrose, vitamin C, fibers, proteins, anthocyanin, tannins and Ca-pectate. Also, we determined the ash content and the contents of certain microelements (in ppm): Cu, Fe, Zn, Mn, Mg, Ca, K and Na. The chemical analyses of the mesocarp were performed in the Laboratory for Quality Testing and Technology of Fruits and Vegetables at the Faculty of Technology in Novi Sad, according to conventional methodologies [10].

All the measurements and analysis of chemical parameters were repeated three times, so that the table part presents the mean values obtained from three replications. The obtained data were processed by the factorial analysis of variance (ANOVA) using the statistical program Statistica 9.1 [11]. Differences were tested by Duncan's multiple range test. To determine the variability of the characteristics, coefficient of variation (CV), being a most reliable indicator of the relative dispersion of data, was calculated for each characteristic.

3. Results and Discussion

Noteworthy selection of natural populations of the Cornelian cherry dates back to the 1960s [12, 13]. Until

recently, the Cornelian cherry has been considered solely as a wild-growing medicinal and decorative species. Only in recent decades has the Cornelian cherry been recognized as an important source of safe food, and breeding programs on this kind of fruit have been launched in several countries: Ukraine [14], Slovakia [15], Turkey [16], Serbia [17-20], the Czech Republic, Bulgaria and Austria.

Consumers worldwide are showing an increased interest in high-quality natural fruits, exactly like those of the Cornelian cherry. The largest problem is associated with fruit collection because these wild trees often grow on rough and inaccessible terrain. The problem can be successfully solved by breeding and growing high-yielding varieties. With this objective in mind, an intensive program of Cornelian cherry breeding has been started at the Department of Pomology, Viticulture, Horticulture and Landscape Architecture of the Faculty of Agriculture in Novi Sad [21, 22].

All the tested characteristics (Table 1) showed high variability which was evidently due to the genotype. The fruit weight of the tested Cornelian cherry genotypes ranged on average in the interval from 4.61 g in the case of KC1, which had significantly larger fruits than the other genotypes, to the genotypes with smallest fruits (BPC2, BPC8 and BPC 7). The average fruit weight (2.47 g) ranged within the limits reported by other authors [16, 23, 24]. The Cornelian cherry selection should be primarily focused on the larger fruit weight, a characteristic that has the highest direct correlation with mesocarp weight [19]. Depending on the genotype, the average flesh ratio ranged in the interval from 67.85% (BPC8) to 85.94% (CPC16), which is consistent with previous studies of the Cornelian cherry population in the Vojvodina Province [17, 18, 25].

The quality of fruits intended for fresh consumption or processing is expressed through the contents of fruit sugars, acids, vitamins, mineral, aromatic, pectic and other substances [10]. Highest TSC and SSC contents (48.60% and 47.50%, respectively) were found in the genotype with smallest fruits (BPC7). These values were significantly higher than those reported by Jaćimović [26], Demir [27] and Tural [28]. The lowest TSC values (24.93% and 24.87%) were found in BPC2 and APC4, respectively. The lowest SSC values (21.20% and 21.00%) were found for the fruits of KC2 and CPC5, respectively. Acids found in fruits have a direct impact on the glandular activity in human body. The average total acid content was 2.68%, the highest being found in KC2 and CPC16 (3.60% and 3.59%, respectively). The balance between dry matter content and total acids determines fruit taste. According to Pirlak et al. [16], this balance ranges between 3.0 and 9.2. Kalkisim and Odabas [29] reported for their material that this ratio ranged from 8.3 to 9.1, which is in accordance with our results. The total sugars content ranged on average from 11.77% (CPC16) to 41.62% (BPC7), which is significantly higher compared with genotypes from the Slovak Republic (6.5% to 15.5%) [15], Montenegro (8.72% to 18.67%) [26] and Ukraine (5.4% to 13.5%) [30]. Demir [27] reported a significantly lower content of total sugars in the fruit compared with our results. At the same time, BPC7 also had the highest content of reducing sugars (38.3%), while sucrose content showed no significant difference between the genotypes low in sucrose: CPC15 (3.25%), BPC7 (3.20%) and BPC1 (3.10%). Suitability of the investigated characteristics for further selection depends on their variability. The highest average variation among the genotypes, expressed through the coefficient of variation (Table 1), was found for the content of reducing sugars (CV = 37.44%) and fruit weight (CV = 36.91%), while the flesh ratio (CV = 5.20 %) was the most stable characteristic, as found in earlier studies of the Cornelian cherry population in the Vojvodina Province [25].

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. Natural remedies made

Table 1 Morphometric fruit traits and chemical content in some *Cornus mas* L. genotypes from the Vojvodina Province.

Genotype	Fruit weight (g)	Flesh/stone ratio (%)	TSC (%)	SSC (%)	Total acid (%)	Total sugars (%)	Reducing sugar (%)	Sucrose (%)
APC1	2.24 gh	79.52 ij	31.37 f	29.30 f	2.83 cdefg	23.23 g	20.83 h	2.30 ef
APC2	2.27 gh	83.04 def	27.30 i	24.50 i	2.68 fghi	17.90 j	16.30 l	1.50 ij
APC4	2.06 hi	82.86 ef	24.87 l	22.03 k	2.57 hij	16.33 kl	13.75 n	2.45 de
APC6	2.26 gh	85.15 ab	23.13 m	22.00 k	2.85 cdefg	17.70 j	15.97 l	1.65 i
APC8	1.72 jk	80.00 hi	26.80 j	25.60 h	2.99 cde	19.13 i	17.60 j	1.43 ijk
APC9	2.40 fg	82.90 ef	21.23 o	19.00 m	3.30 b	13.90 o	12.27 pr	1.54 ij
APC11	2.07 hi	81.29 gh	41.50 c	39.80 b	2.45 ij	32.73 b	30.72 b	1.90 h
APC17	2.50 f	83.26 cdef	29.80 g	27.00 g	2.11 k	21.22 h	19.60 i	1.35 jk
APC20	1.93 i	80.35 hi	22.53 n	19.10 m	1.62 m	13.20 p	11.10 s	2.10 fgh
BPC1	1.89 ij	84.04 bcde	45.90 b	38.60 c	2.10 k	33.00 b	29.90 c	3.10 ab
BPC2	1.43 l	80.49 hi	24.93 l	23.70 j	3.02 cd	17.85 j	16.17 l	1.60 ij
BPC7	1.60 kl	82.56 fg	48.60 a	47.50 a	2.48 ij	41.62 a	38.33 a	3.20 a
BPC8	1.54 kl	67.85 k	31.30 f	29.60 f	2.80 defgh	16.50 k	15.00 m	1.50 ij
CPC1	1.97 i	81.35 gh	25.57 k	23.30 j	3.25 b	19.57 i	16.75 k	2.68 cd
CPC5	2.47 f	83.28 cdef	22.30 n	21.00 l	2.10 k	18.20 j	17.00 k	1.20 k
CPC6	3.08 d	84.39 bcd	19.49 p	16.20 o	2.74 efgh	14.64 n	12.59 p	1.95 gh
CPC9	2.84 e	79.95 hi	19.34 r	17.00 n	2.36 j	15.49 m	12.44 p	2.90 bc
CPC12	1.93 i	76.00 j	29.50 g	23.60 j	2.10 k	23.60 g	22.30 g	1.50 ij
CPC15	2.41 fg	83.86 bcdef	31.80 f	27.52 g	2.85 cdefg	26.18 d	22.75 f	3.25 a
CPC16	4.10 b	85.94 a	19.93 p	18.60 m	3.59 a	11.77 r	9.50 t	2.20 fg
KC1	4.61a	84.54 bc	23.20 m	21.80 k	3.08 bc	15.97 l	13.00 o	2.85 c
KC2	3.46 c	84.82 ab	22.30 n	21.20 l	3.60 a	14.10 o	12.00 r	2.10 fgh
SKC	4.08 b	79.23 ij	33.39 e	32.37 d	2.66 ghi	25.38 e	23.67 e	1.63 i
TC1	3.22 d	84.10 bcde	28.49 h	27.30 g	2.92 cdef	24.16 f	21.95 g	2.07 fgh
DC1	1.60 kl	80.20 hi	34.97 d	31.50 e	1.85 l	31.10 c	28.26 d	2.68 cd
Max	5.55	89.39	49.35	48.00	3.89	41.80	38.50	3.35
Min	1.08	63.21	19.24	16.10	1.45	11.27	9.40	1.10
Average	2.47	81.64	28.38	25.96	2.68	20.98	18.79	2.11
SD	0.91	4.24	7.72	7.42	0.52	7.27	7.03	0.63
CV (%)	36.91	5.20	27.22	28.59	19.29	34.66	37.44	30.06

*Means followed by the different letters within the same block are significantly different at $P < 0.01$.

from Cornelian cherry leaves, flowers and fruits, either fresh or dry, had been used in the traditional medicine for the treatment of throat diseases, digestive and intestinal problems, measles, anemia, melancholy, skin rash and kidney diseases. Fresh or condensed fruit juice had been used against diabetes. Remedies made from bark and condensed juice had been used in traditional medicine for treatment of skin injuries. Cornelian cherry leaves and powdered dried fruits had served for treatment of hemorrhoids. The medicinal value of the Cornelian cherry is not ignored by modern medicine, as it is considered a significant potential source of raw materials for phytopharmacy. According to Mamedov and Craker [31], fatty oils isolated from the Cornelian cherry exhibit antimicrobial activity against Gram-positive *Staphylococcus aureus* and Gram-negative *Escherichia coli*. Furthermore, Ercisli [32] reports that Cornelian cherry leaves and fruits are used as antidiarrhetics in contemporary pharmacy. Fruits and vegetables are valuable sources of natural antioxidants. They contain different antioxidant components that provide protection from harmful free radicals, reduce the occurrence and mortality rate from cancer and coronary diseases, and they possess many other health benefits [33].

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 25.04 mg/100 g fruit. The highest content (42.30 mg/100 g fruit) was recorded in APC2, which was significantly higher than in any other of the examined genotypes (Table 2). In earlier studies, that genotype was also distinguished for a high content of vitamin C [21]. Pirlak et al. [16] claim 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 [34], while the genotypes from Slovakia had a slightly lower content of this vitamin [15].

Cellulose content varied in the range from 0.30% to 1.50%. The highest content was present in the fruits of BPC1 (1.35%), the lowest in the fruits of APC20 (0.43%). Similar results were reported by Burmistrov [35]. The highest variability (CV = 54.59%) was observed for protein content, which was highest in CPC15 (3.58%) while the average value for all of the tested genotypes was 1.61%. Pectic substances are important for human consumption, because they prevent, mitigate or eliminate gastric problems. These substances are contained in significant quantities in

Table 2 Fruit chemical content in some *Cornus mas* L. genotypes from the Vojvodina Province.

Genotype	Vit. C (mg/100 g)	Cellulose (%)	Ca-pectate (%)	Proteins (%)	Anthocyanins (mg/100 g)	Tannins (%)
APC1	20.38 m	0.62 cdef	1.80 c	2.18 d	40.45 r	1.10 defg
APC2	42.30 a	0.74 bcde	1.20 e	0.52 i	31.20 u	1.10 defg
APC4	21.53 l	0.80 bc	1.48 d	1.47 f	22.65 z	1.05 defgh
APC6	19.33 o	0.60 cdef	0.17 k	1.50 f	30.50 v	1.00 efghi
APC8	17.15 s	0.88 b	1.82 bc	1.53 f	27.25 x	0.65 k
APC9	20.20 mn	0.62 cdef	1.50 d	1.43 f	37.06 s	0.93 fghij
APC11	19.87 n	0.73 bcde	1.99 b	2.90 b	35.33 t	1.45 c
APC17	30.30 g	0.75 bcde	0.62 gh	1.25 g	58.90 j	1.00 efghi
APC20	31.20 f	0.43 f	0.32 jk	0.55 i	54.60 l	0.63 k
BPC1	28.60 h	1.35 a	1.10 ef	0.81 h	96.30 a	0.91 ghij
BPC2	24.25 i	0.62 cdef	1.70 c	1.62 f	65.27 h	1.83 b
BPC7	23.33 j	0.62 cdef	1.44 d	2.06 de	23.35 y	2.05 a
BPC8	38.20 c	0.62 cdef	0.41 ij	0.62 i	71.30 g	1.10 defg
CPC1	21.83 l	0.65 cdef	1.70 c	2.71 c	78.35 e	1.18 de
CPC5	36.30 d	0.53 ef	1.10 ef	0.52 i	82.30 d	1.10 defg
CPC6	19.31 o	0.56 def	1.69 c	2.05 de	58.22 k	1.10 defg
CPC9	17.95 r	0.62 cdef	1.73 c	2.71 c	53.30 m	0.81 ijk
CPC12	32.30 e	0.56 def	0.71 g	0.52 i	29.60 w	1.15 def
CPC15	19.84 n	0.76 bcd	1.88 bc	3.58 a	62.37 i	0.75 jk
CPC16	23.36 j	0.56 def	1.47 d	2.14 d	93.04 b	0.95 fghij
KC1	18.87 p	0.65 cdef	2.52 a	1.88 e	87.69 c	0.84 hijk
KC2	39.22 b	0.54 ef	0.50 hi	0.26 j	51.35 o	0.69 k
SKC	19.45 o	0.53 ef	2.44 a	1.17 g	48.25 p	0.82 ijk
TC1	18.25 r	0.93 b	0.93 f	1.49 f	51.85 n	0.95 fghij
DC1	22.73 k	0.86 b	0.93 f	2.71 c	77.25 f	1.26 d
Max	42.55	1.50	2.60	3.70	96.50	2.10
Min	16.90	0.30	0.15	0.19	22.35	0.50
Average	25.04	0.69	1.33	1.61	54.71	1.06
SD	7.42	0.20	0.63	0.88	22.13	0.34
CV (%)	29.62	29.58	47.83	54.59	40.45	32.08

*Means followed by the different letters within the same block are significantly different at $P < 0.01$.

Cornelian cherry fruits. According to Burmistrov [35], the tannin content ranges from 0.6 to 14%. In the tested fruits, the content of tannins was recorded in the interval from 0.65% (APC8) and 0.69% (KC2) to 2.05% (BPC7). The various bright colors (red, blue and violet) of fruits, vegetables and flowers come from anthocyanins, which are used as dietary polyphenols, and which are one of the main ingredients of fruits and vegetables. Anthocyanins contained in fruits tend to reduce the occurrence of coronary diseases and are also used for antidiabetic purposes [6].

Cornelian cherry fruits are characterized by a significant content of colored substances. The average content of anthocyanins in the tested fruits amounted to 54.71 mg/100g fruit, the highest content being found in BPC1 (96.30 mg). Foods of plant origin, fruits, vegetables and cereals, are the principal sources of minerals that compose the human body. The contents of microelements measured in the tested Cornelian cherry fruits (Table 3) showed very high coefficients of variation, especially the content of Na (CV = 62.80%), followed by those of Mn, Ca and Mg. The significantly highest ash content was recorded in the genotype APC8 (1.87%), which also had the highest contents of Cu (1.86 ppm), Fe (14.40 ppm), Zn (3.60 ppm), Mg (372.80 ppm) and Na (273.48 ppm). Our results showed that the fruits of the local Cornelian cherry genotypes were much better provided with microelements than the genotypes from Turkey [27]; however, they had significantly lower contents of K and Mg than the Slovakian genotypes [36]. The genotype APC9 had the highest Mn content (1.59 ppm),

Table 3 Fruit mineral content in some *Cornus mas* L. genotypes from Vojvodina Province (ppm).

Genotype	Ash (%)	Cu	Fe	Zn	Mn	Mg	Ca	K	Na
APC1	1.00 defg	1.09 fg	6.61 h	1.34 efg	0.41 efg	146.10 l	1046.12 c	5061 u	121.33 h
APC2	0.90 efgh	1.07 g	10.97 b	1.04 ij	0.35 fgh	140.70 m	487.50 n	4600 w	160.05 e
APC4	0.77 hijk	1.72 b	11.03 b	1.20 gh	0.35 fgh	164.90 h	494.80 l	11487 a	194.93 c
APC6	0.68 jk	0.90 h	8.64 e	1.00 jk	0.43 ef	10.20 w	33.80 z	2330 z	104.86 k
APC8	1.87 a	1.86 a	14.40 a	3.60 a	0.92 b	372.80 a	834.10 d	10688 c	273.48 a
APC9	0.86 efghij	0.54 i	3.12 p	0.89 k	1.59 a	133.20 o	402.00 t	5609 p	40.75 v
APC11	0.88 efghi	1.08 fg	3.77 n	1.29 fgh	0.40 efgh	151.70 k	592.00 f	5527 r	31.84 x
APC17	0.85 fghij	1.05 g	3.86 n	1.28 fgh	0.33 gh	191.92 f	492.90 m	5721 n	60.83 t
APC20	0.60 k	0.86 h	3.10 p	0.95 jk	0.24 i	81.60 v	335.60 w	4114 x	45.64 u
BPC1	1.57 b	1.18 defg	5.50 j	2.51 b	0.73 c	271.30 c	1307.70 a	9538 d	129.87 f
BPC2	1.13 d	0.62 i	5.93 i	1.55 d	0.52 d	125.40 r	459.23 r	6689 m	23.83 y
BPC7	1.30 c	0.52 i	4.65 k	1.16 hi	0.35 fgh	114.80 s	403.92 s	8836 h	39.33 w
BPC8	1.40 c	1.07 g	3.93 n	1.37 ef	0.41 efg	152.80 j	578.00 g	8997 g	22.82 z
CPC1	1.38 c	1.48 c	10.46 c	2.05 c	0.70 c	284.90 b	1060.00 b	11110 b	118.55 i
CPC5	0.72 hijk	1.20 def	8.33 f	1.40 ef	0.42 ef	160.70 i	467.60 o	5652 o	71.77 p
CPC6	1.00 defg	1.24 de	7.13 g	1.40 ef	0.35 fgh	186.30 g	532.20 i	7624 k	90.70 l
CPC9	0.87 efghij	1.47 c	6.67 h	1.58 d	0.43 ef	160.90 i	526.00 j	9171 e	78.31 n
CPC12	0.80 hijk	1.05 g	7.20 g	1.48 de	0.44 e	204.60 d	555.30 h	8096 j	64.30 r
CPC15	0.92 efgh	1.45 c	7.10 g	1.61 d	0.35 fgh	195.20 e	657.40 e	9069 f	128.65 g
CPC16	0.85 fghij	1.30 d	9.06 d	1.26 fgh	0.32 h	138.50 n	340.20 v	5273 t	185.55 d
KC1	0.69 ijk	1.26 d	3.57 o	1.36 ef	0.42 ef	127.30 p	516.80 k	4755 v	76.73 o
KC2	1.01 defg	0.90 h	2.38 r	0.97 jk	0.32 h	86.30 u	381.10 u	5491 s	83.37 m
SKC	1.05 def	1.12 defg	4.38 l	1.33 fg	0.36 efgh	113.20 t	466.50 p	7518 l	111.17 j
TC1	1.05 def	0.53 i	4.20 m	2.12 c	0.40 efgh	10.30 w	49.83 x	3456 y	62.18 s
DC1	1.37 c	1.23 de	7.10 g	0.92 jk	0.57 d	10.23 w	47.43 y	8615 i	223.07 b
Max	1.97	1.93	14.45	3.70	1.69	372.90	1307.90	11489	273.58
Min	0.49	0.42	2.34	0.80	0.23	10.10	33.70	2328	22.72
Average	1.02	1.11	6.52	1.47	0.48	149.43	522.72	7001	101.76
SD	0.31	0.34	2.98	0.58	0.27	81.21	293.29	2449.95	63.90
CV (%)	30.85	30.94	45.68	39.88	56.47	54.34	56.11	34.99	62.80

*Means followed by the different letters within the same block are significantly different at $P < 0.01$.

while BPC1 stood out regarding the content of Ca (1307.70 ppm). The highest content of K (11487 ppm) was registered in the fruits of APC4.

4. Conclusions

Cornelian cherry fruits produced under pristine natural conditions are free of pesticide residues and meet the most stringent standards of safe food production. In addition, a harmonic content of sucrose, tannin, pectin, organic acids, vitamins, colored substances, etc. makes the Cornelian cherry extremely important from both, nutritional and medicinal aspects. For these reasons, the Cornelian cherry fits exactly the maxim of Hippocrates, the famous Greek physician, made 2000 years ago: "Food should be medicine, and medicine should be food".

Based on the study of morphometric and chemical characteristics of Cornelian cherry fruits, it can be concluded that there exist significant differences in morphological characteristics among its genotypes. Also, chemical analyses showed significant differences in the mesocarp composition among the genotypes. The Cornelian cherry mesocarp has a high nutritional value, primarily because it contains biologically active substances suitable for human consumption. Owing to its balanced chemical composition, the Cornelian cherry fruit meets the high standards set up for its application for medicinal purposes primarily on account of its dietary properties.

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