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Determination of Heavy Metal Levels in Some Weeds Collected from Tokat, Turkey

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Eleven species of weed samples were collected from Tokat in Turkey, which negatively affect germination of crop plants were analyzed for heavy metals by AAS. Six trace metals (Fe, Mn, Cu, Ni, Zn and Cr) in the samples were determined using flame and graphite furnace atomic absorption spectrometry after microwave digestion. The metal concentrations in samples were found to be 122–695, 13.9–96.5, 4.3–17.3, 1.9–8.5, 13.1–30.3 and 1.0–5.5 μg/g for iron, manganese, copper, nickel, zinc and chromium respectively. The high metal accumulation levels in the species were found in *Hypericum perforatum* L. for Fe, Cr, *Sorghum halepense* (L.) Pers for Mn, *Solanum nigrum* L. for Cu, Zn and *Consolida regalis* SF Gray for Ni.

Key Words: Heavy metal levels, Weeds, Atomic absorption spectrometry.

INTRODUCTION

The heavy metal pollution has been a serious environmental problem all over the world in recent years. There has been a rapid growth in pollution in Turkey and other developing countries[1]. Trace metals are considered to be one of the main sources of pollution in the environment, since they have a significant effect on its ecological quality[2]. Lead, iron, copper, manganese, zinc, etc. were chosen as representative trace metals whose levels in the environment represent a reliable index of environmental pollution. 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 do not have any biological function and are toxic even in traces[3]. The essential metals can also produce toxic effects when the metal intake is excessively elevated. According to the report by food and ingredients expert committees of FAO/WHO, a healthy person can consume 3.5 mg lead and 0.525 mg Cd in a week[4,5]. Some plants could absorb trace metals more than others because of their properties such as pubescens-glabrous, erect-lean of stem,

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branching form, narrow large of leaf, flower form etc.[5–8] Lichen, moss and some plants can be used as a biomonitor for the determination of trace element levels[9, 10].

On the other hand, under field condition, weed infestation is a major problem in a lot of crops. Weed species compete with crops for nutrients, light and soil moisture. Moreover, weeds may have a harmful effect on crops because of the chemical substances. They release via their leaves and roots to the environment, mainly to the soil. Especially, these substances may have beneficial effects on some plant species while they may have harmful effects on some other plant species. This beneficial and harmful effect of one plant on another through the production of chemical substances is called allelopathy[11] and these chemicals usually are named as allelochemicals[12]. Allelopathy plays a key role in both natural and agro-ecosystems[13]. These substances are released into the environment through leaching, root exudation, volatilization and decomposition of plant debris[14]. Weeds may cause yield reductions on crops not only by competition but also allelopathic interaction with them[15].

Several species of weeds are commonly grown in Tokat. Thus, in the present study, the levels of trace metals in some weed samples collected from Tokat, Turkey were determined by flame and graphite furnace AAS after microwave digestion methods and are reported here.

EXPERIMENTAL

A total of 44 samples and eleven weed species were used in the present study (Table-1). The samples were collected in Tokat, Turkey during flowering or fruit development stages in 2003. The samples were dried at 105°C for 24 h. Dried samples were homogenized using agate homogenizer and stored in pre-cleaned polyethylene bottles until analysis.

TABLE-1
WEED SPECIES USED FOR HEAVY METAL LEVELS

Latin name	Family	Common name
Avena sterilis L.	Poaceae	Wild oat
Bifora radians Bieb.	Apiaceae	Bifora
Chenopodium album L.	Chenopodiaceae	Common lamb's quarters
Consolida regalis SF. Gray	Ranunculaceae	Forking larkspur
Humulus lupulus L.	Cannabaceae	Hops
Hypericum perforatum L.	Guttiferae	St. John's wort
Reseda lutea L.	Resedaceae	Yellow mignonette
Solanum nigrum L.	Solanaceae	Black night shade
Sorghum halepense (L.) Pers.	Poaceae	Johnson grass
Xanthium strumarium L.	Asteraceae	Hearleaf cocklebur
Xanthium strumarium L. (only seed)	Asteraceae	Hearleaf cocklebur

All reagents were of analytical reagent grade unless otherwise stated. Deionized water (18.2 MΩ cm) from a Milli-Q system (Millipore, Bedford, MA, USA) was used to prepare all aqueous solutions. All mineral acids and oxidants (HNO_3 and H_2O_2) used were of the highest quality grade (Suprapure, Merck, Darmstadt, Germany). All the used plastic and glassware were cleaned by soaking with the contact overnight in a 5% (w/v) HNO_3 solution and rinsed with distilled water prior to use.

Samples (1.0 g) were digested with 4 mL of HNO_3 (65%), 2 mL of H_2O_2 (30%) in microwave digestion system for 31 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). This procedure was preferred because of more accurate with respect to both time and recovery values. The recovery values were nearly quantitative (> 95%) for the above digestion method.

A Perkin-Elmer Analyst 700 AAS with deuterium background corrector was used in this study for the elemental analysis.

RESULTS AND DISCUSSION

The weeds used in this study are predominant in Turkey and throughout the world[16]. Some of them also use medicinal plants and human food. The metal concentrations in samples were found to be 122–695, 13.9–96.5, 4.3–17.3, 1.9–8.5, 13.1–30.3 and 1.0–5.5 µg/g for iron, manganese, copper, nickel, zinc and chromium, respectively (Table-2). As seen from Table-2, it has been established that the concentration of trace metals in the samples is dependent on plant species. For example, the high metal accumulation levels in the species were found in *Hypericum perforatum* L. for Fe and Cr, *Sorghum halepense* (L.) Pers. for Mn, *Solonum nigrum* L. for Cu and Zn and *Consolida regalis* SF Gray for Ni.

The lowest and highest iron concentrations were found to be 122 µg/g in *Avene sterilis* L. and 495 µg/g in *H. perforatum*, respectively. Among all the samples, iron concentrations were found higher than other metal concentrations. Manganese contents of *S. halepense* (96.5 µg/g) and *C. regalis* (95.0 µg/g) were higher than other weed samples (13.9 to 62.6 µg/g). Manganese has the second highest concentration value after iron in samples. Mendil *et al.*[17] found iron and manganese contents as 714–1206 µg/g in moss samples. There are different levels of copper content. *S. nigrum* and *A. sterilis* had high and low copper content. Copper levels were found between 4.3 and 17.3 µg/g. Copper level in our study is higher than some literature values[5].

Zinc contents of the cultivars were between 13.1 and 30.3 µg/g. *S. nigrum* had considerably higher zinc content (30.3 µg/g) than others. The lowest zinc content was in *A. sterilis* (13.1 µg/g). Koç *et al.*[5] reported 1.4–33.7 µg/g and Ajas *et al.*[18] 3.24–35.1 µg/g zinc in medicinal and aromatic plant samples.

TABLE-2
HEAVY METAL LEVELS IN SOME WEED SAMPLES (μg/g)

Species	Fe	Mn	Cu	Ni	Zn	Cr
Avena sterilis L.	122 ± 11	45.8 ± 4.3	4.3 ± 0.3	1.9 ± 0.1	13.1 ± 1.1	1.0 ± 0.1
Bifora radians Bieb.	348 ± 29	53.0 ± 5.2	11.3 ± 1.1	5.2 ± 0.3	23.0 ± 2.2	4.1 ± 0.2
Chenopadium album L.	207 ± 17	55.4 ± 4.7	8.7 ± 0.5	2.0 ± 0.1	23.2 ± 2.7	1.3 ± 0.1
Consolida regalis SF Gray	414 ± 38	95.0 ± 8.9	11.7 ± 0.9	8.5 ± 0.7	21.7 ± 1.9	5.4 ± 0.4
Humulus lupulus L.	176 ± 15	38.9 ± 3.2	5.6 ± 0.5	3.6 ± 0.3	22.4 ± 1.6	1.2 ± 0.1
Hypericum perforatum L.	495 ± 47	62.6 ± 5.3	11.1 ± 1.0	9.4 ± 0.9	19.5 ± 0.9	5.5 ± 0.4
Reseda lutea L.	289 ± 23	29.7 ± 2.8	6.4 ± 0.6	2.5 ± 0.2	16.6 ± 1.3	2.2 ± 0.2
Solanum nigrum L.	284 ± 26	36.5 ± 3.2	17.3 ± 1.3	3.0 ± 0.3	30.3 ± 2.7	1.5 ± 0.1
Sorghum halepense (L.) Pers.	374 ± 29	96.5 ± 7.7	5.7 ± 0.5	5.1 ± 0.4	19.3 ± 0.8	2.4 ± 0.2
Xanthium strumarium L.	178 ± 17	13.9 ± 1.2	7.2 ± 0.7	2.4 ± 0.1	15.0 ± 1.1	1.1 ± 0.1
Xanthium strumarium L. (only seed)	197 ± 18	14.9 ± 1.3	7.7 ± 0.6	2.3 ± 0.2	17.8 ± 1.5	1.1 ± 0.1

The highest nickel and chromium concentrations were found in *C. regalis* (8.5 μg/g) and *H. perforatum* (5.5 μg/g), respectively. The lowest concentrations were found in *A. sterilis* for nickel and chromium. It is therefore of major interest to estabilish the levels of some metallic elements in common herbal plants because, at elevated levels, these metals can also be dengerous and toxic for humans and phytotoxic for other plants[18]. Allelopathy is the chemical interaction between plants including stimulatory as well as inhibitory influences. Some of the plant debris had a strong inhibitory effect on the emergence or seedling in some plants[19]. Uygur *et al.* reported allelopathic potential of *Raphanus sativus* on *Sorghum halepense* in cotton[20].

The values of correlation coefficients between metal concentrations are given in Table-3. There are good correlations between iron-manganese (r = 0.628), iron-nickel (r = 0.896), iron-chromium (r = 0.897), manganese-nickel (r = 0.652), manganese-chromium (r = 0.549), copper-zinc (r = 0.799), nickel-chromium (r = 0.943). There are positive correlations of iron-zinc, manganese-copper, manganese-zinc, copper-nickel, copper-chromium and nickel-zinc. The negative correlations between zinc-chromium were found.

TABLE-3
CORRELATION BETWEEN METAL CONCENTRATIONS

	Fe	Mn	Cu	Ni	Zn	Cr
Fe	1.000					
Mn	0.628	1.000				
Cu	0.465	0.067	1.000			
Ni	0.896	0.652	0.345	1.000		
Zn	0.256	0.141	0.799	0.133	1.000	
Cr	0.897	0.549	0.240	0.943	–0.321	1.000

Conclusion

Heavy metal levels are important pollutants for soil, water, plant and environment. Some species can be used as biomonitor for determination of trace heavy metal levels. Therefore, futher investigations are also needed to determine interactions between weeds and crops about heavy metals and other active compounds.

REFERENCES

1. T. Sawidis, G.A. Zachariadis, J. Stratis and E. Ladukakis, *Fresen. Environ. Bull.*, **2**, 193 (1999).
2. J. Sastre, A. Sahuquillo, M. Vidal and G. Rauret, *Anal. Chim. Acta*, **462,** 59 (2002).
3. H.A. Schroeder, The Trace Elements and Nutrition, London, Faber & Faber (1973).
4. FAO/WHO, List of Maximum Levels Recommended for Contaminants by the Joint FAO/WHO Codex Alimentarius Commission, Second Series, CAC/FAL, Rome, 3 (1976) 1–8.
5. H. Koc, D. Mendil, M. Tuzen, H. Sari and E. Hasdemir, *Asian J. Chem.* (in press) (2005).
6. H.G. Zechmeister, *Environ. Moint. Assess.*, **52**, 441 (1998).
7. T. Okland, R.H. Okland and E. Steinnes, *Plant and Soil*, **209,** 71 (1999).
8. R. Bargagli, F. Monaci, F. Borghini, F. Bravi and C. Agnorelli, *Environ. Pollu.*, **116,** 279 (2002).
9. M. Tuzen, D. Mendil, H. Sari and E. Hasdemir, *Fresen. Environ. Bull.*, **12,** 1283 (2003).
10. U. Divrikli, S. Saracoglu, M. Soylak and L. Elci, *Fresen. Environ. Bull.*, **12,** 1123 (2003).
11. E.L. Rice, Allelopathy, 2nd edn., Academic Press, New York, pp. 1–67, (1984).
12. D.C. Whittaker and P.P. Feeny, *Science*, **171**, 757 (1977).
13. S-U. Chon, Y-M. Kim and J-C. Lee, *Weed Researche*, **43**, 444 (2003).
14. M.A. Turk, M.K. Shatnaw and A.M. Tawaha, *Weed Biol. Manag.*, **3,** 37 (2003).
15. N. Çamurköylü and H. Demirkan, Turkish I. Herbology Congr., 3–5 Feb., 203–209, Adana, Turkey, (1993).
16. Anonymous, Turkish Ministry of Agriculture, Ankara (1995).
17. D. Mendil, M. Tuzen, H. Sari and E. Hasdemir, *Trace Elements and Electrolytes* (in press).
18. A.M.O. Ajasa, M.O. Bello, A.O. Ibrahim, I.A. Ogunwande and N.O. Olawore, *Food Chem.*, **85,** 67 (2004).
19. A.A. El-Khatip, A.K. Hegazi and H.K. Galal, *Weed Biol. Manag.*, **4,** 1 (2004).
20. F.N. Uygur, F. Köseli and L. Cesurer, VI Turkish Phytopathology Congr., pp. 167–171, Izmir, Turkey (1991).

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