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Heavy Metal Bioaccumulation in *Eichhornia Crassipes* (Mart) Solms. Growing in Selected Aquatic Ecosystems of Kochi

ELSAM JOSEPH*
**Department of Botany, St. Teresa's College, Ernakulam, Kerala – 682 035.*

Abstract
Heavy metals are one of the most hazardous contaminations in aquatic ecosystems. Accumulation of heavy metals in aquatic ecosystems causes serious threats to biodiversity. Wetland plants are capable of ameliorating the environment from various hazardous pollutants. The objective of the present study is to examine heavy metal bioaccumulation capacity of wetland plant, Eichhornia crassipes (Mart) Solms, growing in selected polluted aquatic ecosystems of Kochi. It is observed that Eichhornia crassipes bioaccumulates heavy metals such as Pb, Cu, Zn and Ni present in the different aquatic ecosystems studied. It is a cost-effective and eco-friendly technology for environment cleanup.
Key words: *Bioaccumulation, Contaminants, Eichhornia crassipes, Heavy metals.*

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I. Introduction

The rapid pace of industrialization and urbanization has given birth to heavy metal pollution. The deteriorating ecosystem as a result of accumulation of pollutants is an alarming threat to the flora and fauna (Lin *et. al.*, 2008)[1]. Drinking contaminated water causes severe health hazards in humans. Kochi is an important industrial belt of Kerala state. Many of its aquatic ecosystems are receiving industrial effluents and municipal waste water.

Aquatic macrophytes accumulate pollutants at a higher level. Wetland plants are important tools for heavy metals removal (Rai, 2008[2]; Choudhry *et. al.*, 1998[3]; Ghosh and Singh, 2005[4]). They are preferred over other bio-agents due to the low cost, frequent abundance in aquatic ecosystems and easy handling (Prabhat, 2009[5]&Alagoa*et. al*., 2019[6]). Aquatic macrophytes usually follow the mechanism of rhizo-filtration for metal removal (Calaldo and Wildung, 1978[7]). *Eichhornia crassipes* (water hyacinth) is seen growing profusely in polluted water bodies. According to researchers *Eichhornia crassipes* can remove toxins such as cyanide (Mhatre and Chaphekar, 1985[8]); Banuelos, 2000[9]). Since the plant has abundant nitrogen content, it can be used as a substrate for biogas production.

Eichhornia crassipes is a free-floating perennial aquatic plant of the family Pontedieriaceae. With broad, thick, glossy and ovate leaves, water hyacinth may rise above the surface of water as much as 1 meter in height. The leaves are 10-20 cm across and float above the water surface. They have long, spongy and bulbous stalks. The feathery, freely hanging roots are purple-black. An erect stalk supports a single spike of 8-15 conspicuously attractive flowers, mostly lavender to pink in colour with six petals. Water hyacinth reproduces primarily by way of runners or stolons. They also produce large quantities of seeds and they are viable up to thirty years. The present study is conducted to compare the heavy metal content of the selected polluted sites and to evaluate the heavy metal removal efficiency of *Eichhornia crassipes.*

II. Materials and Methods

Eichhornia crassipes was tested for its ability to accumulate five heavy metals such as lead (Pb), Cadmium (Cd), Copper (Cu), Zinc (Zn) and Nickel (Ni) which are commonly found in industrial effluents. A comparative analysis of heavy metal content of the three selected polluted water bodies of Kochi city was also done. The three selected sites at Kochi were Kadavanthra Canal (Site I), Vytila Lake (Site II) and Eroor River (Site III). The concentration of heavy metals such as lead (Pb), cadmium (Cd), Copper (Cu), Zinc (Zn) and Nickel (Ni) were found out both in water samples and plant body by atomic absorption spectrum (AAS). The metal uptake capacity of the plant was monitored by growing them in controlled conditions. Plants were allowed to grow in solutions of 1ppm concentration of each heavy metal for two weeks and the amount accumulated was assayed. Analyses were also conducted to find out the dissolved oxygen, carbon dioxide and chloride concentration of the sample sites. The alkalinity was also analysed to evaluated the water quality.

III. Result and Discussion

Eichhornia crassipes is a beautiful, introduced American plant, which spreads prolifically in water bodies. The morphological and anatomical features of the plant revealed many hydrophytic adaptations. It was observed that plants growing in highly polluted water bodies are small in size compared to those growing in less polluted conditions, which may be due to nutrient imbalance. It is reported that very high levels of heavy metals and high salinity of water can limit the growth of *Eichhornia crassipes* and other aquatic macrophytes (Mathias and Michael, 2007[10]; Chu, 2005[11]). The plants growing in polluted environment possessed may raphide crystals in parenchyma cells. This may be due to the accumulations of calcium content in plants.

The heavy metal content of the samples wasanalysed by atomic absorption spectrum (AAS) and its was found that all the heavy metals studied, except Cadmium, were accumulated in the plant. Zn, Ni and Pb were highly bioaccumulated by the plant. Cadmium was not accumulated in the samples, even though it was present in the water samples (Table 1). The amount of CO_2 and chloride and heavy metals studied were high in Kadavanthra Canal. Higher level of alkalinity was also observed here compared to other sites. The results of water analysis showed that the dissolved oxygen content of Kadavanthra Canal is considered to other two sites studied (Table 2 & 3). So Kadavanthra Canal is considered to be more polluted than Vytilla Lake and Eroor River. The higher concentration of metals in aquatic weeds signified the bioaccumulation that leads to filtration of metallic ions from polluted water (Ahmet *et. al.*, 2005) [12]. From the results it is observed that accumulation of heavy metal in plants is according to its availability.

Table 1: Estimation of Heavy metals in *Eichhornia crassipes* growing in aquatic ecosystems*

Heavy Metal	*Site I (mg/gm tissue)*	*Site II (mg/gm tissue)*	*Site III (mg/gm tissue)*	*Control (1ppm) (mg/gm tissue)*
Lead (Pb)	6.86±4.04	0.788±0.08	4.841±2.03	1.849±0.20
Cadmium (Cd)	0.000	0.000	0.000	0.000
Copper (Cu)	1.358±0.05	1.014±0.10	1.189±0.90	1.252±0.20
Zinc (Zn)	23.067±6.07	9.881±0.23	6.321±0.19	3.765±1.02
Nickel (Ni)	8.156±1.28	3.122±0.53	5.660±0.68	2.793±0.34
*Site I – Kadavanthra canal; Site II – Vytilla Lake; Site III – Eroor River.				

Table 2: Water analysis of selected aquatic ecosystems*

Parameters	*Site I (mg/L)*	*Site II (mg/L)*	*Site III (mg/L)*
Dissolved Oxygen	0.10±0.003	4.16±1.01	4.16±1.02
Carbon dioxide	1.76±0.04	0.88±0.002	0.88±0.001
Chloride	14.2±1.20	0.023±0.004	0.14±0.001
Alkalinity (ppm $CaCO_3$)	52.0±2.70	18.0±3.10	13.0±2.01
*Site I – Kadavanthra canal; Site II – Vytilla Lake; Site III – Eroor River.			

Table 3: Heavy metal analysis of selected aquatic ecosystems*

Heavy Metal	*Site I (mg/L)*	*Site II (mg/L)*	*Site III (mg/L)*
Lead (Pb)	0.132±0.03	0.028±0.001	0.083±0.003
Cadmium (Cd)	0.021±0.002	0.913±0.001	0.007±0.002
Copper (Cu)	0.100±0.08	0.081±0.004	0.082±0.004
Zinc (Zn)	0.829±0.05	0.519±0.03	0.488±0.01
Nickel (Ni)	0.111±0.002	0.042±0.005	0.054±0.002
*Site I – Kadavanthra canal; Site II – Vytilla Lake; Site III – Eroor River.			

IV. Conclusion

Macrophytes are potent tools in abatement of heavy metal pollution from aquatic ecosystems which are receiving industrial effluents and municipal wastewater. At lower concentrations of heavy metals, the plant growth was normal and removal efficiency was greater. Phytoremediation of metals is a cost-effective "green" technology for the cleaning up of environment. From a phytoremediation perspective, it is concluded that *Eichhornia crassipes* (Mart) Solms. is a promising plant species for phytoremediation of natural water bodies polluted with heavy metals such as Pb, Zn, Ni and Cu.

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