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Trace Metal Levels of Some Medical and Aromatic Plants Collected from High Density Traffic Areas in Tokat, Turkey

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The aim of this work was to determine the trace metal levels in some medical and aromatic plants growing on high traffic density areas. Eight species of medical and aromatic plant samples were collected from near the Tokat-Ankara motorway in Turkey. Six trace metals (Fe, Mn, Zn, Pb, Ni and Cu) in the samples were analyzed using flame and graphite furnace atomic absorption spectrometry after microwave digestion. The metal concentrations in samples were found to be 365–90, 55–14, 33.72–1.36, 3.10–1.98, 6.39–1.22 and 11.73–7.03 μg/g for iron, manganese, zinc, lead, nickel and copper, respectively. Trace metal concentrations in samples were found below the toxic levels.

Key Words: Trace metal levels, Traffic, Plants, Atomic absorption spectrometry.

INTRODUCTION

Trace metal levels are important for human health. Metals like iron, copper, zinc and manganese are essential metals since they play an important role in biological systems, whereas lead and cadmium are non-essential metals as they are toxic even in traces[1]. The essential metals can also produce toxic effects when the metal intake is excessively elevated. According to the report by food and ingredients expert commitees of FAO/WHO, a healthy person can consume 3.5 mg lead and 0.525 mg Cd in a week.

Traffic is one of the sources of emission of trace metals such as Pb, Ni, Cu, Fe, Mn, Zn. High density traffic is pollutant for soil, plant and environment[2–5]. Some plants could absorb trace metals more than others because of their properties[6–8]. Lichen, moss and some plants can be used as a biomonitor for the determination of trace element levels [9–11]. Several types of medical and aromatic plants are commonly grown through Tokat-Ankara highway vicinity and people use these plants for medical purposes. The traffic on this highway is very high. The levels of trace metal in medical and aromatic plants are not adequately investigated in Turkey.

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In this study, the levels of trace metals in some medical and aromatic plant samples were determined by flame and graphite furnace AAS after microwave digestion methods.

EXPERIMENTAL

Samples were collected from near the Tokat-Ankara motorway (5 and 1500 metres away) in Turkey in 2003. The samples were dried at 105°C for 24 h. Dried samples were homogenized and stored in polyethylene bottles until analysis. All reagents were of analytical reagent grade unless otherwise stated. Double deionized water was used for all dilutions. HNO_3 and H_2O_2 were of suprapure quality (Merck).

Samples (0.50 g) was digested with 4 mL of HNO_3 (65%), 2 mL of H_2O_2 (30%) in microwave digestion system for 23 min and diluted to 10 mL with deionized water. A blank digest was carried out in the same way (digestion conditions for microwave system were applied as 2 min for 250 W, 2 min for 0 W, 6 min for 250 W, 5 min for 400 W, 8 min for 550 W, vent: 8 min, respectively).

A Perkin-Elmer analyst 700 model atomic absorption spectrometer with deuterium background corrector was used in this study for the elemental analysis. Pb in samples was determined by HGA graphite furnace using argon as inert gas. Other measurements were carried out in an air/acetylene flame.

RESULTS AND DISCUSSION

Trace metal concentrations were determined on dry weight as µg/g. The concentrations of trace metals in plant samples analyzed are given in Table-1. When analyzing these data, iron has the highest concentration followed by manganese, zinc, copper, nickel and lead (Fe > Mn > Zn > Cu > Ni > Pb). The concentration of trace metals in the samples depends on plant species. For example, the high metal accumulation levels in the species were found in *Altaea officinalis* for Fe, *Tribulus terestris* for Pb, Cu, Zn and Ni, *Rumex olimpucus* for Mn, respectively. All the trace metal concentrations were found higher in polluted areas than in unpolluted areas.

The lowest and highest iron concentrations were found to be 90.3 µg/g in *Matricaria chemomilla* and 365.3 µg/g in *Altaea officinalis*, respectively. In these samples, iron concentrations were found higher than other metal concentrations. Average manganese concentration ranged 20.3–55.9 µg/g in plant samples. The lowest and higest manganese concentrations were found in *Mentha aquatica* and *Altaea officinalis*. Manganese is the second high concentration values after iron in samples. Zinc, lead, nickel and copper average values were found to be 10.7–33.7 µg/g, 1.1–3.1 µg/g, 1.2–6.4 µg/g and 5.3–13.7 µg/g in the samples. Manganese is a toxic heavy metal and toxicity limits of manganese for plants are high (400–1000 µg/g). Nickel, copper and lead are middle toxic metals (10–50 µg/g, 100–200 µg/g, 10–30 µg/g)[12]. Our values are low toxicity limits for manganese, nickel, copper and lead. These results were not risk for human health. The highest zinc, lead, nickel and copper concentrations were found in *Tribulus terestris*. The lowest concentrations were found in *Urtica dioica* for zinc and nickel, *Mentha aquatica* for lead and *Rumex olimpicus* for copper.

TABLE-1
CONCENTRATION (IN μg/g) OF SIX TRACE METALS IN INVESTIGATED PLANT SPECIES

Plant Species	Area	Fe	Mn	Pb	Cu	Ni	Zn
Altaea officinalis	p	365.3 ± 24.2	39.9 ± 3.1	1.2 ± 0.1	11.7 ± 1.1	3.1 ± 0.2	23.4 ± 1.8
	c	112.8 ± 10.4	20.3 ± 1.8	1.7 ± 0.1	7.0 ± 0.5	BDL	20.3 ± 1.4
Mentha aquatica	p	359.1 ± 30.3	55.9 ± 4.9	1.1 ± 0.1	9.9 ± 0.8	2.9 ± 0.2	15.7 ± 1.5
	c	179.9 ± 16.4	25.9 ± 2.2	2.4 ± 0.2	7.4 ± 0.8	BDL	10.7 ± 1.0
Urtica dioica	p	322.3 ± 12.8	32.2 ± 2.7	2.0 ± 0.1	10.9 ± 1.1	3.7 ± 0.3	15.5 ± 1.2
	c	138.8 ± 9.2	24.0 ± 2.3	BDL	7.8 ± 0.6	1.2 ± 0.1	1.4 ± 0.1
Achillea millefolium	p	364.9 ± 35.5	46.8 ± 4.2	1.6 ± 0.1	11.9 ± 1.0	3.8 ± 0.2	31.0 ± 2.9
	c	246.4 ± 18.7	14.4 ± 1.1	BDL	6.7 ± 0.5	2.4 ± 0.2	17.1 ± 1.3
Tribulus terestris	p	322.0 ± 29.9	49.0 ± 3.2	3.1 ± 0.2	13.7 ± 1.2	6.4 ± 0.5	33.7 ± 3.1
	c	218.1 ± 17.3	25.9 ± 1.9	BDL	7.4 ± 0.4	BDL	10.7 ± 1.0
Matricaria chemomilla	p	268.5 ± 21.1	21.7 ± 2.1	1.4	12.9 ± 1.1	2.3 ± 0.2	32.9 ± 2.7
	c	90.3 ± 3.9	13.2 ± 1.1	BDL	5.6 ± 0.5	1.0 ± 0.1	14.5 ± 1.3
Rumex olimpicus	p	199.07 ± 17.6	69.4 ± 4.5	2.1	5.3 ± 0.2	3.3 ± 0.3	15.6 ± 1.2
	c	177.1 ± 14.5	30.5 ± 2.8	BDL	7.4 ± 0.6	BDL	12.5 ± 1.1
Malva sylvestris	p	262.7 ± 25.8	30.8 ± 2.1	1.8 ± 0.1	7.3 ± 0.3	2.1 ± 0.2	27.5 ± 2.4
	c	165.0 ± 16.3	24.1 ± 1.3	BDL	7.1 ± 0.5	BDL	12.5 ± 1.2

BDL : below detection limit; c : control: p : polluted.

The values of correlation coefficients between metal concentrations are given in Table-2. There is a good correlation between iron-copper (r = 0.656), lead-copper (r = 0.513), lead-nickel (r = 0.743), manganese-nickel (r = 0.505), copper-zinc (r = 0.600). There are positive correlations of iron-lead, iron-nickel, iron-zinc, manganese-lead, manganese-zinc, lead-zinc, copper-nickel, and nickel-zinc. The negative correlations between zinc-manganese and copper-mangenese were found as 0.448 and 0.459, respectively.

TABLE-2
CORRELATION BETWEEN METAL CONCENTRATIONS

	Fe	Mn	Pb	Cu	Ni	Zn
Fe	1.000					
Mn	–0.133	1.000				
Pb	0.399	0.045	1.000			
Cu	0.656	–0.459	0.513	1.000		
Ni	0.308	0.505	0.743	0.186	1.000	
Zn	0.108	–0.448	0.012	0.600	0.0049	1.000

Conclusion

Traffic is an important pollutant for soil, water, plant and environment. The plant materials were harvested in July 2003 on Tokat-Ankara highway vicinity. This region, at the beginning of summer, is rainy frequently. The concentrations of trace heavy metals were found below toxic levels in the samples. However, it is not preferable to harvest plant materials near the high density traffic areas. Some species can be used as biomonitor for determination of trace heavy metal levels sourced from traffic density.

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