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Determination of major and trace elements in different parts of various medicinal plants with therapeutic effect retaile groing in middle atlas of morocco using icp-oes

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Abstract The elemental composition of fifteen species of medicinal plants growing in the middle atlas of Morocco was determined by ICP-AES. Among major and minor elements, K with a content in the ranged of 4471,97- 20862,43 mg/kg and Fe in the ranged of 20457,45 - 3310,69 mg/kg are the most presented in the analysed species. The highest concentrations of the analyzed elements were found as follows: Ca in *Mentha pulegium* L., Na in *Atractylis gummifera*, K, Mg and Fe in *Herniaria hirsuta*, Mn in *Daphne gnidium,* Cu in *Thymus willdenowii,* Zn in *Corrigiola telephiifolia,*B in *Pistacia lentiscus L.,* P in *Lepidium sativum,* P in *Saw palmetto* .Similarly, the lowest levels were found as follows: Ca, Na, Fe, Mn, Cu, Zn and Mg in *Saw palmetto,* K and S in *Tetraclinis articulata,* B in *Lepidium sativum,* P in *Aristolochia paucinervis.* Significant correlations were observed between the various minerals. The results showed that the analysed plants are constituted a new and interesting source of minerals indispensable for human nutrition and for pharmaceutical purposes and for the treatment of diseases.

Keywords: Medicinal plant, Elemental analysis, ICP-OES, Middle atlas of Morocco

Introduction

Traditional medicinal plants are popular as an alternative solution for public health protection (Vellingiri *et al*., 2020). Medicinal herbs can synthesize a variety of chemical compounds that are used to carry out important biological

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vital functions (Ciftci *et al*., 2021). Aromatic herbs are minority components, as far as consumption is concerned, in the daily diet (García-Galdeano *et al*., 2020). It has been reported that the treatment of various diseases is possible using medicinal herbs (Yabalak *et al*., 2000). The earliest fossil records which were found in the grave of a Neanderthal man in south eastern Turkey show that humans use plants as medicines since the Middle Paleolithicage (60,000 B.C.) (Karahan *et al*., 2020). Mixtures of medicinal plants are prescribed by the traditional healers for diseases ranging from common colds to malaria, arthritis, ulcers (Imelouane *et al*., 2011). The popularity of herbal medicines is connected with their ease access, therapeutic efficacy, low toxic effects and relatively low cost (Zinicovscaia *et al*., 2020). There has been an ever-increasing interest in determination of the elemental composition of medicinal plants (Ciocarlan *et al*., 2022). The consumption of herbal medicinal products and dietary supplements has increased significantly in recent years. about 80% of the world's population use them for part of their primary health care services (Zinicovscaia *et al*., 2020). Thus, plants used in therapeutics should be picked in areas free of any pollution, due to the fact that the amount taken increases with the concentration, increased by constant mass of a taken dose (Zinicovscaia *et al*., 2020). Well known constituents of spices and aromatic herbs are the inorganic elements, which play an important role in biological systems and body development but these last can be toxic when they're in takes lightly exceeds the functional level (Ciftci *et al*., 2021). The storage of essential elements is clearly the result of different plant varieties (Potortí *et al*., 2017), and of the crop environment, including air, water and soil properties (Yan Qing-hua *et al*., 2012). Na and K and other major elements are required for our body. Mn can strengthen the immune system and activate the production of anti-toxin substances. Ca can increase the density of the capillary wall and decrease its permeability. Fe is a transport agent for the hemoglobin protein and a receptor site for several enzymes. Mg plays a role in the excitability of neurons.

Detection techniques for major elements and elements are often atomic absorption spectrometry (AAS), inductively coupled plasma atomic emission spectroscopy (ICP-AES) and inductively coupled plasma mass spectrometry (ICP-MS). The aim of this study was to investigate11 types of major and trace elements (Na, K, Cu, Fe, Zn, Mn, Ca, Mg, P, S, B) in 15 types of medicinal herbs from the Middle Atlas of Morocco with therapeutic effect were analyzed by ICP-OES.

The objective was to ascertain the elemental composition of Moroccan medicinal plant species (Middle Atlas) through the utilisation of ICP-AES.

Materials and methods

Sample preparation

Medicinal plant species were collected during the flowering period between 2021 and 2022. 15 medicinal plant species were collected from sites in the Middle Atlas of Morocco. The collected samples were cleaned, dried in the shade (32°C - 40°C), powdered and packaged for analysis. The powdered plant material was stored at room temperature and protected from light. Then, the samples were packed in polyethylene foil bags for short-term storage.

The herbal plants are among the species used by the traditional healers were shown in Table 1.

Table 1. Medicinal uses of parts analyzed of medicinal plants used in the experiment

Local name	Botanical name	Abreviation	Botanical family	Parts analyzed	Place of use
Khzama	*Lavandula stoechas*	*L. stoechas*	*Lamiaceae*	Leaves	Against renal lithiasis, renal colic and genito-urinary affections.
Alzaz	*Daphne gnidium L.*	*D. gnidium L.*	*Thymelaeaceae*	Leaves	Softening preparation of the hair and as anti-fall.
Azoukni	*Thymus* willdenowii	*T.* willdenowii	*Lamiaceae*	Leaves	against the affections of the digestive tract, itisalsoantispasmodic and against cholesterol.
Addad	*Atractylis gummifera L*	*A. gummifera L*	*Asteraceae*	Root	intestinal parasites, ulcers, snakebite poisoning and hydropsy
Araâr	*Tetraclinis articulata*	*T. articulata*	*Cupressacées*	Leaves	Treatment of gastrointestinal pain, and diabetes.
Herrastlahjer	*Herniaria hirsuta*	*H. hirsuta*	*Caryophyllaceae*	Leaves	Remedial treatment of anuria, expulsion of kidney stones, treatment of biliary and renallithiasis.
fijel	*Ruta gravuolens*	*R. gravuolens*	*Rutaceae*	Leaves	Against sprains, dislocations, tendinitis. Cysts and exostoses.
Jaada	*Teucrium polium*	*T. polium*	*Lamiaceae*	Leaves	gastrointestinal disorders, inflammations, diabetes and rheumatism

Zaatar	*Origanum vulgare*	*O. vulgare*	*Lamiaceae*	Leaves	Against migraine, cough, urinary infection
Thawsarghine	*Corrigiola lephiifolia*	*A. lephiifolia*	*Caryophyllaceae*	Leaves	Antiasthenic, diuretic, antispasmodic, antitussive, dermatology, aphrodisiac, flu.
Habrchad	*Lepidium sativum*	*L. sativum*	*Brassicaceae*	Seed	anti- spasmodic, anti-diarrhoeal, galactagogue, hepatoprotective
Drou	*Pistacia lentiscus L.*	*P. lentiscus L.*	*Anacardiaceae*	Leaves	against the affections of the digestive tract, and against the diabetes.
Fliou	*Mentha pulegium L.*	*M. pulegium L.*	*Lamiaceae*	Leaves	Against bad digestions, stomach aches, flu.
Barztam	*Aristolochia paucinervis*	*A. paucinervis*	*Aristolochiacées*	*Leaves*	skin infections and abdominal pain
Aghaz	*Saw palmetto*	*S. palmetto*	*Arecaceae*	*Fruit*	*against prostate hypertrophy*

Reagents and standards

Hydrochloric acid and nitric acid of analytical grade. For each of the elements Cu, Zn, Fe, B, Mn, Ca, Mg, Na, K, S, and P a standard solution of 1000 µg/mL dissolved in 2% wt HNO_3 supplied by Merck Millipore (Certi PUR, Darmstadt, Germany) was used as the stock solution for calibration. All solutions were prepared from triply distilled water.

Sample preparation

1g of sample was gently weighed in to a porcelain crucible and then calcined in a muffle furnace (Nabertherm, Bremen, Germany) for 2 h at 500 ◦C. After a few mounds, 10 drops of water and 4 mL of HNO3 were added. At 120 °C, the excess nitri cacid was evaporated on a hot plate and the sample was held at 500 °C for 1 h. It was allowed to cool, the ash was dissolved in 10 mL of HCl (20%, v/v).

Sample analysis by ICP-MS

The ICP-OES operating conditions were the following: plasma gas flow rate 14 L.min− 1; auxiliary gas flow rate, 0.8 L.min- 1 ; 1.3 mL.min− 1 of sample flow rate with a time flush of 7 ; 0.8 L.min- 1 of nebulizing gas flow rate ; 1300

W of RF power ; 0.8 L.min− 1 of nebulizer gas flow rate. the axial mode is used for the detection of all elements. The wave lengths used for quantification were as follows: Fe 239.562 nm, B 249.772 nm, Na 589.592 nm, Cu 324.752 nm, Mg 285.213 nm, Zn 213.857 nm, Mn 257.61 nm and Ca 317.933 nm, K 766.490 nm. All samples were tested with blank samples and known standards.

Statistical analysis

The obtained data were subjected to several statistical analyses including analysis of variance (ANOVA) and correlation analysis based on the Pearson correlation coefficient (a=0.05) using the SPSS software (IBM SPSS Statistics 20). Then, the classification of species was carried out by principal component analysis (PCA) using XLSTAT software (2017) and ascending hierarchical analysis according to the UPGMA aggregation method by STATISTICA StatSoft software (1997).

Results

Macro-elements

Fifteen medicinal plants were analyzed by ICP-AOS, the different concentrations of elements in the fifteen medicinal herbs are shown in Table 2. The difference in elemental concentration is mainly due to variations in botanical structure, as well as to the mineral composition of the soil in which the plants are grown. Climatic conditions, irrigation water and preferential uptake are other factors that can influence this mineral composition of the different plant organs. In the present study, their maximum concentrations were determined in order: Ca> K> S>Mg> P>Na.

All these trace elements were presents in variable proportions in the medicinal plants analysed. Ca had reported the highest concentration in the medicinal plant followed by potassium (K) and Mg. The range of variation of this element in the medicinal plants was 699,63 - 27625,43 mg/kg. *Saw palmetto* and *M. pulegium L.* recorded minimum and maximum concentrations of Ca in medicinal plants, respectively. Ca had the highest concentration in 9 plants (Table 2) namely, *L. stoechas, T. willdenowii, A. gummifera, T. articulata, H. hirsuta, R. graveolens, T. polium, O. vulgare, M. pulegium* L. K, which ranged from 4471,97 to 20862,43 mg. Kg^{-1}. The lowest S content was found in *Tetraclinis articulata* with a concentration of 2223.22 mg/kg and the highest content in *Lepidium sativum* with a value of 8586.84 mg/kg. S was found to be the highest element in ten plant species namely L. *Sativum* and *S. Palmetto.* For Mg the highest 8474,79 mg/kg in *H. Hirsute* and the lowest 752,47 mg/kg in *S. Palmetto;*

for *P the highest* 4556,37 mg/kg in *L. Sativum* and the lowest 564,94 mg/kg in *A. Paucinervis.* For Na the highest 8662,56 mg/kg in *A. gummifera* and the lowest 59,21 mg/kg in *S. Palmetto.*

Table 2. Mean values of major element content (mg /kg) of 15 Medicinal Plants with therapeutic effect groing in middle atlas of Morocco. Values are averages of three replicates followed by±SD

Medicinal plants	Ca	Na	K	Mg	P	S
Lavandula stoechas	10273,39±27,39	127,41±3,48	17941,03±36,74	4345,38±	1264,82	3265,80
Daphne gnidium	13330,80±12,30	117,77±4,44	9766,36±20	2886,44±	894,83	2984,11
Thymus willdenowii	18157,03±37,56	152,24±4,15	18170,39±137,75	3800,25±	1680,27	4818,82
Atractylis gummifera	12504,30±13,42	8662,56±21,52	7606,41±10,81	1330,23±	780,35	8379,48
Tetraclinis articulata	17394,30±53,43	133,57±4,81	4471,97±22,9	2003,18±	1287,86	2223,22
Herniaria hirsuta	19674,57±33,08	807,10±14,03	20862,43±51,48	8474,79±	2430,22	6371,11
Ruta graveolens	20457,45±61,5	205,17±7,29	15261,34±49,33	2898,68±	1464,83	4987,95
Teucrium polium	14949,82±69,58	194,83±7,07	10130,63±35,91	2910,47±	1129,54	5185,37
Origanum vulgare	16572,64±56,79	125,26±4,33	12133,28±34,10	3637,25±	910,99	5097,52
Lepidium sativum	3310,69±50,27	238,40±10,63	11836,52±25,30	3299,22±	4556,37	8586,84
Corrigiola telephiifolia	5074,17±46,62	683,04±47,03	13489,12±60,37	1642,30±	1081,49	4668,32
Pistacia lentiscus L.	7210,94±28,23	97,67±6,58	9436,35±23,9	2402,67±	1085,01	2963,93
Mentha pulegium L.	27625,43±46,65	434,50±19,96	8337,39±41,05	2411,10±	2690,54	4188,83
Aristolochia paucinervis	5616,59±32,68	484,08±12,94	12155,25±37,76	3241,71±	564,94	5573,31
Saw palmetto	699,63±55,14	59,21±	15635,36±37,2	752,47±	640,43	11155,87
Mean	12858,29	834,84±	12481,81	3069,07	1468,32	5362,27
Ecart-type	7464,43	2177,20±	4464,20	1779,20	1038,09	2422,83
CV%	58,05	260,79±	35,77	57,97	70,70	45,18
F value	37450,69***	24911,47***	20693,48	5468,81	38,17	5300,10

Significance level : ***P <0,001.

Micro-elements

The S contents in all the medicinal plant extracts analysis were between 2223.22 and 8586.84 mg/kg. The concentrations of Fe in the analysed samples ranged from 35.61 to 1781.20 mg/kg. The maximum (1781.20 mg/kg) in *Herniaria hirsuta* and minimum (35.61mg/kg) in *Saw palmetto* are presented in Table 3. Fe contributes to the proper functioning of the immune system and is responsible for the production of energy as a constituent of various enzymes. It is part of hemoglobin and is responsible for the transport of oxygen. Throughout the world, Fe deficiency can be described as the most common dietary deficiency. The Cu contents of the different samples analysis ranged from 3.12 mg/kg to 17.24 mg/kg. For the extracts studied, Result indicated that the highest Cu concentration was in *Thymus willdenowii* (17.24 mg/kg), but the Cu content in clove (3.12 mg/kg) was the lowest (Table 3). B, was the highest of 46.38 in *Pistacia lentiscus* L. and the lowest of 9.26 mg/kg in *Saw palmetto*. Zn was the highest 56.68 in *C. telephiifolia* and the lowest of 5.93 mg/kg in S. palmetto.

Table 3. Average values of microelements content (mg/ kg) of 15 medicinal plants with therapeutic effect growing in the Middle Atlas of Morocco. The values are the average of three replicates followed by±SD

Medicinal plants	Fe	Mn	Cu	Zn	B
Lavandula stoechas	240,59	49,58	13,33	28,63	23,15
Daphne gnidium	119,75	138,62	10,40	25,73	15,00
Thymus willdenowii	905,76	82,18	17,24	37,28	27,31
Atractylis gummifera	254,48	9,04	13,81	12,97	15,04
Tetraclinis articulata	145,83	46,13	9,57	23,75	14,20
Herniaria hirsuta	1781,20	95,04	16,91	31,42	29,37
Ruta graveolens	235,58	21,30	11,72	25,11	35,64
Teucrium polium	283,53	20,96	15,22	43,66	27,42
Origanum vulgare	216,78	24,22	14,53	32,65	29,60
Lepidium sativum	67,71	18,85	10,51	53,38	7,17
Corrigiola telephiifolia	317,88	61,70	12,73	56,68	9,99
Pistacia lentiscus L.	87,49	14,38	8,21	12,17	46,38
Mentha pulegium L.	502,37	48,94	14,32	32,23	16,25
Aristolochia paucinervis	245,07	24,78	8,85	37,17	9,88
Saw palmetto	35,61	5,19	3,12	5,93	9,26
Mean	362,64	45,11	12,03	30,5	20,38
Ecart-type	446,30	37,26	3,71	14,21	11,35
CV%	123,07	82,59	30,88	46,60	55,67
F value	1361,88	48,58	22,40	42,16	20,37

Significance level : ***P <0,001.

Principal component analysis

PCA is shown to be a powerful mathematical method that reduced the dimensionality of the data and allowed for the creation of a set of new variables called principal components. This method was used in this case as a multivariate statistical approach to distinguish the examined plant species based on the mineral elements analysed (dependent variables).

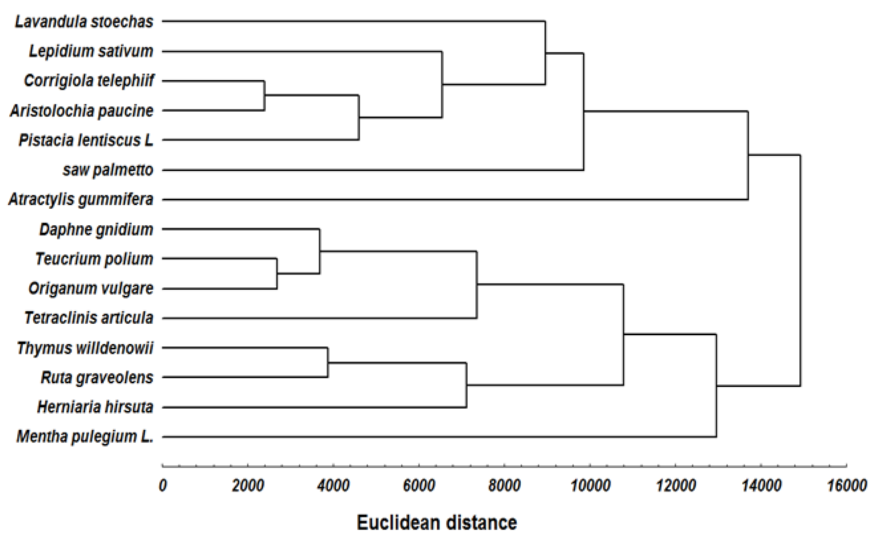

Figure 1. Principal component analysis (PCA) of 15 medicinal plants

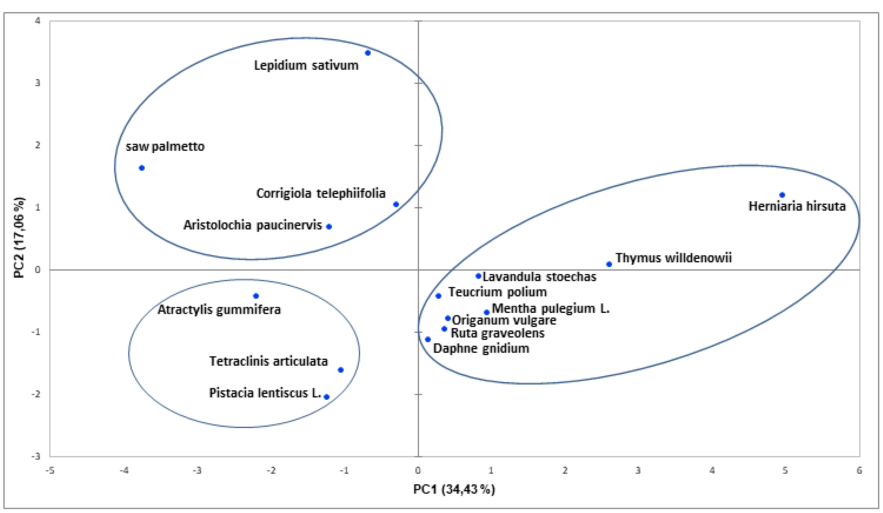

Figure 2. Dendrogram of 15 medicinal plants

The results from the PCA showed that 51.49% of the total variation among different species was represented by the two first components. 34.43% of the variability was expressed by the first component (PC1), while 17.06% was explained by the second component (PC2) (Figure 1). The PC1 was associated with the element Ca, Mg, Fe, Mn and Cu. On the other hand, PC2 was associated with the element S, P and B.

The PCA biplot showed a high variation between the studied species, and they were distributed into three groups. The first group consisted of 8 species. This group is distinguished with high values of elements CA, Mg and B. the second group consists of four species characterized by a high value of element S and low values of elements Ca, B and Cu. The third group composed 3 species, which is characterized by lower values of elements Zn and Mg.

The cluster analysis of all the mineralogical data of the fifteen species leads to obtain a dendrogram according to the UPGMA method and the city-block genetic distance. This dendrogram led to the identification of two main clusters (Figure 2). The first cluster composed of 7 species namely *Lavandula stoechas*, *Lepidium sativum*, *Corrigiola telephiifolia*, *Aristolochia paucinervis*, *Pistacia lentiscus L.*, *saw palmetto* and *Atractylis gummifera* characterized by low values of element Ca, B and medium values of element K. The second cluster comprised species *Daphne gnidium*, *Teucriumpolium*, *Origanum vulgare*, *Tetraclinis articulate*, *Thymus willdenowii*, *Ruta graveolens*, *Herniariahirsuta and Menthapulegium L.* which were distinguished by higher values of element Ca, the majority of species had the high values of element Zn and Mn, and by medium values of element S.

Correlations among studied elements

The correlation matrix between microelements and macroelements is presented in Table 4. Significant correlations were highlighted between some elements. Mg was strongly associated with Fe (r= 0.82**) and K (r=0.62**). Similarly, Cu was positively correlated with Ca (r=0.62**) and positively with Fe (r= 0.61**). S was found negatively correlated with Ca (r=-0.44**) and Mn (r=-0.44**). P was positively correlated with Mg (r=0.31*) and Zn (r=0.46**). Mn was positively associated with Mg (r=0.43**) and Fe (r=0.47**). B was positively correlated with Ca (r=0.32*) and Mg (r=0.31*).

Table 4. Correlation coefficients (Pearson's correlation) between macroelements and microelements studied, in 15 medicinal plants in the Middle Atlas region (Khenifra and BeniMellal)

	Ca	Na	K	Mg	Fe	Mn	Cu	Zn	B	P
Na	0									
K	-0,063	-0,27								
Mg	0,34*	-0,22	0,62**							
Fe	0,46**	0,001	0,59**	0,82**						
Mn	0,37*	-0,23	0,20	0,43**	0,47**					
Cu	0,62**	0,16	0,25	0,54**	0,61**	0,38**				
Zn	-0,029	-0,28	0,14	0,23	0,15	0,21	0,47**			
B	0,32*	-0,14	0,20	0,31*	0,25	-0,01	0,24	-0,25		
P	0,095	-0,15	0,07	0,31*	0,25	0,09	0,22	0,46**	-0,10	
S	-0,44**	0,34*	0,25	-0,14	0,006	-0,44**	-0,26	-0,12	-0,38*	0,17

Significance level: *: p<0.05; **: p< 0.01

Discussion

However, the concentration of K, Mg and Na recorded in the present study was almost lowest than the data reported by the Karahan *et al.* (2020) in Turkey *Pistachia terebinthus L.*, but the Ca in our study is 4 times higher than that found by this author. For other Algerian *P. lentiscus L.* the results showed that Ca and Na are almost 2 times that found in our results (Hamlat *et al*., 2019) for Na 5 times high, Mg almost 4 times, P 2 times, however K found in our results is less than that reported by Özcan (2004). While the concentrations of Ca that were found in the *L. Sativum* samples are similar with the result reported by (Gungor *et al*., 2013). Nevertheless, the concentration of Na and Mg in L. Sativum of Izmir (Turkey) was about 3 times hight and 2 times hight respectively, compared to the results of the present study. However, the concentration of Na and Mg in *L. Sativum* of Izmir (Turkey) was about 3 times and 2 times higher respectively, compared to the results of our study. In *L. Stoechas* The data obtained for K and Mg were significantly higher than the data obtained for the same species grown in Algeria (Noureddine *et al*., 2019), except for Ca which is lower in our result. Another research in *M. peligium* carried out by Ibourki *et al.*

(2022) collected from (Morocco) showed similar results in Mg and P, high contents of K and low contents of Ca and Na compared to the present study.

Calcium plays an important role in the transmission of hormonal effects to target organs through an intracellular signalling pathway. On the other hand, Ca influences certain enzymatic processes, metabolic reactions, skeletal strength and blood coagulation (Anal *et al*., 2016). Mg has a vital role in the phosphorylation reactions of glucose and its metabolism, and it may influence the release and activity of the hormones that help control blood glucose levels (Anal *et al*., 2016). In addition to its role as a cofactor for many enzymes, Mg is involved in energy metabolism, DNA and RNA synthesis, protein synthesis. The main role of K is its ability to maintain water balance in plant cells. It is also involved in protein synthesis, energy transfer, enzyme activation and photosynthesis (Anal *et al*., 2016). Ca is an essential nutrient that influences certain enzymatic processes, metabolic reactions, blood clotting and skeletal strength. Some metals such as Ca, Mg, and Na compounds are used for the treatment of some gastrointestinal diseases in conventional drugs. Ca, Mg and Na are essential minerals obtained from various diets, and they have several essential human body functions within a recommended dietary intake. However, their deficiency and interaction with other elements have adverse effects in gastrointestinal tissues (Watson and Preedy, 2013). Large differences in macroelement composition were found among the plant species studied. These differences may be due to multiple factors, growing conditions, genetic factors, part of the plant analyzed, variations in uptake capacity, geographical variations and analytical procedures (Ibourki *et al*., 2019; Acikgoz and Kamak 2013). In a previous study from Turkey (Karahan *et al*., 2020) in *P. lentiscus* leaves, Fe, Mn, Cu and Zn concentrations were higher than determined in the present study. Hamlat *et al.* (2019), analyzed Fe and Zn concentrations of *P. Lentiscus.* They found that Fe and Zn concentration higher than our result. In the previous study in the region of Eastern Morocco the concentration of Fe, Mn, Cu and Zn 2300 mg/kg, 226.49, 33.55 and 230.36 mg/kg, respectively (Aouinti *et al*., 2014). In addition, a similar study in Turkey reported a higher concentration of Fe and Zn, compared to our results in *R. graveolens* (Ozyigit *et al*., 2018). A study from Turkey (Özcan *et al*., 2004) has reported low concentrations of Fe, Mn, Cu, B and Zn compared to our results in *O. vulgar*. A study on *T. vulgaris* in Turkey reported lower concentrations of Fe, Mn, Cu, B and Zn, compared to our findings in *T. willdenowii.* A similar study from Turkey has reported similar results to our findings in the Fe, Zn and B in *L. stoechas* (Acikgoz and Kamak, 2013). Therefore, Mn was found higher in the sample of Turkey and Algeria (Noureddine *et al*., 2019), in comparison of our result. According to this study, *L. stoechas* has a moderate mineral content compared to other species. The traditional use of this plant can be attributed to the presence of an adequate concentration of these microelements, given their positive roles in the maintenance of certain critical sensitive physical and chemical processes. The results may contribute significantly to the mineral content of the human body. The study that was conducted by Messaoudi *et al.* (2022) showed that the content of Fe, Mn and Zn is higher than the results found in the present study in Mentha pelegium. Zn is an essential metal for the proper functioning of several enzyme systems (Subramanian *et al*., 2012). Medicinal plants are used either as crude herb form collected from the environment or as their formulated mixture products.

Medicinal plants are used both alone in the treatment of human diseases and as a source of raw material in the manufacture of various medicines. The quality of many drugs and nutrients depends on both the content and the type of the elements (Yagi *et al*., 2013). The present study provides a new perspective on the availability of some major elements and trace elements in some medicinal plants. Indeed, eleven mineral elements were analyzed in 15 aromatic and medicinal plants. The result of the analysis shows that major elements like Mg, Ca, K and S are presented in high concentration in most of the studied medicinal plants. Furthermore, the concentrations of essential elements like Mn, Fe, and Zn were found to be highest in *Daphne gnidium* followed by *Herniaria hirsuta* and *Corrigiola telephiifolia* respectively. The results obtained are rich in information and allow to justify a therapeutic use, but also to better understand the mechanisms and interactions of some chemical compounds that have a relation with pharmacology and traditional medicine.

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