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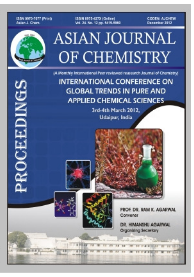


# Variation of Mineral Composition in Different Parts of Mahaleb†

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A wild member of *Rosaceae* family, Mahaleb (*Prunus mahaleb* L.) is a small tree or shrub with white flowers. This wild plant is important rootstock for cultivated cherry plants and its various parts are used as a spice and traditional medicine in Turkey. All the plant parts of mahaleb contain essential oil and coumarins as the major secondary metabolites. Plants capture minerals from the soil and accumulate them in different parts of their body. Mineral compositions and contents of the plants vary by different plant parts, soil properties, environmental conditions, agricultural techniques etc. Besides positive effects on plant development, accumulated minerals in used plant parts are important for human health. Some minerals such as calcium, iron and zinc are known to be useful for health and their optimum levels are desired. In contrast to them, heavy metals harmful for human health like cadmium, copper, nickel and lead -found in industrialized and urban areas- are not desired in high quantities. In recent years, studying on the mineral compositions of functional plants stands out due to their impact on human health. For this purpose, mineral composition (Al, B, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, N, Na, Ni, P, Pb, S and Zn) of distinct parts (stem, leaf, flower, fruit, kernel and resin) of mahaleb cherry were detected by ICP-AES. According to the determined results, investigated parts of mahaleb had acceptable ranges for mineral compositions.

**Key Words: Mahaleb cherry, Medicinal plants, Mineral composition.**

## INTRODUCTION

Mahaleb cherry [*Prunus mahaleb* L. syn. *Cerasus mahaleb* (L.) Mill.], also known as Rock cherry, as a member of *Rosaceae* family is spreading, deciduous, tree with glossy, dark-green leaves and bowl-shaped very fragrant white flowers that blossom in spring[1]. The plant likes warm climates and spreads through the Southern Europe, Western Asia, Northern Africa and commonly in Mediterranean region. It grows naturally nearly in all parts of the country. Besides it has been an important role as a rootstock for cherry and sour cherry cultivation, their various parts have been used as a traditional remedy for some ailments[2]. Fruits and seeds of mahaleb cherry have been used as a traditional healer for diabetes and stomach problems in Turkey for centuries. Gums obtained from the woods are also used for gastritis. Decoctions prepared by stem, fruit stalks, leaves and flowers have locally been used as an herbal tea for winter illnesses. Moreover, their seeds are ingredients of middle east countries, a special wine is locally produced from their fruits and fragrant woods are also imperative material for decorated wooden gifts. The seeds contain protein and fatty oil (27-40 %), which is also important for industrial usage. Main fatty acids in the oil are linoleic acid, oleic acid and eleostarin acid. According to recent scientific studies, coumarins are the key secondary metabolites in the plant parts. They are found free or associated with glucose. It is stated that curative properties of mahaleb cherry might be resulted from these components[3].

Besides secondary metabolites content and composition in medicinal and aromatic plants, mineral composition of them also has vital importance for human health. According to the scientific literature, desired level of mineral composition and contents in food and medicinal plants should be advised for healthy life. However, it is emphasized that higher doses and accumulation of these elements, especially heavy metals, could cause serious health problems. To determine the mineral compositions of some food and medicinal crops, scientific studies have recently been enhanced. Most of the Turkish medicinal plants and products have also been studied for their mineral compositions, as well. Main used parts of the plants have been considered for their elemental compositions in those studies. Among the Turkish medicinal and aromatic plants, Mahaleb cherry has been neglected for its chemical composition. Due to its usage in food and in folk medicine, it is worthwhile to

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TABLE-1
MINERAL COMPOSITIONS OF THE PLANT PARTS OF MAHALEB (mg/kg)

| Samples | Al | B | Ca | Cd | Co | Cr |
|---|---|---|---|---|---|---|
| Seed | 9.94 ± 0.2 | 19.4 ± 0.1 | 6795 ± 67.1 | 0.00963 ± 0.00046 | 0.000000185 ± 0.000000007 | 0.06707 ± 0.027178 |
| Fruit | 9.94 ± 3.7 | 21.6 ± 2.7 | 4964 ± 442.7 | 0.00206 ± 0.00282 | 0.000000030 ± 0.000000040 | 0.04702 ± 0.016487 |
| Fruit stalk | 233.82 ± 6.5 | 19.4 ± 0.7 | 13851 ± 274.4 | 0.00246 ± 0.00208 | 0.000000101 ± 0.000000079 | 0.69886 ± 0.018324 |
| Leaf | 543.22 ± 9.5 | 19.6 ± 0.3 | 16882 ± 163.0 | 0.02493 ± 0.00535 | 0.000001645 ± 0.000000401 | 1.57035 ± 0.028709 |
| Flower | 639.40 ± 0.5 | 20.3 ± 0.3 | 10178 ± 47.2 | 0.01291 ± 0.00394 | 0.000001028 ± 0.000000321 | 1.85202 ± 0.013167 |
| Gum | 125.89 ± 7.1 | 5.0 ± 0.6 | 6191 ± 119.9 | 0.00438 ± 0.00404 | 0.000000071 ± 0.000000056 | 0.37514 ± 0.014317 |
| *** | - | 50-200 | - | 5-30 | 15-50 | 5-30 |

***Critical concentrations in plants

TABLE-2
MINERAL COMPOSITIONS OF THE PLANTS PARTS OF MAHALEB (mg/kg)

| Samples | Cu | Fe | K | Mg | Mn | Mo |
|---|---|---|---|---|---|---|
| Seed | 15.5 ± 0.2 | 59.5 ± 0.3 | 9166 ± 31 | 2907 ± 29 | 18 ± 0.3 | 0.65 ± 0.1 |
| Fruit | 11.3 ± 0.2 | 41.3 ± 2.0 | 11510 ± 518 | 2433 ± 195 | 14 ± 0.8 | 0.23 ± 0.1 |
| Fruit stalk | 7.2 ± 0.3 | 211.8 ± 7.6 | 21458 ± 414 | 1166 ± 28 | 10 ± 0.3 | 0.08 ± 0.1 |
| Leaf | 7.0 ± 0.1 | 479 ± 4.9 | 16767 ± 183 | 5239 ± 9 | 36 ± 0.6 | 0.69 ± 0.0 |
| Flower | 6.8 ± 0.1 | 558 ± 5.6 | 19557 ± 181 | 4172 ± 10 | 28 ± 0.2 | 0.58 ± 0.1 |
| Gum | 0.3 ± 0.0 | 114.5 ± 7.2 | 4655 ± 222 | 2597 ± 68 | 8 ± 0.2 | 0.19 ± 0.1 |
| *** | | | - | - | 300-500 | 10-50 |

***Critical concentrations in plants

TABLE-3
MINERAL COMPOSITIONS OF THE PLANTS PARTS OF MAHALEB (mg $kg^{-1}$)

| Samples | N | Na | Ni | P | Pb | S | Zn |
|---|---|---|---|---|---|---|---|
| Seed | 3.42 ± 0.03 | 45.6 ± 1.3 | 1.3 ± 0.0 | 5767 ± 63 | 0.215 ± 0.02 | 2297 ± 5 | 36 ± 0.6 |
| Fruit | 1.03 ± 0.02 | 19.8 ± 1.0 | 0.9 ± 0.1 | 4716 ± 269 | 0.136 ± 0.06 | 1329 ± 57 | 27 ± 2.2 |
| Fruit stalk | 3.21 ± 0.06 | 91.2 ± 0.1 | 1.7 ± 0.1 | 3054 ± 24 | 0.256 ± 0.09 | 1073 ± 28 | 31 ± 0.5 |
| Leaf | 5.05 ± 0.02 | 58.1 ± 3.3 | 2.7 ± 0.0 | 3793 ± 35 | 0.391 ± 0.06 | 1697 ± 18 | 38 ± 0.5 |
| Flower | 4.04 ± 0.03 | 87.6 ± 0.8 | 3.3 ± 0.0 | 4796 ± 43 | 0.403 ± 0.04 | 1896 ± 21 | 39 ± 0.6 |
| Gum | 0.10 ± 0.00 | 32.2 ± 1.1 | 0.6 ± 0.0 | 62 ± 5 | 0.106 ± 0.02 | 301 ± 0 | 2 ± 0.1 |
| *** | - | - | 10-100 | - | 30-300 | - | 100-400 |

***Critical concentrations in plants

study its chemical composition. To the best of our knowledge, different parts of mahaleb cherry such as leaves, flowers, fruits, fruit stalks, seeds and tree gum were analyzed for their mineral compositions for the first time in the present study.

## EXPERIMENTAL

**Collection of the plant and soil samples:** Different parts of Mahaleb cherry (*Prunus mahaleb* L.-*Rosaceae*), used in this study, were collected in Mardin province located in south-eastern part of Turkey. Flower, leaf, fruit, fruit stalk, seed and gum of the plant were air dried under shade. Dried plant samples were kept in plastic bags until laboratory analysis.

**Chemical analysis pathway:** First of all the plant samples were cleaned and washed by deionized water, later air dried. Pre-dried samples were demoisturized at 70 ºC for 48 h in an oven and ground for chemical analysis. 0.2 g of ground samples were placed into burning cup, 5 mL $HNO_3$ 65 % (Merck, Darmastadt, Germany) and 2 mL $H_2O_2$ 30 %, (Merck, Darmastadt, Germany) were added immediately. After incinerating in a HP-500 CEM MARS 5 microwave (crop. Mathews NC, USA) at 200 ºC, the solution was cooled at room temperature for 45 min. The extracts were passed through a Whatman 42 filter paper and the filtrates were collected by high-deionized water in a 20 mL of polyethylene bottles and kept at 4 ºC in laboratory for ICP-AES analysis. Each sample was analyzed in triplicate.

For all analytical works, distilled-deionized water was used. All the glassware and polyethylene bottles were attentively leached with 2-4 % HCl and rinsed through deionized water for three times. Merck standards (R1 and R2 groups) were used as analytical reagent grade chemicals. Standard solutions of Cd, Cu, Fe, Mn and Zn were prepared in 1 % $HNO_3$ immediately before the analysis by serial dilution of 1000 mg/L stock solution stored in polyethylene bottles. Corn Bran (standard reference material, 8433) and Peach leaves (standard reference material, 1547) were used as reference materials[4].

The ICP-OES (Varian Vista-Pro, Australia) was used to determine the minerals. The wavelengths of the method were Al (396,152), B (208,889), Ca (370,602), Cd (214,439), Co (230,786), Cr (205,560), Cu (324,754), Fe (238,204), K (404,721), Mg (383,829), Mn (257,610), Mo (203,846), Na (588,995), Ni (216,555), P (213,618), Pb (220,353), S (181,972) and Zn (213,857) in the extracts.

## RESULTS AND DISCUSSION

The concentrations of 19 elements determined in seed, fruit, fruit stalks, leaf, flower and gum of *Prunus mahaleb* L.

are collectively listed in Table-1. It was determined that each part of plant contains significant values of elements, of which content in each part presented a wide variability. The macro and micro elements determined in varying concentrations (mg/kg level based on dry weight) were Al, B, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, N, Na, Ni, P, Pb, S and Zn (Tables 1-3).

**Aluminum:** The content of Al, which is known as one of the toxic elements, ranged from 9.94 mg/kg (seed and fruit) to 639.40 mg/kg (flower). On the ranges of Al in some medicinal herbs and their infusions consumed in Turkey reported by Basgel and Erdemoglu[5] were between 87 mg $kg^{-1}$ (linden) and 596 mg/kg (nettle). The critical Al level for most food plants is at 7-104 mg/kg[6]. The concentration of Al is much more than the critical levels proposed. Imelouane *et al.*[7] reported that the aluminum contents of some medicinal and aromatic plants growing in eastern Morocco were in most cases and ranged from 12265 mg/kg Wormwood of Tafouralt to 79152 mg/kg in Thyme (*T. vulgaris*) of Jrada. The concentrations of aluminum in the studied plants by Devi and Sarma[8] ranged between 2 and 1191 mg/kg. Gjorgieva *et al.*[9] reported that the Al contents were high and varied between 655.46 mg/kg (*T. officinale*) and 38.79 mg/kg (*R. pseudoacacia*). On medicinal and aromatic plants used as spices, condiments and herbal tea in Turkey, Özcan and Akbulut[10] determined high Al values, in most cases, from 57.70 mg/kg (*N. sativa*)-2962 mg/kg (*P. anisum*).

**Boron:** The concentration of boron (B) in the various plant parts was found to vary from 5.0 (gum) to 21.6 (fruit) mg/kg. The general trend of B level in the plant parts was fruit > flower > leaf > fruit= fruit stalk > gum. The boron composition of plants are influenced by the part of the leaf, its position in the plant, the plant age and the other the plant parts. In most cases, there is a tendency in increasing boron in aerial parts of plants with age whereas boron in other plant parts remained low and relatively constant[11-13]. Contents of B in plants vary in the range of 5- 30 mg/kg[14]. Özcan and Akbulut[10] reported that the B content ranged from 0.87 mg/kg (*G. glabra*) to 47.67 mg/kg (*F. vulgare*). Koca *et al.*[15] determined the concentration of B in varying contents from 11 to 44 mg/kg in various parts of *Gentiana olivieri.*

**Cadmium:** Cadmium is not required for metabolic processes, but its relatively easy bioavability to plants reveals serious health risk. Therefore, the determination of Cd in plants is a great concern. The range of Cd in plant varies between 5- 400 µg/kg[6]. The highest concentration of Cd found in the present work, 0.02493 mg/kg in mahaleb cherry leaves, is much lower than the limit of 0.3 mg/kg, which has been established as the upper limit for safe human consumption recommended for medicinal plants[16]. The range concentration of Cd content varied from 0.00206 to 0.02493 mg/kg in different parts of the mahaleb cherry. Whereas the lowest content (0.00206 mg/kg) was detected in fruits of mahaleb cherry, the highest content (0.02493 mg/kg) in leaves was up to 12-fold of the lowest content. The range content of Cd content measured in the present study was also much lower than that reported in the previous studies. Basgel and Erdemoglu[5] detected the Cd content at higher levels (1.2-440 µg/kg) in some herbal teas consumed in Turkey. The concentration range of Cd in medicinal plants studied in Italy (79 samples) and Egypt (10 samples) was 10-750 and 50-300 µg/kg, respectively[17,18]. Lozak *et al.*[19] reported a Cd 90 µg/kg-concentration in mint leaves. Koca *et al.*[15] found Cd a concentration ranging from 1.4 to 5.2 µg/kg in the various parts of *Gentiana olivieri*. The content differences of Cd could be attributed to the capacity of plants to take up and accumulate of this metal among plant species genotypes[20,21].

**Cobalt:** Co is essential to both plants and humans[22] and the concentration for Co was determined to be between 0.000000030 mg/kg (fruit) and 0.000001645 mg/kg (leaf) under the present study. The obtained values are much lower than the common contents of Co reported to vary from 8 to 170 µg/g in food plants[6]. But there has not any established criteria for Co in medicinal plants[23]. The concentrations of Co were recorded in the ranges of 3.41 mg/kg (*A. punges*) and 11.26 mg/kg (*H. vulgare*) by Jabeen *et al*. In the concentration range for Co in some herbs consumed in Turkey was 0.14-0.48 mg/kg[5]. In some literatures, the ranges were as follows 0.04- 0.42 mg/kg for Gentiana olivieri[15], 0.24-1.03 mg/kg for medicinal plants growing in unpolluted soils and 0.38-1.48 mg/kg for medicinal plants growing in polluted soil in Nigeria[24]. The lower concentration for Co in the present study could be attributed to gathering this plant from non-polluted areas away from urban.

**Chromium:** Contents of Cr either varies from 0.01 to 0.35 mg/kg[14], or from 0.07 to 0.41 mg/kg[25], or the permissible levels (0.02 mg/kg), which has been established as the upper limit for safe human consumption recommended for medicinal plants[26]. But the concentration of Cr varied in the range of 0.04702 mg/kg (fruit) and 1.85202 mg/kg (flower) in the present study. Stef *et al.*[27] detected the highest 5.7 ppm Cr concentration in *Calendula officinalis*. Cr concentration ofthe herbs were in the range of 0.34-1.22 mg/kgwith the highest level of chamomile in the study reported by Basgel and Erdemoglu[5]. Essiett[24] detected that the chromium level varies between 0.01-0.05 mg/kg in non-polluted areas.

**Copper:** Regarding a relatively small variation between countries, the general mean contents of Cu vary from 3.8 to 6.7 mg/kg for wheat grains, 3-8 mg/kg for leafy vegetables[6] and 3.0 mg/kg for edible plants[26]. The Cu content ranged from 0.3 to 15.5 mg/kg in our study. In many studies, Cu content was determined to be in the ranges of 0.03-1.09 mg/kg[24], 5.0 - 32.7 mg/kg[29], 3.92- 35.8 mg/kg[5], 1.4- 18.1 mg/kg[27], 2.7- 21.3 mg/kg[28], 4.6- 11.5 mg/kg[15], 0-11.0 mg/kg[5], 7.06-19.19 mg/kg[23].

**Iron:** Iron (Fe) is an essential nutrient for all organisms and required for the hemoglobin formation and transfer of oxygen and electron[30]. The concentrations of Fe in various cereal grains does't differ much. The mean content ranges between 31 to 98 mg/kg[6] and 20 mg/kg for edible plants[26]. Fe content varied between 41.3 mg/kg (fruit) and 558 mg/kg (flower) in the present study. Fe content of the herbs was in the range of 224-502.7 mg/kg according to the report by Basgel and Erdemoglu[5].

**Molybdenum:** Various food plants do not differ much in the concentration of Mo, which is, in most cases, about 0.5 mg/kg, neither between cereals nor between field conditions[6].

In the present study, Mo content ranged from 0.08 to 0.69 mg/kg. Street *el al*.[31] determined the Mo level to be 0.080-0.364 mg/kg in South African medicinal plants. The present results were found to be in good agreement with previous results.

**Lead:** The permissible level established in edible plants for Pb, which has acute and chronic poisoning and adverse effects on kidney, vascular and immune system[32] is 0.43 mg/kg[26]. The content of Pb was detected to be in the ranges of 0.106 and 0.403 mg/kg in our study. Lead level was up to 2.63 ppm in the study reported by Ozcan and Akbulut[5]. Jabeen *et al*.[23] reported that the concentration of Pb between 3.15 and 10.63 mg/kg.

**Zinc:** The content of Zn ranged from 2 and 39 mg/kg with the highest value in the flower and lowest level in the gums. Jabeen *et al*.[23] detected that the levels of Zn are between 17.38 and 65.85 ppm in some medicinal plants. The zinc content ranged from 0.26 to 4.80 mg/kg in the study conducted by Basgel and Erdemoglu[5]. The WHO limits for this metal has not yet been published.

**Manganese:** Contents of Mn in plants fluctuate greatly within plant genotypes and their parts. The manganese limit set for edible plant was 2 mg/kg[26]. It was found to vary between 8 mg/kg (gum) and 36 mg/kg (leaf) under the present study. In some literatures, the detected levels of Mn were in the ranges of 5- 58 mg/kg[33], 32.64-105.56 mg/kg[23], 23.0-244 mg/kg[5] and 18.0-214.0 mg/kg[27].

**Nickel:** The flower concentration had the greatest content in nickel (3.3 mg $kg^{-1}$) and lowest content was found to be in gum (0.6 mg/kg). The limit for the edible parts of plant was 1.63 mg/kg[26]. Jabeen *et al*.[23] detected the Ni level between 2.6-15.8 mg/kg, which was much more than the limit set. Similarly, the content of Ni varied in the ranges of 0.5 mg/kg and 13.9 mg/kg[27] and 1.81 and 28.66 mg/kg[5].

Concerning the macroelements, the arrays of magnesium (Mg), potassium (K), phosphorus (P), sulphur (S), sodium (Na) and nitrogen (N) were also determined in the different parts of mahaleb cherry. The results were respectively given as follows. The concentration of Mg, which is one of the most common element in human body and is essential to proper health[34] was in the range of 1166 mg/kg (fruit stalk) and 5239 mg/kg (leaf). The obtained ranges of Mg are in good agreement with previous findings[9,23,35-37]. The most common abundant cation in the human body is potassium cation[38]. For the different parts of mahaleb, the range of K varied between 4655 mg/kg (gum) and 21458 mg/kg (fruit stalk). All studied parts showed high K contents and the present results coincided with the previous literatures on medicinal plants[9,10,15,23,29]. The seed had the greatest concentration of P (5767 mg/kg) whereas the lowest level was detected in gum (62 mg/kg). The ranges of P in different plants were 443.60- 9367.80 mg/kg[10] and 1122-2284 mg/kg[15]. The content of *S. varied* between 301 mg/k g and 2297 mg/kg for gum and seed, respectively. The arrays of Na were estimated to be between 19.8 mg/kg (fruit) and 91.2 mg/kg (fruit stalk). Sodium content was much lower than the previous findings[9,10,23,35,36]. The present results coincided with the previous findings[15,38]. The concentration of N was in the ranges of 0.10 and 3.42 mg/kg. Our findings are agreeable with previous literatures[28,39-41].

## Conclusion

In this paper, it was attempted, for the first time, to contribute knowledge of the nutritional composition of *Prunus mahaleb* L. growing in the South-Eastern parts of Turkey. According to chemical analysis mineral concentrations of different parts of mahaleb cherry were in the same ranges than that of the previous studies results and scientific literatures. Mahaleb leaves had the highest concentrations for Ca, Cd, Co, Mg, Mn, Mo and N. Elemental composition of the gum was quite different than that of the other parts. Gum had the lowest mineral composition for almost all the minerals determined, except for Al, Ca, Cd, Co, Cr, Fe Mg, Mo and Na. Of the determined minerals, heavy metal concentrations, which are poisons in high quantities for plant all the alive, were lower than the critical levels. Other trace elements and content of the mahaleb cherry were in harmony with the scientific literatures. Considering the most used parts of the mahaleb as a spice and traditional medicine are fruits, seeds and gum, it could be said that mahaleb cherry is safe unless they dose excessively.

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