Int. J. Chem. Sci.: 9(3), 2011, 1126-1132
ISSN 0972-768X
www.sadgurupublications.com

DETERMINATION OF HEAVY METAL CONTENTS IN SAMPLES OF DIFFERENT MEDICINAL PLANTS

JAGRATI AGRAWAL[*], NITIN GUPTA, NILIMA BHARADWAJ[a] and S. KALPANA

Department of Chemistry, Govt. College, KOTA (Raj.) INDIA
[a]Department of Botany, Govt. College, KOTA (Raj.) INDIA

ABSTRACT

In view of high risk due to heavy metal contamination in industrial city Kota, the heavy metals Cd, Pb, Zn, Cu, and Fe were determined in 15 samples of most usable part of three medicinal plants namely Ginger, Aloevera and Mint collected from different places within and around Kota city. Samples were processed, digested and then metals were determined atomic absorption spectrophotometrically.

Key words: Heavy metals, Medicinal plants, Atomic absorption spectrophotometer.

INTRODUCTION

Today environmental pollution problem due to heavy metals has taken global dimensions and is still on increase. Specifically contamination of agricultural soil, which is often a direct or indirect consequence of anthropogenic activities such as disposal of industrial wastes, automobiles exhaust, refuse burning and use of pesticides in agriculture. Contaminated soils with heavy toxic metals can potentially lead to the uptake and accumulation of these metals in the edible plant parts causing risk to human and animal health.

Time to time several studies have been made by number of researchers for determining heavy metal levels in spices[1], vegetables[2-5], weeds[6] as well as in medicinal plants[7-9] to identify and indicate their dangerous effects. Present studies have been initiated to investigate the levels and limits of uptake of heavy metals i.e. Pb, Cd, Zn, Fe and Cu to the various usable/edible parts of three chosen medicinal plants, Ginger, Aloevera and Mint maintaining other conditions similar or controlled during cultivations. The plants were chosen keeping in view their wide spread utility, medicinal importance and suitability of

[*]Author for correspondence; E-mail: agrawal_jagrati@yahoo.co.in

climatic conditions for their cultivation. All the three chosen plants are used all over the world for different medicinal purposes both; in crude and extracted form.

EXPERIMENTAL

Sampling

Random sampling of most usable part of three plants i.e. rhizome of ginger, leafy part of mint and fleshy modified stem of aloevera is done from fifteen different sites within and around the Kota city from different agricultural fields or kitchen gardens along with the soil in which these plants were grown or cultivated adopting standard methods from literature. The sites chosen for collection of samples were of different types of areas from industrial, commercial and residential types representing varied sources of heavy metal pollution.

Plant and soil samples were kept classified and marked according to their collection or sampling sources. Sampling for mint was done in second week of June; rhizome of ginger was collected in second week of September and aloevera picked up in first week of November in the year 2009.

Processing

Plant part samples were thoroughly segregated, washed and dried first in sunlight and then in oven at 40-50^oC temperature for approximately 12 hrs. The dried samples were powdered in stainless steel mill obtaining fine particles that passed through a 2 mm mesh and kept in polypropylene pouches for analysis. Soil samples were also dried, powdered and sieved similar to above mentioned process and kept in polypropylene plastic pouches for further analysis. To determine heavy metal concentration, a wet digestion method of the dried samples was adopted. 1 g of each air dried and sieved sample was ashed in a muffle furnace at 460^oC for 4 hrs. The ash was digested in 10 mL aquaregia (1 part conc. HNO_3 + 3 parts HCl) in a digestion tube on the heating blocks at different temperatures for a total of nine hours spreading over 2 h at 25^oC, 2 h at 60^oC, 2h at 105^oC and 3h at 125^oC). After the digestion, the residue was transferred to a 100 mL volumetric flask. The clear solution was made up to the mark with double distilled water. A blank digestion solution was made for comparison. For calibration purpose, a standard solution for each element under investigation was prepared.

Analysis

Metal measurement was performed with a Perkin-Elmer model 2380 atomic absorption spectrophotometer with double beam and deuterium background correction.

Hollow cathode lamps of Pb, Cd, Zn, Fe, and Cu were used at specific wave lengths. All the samples were run in triplicates.

RESULTS AND DISCUSSION

The results pertaining to the plant samples are given in Table 1, which include analysis data of heavy metals viz Cadmium (Cd), lead (Pb), zinc (Zn), iron (Fe), and copper (Cu) concentrations in various samples. Table 2 shows the concentration spectra of various heavy metals in different soil samples.

Table 1: Results of analysis of plant parts

Herbs	Samples	Elements in mg/Kg				
		Pb	Cd	Zn	Fe	Cu
Mint	1	1.33	0.20	0.58	4.76	7.95
	2	1.86	0.83	3.18	32.42	3.94
	3	7.26	1.02	2.56	28.2	3.88
	4	4.40	0.53	1.24	11.8	3.94
	5	3.92	1.01	4.50	32.84	0.49
Aloevera	1	0.56	0.28	1.80	20.60	0.72
	2	1.58	0.29	1.20	21.23	8.35
	3	8.34	0.42	0.68	19.80	0.94
	4	11.30	0.82	1.14	17.40	0.54
	5	12.60	0.97	1.61	1.64	0.66
Ginger	1	0.50	0.14	2.74	10.88	1.06
	2	2.09	0.56	0.64	5.64	0.84
	3	12.60	0.87	6.78	6.92	6.88
	4	11.07	1.07	0.46	5.64	1.68
	5	1.16	0.92	1.58	31.65	9.20

In present studies, Cd concentration ranges from 0.14 to 1.07 mg/Kg in various plant samples. The maximum concentration (1.07 mg/kg) of Cd was recorded in fleshy stem of Aloevera, while minimum concentration (0.14 mg/kg) was registered in rhizome part of Ginger. Acute doses (10-30 mg/Kg/day) of cadmium to human body can cause severe gastrointestinal irritation, vomiting, diarrhea, and excessive salivation, and doses of 25 mg of Cd/kg body weight can cause death. Low-level chronic exposure to Cd can cause adverse health effects including gastrointestinal, musculoskeletal, renal, neurological, and reproductive effects. The main target organ for Cd following chronic oral exposure is the kidney[10]. Intake of Cd can double if one smokes cigarettes because each cigarette contains about 2 mg Cd.

Table 2: Results of analysis of soil in which different plants were grown

Soil	Samples	Elements in mg/Kg				
		Pb	**Cd**	**Zn**	**Fe**	**Cu**
Mint	1	21.4	0.56	1.48	15.72	13.40
	2	10.28	0.98	5.48	39.42	4.64
	3	4.84	0.92	5.40	23.60	10.16
	4	26.16	1.08	6.70	10.16	1.84
	5	21.25	2.96	6.80	20.20	2.48
Aloevera	1	10.08	0.28	3.78	21.23	21.74
	2	12.85	1.46	2.32	6.96	4.24
	3	40.16	3.88	1.20	1.64	2.46
	4	3.12	1.92	1.82	4.98	5.96
	5	20.62	2.02	4.30	3.44	11.24
Ginger	1	0.50	1.88	6.34	18.68	3.96
	2	2.09	0.92	16.84	28.66	14.56
	3	12.60	1.97	6.0	19.34	4.20
	4	11.07	1.90	5.54	17.46	3.50
	5	1.16	2.27	4.57	18.50	3.06

Iron is an essential element in production of Red Blood Cells (RBCs). The concentration of iron (Fe) content was highest in leaves of mint (32.84 mg/kg), while it was found lowest (1.64 mg/kg) in fleshy stem of aloevera. The Fe content ranges from 1.64 mg/kg to 32.84 mg/kg. Low intake of Fe may cause anaemia, tiredness and pallid physique, while high intake may results into hepatic megaly, cardiac infraction and nephric malfunction. The acceptable limit for human consumption of iron is 8 to 11 mg/day for infants as well as adults[11]. During present investigation, the value of Fe was found much higher, which is significant due to iron-rich soil of the area.

The acceptable limit for human consumption of copper (Cu) is 10 ppm[12]. When Cu exceeds its safe level concentration, it causes hypertension, sporadic fever, uraemia etc. Present investigation reveals that Cu varies from 0.49 to 9.20 mg/kg, which falls below the safe limits for human health and hygiene. The highest concentration of Cu was found in rhizome part of ginger (9.20 mg/Kg), while lowest concentration (0.49 mg/Kg) was recorded in leaves of mint plant. As it falls within safety limits (10 ppm), the plants, which contain Cu, can be used for edible purpose without any risk.

During the present study, lead (Pb) content varies from 0.50 mg/Kg to 12.60 mg/Kg, which is above safety limit (1.5 ppm) for human consumption. Pb content was found high in fleshy stem of aloevera (0.50 mg/kg), while rhizome part of ginger showed low concentration of Pb (12.60 mg/Kg). It has been reported that most of the accumulated lead is sequestered in the bones and teeth[13]. This causes brittle bones and weakness in the wrists and fingers. Lead that is stored in bones can re-enter the blood stream during periods of increased bone mineral recycling (i.e., pregnancy, lactation, menopause, advancing age, etc.). Mobilized lead can get redeposited in the soft tissues of the body and can cause musculoskeletal, renal, ocular, immunological, neurological, reproductive, and developmental effects[14].

Among all the metals, zinc (Zn) is the least toxic and an essential element in the human diet as it is required to maintain the proper functions of the immune system. It is also important for normal brain activity and is fundamental in the growth and development of the foetus. Zinc deficiency in the diet may be more detrimental to human health than too much zinc in the diet. Although the average daily intake of zinc is 7-16.3 mg per day, the recommended dietary allowance for it is 15 mg per day for men and 12 mg per day for women[15]. On the contrary, the high concentration of zinc may cause vomiting, renal damage, cramps etc. The acceptable limit for human consumption of Zn is 150 ppm. During present study, the concentration of Zn was found high in rhizome part of ginger (6.78 mg/kg), while low concentration of Zn was observed in fleshy stem of aloevera (1.61 mg/kg). The content of Zn ranges 1.61-6.78 mg/kg, which falls within the safe limit. Thus, the trend of concentration of various heavy metals in studied samples of plants is as follows: Fe > Cu > Pb > Zn > Cd

ACKNOWLEDGEMENT

The authors wish to thank Dr. K. K. Gupta, Head, Department of Chemistry and Principal, Govt. College, Kota for providing necessary research facilities. One of the authors Ms. Jagrati Agrawal (JRF) also expresses her gratitude to CSIR, New Delhi for providing financial support.

REFERENCES

1. F. Ozkutlu, N. Sekeroglu and S. Metinkara, Monitoring of Cadmium and Micronutrients in Spices Commonly Consumed in Turkey, Research J. Agri. Biol. Sci., **2(5)**, 223-226 (2006).
2. M. Farooq, F. Anwar and U. Rashid, Appraisal of Heavy Metal Contents in Different Vegetables Grown in the Vicinity of an Industrial Area, Pak. J. Bot., **40(5)**, 2099-2106 (2008).
3. N. Kumar, H. Soni, R. N. Kumar, Characterisation of Heavy Metals in Vegetables using ICPA, JASEM, **11(3)**, 75-79 (2007).
4. B. Yargholi, A. A. Azimi, A. Baghvand, A. M. Liaghat and G. A. Fardi, Investigation of Cadmium Absorption and Accumulation in Different Parts of Some Vegetables, Ameriacan-Eurasian J. Agric. Environ. Sci., **3(3)**, 357-364 (2008).
5. M. Kala and T. I. Khan, Heavy Metal Contamination in *Pisum Sativum* Var. Azad P-1 Grown in Sanganer Area, Rajasthan (India), J. Environ. Sci. & Engg., **51(3)**, 163-168 (2009).
6. O. Sonmez, B. Bukun, C. Kaya and S. Aydemir, The Assessment of Tolerance to Heavy Metals (Cd, Pb and Zn) and their Accumulation in Three Weed Species, Pak. J. Bot., **40(2)**, 747-754 (2008).
7. I. Baranowska, K. Srogi, A. Wlochowicz and K. Szczepanik, Determination of Heavy Metals in Samples of Medicinal Herbs, Polish J. Environ. Studies, **11(5)**, 467-471 (2002).
8. D. S. Stef et al., Screening of 33 Medicinal Plants for the Microelements Contents, Scientific Papers : Animal Sci. and Biotechnol., **43(1)**, 127-132 (2010).
9. C. K. Yap, M. R. Mohdfitri, Y. Mazyhar and S.G. Tan, Effects of Metal-Contaminated Soils on the Accumulation of Heavy Metals in Different Parts of *Centella asiatica*: A Laboratory Study, Sains Malaysiana, **39(3)**, 347-352 (2010).

10. Agency for Toxic Substances and Disease Registry (ATSDR), Toxicological Profile for Cadmium and Nickel, Agency for Toxic Substances and Disease Registry, US Department of Health and Human Services, Public Health Service, 205-93-0606 (1999).

11. Agency for Toxic Substances and Disease Registry (ATSDR), Toxicological Profile for Nickel and Iron, Agency for Toxic Substances and Disease Registry, US Department of Health and Human Services, Public Health Service, 205-88-0608 (1994).

12. M. Nair, K. K. Balchandran, V. N. S. Sankarnarayan and T. Joseph, Heavy Metals in Fishes from Coastal Waters of Cochin, South West Coast of Indias, Indian J. Marine Sci., **26**, 98-100 (1997).

13. G. C. Todd, Vegetables Grown in Mine Wastes, Environ. Toxicol. and Chem., **19(3)**, 600-607 (1996).

14. Agency for Toxic Substances and Disease Registry (ATSDR), Toxicological Profile for Lead, Agency for Toxic Substances and Disease Registry, US Department of Health and Human Services, Public Health Service, 205-93-0606 (1999).

15. Agency for Toxic Substances and Disease Registry (ATSDR), Toxicological Profile for Zinc and Cobalt, US Department of Health and Human Services, Public Health Service, 205-88- 0608 (1994).

Revised : 10.02.2011 *Accepted : 12.02.2011*