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RESEARCH ARTICLE

STUDIES ON FUNGAL PRETREATED PARTHENIUM LEAVES BIOMASS ON THE BIOSORPTION OF HEAVY METALS

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ABSTRACT

Heavy metals are the major pollutants of marine, ground, industrial and treated waste waters. Heavy metals have lethal effect on human health and aquatic life. Due to their non-biodegradable nature, they enter into the food chain through the disposal of waste in water bodies. Biosorption is an alternative technique to conventional treatment method for the removal of metal ions from waste waters. Various biological materials have been used as biosorbent for the uptake of metal ions from aqueous solutions. The present Investigation was carried out to explore the possibilities of utilization of *Parthenium* leaves for use in the biosorption of Copper, Iron and Lead. An attempt was also made to find out the effect of fungal colonization on the biosorption of metals by leaves of *Parthenium hysterophorus*. The result indicated that *Parthenium* leaf biomass is quite effective material for the biosorption of all the three metals studied. Inoculation with *Aspergillus niger* led to substantial decrease in the capacity of the *Parthenium* leaf biomass to adsorb Copper Iron and Lead.

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INTRODUCTION

Pollution of water bodies such as lakes, river and ocean increasing day by day due to human activities. Due to rapid urbanization, heavy metals have been excessively released into the environment. Heavy metals from industrial wastewater and other human activities are directly and indirectly released into the environment. Unlike organic contaminant, heavy metal pollutants are non-biodegradable and enter into the food chain via biomagnification. Recalcitrance and consequent persistence of metal ions may become increased to such an extent that they begin exhibiting toxicity. Heavy metals such as arsenic, copper, cobalt, cadmium, iron, mercury, nickel, lead and zinc are hazardous to human being and all the life forms. Density, atomic number and chemical properties are the three different criteria which define heavy metals. Heavy metals can be defined by density of such metals ($5g/cm^3$) and the metals with atomic number higher than 20 excluding alkaline metals, alkaline earth metals, lanthanides and actinides.

Toxicity of Copper

The US Environment Protection Agency (EPA) listed copper as a micronutrient and a toxin. It cause serious damage to kidneys and the Brain, also cause liver cirrhosis, gastrointestinal distress, low blood pressure and fetal mortality.

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Toxicity of Iron

It causes gastrointestinal effects such as gastro intestinal bleeding, vomiting and diarrhea. Iron toxicity can cause hypovolemic attack due to the potent ability of iron to vessels. Death may occur from the damage of liver.

Toxicity of Lead

The US Environment Protection Agency (EPA) listed lead as one of 129 priority pollutant. Even the presence of low concentration of lead in drinking water cause anemia, encephalopathy with permanent damage, hepatitis and nephritic syndrome. In humans lead poisoning results into damage to kidney, nervous system, reproductive system, liver and brain. Therefore, the removal of metal ions is essential. The conventional techniques for the removal of metals include presipitation, ion exchange and electrolytic techniques (Blanco and Vardhan, 1999). These techniques are costly and may not always be applicable and are not economically and environment friendly because these produces large quantity of poisonous chemical compound. Therefore, a new scientific discipline of bioadsorption developed in the year 1990 that had an objective for the recovery of heavy metals. Bioadsorption depends on the binding capacities of metals with various biological materials. Biosorption can be defined as "the ability of biological materials to accumulate heavy metals from waste water through metabolically mediated or physico-chemical pathway of uptake". Several biosorption studies have revealed that non-living plant biomass can be used effectively for removing metals from the enviornment (Gardea-Torresday *et al*., 1996; Ingole and Bhole, 2000; Horsfall *et al*., 2003; Mahvi *et al*., 2005; Lokeshappa *et al*., 2007; Chandra Shekar, 2008; Gupta *et al*., 2010; Prabha and Udayashankara, 2014). The present work was carried out to investigate the possibilities of utilization of leaves of *Parthenium hysterophorus* for use in the biosorption of copper, iron and lead. An effort was also made to find out the impact of fungal colonization on the adsorption of metals by leaves of *Parthenium hysterophorus*.

MATERIALS AND METHODS

Preparation of *Parthenium* leaves powder

Only above group plant parts of *Parthenium hysterophorus* were collected. These plant parts were washed with tap water for the removal of dust, and then immediately treated with alcohol. These surface-sterilized plants were then shade-dried for about 45 days. Theleaves, were separated and were then ground in a grinder to obtain fine powder. The powdered sample was stored at a dry place. A number of sterilized flasks containing 10 g of *Parthenium* leaves each were inoculated with spore suspension of *Aspergillus niger.* After 5 days the leaves colonized greatly by the fungus were recovered to obtain powder.

Adsorption of metals by *Parthenium*leaves (untreated and that treated with *Aspergillus niger*)

Three metals i.e., copper (as cupric sulphate), iron (as ferrous sulphate) and lead (as lead nitrate) were used in the present investigation. Stock solutions of these metal salts were prepared in a way to obtain following concentrations of metals in respective solutions - (1) Copper (300 ppm), (2) Iron (500 ppm) and (3) Lead (500 ppm). The procedure followed by Mahvi *et al*. (2005) was used with minimal changes to Find out the effectiveness of biomass varieties under study:

(a) *Parthenium* leaves as such and
(b) *Parthenium* leaves colonized by *Aspergillus niger.*

100ml of 500 ppm solution of lead was taken into each of 9 flasks. These were divided into 3 sets of 3 flasks each. To these sets, biomass samples were added as under :-

1) 1.0 g parthenium leaves powder (3 flasks)
2) 1.0 g parthenium leaves powder containing fungal biomass also (3 flasks)

A set of 3 flasks to which nothing was added served as control. All these flasks were then placed on a shaker for 2 hours. After 2 hours contact time, the content of the flask were filtered through Whatmann number 40 filter paper. The metal concentration of filtered solutions were determined with the help of Merckoquant Metal Analytical Test Strips.

Thereafter, the content of 3 flasks of each were pooled together to get a composite solution for atomic absorption spectrophotometry. The volume of the content was raised to 300ml and a few drops of concentrated nitric acid were added. Similar procedure was repeated for the metallic solution of copper and iron. The amount of metal bound by the biosorbent was calculated as follows (Hussein *et al*., 2004)

$$\mathbf{Q = V (C_i - C_F) / m}$$

Where,

Q indicates the metal uptake (mg metal per g biosorbent),
V indicates the liquid sample volume (ml),
C_i indicates the initial concentration of the metal in the solution (mg/l).
C_f indicates the final (equilibrium) concentration of the metal in the solution (mg/l).
m indicates the amount of the added biosorbent on the dry basis (mg).

The biosorptive capacity of a particular biomass and its particular quantity was interpreted as under:

A. 0-10	Very poor
B. 10-20	Poor
C. 20-40	Moderate
D. 40-60	Good
E. 60-80	Very good
F. 80-100	Excellent

Table 1. Approximate amount of metal remaining in the solution after 2 hrs of biosorption with *Parthenium* leaf biomass (uninoculated and inoculaed with *Aspergillus niger*)

Metal	Conc. of Metal in the original solution (ppm)	Range of Metal in the solution after Biosorption (ppm)	
		Uninoculated	Inoculated
Copper	300	30-100	±100
Lead	500	Nil	±100
Iron	500	100	±250

Table 2. Q value (specific uptake of metal) of uninoculated and inoculated Parthenium biomass for Cu, Fe and Pb

Metal	Initial concentration (mg/lt)	Fnial concentration(mg/lt)		Q Values	
		Uninoculated	Inoculated	Uninoculated	Inoculated
Copper	300	158.4	225.60	14.16	7.44
Lead	500	Nil	94.329	50.0	40.56
Iron	500	215.60	254.20	28.44	24.58

RESULTS AND DISCUSSION

Biosorption of metal by Parthenium leaves biomass

The efficiency of dried biomass of *Parthenium* leaves to adsorb three metals i.e. copper, iron and lead was studied. The powder of *Parthenium* leaves as such as well as that inoculated with *Aspergillus niger* were tried for this study. The results obtained from the testing of metal solution after 2 hours of biosorption are presented in the Table 1. Only range of amount of metals or approximate amount of metals remaining in the solution is presented because these prelimnarytest were made using Merkoquant metal analytical test strips.

Table 1shows that

a) Parthenium leaf biomass is quite effective material for the biosorption of all the three metals studied.
b) In comparison to copper and iron, lead seems to be most efficaciously adsorbed metal as the concentration of lead remaining in the solution after biosorption turned out to be Nil.
C) Lead was followed by Iron, the concentration of which ±100 ppm as compared to 500 ppm in the original solution.
d) Iron was followed by Copper, the concentration of which in the remaining solution was less than 30%.
e) The inoculation with *Aspergilus niger* seems to have adverse effect on the capacity of Parthenium leaf biomass to adsorb copper, iron and lead.
f) The preferential adsorption of metal by uninoculated Parthenium leaf biomass was as under :-

   Pb> Fe > Cu

g) The preferential adsorption of metal by inoculated Parthenium leaf biomass was as under:-

   Cu = Pb> Fe

Further analysis of the solution containing these metals was carried out through atomic absorption spectrophotometer. The results are presented in the Table 2.

Table 2 indicates that uninoculated *Parthenium* leaf biomass was an excellent biosorbent for Pb. In the present study specific uptake of lead was found to be 50.0. Specific uptake of lead ranging from 122 by *Pencillium chrysogenum* (Niu *et al*., 1993) to as high as 601 by *Bacillus subtilis* (Brierley *et al*., 1986) and even 4000 by *Citrobacter* sp. (Macaskie and Dean, 1990), which are much higher than those observed in the present study. Keskinan *et al.* (2003) reported bioadsorption of lead by submerged aquatic plant, *Myriophyllum spicatum* as 46.69 mg per gram, Baig *et al.* (1999) found that *Solanum elaeagnifolium* was able to bind 20.6 mg lead per gram. As compared to the aforesaid reports, the specific uptake by all the components of *Parthenium* in the present study is much more. In the present investigation the specific uptake of Fe by uninoculatedParthenium leaf biomass was 28.44. Tsekova *et al.* (2002) reported 15.7mg per gram uptake of fe by Rhizopusdelamar. Beveridge (1986) found that bacterial cell wall was able to bind 201mg iron per gram. The specific uptake of Cu by uninoculated Parthenium leaf biomass was 14.16. There have been various reports regarding uptake of copper, the specific uptake ranging from 0.4 in *Penicillium spinulosum* (Townsley *et al*., 1986) to 152 by *Bacillus subtilis* (Brierley and Brierley, 1993). Keskinan *et al.* (2003) reported 10.37mg per gram uptake of copper by *Myriophyllum spicatum.* Baig *et al.* (1999) found that *Solanum eleagnifolium* was able to bind 13.1 mg copper per gram. Thus, it is clear that the biomass used in this present study is better biosorbent in comparison to other angiospermic biosorbent. It is also clear from the table 2 that specific uptake of lead is much greater than that of copper and iron both by uninoculated and inoculated biomass. Greater specific uptake of lead in comparison to cobalt and copper by *Staphylococcus saprophyticus* (IIhan *et al*., 2004) *Mucorrouxi* (Lo *et al*., 1999), *Solanum elaegnifolium* (Baig *et al*., 1999), *Myriophyllum spicatum* (Keskinan, 2003), as well a number of other biosorbents (Volesky and Holan, 1995) has been reported which are in conformity with the results of present study. Table 1 and 2 also showed that inoculation with *Aspergillus niger*led to significant reduction in the efficiency of *Parthenium* leaf biomass to adsorb copper, iron and lead.

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