Mineral Contents of Some Medicinal and Aromatic Plants Growing in Eastern Morocco

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Abstract

Many Moroccan plants are known to be of potential medicinal value and are used in herbal medicine. Wormwood (*Artemisia herba alba*), Lavander (*Lavandula dentata*.), Rosemary (*Rosmarinus tournefortii),* Thyme (*Thymus vulgaris)* used as plant material in this study. The goal of this work was to analyse minor and major mineral contents of seven sample of medicinal and aromatic plants collected from two Moroccan regions and the soils in which they grew in 2007. They were established by inductively coupled plasma atomic emission spectrometry (ICP-AES). The samples were composed of Al, Ca, Fe, K, Mg, Mn, P, Ba, Cd, Pb and Zn. The highest mineral concentration were measured between 2.74-7.91 Al, 16.31-37.25 Ca, 0.36-2.70 Fe, 17.72 K, 3.09-6.83 Mg and 0.39-1.84 P % .The heavy metal Cd and Pb contents in samples collected from a traffic area may be due to automobile fumes. These results may be useful for the evaluation of the quality of consumat aromatic pants.

Key Words: Aromatic plants; Mineral contents; Soil; ICP-AES; The heavy metal.

Introduction

The more technology develops, the more people consume processed foods. As a result health problems have increased.

In recent years, with enhanced awareness of the importance of trace elements on health, an increasing number of reports on the role of trace elements in traditional medicines have been published in India [1,2], China[3,4], Nigeria [5,6], Greece [7] and Egypt [8,9].

Mixtures of medicinal plants are prescribed by the traditional healers for diseases ranging from common colds to malaria, arthritis, ulcers, etc... [10]. Minor elements have very important functions and it is believed a key component of proteins such as haemoprotein and haemoglobin which play role in biochemical functions and essential enzyme system even in low doses. Başgel & Erdemoğlu [11] reported the daily mineral intakes by consuming herbal tea for a 70 kg person and the reported amounts of minerals per day are 500 mg Ca, 300 mg Mg, 15 mg Fe, 5 mg Al, 2.8 mg Mn, 15 mg Zn, 2.5 mg Cu, 1.6 mg Sr, 1.1 mg Ba, 0.025 mg Ni, 0.05–0.2 mg Cr, 0.04 mg Co, 0.415 mg Pb and 0.057 mg Cd.

Studies originally showed that optimal intakes of elements such as sodium, potassium, magnesium, calcium, manganese, copper, zinc and iodine could reduce individual risk factors, including those related to cardiovascular disease for both human beings and animals [12-14].
Ca is the main component of bones and teeth. This element functions on cell membranes and on muscles, by regulating endo- exoenzymes and blood pressure [15].
Na and K are of great importance for many regulation systems in the body. Na is excreted in sweat by the body. Diarrhoea and vomiting causes the loss of Na and K. Tea, fruits, vegetables and coffee are good sources of K and Na. The minimum daily intake of Na and K are 2.4 g and 3.5 g [16].
Throughout the world, there is increasing interest in the importance of dietary minerals in the prevention of several diseases. Minerals are of critical importance in the diet, even though they comprise only 4–6% of the human body. Major minerals are those required in amounts greater than 100 mg per day and they represent 1% or less of bodyweight. These include calcium, phosphorus, magnesium, sulphur, potassium, chloride and sodium. Trace minerals are essential in much smaller amounts, less than 100 mg per day, and make up less than 0.01% of bodyweight. Essential trace elements are zinc, iron, silicon, manganese, copper, fluoride, iodine and chromium.
The major minerals serve as structural components of tissues and function in cellular and basal metabolism and water and acid-base balance [17-19].
Trace metals constitute significant health hazards for man and have become an area of particular concern and high priority in environmental research [20]. Trace elements can be directly taken up by the leaves of plants or they are accumulated in the soil and reach the plants through their roots [21].
Several studies have been carried out on edible wild plants [22-28]
But, limited studies on mineral contents of condiments were made [27;29-31].
The aim of this study was to determine the mineral contents of several condiments used for several purposes in eastern Morocco and the soils in which they grew. These plants could potentially be either dangerous or useful for humans who are consuming medicinal plants or to animals feeding on these economically important plants.

Materials and methods

Plant and soil materials: The plant and the surrounding soil were collected from Tafouralt (sub humid) and Jrada (semiarid) in May-June (2007). Identification of the species was confirmed in scientific institute in Rabat. A voucher specimen was deposited at the herbarium in this institute. The common, scientific and family names of the plants are given in Table1.

Table 1: Medicinal and aromatic plants used in experiment

Plant	Botanical name	Family	Used parts
Lavender	*Lavandula dentata*	*Lamiaceae*	Leaves + flowers
Rosemary	*Rosmarinus tournofortii*	*Lamiaceae*	Leaves
Thyme	*Thymus vulgaris*	*Lamiaceae*	Flowers + leaves
Wormwood	*Artemisia herba alb*	*Compositae*	Leaves

The sample was collected from different sites in Jrada and Tafouralt. Wormwood of Jrada (traffic area) (Site I); Thyme of Jrada (non polluted area) (Site II). Wormwood of Jrada (Chakhar) (non polluted area) (Site III) as far lavender of Tafouralt (traffic area) (Site IV); thyme and wormwood of Tafouralt were collected in a deep forest area (site V).

Sample preparation and measurement: 150 mg of the plant sample was ashed with 2 ml HNO3 acid (70%) mixture in a Teflon beaker. The sample was incinerated at 110 °C. 0.5 ml of Hydrofluoric acid (HF) was added and the covered beaker placed on a sand bath. The sample mixture was heated until a clear solution was

obtained. After removing the cover, the mixture was evaporated until drying. 2 ml of HCl acid was added. The residue was extracted by 25 ml 2M HCl. Concentrations were determined with an ICP-AES. The instrument was in radial configuration. Working conditions of the ICP-AES were:
ICPAES ((ULTIMA 2 Jobin Yvon)). Power: 1150 watts. Plasma gas flow rate (Ar): 12 L/min. .

Results and discussion

Mineral contents of 7 samples of medicinal and aromatic plants consumed as spices, herbal tea and condiments in Morocco were established by using inductively coupled plasma atomic emission spectrometry (ICP-AES). Eleven minerals were determined in all samples. Mineral contents vary widely depending on the different species and locations of plants. Table 2 shows that medicinal and aromatic plants content considerably Al, Ca, Fe, K, Mg and P. These elements were found in all studied plants.

Table 2: Mineral contents of plants

Mineral (mg kg^{-1})	**Wormwood of Jrada**	**Wormwood of Chakhar**	**Thyme of Jrada**	**Lavender of Tafouralt**	**Wormwood of Taforalt**	**Thyme of Taforalt**	**Rosmary of Taforalt**
	Sample1	Sample2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7
Al	24529	64085	79152	27470	12265	35768	44361
Ca	170802	163147	200511	349865	193500	313044	372527
Fe	8882	22053	27095	8447	3617	11684	12200
K	468703	393593	177265	270475	447249	279491	406844
Mg	3395	36576	53873	49765	30914	37803	68382
Ba	207.12	336.81	610.78	187.51	89.99	583.63	1294.59
Cd	20.58	3.79	1.04	6.15	1.11	0.45	6.25
Mn	501.59	1255.87	731.41	367.43	583.89	388.74	934.52
P	17348.69	8412.14	3968.43	7198.26	18497.55	6121.16	8897.56
Pb	1036.11	188.97	88.88	68.04	26.71	30.91	285.32
Zn	798.21	377.89	359.46	480.39	682.00	415.33	1016.73

The concentrations of macro nutrients vary from 0.36 to 46.87 %. Among the macro nutrients, the concentration of K ranges from 177265 mg kg^{-1} in *T.vulgaris* of Jrada and 468703 mg kg^{-1} in *A.herba alba* of Jrada. Both *A.herba alba* of Tafouralt and *A.herba alba* of Jrada recorded high accumulation value of potassium. Potassium has highest concentration in the leafy materials than other nutrients as it is an activator of some enzymes. One main feature of K^+ is the high rate at which it is taken up by plant tissues. Usually the absorption of K depends on the soil type. However, this study showed that the K content in the soil less low than that found in the plant studied (Tables 2 and 3).
All the studied plants showed high K contents [32]. The daily adult goat requirements are 1800–2500 mg kg^{-1} DM in their diets [33]. It seems that foliage from shrubs that grow in semiarid regions contains K as much as 10 times the required levels [34,35]. This fact may become a problem because high K concentrations can interfere with Na retention, absorption and Mg utilization [36].
Calcium contents of spices were found in similarly high percentages in all the species analyzed, ranging from 163147-372527 mg kg^{-1} (Table 2). A dietary level of 4300 mg kg^{-1}calcium is required for feeding animals [37]. The maximum level is 20000 mg kg^{-1}of diet dry matter [36]. It seems that foliage from browse plants that grow in semiarid [35] and tropical [39] regions have enough Ca. It is abundant in most soils. Generally the concentration of soil solution is about 10 times higher than that of K^+. The uptake rate of Ca^{2+}, however, is usually lower than that of K^+. This low Ca^{2+} uptake potential occurs because Ca^{2+} can be absorbed only by

young root tips in which the cell walls of the endodermis are still unsupervised [40]. However, our data reveal that medicinal plants are not deficient in Ca.

Table 3: Concentration of major and trace elements in soils.

Minerals (mg kg^{-1})	Site I	Site II	Site III	Site IV	Site V
Al	21698	35348	47041	69374	10935
Ca	254189	72595	15057	22341	15991
Fe	19520	43910	42443	41171	4482
K	9632	20591	25183	61673	4278
Mg	8120	17403	7718	61673	40052
Ba	235.94	430.65	511.71	111.26	80.72
Mn	364.50	1384.28	223.92	338.78	223.92
P	460.75	436.03	94.80	274.48	94.80
Cd	0.46	0.61	0.92	0.41	0.92
Pb	35.46	5.31	8.16	29.96	8.16
Zn	48.87	117.69	12.83	74.84	12.83

Phosphorus ranges from 3968.43 to 18497.55 mg kg^{-1}. Wormwood *(A.herba alba)* contains highest concentration of P, whereas Thyme *(T.vulgaris of* Jrada*)* contains lowest concentration of P. Plant roots are capable of absorbing very low phosphate concentrations from soil solutions. The results show that there is a correlation between soil content of potassium and plant accumulation (Table 2 and 3).
The concentration of Mg ranges from 30914 mg kg^{-1} (Wormwood of Taforalt, *A.herba alba)* to 68382 mg kg^{-1} (*R.tournofortii***).** Generally, the concentrations of Mg^{+} in soil is higher than that of K^{+}(Table 3) but the uptake of Mg^{2+} by root cells is much lower than the uptake of K^{2+} [41]. The level of Mg in plants depends to a large extent on soil type. A magnesium concentration of 2000 mg kg^{-1} in plants is commonly regarded as the minimum ''safe'' dietary concentration for adequate animal health [42;37]. This provides that all studied plants can be used to compensate magnesium deficiency in animals. The high content of Mg in the studied plants could be related to temperature [45].
The content of zinc ranged between 359.46 mg/kg in *T. vulgaris* and 1016.73 mg/kg in *R. tournofortii* (Table 2). Plants absorb Zn as Zn^{2+}. Zn is widely distributed in soils.
The lowest content of Zn was in the soil in which Wormwood of Tafouralt was growing and the highest was in the Jrada soil in which *A.herba alba* and *T.vulgaris* were growing. The content of Zn in the other soils studied ranged between 74.84 (mg kg^{-1}) in *L. dentata* and 126.05 (mg kg^{-1}) in *A.herba alba* of Jrada (Table 3). The physiological activities of the plant influence Zn absorption and the interactions with many elements like Fe, Mn and Cu also affect Zn uptake [44]. The concentration of zinc in Tulsi (*Ocimum sanctum*) and Neem (*Azadirachta indica*) leaves, which are widely used in Indian Ayurvedic medicine, were 140 and 10 mg g^{-1}, respectively [45].The maximum tolerable zinc level has been set at 500 p.p.m. for cattle and 300 p.p.m. for sheep [38]. It seems that goats require about 40–50 mg kg^{-1} DM of Zn in their diets [46]. Khanna et al. [47] observed that the high concentration of Zn in Tulsi leaves and the anti-fertility effect caused by drinking an infusion of its extract may be correlated. The role of Zn in spermatogenesis is well documented [48].
Aluminium contents were high in most cases and ranged from 12265 mg/kg Wormwood of Tafouralt to 79152 mg kg^{-1} in Thyme (*T.vulgaris*) of Jrada. Aluminum toxicity is a major factor limiting crop performance on acid soils that predominate under tropical climate. The primary toxicity symptom observed in plants is inhibition of root growth [49,50], followed by less nutrient and water absorption, resulting in poor growth and

production. Aluminum interferes with the uptake, transport, and utilization of essential nutrients including Ca, Mg, K, P, Cu, Fe, Mn, and Zn [51-55].

Manganese concentration ranged between 388.74 mg kg^{-1} in *T.vulgaris* of tafouralt and 934.52 mg kg^{-1} in *R. tournofortii*. However, the range of Mn in the rest of the examined plants was 367.43–731.41 mg kg. Reddy & Reddy [41] reported that the range of Mn in their study was 10.5–81.6 mg kg^{-1}.While the range in the soil was 223.92-1384.28 mg kg^{-1}. Mn is absorbed by the plant as Mn^{2+} from soils. Mn activates some respiratory enzymes and photosynthetic enzymes and soil are usually not deficient in Mn. The rate of uptake by plant is depressed by Mg. The results show that there is a correlation of Mn content between soil and plant species (Tables 2 and 3) stating that the plants are selective in accumulating Mn. *T.vulgaris* of Jrada exhibited higher Fe concentration than the other plants (Table 2). The level of Fe of *A.herba alba* of Tafouralt found to be small than those of others.
Samudralwar and Garg [45] reported that the concentration of Fe in tulsi (*Ocimum sanctum*) and neem (*Azadirachta indica*) leaves which are widely use in Indian Ayurvedic medicine were 129 and 355 mg g^{-1}, respectively. The suggested Fe requirement for animals range between 30 and 100 p.p.m. and the maximum tolerable level for cattle is suggested as 1000 mg kg^{-1}. [56,57;38]. Plants require more Fe than any other macro nutrients, because Fe deficiency in leaves lead to the iron chlorosis. Iron chlorosis may result from an absolute Fe deficiency in soil [40]. Our data indicate that medicinal leaves chosen here contain much Fe.
Barium was found to be high, ranging from 89.99 to 1294.59 mg $kg^{-1.}$ The results show that there is a correlation of Ba content between soil and plant species (Tables 2 and 3).
The concentrations of toxic trace metals such as Cadmium is from 0.45- 20.58 mg kg^{-1}. Plomb content ranged from 26.71-1036.11 mg kg^{-1}.The higher concentrations of Cd and Pb in samples collected from traffic area may be due to automobile exhausts. Usually, automobile exhaust and smelters are the main sources of Pb and Cd respectively [58].

The concentration of Cd and Pb may depend on the sampling location. In fact, the Thyme and wormwood of Tafouralt were collected in deep forest area, and so these two toxicants were present in low quantities (Table 2).

As can be seen from the data in Table 2, spatial variability is particularly high in elements which show different degrees of bioavailability depending on sampling parameters. Pollutants may also show high spatial variability depending on the pattern of emission sources and processes of transportation prevailing in the atmosphere and in deposition. Among the toxicants, Pb and Cd concentrations are high in samples collected from traffic density dense areas (Site I and IV).

The macro- and micro-element values of wild plants in the same study were lower than the present study. Essential and trace element contents of 20 medical plants were determined in Niger. Elements such as K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Se, Br, Rb, Si, as well as toxic heavy metals such as Cd, As, Pb and Hg were detected in concentrations between 0.18 and 77400 mg kg^{-1}. Herb materials were found to contain any heavy metals such as Cd, As, Pb and Hg [10].

Some of our results of mineral contents of medicinal and aromatic plants used in experiment show minor differences when compared with literature [26;29;59,60]. These differences might be due to growth conditions, genetic factors, geographical variations and analytical procedures [27;59,61].
Most of these elements are essential activators for enzyme - catalyzing reactions. For example, Mn plays a structural role in the chloroplast membrane system and may be responsible for colour, taste and smell, and a cofactor for fatty acids, DNA and RNA synthesis [62]. Iron is an essential activator for enzyme–catalysing reactions involving chlorophyll synthesis and for ferrodoxin nitrate reductase [63]. Potassium is an essential nutrient and has an important role in the synthesis of amino acids and proteins [64]. Ca and Mg play a significant role in photosynthesis, carbohydrate metabolism, nucleic acids, and binding agents of cell walls [65]. Calcium is also the major component of bone and assists in teeth development [66].

Zn is an essential micronutrient and is associated with a number of enzymes, especially those for synthesis of ribonucleic acids [67]. The contents of trace elements in plants are low and in terms of biological activity they are critical. However, when they are incorporated into mineral complexes, their ability is enhanced [68]. Other inorganic elements which may contribute to biological processes, but which have not been established as essential, are barium, cadmium [17]. Cadmium is best known for its toxicological properties [69]. Boron, chromium, manganese, nickel, tin, vanadium, molybdenum, arsenic, lithium, aluminium, strontium, cesium and silicon are regarded as new trace elements in the sense that they have only recently been considered essential in human diets [70-73].

Conclusion

The present study gives a new perspective about the presence of some major and trace elements in some indigenous (Eastern Morocco) medicinal plants and the soils they grow in. The highest mineral contents were Al, Ba, Ca, Fe, K, Mg, P and Mn. This work attempts to enrich knowledge of the nutritional properties of these plants as well as highlighting the importance of mineral contents such as condiments. The composition of plant is mainly dependent on the composition of the soil which influenced primarily by the nature of the rocks from which the soil is derived. The special flow, temperature and humidity conditions of the air layer right above the ground entail extreme fluctuations of element concentration as well as contamination problems which are not easy to assess.

This study indicates that some of these plants accumulate certain elements, and this property is exploited by the use of these plants for medicinal purposes in addition to their bioactive secondary metabolites constituents. The elucidation of element specification in these plants helps interpret the therapeutic actions and may help in designing chemically pure medication.

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Mineral contents of some medicinal and aromatic plants growing in Eastern Morocco. J. Mater. Environ.Â Lokhande R, Singare P, Andhale M (2010). Study on mineral content of some Ayurvedic Indian medicinal plants by instrumental neutron activation analysis and AAS Techniques. Health Sci. J. 4(3):157-168. Meena H, Pandey HK, Pandey P, Arya MC, Ahmed Z (2012). Evaluation of antioxidant activity of two important memory enhancing medicinal plants, Baccopa monnieri and Centella asiatica. Indian J. Pharmacol. 44(1):114-117. Return to Content. Medicinal and Aromatic Plants. Article shared by : ADVERTISEMENTSÂ Medicinal and aromatic plants have a high market potential with the world demand for herbal products growing of the rate of seven per cent per annum. Aromatic plants provide products with are extensively used as spices, flavouring agents and in perfumes and medicine. In addition, they also provide raw materials for the production of many important industrial chemicals.Â Some of these products are the raw materials for the production of important industrial chemical like Î²-ionone from lemongrass oil for the production of vitamin A. India produces turpentine oil in the order of 10,000 to 35,000 tons annually and this oil is used for the production of a number of chemicals. However, the growing number of products utilizing medicinal and aromatic plants (MAPs) has threatened an estimated 9,000 medicinal plant species worldwide, making it critical to reevaluate their research and development, production, and utilization. Continuing advances in Omics methodologies and instrumentation are essential to understanding how plants cope with the dynamic nature of their growing environment, how yields and characteristics can be improved, and how to most effectively direct conservation efforts.Â Table of Contents. 1. Review of the active principles of medicinal and aromatic plants and their disease fighting properties. 2. Unraveling the mode of action of medicinal plants in delaying age related diseases using model organisms.