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RESEARCH ARTICLE

DETERMINATION OF MINERALS IN *LAVANDULA STOECHAS* L. SUBSP. *CARIENSIS* (BOISS.) ROZEIRA BY X-RAY FLUORESCENCE SPECTROSCOPY

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Abstract

Background and objective: Medicinal herbs are sources of bioactive plant secondary metabolites such as phenolic acids, flavonoids, iridoids, tannins, anthracenes, alkaloids, terpenes. Herbs and herbal extracts are important sources for minerals that can create health effects in human diet. The infusion and decoction prepared from *Lavandula stoechas* L., subsp. *cariensis* known as Karabaşotu in Turkey, are used in traditional medicine. The objective of the present work was to comparatively determine the mineral content of dried aerial parts *L. stoeachas* L. subsp. *cariensis* and its water extract which is prepared by 2% infusion.
Methods: The aerial parts of *Lavandula stoechas* L., were air-dried and grounded. 2% infusion was prepared by distilled water and water was evaporated until dryness. The water extract and the plant powder were analyzed for heavy metals and trace elements by Spectro-IQ II instrument.
Results: The analyzed samples differed significantly in terms of mineral contents. The powdered aerial parts of *L. stoechas* L. subsp. *cariensis* and its water extract are characterized by high contents of potassium, calcium, sodium, chlorine, phosphorous and magnesium. Iron in powdered plant material (576.6 ppm) was found to be almost ten times higher than the water extract (51.7 ppm). Microelements such as copper (78.8 ppm) and zinc (3169 ppm) accumulated at higher levels in the water extract of *L. stoechas* L. subsp. *cariensis*.
Conclusion: The mineral content of the water extract and the powdered aerial parts of *L. stoechas* L. subsp. *cariensis* are quantitatively determined by X-ray fluorescence spectroscopy for the first time. *L. stoechas* L. subsp. *cariensis* collected from other regions of Turkey will be comparatively analyzed by XRF spectrometry in our further studies.
Keywords: *Lavandula stoechas*, mineral, X-ray fluorescent analysis.

INTRODUCTION

Mediterranean population has always been a depository for the knowledge of ethnobotany. Among mediterranean countries, Lamiaceae, Asteraceae and Apiaceae families are the most common families which have plant species used as herbal remedy. Herbal teas and herbal extracts are used in the treatment of various diseases[1-4].

Lavandula L. genus (Lamiaceae) is composed of 39 species. The economically valued *Lavandula* species are *L. angustifolia, L. stoechas, L. latifolia* and the hybrid *L.* x *intermedia*. Eastern European countries such as Bulgaria and Russia grow large quantities of *L. angustifolia*[5,6]. Lavender is used for various diseases. Traditionally it is used for sleep disorders, depression and fatigue[7]. For this purpose The German Comission E monograph suggests 1-2 teaspoons (5-10 g) of the herb taken as herbal tea[4,8-13]. In mediterranean region, *L. stoechas* is usually prepared by infusion or decoction and used as analgesic, anticonvulsant, sedative, antidiabetic, expectorant, antispasmodic *etc*. Plant secondary metabolites such as phenolics, flavonoids, terpenes, iridoids, coumarins are previously reported for the plant. *L. stoechas* L. subsp. *cariensis* known as Karabaşotu is used in Turkish folk medicine for its analgesic, expectorant, wound healing and urinary antiseptic properties[14,15]. In a previous study it was reported to have antiinflammatory, anticonvulsant, sedative, antispasmodic, hepatoprotective and

nephroprotective activities. The ethnomedicinal uses of *L. stoechas* in mediterranean countries were reported in a phytopharmacological review by Ez Zoubi *et al*. The flowering branches of *L. stoeachas* were reported to be prepared as infusion and decoction and traditionally used as analgesic, anti-convulsant, antispasmodic, carminative, expectorant for heartburn, sea-sickness, epilepsy and migraine in Algeria, Greece, Morocco, Portugal, Spain and Turkey. Terpenes, phenolic acids, flavonoids, tannins, coumarins have been identified in *L. stoechas*[16,17].

In addition to main bioactive compounds it is also important to determine the mineral status of medicinal plants not only to characterise the nutritional value but also to demonstrate the involvement of minerals in various biochemical and physiological processes.

Bazrafshan *et al.*, investigated lavender tea for its therapeutic effects on anxiety and depression. Total 2 g lavender tea bags were steeped for 10-15 minutes in 300 ml hot water and this was prescribed in the morning and night. The mean scores of anxiety and depression in intervention group were reported to be improved[18]. In another study, lavender tea was shown to have beneficial effects on poor sleep quality in elderly patients[19].

Minerals regulate and coordinate many physiological functions and play vital role for healthy living. Essential nutrients such as vitamins, essential fatty acids and minerals are not synthesized by humans and therefore they must be supplied from foods or food supplements. In the present work, *L. stoechas* subsp. *cariensis* collected from Birgi, Ödemiş-İzmir was investigated for its mineral content by XRF spectroscopy which is a sensitive, simple and rapid technique for multielemental determinations in plant samples. The heavy metals and even the trace elements might contribute to its pharmacological activities. Minerals along with the organic matrix are separately extracted into the liquid medium. The extractibility of minerals may differ according to solvent used and the conditions of extraction techniques. For this purpose, to detect the differences in metal content, plant powder and its water extract prepared by 2% infusion was comparatively analysed.

Experimental studies for different pharmacological effects might also be conducted in terms of its rich mineral content. The minerals found in higher concentrations might attract the scientists to conduct more mineral content and activity related analyses to identify the power of macronutrients and trace elements.

MATERIALS AND METHODS

Plant material and extract preparation

The aerial parts of *L. stoechas* L. subsp. *cariensis* (Boiss.) Rozeira were collected from Birgi village, Odemis, Izmir. Professor Cenk Durmuşkahya (İzmir Katip Çelebi University) collected and identified the plant. The voucher specimen was deposited with number 1439 in the herbarium of Pharmacognosy Department, Faculty of Pharmacy, Ege University. The plant material were air dried at room temperature and ground into fine powder. The water extract was prepared as 2% infusion. 100 ml of boiling distilled water was added to 1 g of plant powder and after standing for 5 minutes at room temperature, the mixture was filtered from Whatman filter No.1 paper and water was evaporated to dryness by rotary evaporator to gain the dried water extract.

Mineral Content by X-ray Fluorescence Spectroscopy

The plant powder and its water extract were analyzed for their mineral constituents. Analyses were conducted by Spectro-IQ II XRF spectrometer with a silicone drift detector at a resolution of 145eV at 10000 pulses. Brag crystal polarized the primary beam and highly oriented pyrolitic graphite (HOPG) was the target. About 300 s duration at a voltage of 25 kV and 50 kV and 0.5 with 1.0 mA current and 1mA helium were process conditions[20].

RESULTS AND DISCUSSION

The analyzed powdered plant material (LS) and its water extract (LSW) differed significantly in terms of mineral contents. LS and LSW were characterized by high contents of macronutrients such as K, Ca, Na, Mg. The mineral contents were determined after three replicates and the mean concentrations were reported for dry weight (dw). K was the major element with a concentration of 16800 ppm and 14920 ppm for LS and LSW respectively. As shown in Table 1, in LS sample, K>Ca>Si>Cl>Al>P>Na>S>Mg were the major elements with descending concentration, whereas LSW had the mineral constituents as K>Cl>Na>P>S> Ca>Mg>Si>Al. From Na to U, 45 elements were investigated. As, Ga, Se, and Ge concentrations were lower than 1 ppm in LS and LSW. Pb, Cd and Hg were present at higher concentrations in LSW than in LS. Zn, and Cu which have both curative and toxic effects in minute quantities were found to be present at higher concentrations in LSW with 3169 ppm and 78.8 ppm, respectively.

Aerial parts of *L. stoeachas* from Algeria were previously investigated for mineral content by atomic absorption-emission spectrometry. K, Mg, Na and trace elements such as Fe, Zn, Cu and Mn contents were established per 100 g of the dried weight. As a result similar to our study, K was the main mineral with a value of 14511.69 ppm. Unlike our results, Ca was not detected in Algerian plant, but as trace elements Fe, Zn, Mn and Cu were detected at values of 1592, 57.3, 63.63, and 6.55 ppm respectively[21]. Mineral contents may differ according to growth area, plant vegetation period and soil characteristics. *L. stoechas* subsp. *cariensis* collected from Aydın region at different altitudes and land conditions were analysed for mineral content. The major mineral, similar to our results was found to be K with 20000-37000 ppm. Fe content varied between 466-891 ppm whereas Zn content was detected between 63-93 ppm[22]. The elemental compositions of samples from Aydın varied significantly from the obtained results in the present study.

Ca, P, S, K, Cl, Na, and Mg are found in larger amounts in blood and they are known as macroelements whereas microelements such as Zn, I, Fe, Mn, Cu are found in smaller amounts. In addition to participating in the structure of bones, Ca affects the sensitivity of nerves and muscles. It also plays role in activating enzymes involved in digestion and metabolism. The daily need for Ca is around 1000-1500mg[23,24]. P which is necessary for healthy skin, hair and nails ensures the neutrality of body fluids. P is also important for nervous system. Total 800-1300 mg P is recommended per day[23,24]. Na and K play important role in functioning of muscles and nerves. The daily requirement of Na is 6 g whereas K is reported to be 2-4 g per day. Na deficiency causes circulatory, respiratory and nervous system disorders. Insufficient levels of K may result in imbalance of blood pressure, irregular heartbeat, kidney and urinary system disorders[23,24].

Table 1: Mineral contents of *L. stoechas* L. subsp. *cariensis* (Boiss.) Rozeira.

Z (Atomic number)	Symbol	Element	LS (ppm)	LSW (ppm)
11	Na	Sodium	1890	2340
12	Mg	Magnesium	1629	1076
13	Al	Aluminum	2616	443
14	Si	Silicon	5828	658.1
15	P	Phosphorous	2069	2165
16	S	Sulfur	1837	1623
17	Cl	Chlorine	3201	6630
19	K	Potassium	16800	14920
20	Ca	Calcium	9257	1476
22	Ti	Titanium	82.7	22.5
23	V	Vanadium	6.5	5.9
24	Cr	Chromium	<5.1	<5.1
25	Mn	Manganese	167.8	197.3
26	Fe	Iron	576.6	51.7
27	Co	Cobalt	<3	<3
28	Ni	Nickel	<0.2	<0.2
29	Cu	Copper	30.7	78.8
30	Zn	Zinc	64.4	3169
31	Ga	Gallium	<1	<1
32	Ge	Germanium	<1	<1
33	As	Arsenic	<1	<1
34	Se	Selenium	<1	<1
35	Br	Bromine	<0.7	467
37	Rb	Rubium	14.9	225
38	Sr	Strontium	20.6	664
39	Y	Yttrium	3	38.2
40	Zr	Zirconium	<510	<510
42	Mo	Molybdenum	13.8	1236
47	Ag	Silver	27.8	3640
48	Cd	Cadmium	<5.3	639
49	In	Indium	<5.1	<5.1
50	Sn	Tin	<6.1	<6.1
51	Sb	Antimony	<6.1	<6.1
52	Te	Tellurium	<7.1	<7.1
53	I	Iodine	<7.1	<7.1
55	Cs	Cesium	<12	<12
56	Ba	Barium	86	<8.1
57	La	Lanthanum	<10	<10
58	Ce	Cerium	<12	<12
80	Hg	Mercury	<2	146.8
81	Tl	Thallium	448.4	531.8
82	Pb	Lead	3.3	<2
83	Bi	Bismuth	<2	<2
90	Th	Thorium	<2	56.4
92	U	Uranium	<3	33.3

Mg which is a cofactor of many enzymes, participates in energy metabolism. Mg is the vital mineral that helps body to absorp Ca, P, Na and K. The recommended daily intake of Mg is 200-400 mg. The deficiency of Mg is related with depression, migraine, cardiovascular diseases and hypertension[23,24].

Fe provides oxygen to the cells and it is required for energy production. The daily need of Fe is 10-15 mg. Fe deficiency causes anemia[23,24]. Zn have vital function on cell growth and differentiation. Zn plays important role in the treatment of diabetes mellitus, infectious diseases, depression and alcoholic liver disease. The daily requirement of Zn is 10-12 mg. The deficiency of

this mineral cause sweelling in joints, enlargement of liver and spleen, lack of appetite and growth retardation[23,24]. Cu is essential mineral for brain, nerves and connective tissue. Cu helps iron to make hemoglobin. The daily requirement of Cu is 2-3 mg.

It is necessary for the utilisation of vitamin C and it is vital component of enzymes that is required for the regeneration of tissues[23,24].

Based on obtained results, 1 g of LS provides K (16.8 mg), Ca (9.257 mg), P (2.069 mg), Na (1.89 mg), Mg (1.629 mg), Fe (0.576 mg), Zn (0.0644 mg) and Cu (0.0307 mg) which covers 0.84, 0.9257, 0.2586, 0.03, 0.8145, 5.766, 0.644 and 1.535 % of daily requirements respectively. Total 1g of LSW provides K (14.92 mg), Ca (1.476 mg), P (2.165 mg), Na (2.34 mg), Mg (1.076 mg), Fe (0.0517mg), Zn (3.169 mg) and Cu (0.0788 mg) which covers 0.746, 0.1476, 0.2706, 0.039, 0.538, 0.517, 31.69 and 3. 94 % of daily requirements respectively.

From this comparison LSW is a rich source for Zn and Cu whereas LS is found to be rich in Fe content. The role of some minerals to prevent and treat depression was discussed in a previous review[25]. Fe, Zn, Mg and Cu were reported to be the most important minerals that have effects on neurological functions. Traditionally lavender is used for a variety of conditions of nervous system including sleep disorders, depression and fatigue. The rich mineral content of *L. stoechas* subsp. *cariensis* might contribute to its observed pharmacological activities.

Limitations of the study

The plant material used for this study was collected from one site. Mineral constituents of plants might differ according to growth area and soil characteristics.

CONCLUSION

To the best of our knowledge, the mineral contents of *L. stoechas* subsp. *cariensis* and its water extract are quantitatively determined by X-ray fluorescence spectroscopy for the first time. Herbs and herbal extracts are used as raw materials in various fields of industry to replace with synthetic products. The aerial parts of *L. stoechas* subsp. *cariensis* could be utilised as a natural source to fortify the mineral constituents of some beverages or nutraceuticals. *L. stoechas* subsp. *cariensis* collected from other regions of Turkey will be comparatively analyzed by XRF spectrometry in our further studies.

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AUTHOR'S CONTRIBUTION

Kayalar H: supervision, interpretation of data, manuscript writing. **Yılmaz ZS**: XRF analysis. **Durmuşkahya C**: collection and authentication of plant material. **Toktaş Ü**: methodology, sample preparations. All authors read and approved the final manuscript for publication.

DATA AVAILABILITY

The data supporting the findings of this study are not currently available in a public repository but can be made available upon request to the corresponding author.

CONFLICT OF INTEREST

None to declare.

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