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Comparative characterization of the content and *in vitro* bioaccessibility of minerals in two Cornus species

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ABSTRACT

In this study, the content and bioaccessibility of minerals were investigated in four different cornelian cherry (*Cornus mas* L.) and one common dogwood (*Cornus sanguinea* L.) genotypes grown in Bursa, Turkey. Mineral content or bioaccessibility was determined using inductively-coupled plasma optical emission spectrometry or *in vitro* artificial gastrointestinal system, respectively. Results revealed that the common dogwood contained significantly greater amounts of minerals, particularly calcium and iron, compared with cornelian cherry genotypes. However, bioaccessibility of calcium or iron was greater in cornelian cherry genotypes (on average 90% or 25%, respectively) compared with that of common dogwood (13.72% or 4.48%, respectively). Bioaccessibility rates of potassium, magnesium and copper were over 50% in all genotypes. Among the cornelian cherry genotypes, G2 contained the highest amount of minerals, except for copper, and the highest amount of bioaccessible minerals. Although the mineral contents were different, amounts of bioaccessible minerals were comparable in both species due to the difference in bioaccessibility rates. In conclusion, the present study shows that fruits with rich mineral contents do not necessarily have high nutritional value due to lower bioaccessibility rates, and suggests that *in vitro* bioaccessibility studies are useful tools in the determination of the nutritional value of foods.

1. Introduction

The genus *Cornus*, classified under the Cornaceae family, is widely distributed in temperate and subtropical (rarely tropical) regions of the Northern Hemisphere, and it includes about 58 species, most of which are shrubs and small trees with hermaphrodite flower structure (Xiang et al. 2006). According to the chloroplast genome data and morphological characteristics, these species are divided into five groups: (1) alternate leaf, blue fruit, (2) opposite leaf, blue or white fruit, (3) Cornus cherries, (4) dwarf, and (5) large bractea, thorny (Truba et al. 2020). Most of the species in this genus are grown as ornamental plants and the most important species in terms of fruit cultivation is *Cornus mas* L. (cornelian cherry). The homeland of the cornelian cherry is Caucasus, Anatolia and Europe and it is found naturally in the forests of Northern Anatolia in Turkey. It grows in the mountains, forests and valleys of various provinces at up to 1400 m altitude in the Mediterranean, Aegean, Marmara and Black Sea regions of Turkey under suitable climatic conditions (Kökosmanlı and Keleş 2000, Demir et al. 2020). Slow-growing plants of this species are highly tolerant of cold, drought, disease and pests and their lifespan is up to 300 years (Bayram and Ozturkcan 2020). The elliptical or pear-shaped fruits, which ripen after midsummer, are 10-15 mm long, smooth-bright red-shelled, hard-core and sour tasting (Kökosmanlı and Keleş 2000). According to 2021 data, annual cornelian cherry production was 13745 tons in Turkey (TUIK 2022). Due to its sour taste, the fruits are used in various product groups after processing such as beverage, syrup, jelly, jam, yoghurt, ice cream, tarhana (a dried Turkish food product made with a fermented mixture of grain and yoghurt or fermented milk) and dried fruit pulp rather than fresh consumption (Kökosmanlı and Keleş 2000, Savaş et al. 2020). In addition to its successful growth in natural conditions without using any pesticides or synthetic fertilizers, the fact that the cornelian cherry is highly tolerant against different environmental conditions as well as pests and diseases makes this fruit suitable for organic production (Bijelić et al. 2011).

Fruits of species belonging to the genus *Cornus* have components (phenolic compounds, mineral content, vitamins, tannoid components and anthocyanins) that show quite strong biological activity. Therefore, they are used in both traditional and modern medicine and in the pharmaceutical industry (Stanković and Topuzović 2012). Studies with the genus *Cornus*, especially with the *C. mas* L. species, revealed anti-inflammatory effects and various beneficial effects (Sozański et al. 2014, Dadkhah et al. 2016). In addition, bioactive components and their bioaccessibilities, as well as mineral contents of *C. mas* L., have been studied previously (Yilmaz et al. 2009, Ochmian et al. 2019, Anđela Martinović and Cavoski 2020, Olędzka et al. 2022). Although *C. mas* L. has been studied extensively, there are limited studies on other species of the *Cornus* genus. The majority of the species included in this genus has recently become the center of attention in the scientific community due to their biofunctional characteristics. For example, *Cornus alba* L., *C. sanguinea* L. (common dogwood), and *C. florida* L. species have been determined to contain rich nutritional sources such as phenolic acids and flavonoids (Truba et al. 2020). In addition, the fruits of *C. sanguinea* L. have been reported to be a promising candidate for a high-value natural antioxidant source (Stanković and Topuzović 2012). At the same time, there is no report on the bioaccessibility of the compounds identified in the fruits of *C. sanguinea*.

Fruits occupy a significant share in human nutrition all over the world and constitute one of the main sources of minerals needed by the organism to fulfill its vital functions. Minerals are essential for humans since they cannot be synthesized by the body and must be taken through diet (Rousseau et al. 2020). After foods are consumed, nutrients are converted into absorbable forms when traveling through the gastrointestinal system, and then they are transported to the relevant target tissues by entering the bloodstream (Boland et al. 2014). While bioaccessibility is defined as the portion of the nutrients released from the food matrix that is accessible for absorption from the stomach and intestine in relation to its total starting content, bioavailability refers to the part absorbed into the body and used in physiological functions or stored (Rousseau et al. 2020, Montiel-Sánchez et al. 2021). Bioaccessibility is examined *in vitro* by experiments that mimic the conditions at every stage of gastrointestinal digestion, while bioavailability is examined by *in vivo* animal and human studies (Rousseau et al. 2020). Since the *in vivo* methods are quite complex, expensive, time consuming and have ethical limitations, *in vitro* methods are preferred and widely used today because they are fast and safe. The *in vitro* method of gastrointestinal extraction has been shown to correlate well with *in vivo* human bioavailability studies (Miller et al. 1981).

The aim of this study was to determine and compare certain mineral contents as well as amounts of bioaccessible minerals by an *in vitro* gastrointestinal extraction method in fruits of four *C. mas* L. (cornelian cherry) and one *C. sanguinea* L. (common dogwood) genotypes grown in Cumalikizik village in the Bursa province in Turkey. To the best of our knowledge, no study has investigated the mineral content in *C. sanguinea* L. and bioaccessibility of minerals in species of *C. mas* L. and *C. sanguinea* L.

2. Materials and Methods

Fruits of four cornelian cherry (*C. mas* L.) (G1-G4) and one common dogwood (*C. sanguinea*) (G5) genotypes cultivated in Cumalikizik village in the Bursa province (Latitude: 40° 11' 25.1340" and Longitude: 29° 10' 20.1360") were used (Figure 1). About 3 kg healthy and mature fruits were randomly collected from four sides of trees in the second week of September for each genotype. Fruits, placed in paper bags, were brought to the laboratory within a short period of time and dried immediately at 65°C for 48 hours and then stored at -80°C until the analyses.

All solutions were of analytical purity and prepared using ultrapure water (18 MΩ cm resistant) with the TKA Ultra Pacific and Genpura water purification system. The 67% HNO_3 was obtained from Merck (Darmstadt, Germany). Argon (99.9995% purity, Linde, Turkey) was used as the carrier gas. Standard stock solutions (1000 mg L^{-1}) were used to prepare Merck (Darmstadt, Germany) calibration standards for each element. Standard solutions were prepared daily using 0.3% HNO_3. For botanical certificate reference materials for method validation: Certified Cabbage: IAEA - 359 Austria, Certified Tea NCSZC 73014- (GSB-7) China, Certified Strawberry LGC7162 UK, were utilized. As external standard solutions, 10 µg L^{-1} Cerium, Lithium, Yttrium, Thallium, and Cobalt were used. The Milestone Brand MLS 1200 Mega (Italy) microwave digestion system with a rotor with 12 sample chambers and polyethylene Teflon coated cups were used in the digestion process of the samples. Polyethylene Teflon containers were disinfected in 10% HNO_3 (67% v/v), then cleaned in ultra-pure water and dried in an oven at 40°C. The samples were homogenized and 0.5 g of samples were placed in Teflon cells and a mixture of 6 ml of HNO_3 (65%) and 1 ml of H_2O_2 (35%) was added. The samples were then digested using a Milestone Brand MLS 1200 Mega microwave burner according

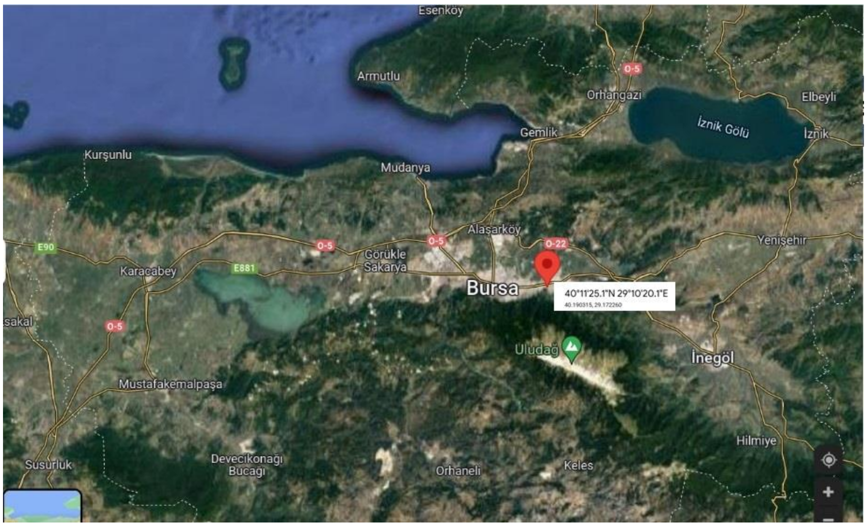


Figure 1. Cumalikizik village of Bursa province (Latitude: 40° 11' 25.1340" and Longitude: 29° 10' 20.1360").

to the following five-step program (250 W 2^{-1} min, 250 W 2^{-1} min, 250 W 6^{-1} min, 400 W 5^{-1} min, 600 W 5^{-1} min). Ultrapure water (Millipore Milli-Q 18.2 MΩ.cm) was added onto samples to reach a final volume of 25 ml which was followed by filtering through 0.45 µm filters (Hydropinilic PVDF Millipore Millex-HV). Filtered samples were then analyzed by ICP-OES (TS EN 13805). Operating conditions of the ICP-OES device have been presented in Table 1.

Table 1. Operating conditions of the ICP-OES

Parameter	Value
Instrument	Optima 2100 DV
Detector	CCD detector
Nebulizer	Concentric
RF generator	40 MHz
RF power	1300 W
Plasma gas flow rate	15.0 l·min^{-1}
Auxiliary gas flow rate	0.8 ml·min^{-1}
Nebulizer gas flow rate	0.5 l·min^{-1}
Pump speed	15 rpm
Auxiliary flow rate	1.0 l·min^{-1}
Integration mode	Field
Wavelengths	Ca 317.933. nm; Cu 324.754 nm; Fe 238.204 nm; Mg 285.213 nm; Mn 257.610 nm; K 766.490.nm; Zn 213.856 nm

Stock solutions were used at 1000 mg L^{-1} concentrations for ICP-OES analyses. Standard solutions were prepared by making dilutions from this stock solution. In addition, detection (LOD), quantification (LOQ) limits, and recovery studies were also carried out. Recovery studies were measured by spiking standard to the sample. The prepared samples were analyzed three times and the recovery values were determined from the results obtained (Table 2). K, Ca, Mg, Fe, Cu, Zn, and Mn contents of the samples were determined by ICP-OES (Perkin Elmer 2100 USA).

Table 2. Performance characteristic of the method

Element	**LOD (mg kg^{-1})**	**LOQ (mg kg^{-1})**	**Recovery %**
K	2.2	7.4	105
Ca	2.7	9.1	91
Mg	2.1	6.9	75
Fe	0.3	1.0	77
Cu	0.2	0.7	100
Zn	0.3	0.8	84
Mn	0.1	0.4	90

Bioaccessibility studies with *in vitro* gastrointestinal extraction were conducted sequentially by creating an artificial stomach and intestinal system (Vitali et al. 2009). This method was carried out as follows: In the first stage, an artificial stomach solution (0.5 mg ml^{-1} pepsin solution adjusted to pH 2 with 5 M HCl) was added to the 0.5 g samples and then they were kept in a shaking water bath for two hours at 37°C. At the end of the shaking period, the samples were neutralized with 1 M $NaHCO_3$ and for the second stage, an artificial intestinal media (5 mg ml^{-1} pancreatine in phosphate buffer: pH 8.2) was added over the existing solution and incubated again for two hours in a shaking water bath at 37°C. Subsequently, samples were centrifuged at 4000 rpm for 20 minutes and 5 ml of the supernatant was taken and microwave combustion was applied, and then mineral analyses were performed with ICP-OES. The bioaccessibility ratio was calculated according to the equation given below:

Bioaccessibility %= [The value of the mineral content of the fruit after *in vitro* gastrointestinal extraction (mg kg^{-1}) / the value of the total mineral content of the fruit (mg kg^{-1})] x 100

In the experiment, at least three trees were used for each genotype and six parallel samples were prepared for each parameter. Each extracted sample was measured three times by ICP-OES. The data were evaluated statistically using the SPSS 23.0 software. LSD test at $P<0.05$ probability level was used to determine the statistically different groups among the average values obtained.

3. Results and Discussion

Functional nutrition has become an important part of our diet today. The increase in average life expectancy and the parallel increase in health costs led to the conduction of various studies in order to ensure a healthier life for people and to improve their quality of life (Odabaş-Serin and Bakır 2019). The importance of mineral substances for human health is indisputable. For example, potassium plays major roles in ion balance and cell functions, heart contraction, the proper functioning of the intestines and muscles. Calcium is responsible for the development of bones and teeth. It is also necessary for muscle contraction, nerve signal transfer, and secretion of hormones and enzymes. Magnesium plays an important role in the nervous and muscular systems. It is also important for the heart and kidneys to function properly (Mitic et al. 2019). Among the minerals found in very small amounts in the human body are iron (Fe), zinc (Zn) and copper (Cu) elements that are often lacking in human diets due to insufficient intake or inadequate absorption because of the food matrix. Insufficient mineral intake and especially iron, calcium and zinc deficiency in young children in industrialized countries are the main causes for diseases such as anemia, rickets, osteoporosis and immune diseases (Promchan and Shiowatana 2005). Daily intake of the minerals recommended by the United States Institute of Medicine for healthy men and women between the ages of 31-50 are as follows: K (4700 mg kg^{-1}), Ca (1000 mg kg^{-1}), Mg (320-420 mg kg^{-1}), Zn (11 mg kg^{-1}), Mn (2.3 mg kg^{-1}), Cu (0.9 mg kg^{-1}) (Koubová et al. 2018).

Mineral contents of cornelian cherry and common dogwood genotypes are presented in Table 3. K was the most abundant element quantified in both species. While the K contents of the cornelian cherry genotypes varied from 1486 mg kg^{-1} (G3) to 3762 mg kg^{-1} (G2), the amount of K in the common dogwood species was much higher (6114 mg kg^{-1}). Previous studies demonstrated that K content of cornelian cherry varied from 1400 to 5000 mg kg^{-1} and the K content of cornelian cherry genotypes fall into this range, in the present study. However, common dogwood was the richest genotype for the K mineral compared to all cornelian cherry genotypes analyzed in previous studies as well as in this study (Kalyoncu et al. 2009, Bijelić et al. 2011). The Ca content was high in both species. The highest Ca content was detected in common dogwood with the amount of 2441 mg kg^{-1} which is approximately 10 times higher than that in cornelian cherry genotypes. Among the cornelian cherry genotypes, the amount of Ca varied from 228 mg kg^{-1} in genotype G3 to 279 mg kg^{-1} in G2. Previous studies reported that the Ca content of cornelian cherry ranged from 27 mg kg^{-1} to 2000 mg kg^{-1} (Bijelić et al. 2011, Cetkovská et al. 2013) and our finding for the Ca content in cornelian cherry genotypes is compatible with these

Table 3. Mineral Contents of *Cornus mas* (G1-G4) and *Cornus sanguinea* (G5) genotypes

	Minerals (mg kg^{-1})						
Genotype	**K**	**Ca**	**Mg**	**Fe**	**Cu**	**Mn**	**Zn**
G1	2538±22.0^{c}	240±8.0^{c}	93±3.0^{d}	4.51±1.8^{bcd}	0.74±0.1^{c}	Nd	Nd
G2	3762±10.0^{b}	279±14.0^{b}	161±32.0^{b}	6.54±2.9^{bc}	0.76±0.1^{c}	Nd	Nd
G3	1486±10.0^{e}	228±20.0^{c}	90±3.0^{d}	3.08±0.8^{d}	0.78±0.1^{c}	Nd	Nd
G4	2472± 4.0^{d}	258±29.0^{bc}	103±16.0^{cd}	4.59±1.5^{bcd}	1.59±0.1^{b}	Nd	Nd
G5	6114±61.0^{a}	2441±205.0^{a}	491±15.0^{a}	41±19.0^{a}	3.33±0.1^{a}	2.37±0.1^{a}	Nd

Results are expressed as milligram dry weight per kilogram; ± standard deviation (n= 3); Nd: <LOQ; differences between averages in the same column bearing different letters are significant at $P<0.05$.

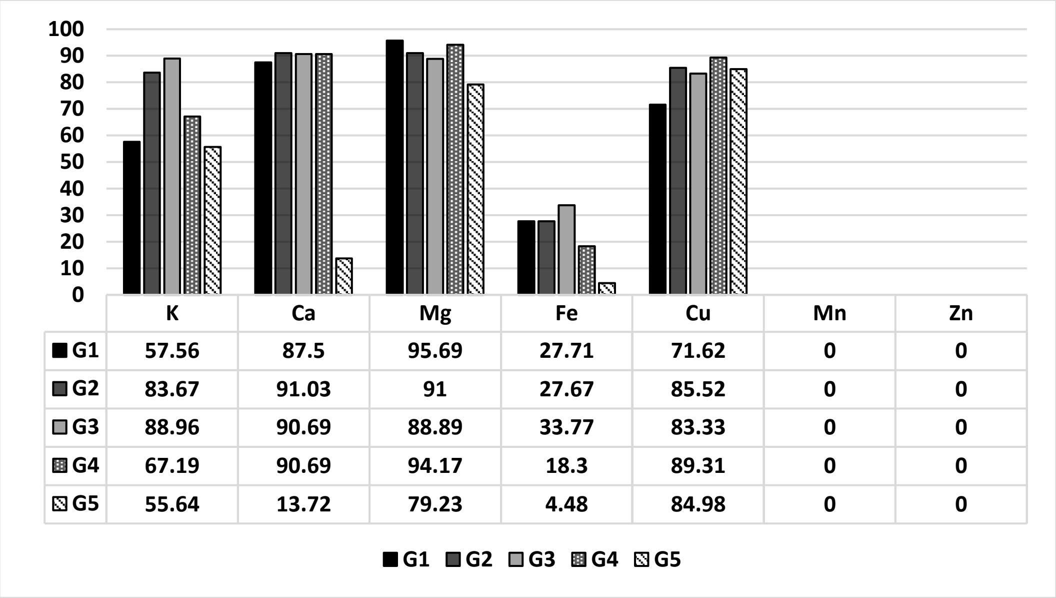
studies. On the other hand, the Ca content of common dogwood is higher compared to the highest Ca content reported in the literature for cornelian cherry. In terms of Mg content, the highest value was measured as 491 mg kg^{-1} in common dogwood. On the other hand, Mg contents in cornelian cherry genotypes varied from 90 mg kg^{-1} in G1 to 161 mg kg^{-1} in G2 genotype. The Mg level of the cornelian cherry detected in previous studies were remarkably variable (10-715 mg kg^{-1}) (Kalyoncu et al. 2009, Bijelić et al. 2011) and our results are in accordance with these studies. The Mg level of the common dogwood was in the range of the Mg level of the previously analyzed cornelian cherry genotypes. Iron mineral was found to be approximately 8-10 times lower in cornelian cherry genotypes than that in common dogwood species (41 mg kg^{-1}). Accordingly, the Fe content in cornelian cherry genotypes ranged from 3.08 mg kg^{-1} in G2 to 6.54 mg kg^{-1} in G3. The results obtained in the present study for both species agreed well with the Fe contents measured in other studies (0.4-48 mg kg^{-1}) (Cindrić et al. 2012, Cetkovská et al. 2013). As far as Cu is concerned, the highest amount among cornelian cherry genotypes was detected in the G4 genotype (1.59 mg kg^{-1}), while the other three genotypes were in the same statistical group. As with all other minerals, common dogwood species had the highest Cu content (3.33 mg kg^{-1}) among the analyzed samples. While Mn could not be determined in cornelian cherry fruits, it was detected in common dogwood with the amount of 2.37 mg kg^{-1}. Zn remained below the limit of detection (0.3 mg kg^{-1}) in all genotypes. Although we were not able to detect manganese and zinc in cornelian cherry genotypes, they were reported to be in the range of 0.2 to 29 mg kg^{-1} in the literature (Bijelić et al. 2011, Cetkovská et al. 2013, Ochmian et al. 2019). The reason for the variations in the content of minerals in different studies may be explained by genotypes as well as many other factors including geographic location, soil structure, agricultural practices, environmental factors, harvest method, storage conditions and analytical methods (Khoja et al. 2021). In the present study, all analyzed genotypes were grown in a garden with homogeneous cultivation practices. Therefore, the differences in minerals contents among the cornelian cherry genotypes and between two species could be due to the genotype.

While many studies have assessed the biological properties and chemical composition of *C. mas' fruits,* few phytochemical studies are present for common dogwood (*Cornus sanguinea* L.) fruits (Tenuta et al. 2022). In addition, there is no literature information regarding the mineral content of common dogwood fruits, therefore, a comparison could not be made with other genotypes of this species. On the other hand, many studies investigated the mineral content in other fruit species. Although the mineral content of the cornelian cherry species is similar or slightly higher than contents of plum, peach, blackberries, raspberries and strawberries except for Zn and Mn detected in other studies, the mineral content of the common dogwood is quite high compared to the commonly consumed fruit species (Baby et al. 2018). The fruits of common dogwood have a much richer mineral content than the fruits of *Corema album*, an edible wild species from the Ericaceae family (Brito et al. 2021). Table 4 shows the mineral content of cornelian cherry and common dogwood fruits measured after in vitro gastrointestinal extraction. When minerals are evaluated in terms of their bioaccessibility, the highest level of K content was determined in the common dogwood (3402 mg kg^{-1}), followed by G2 (3159 mg kg^{-1}), G4 (1661 mg kg^{-1}) G1 and G3 (1461 mg kg^{-1} and 1322 mg kg^{-1}) cornelian cherry genotypes. The results for Ca are quite surprising. Although the Ca content of the fruit is almost 10 times higher in the common dogwood genotype compared to the cornelian cherry genotypes, the bioaccessible Ca content of this species (335 mg kg^{-1}) is in the same statistical group with some cornelian cherry genotypes (G2: 254 mg kg^{-1} and G1: 218 mg kg^{-1}). While the bioaccessible amount of Mg was determined as 389 mg kg^{-1} in the common dogwood, it varied between 80-142 mg kg^{-1} among the cornelian cherry genotypes. Similar to calcium, although the Fe content in the common dogwood species is very high compared to that in cornelian cherry genotypes, the amount of iron measured by passing through the artificial gastrointestinal environment was found to be very close to each other in both species. The bioaccessible amount of Cu was determined as 2.83 mg kg^{-1} in common dogwood fruits and ranged between 0.53 and 1.42 mg kg^{-1} in cornelian cherry genotypes. Among all samples, Mn was determined only in the common dogwood species (Table 3) but its bioaccessibility was below detection limit. According to the proportional bioaccessibility of the mineral measured by in vitro gastrointestinal extraction method in the cornelian cherry and common dogwood species (Figure 2), the lowest bioaccessibility rate for K was detected in common dogwood (55.64%) and

Table 4. Bioaccessible mineral contents (mg kg^{-1}) of *Cornus mas* (G1-G4) *and Cornus sanguinea* (G5) genotypes

Genotype	**K**	**Ca**	**Mg**	**Fe**	**Cu**	**Mn**	**Zn**
G1	1461±42.0^{d}	218±62.0^{abc}	89± 4.0^{cd}	1.25±0.1^{a}	0.53±0.1^{cd}	Nd	Nd
G2	3159±92.0^{b}	254±10.0^{a}	142±16.0^{b}	1.81±0.8^{a}	0.65±0.1^{c}	Nd	Nd
G3	1322±30.0^{e}	209±11.0^{c}	80 ±11.0^{d}	1.04±0.1^{a}	0.65±0.1^{c}	Nd	Nd
G4	661±120.0^{c}	234±4.0^{b}	97±8.0^{c}	0.84±0.2^{ab}	1.42±0.1^{ab}	Nd	Nd
G5	3402± 54.0^{a}	335±79.0^{a}	389±50.0^{a}	1.84 ±0.9^{a}	2.83±1.3^{a}	Nd	Nd

Results are expressed as milligram dry weight per kilogram; ± standard deviation (n= 3); Nd: <LOQ; differences between averages in the same column bearing different letters are significant at $P<0.05$.



	K	Ca	Mg	Fe	Cu	Mn	Zn
■ G1	57.56	87.5	95.69	27.71	71.62	0	0
■ G2	83.67	91.03	91	27.67	85.52	0	0
□ G3	88.96	90.69	88.89	33.77	83.33	0	0
▦ G4	67.19	90.69	94.17	18.3	89.31	0	0
▨ G5	55.64	13.72	79.23	4.48	84.98	0	0

Figure 2. Bioaccessibility (%) of the mineral contents of *Cornus mas* (G1-G4) and *Cornus sanguinea* (G5) genotypes

the bioaccessibility of K in the cornelian cherry genotypes varied from 57.56 to 88.96%. In terms of Ca, the bioaccessibility of Ca in cornelian cherry genotypes was about 90%, while it was found to be at a very low level (13.72%) in common dogwood species. Mg has the highest bioaccessibility rate among the analyzed minerals varying from 79.23% in common dogwood to 95.69% in G1 genotypes. The bioaccessibility of Fe is the lowest among the minerals detected. Fe bioaccessibility in cornelian cherry genotypes ranged from 18.30% to 33.77%, while it was 4.5% in common dogwood species. The Cu bio-uptake rate was approximately 70-90% in all genotypes. While the bioaccessibility rates of the minerals for cornelian cherry fruits discussed in the present study were ranked as Mg>Ca>Cu>K>Fe, the most bioaccessible mineral in common dogwood fruits was Cu, followed by Mg, K, Ca, Fe and Mn (Figure 2).

The bioaccessibility of minerals is affected by many factors such as the chemical structure of the food, ligands in the food, redox activity of food components, chemical structure of the mineral of interest and mineral-mineral interaction (Lakshmi and Kaul 2011). According to the results, a significant amount of the analyzed mineral contents in the cornelian cherry fruits was found to be bioaccessible. Although the mineral contents of the common dogwood fruits were quite high, their bioaccessibility rates were found to be low. The reason for this discrepancy might be explained by the high proportion of compounds such as oxalic acid, carbonate and polyphenols which reduce absorption by forming insoluble complexes with minerals, and mineral-mineral interaction in the common dogwood species. At the same time, another reason might be low concentrations of proteins and amino acids (especially cysteine), because proteins and amino acids perform as reducing and chelating agents and increase the bioaccessibility of the element Fe in fruits and vegetables (Khouzam et al. 2011).

4. Conclusion

In conclusion, the amount of minerals that can be absorbed by the body is more important than that contained by the food. Therefore, the bioaccessibility of nutrients in foods has been important to demonstrate their nutritional value. Considering the mineral content in fruits of the two species in the study, *C. sanguinea* can be suggested as a very rich mineral resource for human nutrition. However, when *in vitro* bioaccessibility of the minerals is considered, both species have similar values. These results show that in investigating the potential of plant sources in terms of nutritional or functional properties, it may be misleading to evaluate the herbal matrix only by the amount of components it contains. The studies for evolution of herbal matrix should be supported by *in vitro* bioaccessibility determinations. Thus, more useful information can be obtained by determination of the nutritional potential of edible wild species. Today, in many areas of public opinion, recommendations are being made to consume wild species, especially dark fruits, due to their beneficial effects on people's health and rich nutritious content. However, as revealed in this study, the high content of a herbal food product may not mean that the food is very nutritious. In conclusion, in this study, the *in vitro* bioaccessibility of the mineral composition of *C. mas* and *C. sanguinea* fruits was examined for the first time and it was determined that the fruits of the *C. mas* species were a good mineral source for human nutrition when evaluated in terms of both total contents and bioaccessibility rates, and the G2 genotype was the most prominent among the studied genotypes.

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