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Study of heavy metals content in water, water hyacinth and soil of Rupahi Beel, Nagaon, Assam (India)

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ABSTRACT

The present study was undertaken for assessing the level of heavy metals such as copper, nickel and zinc in water, water hyacinth and soil samples of Rupahi beel, Nagaon, Assam. Metals were detected using flame atomic absorption spectrophotometry. The results revealed that by and large all the three metals are present in all the samples. The average concentration of Cu, Ni and Zn in both water and soil of the beel are in the order Ni < Cu < Zn. However, the concentration in water hyacinth (both in root and leaf) is in the order Cu < Ni < Zn. The metal concentration in water hyacinth is much more than both in water and soil that signifies the absorption capacity of it.

Key words: Rupahi beel, Bioaccumulation, Water hyacinth, Heavy metals, Atomic absorption spectrometer.

INTRODUCTION

Rupahi beel is situated under Rupahi revenue circle of Nagaon Distrist, Assam (India). The area of the beel is about 75Ha and is approximately 7km long and 0.5km wide and is located towards North-East direction from Nagaon Town (District headquarter). The geographical location of the beel is 92^{o} 61''E longitude and 26^{o} 27''N latitude. The surrounding area of Rupahi beel is agricultural land. People do cultivation such as rice, jute, pulse, mustard etc. with the application of chemical fertilizers. Majority of the people in the surrounding areas do not have sanitary facilities. During rainy season the water from vast area runs down to the beel along with many types of chemicals and wastes [1,2,3,]. The vast majority make use of the beel for fishing, irrigation for their agricultural fields, feeding to their animals, washing and taking bath. Therefore, there may be threat to aquatic animals as well as to humans. It is therefore, highly essential to ascertain the quality of water of the beel and to measure its pollution level.

The beel is covered with approximately with 40% water hyacinth (Eichhornia crassipes).

In aquatic ecosystems water contamination by trace metals is one of the main types of pollution that may stress the biotic community. Although some metals are needed as micronutrients for autotrophic organisms, they can have toxic effects at higher concentrations [4]. Water hyacinth, among other aquatic macrophytes, has been shown to possess a great potential to remove pollutants when being used as a biological filtration system [5]. It contains many polyfunctional metal-binding sites for both cationic and anionic metal complexes. Water hyacinth could remove several heavy metals and other pollutants [6,7,8,9,10,11]. Recorded achievements triggered efforts directed towards the utilization of water hyacinth in phytoremediation. On the removal of Cu^{2+} from aqueous solution by root of water hyacinth [12] showed that the biomass have a high affinity and large sorption capacity for the removal of the metal ion.

The soil, a main part of the terrestrial ecosystem, is perhaps the most endangered component of our environment open to potential contamination by a variety of different pollutants arising from human activities such as nuclear, industrial, agricultural, etc., [13,14,15]. Although the trace elements in soil are very important for the quality of soil and environment, excessive level of trace elements can cause pollution of waters, toxicity in plants, foods and ultimately in animals and humans that feed upon them [16,17]. Uncontrolled development of industry, agriculture and urbanization accelerates the input of heavy metals into the environment in many parts of the world [18]. Heavy metals have been the subject of particular attention because of their long-standing toxicity, mobility in the ecosystems and transfer into the food chains when specific thresholds have been exceeded. Hence rational management, conservation and careful monitoring of this floodplain wetland is needed to save this vital resource, their fishery, biodiversity, both in terms of biomass production and economic value.

MATERIALS AND METHODS

Sampling work had been carried out twice during january 2011(winter) and july 2011(monsoon). The water samples were acidified to a pH < 2.0 by adding required volume of concentrated HNO_3 /L immediately after collection. The samples were stored in a refrigerator at ~ 4°C till analysis for the metals was undertaken. The water samples were digested to find the concentration of both dissolved metals and those associated with the particles. In this work, nitric acid digestion technique (APHA, 1995) was used. For this, a volume of 100 mL of each acid-preserved, well-mixed water sample was taken in a beaker, 5 mL of conc. HNO_3 was added and the mixture was slowly evaporated on a hot plate in a fume-hood to a volume of 10 – 20 mL of clear solution. The beaker walls were washed with double-distilled water and the volume was made to 100 mL in a volumetric flask. The solution was then used in the analysis for the metals with AAS. The heavy metals Cu, Ni and Zn were measured in each water sample with atomic absorption spectrometer (Perkin-Elmer AAnalyst 200 Atomic Absorption Spectrophotometer).

Water hyacinth (Eichhornia crassipes) was collected from the beel twice during monsoon and winter season. These Plants were divided into root and leaf. These samples were washed under tap water to remove dust particles and then in distilled water and finally rinsed carefully in deionised water. Excessive water was removed from the washed samples using Kim wipes. The samples were weighed to determine the fresh weight and then dried in an oven at 80 ºC for 72 h. to determine their dry weight. The dry samples were ground to a fine powder in a mortar and about 5g of the resulting powder was added to a 250 mL conical flask and digested in concentrated HNO_3. The plant digests were filtered and made up to the mark in a 100 mL volumetric flask using deionised water. The resultant supernatant was analysed for total Cu, Ni and Zn using flame atomic absorption spectrophotometer (Perkin-Elmer model, 2380).

Soil samples were air-dried and any clods and crumbs were removed. The dried soils were passed through a 2 mm sieve to remove coarse particles. Soil samples were then ground to a fine powder in a mortar in preparation for chemical analysis. Each sample of 5g of air-dried ground soil was digested in tri-acid mixture (H_2SO_4: HNO_3: HCl) in 3:1:2 ratio. The resulting solution was analyzed for total Copper, Zinc and Nickel using flame atomic absorption spectrophotometer (Perkin-Elmer AAnalyst 200 Atomic Absorption Spectrophotometer) by following standard method.

RESULTS AND DISCUSSION

The concentrations of Copper, Nickel and Zinc found in water and soil of the beel during monsoon and winter season are shown in the table-1. The average values in soil samples were found to be higher than in water samples. The higher concentration in soil may be due to precipitation and deposition. The concentration of Cu, Ni and Zn in water of the beel is lower than the standard value prescribed by IS: 2296/ WHO.

Table-1: Metals concentration in water and soil of the beel during monsoon and winter season

season	Water (mg/L)			Soil (mg/kg)		
	Cu	Ni	Zn	Cu	Ni	Zn
Monsoon	0.034	0.025	3.16	4.43	5.32	5.043
Winter	0.104	0.084	3.23	3.72	2.53	5.31
Average	0.069	0.055	3.195	4.075	3.925	5.176
WHO Guideline	1.0	0.02	3.0	----	-----	------

The percentage compositions of Cu, Ni and Zn in water and soil samples of the beel are shown in pie-diagram figure-1a and figure-1b respectively.

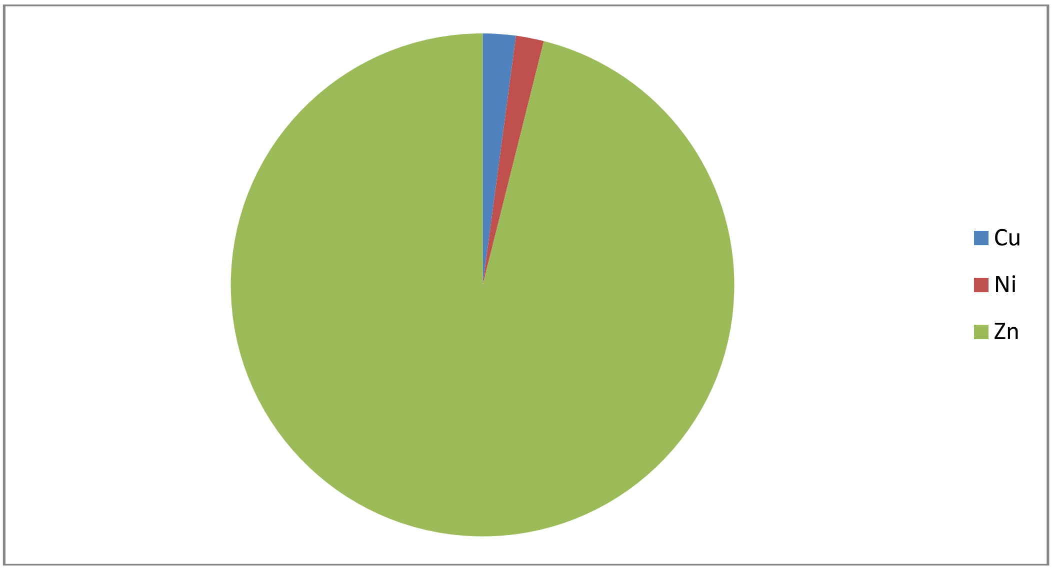

Figure: 1a Pie-diagram showing percentage composition of Cu, Ni and Zn of water samples of beel

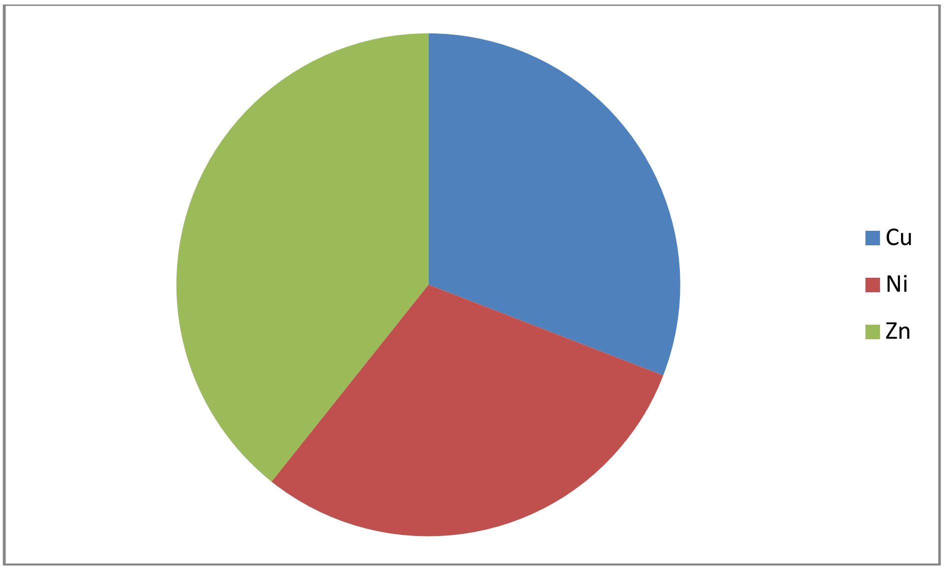

Figure:1b Pie-diagram showing percentage composition of Cu, Ni and Zn of soil samples of beel

The water hyacinth collected from the beel was analyzed by following standard methods as described in the methodology. The average concentration of Cu, Ni and Zn in the roots and leaves were as shown in the table-2. It is observed that the values are higher than that present in water and soil. This may be due to the capacity of metal absorption by Water hyacinth. It is also found that the concentrations of metals are higher in roots than in leaves as expected. The average concentration of Cu, Ni and Zn in leaf and root of water hyacinth is shown in the figure-2 below.

Table-2: Concentration of trace metals (mg/Kg DW) in the leaves and roots of Water hyacinth

	Leaf	Root	Leaf	Root	Leaf	Root
	Cu	Cu	Ni	Ni	Zn	Zn
MONSOON	10.26	14.32	15.24	17.30	121.12	227.24
WINTER	10.33	14.74	15.41	17.38	121.25	227.32
AVERAGE	10.30	14.53	15.33	17.34	121.19	227.28

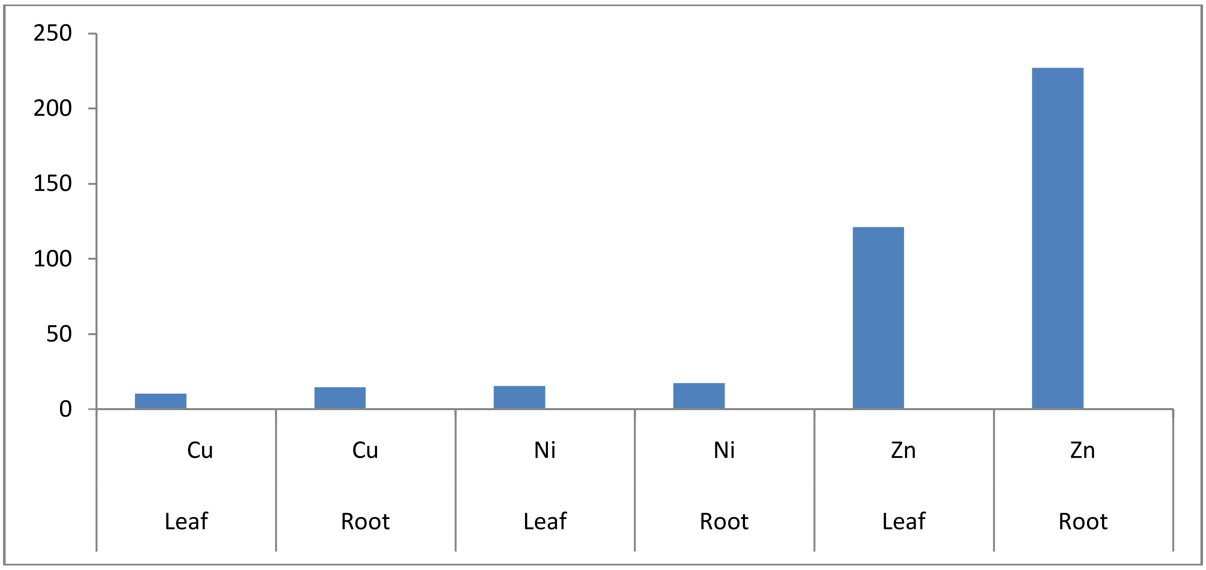

Figure-2 Average concentrations (mg/kg) of Cu, Ni and Zn in leaf and root of water hyacinth

CONCLUSION

The metals Cu, Ni and Zn in water samples of the beel were found to be less than the WHO's guideline value. However, the concentration of these metals in water hyacinth is much higher than it is in water. This implies that water hyacinth has capacity to absorb Cu, Ni and Zn metals. Similar studies are also done by many researchers. Overall the beel water is not polluted as the metals Cu, Ni and Zn is concerned.

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