

Biosorption of heavy metal ions by biomass of marine brown algae in Cheju

Sang-Kyu Kam*, Min-Gyu Lee¹, Dong-Hwan Lee²

*Dept. of Marine Environmental Engineering, Cheju National University, Cheju 690-756

¹Dept. of Chemical Engineering, Pukyong National University, Pusan 608-737

²Dept. of Chemistry, Donggeui University, Pusan 614-714

1. Introduction

Interest has primarily focused on heavy metals due to their known toxicity as they are discharged in small quantities into the environment, where they tend to accumulate, being concentrated through the food chain. This aspect coupled with their persistence results in a serious health hazard threatening water supplies and populations depending on them.

Greene et al.(1986) revealed that algal biomass is a useful material for heavy metal recovery from industrial wastewaters. Elucidation of heavy metal uptake mechanism may provide a useful basis for manipulation and improvement of the biosorbent selectivity for desired heavy metals. The prospects of algae biomass are not only in the exploitation of polysaccharides(e.g., alginates and carrageenans) in the food industry, but also in their potential to bind and remove heavy metals from industrial solutions and wastewaters.

In this paper, the biomass of nonliving, dried marine brown algae *U. pinnatifida*, *H. fusiforme*, and *S. fulvelum* harvested in the sea near Cheju, were used in order to investigate the sorption performance, selectivity of several heavy metals (copper, zinc, lead, and chromium), and the mechanism of these results as a preliminary step to the treatment of industrial wastewaters practically.

2. Material and Methods

The marine brown algae(phaeophyta) *Undaria pinnatifida*, *Hizikia fusiforme*, and *Sargassum fulvelum* harvested in the sea near Cheju were purchased from the market. These materials were washed fully with water, stored in a refrigerator for three days, and then stored in the freezing dryer for 2 days.

Analytical grades of AgNO_3 , $\text{Cu}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$, $\text{Pb}(\text{NO}_3)_2$, $\text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$, and $\text{Cr}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$ (Aldrich Chem. Co., USA), Na_2CO_3 (Hayashi Pure Chem. Co., Japan), HNO_3 (Hori Pharm. Co., Japan), and NaOH (Yakuri Pure Chem. Co., Japan) were used and the solutions were prepared with deionized distilled water.

3. Results and Discussion

The metal ion uptakes by biosorbent materials in the solution containing metal ion of 10mg/L, were performed with time at different pH values. Fig. 1 shows the sorption performance of *U. pinnatifida* at different constant pH values, together with those of *H. fusiforme* and *S. fulvelum*, in the range of C_i 10-500mg/L. The starting pH of copper solution with no pH adjustments was in the range of 5.3-4.8 with and without biomass, but a little pH decrease occurred in the high C_i after 6 hours of

contact.

Fig. 2 shows the sorption performance of *H. fusiforme* at different pH values, together with those of *U. pinnatifida* and *S. fulvelum* at nonadjusted pH, in the range of C_i 10-500mg/L. The starting pH of zinc solution with no pH adjustments was in the range of 5.7-5.4 with and without biomass and changed little after 6 hours of contact. The zinc biosorbent uptake in the solution with no pH adjustments, decreased in the following sequence: *U. pinnatifida* \geq *H. fusiforme* > *S. fulvelum*.

The respective metal uptake in the mixed solution at different pH values was obtained. In order to study the effect of ionic strength on the metal uptake by biosorbent materials, the lead uptake by *U. pinnatifida* was examined in the presence of NaCl(0-1000mM). The lead uptake decreased at higher ionic strengths(above 100mM). The basis for this is to be sought in the screening of biomass/ Pb^{2+} , in particular, due to Na^+ .

4. Conclusions

Using marine brown algae *U. pinnatifida*, *H. fusiforme*, and *S. fulvelum* harvested in the sea near Cheju, their sorption performance and selectivity of copper, zinc, lead, and chromium have been investigated. The metal uptakes by biosorbent materials increased with increasing pH in the range of C_i 10 - 500mg/L. and decreased in the following sequence: $Pb > Cr > Cu > Zn$. Among the biosorbent materials the decreasing order was as follows: *U. pinnatifida* \geq *H. fusiforme* > *S. fulvelum* for copper and zinc; *U. pinnatifida* > *H. fusiforme* > *S. fulvelum* for lead and chromium. Also it is considered that the difference in metal sorption capabilities is due to the content of these groups and selectivity coefficients of the metals for these groups.

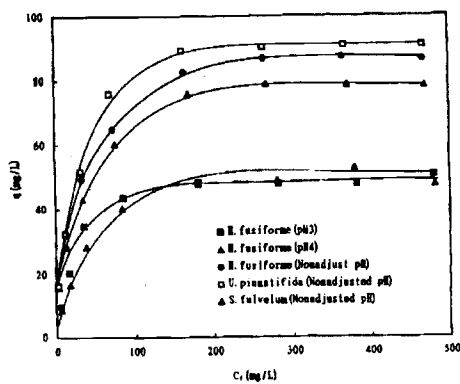


Fig.1. Copper sorption isotherms at different pH values for *H. fusiforme*, together with those at nonadjusted pH for *U. pinnatifida* and *S. fulvelum*.

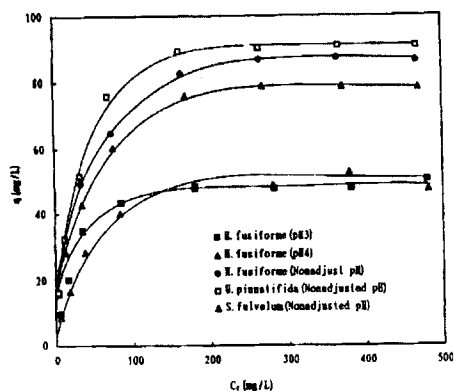


Fig.2. Zinc sorption isotherms at different pH values for *H. fusiforme*, together with those at nonadjusted pH for *U. pinnatifida* and *S. fulvelum*.

Reference

- Greene, B., D.W. Darnell, M.T. Henzel, J.M. Hosea, R.A. McPherson, J. Sneddon and M.D. Alexander, 1986, Elimination of bicarbonate interface in the binding of U(VI) in mill-waters to freeze-dried *Chlorella vulgaris*, Environ. Sci. Technol., 20, 764-767.