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BIOACCUMULATION AND DISTRIBUTION OF Pb, Cu AND Fe IN WATER CHESTNUT (*TRAPA NATANS* VAR. *BISPINOSA* ROXB.) IN THE LUCKNOW REGION

MUKESH BABU* AND DEEPA H. DWIVEDI
Department of Applied Plant Science (Horticulture),
Babasaheb Bhimrao Ambedkar (A Central University) University, Lucknow - 226 025
e-mail: mukeshbbau@gmail.com

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***Corresponding author**

ABSTRACT
Water bodies are primarily contaminated with heavy metals due to increasing urbanization, intensive practices of agricultural and industrial developments, etc. Heavy metals have been reported to be highly toxic to human health since they are not easily disintegrated and decomposed and can be bioaccumulated along the food chain. Therefore, heavy metal contamination in aquatic ecosystems, such as those being used for the cultivation of edible aquatic plants like water cress, trapa etc., is of primary concern. The present study was initiated to study the bioaccumulation of Pb, Cu and Fe by *Trapa natans* var. *bispinosa* Roxb. growing water bodies in Lucknow. The results indicate that the heavy metals accumulate in order viz., Pb: Leaf > root > peel> stem > kernel; Cu: root > leaf > stem > peel > kernel and Fe: root > stem > leaf > peel > kernel. The edible parts of *Trapa natans* accumulated metals from their surrounding water significantly. The metal accumulation potential of the plant parts varied considerably depending upon level of metal contamination in the water body in which the plants were growing.

INTRODUCTION

Water pollution resulting from human activities is gaining serious dimensions. Major cause of pollution is the increasing urbanization, intensive practice of agriculture and industrial developments. During the recent years, urbanization has forced us to utilize marginal lands and aquatic plants are being cultivated more intensively in ponds which are not suitable for agriculture. Despite the exploitation of such aquatic resources to meet increasing demand of food, contamination of these water bodies with toxic metals has become a frequent phenomenon (Chandra *et al.,* 1993; Rai *et al.,* 1996).

Water chestnut is widely distributed throughout the tropical and warm climate region of the world. It is cultivated for its fruit throughout India in ponds, ditches and lakes. The fruit of trapa is an important source of food and the kernel is a good source of carbohydrates and minerals. Processed kernels are used to fasts and seem to be easily digestible. Its flour is used for making sweets for Holi festival and for preparing bread, halwa and biscuits. In certain tribal villages, the flour is used for treatment of diarrhoea and abdominal pain. However, they get laced with toxic metals growing in polluted water bodies (Rai *et al.,* 1996). Although, the study regarding contamination of food crops with toxic metals and pesticides has received some attention, edible aquatic plants are virtually neglected. Dixit and Banerji (1994) have reported the presence of carbofuran residue in Trapa fruits after application and advocated reduced application of the pesticide or any other remedial measure to control the pest of crop. Chandra *et al.* (1993) reported that the water chestnut growing in ponds under different agro climatic regions accumulate many toxic metals in its edible parts. Besides, habitats of water chestnut are threatened recently due to increasing load of metal pollution from municipal, agricultural and domestic wastes. However, no studies have been undertaken on water chestnut laden with toxic metals which may cause numerous health problems through food chain biomagnification. Hence, the present detailed investigation to quantify accumulation of Pb, Cu and Fe in vegetative and reproductive organs of water chestnut.

MATERIALS AND METHODS

The sites (S_1 - S_5) selected for present study were situated in Lucknow, U.P. which varied with respect to the level of metal contamination. Lucknow lies between the parallels of 20º 30' and 27º 10' NL and 80º 34’and 81º 13' EL. The five sites have been represented by S_1 –Mohanlalganj, S_2 –Gosainganj S_3 - Bakshi ka Talab, S_4 - Chinhat and S_5 - Sarojninagar. All the water bodies were located near the highways having several anthropogenic activities in contaminated area. The natural water bodies in rural region supply daily to the local population in terms of bathing, cattle feeding and food shelter for waterfowl and other wild life.

In all the selected ponds *T. natans* was taken as a cultivated crop. Water samples from each site were collected from different location in the pond for heavy metal analysis during November- December of 2010. Water (100mL) was filtered, acidified, stored in acid washed plastic containers and brought to the laboratory for analysis of metal in accordance with standard methods (APHA, 1989). The plants and fruits of water chestnut were collected from these sites, washed thoroughly with distilled water and air dried for two days, after that oven dried in hot air oven at 70-80ºC temperature for 24h. The dried samples were ground and sieved through muslin cloth. Both the samples (In triplicate) water (100mL) and plant (0.5g) were digested in HNO3: HClO4 mixture (3:1; v/v), the temperature was maintained at 120ºC for 3h during digestion and to determine the metal content in the samples by using inductively coupled plasma optical emission spectrometry (OPTIMA 5300 DV ICP-OES). The working wavelengths were as follows: Pb, 220.345 nm; Cu 327.393 nm and Fe, 238.204 nm (Marin S, 2011).

Statistical analysis

The data were statistically analyzed using two-way analysis of variance (ANOVA) to assess the effect of different variables on the concentrations of heavy metals.

RESULTS AND DISCUSSION

Heavy metal content

Heavy metal contents in water, root, stem, leaf, peel and kernel of water chestnut (*Trapa natans* var. *bispinosa* Roxb.) collected from water chestnut growing ponds of different selected sites are shown in Table 1. The metal concentration significantly increased when the concentration were increased in water and ecosystem ($p<0.005$).

Heavy metal content in water

The maximum concentrations in water of Pb, Cu and Fe were observed in site S_4 (0.059, 1.335 and 1.345 (mg/L), respectively). However, the minimum Pb, Cu and Fe concentrations were recorded in sites S_1, S_5 and S_2 (0.036, 1.132 and 0.975 (mg/L), respectively).

Heavy metal content in plant parts

Lead (Pb)

The result in table-1the maximum concentration was found in all the sites: Leaf > root > peel > stem > kernel (Table 1). For S_1 treatment the maximum concentration 16.40 mg/kg dry weight was in leaf followed by in root (14.60 mg/kg dry weight), while the minimum Pb concentration 5.40 mg/kg dry weight was found in kernel. For S_2 treatment the maximum Pb concentration18.40 mg/kg dry weight was found in leaf then in root while the minimum concentration 6.80 mg/kg dry weight was found in kernel. For the S_3 treatment, higher Pb concentration 17.60 mg/kg dry weight was found in leaf and the lower concentration 6.20 mg/kg dry weight was found in kernel. For S_4 treatment the maximum concentration 20.80 mg/kg dry weight was recorded in leaf then 17.60 mg/kg dry weight was found in root while the concentration 7.60 mg/kg dry weight was recorded in the kernel. For S_5 treatment the highest Pb concentration 18.20 mg/kg dry weight was found in leaf and the lowest Pb concentration 6.60 mg/kg dry weight was found in kernel.

Copper (Cu)

The maximum concentration was found in all the treatments: root > leaf > stem > peel > kernel. For S_1 treatment the maximum concentration 16.40 mg/kg dry weight was in root followed by leaf (10.40 mg/kg dry weight), while the minimum Cu concentration (6.60 mg/kg dry weight) was found in kernel. For S_2 treatment the maximum Cu concentration (17.40 mg/kg dry weight) was found in root followed by leaf (11.60 mg/kg dry weight), while the minimum concentration (7.20 mg/kg dry weight) was found in kernel. For the S_3 treatment, the highest Cu concentration (15.20 mg/kg dry weight) was found in root and the lowest concentration (6.48 mg/kg dry weight) was found in kernel. For S_4 treatment the maximum Cu concentration (19.80 mg/kg dry weight) was recorded in root then in leaf (14.40 mg/kg dry weight), while the minimum concentration (8.80 mg/kg dry weight) was recorded in the kernel. For S_5 treatment the highest Cu concentration 14.20 mg/kg dry weight was found in root and the lowest Cu concentration 5.60 mg/kg dry weight was found in kernel.

Table 1: Accumulation of heavy metal in water and different parts of *Trapa natans* var. *bispinosa* (Roxb.) collected from water chestnut growing ponds of different selected sites of Lucknow

Sample	Metals (mg/L)			Interaction CD at 5 %
	Pb	Cu	Fe	($p<0.005$)
Water				
S_1	0.036	1.201	1.325	
S_2	0.055	1.278	0.975	Treatment - 0.067
S_3	0.042	1.192	1.218	Metal -0.052
S_4	0.059	1.335	1.345	Treatment * Metal - 0.116
S_5	0.046	1.132	1.200	
Root				
S_1	14.60	16.40	4880.70	
S_2	16.40	17.40	3672.20	Treatment - 3.599
S_3	15.00	15.20	4840.60	Metal - 2.788
S_4	17.60	19.80	5218.72	Treatment * Metal =-6.234
S_5	15.80	14.20	4284.18	
Stem				
S_1	8.40	9.20	1366.40	
S_2	9.80	10.40	1046.80	Treatment - 4.138
S_3	8.80	8.80	1290.60	Metal -3.205
S_4	10.80	11.80	1486.40	Treatment * Metal - 7.167
S_5	9.20	8.20	1166.60	
Leaf				
S_1	16.40	10.40	1202.02	
S_2	18.40	11.60	1024.66	Treatment =2.278
S_3	17.60	9.80	1198.18	Metal = 1.765
S_4	20.80	14.40	1366.24	Treatment * Metal = 3.947
S_5	18.20	9.20	1105.28	
Peel				
S_1	9.60	7.80	480.40	
S_2	11.40	8.60	382.60	Treatment -4.076
S_3	10.80	7.60	404.20	Metal - 3.157
S_4	12.60	10.60	620.20	Treatment * Metal - 7.060
S_5	11.30	7.20	465.20	
Kernel				
S_1	5.40	6.60	219.20	
S_2	6.80	7.20	135.40	Treatment - 1.688
S_3	6.20	6.48	156.00	Metal - 1.307
S_4	7.60	8.80	297.60	Treatment * Metal - 2.924
S_5	6.60	5.60	181.00	

Iron (Fe)

The maximum concentration was found in all the treatments as follow: root > stem > leaf > peel > kernel (Table 1). For S_1 treatment the maximum concentration (4880.70 mg/kg dry weight) was in root followed by that measured in stem (1366.40 mg/kg dry weight), while the minimum Fe concentration (219.20 mg/kg dry weight) was found in kernel. For S_2 treatment the maximum Fe concentration (3672.20mg/kg dry weight) was found in root, followed bay that found in stem (1046.80 mg/kg dry weight), while the minimum concentration (135.40 mg/kg dry weight) was found in kernel. For the S_3 treatment, the highest Fe concentration (4840.60 mg/kg dry weight) was found in root followed by that in stem (1290.60 /kg dry weight), while the lowest Fe concentration (156.00 mg/kg dry weight) was found in kernel. For S_4 treatment the maximum Fe concentration (5218.72 mg/kg dry weight) was recorded in root then in stems (1486.40 mg/kg dry weight), while the minimum Fe concentration (297.60 mg/kg dry weight) was recorded in the kernel. For S_5 treatment the highest Fe concentration (4284.18 mg/kg dry weight) was found in root followed by that found in stem (1166.60 mg/kg dry weight) , while the lowest Fe concentration (181.00 mg/kg dry weight) was found in kernel. The results are agreement with the Rai and Sinha (2001).

Trapa natans possesses the potential to accumulate metals in its tissue. The results revealed that the accumulations of Pb, Cu and Fe by *T. natans* were increased when the concentration of metal were increased in the water bodies where chestnut grows.

Furthermore, the nature of soil of the production sites, the ability to take up heavy metals by the plants, deposition of heavy metals in the environment, use of untreated water, the nature of fruit, exposed surface area and the anthropogenic activities such as the use of metal based pesticides around production sites and urban industrial activities at market sites are some of the factors responsible to boost up the accumulation of heavy metals in the fruits in many parts of the developing countries (Rai and Sinha, 2001; Sharma *et al.,* 2009).

Spontaneous urban and industrial developments have significantly contributed to the elevated levels of heavy metals in the urban environment of the developing countries (Rai and Chandra, 1992; Tripathi *et al.,* 1997; Sinha, 1999; Khairiah *et al.,* 2004; Sharma *et al.,* 2008).

The results found in the current study suggest a great deal of monitoring and immediate measures to address this issue with respect to economic and health standpoint. Since, sufficient information on the nutritional status of water chestnut has been obtained along with the data on the variability in the concentration of heavy metals with respect to region. Hence, the whole set of information may provide a better understanding of the quality and safety of this minor fruit crop, water chestnut *Trapa natans* var. *bispinosa* Roxb. Since, the importance of the aquatic ecosystem on the uptake of heavy metals by the fruit is established. Therefore, further research is needed on the soil, water and air are significantly contributing factors to the elevated heavy metal content and also authors are suggested that the Trapa should be cultivated in unpolluted water bodies and kernel of the Trapa should be consumed after removing peel from the fruit.

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REFERENCES

American Public Health Association 1989. Standard Methods for Examination of Water and Waste water **14**: Washington, DC.

Chandra, P., Tripathi, R. D., Rai, U. N., Sinha, S. and Garg, P. 1993. Biomonitoring and amelioration of non-point source pollution in some aquatic bodies. *Wat. Sci. Tech.* **28(3-5):** 323–326.

Dixit, B. S. and Banerji, R. 1994. Carbofuran residue in water, soil and Trapa fruits after field application. *Bull. Environ. Contam. Toxicol.* **52:** 772–778.

Khairaih, T., Zaliafah, M. K., Yin, Y. H. and Aminah, A. 2004. The uptake of heavy metals by fruit type vegetables grown in selected agricultural areas. *Pak. J. Biol. Sci.* **7:** 1438-1442.

Marin, S., Lacrimioara, S. and Cecilia, R. 2011. Evaluation of performance parameters for trace elements analysis in perennial plants using ICP-OES technique. *J. Plant Develop.* **18 (2011):** 87-93.

Rai, U. N. and Chandra, P. 1992. Accumulation of copper, lead, manganese and iron by field populations of *Hydrodictyon reticulatum* (Linn.) Lagerheim. *Sci. Total Environ.* **116:** 203–211.

Rai, U. N., Sinha, S. and Chandra, P. 1996. Metal biomonitoring in water resources of Eastern Ghats, Koraput (Orissa), India by aquatic plants. *Environ. Monit. Assess.* **43:** 125–13

Rai, U. N. and Sinha, S. 2001. Distribution of metals in aquatic plants: *Trapa natans* (Roxb.) and *Ipomoea aquatic*a Forsk. *Environmental Monitary and Assessment*. **70:** 241-252

Sharma, R. K., Agrawal, M. and Marshall, F. M. 2008. Heavy metals (Cu, Cd, Zn and Pb) contamination of vegetables in Urban India: a case Study in Varanasi. *Environ. Poll.* **154:** 254-263.

Sharma, R. K., Agrawal, M. and Marshall, F. M. 2009. Heavy metals in vegetables collected from production and market sites of a tropical urban area of India. *Food Chem. Toxicol.* **47:** 583-91.

Sinha, S. 1999. Long term accumulation of metals by a wetland plant *Bacopa monnieri* L. under simulated repeated exposures. *Environ. Monit. Assess.* **57:** 253–264.

Tripathi, R. M., Ragunath, R. and Krishnamurty, T. M. 1997. Dietary intake of heavy metals in Bombay City, India. *Sci. Total Environ.* **208:** 149-159.