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Physico-chemical and Nutritional Properties of Cornelian Cherry Fruits (*Cornus mas* L.) Grown in Turkey

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In present study, several physical, chemical, pomological and nutritional properties of cornelian cherry fruits (*Cornus mas* L.) selected from Konya region were determined. The cornelian cherry fruit mean weight, length, width and thickness were found to be 3.130 g, 21.15 mm, 15.5 mm, 15.35 mm, respectively. The seed of fruit mean weight, length, width and thickness were found to be 0.923 g, 14.5 mm, 6.77 mm, 6.2 mm, respectively. In addition to the levels of acidity, pH, total soluble solids, ratio (solids/acidity), texture, colour, tanin, total sugar, invert sugar and ascorbic acid were determined in fruits. Values of the acidity, pH, total soluble solids, ratio (solids/acidity), texture, colour, tanin, total sugar, invert sugar and ascorbic acid were found to be 1.983 mg/100 g, 2.617, 15.600 mg/100 g, 7.883, 0.357 kg/cm^2, $S_{60}O_{70}M_{90}$, 129.503 mg/L, 8.840 mg/100 mL, 7.130 mg/100 mL, 73,007 mg/100 mL, respectively. Studied of nutritional properties K (14300.984 ppm), Ca (1560.095 ppm), Mg (715.231 ppm), P (605.558 ppm) and S (436.754 ppm) were established as major minerals of the cornelian cherry fruits. Others were determined at minor levels. The highest minerals were K and Ca followed by Mg, P and S. On the other hand, some physical properties sphericity and aspect ratio for fruit and seed of cornelian chery fruit were found to be 80.573, 72.727 and 58.830, 46.710 % respectively. True density, was found to be 1018.703 kg/m^3.

Key Words: Cornelian cherry, Nutritional properties.

INTRODUCTION

Cornelian cherry (*Cornus mas* L.) is the most important from the 40 species of the family *Cornaceae*. These species grow in temperate zone on calcareous, well-drained forest soils and has good adaptability in fact of soil fertility[1]. Many *Cornus* species are used as ornamentals, but only a few are grown for their edible fruits *i.e.*, the cornelian cherry (*Cornus mas* L.)[2]. *Cornus mas* L. ranges from a shrub to a small tree of about 7-8 m in height and can be cultivated under the shade of tall trees[3].

In Turkey, 97 % of the cornelian cherry crop is harvested from open-pollinated seedlings of wild genotypes, which vary widely in terms of productivity and fruit characteristics, such as size, shape, colour, flavour and nutritional value[2,4]. Approximately 12,800 tons of cornelian cherry fruit is produced per annum in Turkey[5].

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The fruits are eaten fresh, dried whole, pickled like olives or processed for preserves, syrups and wines[6]. Fruits are used for centuries to produce different types of soft drinks, jams, jellies, marmalade, syrup, stewed fruit, as edible and in cookery. Ripe fruits contain high concentrations of ascorbic acid, various saccharides and acids, pigments, tannins and mucilaginous substances. In addition, fruits are sometimes used against diarrhea and enteritis whereas bark, shoots and roots against fever[7].

The cornelian cherry fruits which have sour and sweat tasting juice, contain a high amount of vitamin C. Furthermore, fruits are rich in sugar, organic acid and tannin[1]. The ranges of the fruit characteristics varied from 2.907 to 3.906 for fruit weights[8]. 2.87 to 3.12 pH, 106.3 mg vitamin C/100 g, 11.50 to 16.80 total soluble solids (TSS), 10.8-11.8 kg/100 kg total sugar, 10.3-10.8 kg/100 kg invert sugars[9], 1.50 to 4.70 % total acidity (as malic acid), 2.00 to 2.65 % titrable acidity[6-8]. An oil is obtained from the seed and a dye is obtained from the bark and the wood, while the leaves are a good source of tannin. Since its wood is very hard, it is highly valued by turners. The wood is heavier than water and does not float, therefore it is used for tools, machine parts, *etc*. The bark and the fruit are astringent, febrifuge and nutritive. The astringent fruit is a good treatment for bowel coyolaints and fevers and also used in the treatment of cholera. The flowers of this plant are used in the treatment of diarrhoea[1].

The purpose of this study is to determine the approximate composition and some nutritional, pomological and physical properties.

EXPERIMENTAL

Physico-chemical analysis

Sampling: Ten fruits of each treatment were used for all analysis.

Acidity: The acidity was measured by titration with 0.1 N NaOH to pH 8.1 and expressed as malic acid. Acidity was expressed as % (g/100 g)[10].

pH: 10 g of samples were homogenized for pH measurements. A digital pH meter was employed at 25 ºC[10].

Total soluble solids: The content of total soluble solids was determined using samples of fruit pulp with a hand refractometer, at room temperature (range from 18 to 23 °C)[11].

Ratio (solids/acidity): The ratio was calculated using the relation between the total soluble solids by acidity.

Texture: For texture measurements, the fruits were peeled (very thin layer) in two different places in the equatorial region of the cornelian cherries. The texture was measured in a handle penetrometer with crossheads of 0.8 cm of diameter. Texture was expressed by kg/cm^2.

Colour: The colour scale was employed for determination of the fruit juice colour[12].

Tannin: Tannin content was determined according to Horwitz[13].

Total and invert sugar: Total sugar, invert sugar and sucrose contents were analyzed by the Lane-Eynon method[11].

Ascorbic acid: Ascorbic acid was determined by employing the method described by Liegel[14].

Determination of mineral contents: About 0.5 g dried and ground sample was put into burning cup and 10 mL pure HNO_3 was added. The sample was incinerated in MARS 5 Microwave oven under the 170 psi at 200 °C temperature and solution diluted to the certain volume (25 mL) with water. Samples were filtered in fitler paper and were determined with an ICP-AES[15].

Working conditions of ICP-AES: Instrument: ICP-AES (Varian-Vista; Australia); RF power: 0.7-1.5 kW (1.2-1.3 kW for axial); Plazma gas flow rate (Ar): 10.5-15 L/min (radial); 15 L/min (axial); Auxiliary gas flow rate (Ar): 1.5 L/min; Viewing height: 5-12 mm; Copy and reading time: 1-5 s (max. 60 s); Copy time: 3 s (max. 100 s).

Determination of physical properties: The physical properties that were considered in this study are size, shape, true density, bulk density and porosity.

Determination of size: From the samples, 10 fruits were selected at random for determining the physical characteristics. For each fruit, three linear dimensions were measured, that is (a) length, (b) width and (c) thickness, using a Vernier caliper reading to 0.01 mm. Hence measurement of all size indices were replicated 10 times for cornelian cherry fruit.

Determination of shape: The fruit and kernel shape was expressed in terms of its sphericity index and aspect ratio. For the sphericity index Sc, the dimensions obtained for the 10 cornelian cherry fruits were used to compute the index based on the recommendation of Mohsenin[16] as $Sc = (axbxc)^{1/3}/ax100$.

For the aspect ratio, 10 cornelian cherry fruits were also selected at random for conducting the experiment. Measurements of all size and shape indices are replicated 10 times. The Vernier caliper was also used for the measurements. The aspect ratio (Ra) was calculated as recommended by Maduako and Faborode[17] as $Ra = b/a \times 100$.

Determination of fruit mass: The mass of individual fruit for cornelian cherry type were determined by using a electronic balance to an accuracy of 0.001 g. Each measurement was replicated 10 times.

Determination of density: The volume of fruit (V) and fruit density (Pt), were determined using the liquid displacement method. Toluene (C_7H_8) was used in place of water because it is absorbed by fruits to lesser extend. Its surface tension is low, so that if fills even shallow dips in a fruit and its dissolution power is low[18,19].

RESULTS AND DISCUSSION

Some chemical properties of cornelian cherry fruits are given in Table-1. The acidity, pH, total soluble solids, ratio (solids/acidity), texture, colour, tanin, total sugar, invert sugar and ascorbic acid were determined in fruits. Values of the acidity, pH, total soluble solids, ratio (solids/acidity), texture, colour, tanin, total sugar, reducing sugar and ascorbic acid were found to be 1.983 mg/100 g, 2.617, 15.600

mg/100 g, 7.883, 0.357 kg/cm^2, $S_{60}O_{70}M_{90}$, 129.503 mg/L, 8.840 mg/100 mL, 7.130 mg/100 mL, 73,007 mg/100 mL, respectively.

TABLE-1
PHYSICAL AND CHEMICAL PROPERTIES OF K1
CORNELIAN CHERRY FRUIT TYPE

Parameters	Values
Acidity (mg/100 g)	1.983 ± 0.126
pH	2.617 ± 0.139
Total soluble solids (mg/100 g)	15.600 ± 0.361
Ratio (solids/acidity)	7.883 ± 0.456
Texture (kg/cm^2)	0.357 ± 0.015
Colour	$S_{60}O_{70}M_{90}$
Tannin (mg/L)	129.503 ± 2.296
Total sugar (mg/100 g)	8.840 ± 0.413
Reducing sugar (mg/100 g)	7.130 ± 1.031
Ascorbic acid (mg/100 g)	73.007 ± 0.090

Total acidity was found 1.983 % while in other similar studies it was from 1.24 to 4.69 %[1,6,8,20]. pH value was reported as 2,617 in previous studies[1,20]. In the present study, pH value was higher than the previous reports (Table-1).

Demir and Kalyoncu[1] determined total soluble solids (48.39-73.11 mg/100 g), total acidity (13.6-24.1 %), total sugar (1.852-2.348 g/mL), reducing sugar (6.7-9.3 %), tanin (6.924-8.321 %), fruit juice (131.51-601.2 mg/L), pH (15.6-39.92 %) and TSS/acid ratio (2.50-2.88), pH (6.371-12.61) of 6 types of cornelian cherry fruits grown in Kurucuova Region in Konya were harvested manually in September 1999. Colour directly affects the appearance and the consumer acceptability of the fruits. As can be seen from Table-1, there was $S_{60}O_{70}M_{90}$. The colour of the K1 cornelian cherry type sample between red to purple.

Soluble solids were found to be 15.600 %. Soluble solids contents were generally higher than the previous findings[1,6,20,21]. This could be the natural result of different environmental conditions and genotype types since total soluble solids are greatly influenced by those factors according to some reports[1,8].

Total sugar value was reported as 6.60-15.10 % in the literatures Didin *et al.*[20] and Brindza *et al.*[22]. As seen in Table-1, total sugar value (8.840 %) was in agreement with the reports of previous workers[22-24].

Reducing sugar values were in agreement with the findings of Didin *et al.*[20] for some types. They showed that the reducing sugar content was in a range of 6.98-11.56 g/100 g for cornelian cherry. Unreduced sugar contents was found 7,130 g/100 g. Present results have higher values than the data calculated by Guleryuz *et al.*[8] (0.85-5.05 %).

The results for tannin and ascorbic acid in the studied fruit is presented in Table-1. Cornelian cherry fruits are rich in ascorbic acid and tanin. Tanin content

(129.503 mg/100 g) was found to be similar with Demir and Kalyoncu[1]. The ascorbic acid content was found 73.007 mg/100 g. Similar results have been reported by other researchers (16.41-78.58 mg/100 g)[1,8,20,22]. While Klimenko[23] and Pantelidis *et al.*[21] found high ascorbic acid content (101-193 mg/100 g) in cornelian cherry fruits, Krgovic and Vracar[24] determined this parameter very low level (averaged 34.72 mg %). In addition, the content of ascorbic acid was significantly higher than other fruits for their high ascorbic acid content, such as strawberries (46 mg per 100 g) and orange fruits (31 mg per 100 g) and kiwi fruits (29-80 mg per 100 g)[21].

Mineral contents of K1 cornelian cherry fruits are reported in Table-2. K (14300.984 ppm), Ca (1560.095ppm), Mg (715.231 ppm), P (605.558ppm) and S (436.754 ppm) were established as major minerals of the cornelian cherry fruits. Others were determined at minor levels. The highest minerals were K and Ca followed by Mg, P and S.

TABLE-2
SOME NUTRITIONAL PROPERTIES OF K1 CORNELLIAN CHERRY FRUIT TYPE

Parameters	Values (ppm)	Parameters	Values (ppm)
Ag	0	K	14300.984
Al	4.690	Li	1.561
As	0.631	Mg	715.231
B	20.757	Mn	1.396
Ba	4.546	Na	79.711
Bi	0.000	Ni	0.421
Ca	1560.095	P	605.558
Cd	0.000	Pb	0.000
Co	0.000	S	436.754
Cr	0.214	Se	0.669
Cu	1.491	Sr	14.129
Fe	1.192	Ti	0.000
Ga	0.000	V	3.299
In	0.000	Zn	1.497

Aslantas *et al.*[25] have studied on mineral contents of wild cornelian cherry fruits and established K (187 mg/100 g), P (25 mg/100 g), Ca (17.63 mg/100 g), Mg (18.97 mg/100 g), Fe (1.88 mg/100 g), Cu (0.541 mg/100 g), Zn (0.452 mg/100 g) and Mn (0.604 mg/100 g). Çalisir *et al.*[26] have studied on mineral contents of wild plum fruits varieties and established Ca (920.82 mg/kg), P (659.15 mg/kg), K (9879.57 mg/kg), Mg (916.68 mg/kg). In other study, Ca (43973.09 ppm), K (3523.66 ppm) and P (1519.59 ppm) contents of hackberry (*Celtis australis* L.) fruits were found by Demir *et al.*[19]. Marakoglu *et al.*[27] studied on mineral contents of blackthorn fruits and established 1524.22 ppm Ca, 18706.98 ppm K, 968.15 ppm Mg and 1514.54 ppm P. K content was higher than compared with those of wild plum, hackberry and blackthorn fruits[19,26,27].

Calcium is the major component of bone and assists in teeth development[28]. Calcium content (1560.095 ppm) was in agreement with the findings of Marakoglu *et al.*[27] for blackthorn fruits (1524.22 ppm). Demir *et al.*[19] detemined Ca (43973.09 ppm) for hackberry fruit. The K, Ca, Mg, P and S levels are adequate. The importance of these elements can not be overemphasized because many enzymes require them as cofactors[29]. Other inorganic elements which may contribute to biological processes, but which have not been established as essential, are barium, bromine, cadmium, lead and lithium[30]. As a result, it is considered to be important because of their nutritive, physiological and technological significant. This study, attempts to contribute to knowledge of the nutritional properties and mineral contents of K1 cornelian cherry fruit type.

Table-3 shows the size distribution of the cornelian cherry fruits. A summary of the results of the determined physical parameters of the fruit and seed of K1 cornelian cherry type. The cornelian cherry fruit mean weight, length, width and thickness were found to be 3.130 g, 21.15 mm, 15.5 mm, 15.35 mm, respectively. The seed of fruit mean weight, length, width and thickness were found to be 0.923 g, 14.5 mm, 6.77 mm, 6.2 mm, respectively.

When the fruit weight in this study were compared to previous studies[1,6,8], these values were the same those of the reported values (3.130 g). While Tural and Koca[31] determined the studied cornelian cherry fruit type very low (0.39-1.03), Ninic-Todorovic *et al.*[32] determined to be higher fruit weight (3.61 g). Also, flesh/seed ratio was lower than the values reported by several researchers[1,8,20,33] for some types. Krgovic and Vracar[24] determined that stone weight ranged from 0.26 to 0.63 g, averaging 0.36 g. In this experiment this parameter was found to be 0.923.

Fruit width was 15.55 mm, while fruit length was 21.39 mm. Fruit width results are in accordance with the previous studies[1,6,20,24]. But Tural and Koca[30] determined very low value for this parameter (9.59-13.21 mm). The fruit length results higher than published by Brindza *et al.*[22] (13.20-20.10 mm) and Tural and Koca[30] (14.24-22.20) for some types.

TABLE-3
PHYSICAL PROPERTIES OF CORNELIAN CHERRY WITH STANDARD DEVIATION

Property	Mean value (± standard deviation)	
	Fruit	Seed
Fruit mass (g)	3.130 ± 0.062	0.923 ± 0.038
Flesh/seed ratio	3.392 ± 0.098	–
Length (mm)	21.390 ± 0.537	14.280 ± 0.191
Width (mm)	15.550 ± 0.387	6.670 ± 0.100
Thickness (mm)	15.387 ± 0,587	6.223 ± 0.254
Sphericity (%)	80.573 ± 0.355	58.830 ± 1.013
Aspect ratio (%)	72.727 ± 0.275	46.710 ± 0.350
True density (kg/m^3)	1018.703 ± 6.645	–

Sphericity and aspect ratio for fruit and seed of cornelian chery fruit was found to be 80.573 %, 72.727 % and 58.830 %, 46.710 %, respectively. True density was found to be 1018.703 kg/m^3. Demir and Kalyoncu[1] determined that sphericity, varied from 0.749 to 0.849 in the selected types of cornelian cherry fruit.

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