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Estimation of Essential and Toxic Mineral Elements in *Mentha* Species

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The objective of the study is to estimate the essential and toxic mineral elements using atomic absorption spectrophotometer (AAS), in four *Mentha* species aerial parts including *Mentha aquatica*, *Mentha longifolia*, *Mentha spicata* and *Mentha piperita*. Among the 8 elements analyzed, iron, manganese and zinc were the most abundant element distributed throughout all of these species. The highest amounts found in *M. spicata* with 129.76 µg/g of Fe, 8.52 µg/g of Zn and 6.8 µg/g of Mn. It is the best source for useful trace elements.

Key Words: Trace elements, Atomic absorption, *Mentha* species.

INTRODUCTION

There is a growing interest in the mineral content of foods and diets[1]. Experiments in cell culture and in intact organisms reveal the importance of trace elements in many metabolic processes and functions throughout the life cycle. Many current human health problems relate to diets. Micronutrients are involved in numerous biochemical processes and an adequate intake of certain micronutrients related to the prevention of deficiency diseases. Malnutrition is of major concern for many tropical developing countries especially in third world. Iron deficiency anemia, for example, affects one third of the world population[2,3]. Human and animal studies showed that optimal intakes of elements such as manganese, copper and zinc could reduce individual risk factors, including those related to cardiovascular disease[4]. The discovery that organic substances as well as other minerals in plants could impair the availability of trace elements for intestinal absorption and retention also explained why the health of humans, who depend on those foods, is greatly affected by the composition of plants[5,6]. Fruits and vegetables are safe and are valuable sources for minerals[3,7,8]. Vegetables are better sources of minerals than fruits[6]. Among the various medicinal plants, some endemic and edible species are of particular interest because they may be used for producing raw materials or preparations containing high content of minerals with health benefits[9,10]. On the other hand many industrialized processes give rise to environmental problems with increased levels of elements such as cadmium, chromium and lead which can have profoundly deleterious effects on health[6]. The genus *Mentha* is one of the most important members of *Labiatae* family and has over than 6 flavour species in the flora of Iran and commonly used as herbal tea, flavouring agent and medicinal plant[11]. Antiinflammatory[12], MAO-inhibitory[13], antidiabetic[14], antioxidant[15,16], insect repellency[17], antifungal[18] and acetyl cholinesterase inhibitory[19] activities of these species has been previously reported. Because of increasing interest in the importance of dietary minerals in the prevention of disease, data are needed on the mineral content of foods. The aim of this study is to establish the mineral content of some vegetables. The present paper sets out new analyses of the mineral content of four *Mentha* species, used as a home garden vegetable in northern of Iran. Amounts of essential (Cu, Mn, Zn, Fe and Cr) and toxic (Ni, Pb and Cd) trace elements were assessed in samples using atomic absorption spectroscopy.

EXPERIMENTAL

M. aquatica, *M. longifolia*, *M. spicata* and *M. piperita* were collected from Dasht-e-naz area, Panbe choole village, Sari, Iran. Plants were collected from the same farm in September 2009. After identification by Dr. Bahman Eslami (Assistance professor of plant systematic, Islamic Azad University, Branch of Ghaemshahr, Iran), Voucher specimens (No. 432-435) have been deposited in the Sari School of Pharmacy.

All plants were washed with deionized water to remove possible surface contamination of metals such as lead. The properly dried and ground plant samples were ash-dried overnight at 400- 420 ºC in a vitreosil crucible. Care was taken for temperature not to exceed 450 ºC to avoid losses of zinc and potassium. The procedure destroys all organic matter, leaving an inorganic residue that was kept in a desiccator until needed for analysis. Two grams of ash were dissolved in a 1:3 mixture of hydrochloric and nitric acids[22], diluted to 50 mL with distilled water and used for analysis by means of an atomic absorption spectrometer Perkin Elmer AAS 100 (Wellesley, MA). Table-1 gives the operating conditions for the atomic absorption spectrometry..

TABLE-1
OPERATING CONDITIONS OF THE ATOMIC ABSORPTION SPECTROMETER* (AAS 100)

Elements	Detection wave length (nm)	Drying temp. (ºC)	m.p. (ºC)	Detection limits (µg/g)
Cu	324.8	120	1085	0.033
Fe	248.3	120	1535	0.047
Zn	213.9	120	450	0.035
Mn	279.5	120	1246	0.009
Ni	232.0	120	1455	0.056
Cr	357.9	120	1900	0.018
Pb	283.4	120	327.46	0.020
Cd	228.8	120	321.07	0.007

*For all elements, the slit width was 0.2 nm. The air and acetylene flow rates were 4.0 and 0.5 L/min, respectively.

Detection limits of the investigated elements: Sixteen blank control solutions were used to estimate the detection limits of the investigated elements following the same analytical procedures. Three times the standard deviation was used as detection limit (Table-1.)

Statistical analysis: Experimental results are expressed as means ± SD. All measurements were replicated three times. The data were analyzed by an analysis of variance ($p < 0.05$) and the means separated by Duncan's multiple range test.

RESULTS AND DISCUSSION

Table-2 represents the elemental analysis in ash of the above-mentioned plants by AAS technique. The concentration of various elements analyzed in the present work decreases in the order: *M. spicata*: Fe > Cr > Zn > Mn > Ni; *M. longifolia*: Fe > Zn > Mn > Pb > Cu > Cd; M. *piperita*: Fe > Zn > Cr > Mn > Ni > Cu and *M. aquatica* Fe > Zn > Mn. There was difference in elemental content between the different species in same genus. Trace elements are essential to all cells and deficiencies of essential metals may also cause disease. For example in diabetes, chromium, copper and zinc have important role in insulin secretion process from β-cells of the Langerhans islets and reinforcing insulin action[20,21]. Zinc may be one of antidiabetic factors in *Mentha* genus. Insulin complexes of zinc in varying ratios are stored in pancreatic β-cells and released into the circulation *via* the portal vein[22,23]. Zinc is critical for normal growth, preventing infection[24]. In addition, it is involved in wound healing and in preventing from distortion of appetite[25]. Chromium is an active component of the glucose tolerance factor (GTF) and its deficiency can result in impaired action of GTF and subsequent hyperglycemia and glycosuria[25]. It can protect against adult-onset diabetes. *Mentha spicata* had higher chromium content than others. Recently, interest was aroused in copper compounds as radio protective agent and a number of copper complexes were shown to be good scavenging agents for the super oxide radical, which is believed to play an important role in the induction of radiation damage. Super oxide probably exerts its toxicity through its ability to reduce metals ions *in vivo*, for example Cu(II) → Cu(I) and to form OH^- radicals which combine together to form toxic H_2O_2. The mechanism by which copper compounds exerts its protective effect is not known with certainty, but it is thought likely that it facilitates the *de novo* synthesis of superoxide dismutase, a copper and zinc-dependent enzyme that catalyses the dismutation of superoxide and possibly other copper-dependent enzymes that may play important roles in tissue repair[25]. On the other hand copper therapeutic effect in anemia, kinky hair syndrome was proved[25]. In addition, Mn and Fe play vital roles in biochemical processes, improvement of impaired glucose tolerance and have indirect role in the management of diabetes mellitus[26]. Manganese can protect against skeletal deformities, gonadal dysfunction[25] and diabetes[22]. *M. spicata* has higher manganese content than others. This study confirmed the well-known fact that vegetable leaves are very rich sources of minerals such as Fe, Zn and Mn. The daily mineral requirements of an adult man (a 70 kg person) are as follows 15 mg Fe, 2.8 mg Mn, 15 mg Zn, 2.5 mg Cu, 0.025 mg Ni, 0.05- 0.2 mg Cr, 0.415 mg Pb and 0.057 mg Cd[3,27]. On the contrary, the foods consumed in third world countries population are poor in important elements such as Fe and the consumption of this vegetable could bring the amount required to meet the requirements either. These vegetables found all over the world and they have a good potential for human nutrition. The mechanisms of absorption of molecules and ions by plants are selective; plant cells discriminate between substances presented to them, accumulating some and excluding others. However, the discrimination process is not perfect, so plants can take up metals in toxic quantities[6]. The industrial use of cadmium, *e.g.*, in fungicides[6], paint pigments, textiles, plastics, electric batteries, *etc*., has led to widespread contamination of soil. Thus vegetables grown in contaminated areas can be expected to have higher cadmium concentrations. The use of sewage sludge for agricul-

TABLE-2
AMOUNT OF TRACE ELEMENTS IN THE PLANTS BY AAS ANALYSIS (µg/g)

Sample name	Yield (%)	Cr	Fe	Cu	Zn	Ni	Mn	Pb	Cd
M. aquatica	44.7	ND	23.98	ND	5.60	ND	3.60	ND	ND
M. piperita	38.0	5	25.98	1.120	5.12	3.2	4.40	5.42	ND
M. longifolia	38.8	ND	39.96	0.716	6.40	ND	3.78	3.38	0.62
M. spicata	35.0	10	129.76	ND	8.52	3.6	6.80	ND	ND

Values are averages of three independent measurements having a precision of approx ± 1 %, ND = not detected.

tural purposes could also lead to higher uptake of chromium by plants and animals. Contamination of foods may also arise from a number of industrial applications of lead, *e.g.*, lead batteries[6] lead-sheathed cables, in the chemical industries, in plumbing, *etc*. It has been suggested that vegetables grown near busy roads may contain high levels of lead because of the lead compounds in motor fuels. Toxicity of medicinal herbs is of much greater concern today than ever before[28]. Exposure and subsequent toxicity from toxic and heavy metals such as Cd and Pb can come from a number of sources including the family home, workplace, industrial emissions and environmental pollutants[29]. The maximum levels of elemental intake allowed by US Food and Drug Association in food supplement are 10 ppm for Pb and 2 ppm for Cd, in accordance with standard practice[30].

Conclusion

The trace elements present in this species may play a direct or indirect role in their biological activities. It is of great importance that the plants are grown in a lead-free environment to ensure its safety. Since the beneficial effects of trace elements are consequently bioavailability, further research is needed to establish the chemical form of trace elements in these plants.

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