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# Mineral contents and chemical properties of some *Sideritis* and *Origanum* species

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***Abstract***

The mineral contents, flavonoid, total phenol and anthocyanin contents of aerial parts of Sideritis and Origanum species. K was found high in both plant species. While K contents of Sideritis change between 10184.91 mg/kg (*Sideritis libanotica* Labill. subsp. *linearis*) and 17182.86 mg/kg (*S. hispida*), K contents of Origanum ranged from 10265.40 mg/kg (*Origanum majorana*) to 21293.79 mg/kg (*O. vulgare*). While the crude protein contents of Sideritis change between 1.55% (*S. libanotica* Labill. subsp. *linearis*) and 7.83% (S. perfoliata), protein contents of Origano species ranged from 1.99% (*O. leptocladum*) to 5.51% (*O. vulgare*). Also, the flavonoid contents of Sideritis plants change between 246.34 (*S. libatotica* Labill. subsp. *linearis*) and 2013.33 (*S. hololeuca*), the flavonoid contents of Origanum plants ranged from 345.38 (*O. onites*) to 1730.47 (*O. majorana*). The highest total phenol was found in *S. congesta* (6814.31) plant.

***Keywords***: Sideritis, Oreganum, mineral, protein, flavonoid, total phenol, anthocyanin, ICP-AES

## 1. Introduction

The trace elements found in living organisms may be essential, that is, indispensable for growth and health. The nutritional and medicinal properties of these plants may be interlinked through phytochemicals, both nutrient and nonnutrient [1,2]. Human, as well as animal, studies originally showed that optimal intake of elements, such as sodium, potassium, magnesium, calcium, manganese, copper, zinc, and iodine, could reduce individual risk factors, including those related to cardiovascular disease. Throughout the world, there is increasing interest in the importance of dietary minerals in the prevention of several diseases [3,4].

In the past, medicinal plants have been used with multi-functional properties including medical usage, functional food and nutraceutical food components [5]. Recently, increasing demand on both nutritional and health foods with better nutraceutical, pharmaceutical, nutritional and functional properties have been studied extensively. The aim of present study was to determine total phenol, flavonoid, anthocyanins and mineral contents of *Sideritis* and *Origanum* plants growing wild in several provinces in Turkey.

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## 2. Materials and Method

### 2.1.Plant materials

All the *Sideritis* and *Origanum* plant species were collected from Antalya, Karaman, Mersin, Konya, and Niğde provinces in the south parts of Turkey. The plants were identified by Dr Doğu from Necmettin Erbakan University, Konya, Turkey. The voucher specimens (Table 1) were deposited at the same Department, Necmettin Erbakan University.

### 2.2.Methods

#### 2.2.1.Determination of mineral

Plant samples were dried at 70 ºC in a drying cabinet with air-circulation until they reached constant weight. Later, about 0.5 g dried and ground samples were digested by using 5ml of 65% $HNO_3$ and 2 ml of 35% $H_2O_2$ in a closed microwave system (Cem-MARS Xpress). The volumes of the digested plant samples were completed to 20 ml with ultra-deionized water, and mineral contents were determined by ICP AES (Varian-Vista, Australia). Measurements of mineral concentrations were checked using the certified values of related minerals in the reference samples received from the National Institute of Standards and Technology (NIST; Gaithersburg, MD, USA) [6].

**Working conditions of ICP-AES:**

Instrument:ICP-AES (Varian-Vista)
RF Power: 0.7-1.5 kw (1.2-1.3 kw for Axial)
Plasma gas flow rate (Ar): 10.5-15 L/min. (radial)
15 “ (Axial)
Auxilary gas flow rate (Ar) :1.5 “
Viewing height: 5-12 mm
Copy and reading time:1-5 s (max.60 s)
Copy time: 3 s (max. 100 s)

#### 2.2.3.Determination of Anthocyanins, Total Phenolic Contentsand Flavonoids

Anthocyanins were analyzed according to the method of Ticconi et al. [7]. 0,5 g fresh weight (FW) were homogenized in a solution containing propanol, chlorhydric acid, and water (18 : 1 : 81). The resulting homogenates were boiled in a water bath for 3 min and then left in darkness for 24 h at room temperature. 3 mL of the supernatants were centrifuged at 6500 rpm for 40 min. Finally, the absorbencies of the samples were measured at 535 and 650 nm. The absorbance value was calculated and corrected by the following formula:

$$A = A_{535} - A_{650}$$

The phenols of the plant material were extracted with MeOH. Total phenolic content was assayed quantitatively by absorbance at 765 nm with Folin-Ciocalteau reagent according to the method of Madaan et al. [8]. Firstly, a standard curve of known concentrations of gallic acid was prepared to calculate the total phenolic content to be expressed as gallic acid equivalent (GAE). Ten mg of gallic acid was dissolved in 100 mL of 50% methanol (100 µg/mL) and then diluted to 12.5, 25, 50 or 100 µg/mL. 0.076 mL aliquot of each dilution was taken in a test tube and diluted to 0.76 mL of distilled water. Then 0.12 mL FolinCiocalteu's reagent (1 N) was added and allowed to incubate at room temperature for 5 min. 0.32 mL of 20% (w/w) $Na_2CO_3$ was added in each test tube, adjusted with distilled water up to the mark of 2 mL, vortexed and left to stand for 30 min at room temperature. Absorbance of the standard was measured at 765 nm using UV/VIS spectrophotometer (Schimadzu, Japan) against blank, i.e., distilled water. For measurement of plant samples, appropriately diluted methanolic extracts of 0.76 mL were taken in test tubes and then similar procedure was followed with the standards.

Total flavonoids contents of plants were estimated according to Dewanto et al. [9]. Methanol extracts were properly diluted with distilled water. 5% $NaNO_2$ solution was added to each test tube; after five minutes, 10% $AlCl_3$ solution was added and then after six minutes 1.0 M NaOH was added. Finally total volume was filled up to 5 mL with water and the test tubes were mixed well. Absorbance of the resulting pink-colored solution was measured at 510 nm versus blank. Calibration curve was prepared using Catechol as standard. The flavonoid content was expressed as mg Catechol equivalents (CE) per g of dry weight (mg CE/g DW).

### 2.3. Statistical analyses

Results of the research were analysed for statistical significance by analysis of variance [10].

## 3. Results and Discussion

The mineral contents of aerial parts of some Sideritis and Origanum spp. Plants are given in Table 1. According to both plant species, mineral contents shown differences. The highest element of Sideritis samples was K, and its contents ranged from 10184.91 mg/kg (S. libanotica Labill. subsp. linearis) to 17182.86 mg/kg (*S. hispida*). In addition, Ca contents of Sideritis were found high. Ca contents of Sideritis plants changed between 8094.63 mg/kg (S. libanotica Labill. subsp. linearis) and 18570.58 mg/kg (*S. vurualii*). P, Mg and S contents of Sideritis were found low. As a micro nutrition element, Fe, Zn, Mn, B and Mo were determined in Sideritis spp. Fe content was found at the high level, and its content ranged from 123.60 mg/kg (S. perfoliata) to 932.56 mg/kg (*S. libanotica* Labill. subsp. *violascens*).

Also, Zn contents of Sideritis changed between 9.19 mg/kg (S. libanotica Labill. subsp. linearis) and 33.46 mg/kg (S. hispida). The highest Cu content was found in *S. hispida* (32.35 mg/kg).

While K contents of Origanum plants change between 10265.40 mg/kg (*O. majorana*) and 21293.79 mg/kg (*O. vulgare*), Ca contents ranged from 11470.09 mg/kg (*O. saccatum*) to 18797.36 mg/kg (*O. onites*). Depending on the plant species, differences were observed in the mineral contents of samples. In addition, Mg contents of samples changed between 1180.23 mg/kg (*O. leptocladum*) and 2247.16 mg/kg (*O. sipyleum*). The highest P (1781.11 mg/kg) was found in *O. vulgare* sample. While Fe contents of Origanum samples range from 70.16 mg/kg (*O. leptocladum*) to 353.22 mg/kg (O. onites), Zn contents of samples were found between 22.96 mg/kg (*O. leptocladum*) and 39.37 mg/kg (*O. micranthum*).

***Table 1.*** Plants used in experiment

| Family | Species | Location | Altitude | Herbariumno |
|---|---|---|---|---|
| Lamiaceae | *Sideritisperfoliata* | C4 Niğde: Ulukışla, Alihoca Köyü, bahçe içi, 26.06.2014. | 1050 m | S. Doğu 2874 |
| Lamiaceae | *Sideritiscongesta* | C4 Antalya: Manavgat, Manavgat-Konya yolu 9.km, slopes, 27.06.2014. | 350 m | S. Doğu 2878 |
| Lamiaceae | *Sideritislibanoticas*ub sp. *linearis* | C4 Karaman: Karaman-Ayrancı Yolu 15. km, yol kenarı, 26.06.2014. | 1050 m | S. Doğu 2876 |
| Lamiaceae | *Sideritishololeuca* | C4 Karaman: Karaman-Mut Yolu, Sertavul geçidi, yol kenarı, 26.06.2014. | 1250 m | S. Doğu 2875 |
| Lamiaceae | *Sideritisvuralii* | C4 Mersin: Anamur, Abanoz yaylası, yol kenarı, 21.06.2014. | 1550 m | S. Doğu 2858 |
| Lamiaceae | *Sideritiscilicica* | C4 Mersin: Tarsus, Sarıkavak Köyü civarı, rocky slopes, 21.06.2014. | 550 m | S. Doğu 2857 |
| Lamiaceae | *Sideritiscondensata* | C4 Antalya: Manavgat, Manavgat-Konya yolu 11.km, yamaçlar, 27.06.2014. | 370 m | S. Doğu 2879 |
| Lamiaceae | *Sideritisbrevidens* | C4 Mersin: Gülnar, Gülnar-Mut yolu 2.km, yol kenarı, 21.06.2014. | 850 m | S. Doğu 2859 |
| Lamiaceae | *Origanumonites* | C4 Antalya: Manavgat, Manavgat-Konya yolu 6.km, yamaçlar, 12.08.2014. | 300 m | S. Doğu 2894 |
| Lamiaceae | *Origanummicranthu m* | C4 Mersin: Tarsus, Gülek kasabası, Kale location, yol kenarı, 14.08.2014. | 900 m | S. Doğu 2896 |
| Lamiaceae | *Origanumsipyleum* | C4 Konya: Beyşehir, Konya-Beyşehir road 54.km, *Pinus* birliği açıklıkları, 10.08.2014, | 1150 m | S. Doğu 2892 |
| Lamiaceae | *Origanumvulgare*sub sp. *viride* | C4 Adana: Tekir, Mezbaha location, yamaçlar, 14.08.2014. | 1000 m | S. Doğu 2895 |
| Lamiaceae | *Origanumleptocladu m* | C4 Karaman: Ermenek, Ermenek-Karaman yolu 5.km, taşlık yamaçlar, 10.08.2014. | 1500 m | S. Doğu 2894 |
| Lamiaceae | *Origanummajorana* | C4 Mersin: Aşağıkeşlik Köyü civarı, yol kenarı, 14.08.2014. | 300 m | S. Doğu 2897 |
| Lamiaceae | *Origanumsaccatum* | C4 Antalya: Alanya, Gevne valley, slopes, 10.08.2014. | 1100 m | S. Doğu 2893 |

***Table 2.*** Mineral contents of some *Sideritis* and *Origanum* species

| | Macro elements ( mg kg$^{-1}$) | | | | | Micro elements (mg kg$^{-1}$) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Samples** | **P** | **K** | **Ca** | **Mg** | **S** | **Fe** | **Zn** | **Mn** | **B** | **Cu** | **Mo** |
| *S.perfoliata* | 2016,98± 35,10 | 15118,98± 425,71 | 11029,42± 294,74 | 2762,85± 45,89 | 2037,48± 29,06 | 123,60± 2,92 | 27,23± 1,55 | 15,69± 0,19 | 16,37± 0,59 | 12,57± 0,35 | 0,33± 0,03 |
| *S.congeste* | 649.39± 28.88* | 10284.13± 295.79 | 10066.77± 1073.70 | 1300.87± 35.58 | 2135.88± 29.29 | 160.78± 14.90 | 19.10± 0.18 | 4.98± 0.61 | 16.96± 1.75 | 11.22± 0.63 | 0.07± 0.02 |
| *S.libanotica Labill.subsp.linearis* | 1046.85± 38.04 | 10184.91± 625.69 | 8094.63± 1382.18 | 1194.51± 79.31 | 892.21± 58.37 | 129.42± 5.78 | 9.19± 0.33 | 26.08± 2.82 | 12.49± 0.29 | 11.04± 1.17 | 2.70± 0.95 |
| *S.hispida* | 1345.42± 67.02 | 17182.86± 466.28 | 10418.49± 373.17 | 2208.78± 29.52 | 1039.76± 43.67 | 364.95± 12.87 | 33.46± 0.52 | 39.40± 1.47 | 18.18± 1.02 | 32.35± 1.32 | 0.21± 0.01 |
| *S.bilgerana* | 762.16± 15.95 | 13015.47± 11.70 | 17420.45 159.29 | 2145.60± 9.89 | 973.15± 9.07 | 651.73± 7.92 | 25.54± 1.22 | 31.11± 0.29 | 18.64± 0.65 | 28.63± 2.38 | 0.63± 0.13 |
| *S.libanotica Labill.subsp.vialascens* | 965.78± 33.08 | 16362.16± 291.65 | 16999.53± 824.48 | 2052.45± 44.34 | 1300.41± 32.92 | 932.56± 69.55 | 18.48± 0.36 | 37.37± 2.30 | 20.23± 0.30 | 12.50± 0.61 | 0.00± 0.00 |
| *S.hololeuca* | 1523.94± 17.95 | 15456.66± 311.97 | 14117.47± 27.47 | 1519.54± 15.64 | 1157.97± 14.97 | 212.98± 6.41 | 20.58± 0.69 | 16.66± 1.00 | 19.12± 0.31 | 14.80± 1.58 | 0.00± 0.00 |
| *S.vurualli* | 1629.87± 76.27 | 16622.06± 297.15 | 18570.58± 1158.16 | 2013.91± 42.04 | 1424.31± 49.70 | 360.27± 10.01 | 21.41± 0.97 | 24.29± 0.87 | 23.06± 2.10 | 10.86± 0.57 | 0.16± 0.03 |
| *S.cilicia* | 1467.14± 29.39 | 10322.65± 304.14 | 16334.72± 487.68 | 2010.29± 3.80 | 1220.87± 16.06 | 2060.67± 22.90 | 25.73± 1.68 | 66.17± 1.24 | 19.92± 0.29 | 13.91± 1.99 | 0.03± 0.02 |
| *S.condensata* | 680.25± 8.81 | 15630.82± 437.11 | 11584.66± 340.22 | 2890.00± 32.82 | 1360.19± 30.71 | 310.57± 9.10 | 23.59± 0.33 | 11.43± 0.38 | 17.96± 0.50 | 11.67± 0.55 | 0.45± 0.11 |
| *S.brevidens* | 1082.41± 59.61 | 15757.91± 169.65 | 10415.11± 1070.62 | 1464.80± 19.81 | 1370.16± 68.79 | 146.13± 26.28 | 19.23± 1.48 | 5.71± 0.42 | 10.61± 0.32 | 7.58± 1.10 | 0.00± 0.00 |
| *O.onites* | 1430.00± 11.17 | 14990.59± 684.41 | 18797.36± 685.79 | 1856.33± 26.72 | 2240.63± 33.25 | 353.22± 32.86 | 29.30± 0.30 | 18.81± 0.34 | 19.83± 0.66 | 10.82± 0.54 | 0.45± 0.02 |
| *O.micranthum* | 1463.60± 31.47 | 19360.62± 366.53 | 14358.41± 647.05 | 1931.67± 30.18 | 1632.84± 20.92 | 224.52± 11.44 | 39.37± 1.64 | 10.92± 0.54 | 30.47± 0.97 | 10.05± 0.58 | 1.33± 0.04 |
| *O.sipyleum* | 682.14± 46.40 | 12439.55± 301.46 | 15199.17± 879.92 | 2247.16± 30.96 | 2057.58± 38.96 | 126.61± 12.40 | 24.51± 0.93 | 10.32± 0.92 | 32.10± 2.62 | 6.19± 0.54 | 0.26± 0.02 |
| *O.vulgare* | 1781.11± 35.82 | 21293.79± 796.55 | 12330.22± 577.59 | 1896.63± 45.18 | 2122.25± 37.13 | 91.99± 3.74 | 37.06± 1.85 | 9.14± 0.30 | 18.30± 0.84 | 12.24± 1.77 | 0.39± 0.11 |
| *O.leptocladum* | 704.87± 9.23 | 15474.31± 105.00 | 14561.98± 311.96 | 1180.23± 36.04 | 1547.80± 24.34 | 70.16± 1.94 | 22.96± 1.29 | 0.79± 0.15 | 18.01± 1.71 | 14.36± 1.32 | 1.94± 1.94 |
| *O.majorana* | 1164.27± 46.77 | 10265.40± 60.77 | 14247.00± 314.10 | 2235.91± 19.84 | 1249.76± 8.78 | 388.80± 13.54 | 31.35± 1.15 | 8.67± 0.31 | 14.59± 0.58 | 26.43± 2.87 | 0.34± 0.01 |
| *O.saccatum* | 1738.88± 12.12 | 19447.97± 259.80 | 11470.09± 200.14 | 1330.73± 13.34 | 2256.31± 8.62 | 82.87± 1.39 | 28.38± 1.05 | 9.12± 0.29 | 17.25± 0.33 | 22.30± 2.58 | 1.28± 0.04 |

*mean±standard deviation

***Table 3.*** Flavonois, phenol and anthocyanin contents of some *Sideritis* and *Origanum* species

| **Samples** | **Flavonoid** | **Phenol** | **Anthocyanin** |
|---|---|---|---|
| S.perfoliata | 371.20±6.56* | 6812.96±13.13 | 1.08±0.04 |
| S. congesta | 370.73±5.51 | 6814.31±9.70 | 1.09±0.03 |
| S. libanotica Labill. subsp. linearis | 246.34±1.20 | 5441.45±8.31 | 1.39±0.04 |
| S. hispida | 290.10±2.33 | 5808.00±12.52 | 4.07±0.03 |
| S. bilgerana | 293.92±1.42 | 5402.64±5.92 | 1.99±0.05 |
| S. libanotica Labill. subsp. violascens | 1605.00±3.61 | 4662.19±6.96 | 4.21±0.04 |
| S. hololeuca | 2013.33±4.04 | 3442.49±5.86 | 1.58±0.04 |
| S. vurualii | 412.33±1.53 | 3614.84±6.33 | 2.11±0.05 |
| S. cilicia | 729.67±3.51 | 3093.16±4.12 | 1.77±0.06 |
| S. condensata | 471.60±3.50 | 6365.06±5.20 | 3.00±0.06 |
| S. brevidens | 386.14±3.59 | 6271.08±4.44 | 2.64±0.61 |
| O. onites | 345.38±2.96 | 8764.92±5.68 | 1.11±0.04 |
| O. micranthum | 425.16±3.68 | 7250.31±4.64 | 1.72±0.04 |
| O. sipyleum | 641.95±1.67 | 8312.59±3.88 | 1.05±0.03 |
| O. vulgare | 547.17±3.22 | 7696.50±5.51 | 0.83±0.04 |

*mean±standard deviation

The higgest Cu (26.43 mg/kg) was found in *O. majorana* sample. In general, the same mineral contents (P, K, Ca, Fe) were found high. But, mineral contents of Sideritis were found partly higher than those of results of Origanum samples. Both plant can be used as herbal tea due to tonic effect covered several high minerals. So both plant species are rich source of potassium, and K is very important for the functioning of the human body.

The protein, flavonoid, total phenol and anthocyanin contents of Sidentis and Origanum plants are given in Table 2. While protein contetns of Sideritis change between 1.55% (S. libanotica Labill. subsp. linearis) and 7.83% (*S. perfoliata*), protein contents of Origano plants ranged from 1.99% (*O. leptocladum*) to 5.51% (O. *vulgare*). Generally, cmde protein contents of Origanum samples were found partly higher than those of Sideritis samples (except S. perfoliata). While the flavonoid contents of Sideritis plants change between 246.34 (S. *libanotica* Labill. subsp. *linearis*) and 2013.33 (S. hololeuca), the flavonoid contents of Origanum plants ranged from 345.38 (*O. onites*) to 1730.47 (*O. majorana*). While the highest total phenol is found in *S. congesta* (6814.31) plant, the lovest total phenol was found in S. cilicia (3093.16) plant. Also, the total phenol contents of Origanum samples changed between 582.40 (*O. leptocladum*) and 8764.92 (*O. onites*). While the anthocyanin contents of Sideritis range from 1.39 (*S. libanotica* Labill. subsp. *linearis*) to 4.21 (*S. libanotica* Labill. subsp. *violascens*), the anthocyanin contents of origanum were found between 0.77 (O. saccatum) and 1.88 (*O. leptocladum*). Generally, the total phenol and anthocyanin contents of Sideritis samples were found higher than those of results of Origanum plants. Differences among plant species were observed. These differences can be probably due to genetic factors, plant species, geographical factors, climatic conditions, soil structure and analytical conditions.

While K contents of plants changed between 14.518 and 24.171 mg/kg, Ca contents ranged between 12,402 and 18,553 mg/kg. P and Mg contents were found low compared with K and P values of plants [11].

Mg content was changed between 2,118 and 2,914 mg/kg; the mean was calculated as 2,496 mg/kg [11]. P contents of plants were determined between 1,385 to 1,910 mg/kg [11]. As a microelement, Fe contents of plants were found between 179 and 782 mg/kg [11].

Different micronutrients, although required in minor quantities are essential for good health of mankind and animals. In addition to micronutrients, we need some major elements in higher amounts for good health. In this respect, phosphorus is a major element for many biochemical reactions taking place in the body, such as conversion of foods to energy [12].

Generally, several differences in mineral, crude protein, flavonoid, total phenol, and anthocyanin contents were observed. These differences can be probably due to different plant species, climatic factors, locations, soil structure, genetic factor and other parameters like analytical conditions. Because of these properties, these plants can be used for various purposes like herbal tea, condiment, medicine and cosmetic fields.

## Conclusion

The study showed that the plants were well supplied with essential elements. The mineral elements contained in those medicinal plants are very important in human nutrition. The high levels of these elements (Ca, P,Mg) show that the leaves of the plants could provide alternative source of calcium potassium and magnesium in diet. The content of mineral elements and bioactive properties are a few of the most essential aspect that influence the use of edible flowers in human nutrition. Because of these properties, these plants can be used as functional food in Turkey such as herbal tea, spices, food preservative and food ingredient. Further studies of this plant species should be directed to carry out *in vivo* studies of its medicinal active components in order to prepare a natural pharmaceutical products of high value. Therefore, these plants can be used for its antioxidant activities in future due to the presence of above mentioned anthocyanins, phenol and flavonoids.

**Compliance with Ethics Requirements.** Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

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