Content of certain food components in flesh and stones of the cornelian cherry (*Cornus mas* L.) genotypes

R. Vidrih*, Ž. Čejić, J. Hribar

University of Ljubljana, Biotechnical Faculty, Department of Food Science and Technology, Jamnikarjeva 101, SI-1000 Ljubljana, Slovenia

original scientific paper

Summary

The aim of this study was to determine the colour components (L^*, a^*, b^*), soluble solid (SS), water and L-ascorbic acid contents in the fruit of ten different genotypes of cornelian cherry (*Cornus mas L.*) Fatty-acid composition, the total fat and ash and mineral contents were determined in the stones. The values of the colour components were: L^* from 21.51 to 27.85, a^* from 8.64 to 26.22, and b^* from 2.15 to 11.90. They contained from 10.70 % to 19.30 % SS. The L-ascorbic-acid content ranged from 29.29 to 86.40 mg/100 g. The genotypes showed statistically significant differences according to the colour parameters and the content of soluble solids and L-ascorbic acid. In 100 g stones, there were from 5.82 to 6.73 g water, from 0.84 to 1.51 g ash, and from 4.45 to 7.94 g fat. For the fatty-acid composition, these were mainly represented by: linoleic acid from 64.78 % to 72.21 %; oleic acid from 15.50 % to 22.97 %; palmitic acid from 7.31 % to 8.11 %; stearic acid from 2.02 % to 2.99 %; linolenic acid from 1.47 % to 1.62 %; and arachidic acid from 0.27 % to 1.52 %. The genotypes showed statistically significant variations in the content of fatty acids with the exception of linolenic acid. 100 g of stones contained: calcium from 385.79 to 432.91 mg; potassium from 243.09 to 327.04 mg; phosphorus from 152.01 to 261.48 mg; magnesium from 39.38 to 56.68 mg; sodium from 13.22 to 19.40 mg; and copper from 0.39 to 0.81 mg.

Keywords: Cornus mas, genotypes, colour, ascorbic acid, fatty acids, minerals

Introduction

Cornelian cherry (*Cornus mas* L.) fruit are widely grown in Asia and Europe (Tural and Koca, 2008). Eyde (1988) reported that there are 65 species of cornelian cherry, which are grown mainly in the northern temperate regions. *Cornus mas* varieties are known not to be homogenous and to range from shrubs to small trees of about 7 m in height. The shape of the cornelian cherry fruit is similar to rosehips or small olive fruit, and they are generally 10 - 20 mm long, yellow or red in colour, with a sweat-sour taste (Tural and Koca, 2008).

The world production of cornelian cherries is not known, Guleryuz et al., (1996) reported the yield in Turkey as approximately 14,000 tons. The fruits are not only consumed fresh, but also used to produce jams, stewed fruit, gels, syrup, vinegar and several soft drinks (Demir and Kalyoncu, 2003; Millspaugh, 1974), while also being used for medicinal purposes. In Turkey, cornelian cherries are used for medical treatment of gastrointestinal disorders and diarrhoea (Celik et al., 2006). Other *Cornus* specimens are used in Chinese herbal medicine, due to their tonic, analgesic and diuretic activities. Some reports have shown anti-bacterial, antihistamine, anti-alergy and anti-malarial effects (Vareed et al., 2006). In Asia, *Cornus* fruits are among the major constituents of several antidiabetic herbal extracts (Jayaprakasam et al., 2005). As a fruit that contains compounds with medicinal effects, cornelian cherries are rich in antioxidants: i.e. ascorbic acid (Yilmaz et al., 2009) and flavonoids (Hashempour et al., 2010; Pawlowska et al., 2010; Rop et al., 2010; Seeram et al., 2002; Yilmaz et al., 2009).

Cornelian cherries are a significant source of ascorbic acid (up to 100 mg/100 g), which is more than other commonly consumed fruits, such as strawberries, orange and kiwifruit. Due to their high levels of antioxidants, cornelian cherries have higher antioxidative potential as compared to these other fruits. As observed by Pantelidis et al., (2007) and compared to other small fruits, cornelian cherries are an extremely rich source of not just ascorbic acid, but also anthocyanin, phenols and other antioxidants, and they are already used in food and nutraceutical supplement formulations.

The cornelian cherry genotypes show a wide variation in many of the fruit quality parameters (Yilmaz et al., 2009). In the literature, the genotypes are mainly mentioned, with only a few exceptions also providing the cornelian cherry cultivars (Brindza et al., 2009; Pantelidis et al., 2007). However, across the genotypes, when breeding cornelian cherry cultivars, there is a wide variety of agronomic characteristics that can be considered,

*Corresponding author: rajko.vidrih@bf.uni-lj.si

such as improvements in yields, pest and disease resistance, fruit weight, soluble solids and total antioxidants.
The purpose of the study was to find out differences in chemical composition of 10 cornelian cherry genotypes. Corenelian cherry is used to produce various products like spirit, liquor and marmelade. We suppose that the information regarding chmemical composition of genotypes will enable local producers to better decide suitability of genotyes for different products.

Material and methods

Fruit Samples

Samples of the native cornelian cherry (*Cornus mas* L.) population with red coloured fruit were collected from the Drvar, republic of Bosnia and Hercegovina in 2010. All genotypes were grown widely with no use of fertilisers; environmental, growing and soil conditions were the same for all genotypes. Soil is red type rich in carbonates. The fruit of 10 different genotypes (numbered from 1 to 10) were harvested on the same day (approximately 1 kg of each genotype). Genotypes were characterised according to visual appearance of trees and fruits. According to visual appearance of fruits, all genotypes were at a similar maturity level at harvest. After the harvest, the samples were immediately transferred to the laboratory of the Biotechnical Faculty and frozen at −20 °C, until needed. Colour measurements and soluble solids content were analysed on fresh fruits, all other analyses were made on frozen samples.

Colour Measurements

The cornelian cherry fruit skin colours were measured using a portable tristimulus Minolta Chroma Meter CR-200 colorimeter (Minolta Corp, Osaka, Japan) and recorded as Commission Internationale d'Eclairage (CIE) colour space coordinates: L^*, a^* and b^*. The colorimeter was standardised using the CR.A43 Minolta calibration plate before measurements were taken. Ten fruits of each genotype were measured twice, on opposite sides.

Water content

Water content was determined by weight difference after drying of sample, following the official method of AOAC (950.46, 1997).

Lipid content in stones

Lipid content in stones was determined by means of Soxhlet apparatus according to the method of Weibull and Stoldt (AOAC 991.31, 1997)

Ash content

Ash content was determined according to the standard procedures (AOAC 920.153, 1997).

Soluble Solids Content

Samples of the genotypes examined were pooled to obtain composite samples, and analysed for soluble solids content (SSC) using a digital refractometer (Atago Model PR-1, Tokyo).

Ascorbic-Acid Content

Ascorbic-acid content was determined according to the method described by (de Quirós et al., 2009). Ten g of each cornelian cherry sample was homogenised in 10 g stabilising solution (2 % [w/v] metaphosphoric acid). The analyses were performed on an HP1100 HPLC system (Hewlett-Packard) equipped with an HP1100 quaternary pump, an HP1100 degassing device, a 20-µl injection loop (Rheodyne, Cotati, CA), a Bio-Rad Aminex HPX (87H, 300 x 7.8 mm) column fitted with the same guard column and an HP1100 UV-detector set at 245 nm. The HPLC system was controlled by a personal computer running Agilent ChemStation software for LC and LC/MS systems.

Fatty-Acid Analysis

The fatty-acid compositions of the samples were determined by gas-liquid chromatography, using *in-situ* transesterification (Park and Goins, 1994), as modified by Polak et al., (Polak et al., 2008). All of the samples were analysed in three parallel analyses.

Results and discussion

Fruit Colour

For the brightness, the L^* values here ranged from 21.51 to 27.85, with statistically significant differences ($p < 0.0032$) seen among the genotypes (Table 1). A positive a^* value, that mimics intensity of red colour ranged in our study from 8.64 to 26.13 again with statistically significant differences ($p < 0.0001$) among genotypes. Comparing L^* and a^* value, much wider range is observed for a^* value with a ratio between the lowest in the highest point amount to 3:1.

Table 1. Colour space coordinates of the 10 genotypes of cornelian cherry used in the present study ($\bar{x}$ ± sd, Duncan test, α = 0.05)

	Colour space coordinates		
Genotype	*L**	*a**	*b**
1	21.51 ± 2.21^{c}	11.07 ± 0.33^{bc}	3.38 ± 0.43^{d}
2	26.42 ± 0.21^{a}	22.61 ± 2.28^{a}	8.40 ± 0.81^{abc}
3	27.85 ± 1.32^{a}	26.13 ± 4.43^{a}	11.90 ± 3.75^{a}
4	26.49 ± 1.35^{a}	25.55 ± 3.70^{a}	10.71 ± 2.28^{ab}
5	26.90 ± 1.61^{a}	26.22 ± 0.59^{a}	10.91 ± 0.46^{ab}
6	22.61 ± 1.60^{bc}	22.16 ± 0.30^{a}	7.86 ± 0.29^{bc}
7	23.13 ± 0.78^{bc}	15.41 ± 1.97^{b}	4.85 ± 0.67^{cd}
8	22.61 ± 0.69^{bc}	10.31 ± 2.92^{bc}	2.92 ± 1.29^{d}
9	22.41 ± 0.16^{c}	8.64 ± 1.97^{c}	2.15 ± 0.65^{d}
10	25.61 ± 1.08^{ab}	24.40 ± 0.30^{a}	10.33 ± 0.28^{ab}
P value	< 0.0032	< 0.0001	< 0.0003

^{a,b,c} groups with different superscript letters within columns differ significantly (P ≤ 0.05)

*b** value which is like *L** and *a** value not as important parameter to determine fruit maturity ranged from 2.15 to 11.90 with statistically significant differences ($p < 0.0003$) among genotypes.

Consumer acceptability of cornelian cherry fruit depends on a number of parameters, although skin colour is often regarded as the one on which the consumer makes the first choice of whether to buy them or not. Colour characteristics like brightness, redness, yellowness and shyness are among characteristics that can trigger consumer willingness at first glance.

In Turkey, Tural and Koca (Tural and Koca, 2008) reported *L** values in the range of 10.82 to 19.69, which were considerably lower when compared with our data, indicating that our genotypes were generally brighter in colour. The genotypes also had statistically significant effects on the *a** and *b** parameters. The *a** values are the aspect that is most commonly used in research to indicate the colour, and they range from negative values (green) to positive values (red), which represent changes in the green to red colour during fruit ripening.

In the present study, the *a** values were in range of 8.64 to 26.13, which is higher than those reported by Tural and Koca (Tural and Koca, 2008). Although not as important as the *a** value, the *b** value represents the colour changes from blue (negative) to yellow (positive). In the present study, colour parameter *b** ranged from 2.15 to 10.91, and was again higher that published by Tural and Koca (Tural and Koca, 2008). These colour measurements thus show that the cornelian cherry fruit in the present study were brighter and had more intensive red and yellow colours, as compared to those of Tural and Koca (Tural and Koca, 2008).

Soluble Solids Content

As one of the most important quality parameter for many fruit species, soluble solids represent sugar content in fruit pulp. In our study, average soluble solids ranged from 10.7 % to 19.3 % (Table 2) which is in terms of quality quite wide range. The statistical analyses showed that the average soluble soluble solids content was significantly affected by genotype ($p < 0.001$). Fruit maturity on trees is most often evaluated by measuring the SSC, using refractometry, with the aim of determining the optimum harvest date. During fruit development, the SSC increases, until a steady state is reached. At this point, the fruit should be harvested. The SSC is also regarded as an important quality attribute, as its value directly mimics the sugar content and affects the sensory properties of the fruit. Statistically significant differences were found among the genotypes for SSC and ascorbic-acid content. The SSCs were in the range of 11.0 % to 19.30 % which were slightly less when compared to the previous studies (Demir and Kalyoncu, 2003; Tural and Koca, 2008). The variations in the SSC are the result of both different environmental conditions and genetic factors, as described by Guleryuz et al., and Demir and Kalyoncu (Demir and Kalyoncu, 2003; Guleryuz et al., 1996).

Table 2. SSC and ascorbic acid content of the 10 genotypes of cornelian cherry used in the present study ($\bar{x}$ ± sd, Duncan test, α = 0.05)

Genotype	Soluble solids (%)	Asorbic acid (mg/100 g)
1	15.90 ± 0.71^{cb}	40.89 ± 0.71^{f}
2	11.90 ± 1.13^{ef}	32.51 ± 0.65^{g}
3	14.70 ± 0.85^{cbd}	58.89 ± 0.37^{d}
4	12.50 ± 0.42^{fed}	62.28 ± 1.05^{cd}
5	11.05 ± 0.35^{f}	71.22 ± 1.23^{b}
6	10.70 ± 0.00^{f}	67.15 ± 2.35^{cb}
7	14.05 ± 2.47^{cde}	29.29 ± 1.19^{g}
8	16.90 ± 0.42^{b}	60.88 ± 5.05^{d}
9	19.30 ± 0.14^{a}	86.40 ± 3.29^{a}
10	14.05 ± 0.49^{cde}	51.39 ± 0.40^{e}
P value	< 0.0001	< 0.001

[a,b,c] groups with different superscript letters within columns differ significantly (P ≤ 0.05)

Content of Ascorbic Acid

The average content of ascorbic acid is presented in Table 2. In the present study, the ascorbic-acid contents were in the range of 29.29 to 86.40 mg/100 g, with a mean of 56.1 mg/100 g. Statistical analyses showed significant interaction between genotypes ($p < 0.001$). Ascorbic acid is a water soluble vitamin and an important antioxidant. Compared to other commonly consumed fruits, cornelian cherries are regarded as a better source of ascorbic acid. Their content is dependent on both genetic factors and pedoclimatic conditions. Similar data have been reported in other studies (Demir and Kalyoncu, 2003; Guleryuz et al., 1996), while Pantelidis et al., and Klimenko (Klimenko, 2004; Pantelidis et al., 2007) reported higher concentrations of ascorbic acid (101 to 193 mg/100 g).

Analyses of Cornelian Cherry Seeds

The content of water, total fat and ash is given in Table 3.

Table 3. Water, total fat and ash contents in the stones of the 10 genotypes of cornelian cherry used in the present study ($\bar{x}$ ± sd, Duncan test, α = 0.05)

Genotype	Water (g /100 g)	Total fat (g /100g dry matter)	Ash (g/100 g dry matter)
1	6.48 ± 0.28^{abc}	4.68 ± 0.08^{hi}	1.07 ± 0.04^{bc}
2	6.45 ± 0.11^{ab}	5.81 ± 0.26^{f}	1.34 ± 0.25^{ab}
3	5.82 ± 0.20^{d}	4.91 ± 0.11^{h}	1.22 ± 0.24^{abc}
4	6.52 ± 0.33^{abc}	4.45 ± 0.14^{i}	0.84 ± 0.06^{c}
5	6.55 ± 0.28^{ab}	6.69 ± 0.14^{d}	1.14 ± 0.01^{abc}
6	6.47 ± 0.17^{abc}	5.30 ± 0.04^{g}	1.51 ± 0.02^{a}
7	5.95 ± 0.16^{cd}	7.94 ± 0.02^{a}	1.45 ± 0.20^{ab}
8	6.73 ± 0.20^{a}	7.47 ± 0.06^{b}	1.25 ± 0.21^{abc}
9	6.15 ± 0.34^{bcd}	6.39 ± 0.02^{e}	1.48 ± 0.30^{ab}
10	6.17 ± 0.07^{abcd}	7.20 ± 0.03^{c}	1.11 ± 0.02^{abc}
P value	0.0411	< 0.0001	< 0.0520

[a,b,c] groups with different superscript letters within columns differ significantly (P ≤ 0.05)

Air dried stones contain from 5.9 % to 6.55 % of water. The content of total fat ranged from 4,45 % to 7,94 %, statistical analyses showed significant differences between genotypes ($p < 0.0001$). Ash content was found in range from 0,84 to 1.48 g/100 g dry mater with no statistically significant differences between genotypes. The stones of different plant species are known to be good sources of fat, minerals, protein and dietary fibre. The main factor affecting the 'storeability' of stones is their water content, which is recommended to be below 12 % to ensure the quality of the stones. The stones of all of our genotypes contained from 5.9 % to 6.73 % water. Our genotypes also showed statistically significant differences in total fat contents, that ranged from 4.45 % to 7.94 %. Our data show slightly higher fat values when compared

to the data obtained by Brindza et al., (Brindza et al., 2009), who reported an average value of total fat as 4.6 %. Beside genetic factor, possible reason coul also be pedoclimatic conditions. As compared to other stones, cornelian cherry stones contain considerably less fat. The stones of the cornelian cherry are also very well protected by their thick endocarp, which does not break easily, so these stones can start to germinate two years after being deposited in the soil.

Table 4. Fatty-acid composition in the stones of the 10 genotypes of cornelian cherry used in the present study ($\bar{x}$ ± sd, Duncan test, α = 0.05)

	Fatty-acid composition (% total fatty acids)					
Genotype	Palmitic C16:0	Stearic C18:0	Oleic C18:1	Linoleic C18:2	Linolenic C18:3	Arachidic C20:0
1	7.3 + 0.42^{c}	2.0 + 1.03^{e}	17.7 + 0.12^{e}	70.9 + 0.03^{b}	1.6 + 0.01^{a}	0.4 + 0.41^{b}
2	8.1 + 0.11^{a}	2.3 + 0.04^{d}	22.9 + 0.15^{a}	64.8 + 0.21^{f}	1.6 + 0.01^{ab}	0.3 + 0.00^{cd}
3	8.1 + 0.03^{a}	2.0 + 0.06^{e}	20.9 + 0.01^{b}	67.2 + 0.10^{d}	1.5 + 0.01^{ab}	0.3 + 0.01^{d}
4	8.1 + 0.07^{a}	2.1 + 0.10^{ed}	19.2 + 0.38^{d}	68.6 + 0.55^{c}	1.5 + 0.02^{ab}	0.4 + 0.42^{b}
5	7.6 + 0.05^{b}	2.2 + 0.04^{ed}	21.2 + 0.05^{b}	67.3 + 0.16^{d}	1.5 + 0.00^{b}	0.3 + 0.02^{c}
6	7.4 + 0.12^{c}	2.1 + 0.14^{ed}	19.4 + 0.27^{d}	69.2 + 0.53^{c}	1.5 + 0.00^{ab}	0.4 + 0.00^{b}
7	8.0 + 0.07^{a}	2.9 + 0.02^{a}	19.3 + 0.46^{d}	66.1 + 0.10^{e}	1.6 + 0.00^{a}	1.5 + 0.02^{a}
8	7.6 + 0.04^{b}	2.8 + 0.07^{b}	15.5 + 0.00^{f}	72.2 + 0.09^{a}	1.5 + 0.03^{ab}	0.3 + 0.02^{cd}
9	7.8 + 0.10^{b}	2.5 + 0.04^{c}	20.7 + 0.16^{cb}	67.2 + 0.28^{d}	1.5 + 0.01^{b}	0.3 + 0.03^{cd}
10	7.4 + 0.08^{c}	2.1 + 0.04^{ed}	19.7 + 1.21^{cd}	68.8 + 1.26^{c}	1.5 + 0.15^{ab}	0.3 + 0.02^{cd}
P value	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.1486	< 0.0001

^{a,b,c} groups with different superscript letters within columns differ significantly (P ≤ 0.05)

Fatty acid composition of stones is presented in Table 4. Altogether 6 fatty acids were determined in stones. The most abundant fatty acids were unsaturated linolic and oleic followed by linolenic. Among saturated fatty acids the prevailing fatty acid was palmitic, followed by stearic and arachidic. Genotype influenced highly statistically significantly ($p < 0.001$) the content of all fatty acids, with the exception of linolenic acid ($p > 0.05$). Although genetic factors may influence the content of fatty acids, here no statistical differences were found between genotypes. The reason could be its relatively low concentration as compared to other fatty acids and substantial standard deviation.

The main fatty acid was linolic acid, which represented 70 % of all of the fatty acids. Oleic acid represented 20 % of all fatty acids, while for palmitic acid this was 8 %. Other fatty acids, like stearic, linolenic and arachidic, were found at lower concentrations. These data from our investigation are in good agreement with those reported by Brindza et al., (Brindza et al., 2009), who also detected pentadecenic, palmitooleic and vaccenic fatty acids, although at levels of less than 0.5 % each. From the nutritional point of view, the fatty-acid composition of these cornelian cherry stones is similar to that of the common vegetable oils consumed today, such as from sunflower, corn, pumpkin and cotton.

Analyses of Minerals In Cornelian Cherry Seeds

Mineral composition of cornelian cherry stones is presented in Table 5. The most abundant mineral present in stones was calcium, followed by potassium, phosphorus, magnesium and sodium. All minerals studied in our investigation appeared to be significantly affected by genotype. Highly statistically significant ($p < 0.001$) were found for phosphorus and magnesium, while the differences were statistically significant ($p < 0.05$) for other minerals. With regard to the mineral composition of fruits, the soil type and levels of nitrogen fertilisation are the main deciding factors (Peuke, 2009). While there is some data available regarding the macro-elements and micro-elements in the mesocarp of cornelian cherries (Brindza et al., 2009), in the literature there are no such data for the stones. Thus, the main mineral in the cornelian cherry mesocarp was reported as potassium, followed by calcium and phosphorus (Brindza et al., 2009). In the present study, we carried out elemental analyses only for the cornelian cherry stones. As seen from Table 5, the main element was calcium, followed by potassium, phosphorus and magnesium. These data show that the genotype significantly affected the mineral composition of the stones. As shown by Arvanitoyannis et al., (Arvanitoyannis and Mavromatis, 2009) for the mineral composition of banana, this was correlated with the genotype and the growing conditions. Indeed, in the

same study, minerals were used to discriminate quite accurately between banana cultivars from different geographical origins. Our genotypes were collected from different microclimatic and soil conditions, which would in part explain the variability observed among our genotypes.

Table 5. Mineral composition in the stones of the 10 genotypes of cornelian cherry used in the present study ($\bar{x}$ ± sd, Duncan test, α = 0.05)

	Mineral composition (mg/100g)					
Genotype	Ca	K	P	Mg	Na	Cu
1	416.1 ± 0.2^{abc}	305.2 ± 0.2^{bc}	180.2 ± 0.3^{c}	50.0 ± 0.0^{b}	16.1 ± 0.1^{bcd}	0.8 ± 0.0^{a}
2	415.0 ± 10.8^{abc}	307.8 ± 15.1^{bc}	254.5 ± 2.1^{ab}	59.7 ± 0.7^{a}	18.0 ± 0.6^{abc}	0.6 ± 0.1^{bc}
3	432.9 ± 28.8^{a}	316.9 ± 11.9^{abc}	242.1 ± 11.9^{b}	44.0 ± 1.6^{c}	18.4 ± 1.4^{ab}	0.8 ± 0.0^{a}
4	415.4 ± 0.6ab^{c}	295.2 ± 0.3^{e}	152.0 ± 0.0^{d}	39.4 ± 0.5^{e}	13.2 ± 0.3^{e}	0.6 ± 0.0^{b}
5	421.0 ± 3.6^{ab}	315.6 ± 6.3^{bc}	257.1 ± 8.9^{ab}	41.8 ± 0.8^{cd}	19.4 ± 0.4^{a}	0.6 ± 0.0^{bc}
6	394.4 ± 0.6^{bcd}	321.0 ± 0.1^{ab}	261.5 ± 0.7^{ab}	51.1 ± 0.2^{b}	18.1 ± 0.1^{abc}	0.5 ± 0.0^{cde}
7	408.9 ± 14.1^{bcd}	327.0 ± 20.7^{ab}	250.5 ± 13.0^{ab}	40.1 ± 0.4^{ed}	18.0 ± 0.1^{abc}	0.4 ± 0.0^{ed}
8	391.3 ± 5.9^{cd}	321.0 ± 5.1^{ab}	244.6 ± 1.2^{ab}	44.0 ± 1.6^{c}	16.8 ± 3.7^{abc}	0.4 ± 0.0^{e}
9	412.4 ± 0.6^{abcd}	243.1 ± 0.1^{f}	243.0 ± 0.1^{b}	44.1 ± 0.2^{c}	15.1 ± 0.2^{cd}	0.5 ± 0.0^{bcd}
10	385.8 ± 7.7^{d}	311.4 ± 5.4^{bc}	255.9 ± 10.1^{ab}	42.4 ± 1.6^{c}	15.0 ± 0.4^{cd}	0.5 ± 0.0^{cde}
P-value	< 0.0351	< 0.0369	< 0.0001	< 0.0001	< 0.0143	< 0.0455

^{a,b,c} groups with different superscript letters within columns differ significantly (P ≤ 0.05)

Conclusions

With regard to the cornelian cherry, only a few cultivars are known, with most of the cornelian cherry population usually referred to as genotypes. There also remains great interest in the isolation of valuable genotypes that can be used by breeders to produce new cultivars with higher nutritional value. Our data confirm previous observations that have shown wide variability among genotypes grown in the wild. Wide variations were found among these cornelian cherry genotypes in terms of all of the parameters that we have studied. From the consumers' point of view, the most important characteristics of cornelian cherries are the fruit weight and the SSC and antioxidant content. As no commercial cornelian cherry cultivars exist, the existing genotypes can be used in breeding programmes to incorporate a wide range of agronomic characteristics into a final cornelian cherry cultivar. In conclusion, the present study clearly shows the potential value of the cornelian cherry germplasm.

References

AOAC 920.153. (1997): Ash of meat. In: P. Cunnif (ed.), Official methodsof analyses of AOAC International. 16th ed. Washington, DC, USA: AOAC International: Chapter 39, 4-4.

AOAC 950.46. (1997): Moisture in meat. In: P. Cunnif (ed.), Official methodsof analyses of AOAC International. 16th ed. Washington, DC, USA: AOAC International: Chapter 39, 1-2.

AOAC 991.36. (1997): Fat (crude) in meat and meat products. In: P. Cunnif (ed.), Official methodsof analyses of AOAC International. 16th ed. Washington, DC, USA: AOAC International: Chapter 39, 3-4.

Arvanitoyannis, I. S., Mavromatis, A. (2009): Banana Cultivars, Cultivation Practices, and Physicochemical Properties. *Crit. Rev. Food Sci. Nutr.* 49 (2), 113-135.

Brindza, P., Klimenko, S. V., Grigorieva, O., Brindza, J.,Toth, D. (2009). Biological and Commercial Characteristics of Cornelian Cherry (*Cornus mas* L.) Population in the Gemer Region of Slovakia. In: *I International Symposium on Pomegranate and Minor Mediterranean Fruits* vol. 818 (pp. 85-93). Adana, Turkey: ISHS.

Celik, S., Bakirci, I., Sat, I. G. (2006): Physicochemical and organoleptic properties of yogurt with cornelian cherry paste. *Int. J. Food Prop.* 9 (3), 401-408.

de Quirós, A. R. B., Fernández-Arias, M., López-Hernández, J. (2009): A screening method for the determination of ascorbic acid in fruit juices and soft drinks. *Food Chem.* 116 (2), 509-512.

Demir, F., Kalyoncu, I. H. (2003): Some nutritional, pomological and physical properties of cornelian cherry (*Cornus mas* L.). *J. Food Eng.* 60 (3), 335-341.

Eyde, R. H. (1988): Comprehending cornus - puzzles and progress in the systematics of the dogwoods. *Bot. Rev.* 54 (3), 233-351.

Guleryuz, M., Bolat, I.,Pirlak, L. (1996): Selection of table cornelian cherry (*Cornus mas* L.) types in Coruh valley. *Turk. J. Agric. For.* 22, 357-364.

Hashempour, A., Ghazvini, R. F., Bakhshi, D., Ghasemnezhad, M., Sharafti, M.,Ahmadian, H. (2010): Ascorbic Acid, Anthocyanins, and Phenolics Contents and Antioxidant Activity of Ber, Azarole, Raspberry, and Cornelian Cherry Fruit Genotypes Growing in Iran. *Hortic. Environ. Biotechnol.* 51 (2), 83-88.

Jayaprakasam, B., Vareed, S. K., Olson, L. K.,Nair, M. G. (2005): Insulin secretion by bioactive anthocyanins and anthocyanidins present in fruits. *J. Agric. Food Chem.* 53 (1), 28-31.

Klimenko, S. (2004): The cornelian cherry (*Cornus mas* L.): collection, preservation and utilisation of genetic resources. *J. Fruit Ornam. Plant Res.* 12, 93-98.

Millspaugh, C. F. (1974). *American Medicinal Plants*. New York: Dover Publications.

Pantelidis, G. E., Vasilakakis, M., Manganaris, G. A.,Diamantidis, G. (2007): Antioxidant capacity, phenol, anthocyanin and ascorbic acid contents in raspberries, blackberries, red currants, gooseberries and cornelian cherries. *Food Chem.* 102 (3), 777-783.

Park, P. W., Goins, R. E. (1994): In-situ preparation of fatty-acid methyl-esters for analysis of fatty-acid composition in foods. *J. Food Sci.* 59 (6), 1262-1266.

Pawlowska, A. M., Camangi, F., Braca, A. (2010): Quali-quantitative analysis of flavonoids of *Cornus mas* L. (*Cornaceae*) fruits. *Food Chem.* 119 (3), 1257-1261.

Peuke, A. D. (2009): Nutrient composition of leaves and fruit juice of grapevine as affected by soil and nitrogen fertilization. *Z. Pflanzenernähr. Bodenkd.* 172 (4), 557-564.

Polak, T., Rajar, A., Gasperlin, L.,Zlender, B. (2008): Cholesterol concentration and fatty acid profile of red deer (*Cervus elaphus*) meat. *Meat Sci.* 80 (3), 864-869.

Rop, O., Mlcek, J., Kramarova, D., Jurikova, T. (2010): Selected cultivars of cornelian cherry (*Cornus mas* L.) as a new food source for human nutrition. *Afr. J. Biotechnol.* 9 (8), 1205-1210.

Seeram, N. P., Schutzki, R., Chandra, A., Nair, M. G. (2002): Characterization, quantification, and bioactivities of anthocyanins in Cornus species. *J. Agric. Food Chem.* 50 (9), 2519-2523.

Tural, S.,Koca, I. (2008): Physico-chemical and antioxidant properties of cornelian cherry fruits (*Cornus mas* L.) grown in Turkey. *Sci. Hortic.* 116 (4), 362-366.

Vareed, S. K., Reddy, M. K., Schutzki, R. E., Nair, M. G. (2006): Anthocyanins in Cornus alternifolia, and Cornus controversa, Cornus kousa and Cornus florida fruits with health benefits. *Life Sci.* 78 (7), 777-784.

Yilmaz, K. U., Ercisli, S., Zengin, Y., Sengul, M.,Kafkas, E. Y. (2009): Preliminary characterisation of cornelian cherry (*Cornus mas* L.) genotypes for their physico-chemical properties. *Food Chem.* 114 (2), 408-412.

Received: April 20, 2012
Accepted: July 2, 2012