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Bioaccumulation of Chromium by Aquatic Macrophytes *Hydrilla sp. & Chara sp.*

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ABSTRACT

The absorption process is being widely used by various researchers for the removal of heavy metals from aqueous solutions. In the recent years the use of various natural products has been widely investigated as an alternative for the currently expensive methods of water treatment. Some of the natural products can be effectively used as a low cost absorbent. Heavy metals can be absorbed by living or non-living biomass. Phytoremediation uses plants to remove pollutants from the environment. About two aquatic species were examined as potential, phytoremoval agents for chromium in aqueous solutions. Aquatic plants can be used for the removal of heavy metals. For the present study batch studies were conducted and the uptake of chromium from aqueous solutions by Hydrilla sp. and Chara sp. were investigated thoroughly. The daily chromium uptakes was recorded, analyzed the results and were compared with other aquatic plants. The present study revealed that these aquatic plants Hydrilla sp. and Chara sp.can be successfully used for heavy metal removal.

Key words: Chromium, Aqueous solution, Aquatic macrophytes, UV Spectrophotometer.

INTRODUCTION

Rapid urbanization, industrialization, mining activities, metal ore refining, agricultural chemicals, liquid and solid wastes resulted in heavy metal pollution of water and land resources. The increasing load of heavy metals have caused imbalance in aquatic ecosystems and the biota growing under such habitats accumulate high amounts of heavy metals like Cu, Zn, Cd, Cr, Hg and Ni which in turn, are being assimilated and transferred within food chains by the process of magnification, called as 'Biomagnification' [12].

The most important features that, distinguish heavy metals from other toxic pollutants are their non-biodegradable nature. The toxicity due to metal ion is owing to their ability to bind with protein molecules and prevent replication of DNA and subsequent cell division. To avoid health hazards, it is essential to remove these toxic heavy metals from wastewater before its disposal [11].

The conventional treatment methods used for removing metal ions from aqueous solutions include chemical precipitation, lime coagulation, ion exchange, reverse osmosis solvent extraction, aeration, chemical oxidation, electrodialysis, ultra filtration, and chlorination [6].Precipitation is accompanied by flocculation or coagulation, and one major problem is the formation of large amounts of sediments containing heavy metal ions. In recent years, considerable attention has been devoted to find new absorbents. One of the suitable methods for removing heavy metals from water and waste water is using surface absorption process [3].

The major advantages of bioabsorption over conventional treatment methods include:
• Low cost;
• High efficiency;
• No additional nutrient requirement;
• Minimisation of chemical and biological sludge;
• Regeneration of biosorbent; and
• Possibility of metal recovery.

Heavy metals removed by the plants due to storage in the roots, stems, or leaves. The metals convert into less harmful substances within the plant or gaseous form and are released into the air through transpiration activities[8].

The natural sources of chromium in the environment are erosion and weathering of chromium bearing minerals [9]. The anthropogenic sources like chrome plating, fertilizers, tanning, explosives, pigments, paints, electroplating, Textile, alloys and ceramic industrial effluent [10].

Chromium is toxic to many mammals, plants, aquatic lives and microorganisms. It causes diarrhoea, nausea, low blood pressure, lung irritation, CNS disease, cancer, dermatitis etc.

The conventional technologies for the removal of chromium from aqueous solutions are the chemical treatments, ion exchange, solvent extraction, evaporation and reverse osmosis. These are inefficient and expensive methods. In such situations attention has to be given towards the natural abilities of plants to uptake metals i.e.phytoremediation. This method is simple in operation, maintenance and therefore suitable for rural communities. The aquatic macrophytes use solar radiation and thus have a low energy requirement as compared to other methods of tertiary treatment.

Aquatic weeds are those unabated plants which grow and complete their life cycle in water and cause harm to aquatic environment directly and to related environment. But some aquatic weeds are used for bioremediation technique. The *Hydrilla sp.* and *Chara sp*. are submerged aquatic plants having higher productivity and they are found beneath the water resources.

Botanical Name	*Chara sp.*
Common Name	*Musk grass*
Group	Submerged weeds
Family	*Characeae*

Botanical Name	*Hydrilla sp.*
Common Name	. Hydrilla
Group	Submerged weeds
Family	Hydrocharitaceae

The present investigation was aimed to observe chromium uptake capacity of two aquatic plants under the laboratory conditions.

MATERIALS AND METHODS

The stock metal solution of chromium concentration 100 mg/L was prepared by using analytical grade 0.283gm of potassium dichromate ($K_2Cr_2O_7$) in 1000ml distilled water (1ml=0.1mg. of Cr). The solution was prepared using standard volumetric flasks. The solution of 2mg/L was prepared by diluting the stock chromium solution, which were obtained by dissolving in distilled water. The P^H of the solutions was adjusted with HCl and NaOH. The collected aquatic plants were washed with distilled water, blotted and weighed. The *Hydrilla sp.* and *Chara sp*. were introduced at the rate of two grams per litre into glass troughs. The set was examined for a period of 7 days by 24 hours interval. The concentrations of the chromium metal before and after absorption by plants were determined by Diphenylcarbazide method using UV spectrophotometer [1].

The percent removals of Chromium by Aquatic plants were calculated by using the following formula:

$$\% \text{ Removal} = \frac{C_1 - C_2}{C_1} \times 100$$

Where, C_1 is the initial concentration of chromium and C_2 is the final concentration of chromium.

This experiment performed with two same sets of solutions with plants and their mean values have taken as final results. A control experiment was carried out at the same conditions in the absence of plants and there was no change observed in the chromium concentration in this experiment.

RESULT AND DISCUSSION

The metal studies by *Hydrilla sp*. and *Chara sp*.for a treatment period of 7 days using chromium metal revealed their potential as good metal bioabsorbant. *Hydrilla sp.* could remove upto 99.70% of chromium and *Chara sp.* remove 91.70% at a concentration of 2mg/L.The time dependent behaviour of metal absorption was examined by varying the contact time between adsorbate and adsorbent for a week. Maximum percentage removal of chromium from aqueous solution was noticed on the seventh day of dosimetry. Daily percent removal of chromium by *Hydrilla sp*. and *Chara sp*. are represented in Figure 1 and 2 respectively.

Absorption by *Hydrilla sp*. with the increasing contact time upto 4 days showed that the chromium concentration was nearly equal to permissible level 0.05mg/L while that for *Chara sp*. it was much above the permissible level.

The results on change of chromium concentration with increasing contact time with *Hydrilla sp*. and *Chara sp*. are shown in table 1 and 2 respectively.

Salvinia and *Azolla* could remove 99.5% of chromium at a concentration of 2mg/L With increase in initial chromium concentration of 4, 6, 8 and 10mg/L the percentage metal removal reduced .Everyday the removal efficiency varied drastically. This may be due to direct and indirect involvement of chromium in metabolic reactions inside the plants. The reduction in chromium concentration due to binding of the softer Cr (III) with thiol (-SH) part of the protein in root via soft-soft interaction. The decrease in concentration of chromium (total) compared to the Cr (VI) was not due to the precipitation of chromic hydroxide , because analyses of collected sediments from experimental sets showed that total chromium in sediment was below the detectable amount. Thus, the uptake of the experimental toxic species by the plant took place via reduction, which is evident from the lower Cr (III) concentration than total decrease of Cr (VI) concentration [4].

Ipomea aquatica plant remove chromium metal upto 0.05mg/L after 40 days of contact time from initial chromium concentration 2.04mg/L [7].

The Water Hyacinths (*Eiccornia sp.*) absorbs nickel 85% and zinc 84% in the 40% concentration of industrial effluent. At 80% and 100% concentration of effluent, the percentage absorption of nickel was found to be 60% and 54% respectively and that of absorption of zinc was found to be 69.4 % in 80% concentration of effluent and 40% of absorption by plants in 100% concentration of effluent [5].

Water lettuce (*Pistia strationtes*) removed 82% of arsenic with 60gms biomass from 0.25mg/L arsenic solution after a contact time of 144 hours at P^H 7 and maximum 85.5% removal at 6.5 P^H [2].

Abida and Harikrishna [14], noted that iron absorbed by *Hydrilla vercillata*, about 91.2 % in 5 days, *Elodea canadensis rich* 94.4 % in 8 days and *Salvinia* sp., 88.8 % in 10 days. They observed that copper removed by *Hydrilla vercillata*, 89.2 % in 10 days, *Elodea canadensis rich* 86.4 % in 10 days, *Salvinia.* sp., 67 % in 10 days and also noted that Nickel absorbed by *Hydrilla vercillata* , 83 % in 10 days, *Elodea canadensis Rich* 75% in10 days, *Salvinia.* sp., 40.4% in 10 days.

The adsorption efficiency of Cr (VI) removed by commercial activated carbon of dose 0.5 gm/L at P^H 2 increased from 16 - 63.12% with an increase in contact time and equilibrium was attained within 120 minutes .The adsorption efficiency of Cr (VI) removed by chemically activated tendu leaf refused at pH 2 increased from 85.3-95.2% with an increase in contact time [13].

Table 1: Concentration of chromium removed from the solution after bioabsorption by *Hydrilla sp*.

Days	Chromium removed (mg/L)	% Removal
0	0	0.0
1	1.224	61.2
2	1.314	65.7
3	1.344	67.2
4	1.94	97.01
5	1.985	99.25
6	1.999	99.64
7	1.994	99.70

Table 2: Concentration of chromium removed from the solution after bioabsorption by *Chara sp*.

Days	Chromium removed (mg/L)	% Removal
0	0	0.0
1	1.25	62.5
2	1.417	70.85
3	1.473	73.65
4	1.695	84.75
5	1.778	88.9
6	1.778	88.9
7	1.834	91.7

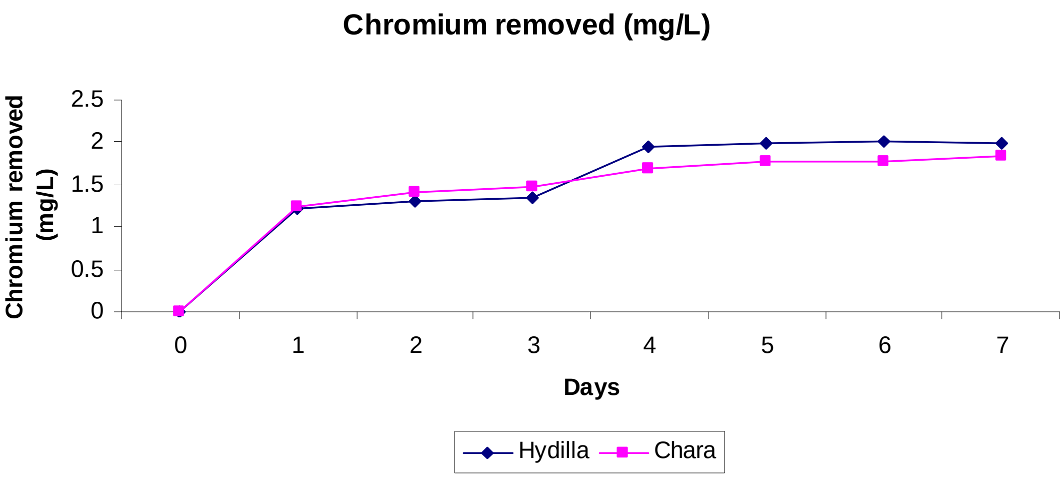

Fig.1: Effect of contact time on chromium concentration by *Hydrilla sp.and Chara sp.*

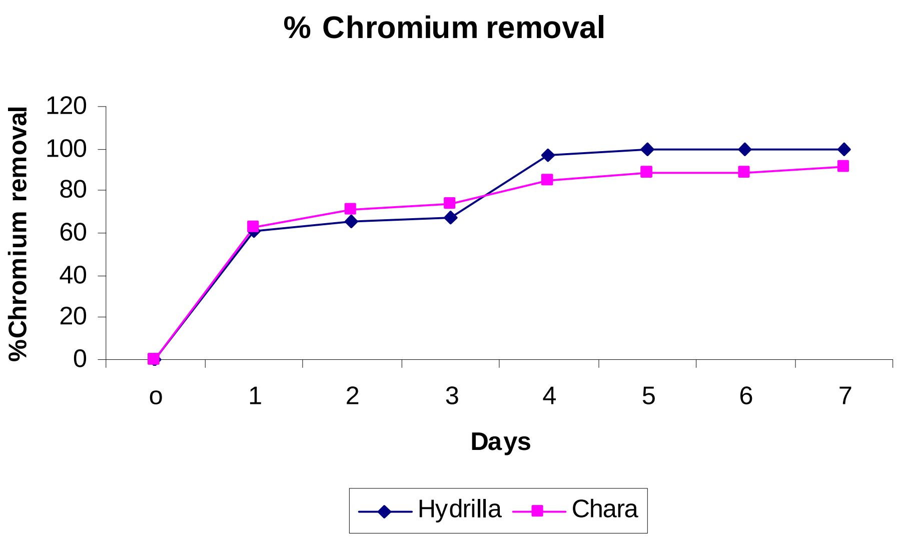

Fig. 2: Effect of contact time on % removal of chromium concentration by *Hydrilla sp.and Chara sp.*

CONCLUSION

The following conclusions were drawn from the present investigations:

- *Hydrilla sp*. and *Chara sp*. can be used as bioabsorbant material for removal of chromium.
- The removal of Chromium is at higher level of contamination, and needs generally a week to bring down the percent removal level above 90%.
- About 99.70% removal was obtained with 2gms *Hydrilla sp*. at 2mg/L chromium concentration after a contact period of 7 days at P^H 4.
- About 91.70% removal was obtained with 2gms *Chara sp*. at 2mg/L chromium concentration after a contact period of 7 days at P^H 4.
- The results indicate that the metal removal was increases as the days were extended.

- With increasing contact time, *Hydrilla sp*. proved to be better than *Chara sp.* in the removal of chromium.

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