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RESEARCH ARTICLE

Eichhornia and *Ipomoea*: Efficient phytoremediators of manganese

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ABSTRACT

Phytoremediation uses plants to remove pollutants from the environment. The content of heavy metals in the biosphere has been increasing over the past hundred years due to the economic activity of man. Manganese is one of the heavy metals which is toxic but then too necessary in trace amounts for all living organisms. However accumulation of this heavy metal is not ignorable. To maintain the balance of manganese in the environment phytoremediation of manganese is the most cost effective method. Leaves of two aquatic plant species viz. *Eichhornia crassipes* and *Ipomoea aquatica* were used as research tool for removal of manganese ions. The removal is dependent on the rate of adsorption by the leaves. Filtrate of leaves was used for various chemical tests and estimation of Mn by Ammoniumpersulphate method and volumetric analysis. *Eichhornia* gives better results as compared to *Ipomoea*. This was due to the increase in the adsorption capacity at higher dose of adsorbent. The removal of Mn ions from aqueous solutions using powder of different waste materials viz., *Ipomoea* leaves and water hyacinth was found to be increased on adsorbent dosage, initial concentration of sorbate, p^H and contact time. As far as contact time is concerned *Ipomoea* showed better results for largest removal of manganese ions in comparison to *Eichhornia.*

Keywords: Phytoremediation, *Eichhornia, Ipomoea,* adsorption, contact time.

INTRODUCTION

Environmental science is the interdisciplinary study of human impact on the living and nonliving components of the world. It examines the Earth's processes, climate change, natural resources, pollution and alternative sources of energy. Soil and water contaminated with metals pose a major environmental and human health problem that is still in need of an effective and affordable technological solution (Raskin, 1997). The content of heavy metals in the biosphere has been increasing over the past hundred years due to the economic activity of man. One of the toxic metals is manganese, which is needed by living organisms in trace amount. Manganese with atomic number 25 forms an essential part of the enzyme systems that metabolize proteins and energy in all animals.

Although necessary for the survival of humans Mn is also toxic when present in high concentrations. Symptoms of manganese poisoning are hallucinations, forghetfulness and nerve damage. Manganese can also cause Parkinson's disease, lung embolism and bronchitis. Between toxic concentrations and concentration that cause deficiencies in plants, small area of concentrations for optimal growth of plant can be detected. To curtail heavy metal pollution problems, phytoremediation is used where plants are introduced into an environment toremove contaminants from it. Studies have also shown where these plants have turned the contaminant into a harmless substance and then once harvatsed can be used for mulch, animal feed, paper, etc. (Hinchman *et al*., 1994).

Considering the significance of phytoremediation in removal of pollutants, *Eichhornia crassipes* (Pontederiaceae) and *Ipomoea aquatica* (Convolvulaceae) are used in the present study as phytoremediators of manganese. *Eichhornia* commonly called water hyacinth is usually a free floating plant, but is also found on river banks with rooted condition. It reproduces by means of vegetative reproduction and by seeds. Water hyacinth has high water retention property and high content of nitrogen. The aquatic plant *Ipomoea aquatic*a (water spinach) grows wild in tropics and sub- tropics. Only a very few scientific studies have been conducted on its medicinal aspects. These include inhibition of prostaglandin synthesis, effects on liver diseases, constipation and hypoglycemic effects (Badruzzaman and Husain,1992). In the present work, phytoremediation of mn ions is carried out using the leaf extraction of *Eichhornia crassipes* and *Ipomoea aquatica.* The parameters studied were adsorbent dose, contact time and effect of pH.

MATERIALS AND METHODS

Dried powder of *Eichhornia crassipes*/ *Ipomoea aquatica* leaves is taken (ADSORBENT DOSE). 50 ml of distilled water was added separately to the dried powders respectively and kept in the shaker is for 2 hrs for vigorous shaking. 2mg to 35mg of Manganese sulphate($MnSO_4$) was added to the solution and again put in the shaker for around 1 hr. to maintain steady period of time. The solution was then filtered and filtrate was used for furthur testing.

The above filtrate was used for: 1) Chemical tests, 2) Ammoniumpersulphate method and 3) Volumetric analysis.

Detection of Mn by chemical tests:

1. 2 to 3 drops of filtrate + 0.001g $Na_2S_2O_8$ + 2-3 drops of 2N H_2SO_4 + 0.1N $AgNO_3$ + boil = reddish brown color is obtained.

2. 2 to 3 drops of filtrate + 0.002g PbO_2 + 5 to 6 drops of conc. HNO_3 + boil strogly and allow it to settle = purple or reddish brown colour is obtained.

Estimation of Mn by Ammoniumpersulphate method:

20 ml of filtrate is taken and one drop of H_2O_2 is added. The above solution is concentrated by boiling. 1 gm of ammoniumpersulphate is added to the solution. Above solution is boiled for one minute. The solution is removed from heat source, and kept steady for 1 minute and then cooled under tap water. Above solution was diluted with 5 ml of distilled water. The absorbance was read at 525nm wavelength.

Volumetric analysis for estimation of Mn:

1. Solution in burette: EDTA
2. Solution in conical flask: filtrate + 10 ml buffer NH_3 (aq.)/ NH_4Cl of pH 10.
3. Indicator: pinch of EBT. The solution in flask was titrated against solution in burette. The burette reading was note.

Formula used for finding out the amount of Mn adsorbed:

1000cm^3 of 1M EDTA = 54 gms of Mn

Burette reading of 0.2 M EDTA= _ Amount of Mn

RESULTS AND DISCUSSION

According to the study of work, the following results were observed. Concentration of 15, 25 and 35 mg Mn was considered in *E. crassipes* which gave titrated reading of 1.3, 1.9 and 2.3 respectively. Using the earlier mentioned formula, amount of Mn absorbed was calculated as 0.96, 4.48 and 11 mg respectively. The O.D. was taken at 525nm showing 0.18, 0.24 and 0.29 respectively. Similar method was used for *I. aquatica* and showed the titrated result of 1.2, 2.1 and 2.4 respectively. The amount of Mn adsorbed was found to be 2.04, 2.32 and 9.08 showing respective O.D. of 0.31, 0.38 and 0.43. Taking adsorbent dose of Mn of 0.5, 1.0 and 1.5 gms. Burette reading showed 2.7, 2.5 and 1.9 respectively for *E. crassipes* which also resulted in 5.84, 8 and 14.48 amount of Mn adsorbed. The spectrophotometric method revealed 0.24, 0.36 and 0.39 respectively. Same method in *I. aquatica* gave burette reading 3.2, 3.1 and 2.9 which further lead to 0.44, 1.52 and 3.68 amount of Mn adsorbed.

The spectrophotometric method revealed 0.16, 0.19 and 0.21 respectively. Contact time of 2 hours, 12 hours and 24 hours was considered to find the burette reading, amount of Mn adsorbed and and O.D. in *E. crassipes* and *I. aquatica* separately. The burette reading was observed as 3.3, 2.9 and 2.6 in *E. crassipes* and 2.6, 2.2 and 1.8 in *I. aquatica* while amount of Mn adsorbed as calculated from the standard formula was 0.64, 3.68 and 6.92 in *E. crassipes* and 6.92, 11.24 and 15.56 in *I. aquatica.* The spectrophotometric method revealed 0.51, 0.36 and 0.57 in *E. crassipes* and 0.08, 0.17 and 0.26 in *I. aquatica.* The final aspect which was considered was the effect of variation in pH which was taken as 5.5, 3.5 and 1.5. Here again the titrated result observed was 2.6, 2.7 and 2.2 in *E. crassipes* while 3.1, 2.9 and 2.7 in *I. aquatica*. The amount of Mn observed was 6.92, 5.84 and 11.24 in *E. crassipes* whereas 1.52, 3.68 and 5.84 in *I. aquatica.* The spectrophotometric method revealed 1.06 ,0.98 and 1.27 in *E. crassipes* whereas 0.39, 0.48 and 0.51 in *I. aquatica.*

The observations indicated that as concentration of Mn increased, rate of adsorption also increases. It was also found that as adsorbent dose increase adsorbent rate also increases. *Eichhornia crassipes* proved to show better efficiency as bioremediator than *Ipomoea aquatica*. Higher adsorbent dose increases the active sites of adsorbent. Adsorption increases by increasing contact time. This is because increase in contact time favors increasing adsorption of metal. Largest removal was observed in *Ipomoea aquatica* in this parameter. With decreasing pH adsorption increases. This is because with decreasing pH concentration, H^+ ions increase resulting in protonation of active sites of the adsorbent.

Table 1: *E. crassipes* (concentration of Mn)

Conc. of Mn in mg	Burette reading (0.2 M EDTA)	Amt of Mn adsorbed in mg	O.D.
15	1.3	0.96	0.18
25	1.9	4.48	0.24
35	2.3	10.16	0.29

Table 2. *I. aquatica* (concentration of Mn)

Conc. of Mn in mg	Burette reading (0.2 M EDTA)	Amt of Mn adsorbed in mg	O.D.
15	1.2	2.04	0.31
25	2.1	2.32	0.38
35	2.4	9.08	0.43

Table 3. *E. crassipes* (Adsorbent dose in gms)

Adsorbent dose in gms	Burette reading(0.2 M EDTA)	Amt of Mn adsorbed in mg	O.D.
0.5	2.7	5.84	0.24
1	2.5	8	0.36
1.5	1.9	14.48	0.39

Table 4. *I. aquatica* (Adsorbent dose in gms)

Adsorbent dose in gms	Burette reading (0.2 M EDTA)	Amt of Mn adsorbed in mg	O.D.
0.5	3.2	0.44	0.16
1	3.1	1.52	0.19
1.5	2.9	3.68	0.21

Table 5. *E. crassipes* (Contact time)

Contact time in hrs	Burette reading (0.2 M EDTA)	Amt of Mn adsorbed in mg	O.D.
2	3.3	0.64	0.51
12	2.9	3.68	0.36
24	2.6	6.92	0.57

Table 6. I. *aquatica* (Contact time)

Contact time in hrs	Burette reading (0.2 M EDTA)	Amt of Mn adsorbed in mg	O.D.
2	2.6	6.92	0.08
12	2.2	11.24	0.17
24	1.8	15.56	0.26

Table 7. *E. crassipes* (Effect of pH)

Effect of pH	Burette reading (0.2 M EDTA)	Amt of Mn adsorbed in mg	O.D.
5.5	2.6	6.92	1.06
3.5	2.7	5.84	0.98
1.5	2.2	11.24	1.27

Table 8. *I. aquatica* (Effect of pH)

Effect of pH	Burette reading (0.2 M EDTA)	Amt of Mn adsorbed in mg	O.D.
5.5	3.1	1.52	0.39
3.5	2.9	3.68	0.48
1.5	2.7	5.84	0.51

Phytoremediation is the process where in situ treatment of polluted area is carried out using various vegetative species (Sykes *et al*., 1999). Many of the plant species, along with their growth and development, also have an ability to accumulate high level of heavy metals from the soil (Lasat, 2000). However, recently discovered genetic technology has made it possible for scientists to determine the genetic basis to increase the accumulation of toxic substances in plants (Moffat, 1995). Huang and Cunningham, (1996) have studied that genetic engineering will also be beneficial for the production of transgenic plants that will be able to combine the remediation capabilities of both plants

Fig. 1: ***E. crassipes*** **(concentration of Mn)**

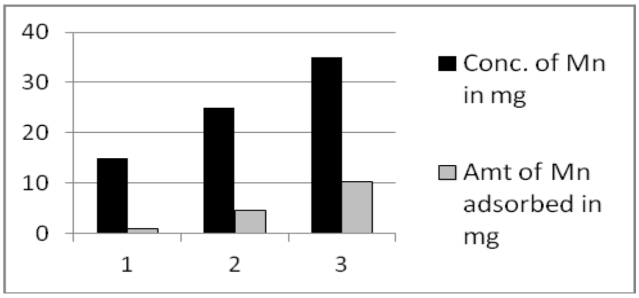


Fig. 2: ***I. aquatica*** **(concentration of Mn)**

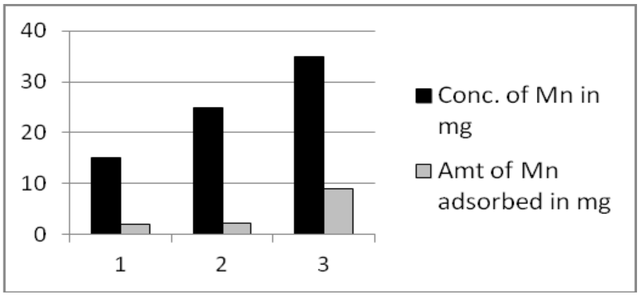


Fig. 3: ***E. crassipes*** **(Adsorbent dose in gms)**

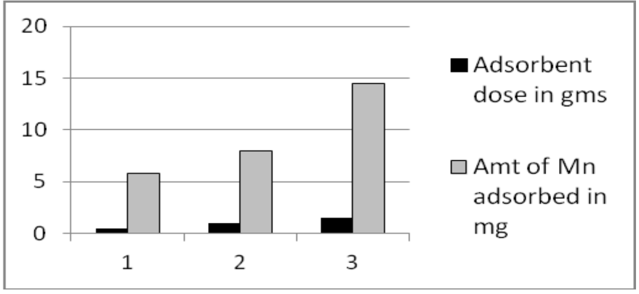


Fig. 4: ***I. aquatica*** **(Adsorbent dose in gms)**

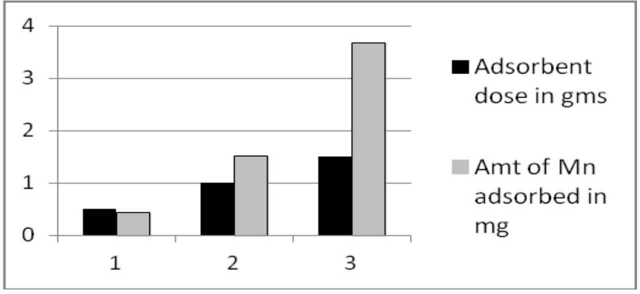


Fig. 5: ***E. crassipes*** **(Contact time**

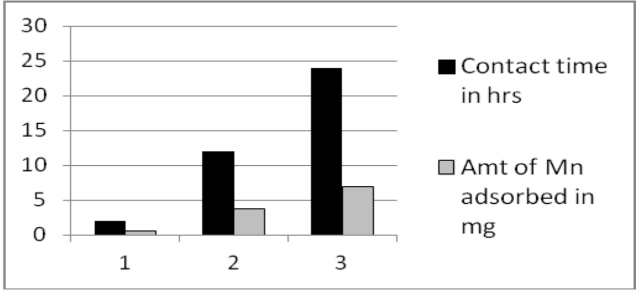


Fig. 6: **I.** ***aquatica*** **(Contact time)**

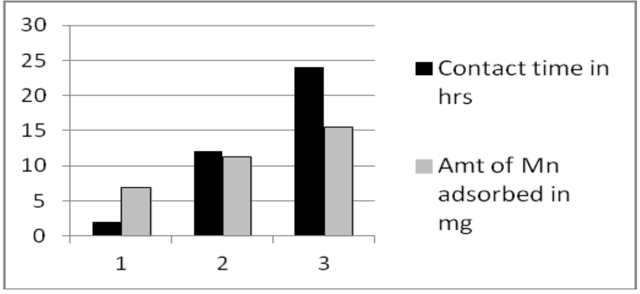


Fig. 7: ***E. crassipes*** **(Effect of pH)**

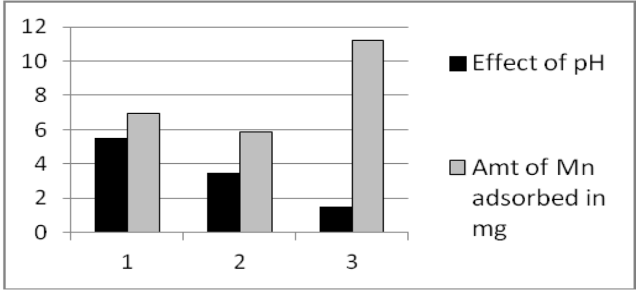
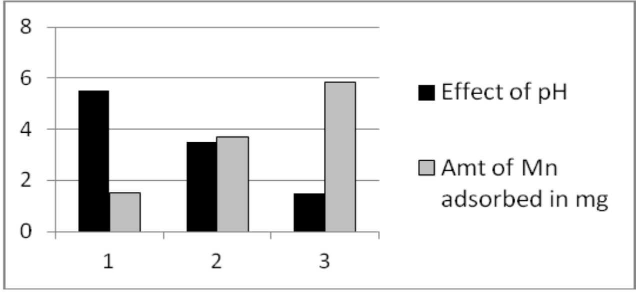


Fig. 8: ***I. aquatica*** **(Effect of pH)**



and bacteria so that their efficacy for bioremediation will be increased considerably. Ideal phytoremediator is a species that creates a large biomass, grows quickly with an extensive root system and can be easily cultivated and harvested. Xia and Ma, (2005) investigated the potential of water hyacinth (*Eichhornia crassipes*) in removing a phosphorus pesticide Ethion. It is necessary to carry out phytoremediation of heavy metal contaminated water and sediments by selected aquatic macrophytes viz. *Eichhornia crassipes*, *Ipomoea aquatica*, *Typha angustata*, *Hydrilla verticillata* and *Vallisneria spiralis* (Kumar *et al.*, 2006). Natural-growing aquatic macrophytes can be used to remove nitrates, phosphates and heavy metals, by consuming them in the form of plant nutrients (Reddy *et al*., 1991). Mishra *et al*. (2008) compared arsenic removal efficiency of *E. crassipes*, *L. minor* and *S. polyrhiza* from tropical open cast coalmine effluent and observed that *E. crassipes* had the highest removal efficiency (80%) compared to other aquatic macrophytes. According to Muramoto and Oki, (1983) *Eichhornia crassipes* showed high removal efficiency of arsenic supposedly to be due to faster growth rate, greater biomass production, and higher uptake ability of arsenic. So, the use of water hyacinth in phytoremediation technology should be considered carefully.

In the present work, Mn was adsorbed in highest amount at 35mg concentration of Mn in both *E. crassipes* and *I. aquatica* . Amongst the two, highest adsorption was found in *E. crassipes*. Taking adsorbent dose into consideration, Mn was adsorbed in highest amount in 1.5 gms concentration in both the plants whereas highest adsorption was comparatively found to be better in *E. crassipes*. Similarly, with another parameter of contact time, highest adsorption was found with 24 hours in both the members while highest adsorption was observed in *I. aquatica*. When the effect of pH values was studied, adsorption was found to be highest with pH 1.5 and better results were obtained in *E. crassipes*.

CONCLUSION

The results obtained indicate the efficiency of both *Eichhornia crassipes* and *Ipomoea aquatica* as phytoremediators. The adsorbent dose prepared by both the plants shows high ability to absorb manganese from surrounding environment. Hence both the above members can be effectively used to bring manganese at the optimum level required for the survival of living organisms. The results with various parameters studied also conclude that both the plants show huge scope to be implemented at the industrial level to carry out the phytoremediation of manganese. However the results clearly indicated *Eichhornia crassipes* showing better potential as compared to *Ipomoea aquatica* and is more suitable phytoremediator than *Ipomoea aquatica.*

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