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BIOSORPTION OF LEAD FROM AQUEOUS SOLUTION USING CHLORELLA SPECIES

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ABSTRACT

Biosorption with algal biomass in the metal ion removal from aqueous solutions is an emerging technique which can replace the conventional processes using costly adsorbents. Algal species possess cell wall which is made up of polysaccharides and functional groups which act as biosorption sites for sequestering metal ions. The biosorptive potential of Chlorella species to adsorb lead ions from synthetic waste water was evaluated in this article. In this study, batch biosorption experiments were performed to determine the effect of influencing parameters such as contact time and initial metal ion concentration on the adsorption of lead ions. The optimum contact time was found to be 100 minutes. It was also observed that the increase in initial metal ion concentration decreases the metal removal efficiency. The results show that Chlorella species may be an efficient sorption material for lead removal from lead contaminated waste water.

1. Introduction

The presence of heavy metals in aqueous water streams has become a problem due to their harmful effects on human health and on the flora and fauna of receiving water bodies. It is recognized that finding methods for removal of heavy metals from aqueous water is of great importance. Lead is among the most toxic heavy metal ion affecting the environment [1]. It is used in battery manufacturing, alloys, plating, explosive industries which cause pollution and health hazards when disposed in water bodies. 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 [2]. The current EPA and WHO drinking water standard for lead is 0.05 mg/L and 10g/L respectively. Application of bio-sorbents/biomass from various microbial sources, moss, aquatic plants and leaf-based adsorbents was reported by various investigators [3-8] with the aim of finding more efficient and cost-effective metal-removal biosorbent. Algal biomass has been found to possess the potential of removing heavy metals. Biosorption can be a promising alternative method to treat industrial effluents, mainly because of its low cost, high metal binding capacity, high efficiency in dilute effluents and environmental friendly [9]. It can effectively sequester dissolved metals from very dilute complex solutions with high efficiency. There are many reports and reviews on the biosorption of lead metal ion on marine algae [10], green seaweed [11,12], and freshwater green algal species [13,14] with varying removal efficiencies, maximum adsorption capacities (q_{max}) and binding constants. The present study emphasizes on biosorption of Lead from synthetic wastewater using chlorella, a fresh water algal species in batch process. The effects of sorption time and initial metal ion concentration were analyzed and the results are reported.

2. Materials and Methods

2.1. Preparation of synthetic lead solution

Lead stock solution of 1000mg/L was prepared by dissolving 1.598 gms of Analytical Lead nitrate in 1000ml of distilled water. From this stock solution, required concentration of solution was prepared. Four different working concentrations of synthetic Lead ion solutions 50ppm, 100ppm, 150ppm and 200ppm were prepared.

2.2. Collection and Preparation of Algal sorbent

Algal sample was collected from a nearby fresh water pond. It was washed well with tap, followed by detergent wash and distilled water wash. Washed Algae was sun dried. This dried algal mass was mortared well with pestle. Mortared sample was treated with Calcium chloride ($CaCl_2$) solution to increase the ion exchange efficiency of the Algal biomass. Pre-treated sample was oven dried at 80ºC for 4 hours and sieved and stored for use as Sorbent. Various parameters of the sorbent such as pH, electrical conductivity, ash content and matter soluble in water were analyzed.

2.3. Lead analysis using Atomic Absorption Spectrometer

Atomic absorption spectrophotometer of GBC make model 905 was used to analyse the initial and final Lead concentrations after each and every treatment. Flame method was used for the analysis of Lead and flame was produced by air-acetylene mixture. Spectrometer was fixed with appropriate lead lamp. Prior to analysis, the instrument was adjusted to wavelength of 261.4nm, slit width of 0.5 and 5mA of lamp current. After standardisation the lead ion concentration of unknown samples were evaluated.

2.4. Batch Biosorption Experiments

Batch Biosorption experiments were carried out to find the optimum contact time and the effect of lead ion concentration on the removal efficiency. Experiments were conducted using 250mL Erlenmeyer flasks in an Incubator shaker. Synthetic lead ion solution of pH 6 and varying concentrations such as 50, 100, 150 & 200 ppm were prepared in separate flasks. Known biosorbent dosage (1g/100mL) were added to the flasks and agitated with synthetic lead ion solution for varying contact times (20 to 120 minutes). The residual concentrations of the obtained samples were determined using Atomic Absorption Spectrometer.

3. Results and Discussion

3.1. Characterization of the Biosorbent

Biomass sample collected was subjected to identification by microbiological procedures to identify the species present in the collected sample. The prepared Biosorbent was subjected to analysis in order to determine its characteristics such as pH, Electrical conductivity,Ash content, Matter soluble in water. Observed results are shown in Table.1.

Table.1. SORBENT CHARACTERISTICS

PARAMETER	Species	pH	Electrical conductivity	Ash content	Matter soluble in water
VALUE	Chlorella	6.09 ± 0.1	5.62 ± 0.3 mS/m	12%	0.2mg/ml

3.2. Effect of Contact Time

The batch biosorption study was conducted at various contact times ranging from 20 mins to 120 mins (20, 40, 60, 80, 100 and 120) for synthetic lead solutions of concentrations ranging from 50 to 200 mg/L. Removal of lead with respect to contact time was plotted as shown in Fig.1.

Fig.1. Effect of contact time

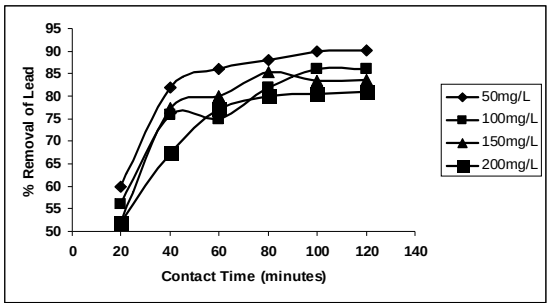
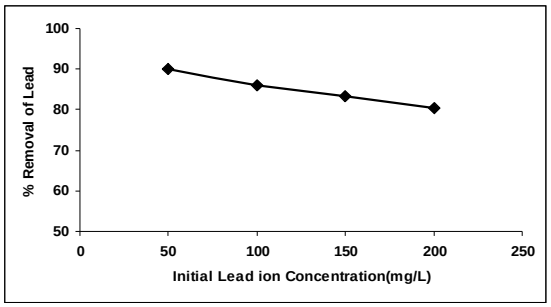


Fig.2. Effect of initial lead concentration



3.3. Effect of Initial Lead Concentration

From the batch study data, lead ion removal efficiencies for various concentrations were determined. The removal efficiencies for various initial lead ion concentrations were plotted in Fig.2. From the plots, it is seen that maximum lead ion removal of 90% was obtained at a contact time of 100 minutes for initial lead ion concentration of 50mg/L. Also it is seen that the biosorption efficiency decreases as the initial lead ion concentration increases.

4. Conclusion

The biosorbent prepared from Chlorella species demonstrated a good lead adsorption capacity, highlighting its potential for effluent treatment processes. From the batch study results it can be concluded that the optimum contact time for biosorption of lead on to chlorella species is 100 minutes at which 90% removal was obtained for initial lead concentration of 50mg/L. The lead removal efficiency decreases as the initial lead ion concentration of the solution increases. The chlorella species, a fresh water alga can be effectively used as a biomaterial for adsorption of lead from industrial wastewaters.

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