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ORIGINAL ARTICLE

Biosorption of Lead (II) and Chromium (IV) from Aqueous Solutions by Using Green Algae Spirogyra Sp. Biomass

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ABSTRACT
The aim of this work was to study the biosorption parameters of green algae for chromium and lead. Heavy metal ion removal from aqueous solution or from wastewater by Biosorption Method is very cost effective and efficient Process. Results of metal ion removal from aqueous solution by using spirogyra sp.is studied. Effect of pH, Time, Biosorbent Dose on the biosorption of heavy metals Pb(II) and Cr (VI) also described in this paper. Batch experiment were conducted to determine the biosorption capacity of spirogyra sp. and results found maximum biosorption capacity of spirogyra sp. for lead is 82% and for Cr is 75% with algal dose of 5 gram at 25^{0}C for both heavy metal ions. The effective pH Value for Pb (II) and Cr(VI) are found to be 5 and 5.5, Time required for metal uptake from wastewater was investigated for both metal ion and results indicate that optical time is 90 minutes for Cr(VI) removal and 50 minutes for Pb(II) removal. Results shows that green algae spirogyra sp. is suitable biosorbent for the removal and with good recovery of Pb(II) and Cr(VI) from aqueous solution.
Keywords: *Heavy metals, biosorption, biosorbent, Spirogyra sp.*

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INTRODUCTION

Water pollution due to the heavy metals is very serious problem in the world. The quality of life on earth is inextricably linked to the overall quality of the environment. The indiscriminate release of hazardous pollutants by industries and dumping of domestic sewage in the human environment pose a major threat to all kinds of organisms inhabiting aquatic as well as terrestrial ecosystems [1]. A heavy metal is a collective term for metals of high atomic mass, particularly those that are toxic and cannot be processed by living organisms. These include lead, chromium among others. Many other definitions of heavy metals have been proposed based on density, atomic number and atomic weight. Heavy metals have thus been defined collectively as metals of high atomic mass, particularly those transition metals that are toxic and cannot be processed by living organisms [2].

Lead and Chromium are among the most toxic heavy metals ion affecting the environment [3] . Lead comes into water through the combustion of fossil fuels and the smelting of sulphide ore, and into lakes and streams by acid mine drainage. Process industries, such as battery manufacturing and metal plating and finishing are also prime source of Pb pollution.

The current EPA and WHO drinking water standard for lead is 0.05 mg/L and 10 g/L, respectively. Lead accumulates mainly in bones, brain, kidney and muscles and may cause many serious disorders like anaemia, kidney diseases, nervous disorders and sickness even death . It is therefore, essential to remove Pb(II) from wastewater before disposal.

Chromium is one of the contaminants, which exists in hexavalent and trivalent forms.

Hexavalent form is more toxic [4] than trivalent and requires more concern. Strong exposure of Cr(VI) causes cancer in digestive tract and lungs [5] and may cause epigastric pain, nausea, vomiting, severe diarrhea and hemorrhage [6]. It is therefore, essential to remove Cr(VI) from wastewater before disposal. The main sources of chromium (VI) are tannery, paint, ink, dye, and aluminium manufacturing industries etc.

Many treatment methods has been applied for the removal of heavy metals from waste water these are chemical precipitation, membrane filtration, ion exchange, reverse osmosis, electro dialysis, solvent extraction, evaporation, oxidation, activated carbon adsorption [7]. However, these methods are often

expensive and difficult to maintain due to high capital and operational costs, as well as, extra cost of treating the resultant sludge generated before disposal [8]. So it is require to find best and secure technology for the removal of these toxic metals ions from waste water and I choose biosorption process for the treatment of waste water because the cost of it is less and high metal binding capacity.
Aim of this study was to investigate that whether green algae spirogyra sp. Is suitable for the removal of lead and chromium ions from waste water (and under which experimental conditions: pH, contact time, *etc*.) AAS (Atomic Adsorption Spectrometry) was used for the determination of the Concentration of heavy metals in treated model solutions.

MATERIALS AND METHODS

Preparation of Biosorbents

Biomass of green algae spirogyra was collected from a pond near of Dewas India. Before used it washed from the tap water and then distilled water to remove the unwanted material. After wash it was air dried to reduce the water. The algae biomass was then dried in an oven for 10 hrs. The weight of dry algae was recorded and the crushed through a 250nm sieve to obtain a uniform particle size.

Glassware and Apparatus:

All the glasswares (Beaker, Pipette, Conical flasks, Volumetric flasks, Test tubes etc.) used were of Borosil/Rankem make. Before used, the apparatus washed with distilled water and then dried in oven at 65^0C for 1 hrs.

Equipment

The equipment used throughout the experiment are listed in table below:

Table 2.1 List of Instrument used during the whole Experiment.

S.No.	Instrument	Make
1.	Atomic Adsorption Spectrophotometer	GBC AVANTA PM HG3000
2.	Digital Weight Balance	Atco company
3.	What man filter Paper no. 1	-
4.	Orbital Incubator shaker	REMI Instrument, Mumbai
5.	pH meter	Adair dutt (AOP-Series)
6.	Hot air oven 142	Remi Instrument, Mumbai
7.	Magnetic hot plate stirrer	Neolab Company, Mumbai

Reagent used:

All chemicals used in this work were of either analytical grade or Laboratory reagent (LR) grade obtained either from Merck, Germany or SD Fine Chem. Ltd India.Stock solution of lead and chromium were prepared by using lead nitrate and potassium dichromate in distilled water. Pb(II) and Cr (VI) solutions of different concentrations were obtained by diluting the stock solution. Standard solution of Pb(II) and Cr(VI) (1000 mg/L) for atomic adsorption spectrophotometer was obtained from Merck, Germany. Standard acid and base solutions (0.1N HCl and 0.1N NaOH) were used for pH adjustments.

Batch Adsorption studies:

The heavy metals biosorption by spirogyra sp. was studied by batch technique.
The adsorption features of the biosorbent *Spirogyra* sp. were investigated as a function of initial pH, initial heavy metal concentration, biosorbent dose and contact time.
The equilibrium and kinetics were obtained from batch experiments, using 250mL flasks containing 100mLof heavy metal solutions and 0.05 g of biomass kept at a fixed temperature (25^0C). 1000mg/l stock solution of each of the metals was prepared, from where the working solutions were prepared by serial dilution method. The concentrations in mg/l for all the metals are 20mg/l.
The pH value was adjusted to the required value with 0.1MHCl or 0.1N NaOH throughout the experiment. The remaining concentration of Pb(II) and Cr(VI) in residual solution was analyzed by taking absorbance on the atomic absorption spectrophotometer.

RESULTS AND DISCUSSION

Effect of contact pH, time and biosorbent dose on biosorption of Pb and Cr ions by green algae Spirogyra Sp.:

Effect of pH:

pH is one of the important parameters in metal sorption by spirogyra sp. therefore metal sorption studies were carried out at different pH values.The biosorption of Pb and Cr ions were studied at different pH values, such as 2.0, 3.0, 4.0, 5.0, 6.0 and 7.0 (at constant temperature 25^0C, time 120 minutes for Pb and Cr ions). Optimum pH value observed 5 for Pb and 5.5 for Cr Biosorption in metal ion solution as shown in **figure 3.1.**

For all the metals considered, metal removal by all processes was low at low pH. For biosorption the removal rises to a peak between pH 5 and pH 5.5 then starts to decline. At low pH there is high competition for adsorption sites between metal ions and protons. Furthermore, at low pH both the hydrogen ion and the metal ion concentration are high since the metals are not precipitated but are available in solution. This explains why both processes are ineffective at low pH values. Since algal biomass has a high content of carboxyl groups on its cell walls, biosorption process can be affected by changes in the solution pH Interaction od dissociation sites on the biosorbent surface and sorbate solution chemistry depends upon the pH of the solution, such as hydrolysis, complexation by ligands, precipitation and availability of Pb and Cr ions, etc.

Table 3.1 Percentage metal removal by biosorption at different pH values.

Metal removal %		**pH**						
		2.0	**3.0**	**4.0**	**5**	**5.5**	**6**	**7**
Cr	Total removal	28	36	49	65	75	74	60
Pb	Total Removal	35	48	60	82	81	78	65

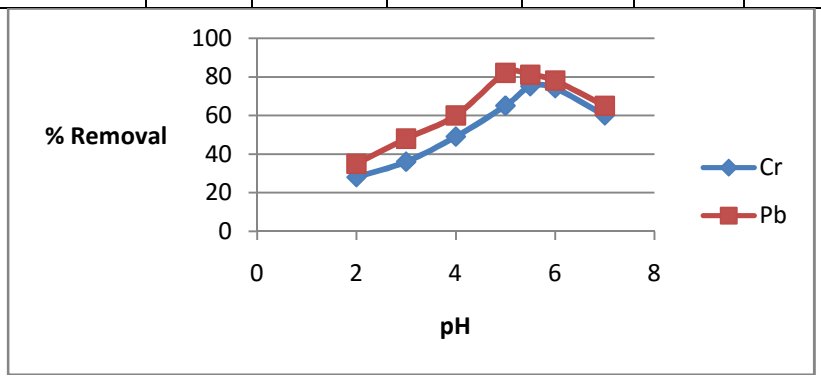

Figure: 3.1: Effect of pH for the removal of Pb and Cr ions by spirogyra sp.
(pH = 2 to 8, Adsorbent dose=5gm/l metal solution, temperature =25°C, Orbital shaking speed=200rpm,Time=120min.)

Effect of contact time Variation:

The effect of contact time is highly influencing the biosorption process. Fig. 3.2 showed the effect of contact time on the biosorption of Cr(VI) and Pb(II) ions using the Spirogyra sp. These results indicated that the biosorption of both metals was rapid in the first 20 min then was gradually increased till the equilibrium attained at 50 min and 90 min for Pb and Cr, respectively, and the biosorption became almost constant thereafter. Therefore, a contact time of 50 and 90 min was used as the optimum time for Pb and Cr for the rest of experiments

The maximum uptake capacity of green algae spirogyra sp. is 82% at 50 minute for Pb ion and 75% at 90 minute for Cr ion (**figure: 3.2**).

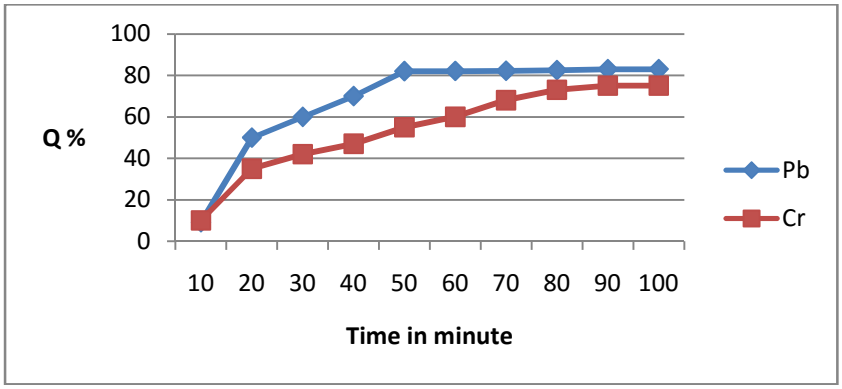

Figure: 3.2: Effect of time for the removal of Pb and Cr ions by green algae spirogyra sp.
(Adsorbent dose =5gm/l metal solution, temperature =25°C, pH 5 for Pb and 5.5 for Cr , Orbital shaking speed =200rpm.)

Effect of Biosorbent Dose:

To study the biosorbent dose on metal uptake, different amount of dose (0.5-7g) were used in 10 ml solution of Pb(II) and Cr(VI) in which intake concentration of lead and Cr was 20mg/l. The amount of

dose significantly affects the removal of Pb and Cr at optimum pH 5 for lead and at optimum pH 5.5 for chromium as shown in **figure 3.3**.

The percentage removal of lead was 32% at algal dose of 0.5 gram and it increased to 82% at algal dose of 5 gram. The results indicate that with further increase in adsorbent dose, % removal of Pb(II) & Cr(VI) is almost constant. At low algal dose, all types of sites are entirely exposed and the adsorption on the surface is saturated faster. The percent removal of Cr was 8% at algal dose of 0.5 gram with contact time of 120 minutes and it increased to75% at algae dose of 5 gram. It is shown in figure 4.3 that there is slight change between from algal dose of 3-5 gram. This is consistent with the results obtained for the other adsorbent system.

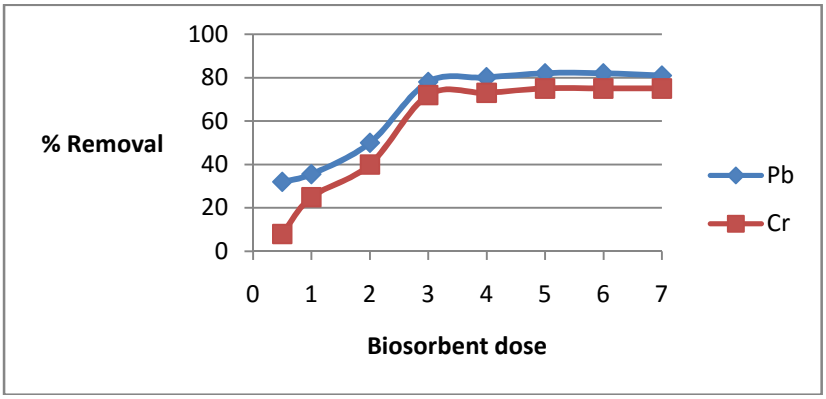

Figure 3.3: Effect of Biosorbent dose for the removal of Pb and Cr ions (20mg/l)
(Adsorbent dose = 0.5 to 7 gm, temperature = 25^{o}C, pH5 for Pb and 5.5 for Cr, Orbital shaking speed = 200rpm, Time = 120min.)

CONCLUSION

The biosorption study conducted in this work provides significant information regarding suitability of green algae as a biosorbent for the selected heavy metal pollution. Adsorption parameters were determined. The best pH for adsorption of the selected metals was found to be 5.0 and 5.5 for lead and chromium, respectively and the times required for equilibrium to be established for metal adsorption from model solutions by green algae were 90 minutes for chromium and 50 minutes for lead. The maximum removal of lead is found to be 82% at algal dose of 5 gram and the maximum removal of chromium is found to be 75% from aqueous solution at algal dose of 5 gram. With the advantage of high metal biosorption capacity, the biomass of Spirogyra has the potential to be used as an efficient and economic biosorbent material for the removal and with good recovery of lead and chromium from aqueous solutions. From this work, green algae was found to be a biosorbent which can be used for effectively removing heavy metals from polluted water

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