Biosorption of Copper Ions by Green Algae Spirogyra

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Abstract
The removal of toxic heavy metal ions from waste water is of great importance from an environmental view point. Biosorption is an effective technology, using non-living biomass to remove heavy metals from aqueous solutions. In this paper, the biosorption of copper ions onto the dead biomass of Spirogyra, a green algae, was investigated in batch mode. The results indicated that the biomass of Spirogyra sp. is an efficient biosorbent for the removal of Copper ions from aqueous solutions and pH dependent. The maximum removal rate was achieved at a solution of pH of 8.5.

Keywords: Biosorption, Kinetics, Spirogyra sp, waste water.

Introduction
Heavy metals are among the major concerns in waste water treatment. Heavy metals are often derived from heavy industry, such as electroplating and battery factories. The treatment of this type of waste water involves high cost techniques such as ion exchange, evaporation, precipitation, membrane separation etc. However, these common techniques are too expensive to treat low levels of heavy metal in waste water (Banerjee, 2002). Therefore a low cost biosorption process using algae as an adsorbent has lately been introduced as an alternative (Volesky, 1990).

Biosorption is a term that describes the removal of heavy metal, by the passive binding to non – living biomass from an aqueous solutions. Biosorption uses inexpensive dry biomass to extract industrial effluents of toxic heavy metals. The biosorption is a process in which solids of natural origin are employed for binding heavy metals. The biomass can be composed of algae, mosses, fungi, bacteria and various, plant species. It is a promising alternative method to treat industrial effluents, mainly because of its low cost and high metal binding capacity. The algae can be collected and/or cultivated in many parts of the world, factor that has encouraged the development of new biosorbent materials using biomass. The toxic effects of copper on microorganisms are well documented and many report exists of copper uptake by microorganisms (Romera et al., 2008; Holan and Volesky 1994; Sheng et al., 2004). Copper, like the majority of heavy metals, is toxic but it has been widely used in metallurgical and tanning industries. Therefore, this work was developed with the objective of evaluated the copper biosorption process by means of the dead green algae biomass. The objective of the present study was investigate the use of green algae biomass as a biosorbent for the removal of copper ions from aqueous solution and also the effect of pH.

Materials and methods
Biosorbent – Algal biomass, Spirogyra was washed thoroughly in running tap water 4-5 times and distilled water to remove alkalinity. Later it was dried in a hot air oven at 60 °C for 24 hours. The dried biomass was then ground well and passed through a 100-200 mesh sieve to obtain a powder form. Finally the contents were stored in a desiccator at room temperature to be used as a powdered biosorbent.

Preparation of synthetic solution
A stock solution of 1000 ppm copper solution was prepared by dissolving 2.51 g of CuSO₄·5H₂O in 1 L of deionized distilled water. Various concentrations of test solutions were prepared by appropriate dilution of the stock solution. The initial pH of each solution was then adjusted to the required value with different concentrations of HCl and NaOH solutions using pH meter.
Batch Biosorption studies
Batch mode adsorption studies were carried out to investigate the effect of different parameters such as contact time and pH on the rate of adsorption of copper by biomass. The amount of adsorbed metal ions per gram of dead algae was obtained using the following equation:

\[ q = \frac{[(C_i - C_e) \times V]}{M} \]

where \( q \) is the metal uptake (mg/g), \( C_i \) is the initial metal concentration (mg/l), \( C_e \) is the initial metal concentration (mg/l), \( V \) is the volume of metal solution and \( M \) is the mass of biosorbent used in the reaction mixture (Hashim and Chu, 2004).

Results and discussion
Effect of pH
Biosorption of heavy metals ions is depend on the pH of solution as it affects biosorbent surface charge, degree of ionization, and the species of biosorbent (Ahmady- Asbchin et al., 2008). The pH of the solution influence both metal bindings sites on the cell surface and the the chemistry of metal in solution (Dursun, 2006). In order to demonstrate the effect of pH on biosorption capacity, uptake of copper onto dead algae as a function of pH was studied in the pH ranges of 4 to 8.5.

Conclusion
The study indicated that the dried biomass of green algae Spirogyra could bw used as an efficient biosorbent maerial for the removal of copper ions from aqueous solutions. The dried algal biomass, was found to be very efficient in removing copper ions (≈ 78.0%) from aqueous solution and the maximum removal rate was achieved at a solution of pH of 8.5. It has been concluded that this adsorbent has a great potential for removing copper from aqueous solutions as an eco-friendly process.

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References
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