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RESEARCH ARTICLE

IMPACT OF CO AND CU (HEAVY METALS) ON *EICHHORNIA CRASSIPES* (MART.) SOLMS, WITH SPECIAL REFERENCE TO BIOACCUMULATION AND PHYTOREMEDIATION

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ABSTRACT

An attempt has made to study the accumulation of heavy metals such as copper and cobalt in *Eichhornia crassipes* (Mart). Solms, as bioaccumulation of this compounds leads to some alteration to its metabolism and physiological processes. The study was conducted by treating the plant *Eichhornia crassipes* (Mart). Solms with 800µM of Co and Cu separately and compared with the one kept as control. At the end of 60th day ICP-AES studies proved the presence of heavy metals on the leaves, petioles and roots of the plant.

INTRODUCTION

An ecosystem is a community of living organisms (plants, animals, and microbes) in conjunction with the non living components of their environment (things like air, water and minerals soil), interacting as a system (Tansley, 1935). An organism is always in the state of perfect balance with the environment. The favorable unpolluted environment has a specific composition. When this composition gets changed by addition of harmful substances, the environment is called polluted environment and the substances that pollutes it are called pollutants. Water pollution occurs when pollutants are discharged directly or indirectly into water bodies. Among various water pollutants, heavy metals are of major concern because of their persistent and bio-accumulative nature. They are highly toxic and cause ill effects at very low concentrations (Little, 1977). *Eichhornia crassipes* (Mart.) Solms is a free floating aquatic plant well known for its removal of pollutants from water (Mishra *et al*., 2007). Present study aims to determine the impact of heavy metals on the morphology and phytochemical characters of the plant and also to analyze the amount of heavy metal accumulation in leaves, petiole and roots, at the end of 60th days using Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES).

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MATERIALS AND METHODS

Before starting the experiment, young plants of *E. crassipes* was collected from Chittoor river of Ernakulam District and Kerala state. The plants were acclimated to room conditions for a short duration prior to experimentation. Tanks of similar size were taken. Eight liters of distilled water had been added to each tank. *Eichhornia* plants were introduced. Stock solution of heavy metal Copper and Cobalt are prepared. For this 800µM of Cu and Co weighed and separately treated with eight liters of distilled water. Metallic solution kept in the tanks considered as treated condition and the other tank to which no metallic solution was added considered as controlled condition. The tanks were then transferred to an open place. For each treatment 3 replicates were maintained. At a regular interval of 20 days after introduction into the tank the morphological parameters like height of the plants, diameter of leaves, length of the petioles, diameter of petioles, length of roots were recorded and comparison was made with the control. For each treatment 3 replicates were maintained. Foliar features like stomatal index and palisade ratio were studied using microscope. In Phytochemical analysis, test for tannins and alkaloids were done. Estimation of chlorophyll, carotenoids and carbohydrates was also carried out. ICP-AES was performed to know the accumulation of heavy metals such as copper and cobalt in the leaves, petioles and roots of the plant at the end of 60th days.

Table 1. Effects of cobalt and copper on growth parameters in *Eichhornia crassipes* (Mart.) Solms

Conditions	Height of plant (cms)				No. of leaves (cms)				Diameter of leaves (cms)			
	1st day	20th day	40th day	60th day	1st day	20th day	40th day	60th day	1st day	20th day	40th day	60th day
Control	24.1	33.9	42.5	51.8	6	10	13	13	6.4	7.1	9	10.2
Treated with Cobalt	24.3	33.1	40.1	49.3	7	10	12	12	6.5	7	8.1	10
Treated with Copper	24.2	32.8	37.2	45.8	6	9	10	10	6.4	7.1	8.2	10

Table 2. Effects of cobalt and copper on length and diameter of petiole and length of roots in *Eichhornia crassipes* (Mart.) Solms

Conditions	Length of petiole (cms)				Diameter of petiole(cms)				Length of roots (cms)			
	1st day	20th day	40th day	60th day	1st day	20th day	40th day	60th day	1st day	20th day	40th day	60th day
Control	12.5	16.7	21.8	25.9	2.8	3.8	4.7	4.8	7.6	11.9	15.9	18.5
Treated with cobalt	12.3	16.6	20.3	23.9	2.9	3.8	4.3	4.4	7.7	11.8	14.3	16.2
Treated with copper	12.4	16	19.5	21.2	2.9	3.6	4	4	7.8	11.7	14.2	16.2

Table 3. Effects of cobalt and copper on stomatal index and palisade ratio in *Eichhornia crassipes* (Mart.) Solms

Conditions	Stomatal index (%)				Palisade ratio			
	1st day	20th day	40th day	60th day	1st day	20th day	40th day	60th day
Control	18	21.8	24.4	26.6	27.5	29.5	30.5	31.5
Treated with cobalt	18.2	20.1	21.4	23.6	27.4	28.4	28.9	29.5
Treated with copper	18	18.8	19.2	21.4	27.5	27.7	27.8	27.8

Table 4. Preliminary Phytochemical screening of extracts in control and treated plants of *Eichhornia crassipes* (Mart). Solms

Conditions	Tannins	Alkaloids	Carbohydrates
Control	+	++	++
Treated with cobalt	-	+	+
Treated with copper	-	+	+

++ : High precipitation, + : Moderate precipitation, - : Absent

Table 5. Estimation of chlorophyll, carotenoids and carbohydrates in different conditions in *Eichhornia crassipes* (Mart.) Solms

Conditions	**Chlorophyll concentration (µg/mL)**			**Carotenoid (µg/mL)**	**Carbohydrates (µg/mL)**
	Chl. a	**Chl. b**	**Total Chlorophyll**		
Control	0.221	0.110	0.335	0.025	94.89
Treated with cobalt	0.165	0.069	0.241	0.021	90.81
Treated with copper	0.141	0.053	0.198	0.017	80.61

Table 6. ICP-AES studies in different conditions in *Eichhornia crassipes* (Mart.) Solms. and in water samples

Conditions	concentration in leaf (ppm)	concentration in petiole (ppm)	concentration in roots (ppm)	Water samples (ppm)
Control	0	0	0	0
Treated with cobalt	12.45	5.70	22.75	0.08
Treated with copper	13.82	8.99	30.64	0.02

RESULT AND DISCUSSION

In the present study, it was evident that the plants in the treated conditions shows decrease in the growth and development. Control showed highest value in the plant height, while both the treated conditions showed the lowest. In all the morphological parameters, such as diameter of the leaves, length of petioles, diameter of petiole, number of leaves, length of rootsthe control shows highest value (Table 1- 2). A significant inhibitory effect in the presence of heavy metals (Cd, Pb and Mn) on the morphological growth was reported by (Agarwala *et al*., 1977 and Misra, 1984). Heavy metal toxicity retards growth of the plants. Foliar features like stomatal index and palisade ratio revealed higher values in control than treated conditions (Table 3). Polluted environment has decreasing effect on stomatal frequency. When there is

decrease in stomata number, gases exchange in the plant gets reduced. This effects photosynthesis and respiration. These observations are in agreement with those of (Fuhrer, 1988; Inamdar *et al*., 1984)

In phytochemical analysis, tannins were present only in control plants. Alkaloids and carbohydrates were present in all the three conditions but control plants showed high precipitation and both the treated conditions showed moderate precipitation (Table 4). It was analyzed that the use of heavy metals like Cobalt and Copper affect the growth and reproduction in plants. Usually the application has a negative impact when applied commercially and carelessly. Absence of Tannins and lesser precipitation of alkaloids and carbohydrates in comparison with control however show that the heavy metal does accumulate in plant parts causing some alteration to its metabolism and physiological processes. Higher concentration application of the heavy metals naturally stunts the growth, development and reproduction of the plants. Studies of [4, 12] also supported these findings. Estimation of chlorophyll and carotenoids revealed that the concentration is higher in control. Lowest concentrations were present in copper treated conditions than cobalt treated conditions. Similar observations was reported by [11] Estimation of carbohydrates also revealed that highest concentrations were present in control plants and lowest concentration in copper treated conditions (Table 5). From ICP-AES studies, it is found that copper was accumulated in leaves, petioles and roots at toxic levels followed by those treated with cobalt (Table 6). Many scientists have worked out the effect on accumulation of heavy metal [2,3,5]. More was accumulated by the roots of *Eichhornia crassipes* and lesser amount in petioles. The result showed the effect of higher level of bioaccumulation by the plant, which shows a low level of heavy metal present in the water samples [14]. The higher concentration of metals in aquatic weed signified the bioaccumulation that lead to filtration of metallic ions from the polluted water.

Conclusion

The result of the present study clearly indicated that even at lower concentrations of heavy metals the plant showed reduced growth rate and it is also harmful to humans as well as animals. From the results obtained, it can be stated that a small amount of heavy metals has a negative impact on the growth of the plant and it has shown to accumulate large amount of metals in its parts which is said to be major cause of heavy metal poisoning, pollution and bioaccumulation. From the phytoremediation perspective, it was concluded that *Eichhornia crassipes*is a promising plant species for remediation of natural water bodies polluted with heavy metals.

Smaller concentrations of the applications of heavy metals naturally stunts the growth, development and reproduction of the plants. Its deleterious effects can be far reaching.

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