

### Mineral Composition of Various Extracts and Essential Oil of Pickled *Ferula orientalis* L

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**ABSTRACT:** Edible wild plants are important food sources of the increasing world population and contribute to the healthy functioning of the body. Some of the edible wild plants, which are considered among the favourite flavours and consumed with pleasure in many countries, are rich in trace elements that play an effective role in the fight against various diseases. *Ferula*, a genus of edible wild plants in the Apiaceae family, is also known worldwide for its aromatic composition and medicinal properties. In this study, the essential oil of *F. orientalis* obtained by hydrodistillation and water, ethanol: water, methanol: water, chloroform, and n-hexane extracts prepared by classical and ultrasonic were studied. According to the mineral composition data determined by the Inductively Coupled Plasma-Mass Spectrometry (ICP-MS), the essential oil was found to contain only sodium, potassium, manganese, and aluminum, among the 18 elements scanned. The most common elements found in the extracts were potassium, sodium, and phosphorus, and their amounts varied between 982.504- 42 282.486 ppm, 3267.141- 39 103.835 ppm, and 1898.652- 9280.814 ppm, respectively. According to the results, the ultrasound process significantly increased the mineral transfer to the extracts ( $p < 0.01$ ).

**Keywords:** Essential oil, Extraction, *Ferula orientalis*, Mineral composition

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## INTRODUCTION

*Ferula*, a genus of the Apiaceae family, is represented with about 180 species in the world. *Ferula orientalis* L. grows in the East Anatolia Region in Turkey and is found in the Canary Islands, North Africa, and Iran (Downie et al., 2000; Pavlović et al., 2012). In Turkey, it grows on steep rocky slopes at an altitude of 1600-2900 m (TUBIVES, 2020). It is collected in April-May, turned into the pickle and consumed as a salad with meals.

Edible wild plants function as main biochemicals which contribute to the greater part of the human diet, such as carbohydrates, proteins, and lipids, as well as supplementary sources of vitamins and minerals, which are essential needs of the body to maintain its proper physiological homeostasis (Datta et al., 2019). According to Ebert (2014), the nutritional qualities of wild edibles are sometimes superior to the domesticated variety. Many studies have focused on wild edible plants as food sources (Narzary et al., 2015; Abdus Satter et al., 2016; Seal et al., 2017). Mineral studies on edible plants are generally about determining the total content (Dawczynski et al., 2007; Kim et al., 2008; Ródenas et al., 2009; Hu et al., 2010) or about soluble particulate and alterable-unalterable minerals (Versantvoort et al., 2005).

According to Shirin et al. (2010), edible wild, medicinal and aromatic plants are rich in trace elements which play an active role in the fight against various diseases. Determination of the mineral composition of such plants is critical in terms of determining the elements that play an essential role in the functioning of metabolism, such as magnesium, calcium, potassium, zinc, copper, and phosphorus (Kumar et al., 2005), and determining the levels of elements with a potentially adverse effect on health, such as mercury, lead, cadmium, and aluminum (Mamani et al., 2005). Essential elements have a part in many metabolic activities in the human organism, especially as enzyme activators (Fe, Zn, Mn, etc.) (Razic et al., 2005). Low intake of essential minerals may result in nutritional deficiency (Tapiero et al., 2001; Goldhaber, 2003), while excessive intake causes potential toxicity (Barroso et al., 2009). For example, excessive iron intake causes tissue damage, coronary heart disease, and cancer (Morris et al., 1995; Li et al., 2003). Relatively high manganese intake may cause mammalian cell gene mutation, DNA damage, and chromosomal aberration (Gwiazda et al., 2002; Li et al., 2005). Zinc loading can cause neuron death (Chen et al., 2009).

The macro, micro, or toxic minerals found in plants are generally determined by spectrometric techniques such as inductively coupled plasma mass spectrometry (ICP-MS) (Zhang et al., 2018; Santana et al., 2020), graphite furnace atomic absorption spectrometry (GF-AAS) (Junior and Dantas, 2016), electrospray ionization mass spectrometry (ESI-MS) (Lorenc et al., 2020) and inductively coupled plasma atomic emission spectroscopy (ICP-OES) (Marques and Nóbrega, 2017). Acid digestion procedures are generally used in these techniques to transform solid material into a homogeneous aqueous solution (Krug and Rocha 2016). Although ultrasound-assisted extraction has not been used sufficiently yet, it is considered to be an effective procedure because of its low cost and accelerating some processes such as dissolution and leakage of minerals and other functional components from plant tissues (Armenta et al., 2015; Capote and De Castro, 2007; Tiwari, 2015).

In the present study, it is aimed to determine the effect level of the ultrasonic extraction method used in addition to the acid digestion procedure on the mineral transfer from pickled *F.orientalis* to different solvents compared to the classical extraction method. Besides, the mineral composition of the essential oil (EO) has been determined. Thanks to this study, existing scientific gaps may be filled in terms of some toxic minerals related to this plant.

## MATERIAL AND METHOD

### Material

Aerial parts of *F.orientalis* were collected from Erzurum, Turkey (40°29' 20.23 N and 41°21'52.43 E) in April 2017. After the polluted parts of the plant were cleaned and the leaves were separated, the stems were brined using salty water with a Baumé degree of 9. After 10 days, the Baumé degree of the brines was measured as 7 at 20°C and maintained at this value.

### Extracts and EO preparation

*EO*: Fifty grams of the pickled plant was crushed by a blender (Waring, HGB2WTS3, USA) and mixed with 500 ml distilled water. The EO was obtained in approximately 3 h using a Clevenger-type apparatus.

*Classical extraction*: Fifty grams of pickled plant material was lyophilized ( $10^{-3}$  mTorr, -86°C) (Operon FDU- 8612, Korea) and agitated in a shaking water bath (JSR, JSSB-30T, Korea) for 20 h at 40°C and 90 rpm by adding 500 ml of each solvent (water, ethanol: water (1/1,v/v) methanol: water (1/1,v/v), chloroform and n-hexane). The extracts were filtered and centrifuged (4500 rpm, 15 min). The supernatant was evaporated and then lyophilized at 40°C, 150 rpm. Lyophilized extracts were stored in the dark at -20°C until the analyses were made.

*Ultrasonic extraction*: Fifty grams of pickled plant material was lyophilized ( $10^{-3}$  mTorr, -86°C). Extraction was performed according to the procedure adopted by Oniszczyk and Podgórski (2015) by adding 500 ml of each solvent (water, ethanol: water (1/1,v/v) methanol: water (1/1,v/v), chloroform, and n-hexane). For this purpose, the temperature of the ultrasonic bath operating at 35 kHz frequency was kept constant at  $40 \pm 2^\circ\text{C}$ , and 20 min of ultrasound + 20 min of the resting process were applied to the extracts for 4 times. The extracts were filtered and centrifuged (4500 rpm, 15 min). The supernatant was evaporated at 40°C, 150 rpm and then lyophilized. Lyophilized extracts were stored in the dark at -20°C until the analyses were made.

### Determination of mineral substance composition by ICP/MS

8 ml 65% HNO<sub>3</sub> and 2 ml 31% H<sub>2</sub>O<sub>2</sub> were added to a sample of 500 mg and it was kept waiting for 15-20 min. Then, it was subjected to wet combustion in the microwave system (Milestone Ethos up SK-15). A standard solution prepared for each element (at concentrations of 0, 2.5, 5, 7.5, and 10 ppb for Hg; 0, 10, 25, 50, 100, 250, and 500 ppb for other elements) was scanned in the ICP/MS (Agilent 7800, UK), and the residual element amounts in the samples were determined by using the calibration curve obtained against the standards (Anonymous, 2007). Detection limits of minerals analyzed with the ICP-MS are shown in Table 1.

**Table 1.** Detection limits of the minerals

Minerals	Detection limits (ppb)
Sodium (Na)	4.034
Magnesium(Mg)	0.363
Aluminum (Al)	0.282
Phosphorus (P)	2.639
Potassium(K)	2.438
Calcium (Ca)	2.047
Chromium (Cr)	0.049
Manganese(Mn)	0.024
Iron (Fe)	0.200
Copper (Cu)	2.343
Nickel (Ni)	0.381
Cobalt (Co)	0.003
Zinc (Zn)	0.603
Selenium (Se)	0.061
Silicon (Si)	3.771
Cadmium (Cd)	0.002
Mercury (Hg)	0.025
Lead (Pb)	0.054

## Statistical Analysis

All data were subjected to statistical analysis using IBM SPSS Statistics Version 20.0 package software. The Duncan test, one of the One-way ANOVA Multiple Comparison tests, was applied to the significant differences as a result of the variance analysis. Results are given as mean  $\pm$  standard deviation and all  $p < 0.05$  values were considered as statistically significant.

## RESULTS AND DISCUSSION

The average values of 18 minerals detected in extracts and EO using ICP-MS are shown in Table 2. The Na values of extracts and EO varied between 3184.277 ppm and 39 103.835 ppm. Among the extracts, the highest Na value was found in the ultrasonic water extract (UWE), while the EO had the lowest. The higher amount of Na in water extracts compared to other extracts and the EO is believed to be due to the more dissolution of the groups formed in complex with sodium by water. Also, it was found that the ultrasound process significantly increased the Na transfer to the water extract compared to the classical extraction process. In the mineral matter analysis made by Tunçtürk and Özgökçe (2015) on *Anethum graveolens* L., *Anthriscus* sp., *Chaerophyllum macropodium*, *F. haussknechtii* H. Wolff ex Rech.f., *Ferula rigidula* DC., *Heracleum persicum*, *Hippomarathrum microcarpum*, *Pimpinella aurea* DC, and *Prangos ferulacea* L., which are from the Apiaceae family to which *F. orientalis* L. also belongs, they found that Na contents of plants were between 0.32 and 1.26 g kg<sup>-1</sup>. When these results are compared with the results of this study, the most important point is that the Na amount is very high in all extracts and EO. This is believed to be due to the high salt concentration of the pickled *F. orientalis*. In Turkey, many products with high salt concentration, such as various pickles, vine leaves, or olive brine, are produced and consumed by the people with pleasure. Although such plant products with high salt concentration could be preferred for their good tastes, it is thought that consumption of these products with a lower level of salt content would be more appropriate for public health considering the disadvantages arising from high salt concentration.

Mg contents of extracts varied between 376.504 ppm and 1980.377 ppm (Table 2). The highest Mg value was found in the classically obtained water extract (CWE) and the lowest Mg value was found in the ultrasonic ethanol: water extract (UEWE). The effect of solvent type and process variables and process x solvent type interaction on Mg mineral was found to be statistically very significant at  $p < 0.01$  level. In their study, Arceusz et al. (2010) researched 16 plants in the Apiaceae family and reported that the Mg content of the plants ranged between 1.49-5.91 mg g<sup>-1</sup>. The findings of this study are consistent with the Mg values that the extracts of *F. orientalis* contain. Although its effects have not been proven scientifically, the pickled *F. orientalis* is widely consumed by the people living in the Eastern Anatolia Region thinking that it relieves diabetes patients. This effect is thought to be due to the Mg mineral contained in *F. orientalis*. Because it is reported that Mg, in addition to insulin synthesis and secretion, is also effective on the intracellular activity of insulin and therefore, glucose transport into the cell through insulin (Takaya et al., 2004; Chaudhary et al., 2009). A decrease in intracellular magnesium levels causes a decrease in the insulin effect (Paolisso et al., 1990; Rodriguez-Hernandez et al., 2005).

When Table 2 is evaluated in terms of Ca, the 5<sup>th</sup> most abundant element in our body (Renna et al., 2015), the interaction of process and the solvent type and process x solvent type is significant on Ca mineral at the level of  $p < 0.01$ . Ca amounts of the extracts varied between 233.428 ppm and 751.755 ppm, but no Ca could be detected in EO. The ultrasonic hexane extract (UHE) had the highest Ca amount and the classically obtained ethanol: water extract (CEWE) had the lowest. Table 2 shows that extractions performed by the ultrasonic method are more effective among all other extracts except for water extracts. No study was found about the Ca content of *F. orientalis*. However, in the studies

conducted on raw plants on different *Ferula* species, the Ca contents were found to be between 2.29-26.30 mg g<sup>-1</sup> (Arceusz et al., 2010) and 10.6-14.1 g kg<sup>-1</sup> (Tunçtürk and Özgökçe, 2015).

Phosphorus (P) is the second major element of the human body with important roles in carbohydrate, fat, and protein metabolisms and neural transmission and tooth-bone formation (Kurt, 2007). P contents of the extracts were varied between 1898.652 ppm and 9280.814 ppm. The CEWE extract had the lowest P content, while the ultrasonic chloroform extract (UCE) had the highest. It was also found that EO does not contain P. In a study conducted on *F. rigidula* and *F. haussknechtii*, it was found that the plants contain 3.72 g kg<sup>-1</sup> and 2.51 g kg<sup>-1</sup> of P, respectively (Tunçtürk and Özgökçe, 2015). When we evaluate the findings of this study, it is observed that P contents of the extracts, except for chloroform extracts, are generally consistent with the findings of the study conducted by Tunçtürk and Özgökçe (2015). The higher amount in chloroform extracts compared to other extracts and EO is believed to be due to the more dissolution of the groups formed in complex with P by chloroform.

Considering that it is an essential component of many enzymes and proteins, Cu is an indispensable trace element for all living organisms, including human beings (Renna et al., 2015). The daily intake dose of Cu for male and female adults was calculated as 900 µg (Scientific Committee for Food, 1993). Cu was not detected in the EO. The Cu amounts of extracts ranged between 4.230 ppm (classical n-hexane extract, CHE) and 15.563 ppm (UWE). It was found that the ultrasound process increased the Cu content of extracts at  $p < 0.05$  level. In the literature, there is no study about the Cu element content of the *F. orientalis*. However, in a study conducted on the plants in the Apiacea family, the Cu contents were found to be between 21.2 and 23.7 mg kg<sup>-1</sup> (Tunçtürk and Özgökçe, 2015).

Selenium is an essential microelement required for human and animal nutrition, reduces the risk of cardiovascular diseases and cancer (Thomson, 2004; Rayman, 2008). Foods are the primary ways of selenium intake. Meat and sea products have a high Se content between 0.4 µg g<sup>-1</sup> and 1.5 µg g<sup>-1</sup>. Although not as much as meat and sea products, fruits and vegetables are also rich sources of Se (Rayman, 2008). Recently, many studies have been conducted on Se with various plants (Germ et al. 2009; Bhatia et al. 2013; Thosaikham et al., 2014; Bañuelos et al., 2015; Funes-Collado et al., 2015; Longchamp et al., 2015; Castro Grijalba et al., 2017; Mahn, 2017). However, no study was found in the literature on Se contents of *Ferula* species. When the findings of this study are evaluated, the process and the solvent type variables and process x solvent type interaction has a significant effect on Se at  $p < 0.01$  level. Among the extracts, CEWE had the lowest Se amount with a value of 0.049 ppm and ultrasonic methanol: water extract (UMWE) had the highest value with 0.558 ppm. The higher Se content in the UMWE, may be due to the ultrasound process increasing the number of groups to which Se is bound by breaking down the cell membrane, and the methanol: water solvent dissolving these groups more.

Potassium is predominantly an intracellular cation in the human body and plays a fundamental role in acid-base regulation, fluid balance, muscle contraction, and nerve conduction (Thomas, 2001). It was found that the effects of the process variable, solvent variable, and process x solvent interaction on K amount of extracts and EO were statistically very significant at the level of  $p < 0.01$ . The water extracts obtained both through ultrasonic and classical methods contained a significantly higher concentration of K compared to other extracts. It was observed that EO had the lowest K value (148.521 ppm). The data on K amounts obtained in this study were found to be higher than the findings of Arceusz *et al.* (2010) (2.29-26.3 mg g<sup>-1</sup>) and Tunçtürk and Özgökçe (2015) (13.8-25.6 g kg<sup>-1</sup>) who studied the plants in the same family with *F. orientalis* L. The Institute of Medicine reported that a daily intake of 4.7 g K through foods is sufficient (Anonymous, 2005). Therefore, it is believed that the consumption of about 115 g of pickled *F.orientalis* can meet the daily need for K.



Manganese, as one of the trace elements like Cr, Zn, and Co, has an important role in performing many physiological functions in the human body (Renna et al., 2015). As seen in Table 2, the Mn content of the samples varied between 0.120 and 11.880 ppm. EO had the lowest value, while UHE extract had the highest value. Here the most important point is that the Mn element was found at a higher rate in extracts of chloroform, which is the solvent with the lowest polarity index compared to apolar n-hexane and other polar solvents. This suggests that groups that are complexed with Mn dissolve better in apolar solvents. The effect of solvent type variable and process x solvent type interaction on the Mn content of extracts was found to be very significant at the level of  $p < 0.01$ . The results of this study are very low in Mn values when compared with the findings of the study conducted on *F. rigidula* DC (27.2 mg kg<sup>-1</sup>) and *F. haussknechtii* (48.5 mg kg<sup>-1</sup>) by Tunçtürk and Özgökçe (2015).

Zinc is an important trace element for humans as it involves in the structure of many enzymes and assumes a regulatory and catalytic role. It plays important roles in growth and development, immune response, neurological function, and reproduction. The Scientific Committee for Food (1993) recommends Zn intake of 9.5 mg day<sup>-1</sup> for men and 7.0 mg day<sup>-1</sup> for women. The amount of Zn in extracts varied between 24.247 and 125.195 ppm (Table 2). The UCE had the highest Zn amount and the CEWE had the lowest. It was found that ultrasound increased the Zn level in all extracts by  $p < 0.05$ , except methanol: water extract. Compared with the study conducted by Tunçtürk and Özgökçe (2015) on different *Ferula* species, the Zn amounts found in the extracts were higher.

Since Cd causes kidney and liver dysfunction, and osteoporosis in the long term, it is believed that the intake of this mineral with food will result in a toxic effect (Godt et al., 2006). The UCE had the highest Cd content (0.076 ppm), while ethanol extracts (CEWE and UEWE) were the lowest (0.012 ppm). No Cd was found in EO. The effect of process and solvent type variables and process x solvent type interaction on the Cd content of the extracts was found to be statistically significant at the  $p < 0.01$  level. The Cd values found in this study, were far below the limit (0.20 mg kg<sup>-1</sup> wet weight) set for vegetables and plants in the European Commission Regulation no. 1881/2006.

Lead (Pb) is a heavy metal with no biochemical and physiological function in the human body and has a toxic effect. It is classified as a Class II carcinogenic metal by the World Health Organization (Osma, 2009). It contaminates food mostly by polluted air, water, and soil. This toxic metal was not detected in EO, and it varied between 1.048 ppm (CEWE) and 2.130 ppm (UMWE) in the extracts. The interaction of process and the solvent type and process x solvent type has an effect on Pb amounts of extracts at the level of  $p < 0.01$ . The World Health Organization (WHO) reported that a weekly intake of Pb between 1.5 and 175 mg is tolerable (Anonymous, 1993). Pb levels for the pickle, its extracts, and EO remain below the specified toxic limits. Also, the levels of Fe, Co, Cr, Ni, and Hg heavy metals and Si analyzed in the samples were below the limits of detection.

Due to the increased exposure of people to Al through food packaging, kitchen utensils, medicines, or drinking water (You and Song, 2013) and potential adverse effects of this element on human beings, there has been increasing interest in the determination of trace amounts (Mailloux et al., 2011). Its dissolved form, in particular, is considered to be more important due to its high bioavailability and toxicity (Luoa and Bi, 2003). The effect of solvent type variable and process x solvent type interaction on the Al amounts of extracts was found to be statistically significant ( $p < 0.01$ ). Also, it was found that UCE had the highest Al amount after pickle. The Joint FAO/WHO Expert Committee on Food Additives (JECFA) reported that the limit that metabolism can tolerate when Al components are taken into the body is 2 mg kg<sup>-1</sup> body weight per week (Anonymous, 2011). Al content of the pickled *F. orientalis* was found to be 59.495 ppm (5.950 mg 100g<sup>-1</sup>), and Al contents of the extracts and EO were found to be between 0.558- 57.210 ppm. Considering that the weekly tolerable Al level for an adult of 60 kg is 120

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mg, it is observed that even the pickled *F. orientalis*, in which the highest amount was found, is well below the weekly tolerable level.

**Table 2.** Mineral matter values of extracts and EO (ppm)

	PFO	CWE	UWE	CEWE	UEWE	CMWE
Na	41962.520±229.951 f	38153.847±296.985 d	39103.835±462.596 e	29266,101±73.765 c	29033.938±507.879 c	25613.509±456.331 b
Mg	2083.080±30.802 j	1980.377±49.135 i	1800.295±39.689 g	1589.261±60.486 e	376.504±12.113 a	893.101±14.248 d
Ca	862.830±9.525 h	664.060±14.231 f	606.930±7.789 e	233.428±10.054 a	549.323±7.466 d	389.654±11.865 c
P	9424.843±70.796 j	3607.751±31.825 f	2796.573±19.715 c	1898.652±56.742 a	3319.033±71.672 e	4487.660±42.609 g
K	42418.350±70.852 j	38252.764±71.189 i	42282.486±90.602 j	18655.418±92.437 e	19648.729±71.672 f	21735.882±92.029 g
Zn	130.487±0.229 i	26.241±0.474 b	48.235±0.295 d	24.247±0.197 a	50.920±0.107 e	81.564±0.460 f
Mn	12.355±0.676 j	2.290±0.048 c	5.224±0.559 e	7.209±0.092 f	1.863±0.081 b	4.899±0.117 d
Se	0.727±0.002 g	0.305±0.011 c	0.388±0.013 d	0.049±0.004 a	0.279±0.006 c	0.443±0.021 de
Cu	15.819±0.072 j	12.174±0.083 g	15.563±0.076 i	5.329±0.069 c	6.556±0.084 e	4.275±0.109 a
Al	59.495±0.103 i	2.799±0.134 c	3.203±0.095 c	1.664±0.073 b	1.638±0.069 b	13.018±0.338 d
Cd	0.078±0.004 f	0.020±0.002 b	0.037±0.004 d	0.012±0.001 a	0.012±0.004 a	0.019±0.001 b
Pb	3.728±0.078 f	1.532±0.049 c	1.299±0.037 b	1.048±0.062 a	1.836±0.071 d	1.311±0.127 b
Fe	-	-	-	-	-	-
Cr	-	-	-	-	-	-
Ni	-	-	-	-	-	-
Hg	-	-	-	-	-	-
Si	-	-	-	-	-	-
Co	-	-	-	-	-	-

\* PFO: pickled *F.orientalis*, CWE: classical water extract, UWE: ultrasonic water extract, CEWE: classical ethanol: water extract, UEWE: ultrasonic ethanol: water extract, CMWE: classical methanol: water extract.

\*\*Statistical analysis for each line was made within itself and the mean values are shown with the same letter were considered the same at  $p<0.05$  significance level.

\*\*\*-: not determined.

**Table 2.** Mineral matter values of extracts and EO (ppm) (continued)

	UMWE	CHE	UHE	CCE	UCE	EO
Na	25858.289±331.718 b	3378.980±116.142 a	3413.735±112.840 a	3267.141±121.325 a	3301.596±84.146 a	3184.277±114.660 a
Mg	1892.537±46.216 h	1869.229±27.754 gh	700.317±35.044f	496.097±3.005 b	794.396±6.724 c	-
Ca	596.144±11.558 e	595.179±14.982 e	751.755±5.855g	278.983±9.103 b	531.0185±14.240 d	-
P	3363.598±60.359 e	2969.221±46.896 d	2228.689±46.137b	8710.091±88.555 h	9280.814±70.873 i	-
K	31464.541±81.539 h	982.504±28.435 b	1773.572±59.644c	2524.067±38.336 d	1789.427±23.163 c	148.521±0.838 a
Zn	28.453±0.394 c	48.493±0.233 d	50.787±0.379e	88.606±0.275 g	125.195±0.201 h	-
Mn	9.873±0.337 g	11.876±0.127 i	11.880±0.121 i	11.080±0.110 h	11.158±0.083 h	0.120±0.014 a
Se	0.558±0.799 f	0.390±0.017 d	0.315±0.007 c	0.143±0.015 b	0.483±0.024 e	-
Cu	6.043±0.086 d	4.230±0.080 a	4.639±0.066 b	11.021±0.141 f	14.266±0.132 h	-
Al	14.909±0.098 e	37.524±0.346 f	37.864±0.475 f	55.033±0.149 g	57.210±0.387 h	0.558±0.012 a
Cd	0.047±0.002 e	0.028±0.002 c	0.038±0.001d	0.018±0.003 b	0.076±0.002 f	-
Pb	2.130±0.073 e	1.361±0.018 b	2.051±0.076 e	1.543±0.068 c	1.978±0.049 de	-
Fe	-	-	-	-	-	-
Cr	-	-	-	-	-	-
Ni	-	-	-	-	-	-
Hg	-	-	-	-	-	-
Si	-	-	-	-	-	-
Co	-	-	-	-	-	-

\*UMWE: ultrasonic methanol: water extract, CHE: classical n-hexane extract, UHE: ultrasonic n-hexane extract, CCE: classical chloroform extract, UCE: ultrasonic chloroform extract, EO: essential oil.

\*\*Statistical analysis for each line was made within itself and the mean values are shown with the same letter were considered the same at  $p<0.05$  significance level.

\*\*\*-: not determined.

## CONCLUSION

In this study, the mineral compositions of pickle, EO, and classical and ultrasonic extracts of *F.orientalis* were determined by ICP-MS. A total of 12 minerals were identified in pickle and extracts. The Cr, Co, Fe, Si, Ni, and Hg could not be detected as they were below the measurement limits. When extracts and EO were evaluated for Cd, Ni, Pb, and Al, it was found that they were significantly below

the daily intake limit. Na level was found to be very high in all extracts and EO. This is believed to be due to the high salt concentration of the pickle. According to the WHO, the maximum daily sodium intake in adults is 2 g day<sup>-1</sup> (salt equivalent to 5g day<sup>-1</sup>) (Anonymous, 2012). Due to the high level of salt consumption worldwide, many countries implement salt reduction policy, and this policy is also supported by scientific researches (Andersen et al., 2009; He and MacGregor, 2009; Agarwal et al., 2011; Ahuja et al., 2015). The effect of solvent type and process variables and process x solvent type interaction on Mg mineral was statistically significant at  $p < 0.01$  level. It was found that the ultrasound application generally increased element transition because of the effect of breaking down the cell membrane.

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## Conflict of Interest

The article authors declare that there is no conflict of interest between them.

## Author's Contributions

Elif Feyza Topdas collected and prepared the samples, evaluated the analytical results, and wrote the original draft. Memnune Sengul was project administration and also review and edited the manuscript. Authors read and contributed to the final paper.

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