Research Journal of Recent Sciences ISSN 2277-2502
Vol. **1(9),** 13-17, September **(2012)** *Res.J.Recent Sci.*

Removal of Zinc (II) by Non Living Biomass of *Agaricus Bisporus*

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Available online at: www.isca.in
Received 31st March 2012, revised 14th April 2012, accepted 17th April 2012

Abstract

The feasibility of Agaricus bisporus as a bio sorbent to remove zinc(II) from aqueous solution was determined by batch experiments, which were carried out using shake flasks. The effect of different biomass loading, pH and contact times were investigated. Biosorption of zinc was determined using Langmuir, Freundlich, Dubinin Radushkevich and Temkin isotherm models. The characteristic parameters for each isotherm were determined Temkin and Dubinin Radushkevich isotherm models fitted well to the data of biosorption of zinc by Agaricus bisporus, suggesting that the uptake of zinc was physical, saturable and equilibrium mechanism.

Keywords: Biosorption, agaricus bisporus, zinc, isotherm.

Introduction

Environmental pollution by heavy metals which are released into the environment through various anthropogenic activities such as mining, energy and fuel production[1-4], electroplating, wastewater sludge treatment and agriculture are one of the world's major environmental problem. This is probably due to rapid industrialization[5-8], population growth and complete disregard for the environmental health. Initially, heavy metals are naturally present in soils as natural components but as of now, the presence of heavy metals in the environment has accelerated due to human activities. Contamination of soil environment by heavy metals is becoming prevalent across the globe[9].

It is well established that the risk of excessive Zn in soil is related to its effect on primary production. Even though zinc is an essential requirement for a healthy body[10-13], excess zinc can be harmful, and cause zinc toxicity[14-18]. Excessive absorption of zinc can suppress copper and iron absorption. Zinc concentration above 500g/Kg reduces the ability of soil to absorb iron and manganese. The free zinc ion in solution is highly toxic to plants, invertebrates, and even vertebrate fish. Stomach acid contains hydrochloric acid, in which metallic zinc dissolves readily to give corrosive zinc chloride, which can cause damage to the stomach lining due to the high solubility of the zinc ion in the acidic stomach.

The use of dried, nonliving biomass seems to be a preferred alternative to the use of living cells for the removal of heavy-metal ions. The use of dead cells offers the following advantages over live cells: The metal removal system is not subject to toxicity limitations, there is no requirement for growth media and nutrients, the biosorbed metal ions can be easily desorbed, and biomass can be reused, and dead biomass-based treatment systems can be subjected to traditional adsorption models in use. As a result, the use of dead fungal biomass has been preferred in numerous studies on biosorption of toxic metal ions from aqueous solutions. Agaricus *bisporus* is chosen as biosorbent because of the relative lack of information about its sorption abilities on zinc.

Material and Methods

Reagents were prepared from analar grade chemicals in deionized water obtained from loba chem. Ltd., India. A test solution containing zinc (II) was prepared by diluting 1 ml of stock solution of metal to the desired concentrations.

Biomass preparation: The Agaricus *bisporus* (Raw Non-living biomass) was collected and washed three times with de ionized water. Then it was air-dried in sunlight and sieved to particle size of 1.5mm.

Batch biosorption studies: Batch experiments were carried out in 500ml shake flasks by adding known weight of biomass in 200 ml of zinc(II) solutions. The flasks were gently agitated at room temperature on a shaker at 150 rpm constant shaking rate for 8 h to ensure equilibrium. To determine the effect of biomass loading on metal uptake, the experiment was carried out in different biomass loading ranging 10 to 50g for 50 mg/L zinc concentration at pH 6.5. To study the effect of pH on zinc uptake, the experiment was carried out with 40g of biomass in 200ml of zinc solution. The pH was adjusted using 0.1M HCl and 0.1M NaOH. To determine the equilibrium contact time the experiment was carried out with constant biomass loading (40g) and pH (6.5). In every one-hour interval zinc(II) concentration was determined. In all experiments at the end of predetermined time intervals, the metal concentration in the resulting supernatant was determined by Flame atomic adsorption spectrometer.

The amount of zinc (mg) biosorbed per gram of dried biomass was calculated using the following equation:

$$Q = ((C_0 - C)/m)V \quad (1)$$

Q = mg of metal ion biosorbed per gram of biomass;C_0= initial metal ion concentration, mg/L; C = final metal ion concentration, mg/L;m = dry weight of biomass in the reaction mixture,g;V = volume of the reaction mixture, L.

Sorption Isotherm Models: Models have an important role in technology transfer from laboratory to pilot plant scale. An appropriate model can help in understanding the process mechanism, analyze experimental data, answer to operational conditions and optimize process. Langmuir, Freundlich, Dubinin Radushkevich and Temkin models are used in the present work. These models are simple, well established, having physical meaning and are easily predictable (table-1).

Table-1
Adsorption isotherm

Isotherm Model	Equation
Langmuir	$x= x_0kc / (1+kc)$
Freundlich	$q_e = k_F c_e^{1/n}$
Dubinin Radushkevich Model	$q_e = x_m \exp(-\beta F^2)$
Temkin	$q_e = RT /b \ln(K_T C_e)$

Results and Discussion

Biosorption of heavy-metal ions using a macro fungal biomass (Agaricus *bisporus*) are affected by several factors like biomass loadng, pH and contact time. Results showed that the specific zinc(II) uptake was found to increase with an increase in biomass loading upto a certain level. Then it begin to decrease. The zinc uptake also increase with increasing pH. The effect of biomass loading, pH and effect of contact time are presented in fig 1, 2 and 3.

The linearized isotherm plots are given in figures 4, 5, 6 and 7.

In this study the different aspects of the biosorption of Zinc by Agaricus *bisporus* is showed. Results showed that the specific zinc uptake was found to increase with increase in biomass loading. The equilibrium data fitted very well with Dubinin Radushkevich and Temkin isotherm models.

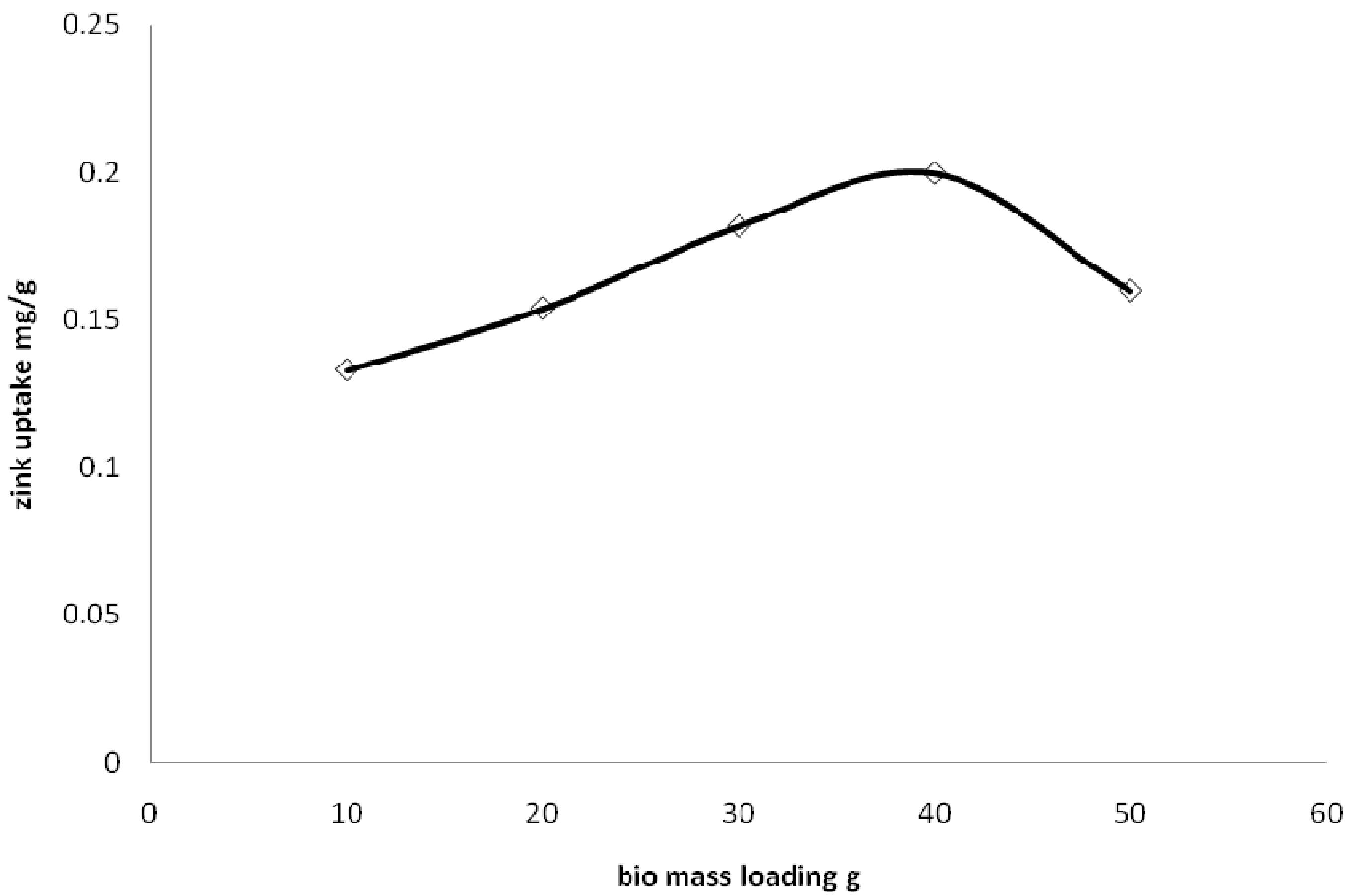

Figure-1
Effect of Biomass loading on zinc(II) uptake by Agaricus *bisporus*

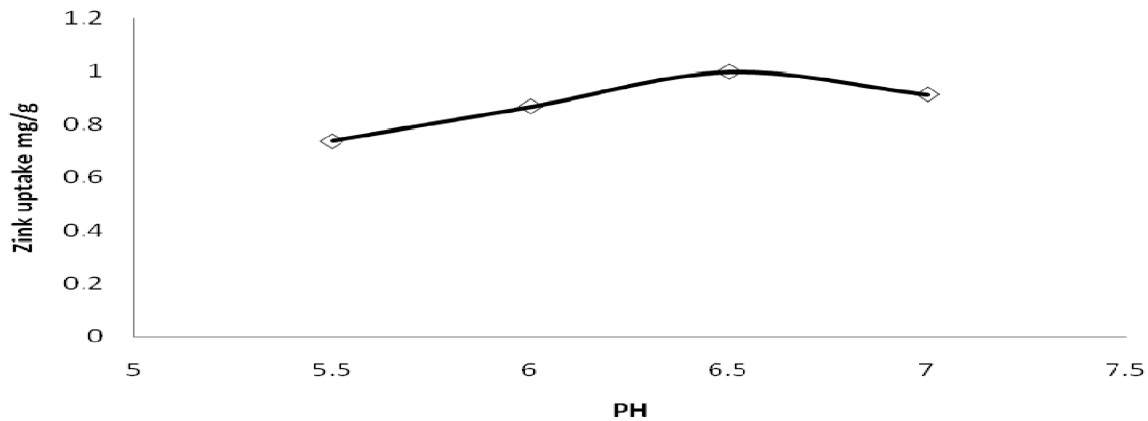

Figure-2
Effect of pH on zinc(II) uptake by Agaricus *bisporus*

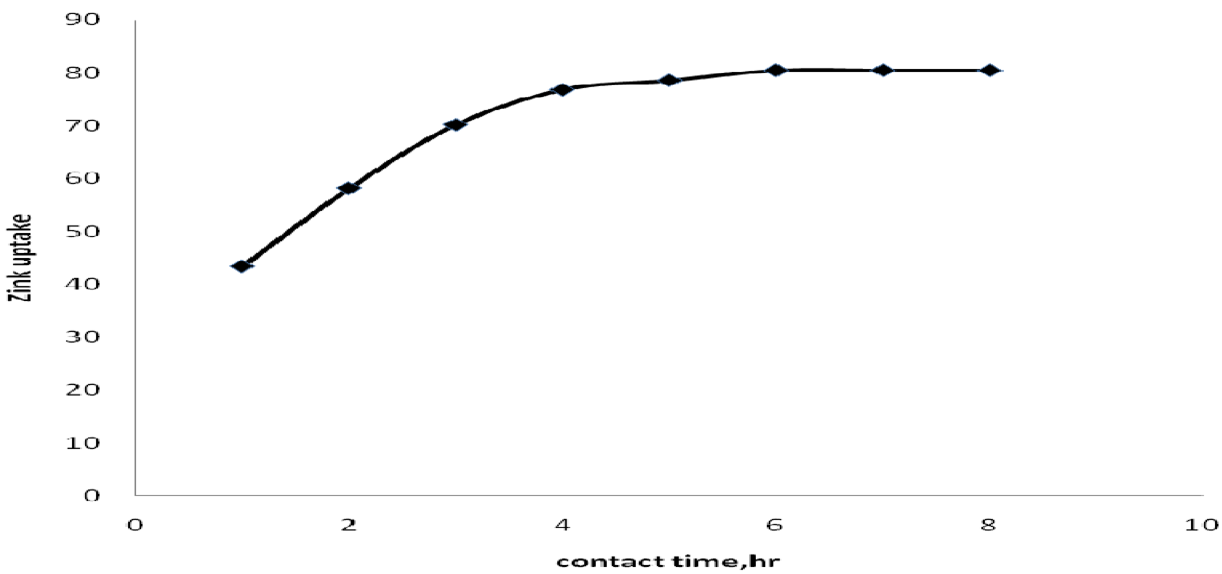

Figure-3
Effect of Contact time on zinc(II) uptake by Agaricus *bisporus*

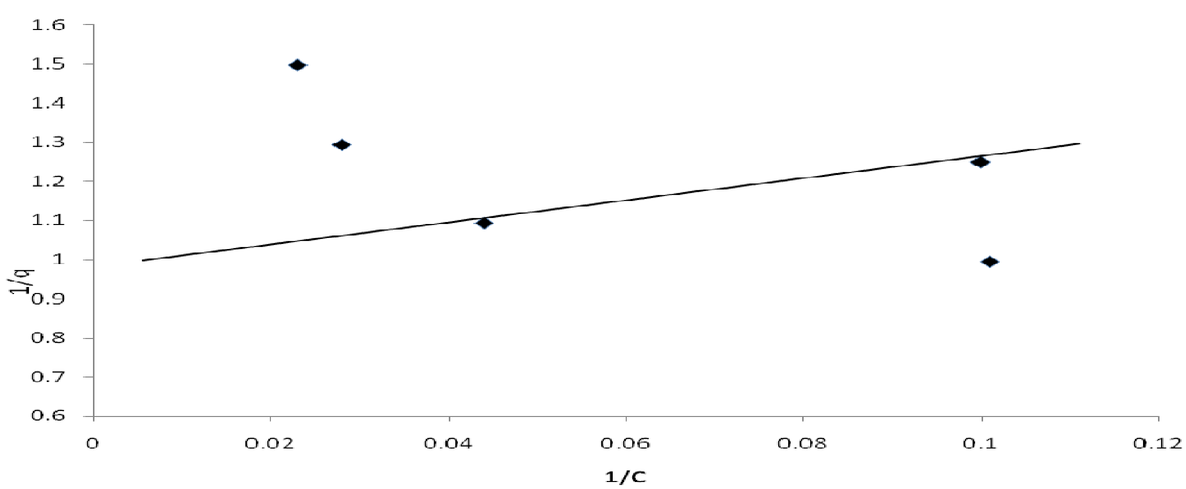

Figure-4
Langmuir plot for adsorption of zinc(II) by Agaricus *bisporus*

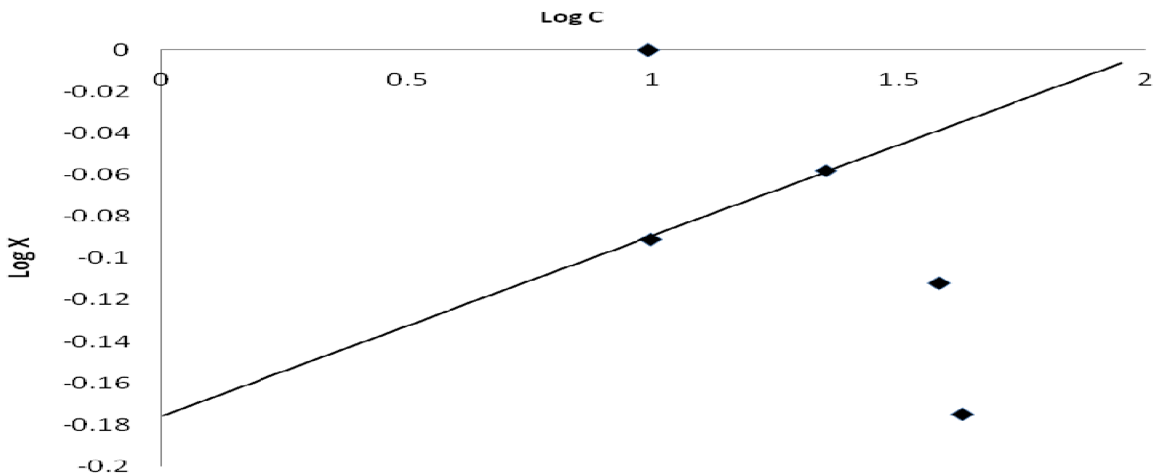

Figure-5
Freundlich plot for adsorption of zinc(II) by Agaricus *bisporus*

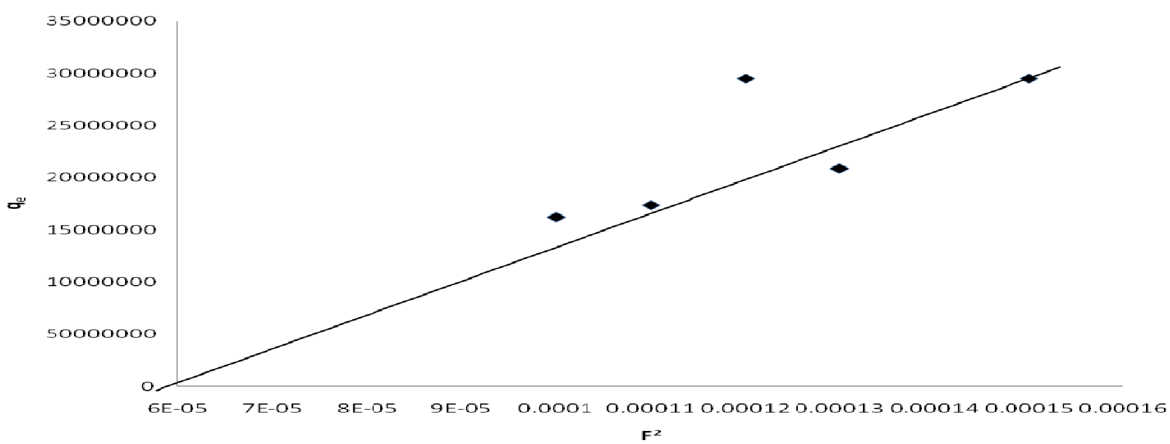

Figure-6
Dubinin Radushkevich plot for adsorption of zinc(II) by Agaricus *bisporus*

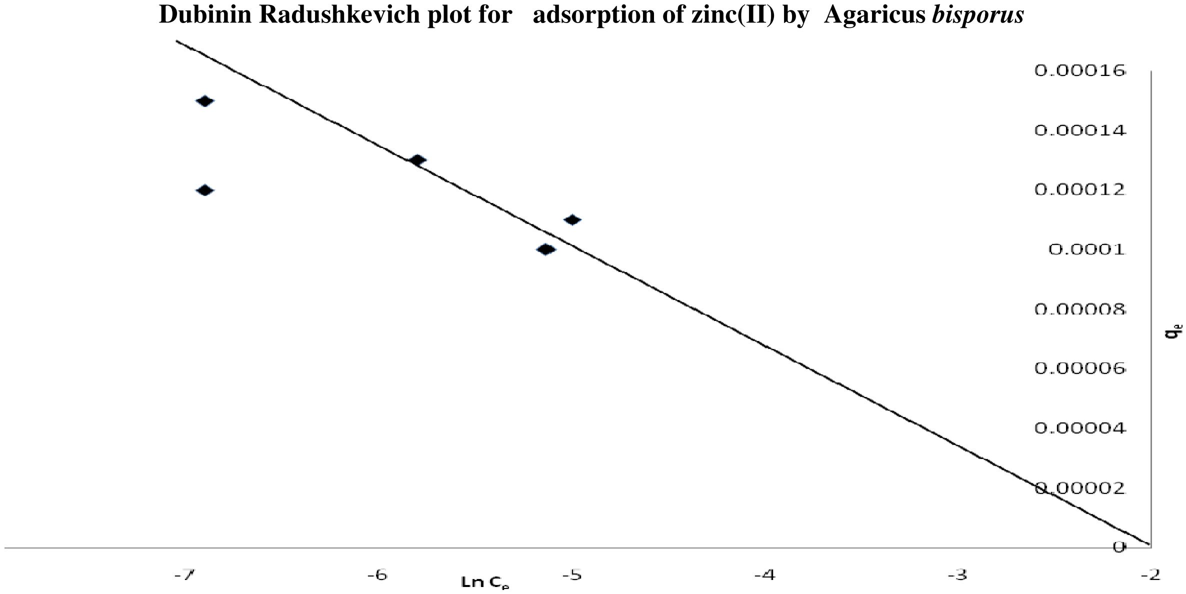

Figure-7
Temkin plot for adsorption of zinc(II) by Agaricus *bisporus*

Conclusion

The present investigations showed the different aspects of the biosorption of Zinc (II) by *Agaricus bisporus*. Results showed that the specific zinc (II) uptake was found to decrease with increase in biomass loading The effects of process parameters like pH, bio mass loading and contact time were studied. The uptake of zinc(II) by *Agaricus bisporus* was increased by increasing the biomass loading and P_H up to the optimum level ,it was studied 40 g and 6.5. Further studies shown the optimum contact time were 6 hrs. The adsorption isotherms could be well fitted by the Langmuir equation followed by Dubinin Radushkevich and Temkin equation. The biosorption process could be best described by the second-order equation.

References

1. Ayoub G.M., Semerjian L., Acra A., El Fadel M. and Koopman B., Heavy metal removal by coagulation with seawater liquid bittern, *J. Env Eng*., **127**, 196–202 **(2001)**

2. Bose P., Bose M.A. and Kumar S., Critical evaluation of treatment strategies involving adsorption and chelation for wastewater containing copper, zinc, and cyanide, *Ad Env Res.,* **7,** 179–195 **(2002)**

3. Chantawong V., Harvey N.W. and Bashkin V.N., Comparison of heavy metal adsorptions by thai kaolin and ballclay, *Asian J. Eng & Env*., **1**, 33–48 **(2001)**

4. Edith Leuf, Theodor Prey, Christian P. Kubicek, Biosorption of zinc by fungal mycelial wastes, *Appl. Micro. Bioteh*., **34,** 688-692 **(1991)**

5. Gupta D.C. and Tiwari U.C, Aluminium Oxide as adsorbent for removal of hexavalent chromium from aqueous waste, *Ind. J Envi Health.,* **27,** 205–215 **(1985)**

6. Ho Y.S., Removal of copper ions from aqueous solution by tree fern, *Water Res,* **37**, 2323–2330 **(2003)**

7. Inbaraj B.S., Selvarani K. and Sulochana N., Evaluation of a carbonaceous sorbent prepared from pearl millet husk for its removal of basic dyes, *J Sci & Ind Res*., **61**, 971–978 **(2002)**

8. Kawamura Y., Mitsuhashi M., Tanibe H. and Yoshida H., Adsorption of metal ions on polyaminated highly porous chitosan chelating agents, *Ind Eng &Chem Res*., **32**, 386–391 **(1993)**

9. Khan S.A., Rehman R. and Khan M.A., Adsorption of Cr(III), Cr(VI) and Ag(I) on bentonite, *Waste Mgt*., **15**, 271–282 **(1995)**

10. Khan S.A, Rehman R. and Khan M.A., Adsorption of strontium (II) on bentonite, *Waste Mgt*., **15,** 641–650 **(1995)**

11. Lo W.H., Chua H., Lam K.H. and Bi S.P., A comparative investigation on the biosorption of lead by filamentous fungal biomass, *Chemosphere,* **39**, 2723–2736 **(1999)**

12. Louise de Rome and Geoffrey M. Gadd, Copper adsorption by Rhizopus arrhizus, Cladosporium resinae and penicillium italicum, *App. Micro. Biotec*., **26**, 84- 90 **(1987)**

13. McKay G., Blair H.S. and Findon A., Equilibrium studies for the sorption of metal ions onto chitosan, *Ind J. Chem*., **28**, 356–360 **(1989)**

14. Mellah A. and Chegrouche S., The removal of zinc from aqueous solutions by natural bentonite, *Water Res.,* **31**, 621–629 **(1997)**

15. Srivastava S.K, Tyagi R. and Pal N., The application of nature absorbents for heavy metals uptake from contaminated water, *Env.Tech*. **10**, 275–282 **(1989)**

16. Undaybeytia T., Morillo E. and Maqueda C., Adsorption of Cd and Zn on montmorillonite in the presence of a cationic pesticide, *Clays and Clay Min*., **31,** 485–490 **(1996)**

17. Mangale Sapana M., Chonde Sonal G. and Raut P.D., Use of *Moringa Oleifera* (Drumstick) seed as Natural Absorbent and an Antimicrobial agent for Ground water Treatment, *Res. J. Recent Sci.,* **1(3)**, 31-40 **(2012)**

18. Vaishnav V., Daga Kailash, Chandra Suresh and Lal Madan, Adsorption Studies of Zn (II) ions from Wastewater using Calotropis procera as an Adsorbent**,** *Res.J.Recent.Sci*, **1,** 160-165 **(2012)**