REPORT

EVALUATION OF MINERAL CONTENTS OF SOME EDIBLE MEDICINAL PLANTS

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ABSTRACT
The contents of macro-(Cd, Al, Pb, Mg, Ca, Na, K) and trace- metals (Cu, Ni, Cr, Fe, Mn) in ten edible medicinal plants have been determined by atomic absorption spectrophotometry using a wet digestion method. The overall reproducibility of the method is within ± 10%. The results indicate large variations in the concentration of metals in plants samples studied. Out of the total contents of metals in these plants, the macro-metals including Cd (0.00024-0.00028%), Pb (0.00032-0.00047%), Mg (0.20-0.54%), Ca (0.32-0.39%), and Al (0.008-1.64%) are present in very low concentrations whereas Na (18.76-38.95%) and K (59.66-78.67%) are present comparatively in very high concentrations. Similarly, the trace elements, Cu (0.0022-0.016%). Cr (0.16-0.44%) and Ni (0.38-0.66%) show the lowest concentration and Mn (2.59-14.50%) and Fe (84.36-96.87%) show the highest concentration which may be toxic to health.

Keywords: Medicinal plants, macro-metals, trace metals, atomic absorption spectrophotometry.

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INTRODUCTION

Medicinal plants have great importance as food materials and in the treatment of various ailments. They provide essential trace metals which play a vital role as structural and functional components of metalloproteins and enzymes in the living cell (Ansari *et al,* 2004)**.** A number of edible and other medicinal plants have been analysed for mineral contents including macro-metals (Ca, P, Na, K) and trace metals (Mn, Cu, Zn, Fe) (Han, 2001; Ansari *et al*, 2004). Several studies have been conducted to determine the heavy metals in vegetables grown in mine wastes (Cobb *et al,* 2000), in leafy and other vegetables (Itanna, 2002; Mohamed *et al*, 2003), and in mudfish and sediments (Aardt and Erdmann, 2004) for toxicological implications. Some workers have determined the trace elements composition in soil and plants (Kabata-Pendias, 2001), in leafy and other vegetables (Itanna, 2002; Mohamed *et al*, 2003; Umeta *et al*, 2005), and in forage samples (Diaz and Mossol-Deya, 2003). The present study is based on the elemental analysis of twelve macro- and trace elements in selected edible medicinal plants available in United Arab Emirates, and consideration of their toxicity, nutritional value and as a source of trace elements.

MATERIALS AND METHODS

Collection of plant samples

The samples of edible medicinal plants (leaves) used in this study included coriander (*Coriandrum sativum*), spring onion (*Allium cepa*), soya (*Anethum graveolus*), mint (*Mentha viridis*), spinach (*Spinacia oleraceae*), arnica (*Arnica montana*), Fenugreek/methi (*Trigonella foenum graecum*), parsely (*Carum petroselium*), white radish (*Raphanus stivus*), and thyme (*Thymus vulgaris*), and were obtained directly from the growing fields of Zhad near Sharjah. They were identified by the Pharmacognosy Staff of Dubai Pharmacy College. All samples were washed, dried overnight at 70^0 C in an electronic oven, powdered and used for the analysis of metal contents.

Standard solution

The twelve metals selected for the analysis were copper (Cu), cadmium (Cd), nickel (Ni), chromium (Cr), iron (Fe), aluminium (Al), manganese (Mn), lead (Pb), sodium (Na), potassium (K), calcium (Ca), and magnesium (Mg). The standard used for the atomic absorption analysis of these metals was multi-element and was prepared from the stock standard (BDH spectrosol, UK) by appropriate dilution with 0.5 N nitric acid.

Preparation of test solutions

A 1 g quantity of the sample was digested with 10 ml of concentrated nitric acid for 1-2 hours and then cooled to room temperature. The contents were further digested with a 10 ml mixture of nitric acid and perchloric acid and (3:1, v/v) till the solution became colorless. The sample was then diluted to bring it within the concentration range of the standard calibration curves of the metals. The samples, standard and blank were treated under the same condition prior to analysis.

Atomic absorption analysis

A GBC atomic absorption spectrophotometer model 906 fitted with an eight lamp turret and equipped with a graphite furnace and an autosampler was employed for the analysis using an Avanta Sigma software.

The instrument parameters for the individual element and furnace programming was carried out as mentioned in table 1.

RESULTS AND DISCUSSION

Atomic absorption spectrophotometric method has been used to analyze the macro- and trace metal contents of medicinal plants used in this study. It is a highly specific and sensitive technique for the determination of metals in ppm or even lower concentrations. The reproducibility of the method, on application to the analysis of metals in plant material, has been found to be within ± 10% .

Macro-metal contents

The results of the analysis of macro-metal contents in the edible medicinal plants including Cd, Al, Pb, Mg, Ca, Na and K are presented in table-2. The concentrations of the macro-metals in all the samples ranged from 0.06-0.40 ppm (Cd), 349-3080 ppm (Al), 0.10-0.46 ppm (Pb), 115-375 ppm (Mg), 84-463 ppm (Ca), 4000-56433 ppm (Na) and 16779-86422 ppm (K). The values indicate that out of the total contents of metals in these plants, Cd (0.00024-0.00028%), Pb (0.00032-0.00047%), Mg (0.26-0.54%), Ca (0.32-0.39%), and Al (0.008-1.64%) are present in very low concentration where as Na (18.76-38.95%) and K (59.66-78.67%) are present comparatively in very high concentrations.

The highest concentration of metals including Cd, Al, Pb, Mg, Ca, Na and K was found in *Mentha veridis* (0.40 ppm), *Spinacea oleracea* (380 ppm), *Arnica Montana* (0.461 ppm), *Arnica Montana* (375 ppm), *Thymus vulgaris* (463 ppm), *Spinacea oleracea* (56433 ppm) *and Allium cepa* (86422 ppm), respectively, and the lowest concentration of these metals was detected in *Allium cepa* (0.06 ppm), *Coriandrum sativum* (349 ppm), *Arnica Montana* (0.100 ppm), *Carum petroselium* (115 ppm), *Mentha veridis* and *Trigonella foenum graecum* (84 ppm), *Arnica Montana* (4000 ppm), and *Raphanus sativus* (16779 ppm), respectively. The metal contents of other plants occupied intermediate position between the highest and the lowest concentrations stated above (table-2).

Table 1: Instrumental parameters for individual elements and furnace programming in AAS

	Cu	Cd	Ni	Cr	Fe	Al	Mn	Pb	Mg	Ca	Na	K
Wavelength	324.7	228	232	357.9	248.3	309.3	279.5	283	285.2	422.7	589	766.5
Working range of standard (ng /ml or ppb)	10, 20, 40	1, 2, 4	20, 40, 80	6.25, 12.5, 25	6, 12, 24	20, 40, 80	2.5, 5, 10	20, 40, 80	3, 6, 12	2, 4, 8	20, 40, 80	1.75, 3.5, 7.0
Standard deviation	0.03	0.12	7.37	3.08	0.92	0.67	2.58	0.12	2.00	2.00	2.20	6.50
Ash temperature ^{o}C	800	300	900	1100	800	1400	700	400	800	1000	700	700
Atomization temperature ^{o}C	2300	1800	2400	2500	2300	2500	2400	2000	2200	2500	2000	2000

Table 2: Macro-metal contents of edible medicinal plants (ppm)

Botanical name	Cd		Al		Pb		Mg		Ca		Na		K	
Coriandrum sativum	0.28	(9.98)	349	(5.19)	0.37	(7.50)	212	(1.93)	210	(1.81)	40302	(2.65)	27555	(2.19)
Allium cepa	0.06	(8.00)	430	(4.93)	0.24	(9.52)	241	(2.15)	84	(4.59)	15113	(2.23)	86422	(0.67)
Anethum graveolus	0.15	(7.90)	1040	(3.97)	0.26	(0.92)	141	(3.25)	168	(3.26)	22000	(3.25)	73476	(3.21)
Mentha viridis	0.34	(5.29)	680	(7.20)	0.18	(6.85)	165	(1.83)	168	(3.85)	4000	(4.91)	69138	(1.10)
Spinacia oleraceae	0.40	(5.80)	3080	(2.35)	0.45	(2.81)	312	(2.56)	126	(4.10)	56433	(1.92)	46092	(1.50)
Arnica Montana	0.30	(6.23)	1160	(4.15)	0.10	(5.29)	208	(2.20)	378	(2.32)	12091	(2.86)	53000	(1.39)
Trigonella foenum graecum	0.30	(6.50)	680	(5.28)	0.25	(2.58)	168	(3.95)	84	(5.10)	37280	(1.35)	18203	(2.56)
Carum petroselium	0.13	(9.25)	1460	(2.31)	0.26	(2.91)	115	(2.68)	210	(2.13)	15000	(1.69)	63300	(0.87)
Raphanus stivus	0.40	(6.20)	640	(4.80)	0.43	(5.93)	234	(2.15)	294	(2.36)	46500	(0.95)	16779	(1.67)
Thymus vulgaris	0.18	(9.45)	1920	(1.23)	0.46	(6.20)	375	(1.98)	463	(1.25)	11000	(1.23)	54776	(1.01)

Contents expressed as mean of three determinations. Values in parenthesis represent relative standard deviations.

The toxicity of the metals ions determined in these plants would depend on their concentration and the salts from which they are derived. The Na and K metals have been found in the highest concentration (table-2). These metal ions are also present in the human body in relatively large amounts, i.e. 1.8 g/kg and 2.6 g/kg, respectively, and have no adverse effect upon the physiological system. The Na ion is responsible for maintaining normal hydration and osmotic pressure and the K ion is necessary for cell growth and function. Excess Na and K ions are rapidly excreted by the kidney (Block *et al*, 1986; Tietz *et at*, 1987).

Trace metal contents

The concentrations of the trace metals, including Cu, Ni, Cr, Fe, and Mn, present in the edible medicinal plants, are given in table-3. The values of trace metals in the samples studied

Table 3
Trace-metals contents of edible medicinal plants (ppm)

Botanical name	Cu		Ni		Cr		Mn		Fe	
Coriandrum sativum	0.08	(2.60)	3.44	(4.11)	1.8	(2.06)	77	(9.24)	348	(2.60)
Allium cepa	0.10	(9.97)	12.8	(9.81)	4.2	(0.71)	76	(2.58)	256	(3.88)
Anethum graveolus	0.05	(5.60)	4.0	(4.06)	2.2	(1.17)	160	(8.77)	432	(1.90)
Mentha viridis	0.08	(2.75)	7.0	(10.05)	3.0	(0.94)	72	(3.90)	568	(0.84)
Spinacia oleraceae	0.14	(10.00)	2.0	(1.00)	1.4	(1.54)	44	(10.04)	692	(1.20)
Arnica Montana	0.07	(10.03)	14.0	(10.00)	7.4	(1.98)	92	(4.43)	700	(2.67)
Trigonella foenum graecum	0.14	(6.60)	3.0	(3.50)	1.8	(2.24)	48	(4.34)	588	(8.17)
Carum petroselium	ND		15.0	(4.52)	3.7	(3.20)	72	(4.58)	332	(0.38)
Raphanus stivus	0.05	(4.90)	5.4	(7.87)	7.0	(2.6)	172	(4.42)	644	(1.51)
Thymus vulgaris	0.09	(5.04)	25.0	(2.90)	10.7	(5.30)	96	(9.64)	1322	(0.95)

Contents expressed as mean of three determinations. Values in parenthesis represent relative standard deviations.

were found to be 0.05-0.14 ppm (Cu), 2.0-25.0 ppm (Ni), 1.4-10.7 ppm (Cr), 72-172 (Mn), and 256-6444 ppm (Fe). These values indicate that out of the total contents of trace metals, Cu (0.0022-0.016%), Cr (0.16-0.44%) and Ni (0.38-0.66%) have the lowest concentrations compared to those of the Mn (2.59-14.5%) and Fe (84.36-96.87 %). The highest concentration of Cu, Ni, Cr, Fe and Mn was present in *Trigonella foenum graecum* (0.144 ppm), *Thymus vulgaris* (25.0 ppm), *Thymus vulgaris* (10.7 ppm), *Raphanus sativus* (6444 ppm), and *Raphanus sativus* (172 ppm), respectively, and the lowest concentration of these metals was found in *Anethum graveolus* (0.05 ppm), *Spinacea oleracea* (2 ppm), *Coriandrum sativum* and *Trigonella foenum graecum* (1.4 ppm), *Spinacea oleracea* (44 ppm), and *Raphanus sativus* (256 ppm), respectively. The concentration values of metals in other plants ranged between the maximum and minimum values given above. Similar values have been obtained for Mn and Fe in a number of medicinal plants (Ansari *et al,* 2004).

The presence of Fe (256 – 6444 ppm), Mn (44-172 ppm), and Ni (2-25 ppm) in high concentrations may be toxic to the consumer. The other metals (i.e., Cu, Cr) are present in less than about 10 ppm and may be tolerated.

CONCLUSIONS

The present study on the analysis of macro- and trace metals in ten edible medicinal plants reveals large variations in their concentration. The range of macro-metals content in these plants has been found as: Cd (0.06-0.40 ppm) Pb (0.100-0.461 ppm), Ca (84-463 ppm), Mg (115-375 ppm), Al (349-3080 ppm), Na (4000-56433 ppm) and K (16779-86422 ppm) and that of trace metals as: Cu (0.05-0.14 ppm), Cr (1.4-10.7 ppm), Ni (2.0-25.0 ppm), Mn (72-172 ppm), and Fe (256-6444 ppm). The concentration of trace metals, Mn and Fe, in these amounts may be harmful as it exceeds the recommended dietary allowance (RDA) per day, established by the Food and Nutrition Board, National Research Council, USA. The toxicity of these metals would depend on their concentration in the plant material and the nature of salts from which they have been derived.

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