International Journal of Chemical Studies

P-ISSN2349–8528
E-ISSN 2321–4902
IJCS 2015; 3(3): 36-38

Received: 09-10-2015
Accepted: 26-11-2015

Anamika Kushwah
M. Tech., Department of Chemical Engg. Ujjain Engg. College, Ujjain (M.P.)-456010, India.

JK Srivastav
Associate Professor, Department of Chemical Engg, Ujjain Engg. College, Ujjain (M.P.) 456010, India.

Correspondence
Ishmael B Masesane
Department of Chemistry, University of Botswana, Private Bag 00704, Gaborone, Botswana

Biosorption of Copper Ions by Green Algae *Spirogyra*

Anamika Kushwah, JK Srivastav

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 $CuSO_4.5H_2O$ 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:

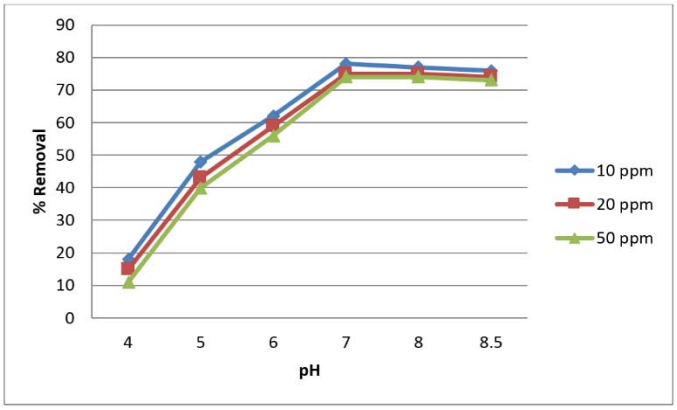
$$q = [(C_i - C_e) \times V]/M$$

where q is the metal uptake (mg/g), Ci is the initial metal concentration (mg/l), C_e is the intial 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.

Acknowledgment

This work is supported by the U.E.C, Ujjain, India and M.P.P.C.B, Indore, India.

References

1. Alloway BJ, Ayres DC. Chemical Principles of Environmental Pollution, Blackie Academic and Professional, London, 1993.
2. Chua LWH, Lam KH, SP Bi. A comparative investigation on the biosorption of lead by filamentous fungal biomass, Chemosphere 1999; 39:2723-2736.
3. Wilde EW, Benermann JR. Bioremoval of heavy metals by the use of microalgae, Biotech. Adv 1993; 11:781-812.
4. Kuyucak N, Volesky B. Biosorbent for recovery of metals from industrial solutions, Biotechnol. Lett 1998; 10:137-142.
5. Volesky B, Holan ZR. Biosorption of heavy metals, Biotechnol. Prog 1995; 11:235-250.
6. Fourest E, Roux J. Heavy metal biosorption by fungal mycelial byproducts: mechanism and influence of pH, Appl. Microbiol. Biotechnol 1992; 37:399-403.
7. Chang J, Law R, Chang C. Biosorption of lead, copper and cadmium by biomass of *Pseudomonas aeruginosa* PU21, Water Res. 1997; 31:1651-1658.
8. Niu H, XS Xu, JH Wang, Volesky B. Removal of lead from aqueous solutions by *penicillium* biomass, Biotechnol. Bioeng 1993; 42:785-787.
9. Itoh M, Yuasa M, Kobayashi T. Adsorption of metal ions on yeast cells at varied cell concentrations, Plant cell Physiol 1975; 16:1167-1169.
10. Lee CK, Low KS. Removal of copper from solution using moss, Environ. Technol. Lett 1989; 10:395-404.
11. Jain SK, Vasudeven P, Jha NK. *Azolla pinnata* R. Br. and *Lemna minor* L. for removal of lead and zinc from polluted water, Water Res 1990; 24:177-183.
12. King P, Rakesh N, Beenalahari S, Prasanna Kumar Y, Prasad VSRK. Removal of lead from aqueous solution using *Syzygium cumini* L: equilibrium and kinetic studies, J. Hazard. Mater. 2007; 142:340-347.
13. Tuzun G, Bayramoglu YE, Alcin Basaran G, Celik G, Arica MY. Equilibrium and kinetic studies on biosorption of Hg(II), Cd(II) and Pb(II) ions onto microalgae *Chlamydomonas reinhardtii*, J Environ. Manage. 2005; 77:85-92.
14. Gupta VK, Rastogi A, Saini VK, Jain N. Biosorption of Cu(II) from aqueous solutions by *Spirogyra* species, J Colloid Interface Sci 2006; 296:59-63.
15. Gupta VK, Shrivastava AK, Jain N. Biosorption of chromium(VI) from aqueous solutions by green algae *Spirogyra* species, Water Res 2001; 35(17):4079-4085.
16. Bishnoi NR, Bajaj M, Sanatomba K. Biosorption of zinc (II) using *Spirogyra* species from electroplating effluent, J Environ. Biol. 2005; 26(4):661-664.
17. Venkatamohan S, Ramanaiah SV, Rajkumar B, Sharma PN. Removal of fluoride from aqueous phase by biosorption onto algal biosorbent *Spirogyra* sp. I02: sorption mechanism elucidation, J Hazard. Mater. 2007; 141:465-474.
18. Liping D, Yingying S, Hua S, Xinting W, Xiaobin Z. Sorption and desorption of lead(II) fromwastewater by green algae *Cladophora fascicularis*, J Hazard. Mater. 2007; 143(1-2):220-225.
19. Andrade AD, Rollemberg MCE, N´obrega JA. Proton and metal binding capacity of the green freshwater alga *Chaetophora elegans*, Process Biochem. 2005; 40(5):1931-1936.
20. Onmez GCD, Aksu Z, Ozturk A, Kutsal T. A comparative study on heavy metal biosorption characteristics of some algae, Process Biochem 1999; 34(9):885-892.
21. Aksu Z. Equilibrium and kinetic modelling of cadmium (II) biosorption by *C. vulgaris* in a batch system: effect of temperature, Sep. Purif. Technol. 2001; 21(3):285-294.
22. Senthilkumar R, Vijayaraghavan K, Thilakavathi M, Iyer PVR. Velan, Application of seaweeds for the removal of lead from aqueous solution, Biochem. Eng. J. 2007; 33:211-216.
23. Matheickal JT, Q Yu. Biosorption of lead (II) and copper (II) from aqueous solutions by pre-treated biomass of

Australian marine algae, Bioresour. Technol 1999; 69:223-229.
24. Ho YS, McKay G. The sorption of lead (II) ions on peat response to comment, Water Res 1999; 33:578-584.
25. McKay G, YS Ho. Pseudo-second-order model for sorption processes, Process Biochem 1999; 34:451-465.
26. Dahiya S, Tripathi RM, Hegde AG. Biosorption of lead and copper from aqueous solutions by pre-treated crab and arca shell biomass, Bioresour. Technol 2008; 99:179-187.
27. Han R, Zhang W, Zou J, Shi H, Liu Y. Equilibrium biosorption isotherm for lead ion on chaff, J Hazard. Mater. 2005; 125:266-271.
28. Matheickal JT, Yu Q. Biosorption of lead from aqueous solution by macro-fungi *Phellinus badius*, in: Proceedings of the 10th National Convention of Royal Australian Chemical Institute, Adelaide, Australia, 1996.
29. Tunali S, Cubak A, Akar T. Removal of lead and copper ions from aqueous solutions by bacterial strain isolated from soil, Chem. Eng. J. 2006; 115:203-211.
30. Bahadir T, Bakan G, Altas L, Buyukgungor H. The investigation of lead removal by biosorption: an application at storage battery industry waste waters, Enzyme Microb. Technol. 2007; 41(1-2):98-102.
31. Goksungur Y, Uren S, Guvenc U. Biosorption of cadmium and lead ions by ethanol treated waste bakers yeast biomass, Bioresour. Technol. 2005; 96:103-109.