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Phytoremediation of rubber wood processing factory effluent using *Ipomeas aquatic*

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Abstract

The phytoremediation technique which consists of using plants to remove ions has been increasingly chosen over past decades due to its low cost technology to mitigate contaminated areas. The aim of this study was to evaluate the potential of the aquatic macrophyte, *Ipomea aquatica* Forsk to translocate copper which at higher concentrations may be toxic to human populations. Translocation ability was defined as the amount of copper translocated in the plant tissue. The results were in the order of Roots > Stems > Leaves. *Ipomea aquatica* plants had a high bioconcentration of this trace element even when grown in water environment with low concentrations. High accumulated copper content in the tissues of *Ipomea aquatica* suggested that the sps. *Ipomea aquatica* is able to accumulate copper. Therefore it has potential use in phytoremediation and provides a new resource for exploring the copper accumulation mechanism.

Keywords: Phytoremediation, *Ipomea aquatica*, copper accumulation, rubber wood effluent.

1. Introduction

Anxiety Heavy metals from the effluents cause severe damage to the ecosystem. Toxic metals may originate from mining waste water, solid wastes, soil additives, fertilizers, pesticides and air pollutants [4, 18]. The rubber wood processing factory effluent contains copper and it is toxic to aquatic fauna and flora.

Toxic metal contaminants in water are usually removed by ion exchange, reverse osmosis, microfiltration and precipitation. These methods are highly expensive when they are used for treating large water volumes of polluted water [6]. Chemical treatments often leave behind certain residues which make the treated effluents unsuitable for domestic use. Plants are used for removing metals from contaminated soils and waters, since they are more sustainable leave behind little residue, cost efficient, generate recycle able metal rich plant residue and eco-friendly.

Phytoremediation of Industrial effluents employs plants like water hyacinth [9]. [17] Reported about the uptake of heavy metals like cadmium, lead and Mercury from polluted waters by water hyacinth, *Eichhornia crassipes*. Chemical treatments are often coupled with biological treatments like phytoremediation [3] such systems convert even toxic effluents into non-toxic components making provision for allowing them into regular fresh water bodies.

The present study is done to assess the efficiency of *Ipomea aquatica* in absorbing free copper from RWPF effluents and accumulating it in different phytal parts and thus examining the possibility of using the plant in the management of using the plant in the management of the toxic RWPF effluent.

Materials and Methods

Test plant

The floating macrophyte *Ipomea aquatica* Forsk (Water spinach) was collected from Pazhayar River in Ozhuginasery, area of Nagercoil. The collected plants acclimatized for 7 days in fresh water in large FRP tanks. Only mature and healthy plants was used for metal adsorption and accumulation studies.

Collection of RWPF effluent

The Rubber Wood Processing Factory effluent (RWPF) was collected from the factory premises at Cape Comerin.

The copper containing effluent issuing out of the log boiler was collected in 10L plastic cans. The cans were brought to the laboratory and stored in a BOD incubator at 20 °C.

Preparation of toxicant water for raising *I. aquatica*

Standard stock solution was prepared by diluting 25ml of the Cu containing concentrated RWPF effluent with 975ml of tap water such that the stock contained 25ml of Cu per litre. Toxicant samples were prepared in 4 concentrations by diluting the stock 0.125, 0.25, 0.5 and 1 ml/dl. A control was also maintained along the side.

Experimental design

Acclimatized plants were transplanted into plastic tubs of 25L capacity containing 15L of toxicant water sample. All the tubs were exposed to enough sunlight for a detention period of 35 days. Level of water in the holding tubs was maintained by adding tap water once a week. Tissue samples were collected on the 3rd day and subsequent collections were made on the 7th, 14th, 21st, 28th and 35th days of observation.

Tissues tested for bioaccumulation

The plant tissues namely leaves, shoot and root were collected for analysis. Samples were thoroughly washed in distilled water to remove trace soil, weighed and dried in a hot air oven at 110 °C for 24 hours and powdered using a glass mortar and pestle. Simultaneous collections of water samples from the holding tubs were also made.

Preparation of sample (By Acid Digestion)

7.5 ml of Nitric acid and 2.5ml of concentrated Hydrochloric acid were added to about 1 g of powdered tissue sample in 100 ml Erlenmeyer flask and it is kept overnight. Digestion was performed on a hot plate (70– 80 °C) till the samples get dried. Then 3 ml HNO₃ and 1ml conc. HCL were added and

the digestion was allowed to proceed till a white residue is obtained [12]. The solutions were then filtered and made to 10 ml each with double distilled water. Samples were stored in clear high quality plastic containers for further analysis.

Estimation of Cu accumulation

Copper results in both water and digested plant samples were estimated using Atomic Absorption spectrophotometer (AAS 4129, Electronics Corporation of India Limited). Standard statistical parameters were employed in analysing the results.

Results

Table I shows the accumulation of copper in the leaves, stems and roots of *Ipomea aquatica* copper accumulation significantly decreased in the leaf on the fourteenth day 3.550 percent in 0.125 (ml/dl) and increased significantly to 62.236 percent in 0.5 (ml/dl) effluent concentrations. In the leaf copper accumulation significantly increased on the thirty fifth day ranging from 132.484 percent to 287.47 percent in 0.125 (ml/dl) effluent concentration to 1 (ml/dl) effluent concentration. In the stem copper accumulation significantly increased on the thirty fifth day ranging from 29.72 percent to 194.45 percent in 0.125 (ml/dl) effluent to 1(ml/dl) effluent concentrations. In the root copper accumulation significantly increased on the thirty fifth day ranging from 79.67 percent to 99.178 percent in 0.125 (ml/dl) effluent to 1(ml/dl) effluent concentration.

(Table 2) shows the copper flux in water used for raising *I. aquatica*. When *I. aquatica* was raised in eater mixed with 0.125 (ml/dl) effluent the copper lever gradually decreased ranging from 0.839 ppm to 0.027 ppm from third to thirty fifth day. When *I. aquatica* was raised us water mixed 1(ml/dl) effluent the copper lever gradually decreased ranging from 0.855 ppm to 0.120 ppm from third to thirty fifth day.

Table 1 : Accumulation of copper in the leaves, stem and of *I. aquatica*

Effluent conc. (ml/dl)	Active copper conc (in ppm)	Days of Exposure													
		3 day		7 day		14 day		21 day			28 day		35 day		
		Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem	Root	Leaf	Stem	Leaf	Stem	Root
		2.084±	2.308±	2.084±	2.308±	2.084±	2.308±	2.084±	2.308±	5.359±	2.084±	2.308±	2.084±	2.308±	5.359±
Control	0.000	0.006	0.004	0.006	0.004	0.006	0.004	0.006	0.004	0.002	0.006	0.004	0.006	0.004	0.002
		1.609	1.405	1.679	2.119	2.010	2.120	3.378	2.789	9.408	4.778	2.989	4.845	2.994	9.629
0.125	1.039	(-22.79)	(-39.1)	(-19.4)	(-8.18)	(-3.550)	(-8.14)	(62.09)	(20.84)	(75.55)	(129.3)	(29.5)	(132.48)	(29.7)	(79.7)
					(NS)	(NS)	(NS)								
		0.965	0.780	2.323	1.175	2.531	1.1692	2.686	2.096	9.141	3.064	3.378	4.846	3.407	9.107
0.25	1.059	(-53.69)	(-66.20)	(11.5)	(-49.09)	(21.450)	(-26.7)	(28.88)	(-9.18)	(70.57)	(47.02)	(46.4)	(132.6)	(47.6)	(69.9)
		1.155	0.724	1.947	1.268	3.381	1.908	3.803	2.330	11.196	6.283	3.135	6.545	3.275	11.981
0.5	1.090	(-44.57)	(-68.63)	(-6.57)	(-45.06)	(62.23)	(-17.3)	(82.48)	(0.953)	(108.91)	(201.48)	(35.8)	(214.05)	(41.9)	(124)
									(NS)						
		0.817	1.567	1.043	1.684	2.223	2.541	5.381	5.601	12.332	7.676	5.760	7.950	6.796	10.674
1	1.165	(-60.79)	(-32.10)	(-50)	(-27.03)	(6.669)	(10.1)	(158.2)	(142.67)	(130.11)	(268.33)	(149.6)	(281.47)	(195)	(99.2)

Note: NS - T test value not significant all other deviations significant at p≤0.01 and values in parentheses indicate percent change over control.

Table 2: Copper flux in water used for raising *Ipomea aquatica*

Effluent concentration (ml/dl)	Days of Exposure						
	0 day	3 day	7 day	14 day	21 day	28 day	35 day
Control	0.008	—	—	—	—	—	—
0.125	1.039± 0.19	0.839± 0.09	0.654± 0.084	0.193± 0.008	0.157± 0.007	0.138± 0.004	0.027± 0.001 (97.40)
0.25	1.059± 0.2	1.048± 0.18	0.882± 0.081	0.211± 0.009	0.176± 0.007	0.173± 0.007	0.120± 0.004 (88.66)
0.5	1.090± 0.21	0.853± 0.09	0.722± 0.087	0.137± 0.006	0.123± 0.005	0.115± 0.003	0.102± 0.004 (91.74)
1	1.165± 0.003	0.855± 0.088	0.696± 0.073	0.211± 0.006	0.138± 0.005	0.134± 0.004	0.120± 0.007 (89.69)

Discussion

Phytoremediation of industrial is a sound alternative to a variety of chemical treatments. Phytoremediation is carried out to clear polluted waters of heavy metals and certain chemicals. Industrial pollutants containing heavy metals cannot be degraded and therefore accumulate in water, soil, bottom sediments and living organisms. Heavy metal removal from water has been attempted using different technologies phytotechnologies are increasingly developed during the last two decades involving plants for heavy metal removal [16] water hyacinth showed 4.8% arsenic removal, 58% copper removal and 72.35% chromium removal from the environment [7]. Heavy metals entering the aquatic ecosystem, affects the fauna and flora. The identification of certain water plants that accumulated heavy metals in certain tissues had been a great land mark in the management of aquatic system polluted with heavy metals [21].

Heavy metals are continuously released in to the terrestrial environment by natural sources and human activities. The uptake and accumulation of heavy metals by plants promotes a mechanistic understanding of the biological significance of particular metal concentrations and distributions in biota [13]. Aquatic plants are known to accumulate metals from the environment which are discharged into the environment due to the dispersal of industrial wastes [14]. Plants accumulate the pollutants that they absorb in the different phytal parts like leaves, stem, roots, bark, midribs and other special tissues like the palisade parenchyma. A mechanism of accumulation in some plants apparently involves binding potentially toxic metals at cell walls of roots and leaves, away from sensitive sites within the cell or storing them in a vacuolar compartment. Plant species which have no exclusion mechanism in the roots absorb translocate large concentrations of metals and accumulate them in their growing parts specially in the leaves without showing any toxicity symptoms [11]. Aquatic macrophytes remove metals by surface adsorption and incorporate them into their own tissues in a bound form [16]. [5] Reported that the aquatic macrophytes absorb heavy metals through roots.

In *Azolla filiculoides* copper, cadmium, and uranium, were stored and distributed in root and shoot tissues [20]. *Colacasia esculenta* accumulated about 195µg of arsenic in root [1]. Living plants can be compared to solar driven pumps which can extract and concentrate several metals from their environments and store them into their tissues [8]. Phytomass

of *Quercus ilex* was able to remove toxic metals from the aqueous solution by the leaf, stem and root [15].

I. aquatica is known for its ability to transport heavy metals into its system against a concentration gradient. *I. aquatica* is commonly found in fresh water bodies, being part of the riparian vegetation. It thrives well even in highly polluted water bodies and has been repeatedly indicated in phytoremediation of heavy metals.

The analysed tissues of *I. aquatica* namely leaves, stem, and root showed maximum copper absorption in plants that were grown in higher concentration of 1ml/dl when the copper concentration in the medium increased the bioaccumulation potential also increased [10, 19]. Maximum concentration of 12.332 ppm of copper was observed in the roots of *I. aquatica* grown in 1ml/dl concentration on the 21st day whereas the leaf and stem tissues showed minimum absorption of 5.381 ppm and 5.601 ppm respectively on the same day. Rapid immobilisation of copper was observed. The copper concentration in the root decreased to 10.674 ppm in 1ml/dl concentration on the 35th day whereas the leaf and stem showed increased copper absorption of 7.950ppm and 6.796ppm respectively. Roots showed maximum accumulation followed by leaves and shoot. The results are in agreement with [2] who observed higher concentrations of copper in roots than in shoots. From the roots there was gradual distribution of copper among the various plant parts. Shoots served as transient passages in mobilizing copper to leaves the final point of storage. The leaves showed normal health signs even on the 35th day of continuous exposure.

In the present study, the effectiveness of *I. aquatica* in the phytoremediation of rubber wood processing plant effluent has been established. The plant effectively accumulates copper the major consistent of the rubber wood processing effluent. It is possible to bioremediate this effluent using *I. aquatica*. This study revealed that the accumulated copper circulated between the different tissues through the root. It could be used in biomonitoring studies since it is a perennial plant available throughout the year.

Reference

1. Aksorn E, Visoottiviset P. Selection of suitable emergent plants for Removal of arsenic from arsenic contaminated water. *Science Asia* 2004; 30:105-113.
2. Baldantoni D, Alfani A, Tommaqi AAPD, Bartoli G, Santo AVD. Assessment of macro and micro element accumulation capability of two aquatic plants. *Environmental pollution* 2004; 130:149-156.
3. Brix H, Schrup HH. Use of aquatic macrophytes in water. *Pollution control, Ambio Amboex* 1989; 18(2):100-107.
4. Cox RM, Hutchinson TC. Metal Co-tolerance in grass *Deschampsia cespitosa* (L) Beau from the sudbury the smelting area. *New phytol* 1979; 84:631-647.
5. Denny H, Wilkins D. Zinc tolerance in *Betula spp.* II. Micro analytical studies of Zinc uptake into root tissues. *New phytol* 1987; 106:524-534.
6. Dushenkov VPBA, Kumar N, Motto H, Raskin I. Rhizofiltration. The use of plants to remove heavy metals from aqueous streams. *Environ sci Technol* 1995; 29:1239-1245.
7. Keith C, Borazjani H, Dielhi SV, Su Y, Baldwin BS. Removal of copper, chromium and Arsenic by water hyacinths. 2006 proceedings 26th annual mississippi water Resource conference, 2006.
8. Langille WM, Maclean KS. Some essential nutrient elements in forest plants as related to species plant part, season and location. *Plant soil* 1976; 45:17-26.
9. Mala R, Babu SS. Biological treatment of textile dye effluent using water hyacinth. *Pollution research* 2003; 25(1):151-153.
10. Malaea P, Haritonidis A. Local distribution and seasonal variation of Iron, Lead, Zinc, Copper, Cadmium, Calcium and Magnesium concentration in the sea grass *Cymodocea Nodosa Ascheris* in the antikyra Qulf Greece. *Mar E coli* 1995; 16:41-56.
11. Memon AR, Aktoprakligil D, Ozdemir A, Vertill A. Heavy metal accumulation and detoxification mechanism in plants. *Turk J Biol* 2001; 25:111-121.
12. Ming C, Ma LQ. Comparison of three aqua regia digestion methods for twenty floride soils. *Soils sci soc am J* 2001; 65:491-499.
13. Neylan D, Ilgen IR. Accumulation of heavy metals in freshwater organisms: Assessment of Toxic interactions. *Turk J chem* 2001; 25:173-179.
14. Outridge PM, Nollar BN. Accumulation of toxic trace elements by fresh water vascular plants. *Rev Environ Contam Toxicol* 1991; 121:1-63.
15. Prasad MNV, Freitas H. Removal of toxic metals from the aqueous solution by the leaf, stem and root phytomass of *Quercus ilex*. *Environmental pollution* 2000; 110(2):277-283.
16. Rai UN, Sinha RD, Tripathy S, Chandra P. Removal of heavy metal from polluted River water using aquatic macrophytes *Salvinia sp.* *Ecological Engineering* 1995; 5:744-746.
17. Chigbo F. Uptake of arsenic, cadmium and mercury from polluted water by the water hyacinth *E. crassipes*. *Environ Poll* 1982; 27:31-36.
18. Rhoads FM, Olson SM, Manning A. Copper toxicity in tomato plants. *J. Environ Qual* 1989; 18:195-197.
19. Sanchiz C, Garcia AM, Pastor G. Bioaccumulation of Mercury, Cadmium, Lead and zinc in four marine phanerogames and the alga *Lamouroux* from the East Coast of Spain. *Botanic Marina* 1999; 42:157-167.
20. Sela M, Tel-or E, Feritz E, Huttermann A. Localization and toxic effects of Cadmium, Copper and Uranium in *Azolla filicoides*. *Plant physiology* 1998; 88:30-36.
21. Sen K, Bhattacharya N. Studies on update and toxic effects of lead on *Salvinia natans*. *Indian Environment Health* 1993; 35(4):308-320.