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Distribution of heavy metals in edible aquatic plant: water chestnut (*Trapa natans* var. *bispinosa* Roxb.)

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SUMMARY

Lakes, ponds and streams are the sources of surface water, which anchorage the survival of aquatic life flora and fauna and maintain ecological balance. Due to urbanization, population explosion, and industrialization, these natural sources are getting polluted. Present paper is an attempt to evaluate the accumulation of heavy metals namely, lead (Pb), copper (Cu), and iron (Fe) by the macrophytes. The one macrophyte taken for the study was *Trapa natans* var. *bispinosa* (Roxb.). The macrophyte has the capacity to absorb heavy metals from contaminated water. The present experimental study was conducted to identify their potential to improve the water quality by removing the heavy metals. The paper critically evaluates the water-purifying capacity of macrophyte *Trapa natans* var. *bispinosa* Roxb.

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The principle sources of water for human use are lakes, ponds, and streams are the sources of surface water. Water quality in lakes and reservoirs is subjected to the natural degradation, the process of eutrophication, and the impact of human activities, Shrivastava (2008). Natural sources of water are fast depleting and are polluted due to industrialization and urbanization in haphazard manner. Pollution of the aquatic bodies by (synthetics and organic) pollutants like pesticides, polyaromatic hydrocarbons, heavy metals, etc., have caused imbalance in the natural functioning of the ecosystem. Among these pollutants, heavy metals cause severe damage to the living system at various levels. Heavy metals also enter the water bodies from industrial and consumer waste from acid rain breaking down soils, rocks, and releasing heavy metals. The potential toxic metal elements such as chromium, lead, copper, zinc, etc. are identified to cause health hazards in animals (Bryan 1976). These heavy metals are reported to be toxic and found associated with the occurrence of several health effects. Considering its effect on human being and aquatic life, appropriate treatment of heavy metals from wastewater is of utmost importance. Increasing awareness of ecological hazard of toxic metals from urban and industrial sources have involved considerable interest in the study of levels and fate of heavy metals in the aquatic environment. Water chestnut growing in ponds under different agro climatic regions accumulated 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 biomagnifications. Hence, the present detailed investigation to quantify toxic metal accumulation in different parts of *Trapa* growing in contaminated water bodies was undertaken to determine quantities of Pb, Cu and Fe in vegetative and reproductive organs of water chestnut.

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MATERIALS AND METHODS

The site (SI - SIV) 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 $20^0 30'$ and 27^0 $10'$ north latitude and $80^0 34'$and $81^0 13'$ east longitude. The four sites in the present study have been represented by SI - Mohanlalganj, S II – Gosainganj, S III - Bakshi ka Talab and S IV-Chinhat. All the water bodies were located near the highways having high anthropogenic activities in contaminated area. The natural water bodies in rural region cater to the daily of local people in term of bathing, cattle feeding and food shelter for water fowl and other wild life. Since the water bodies are contaminated due to various pollution sources. The toxic metals present in eatable may be a health threat to the local inhabitant.

In all the selected ponds *T. natans* was taken as a cultivated crop. The experimented sites received varied level of contaminants from domestic, industrial, recreational and agricultural wastes. Water samples from each of sites were collected from different location in the pond for heavy metal analysis during November-December, 2009. Water (100 ml) 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 oven dried for metal analysis. Both the water and plant samples were wet digested in HNO_3: $HClO_4$ mixture (3:1; v/v) and to determine the metal content in the samples, inductively coupled plasma optical emission spectrometry (OPTIMA 5300V ICP-OES) was used. The working wavelengths were as follows: Pb, 220.4 nm; Cu, 324.752 nm and Fe, 238.20 nm.

RESULTS AND DISCUSSION

The levels of metal contamination in cultivated ponds (S I - SIV) are presented in Table 1. The level of metal contamination varied especially in case of Pb, Cu and Fe. Although, high concentration of essential plant nutrient Fe were found in these water bodies, the level of toxic metal Pb were alarming (WHO, 1995). The level of Cu was found above prescribed limit (0.05 mg/L) in all ponds.

Bioaccumulation of different metals in various parts of *Trapa natans* are represented in Table 2-4 and the metals concentration significantly increased when the concentrations were increased in water bodies (p< 0.001).

Table 1 : Metal content in water of water chestnut growing ponds at different cultivated sites

Sites	Metals (mg/L)		
	Pb	Cu	Fe
S I	0.064	0.014	1.435
S II	0.082	0.012	0.579
S III	0.159	0.024	1.278
S IV	0.086	0.017	1.201
M.p.l.	0.05	0.05	0.3

For Pb samples of sites SI, SII, SIII and S IV. Sites I, samples content showed higher Pb concentration as observed in leaf (19.20 mg/kg) followed by in root (17.40 mg/kg) and the lower concentration and was observed in kernel (4.83 mg/kg). The site II samples showed higher Pb concentration was found in root (32.40 mg/kg) and minimum and was found in kernel (6.60 mg/kg). Site III samples showed that the higher concentration of Pb was observed in leaf (23.80 mg/kg) and lower concentration was recorded in kernel (6.20 mg/kg) while the site IV highest Pb concentration was observed in leaf (23.20 mg/kg) followed by in root (14.40 mg/kg) and the minimum Pb concentration was observed in kernel (5.40 mg/kg) ($p < 0.001$) (Table 2).

For Cu samples, site I, the maximum Cu concentration was observed in root (14.40 mg/kg) followed by in leaf (11.60 mg/kg) and minimum Cu concentration was observed in kernel (6.80 mg/kg), site II, the higher Cu concentration was observed in root (15.40 mg/kg) and lower Cu concentration was observed in kernel (7.20 mg/kg) similar was found in the stem. For site III, the maximum Cu concentration was observed in root (19.00 mg/kg) and the minimum Cu concentration was observed in kernel (9.80 mg/kg), while the site IV higher Cu concentration was found in the leaf (14.40 mg/kg) followed by in the root (13.20 mg/kg) and the minimum Cu concentration was found in the stem (6.00 mg/kg) (Table 3).

For Fe samples, in sites I, the maximum Fe concentration was found in the root (4230.000 mg/kg) followed by in the stem (2830.00 mg/kg) and the lower

Table 2 : Pb bioaccumulation in different part of *Trapa natans* varieties collected from different water bodies of Luck now district

Sites	Metals in mg/kg					Interaction CD (P=0.05)
	Root	Stem	Leaf	Peel	Kernel	
S I	17.40	9.80	19.20	9.80	4.83	Treatment= 0.0515***
S II	32.40	19.40	24.20	10.80	6.60	Parts= 0.0576***
S III	17.80	8.60	23.80	11.40	6.20	Treatment*Parts= 0.1153***
S IV	14.40	11.80	23.20	9.20	5.40	
MPL			0.05			

Table 3 : Cu bioaccumulation in different part of *Trapa natans* varieties collected from different water bodies of Lucknow district

Sites	Metals in mg/kg					Interaction C.D. (P=0.05)
	Root	Stem	Leaf	Peel	Kernel	
S I	14.40	7.60	11.60	7.40	6.80	Treatment= 0.0439**
S II	15.40	7.20	9.80	8.80	7.20	Parts= 0.0491**
S III	19.00	11.60	10.40	11.80	9.80	Treatment*Parts= 0.0983**
S IV	13.20	6.00	14.40	9.20	8.20	
MPL			0.05			

Table 4 : Fe bioaccumulation in different part of *Trapa natans* varieties collected from different water bodies of Lucknow district

Sites	Metals in mg/kg					Interaction C.D. (P=0.05)
	Root	Stem	Leaf	Peel	Kernel	
S I	4230.00	2830.00	1902.00	720.00	161.00	Treatment= 2.6807**
S II	3820.00	1166.60	1498.00	392.60	117.60	Parts= 2.9971**
S III	5120.00	2360.00	1586.60	404.20	135.40	Treatment*Parts= 5.9942**
S IV	3472.00	1263.60	1002.40	384.00	126.00	
MPL			0.30			

Fe concentration was found in kernel (161.00mg/kg). Site II, the maximum Fe concentration was observed in root (3820.00 mg/kg) followed by in leaf (1498.00 mg/kg) and the minimum Fe concentration was observed in kernel (117.60 mg/kg), Site III, the maximum Fe concentration was observed in root (5120.00 mg/kg) followed by in the stem (2360.00 mg/kg) and the minimum Fe concentration was found in the kernel (135.40 mg/kg), while site IV, the higher Fe concentration was observed in root (3472.00 mg/kg) followed by in the stem (1263.60 mg/kg) and the lower Fe concentration was observed in the kernel (126.00 mg/kg) (Table 4).

In the present study, the leaves and fruits of *T. natans* significantly bioconcentrated metals from their surrounding water. Despite varying levels of metals found in various parts of *T. natans*, the metal accumulation in kernel was alarming. Rai and Sinha (2001) reported high accumulation values of metals in *T. natans*. However, the metal contaminating potential varied depending upon the chemical composition of the water bodies. The high concentrations of Fe and Zn at all the cultivated sites may be due to their high solubility and mobility than other metals in natural waters (Knowlton *et al.,* 1983). Although, water bodies were found contaminated with high level Cu and is an essential nutrient, plants accumulated considerably lower amount of the metals than others, which might be ascribed due to its low mobility potential to form complex with the humic compounds which are not available for plant uptake. These results are in agreement with earlier studies on *Typha latifolia* and *Bacopa monnieri* under contaminated field conditions (Taylor and Crowder, 1983; Reboredo, 1991, Sinha, 1999). Such high accumulation values were reported for some aquatic vegetable like I. aquatic, *Nelumbo nucifera* and *T. natans* (Rai *et al*., 1996). The result of the study limits the exploitation of water chestnut to meet the demand of food. However, tolerance limits are yet to be determined before reaching some conclusions which is likely to vary in the different herbaceous and human eating. These plants should be cultivated in unpolluted water bodies and the kernel of *Trapa* should be consumed after removing peel from the fruit.

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