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Review Article

Heavy Metal Accumulation in the Highest Consumable Leafy Vegetables Normally Growing in the Moradabad District

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Abstract

The alloys using industry has a lot of waste material which were disposed randomly on ground as unauthorized disposal and leads to soil contamination. which were in addition to high polluted water due to heavy metal presence in the water used for irrigation and cleaning of the many leafy vegetables as spinach, Fenugreek, Chenopodium, coriander which were very often used in the food as source of nutrition in every day and every house despite of the fact that they were a lager accumulates of the heavy metal due to soil pollution and water pollution by these industry efflux.

Introduction

Heavy metals and metalloids emitted from industries like metallurgical industry, alloy using industry, utensil industry, automobile, mining, smelting, electroplating, energy and fuel production, power transmission, intensive agriculture, sludge dumping and military operations make a significant contribution to environmental pollution as a result of human activities [1-7]. These pollutants present a risk for primary, secondary and top consumers[8]. In optimum quantities Mn and Zn are essential for plant growth and development[9] because they are constituents of many enzymes and other proteins. However, elevated concentrations of both essential and non-essential heavy metals in the soil can lead to toxicity and inhibits the plant growth[10,11]. Toxicity may result from the binding of metals to sulfhydryl groups in proteins, leading to inhibition of activity or disruption of structure, or from displacement of an essential element, resulting in deficiency effects[12]. Further, excess heavy metal stimulates the formation of free radicals and reactive oxygen species and may result in oxidative stress[10].The lifetime of active oxygen species within the cellular environment is determined by the antioxidant system (Enzymes and compounds of low molecular weight) provides crucial protection against oxidative damage[11].

The antioxidant properties of plants exposed to various stress factors have been studied[13], but studies related to heavy metal-induced variations are lacking. Pb and Hg were reported to cause an increase in ascorbic acid levels in two Oryza sativa cultivars[14–16]. Reports suggested that heavy metals and metalloids have effects on chlorophyll and amino acid content in plants. Heavy metals are known to interfere with chlorophyll synthesis either through direct inhibition of an enzymatic step or by inducing deficiency of an essential nutrient[17]. Heavy metal accumulation in plants can affect plant productivity, food quality and human health[18]. The Pb accumulation in human blood via food chain has been reported[18] to cause cognitive development and reduce intellectual performance of children and result in a number of cardiovascular dysfunctions in adults[14–18]. Cadmium (Cd) can cause kidney damage, impair skeletal and reproductive systems and other health problems[15]. These heavy metals are used as bioaccumulaters in this study and also to decide the suitable condition for growth and development of the plant material used in this study.

Experimental setup:

The study was done in the Moradabad area of UP district which were known by the petal industry hotspot in the Up for its brass and bronze utensils, beside other large industry occupy the other UP region this area has his unique feature of brass metal industry and also the main source of the pollution found in this area as a main source of the soil and water pollution. Furthermore the four main daily consumable leafy vegetables spinach, Fenugreek, Chenopodium, coriander were choose for the study of heavy metal accumulation in the plants because these were daily consumed as main source of nutrients throughout the year, and irrigated by the river water and normal soil. Which were found highly contaminated and examined in earlier study. We also take the 3 main vegetable growing point of the district and a huge production of these leafy vegetables from where it will distributed in market throughout the district and labeled as A B and C.

Estimation of heavy metal:

Soil, water and plant samples (1g) were digested by adding tri-acid mixture (HNO3, H2SO4, and HClO4 in 5:1:1 ratio) at 80ºC open vessel method was used. 10 ml of concentrated Nitric acid was added to 10 g of the concerned drug in a conical flask. This solution was then heated for three hours. After three hours of digestion, the solution was cooled to room temperature and 5 ml of concentrated Perchloric acid was added to it. The sample was then heated up to 150°C for three hours to ensure its complete digestion. At 80ºC open vessel method was used. 10 ml of concentrated Nitric acid was added to 10 g of the concerned drug in a conical flask. This solution was then heated for three hours. After three hours of digestion, the solution was cooled to room temperature and 5 ml of concentrated Perchloric acid was added to it. The sample was then heated up to 150°C for three hours to ensure its complete digestion. Digestion was continued with subsequent addition of Perchloric acid till a white powder or ash was obtained. If the sample was dark brown in colour, a few ml of Nitric acid and Perchloric acid were added and the sample was re-digested to get the white powder. The final white powder or ash was dissolved in small amount of warm distilled water and then filtered through Whattman filter paper No.1. Volume of the filtrate obtained was made up to 10 ml and this was then subjected to metal analysis by Volume of the filtrate obtained was made up to 10 ml and this was then subjected to metal analysis by Atomic Absorption Spectrophotometer. Metal analysis was performed on a Perkin Elmer Model Analyst 100 double beam atomic absorption spectrophotometer fitted with high intensity hollow cathode lamps. Compressed air and acetylene gas were used to ignite the flame. Standard curves were constructed with solution of known concentrations. The unknown samples were analyzed against the standard curve for measuring the concentration of the desired metal. The concentrations were expressed in microgram/gram of the sample.

Result and discussion

The heavy metals present in leafy vegetable across the district, and year are shown in Table 1 a and b. Across the study the value (µg g-1) of Cu, Cd, Cr, Ni, Pb, Zn, Fe and Mn varied from 54 to 101, 8.10

to 28.22, 23 to 66, 14 to 72, 11 to 40, 51 to 142, 840 to 2583 and 25 to 63, respectively, as shown in Table 1 a and b.

Table 1a: *Heavy Metals (µg g^{-1}) in leafy vegetable Spinatch and Chenopodium across the three study point.*

Heavy Metals	Spinach			Chenopodium		
	A	B	C	A	B	C
Cu	87.07	77.03	74.20	91.43	87.83	70.67
	(1.89)	(5.26)	(3.94)	(5.54)	(3.25)	(1.91)
Cd	15.00	8.10	14.80	20.01	15.31	18.70
	(3.60)	(1.11)	(2.31)	(1.30)	(2.72)	(3.11)
Cr	35.67	36.23	23.47	45.67	38.87	26.00
	(3.13)	(0.91)	(1.9)	(3.68)	(2.91)	(2.72)
Ni	14.27	26.33	22.00	25.67	49.77	38.50
	(1.05)	(5.6)	(3.18)	(4.29)	(1.36)	(1.15)
Pb	14.33	10.67	13.23	23.30	13.27	24.47
	(0.81)	(1.36)	(2.05)	(2.01)	(1.76)	(4.39)
Zn	122.43	88.63	70.90	142.03	90.83	82.50
	(19.3)	(3.07)	(8.27)	(18.96)	(3.82)	(7.36)
Fe	2583	1818	1264	2052	1527	853
	(92.1)	(105)	(15)	(108)	(54.9)	(29.69)
Mn	45.00	52.93	33.37	54.37	62.93	36.53
	(3.18)	(1.42)	(2.51)	(4.57)	(2.12)	(2.87)

A, B, and C are tree leafy vegetable production points across the district, respectively. The values in the parentheses are ±SD.

Table 1b: *Heavy Metals (µg g^{-1}) in leafy vegetable Fenugreek and Coriander across the three study point.*

Heavy Metals	Fenugreek			Coriander		
	A	B	C	A	B	C
Cu	74.17	66.80	53.50	100.70	88.57	78.27
	(2.81)	(1.59)	(2.4)	(7.39)	(3.33)	(5.1)
Cd	23.62	14.73	24.60	28.22	25.32	25.41
	(1. 51)	(1.50)	(3.02)	(1.81)	(1.30)	(4.11)
Cr	53.97	50.10	34.77	65.77	46.70	43.00
	(1.95)	(1.83)	(3.71)	(3.05)	(6.05)	(2.2)
Ni	35.30	53.30	47.50	43.63	71.80	56.23
	(1.15)	(2.91)	(2.61)	(2.78)	(3.22)	(2.6)
Pb	30.03	22.10	29.70	39.80	26.40	36.07
	(3.1)	(2.95)	(1.45)	(3.4)	(1.9)	(4.8)
Zn	80.43	64.90	51.00	124.47	87.53	65.23
	(5.71)	(3.4)	(1.28)	(16.4)	(2.21)	(3.3)
Fe	1919	1509	1047	1377	1245	840
	(86.16)	(41.53)	(20.59)	(46.66)	(35.85)	(24.2)
Mn	36.73	25.67	25.40	29.27	35.37	32.43
	(3.72)	(2.55)	(3.72)	(3.51)	(4.06)	(4.05)

A, B, and C are tree leafy vegetable production points across the district, respectively. The values in the parentheses are ±SD. season also exhibited notable differences in the values of heavy metals due to age, except for Cd, Pb and Fe. Further, the analysis suggested that the Fe and Mn varied statistically due to two way and three way interactions of age, propagation and watering condition (Table 2).

Table 2: *Summary of Repeated Measure ANOVA on the Heavy Metals of study material plant and study points.* $^{ns}P > 0.05$; $*P < 0.05$; $**P < 0.01$; $***P < 0.001$.

Parameter	Study points (A) *F*(1,8)	Plants (P) *F*(1,8)	Season (S) *F*(1,8)	A×P *F*(1,8)	S×P *F*(1,8)	A×S *F*(1,8)	A×P×S *F*(1,8)
Cu	209.8***	6.17*	64.41***	3.19^{ns}	3.33^{ns}	33.88**	1.34^{ns}
Cd	0.34^{ns}	206.3***	84.94***	0.009^{ns}	0.75^{ns}	0.00^{ns}	0.23^{ns}
Cr	275.01***	209.72***	27.13*	5.14*	6.14*	0.05^{ns}	0.76^{ns}
Ni	81.44***	368.29***	161.49***	0.70^{ns}	1.19^{ns}	5.31*	0.87^{ns}
Pb	0.62^{ns}	278.67***	72.37***	0.66^{ns}	0.05^{ns}	0.21^{ns}	1.25^{ns}
Zn	203.7***	26.84**	22.89**	2.56^{ns}	7.29*	3.94*	2.42^{ns}
Fe	1.30^{ns}	478.86***	518.78***	103.8***	17.43**	4.95*	3.84*
Mn	45.91***	721.76***	72.6***	14.70*	2.23^{ns}	12.63**	13.89**

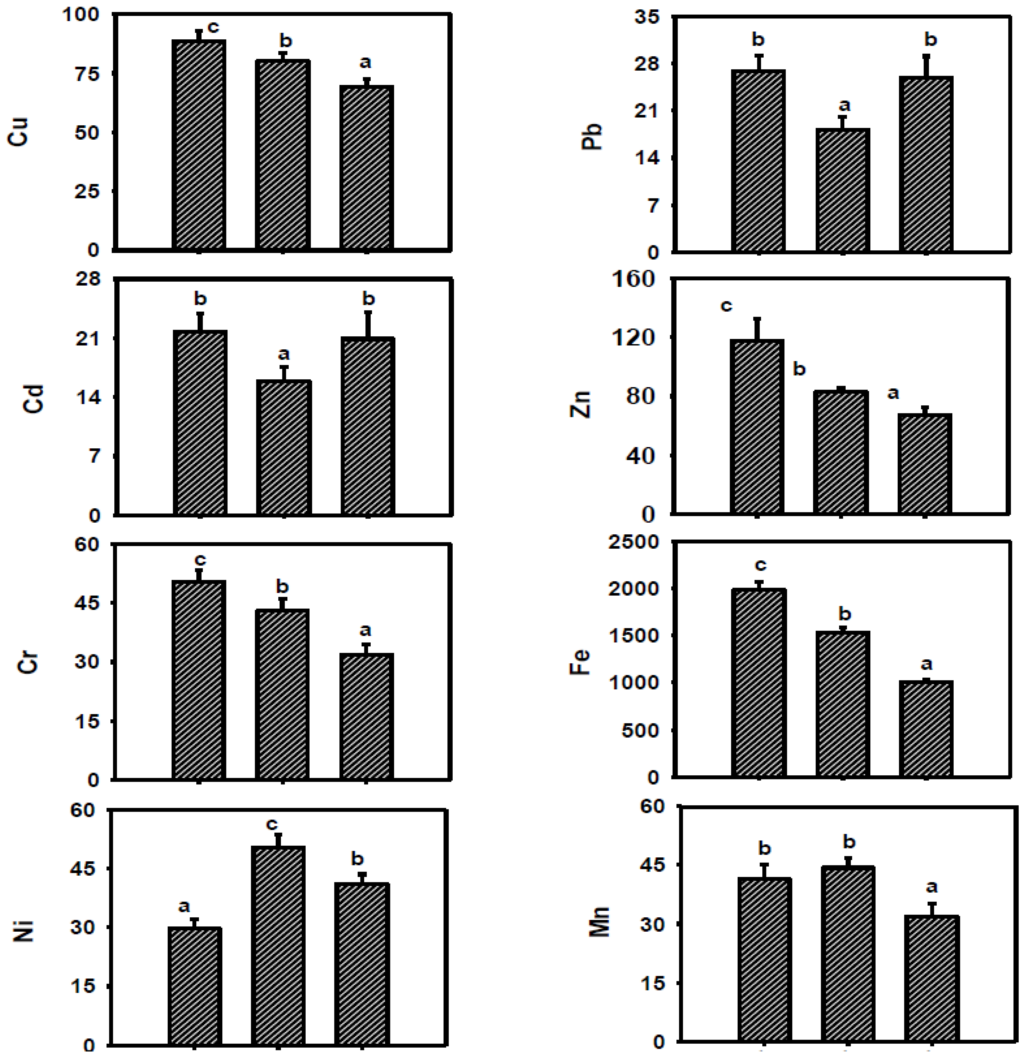

Fig 1: *Heavy Metals (µg g-1) Variation in leafy vegetables across district in three consecutive season. Different Letters within a Diagram are Significantly Different at P ≤0.05.*

Discussion and Conclusion:

Heavy metals inhibit physiological processes such as respiration, photosynthesis, cell elongation, plant-water relationship, N-metabolism and mineral nutrition[20]. Metals can be transported via an apoplastic system and immobilized in cell walls[22]. Toxic metals become a real threat to plants mainly when they reach to the cytosol of the cell. Therefore, the ability of root cells to control the transport of heavy metals via membranes determines tolerance by plants[25]. They can be immediately complexed, inactivated and transformed into a physiologically tolerable form via action of phytochelatins and sequestred in cell vacuoles[28]. Ni accumulation damages the cellular parts of the leaves, alters its water metabolism, pigment and reserve material synthesis and finally inhibits the yield production[22,18]. Decreased Fe concentration has been associated with reduction of chlorophyll content. Reduction in Fe concentration is also associated with decrease in the activities of the Fe enzymes, catalase and peroxidase, and thus, reduced availability of Fe for chlorophyll–heme biosynthesis [21].

The toxic metal accumulation were found in all leafy vegetables and does not lies in the dietary standards so none of the leafy vegetables were recommended for the consumption for the local people as it worsen the condition of the health and also generated the cancerous property with long consumption.

References

1. Sinha, D.K. and Saxena Ritesh, Statistical Assessment of Underground Drinking Water Contamination and Effect of Monsoon at Hasanpur, J.P nagar (Uttar Pradesh, India), Journal of Environ. Science & Engg., 48(3), 157-164 July (2006).
2. Pathak J.K, Alam Mohd,and Sharma Shikha, Interpretation of Ground water Quality Using Multivariate Statistical Techniques in Moradabad City, western uttar Pradesh State, India, E-Journal of Chemistry , 5(3), 607-619, July (2008).
3. Sinha, D. K., Saxena, Shilpi and Saxena, Ritesh, Water Quality Index for Ram Ganga river at Moradabad, Poll. Res., 23(3), 527-531 (2004).
4. Mohan A, singh R.K, pandey Kirti, Kumar V and Jain V ., Assessment of Water Quality in Industrial zone of Moradabad: Physico-chemical Parameters and Water Quality Index, Ind. J. Env. Protection, 27 (11), 1031-1035 (2007).
5. Sinha, D. K. and Kumar Navneet., Level of gagan River water Pollution in and around Moradabad, Poll Res. , 27(4), 743-746 (2008).
6. Sinha, D. K. and Kumar Navneet., Monitoring of Trace Metals in Gagan River water at Moradabad, Ind. J. Env. Protection, 26 (5), 516-520 (2006).
7. Nedelkoska T.V., Doran P.M. Hyperaccumulation of cadmium by hairy roots of Thlaspi caerulescens. Biotechnology and Bioengineering. 2000; 67(5): 607–15p.
8. Herren T, Feller U.1997. Transport of cadmium via xylem and phloem in maturing wheat shoots: comparison with the translocation of zinc, strontium and rubidium. Annals of Botany. 80; 623–8p.
9. Marschner H., Cakmak I. 1989. High light enhances chlorosis and necrosis in leaves of zinc, potassium, and magnesium deficient bean (Phaseolus vulgaris) plants. Journal of Plant Physiology. 134: 308–15p.
10. Kabata-Pendias A., Pendias H. 1991. Trace Elements in Soils and Plants, 2ed. CRC Press.
11. Hall J.L. Cellular mechanisms for heavy metal detoxification and

tolerance. Journal of Experimental Botany. 2002; 53: 1–11p.

12. Dietz K.J., Baier M., Krämer U. 1999. Free radicals and reactive oxygen species as mediators of heavy metal toxicity in plants. In: Prasad MNV, Hagemeyer J, eds. Heavy metal stress in plants: from molecules to ecosystems. Berlin: Springer-Verlag. 73–97p.
13. Noctor G., Foyer C.H. Ascorbate and glutathione: keeping active oxygen under control. Annu Rev Plant Physiol Plant Mol Biol. 1998; 49: 249–79p.
14. Havaux M., Kloppstech K. 2001. The protective functions of carotenoid and flavonoid pigments against excess visible radiation at chilling temperature investigated in Arabidopsis npq and tt mutants. Planta. 213: 953–66p.
15. Mishra A., and Choudhuri M.A. Monitoring or phytotoxicity of lead and mercury from germination and early seedling growth induces two rice cultivars. Water, Air, and Soil Pollution. 1999; 114: 339 –46p.
16. Assche V., Clijsters H. Effect of metals on enzyme activity in plants. Plant Cell Environment. 1990; 13: 195–206p.
17. Alloway B.J. Heavy metals in soils. New York: John Wiley and Sons; 1990. ISBN 0470215984 EC (1999) Integrated Pollution Prevention and Control (IPPC) Best available techniques reference document on the production of iron and steel. Publ: EC European IPPC Bureau 370 p.
18. Jorgensen S.S. Mobility of metals in soils. Folia Geogr Danica. 1991; 104–14p.
19. Grath M., Zhao F.J., Lombi E. Plant and rhizosphere process involved in phytoremediation of metal-contaminated soils. Plant and Soil. 2001; 232: 207–14p.
20. Venkataraman R., Gopalakrishnan S. Trace elemental profile in medicinal plants traditionally used for jaundice. J Current Sci. 2002; 2: 305–8p.
21. Vermani A., Navneet, Chauhan P.A. Physico-Chemical Analysis of Ash of Some Medicinal Plants Growing in Uttarakhand, India. Nature and Sci. 2010; 8(6): 88p.
22. Singh V., Jain D.K. Nootan biology. 7th Edn. Meerut, India: Nageen Prakashan Pvt Ltd; 2006.
23. Chatterjee M.N., Shinde R. Text book of medical biochemistry. 2nd Edn. New Delhi, India: Jaypee Brother Medical Pub Ltd; 1995; 811–46p.
24. Indrayan A.K., Sharma S., Durgapal D., et al. Determination of nutritive value and analysis of mineral elements for some medicinally valued plants from Uttaranchal. Current Sci. 2005; 89: 1252–5p.
25. Rusch G.M., Skarpe C., Halley D.J. Plant traits link hypothesis about resource-use and response to herbivory. Basic Appl Ecol. 2009; 10: 466–74p.
26. Pakeman R.J., Leps J., Kleyer M., et al., and Vista Consortium. Relative climatic edaphic and management controls of plant functional traits signatures. Journal of Vegetation Science. 2009; 20: 95–102p.
27. Hunt R., Cornelissen J.H.C. Components of relative growth rate and their interrelations in 59 temperate plant species. New Phytol. 1997; 135: 395–417p.
28. Hoffmann W.A., Franco A.C., Moreira M.Z., et al. Specific leaf area explains differences in leaf traits between congeneric savanna and forest trees. Funct. Ecol. 2005; 19: 932–40p.