UDC 575. 630
https://doi.org/10.2298/GENSR2301095K
Original scientific article

PHYSICOCHEMICAL SUBSTANCES AND BIOACTIVE COMPONENTS OF WILD CORNELIAN CHERRY (*Cornus mas* L.) FRUITS IN ERZİNCAN PROVINCE OF EASTERN TURKEY

Koray OZRENK[1], Akgul TAS[2], Muttalip GUNDOGDU[3], Nurhan KESKIN[4*], Sezai ERCISLI[5]

[1]Siirt University, Faculty of Agriculture, Department of Horticulture, Siirt, Turkey
[2]Bolu Abant Izzet Baysal University, Seben Izzet Baysal Vocational School, Department of Plant and Animal Production, Bolu, Turkey
[3]Bolu Abant Izzet Baysal University, Faculty of Agriculture and Natural Sciences, Department of Horticulture, Bolu, Turkey
[4]Van Yüzüncü Yıl University, Faculty of Agriculture, Department of Horticulture, Van, Turkey
[5]Ataturk University, Faculty of Agriculture, Department of Horticulture, Erzurum, Turkey

Ozrenk K., A. Tas, M. Gundogdu, N. Keskin, S. Ercisli (2023). *Physıcochemıcal Substances and bıoactıve components of wıld cornelıan cherry (Cornus mas L.) fruıts ın Erzincan provınce of Eastern Turkey***.** - Genetika, Vol 55, No.1, 95-110.

Turkey has a very rich flora due to diverse climatic and topographic conditions within the country. Cornelian cherry (*Cornus mas* L.) is an important wild edible fruits and widely distributed in Turkey and well known for its fruit antioxidants and nutrients. In this study, phytochemical content in fruits of a number of Cornelian cherry genotypes in Erzincan region were determined. The biochemical analysis included organic acids, sugars, vitamin C, antioxidant and individual phenolic compounds. In the study, organic acid content was between 253.09 mg/100 g and 112.50 mg/100 g. Vitamin C content varied between 115.85 mg/100g and 43.77 mg/100 g. Likewise, the sugar content of Cornelian cherry fruits varied from 6.17 g/100 g to 4.06 g/100 g. When the antioxidant content was examined, the highest antioxidant was 980.91 µmol TE/g fresh weight (FW) base and the lowest was 490.38 µmol TE/g FW. In the genotypes examined, gallic acid was determined as the highest among the individual phenolic compounds, while the individual phenolic amounts ranged from 38.93 mg/100 g FW to 4.31 mg/100 g FW. As a result of the study, it was determined that

Corresponding author: Nurhan Keskin,Van Yüzüncü Yıl University, Faculty of Agriculture, Department of Horticulture, Van, Turkey, e-mail: keskin@yyu.edu.tr

Cornelian cherry fruits are very rich in vitamin C and other phytochemicals and as a result of this examination, 24ER04 and 24ER08 genotypes came to the fore.

Keywords: Cornelian cherry, phenolic compound, organic acid, antioxidant, sugars

INTRODUCTION

Cornelian cherry is one of the fruit species that grows in temperate climates and has a rich biochemical content. This fruit species, which has a wide distribution area in the Black Sea and Marmara regions of Turkey, has become increasingly popular in recent years (ERCISLI, 2004; SOCHOR *et al*., 2014; JACIMOVIC *et al*., 2020; SKENDER *et al.*, 2022). According to TUIK data, a total of 13750 tons of Cornelian cherry fruits were produced in Turkey (ANONYMOUS, 2022). Healthy nutrition has great importance in the prevention of many diseases. In general, the increasing interest in healthy lifestyle in recent years has led the majority of consumers to look for little known plant species (KUCHARSKA *et al*., 2015; ABANOZ and OKCU, 2022), especially fruit species with high antioxidant content (including *Cornus* genus) (KAZIMIERSKI *et al*., 2019; SENICA *et al*., 2019). Natural functional nutrients, which have an important place in human nutrition and health, are generally obtained from horticultural plants with high antioxidant content (CAĞLAR and DEMIRCI, 2017; DAWADI *et al*., 2022). Cornelian cherry fruits are gaining increasing attention among consumers due to their unique taste, nutritional properties and health benefits (ERCISLI *et al*., 2011; JACIMOVIC *et al*., 2015; DE BIAGGI *et al*., 2018). Turkey is among the regions considered to be the origin of Cornelian cherry and several selection studies have been done previously on seed propagated cornelian cherry in Turkey (YALCINKAYA *et al*., 2002; AKTEPE TANGU and SEN, 2016). Although most of the selection studies on Cornelian cherry concentrate on pomological parameters such as fruit weight, fruit dimensions and yield (AKTEPE TANGU and SEN, 2016), few studies have been conducted on bioactive components (TURAL and KOCA, 2008). Studies in Cornelian cherry fruits in recent years have shown that fruits contain bioactive compounds such as vitamin C, organic acids, pectin, phenolic acids, flavonoids (anthocyanins, flavonols), triterpenoids and iridoids (WEST *et al*., 2012; DENG *et al*., 2013; KUCHARSKA *et al*., 2015). It is reported that consuming Cornelian cherry fruits or its derivatives with high bioactive compound have a positive effect on the prevention of inflammatory or cardiovascular diseases, especially cancer (MIKAILI *et al*., 2013). Phenolic compounds are scarce in fruits and vegetables and are effective in the taste of the products, especially in the mouth for a bitter sweet taste. Anthocyanins, which are phenolic substances, provide the unique colors of fruits and vegetables (CEMEROGLU *et al*., 2004; GUNDOGDU and YILMAZ, 2012). Increasing the consumption of vegetables and fruits against various chronic and degenerative diseases is reported that the intake of exogenous antioxidants in the human diet plays a positive role in increasing the endogenous antioxidant (ROP *et al*., 2010; GIAMPIERI *et al*., 2014).

Phytochemicals such as organic acids, phenolic compounds and antioxidants, which are very important for human health, are abundant in Cornelian cherry fruits. Previously it has been observed that the studies on phytochemicals contained in Cornelian cherry fruits are limited. Cornelian cherry trees or shrubs in general found field border and gardens in rural areas in Turkey and has not been given much importance (ERCISLI, 2004). However, in recent years, interest in this type of fruit, which has high nutritional value and can be used in different ways, has been increasing and studies are intensifying. According to FAO sources, there is no information about

world Cornelian cherry production and cultivation. According to TUIK data, a total of 10269 tons of Cornelian cherry fruits were produced in Turkey (ANONYMOUS, 2019). In Turkey, each agricultural region had cornelian cherry populations that show great diversity.

In this study, it was aimed to determine some physicochemical properties and bioactive components (glucose, fructose, phenolic compounds, organic acid, antioxidant capacity and vitamin C) in fruits of Cornelian cherry genotypes.

MATERIALS AND METHODS

Plant material

In this study, 23 Cornelian cherry genotypes growing wild in the Eastern Anatolia Region (Erzincan) were selected. Erzincan province is located between 39 02'-40 05 'north latitudes and 38 16'-40 45 east longitudes in the North West basin of East Anatolia Region. Its area is 11.903 km². The fruits of the genotypes examined were harvested between 20 August and 10 September (in 2018-2019). Approximately 600 g of fruit samples were collected from each genotype. Cultural practices are not practiced in this type of fruit grown naturally in mountainous areas of Erzincan. The biochemical contents in fruits of Cornelian cherry genotypes, which were selected as promising, were determined. When the fruits reached harvesting maturity, they were collected and brought to the laboratory in sample containers. Fruit samples were stored at -20°C until analysis. Analyzes were made on fresh fruit (FW).

Phenolic compounds

Phenolic compounds were detected with modified HPLC procedure (GUNDOGDU and YILMAZ, 2012) suggested by RODRIGUEZ-DELGADO *et al*. (2001). 50 g of fruit samples were taken and transferred to the tubes and then crushed with a homogenizer at 12.000 rpm for 5 minutes. The fruits extracts were mixed with acetone and water (1:4). The mixture was centrifuged for 15 min at 15000 rpm. Supernatants were filtrated with coarse filter paper and twice with 0.45 µm membrane filter (Millipore Millex-HV Hydrophilic PVDF, Millipore, USA), and injected into a HPLC (Agilent, USA). Chromatographic separation was performed with a 250 x 4.6 mm, 4 µm ODS column (HiChrom, USA). Solvent A methanol: acetic acid: water (10:2:28) and Solvent B methanol: acetic acid: water (90:2:8) were used as the mobile phase (Table 1). Spectral measurements were made at 254 and 280 nm, and flow rate and injection volume were adjusted to 1 ml min^{-1} and 20 µl, respectively (GUNDOGDU and YILMAZ, 2012).

Table 1. Gradient elution program

Time (min)	Dissolvent A (%)	Dissolvent B (%)
0	100	0
15	85	15
25	50	50
35	15	85
45	0	100

Organic acids

Organic acids were identified using the method of BEVILACQUA and CALIFANO (1989). Each sample (50 g) was mixed with 80 ml of 0.009 N H_2SO_4 (Heidolph Silent Crusher M, Germany), then homogenized for 1 hour with a shaker (Heidolph Unimax 1010, Germany). The mixture was

centrifuged for 15 min at 15000 rpm, and supernatants were filtrated twice with 0.45 μm membrane filter following filtration with coarse filter (Millipore Millex-HV Hydrophilic PVDF, Millipore, USA) and run through a SEP-PAK C18 cartridge. Organic acid readings were performed with HPLC using Aminex column (HPX - 87 H, 300 mm x 7.8 mm, Bio-Rad Laboratories, Richmond, CA, USA) at 214 and 280 nm wavelengths, on Agilent package program (Agilent, USA).

Vitamin C

Vitamin C content of fruits was detected with modified HPLC procedure suggested by CEMEROGLU (2007). 75 g of fruit samples were taken and transferred to the tubes and then crushed with a homogenizer at 10.000 rpm for 3 minutes. Fruit extracts (50 g) were supplemented with 2.5% (w/v) metaphosphoric acid (Sigma, M6285, 33.5%), then centrifuged at 6500 rpm for 10 min at 4°C temperature. 0.5 ml of the mixture was brought to final volume of 10 ml with 2.5% (w/v) metaphosphoric acid. Supernatants were filtered with 0.45 μm PTFE syringe filter (Phenomenex, UK). C18 column (Phenomenex Luna C18, 250 x 4.60 mm, 5 μ) was used for the identification of ascorbic acid at temperature of 25°C. Double distilled water with 1 ml/min flow rate and pH of 2.2 (acidified with H_2SO_4) was used as a mobile phase. Spectral measurements were made at 254 nm wavelength using DAD detector. Different standards of L-ascorbic acid (Sigma A5960) (50, 100, 500, 1000, and 2000 ppm) were used for quantification of ascorbic acid readings.

Extraction and determination of sugars

Fruits were prepared according to the method described by MELGAREJO *et al*. (2000) with minor modifications. 50 g of fruit samples were taken and transferred to the tubes and then crushed with a homogenizer at 10.000 rpm for 5 minutes. Fruit samples of 15 g of fruit were centrifuged at 12.000 rpm for 2 min at 4°C (GUNDOGDU *et al*., 2011). Then the supernatant was filtrated with SEP-PAK C18 cartridges and transferred into a vial and used for analysis. Analysis of sugars was performed by HPLC (isocratic program) with a μbondapak-NH_2 column and refractive index (RI) detector using 85% acetonitrile as the mobile phase. The calculation of concentrations was based on standards prepared in the laboratory.

Extraction and determination of total antioxidant activity

Trolox equivalent antioxidant capacity (TEAC) extract was prepared: ABTS was dissolved in acetate buffer and prepared with potassium persulfate, as described by RICE-EVANS *et al*. (1995) and OZGEN *et al*. (2006). The mixture was diluted in an acidic medium of 20 mM sodium acetate buffer (pH 4.5) to an absorbance of 0.700 ± 0.01 at 734 nm for longer stability (OZGEN *et al*., 2006; GUNDOGDU *et al*., 2011). For the spectrophotometric assay, 3 mL of the ABTS + solution and 20 μL of fruit extract were mixed and incubated for 10 min and the absorbance was determined at 734 nm after 6 min from mixing.

Statistical analysis

Descriptive statistics for the studied characteristics were presented as mean ± standard deviation. One-way ANOVA was used to compare group means. Duncan multiple comparison test was performed to identify different group means followed by ANOVA. Principal Component

analysis and Categorical Principal Components analysis were performed to dimension reduction and present in a simple and easy-to-understand the relationships between variables (principal component) and genotypes in a two-dimensional space. Statistical significance level was considered as 5% and SPSS (ver: 20) statistical program was used for all statistical computations.

RESULTS AND DISCUSSION

Organic acids

In this study, important phytochemical contents in fruits of Cornelian cherry genotypes such as organic acids, phenolic compounds, vitamin C, antioxidant activity and specific sugars were investigated. Bioactive compounds level differed significantly among genotypes in the study ($p<0.05$). Malic acid came to the fore in organic acid compounds, followed by oxalic acid, citric acid and succinic acid, respectively. The highest malic acid content was determined in the 24ER08 (253.09 mg/100 g) genotype, while the lowest malic acid content was measured in the 24ER15 (112.50 mg/100 g) genotype. In terms of oxalic acid level, the highest amount of oxalic acid was determined in the genotype 24ER04 (96.88 mg/100 g), while the lowest amount of oxalic acid was determined in the genotype 24ER14 (42.43 mg/100 g) (Table 2).

Table 2. Organic acid contents of Cornelian cherry genotypes (mg/100 g).

Genotypes	Oxalic	Malic	Citric	Succinic
24ER01	65.86 ± 0.33 f*	153.97 ± 1.23 hij	33.57 ± 0.44 bc	10.68 ± 0.45 g
24ER02	86.73 ± 1.4 c	204.42 ± 3.26 c	44.42 ± 1.18 a	7.47 ± 0.06 jk
24ER03	76.52 ± 1.18 e	125.08 ± 0.53 m	24.05 ± 0.05 fgh	10.11 ± 0.11 g
24ER04	96.88 ± 2.64 a	195.08 ± 3.67 d	16.21 ± 0.03 jk	6.19 ± 0.04 m
24ER05	61.74 ± 1.4 fg	161.56 ± 1.56 gh	30.58 ± 0.03 cde	7.06 ± 0.06 kl
24ER06	61.38 ± 1.36 fg	156.24 ± 0.9 hij	13.26 ± 0.16 lm	12.07 ± 0.07 e
24ER07	76.65 ± 0.5 e	207.18 ± 6.04 c	15.59 ± 0.04 jkl	18.63 ± 0.38 a
24ER08	53.66 ± 1.48 h	253.09 ± 3.09 a	21.67 ± 0.3 ghi	13.21 ± 0.21 d
24ER09	73.24 ± 1.92 e	148.14 ± 3.01 ijk	11.22 ± 0.12 lm	5.13 ± 0.05 n
24ER10	82.27 ± 2.08 d	175.50 ± 2.5 ef	36.87 ± 0.31 b	8.24 ± 0.09 i
24ER11	51.12 ± 0.62 h	163.06 ± 3.06 gh	10.13 ± 0.13 m	11.38 ± 0.38 f
24ER12	42.53 ± 1.03 i	211.58 ± 1.58 bc	26.17 ± 0.17 efg	7.06 ± 0.06 kl
24ER13	60.55 ± 0.43 g	195.00 ± 2 d	21.77 ± 5.23 ghi	9.05 ± 0.05 h
24ER14	42.43 ± 0.72 i	157.19 ± 2.19 hi	17.69 ± 0.51 ijk	13.52 ± 0.52 d
24ER15	72.23 ± 2.04 e	112.50 ± 5.5 n	16.43 ± 1.43 jk	5.06 ± 0.06 n
24ER16	92.41 ± 1.14 b	211.00 ± 4 bc	19.90 ± 4.24 hij	6.37 ± 0.37 lm
24ER17	55.55 ± 1.21 h	169.50 ± 3.5 fg	30.57 ± 0.57 cde	4.06 ± 0.06 o
24ER18	64.29 ± 1.12 fg	147.00 ± 2.88 jk	25.79 ± 0.65 efg	13.37 ± 0.37 d
24ER19	75.19 ± 1.64 e	139.15 ± 2.02 kl	32.78 ± 0.22 bcd	14.28 ± 0.28 c
24ER20	84.86 ± 1.29 cd	219.56 ± 1.93 b	17.44 ± 0.42 ijk	8.08 ± 0.08 i
24ER21	61.45 ± 1.02 fg	154.87 ± 1.87 hij	27.06 ± 0.11 ef	6.26 ± 0.09 m
24ER22	72.36 ± 2.19 e	136.92 ± 0.09 l	33.07 ± 0.07 bc	15.22 ± 0.09 b

*Different lower cases in the same column represent statistically significant differences among the genotypes ($p<0.05$).

In the research conducted to determine some chemical properties of cornelian cherry fruits, the total acidity in malic acid type was determined as 3.9 g/100 g (TARKO *et al*., 2014). In a study based on different altitude, the malic acid content of Cornelian cherry grown in Visegrad (389 m) region is 43.7 g/kg FW, in Gorazde (345 m) region 40.1 g/kg FW and in Drvar (700 m) region was detected as 35.2 g/kg FW. Similarly, when citric acid content was examined, 1.8 g/kg FW in Visegrad region, 0.5 g/kg FW in Gorazde region, and citric acid content in Cornelian cherry grown in Drvar region was determined as 0.3 g/kg FW (DRKENDA *et al*., 2014). BIAGGI *et al*. (2018) determined the predominant organic acid in citrus fruits as citric acid (58.24 mg/100 g FW) being 38%, and malic acid 32% (48.59 mg/100 g FW) of total organic acid content. They reported that they followed by low amounts of succinic (2.67 mg/100 g FW) and oxalic acid (2.11 mg/100 g FW). Despite the increased interest, researchers have studied the analysis of these biochemical classes very scarce. Cornelian cherry has not been studied adequately despite its interesting nutraceutical aspects (KRIVORUCHKO *et al*., 2011). The differences between organic acids determined in this study are thought to occur from genotypic and ecologic differences.

Antioxidant capacity, sugars and vitamin C

Looking at antioxidant amount of Cornelian cherry fruit, the highest antioxidant capacity was determined in 24ER08 (980.91 µmol TE/100 g) genotype, while the lowest amount of antioxidant was seen in 24ER19 (490.38 µmol TE/100 g) genotype (Table 3). MOLDOVAN *et al*. (2016) found that the antioxidant activity of fresh Cornelian cherry fruits is 628.75 µmol TE/100 g FW (in FRAP assay). KLYMENKO *et al*. (2019) reported that the antioxidant activity in Cornelian cherry fruits is between 8.45 (Koralovyi) to 22.49 (Kostia) µMol TE/g (in FRAP assay). In another study, the antioxidant activity of Cornelian cherry varieties was reported to range from 5.94 (Kozerog) to 16.56 (Kostia) µMol Trolox/g (KLYMENKO *et al*., 2017a, b). The data we obtained in our study was determined to be higher than the results of the above studies. It is predicted that the difference in antioxidant activity results from genotypic and ecological differences.

When Cornelian cherry fruits were examined in terms of glucose and fructose contents, it was determined that the amount of glucose was statistically higher than the amount of fructose. The highest glucose amount was found in 24ER01 (6.17 g/100 g FW) genotype, while the lowest glucose amount was found in 24ER17 (4.06 g/100 g) genotype. When we look at the fructose levels of fruits, the highest fructose amount was determined in 24ER06 (3.36 g/100 g) genotype, while the lowest fructose amount was determined in 24ER10 (1.74 g/100 g) genotype (Table 2). In a study conducted by researchers, sugar content was determined between 8.0% and 15.0 % (KLYMENKO *et al*., 2017a, b). In another study, the total sugar content was determined as 93.42 g/kg (TURAL and KOCA, 2008). DRKENDA *et al*. (2014) examined the total sugar content of Cornelian cherry plants growing at different altitudes and total sugar content was determined as 62.46 g/kg FW in Visegrad (389 m) region and as 69.76 g/kg FW in Gorazde (345 m) region. The same researchers reported that the total sugar content of Cornelian cherry fruit grown in the Drvar (700m) region was 85.20 g/kg FW. The sugar values obtained in this study were found higher than the values reported by previous researchers. TARKO *et al*. (2014) reported that the fructose content of Cornelian cherry fruits was 3.7% and the glucose content was 5.4%. In fruit species sugar content are affected by genetic and ecological factors (ERCISLI *et al*., 2005).

Table 3. Antioxidant capacity, vitamin C and sugar contents of Cornelian cherry fruits

Genotypes	Vitamin C (mg/100 g)	Glucose (g/100 g)	Fructose (g/100 g)	TEAC (μmol TE/100 g)
24ER01	67.01 ± 0.47 jk*	6.17 ± 0.04 a	3.09 ± 0.07 bc	842.76 ± 2.4 b
24ER02	93.71 ± 1.45 de	5.17 ± 0.07 e	2.94 ± 0.04 cd	914.68 ± 3.68 ab
24ER03	64.18 ± 0.16 k	5.85 ± 0.14 bc	3.06 ± 0.05 bcd	620.27 ± 1.74 d-h
24ER04	115.85 ± 0.48 a	4.19 ± 0.06 h	1.95 ± 0.03 i	684.28 ± 3.73 c-g
24ER05	76.51 ± 1.14 h	5.08 ± 0.07 e	2.07 ± 0.04 hi	745.84 ± 3.84 c
24ER06	96.98 ± 1.65 d	5.96 ± 0.05 ab	3.36 ± 0.05 a	616.08 ± 3.08 e-h
24ER07	81.85 ± 1.7 g	5.14 ± 0.14 e	2.54 ± 0.05 f	864.80 ± 1.21 b
24ER08	49.44 ± 0.43 m	5.97 ± 0.04 ab	3.20 ± 0.04 b	980.91 ± 4.09 a
24ER09	58.39 ± 0.74 l	5.08 ± 0.08 e	2.63 ± 0.03 ef	617.28 ± 4.28 e-h
24ER10	103.30 ± 1.97 c	4.09 ± 0.09 h	1.74 ± 0.04 j	710.59 ± 5.41 c-f
24ER11	72.41 ± 1.26 i	5.53 ± 0.07 d	2.25 ± 0.09 g	919.89 ± 3.89 ab
24ER12	56.64 ± 0.9 l	4.24 ± 0.06 h	2.09 ± 0.06 ghi	512.42 ± 2.42 i
24ER13	83.84 ± 2.34 fg	4.77 ± 0.02 f	2.15 ± 0.04 gh	606.69 ± 5.31 gh
24ER14	95.41 ± 2.14 de	5.59 ± 0.08 d	3.07 ± 0.06 bcd	659.40 ± 4.4 c-g
24ER15	43.77 ± 0.21 n	4.15 ± 0.05 h	2.22 ± 0.06 gh	609.49 ± 7.49 fgh
24ER16	63.49 ± 1.08 k	5.52 ± 0.04 b	2.74 ± 0.04 e	883.78 ± 4.22 b
24ER17	92.52 ± 2.02 e	4.06 ± 0.05 h	2.09 ± 0.06 ghi	716.60 ± 6.6 cde
24ER18	66.75 ± 0.63 jk	5.06 ± 0.06 e	3.07 ± 0.04 e	505.84 ± 4.17 i
24ER19	75.46 ± 1.09 hi	6.06 ± 0.08 ab	3.37 ± 0.08 a	490.38 ± 3.38 i
24ER20	94.31 ± 0.9 de	5.71 ± 0.05 cd	3.19 ± 0.07 b	720.32 ± 4.32 cd
24ER21	111.62 ± 1.39 b	6.08 ± 0.07 a	2.69 ± 0.04 ef	725.00 ± 145 c
24ER22	68.43 ± 0.84 j	4.53 ± 0.05 g	2.09 ± 0.03 ghi	696.37 ± 3.37 c-g
24ER23	86.24 ± 1.87 f	5.08 ± 0.03 e	2.92 ± 0.04 d	550.87 ± 5.87 hi

*Different lower cases in the same column represent statistically significant differences among the genotypes ($p<0.05$).

When we look at the parameter of vitamin C, it was found statistically significant ($p<0.05$). Vitamin C, which was a white crystalline structure, is found in more or less in the structure of many fruits and vegetables. This rate is also very high in Cornelian cherry fruit, which was our study material. In the study, the highest vitamin C content was determined in the 24ER04 (115.85 mg/100 g) genotype, while the lowest vitamin C content was measured in the 24ER15 (43.77 mg/100 g) genotype (Table 2). Vitamin C content of the other genotypes was determined between these values. In a study, the highest ascorbic acid content was determined at 103 mg/100 g FW (MANGANARIS *et al*., 2007). In another study, it was observed that there was a wide variation among Cornelian cherry genotypes in terms of total ascorbic acid content and it ranged from 183.25 mg (C14) to 299.5 mg (C27) per 100 g (HAMID *et al*., 2011). In Montenegro, researchers pointed out that fruits have a high vitamin C level (48-108 mg/100 g) (MARTINOVIĆ and CAVOSKI, 2020). AGHDAM *et al*. (2013) determined the highest ascorbic acid content in Cornelian cherry fruits as 162.44 mg/100 g FW. Although the vitamin C content in Cornelian cherry fruits varies considerably compared to the studies, the vitamin C values obtained in our study was similar some of the previous studies, while higher values were reported in some studies. In addition to genetic

and ecological differences, it is anticipated that the cultural treatments should be effective on this situation (ERTURK *et al*., 2012).

Phenolic compounds

In the study, 8 different individual phenolic compounds (gallic acid, chlorogenic acid, *o*-coumaric acid, ferulic acid, *p*-coumaric, ellagic acid, caffeic acid and quercetin) were determined. As a result of the research, statistically significant differences were observed in the amount of phenolic compounds ($p<0.05$). In the studied genotypes, the highest amount of individual phenolic compounds was determined as gallic acid. This was followed by chlorogenic acid, caffeic acid, ellagic acid, *o*-coumaric acid, quercetin, ferulic acid and *p*-coumaric acid respectively. While the highest gallic acid content in fruits was determined in the 24ER13 (38.93 mg/100 g) genotype, the lowest gallic acid content was found in the 24ER04 (4.31 mg/100 g) genotype. The highest amount of chlorogenic acid was determined in the 24ER04 (10.88 mg/100 g) genotype, while the lowest amount of chlorogenic acid was determined in the 24ER05 (2.64 mg/100 g) genotype (Table 4 and 5).

Table 4. Individual phenolic compounds of Cornelian cherry fruits (mg/100 g)

Genotypes	Gallic acid	Chlorogenic acid	*o*-coumaric acid	Ferulic acid
24ER01	5.68 ± 0.24 kl*	4.10 ± 0.03 p	3.62 ± 0.06 l	3.45 ± 0.06 d
24ER02	4.60 ± 0.07 lm	9.44 ± 0.05 f	7.23 ± 0.04 c	1.29 ± 0 l
24ER03	21.88 ± 0.61 g	7.92 ± 0.06 j	5.41 ± 0.04 e	3.69 ± 0.09 c
24ER04	4.31 ± 0.08 m	10.88 ± 0.04 a	9.91 ± 0.12 a	3.90 ± 0.12 b
24ER05	7.20 ± 0.07 j	2.64 ± 0.05 s	1.83 ± 0.03 o	4.95 ± 0.12 a
24ER06	29.17 ± 0.88 e	3.83 ± 0.03 r	5.05 ± 0.02 fg	1.84 ± 0.21 ij
24ER07	21.48 ± 0.07 g	5.12 ± 0.06 n	2.64 ± 0.01 n	1.36 ± 0.03 kl
24ER08	14.63 ± 0.05 h	5.46 ± 0.05 m	4.91 ± 0.12 g	1.94 ± 0.06 i
24ER09	7.17 ± 0.2 j	4.87 ± 0.04 o	2.56 ± 0.02 n	2.48 ± 0.11 g
24ER10	30.67 ± 0.12 cd	10.71 ± 0.13 b	4.38 ± 0.02 i	1.70 ± 0.08 j
24ER11	31.92 ± 0.03 bc	9.91 ± 0.08 d	2.65 ± 0.02 n	2.18 ± 0.12 h
24ER12	31.10 ± 0.09 cd	8.50 ± 0.07 h	1.59 ± 0.02 p	1.40 ± 0.03 kl
24ER13	38.93 ± 0.51 a	9.63 ± 0.04 e	6.17 ± 0.04 d	0.89 ± 0.07 m
24ER14	22.43 ± 0.36 g	6.39 ± 0.03 ı	4.26 ± 0.1 i	2.32 ± 0.08 gh
24ER15	10.58 ± 0.11 i	10.32 ± 0.16 c	4.56 ± 0.02 h	3.19 ± 0.04 e
24ER16	27.76 ± 1.32 f	9.65 ± 0.02 e	3.77 ± 0.13 k	1.50 ± 0 k
24ER17	32.81 ± 1.1 b	3.96 ± 0.05 pr	2.87 ± 0.03 m	2.48 ± 0.1 g
24ER18	29.80 ± 0.13 de	9.16 ± 0.09 g	8.44 ± 0.14 b	1.71 ± 0.12 j
24ER19	15.38 ± 0.52 h	9.48 ± 0.09 f	0.87 ± 0.01 r	2.86 ± 0.04 f
24ER20	15.41 ± 0.4 h	7.44 ± 0.04 k	1.50 ± 0.04 p	1.50 ± 0.02 k
24ER21	31.33 ± 1.84 c	8.62 ± 0.11 h	4.91 ± 0.03 g	0.86 ± 0.01 m
24ER22	29.33 ± 0.4 e	9.12 ± 0.07 h	4.05 ± 0.03 j	1.73 ± 0.03 j
24ER23	6.72 ± 0.03 jk	8.32 ± 0.04 i	5.16 ± 0.1 f	1.86 ± 0.02 ij

Continue of Table 4 (mg/100 g).

Genotypes	*p*-coumaric acid	Ellagic acid	Caffeic acid	Quercetin
24ER01	0.63 ± 0.03 m*	4.73 ± 0.23 f	4.28 ± 0.07 k	3.56 ± 0.05 d
24ER02	2.55 ± 0.15 f	1.50 ± 0.02 j	7.68 ± 0.05 j	2.62 ± 0.11 fg
24ER03	1.44 ± 0.02 i	2.41 ± 0.06 i	9.86 ± 0.16 i	6.39 ± 0.36 a
24ER04	1.09 ± 0.01 k	3.37 ± 0.06 h	6.45 ± 0.05 h	2.82 ± 0.12 ef
24ER05	0.74 ± 0 lm	9.47 ± 0.26 b	12.08 ± 0.07 b	2.24 ± 0.05 h
24ER06	3.16 ± 0.15 c	7.65 ± 0.1 c	1.16 ± 0.02 c	0.93 ± 0.01 k
24ER07	0.98 ± 0.02 k	7.26 ± 0.01 c	1.55 ± 0.06 c	0.66 ± 0.01 l
24ER08	0.71 ± 0.03 lm	10.58 ± 0.63 a	3.61 ± 0.12 a	2.56 ± 0.05 g
24ER09	0.70 ± 0.01 lm	3.67 ± 0.01 h	2.61 ± 0.28 h	1.64 ± 0.04 j
24ER10	1.78 ± 0.02 h	4.27 ± 0.03 g	1.75 ± 0.03 n	2.67 ± 0.05 fg
24ER11	2.89 ± 0.08 de	6.27 ± 0.28 d	1.18 ± 0.03 o	3.84 ± 0.11 c
24ER12	0.82 ± 0.02 l	5.22 ± 0.17 e	1.75 ± 0.07 n	4.66 ± 0.2 b
24ER13	3.01 ± 0.03 d	6.38 ± 0.05 d	4.65 ± 0.06 j	1.07 ± 0.02 k
24ER14	2.51 ± 0.09 f	10.66 ± 0.48 a	4.51 ± 0.08 jk	1.17 ± 0.03 k
24ER15	3.84 ± 0.09 a	4.17 ± 0.17 g	10.61 ± 0.36 c	2.04 ± 0.05 hi
24ER16	2.06 ± 0.04 g	3.63 ± 0.01 h	8.45 ± 0.12e	2.84 ± 0.19 ef
24ER17	1.06 ± 0.02 k	2.12 ± 0.09 i	7.15 ± 0.2 h	2.79 ± 0.03 efg
24ER18	1.29 ± 0.05 j	4.17 ± 0.06 g	6.62 ± 0.1 i	3.57 ± 0.06 d
24ER19	2.93 ± 0.1 d	9.16 ± 0.21 b	1.53 ± 0.09 n	3.49 ± 0.05 d
24ER20	2.77 ± 0.02 e	5.60 ± 0.14 e	7.80 ± 0.12 f	1.85 ± 0.04 ij
24ER21	1.65 ± 0.02 h	1.54 ± 0 j	7.47 ± 0.04 g	2.83 ± 0.03 ef
24ER22	3.66 ± 0.07 b	4.77 ± 0.18 f	15.30 ± 0.18 a	1.01 ± 0.02 k
24ER23	0.75 ± 0 lm	2.18 ± 0.01 i	12.08 ± 0.11 b	3.02 ± 0.01 e

*Different lower cases in the same column represent statistically significant differences among the genotypes ($p<0.05$).

In a study, ellagic acid (23.56 mg/100 g), gallic acid (0.05 mg/100 g), caffeic acid (0.066 mg/100 g), chlorogenic acid (11.27 mg/100 g), *q*-coumaric acid (3.86 mg/100 g) and ferulic acid (2.11 mg/100 g) were determined (BIAGGI *et al*., 2018). As compared with our study, it was noted that our study results were lower in terms of ellagic acid and chlorogenic acid content. However, our study data were found higher in terms of gallic acid, caffeic acid and ferulic acid contents. However, the values were similar in terms of *p*-coumaric acid amount. The total phenolic compound between Cornelian cherry varieties were found 91.34 (Kozerog) and 289.79 mg/100 g (KLYMENKO *et al*., 2019). In another study, ellagic acid content (187.91 mg/100 g), caffeic acid content (27.12 mg/100 g), chlorogenic acid content (32.76 mg/100 g) was determined (MOLDOVAN *et al*., 2016). The values reported by the aforementioned researchers appear to be higher than the values obtained in this study. In another study, gallic acid (443.53 mg/kg), caffeic acid (12.51 mg/kg), quercetin (0.65 mg/kg) and *p*-coumaric acid (48.75 mg/kg) amounts of have been determined (RADOVANOVIĆ *et al*., 2013). Except for the amount of quercetin reported by previous researchers, other phenolic compound contents appear to be relatively high in our study. Indeed,

many researchers have reported that the amount of phenolic compounds in fruits varies depending on the fruit variety or genotype difference (DRKENDA *et al*., 2014).

Table 5. Brief results of Principal component analysis

	PC1	PC2	PC3	PC4	PC5	PC6	PC7
Gallic acid	0.036	**0.486**	-0.244	-0.084	-0.295	0.024	0.126
Chlorogenic acid	**-0.328**	0.298	-0.003	0.277	-0.136	0.183	-0.322
p-coumaric acid	-0.267	0.071	0.242	0.227	-0.002	**-0.350**	-0.118
Ferulic acid	-0.046	**-0.525**	-0.195	-0.039	0.263	-0.129	-0.117
o-coumaric acid	-0.026	0.357	-0.210	**0.396**	0.323	0.241	-0.042
Ellagic acid	**0.443**	0.034	-0.115	-0.072	0.265	0.019	-0.021
Caffeic acid	-0.284	-0.196	-0.059	0.170	0.251	**0.316**	0.305
Quercetin	-0.131	-0.288	-0.101	0.099	**-0.630**	0.092	-0.181
Oxalic acid	-0.277	-0.066	**0.358**	0.247	0.247	0.081	-0.231
Malic acid	0.106	0.149	**0.518**	-0.324	-0.113	0.152	-0.110
Citric acid	-0.192	-0.111	0.108	0.074	-0.189	0.272	**0.713**
Succinic acid	**0.347**	0.151	0.001	0.265	0.058	0.083	0.133
Vitamin C	-0.130	0.198	0.293	0.020	0.105	**-0.588**	0.359
Glucose	0.376	-0.147	0.184	**0.392**	-0.167	-0.018	0.026
Fructose	0.323	-0.148	0.172	**0.487**	-0.171	-0.107	0.019
TEAC	0.123	-0.019	**0.465**	-0.168	0.103	0.438	-0.058
Eigenvalue	3.120	2.274	1.871	1.685	1.428	1.057	1.032
Cumulative variance (%)	0.195	0.337	0.454	0.559	0.649	0.715	0.779

PCA analysis

In the study, principal components (PCs) analysis was performed to reduce 16 variables consisting of phenolic and organic compounds. 7 of the 16 principal components which have eigenvalues of greater than 1 were selected for further analyses. Brief results of these components are given in Table 4. As seen in Table 4, seven principal components accounted for 78% (77.9%) of the total variance. Original variables that are chlorogenic, ellagic and succinic acids provide the highest contribution to the first principal component (PC1). Similarly, gallic acid and ferulic acid have the highest loadings for the second principal component (PC2). While oxalic acid, malic acid and TEAC contribute to the third principal component (PC3), o-coumaric acid, glucose and fructose have the highest contributions to the fourth principal component (PC4). The sixth principal component (PC6) consists of *p*-coumaric acid, caffeic acid and vitamin C contributions. Quercetin and citric acid provide the highest contributions to the fifth (PC5) and seventh (PC7) component, respectively. From these variables, chlorogenic, ferulic, quercetin, *p*-coumaric and vitamin C are negatively correlated with own principal component.

Score values of the seven principal components classified into three groups: low, middle and high. Categorical principal component analysis was performed to determine the relationships between the categories of the principal component scores as well as principal components and genotypes. Thus, the configurations of the categories, genotypes and principal components on two-dimensional spaces are presented in Figure 1 and 2. As seen in Figure 1, the low and middle

categories of second and fifth principal components as well as only the low category of sixth principal component were in the upper right region of the Figure 1 which is a positive region for both dimensions. The low categories of the first and second principal components as well as high categories of the fourth and seventh principal components were in the bottom right region of the Figure 1 which is positive for the first dimension and negative for the second dimension. The high categories of the first and third principal components as well as low category of the seventh principal component were located in the upper left region of the Figure 1 where the first dimension is negative, and the second dimension is positive. High categories of second, fifth, and sixth principal components were in the bottom left region which is negative for both dimensions in the Figure 1.

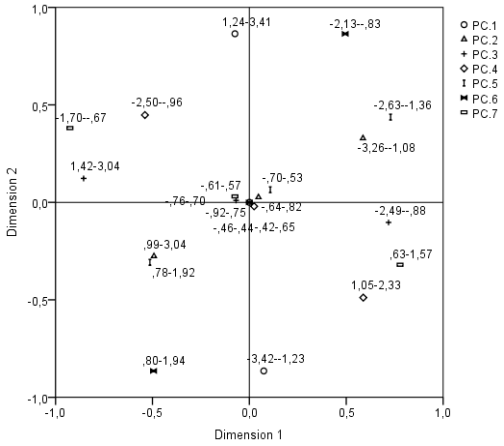

Figure 1. Configuration of the genotypes and categories of principal component on two-dimensional space.

Categories which are in the four regions are high and positively correlated in the intra-region while negatively correlated in inter-region. In general, the "middle" categories of the principal components were located close to the origin and low correlations were observed between these categories.

When Figure 2 examined for the relationships between principal components and genotypes, PC4 and PC7 were high and positively correlated with genotypes 2, 17, 22, and 23. Therefore, o-coumaric acid, glucose and fructose that high contribute to PC4, and citric acid to PC7 are likely to become high values for these genotypes. Similarly, genotypes 10, 15, 16, 20 and 26, as well as PC2, PC5 and PC6 were located in the bottom left region of Figure 2 and these were positively correlated with each other. Thus, it is expected to be high values of the variables that contribute to these principal components in these genotypes.

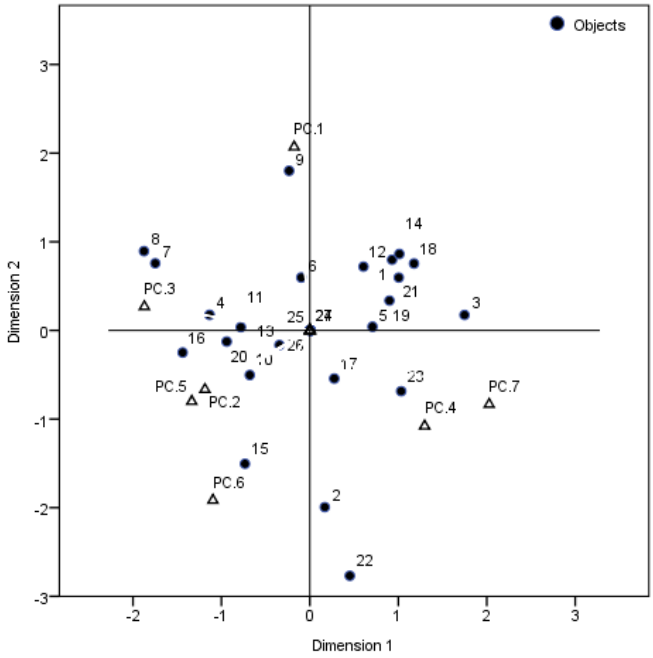

Figure 2. Configuration of the genotypes and principal components on two-dimensional space.

Genotypes 4, 6, 7, 8 9, 11 and 13 with PC1 and PC3 were located in the upper left region of the Figure 2. These principal components were positively correlated with genotypes. Thus, in genotypes 4, 6, 7, 8, 9, 11, and 13, it is expected to being low value of chlorogenic acid which provides negative contribute to the first principal component. However, in these genotypes, other variables, except for this variable, are seemed to being high values due to positively contribution to the first and third principal components.

CONCLUSION

In the study, organic acid, individual phenolic compounds, vitamin C content, sugar capacity and antioxidant activities of Cornelian cherry genotypes were investigated. In Cornelian cherry fruits, malic acid was seen as the primary organic acid, while oxalic acid has been identified as the secondary dominant acid. Among individual phenolic compounds, gallic acid was determined to be the highest, followed by chlorogenic acid. In this study, 24ER04 and 24ER08 genotypes came to the fore as a result of some primary and secondary metabolite (glucose, fructose, phenolic compound, organic acid, antioxidant capacity and vitamin C) content of Cornelian cherry fruit. Interest in anti-inflammatory and antioxidant compound sources has become important in recent years. It has been found that Cornelian cherry berries have many bioactive compounds that show high pharmacological and nutraceutical properties as well as high biochemical properties based on the parameters studied. It is also thought to have a significant

potential as a functional food ingredient, as it is a new food source with little awareness. Experimental findings obtained in this research show that Cornelian cherry fruits are promising sources in human health and nutrition.

Received, March 16th, 2022.
Accepted December 28th, 2022.

REFERENCES

AGHDAM, M.S., A.Y., DOKHANIEH, H., HASSANPOUR, J.R., FARD (2013): Enhancement of antioxidant capacity of cornelian cherry (*Cornus mas*) fruit by postharvest calcium treatment. Scientia Horticulturae, *161*:160-164.

ABANOZ, Y.Y, Z., OKCU (2022): Biochemical content of cherry laurel (*Prunus laurocerasus* L.) fruits with edible coatings based on caseinat, Semperfresh and lecithin. Turkish Journal of Agriculture and Forestry, *46*: 908-918.

AKTEPE TANGU, N., A., SEN (2016): Pomological characteristics of 'Erolbey 77' and 'Yalcinkaya 77' the first registered cornelian cherry varieties of Turkey. Derim, *1*:80-84.

ANONYMOUS (2019): Statistic Year book of Turkey. https://biruni.tuik.gov.tr/medas/?kn=92&locale=tr (Access date: 06.19.2020).

BEVILACQUA, A.E., A.N., CALIFANO (1989): Determination of organic acids in dairy products by high performance liquid chromatography. Journal Food Science, *54*:1076-1079.

BIAGGI, DE M., D., DONNO, M.G., MELLANO, I., RIONDATO, E.N., RAKOTONIAINA, G.L., BECCARO (2018): *Cornus mas* (L.) fruit as a potential source of natural health-promoting compounds: Physico-chemical characterisation of bioactive components. Plant Foods for Human Nutrition, *73*(2):89-94.

CAGLAR, M.Y., M., DEMIRCI (2017): Phenolic compounds in berry fruits and importance in nutrition. European Journal of Science and Technology, *7*(11):18-26.

CEMEROGLU, B., A., YEMENICIOGLU, M., OZKAN (2004): Composition of fruits and vegetables. 1. Fruit and Vegetables Processing Technology (Ed. B. Cemeroglu). Baskent Klise Publication Ankara, 670 p.

CEMEROGLU, B. (2007): Food analysis. Publication of Food Technologists, *34*:168-171 (in Turkish).

DAWADI, P., R., SHRESTHA, S., MISHRA, S., BISTA, R.K., RAUT, T.P., JOSHI, L.R., BHATT. (2022). Nutritional value and antioxidant properties of *Viburnum mullaha* Buch.-Ham. Ex D. Don fruit from central Nepal. Turkish Journal of Agriculture and Forestry, *46* : 781-789.

DENG, S., B.J., WEST, C.J., JENSEN (2013): UPLC-TOF-MS characterization and identification of bioactive iridoids in *Cornus mas* fruit. Journal of Analytical Methods in Chemistry, 710972.

DRKENDA, P., A., SPAHIC, A., BEGIC-AKAGIC, F., GASI, A., VRANAC, M. BLANKE (2014): Pomological characteristics of some autochthonous genotypes of cornelian cherry (*Cornus mas* L.) in Bosnia and Herzegovina. Erwerbs-Obstbau, *56*(2):59-66.

ERCISLI, S. (2004): Cornelian cherry germplasm resources of Turkey. Journal of Fruit and Ornamental Plant Research, *12*:87-92.

ERCISLI, S., A., ESITKEN, C., TURKKAL, E., ORHAN (2005): The allelopathic effects of juglone and walnut leaf extracts on yield, growth, chemical and PNE composition of strawberry cv. Fern. Plant, Soil and Environment, *51*: 283-387.

ERCISLI, S., S.O., YILMAZ, J., GADZE, A., DZUBUR, S., HADZIABULIC, J., ALIMAN (2011): Some fruit characteristics of cornelian cherries (*Cornus mas* L.). Notulae Botanicae Horti Agrobotanici Cluj-Napoca, *39*(1):255-259.

ERTURK, Y., S., ERCISLI, R., CAKMAKCI (2012): Yield and growth response of strawberry to plant growth-promoting rhizobacteria inoculation. Journal of Plant Nutrition, *35*: 817-826.

GIAMPIERI, F., J.M., ALVAREZ-SUAREZ, L., MAZZONI, T.Y., FORBES-HERNANDEZ, M., GASPARRINI, A.M., GONZALEZ-PARAMAS, C., SANTOS-BUELGA, J.L., QUILES, S., BOMPADRE, B., MEZZETTI, M., BATTINO (2014): Polyphenol-rich

strawberry extract protects human dermal fibroblasts against hydrogen peroxide oxidative damage and improves mitochondrial functionality. Molecules, *19*(6):7798-7816.

GUNDOGDU, M., F., MURADOGLU, R.I., GAZIOGLU SENSOY, H., YILMAZ (2011): Determination of fruit chemical properties of *Morus nigra* L., *Morus alba* L. and *Morus rubra* L. by HPLC. Scientia Horticulturae, *132*:37-41.

GUNDOGDU, M., H., YILMAZ (2012): Organic acid, phenolic profile and antioxidant capacities of pomegranate (*Punica granatum* L.) cultivars and selected genotypes. Scientia Horticulturae, *143*:38-42.

HAMID, H., H., YOUSEF, H., JAFAR, A., MOHAMMAD (2011): Antioxidant capacity and phytochemical properties of cornelian cherry (*Cornus mas* L.) genotypes in Iran. Scientia Horticulturae, *129*:459-463.

JACIMOVIC, V., D., BOZOVIC. S. ERCISLI, V., OGNJANOV, B., BOSANCIC (2015): Some fruit characteristics of selected cornelian cherries (*Cornus mas* L.) from Montenegro. Erwerbs-Obstbau, *57*:119-124.

JACIMOVIC, V., D., BOZOVIC, S., ERCISLI, B., BOSANCIC, T., NECAS (2020): Sustainable cornelian cherry production in Montenegro: Importance of local genetic resources. Sustainability, *12*: 8651.

KAZIMIERSKI, M., J., REGULA, M., MOLSKA (2019): Cornelian cherry (*Cornus mas* L.)-characteristics, nutritional and pro-health properties. Institute of Human Nutrition and Dietetics, Poznań University of Life Sciences Wojska Polskiego, Poznań, Poland, *31*:60-624.

KLYMENKO, S., O., GRYGORIEVA, J., BRINDZA (2017a): Less known species of fruit crops. Slovak University of Agriculture in Nitra, 104 p.

KLYMENKO, S., O., GRYGORIEVA, L., ONYSHUK (2017b): Biological bases of seed and vegetative reproduction of cornelian cherry (*Cornus mas* L.) in nature and culture. In Agrobiodiversity for Improving Nutrition, Health and Quality, *1*:233-248.

KLYMENKO, S., K.A., ZOFIA, S.L., ANNA, P., NARCYZ (2019): Antioxidant activities and phenolic compounds in fruits of cultivars of Cornelian cherry (*Cornus mas* L.). Agrobiodiversity, 484-489.

KRIVORUCHKO, E., V., SAMOILOVA, V., KOVALEV (2011): Constituent composition of essential oil from *Cornus mas* flowers. Chemistry of Natural Compounds, *47*(4):646-647.

KUCHARSKA, A.Z., A., SZUMNY, A., SOKÓŁ-ŁĘTOWSKA, N., PIÓRECKI, S.V., KLYMENKO (2015): Iridoids and anthocyanins in cornelian cherry (*Cornus mas* L.) cultivars. Journal of Food Composition and Analysis, *40*:95-102.

MANGANARIS, G.A., G.E., PANTELIDIS, M., VASILAKAKIS, G.R., DIAMANTIDIS (2007): Antioxidant capacity, phenol, anthocyanin and ascorbic acid contents in raspberries, blackberries, red currants, gooseberries and Cornelian cherries. Food Chemistry, *102*:777-783.

MARTINOVIĆ, A., I., CAVOSKI (2020): The exploitation of cornelian cherry (*Cornus mas* L.) cultivars and genotypes from Montenegro as a source of natural bioactive compounds. Food Chemistry, *318*:126549.

MELGAREJO, P., D.M., SALAZAR, F., ARTES (2000): Organic acids and sugars composition of harvested pomegranate fruits. European Food Research and Technology, *211*:185-190.

MIKAILI, P., M., KOOHIROSTAMKOLAEI, S.S., BABAEIMARZANGOU, S., AGHAJANSHAKERI, M., MOLOUDIZARGARI, N.S., GAMCHI, S., TOLOOMOGHADDAM (2013): Therapeutic uses and pharmacological effects of *Cornus mas* – A review. Journal of Pharmaceutical Biomedicine Science, *35*(35):1732-1738.

MOLDOVAN, B., A., FILIP, S., CLICHICI, R., SUHAROSCHI, P., BOLFA, L., DAVID (2016): Antioxidant activity of Cornelian cherry (*Cornus mas* L.) fruits extract and the in vivo evaluation of its anti-inflammatory effects. Journal of Functional Foods, *26*:77- 87.

OZGEN, M., , R.N., REESE, A.Z., TULIO, J.C., SCHEERENS, A.R., MILLER (2006): Modified 2,2-Azino-bis-3-ethylbenzothiazoline-6-sulfonic Acid (ABTS) method to measure antioxidant capacitiy of selected small fruits and a comprasion to Ferric Reducing Antioxidant Power (FRAP) and 2,2-Diphenyl-1-picrylhdrazyl (DPPH) methods. Journal of Agricultura and Food Chemistry, *54*:1151-1157.

RADOVANOVIĆ, B.C., A.S.M., ANĐELKOVIĆ, A.B., RADOVANOVIĆ, M.Z., ANĐELKOVIĆ (2013): Antioxidant and antimicrobial activity of polyphenol extracts from wild berry fruits grown in southeast Serbia. Tropical Journal of Pharmaceutical Research, *12*(5):813-819.

RICE-EVANS, C.A., N.J., MILLER, P.G., BOLWEEL, P.M., BRAMLEY, J.B., PRIDHAM (1995): The relative antioxidant activities of plant-derived polyphenolic flavonoids. Free Radical Research, *22*:375-383.

RODRIGUEZ-DELGADO, M.A., S., MALOVANA, J.P., PEREZ, T., BORGES, F.J., GARCIA-MONTELONGO (2001): Separation pf phenolic compounds by high-performance liquid chromatography with absorbance and fluorimetric detection. Journal of Chromatography, *912*:249-257.

ROP, O., J., MLCEK, D., KRAMAROVA, T., JURIKOVA (2010): Selected cultivars of cornelian cherry (*Cornus mas* L.) as a new food source for human nutrition. African Journal of Biotechnology, *9*(8):1205-12101.

SENICA, M., F., STAMPAR, M., MIKULIC-PETKOVSEK (2019): Different extraction processes affect the metabolites in blue honeysuckle (*Lonicera caerulea* L. subsp. *edulis*) food products. Turkish Journal of Agriculture and Forestry, *43*:576-585.

SKENDER, A., S., HADŽIABULIĆ, S., ERCISLI, J., HASANBEGOVIĆ, S., DEDIĆ, R., ALMEER, A.A., SAYED, R., ULLAH, A., ASSOUGUEM (2022): Morphological and biochemical properties in fruits of naturally grown cornelian cherry (*Cornus mas* L.) genotypes in northwest Bosnia and Herzegovina. Sustainability, *14*:4579.

SOCHOR, J., T., JURIKOVA, S., ERCISLI, J., MLCEK, M., BARON, S., BALLA, S.O. YILMAZ, T., NECAS (2014): Characterization of cornelian cherry (*Cornus mas* L.) genotypes–genetic resources for food production in Czech Republic. Genetika, *46*: 915-924.

TARKO, T., A., DUDA-CHODAK, P., SATORA, P., SROKA, P., POGON, J., MACHALICA (2014): *Chaenomeles japonica*, *Cornus mas*, *Morus nigra* fruits characteristics and their processing potential. Journal of Food Science and Technology, *51*(12):3934-3941.

TURAL, S., I., KOCA (2008): Physico-chemical and antioxidant properties of cornelian cherry fruits (*Cornus mas* L.) grown in Turkey. Scientia Horticulturae, *116*:362-366.

WEST, B.J., S., DENG, C.J., JENSEN, A.K., PALU, L.F., BERRIO (2012): Antioxidant, toxicity, and iridoid tests of processed Cornelian cherry fruits. International Journal of Food Science and Technology, *47*(7):1392-1397.

YALCINKAYA, E., Y., ERBIL, M., BAS, S., SOYERGIN, F.G., CELIKEL, S., ERDOGAN (2002): Pomological and technological properties and content of plant nutrients, postharvest physiology of Cornelian cherry genotypes grown in South Marmara. Ataturk Horticultural Central Research Institute, 54 p.

FIZIČKO-HEMIJSKE SUPSTANCE I BIOAKTIVNE KOMPONENTE PLODOVA DRENA (*Cornus mas* L.) U PROVINCIJI ERZINČAN U ISTOČNOJ TURSKOJ

Koray OZRENK[1], Akgul TAS[2], Muttalip GUNDOGDU[3], Nurhan KESKIN[4*], Sezai ERCISLI[5]

[1]Siirt Univerzitet, Poljoprivredni fakultet, Department za hortikulturu, Siirt, Turska
[2]Bolu Abant Izzet Baysal Univerzitet, Seben Izzet Baysal Vocational School, Departmant za biljnu proizvodnju i stočarstvo, Bolu, Turska
[3]Bolu Abant Izzet Baysal Univerzitet, Poljoprivredni fakultet, Departmant za hortikulturu, Bolu, Turska
[4]Van Yüzüncü Yıl Univerzitet, Poljoprivredni fakultet, Departmant za hortikulturu, Van, Turska
[5]Ataturk Univerzitet, Poljoprivredni fakultet, Departmant za hortikulturu, Erzurum, Turska

Izvod

Turska ima veoma bogatu floru zbog raznovrsnih klimatskih i topografskih uslova u zemlji. Dren (*Cornus mas* L.) je važno samoniklo jestivo voće, široko rasprostranjeno u Turskoj i dobro poznato po svojim voćnim antioksidansima i hranljivim materijama. U ovom istraživanju utvrđen je fitohemijski sadržaj u plodovima većeg broja genotipova drena u regionu Erzinčan. Biohemijska analiza je uključivala organske kiseline, šećere, vitamin C, antioksidanse i pojedinačna fenolna jedinjenja. U ovom radu, sadržaj organske kiseline bio je između 253,09 mg/100g i 112,50 mg/100g. Sadržaj vitamina C varirao je između 115,85 mg/100g i 43,77 mg/100g. Sadržaj šećera u plodovima drena varirao je od 6,17 g/100 g do 4,06 g/100 g. Najveći sadržaj antioksidansa bio je 980,91 µmol TE/g sveže mase (FW), a najmanji 490,38 µmol TE/g FW. U ispitivanim genotipovima, galna kiselina je imala najveći sadržaj među fenolnim jedinjenjima, dok su se pojedinačne vrednosti kretale od 38,93 mg/100g FW do 4,31 mg/100g FW. Kao rezultat istraživanja utvrđeno je da su plodovi drena veoma bogati vitaminom C i drugim fitohemikalijama, a kao rezultat ovog ispitivanja došli su do izražaja genotipovi 24ER04 i 24ER08.

Primljeno 16.III.2022.
Odobreno 28. XII. 2022.