LEAD (II) BIOSORPTION BY POWDERISED *RHIZOPUS OLIGOSPORUS*

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Introduction

Biosorption, the metabolism-independent binding of heavy metals to non-living cells, has been explored for its potential in removing toxic metals from aqueous solution. It is a potential alternative to conventional processes for the removal of metals such as chemical precipitation and ion exchange processes. Lead and cadmium for instance, have been effectively removed from very dilute solutions by dried fungal biomass (Fourest and Roux, 1992). Filamentous fungi are widely used in fermentation industries to produce various metabolites such as enzymes, flavouring or antibiotics. The fungal biomass contains poorly biodegradable biopolymers (cellulose, chitin and glucans), which make poor fertilisers. Biosorption processes using dead cells can be of great interest, because of the large variety and the low cost of these biosorbent materials (Brierly et al. 1986). The present study investigated the mechanism and kinetics of lead (II) sorption by powdered *Rhizopus oligosporus* at different sorption conditions. This fungus was chosen as the biosorbent material because of the relative lack of information about its sorption abilities.

Materials and Methods

The mycelia of *Rhizopus oligosporus* from the culture broth were separated from the liquid by filtration using Whatman filter paper (No. 1) and washed with distilled water. The wet mycelium biomass was dried for 18 hours at 55°C in an oven. Dried material was ground using Waring Blendor and sieved using Endecotts, Octagon 200 Test Sieve Shaker with mesh number 300-600 μm. The lead (II) solutions at a range of the desired concentration (10 to 700 mg/l) were prepared by dissolving $Pb(NO_3)_2$ stock in double distilled water. Sorption equilibrium experiments were carried out using 500-ml shake flask containing 200 mg/l lead solution. After the addition of powdered *R. oligosporus*, the flasks were agitated at 200 rev/min on waterbath shaker and the temperature was controlled at 30°C. Separation of the eluent solution from the biosorbent was performed by filtration using membrane filter having 0.45 μm pore size. The concentration of lead was measured using atomic absorption spectrophotometry. The mechanism of lead sorption by powdered *R. oligosporus* was investigated using transmission electron microscope (TEM) examination and energy dispersive x-ray analysis (EDX).

Results and Discussion

The optimum biomass concentration and initial solution pH for lead sorption at initial lead concentration ranged from 50 to 200 mg/l was obtained at 0.5 g/l and pH 5, respectively. In term of the ratio of initial lead concentration to biomass concentration ratio, the highest lead adsorption was obtained at 750 mg/g, which gave the maximum lead uptake capacity of 126 mg/g. These types of data can be used for optimisation and scale-up of industrial effluent purification. TEM micrograph of non-exposed cells to lead indicates that there was no definable lead ion. On the other hand, the dense layers of electron (black dots) throughout the fungal cell wall was observed in the micrograph of lead-exposed cells, indicating that lead ion was present at the cell wall of *R. oligosphorus*. The resulting spectra of x-ray analysis for native and lead exposed cells did not indicate any crystalline structure, implying that the incorporation of lead within the cells did not cause any changes in the amorphous structure of *R. oligosporus* biomass. The peaks of Mg^{2+}, P^{+}, S^{2+}, and K^{+} were noticed as the elements present on the surface of the native cells. On the other hand, the peak of the elements observed on the surface of lead-exposed cells were Pb^{2+} and P^{+}, suggesting that lead was adsorbed and replaced Mg^{2+}, S^{2+} and K^{+} on the cells surface. From the TEM and EDX analyses, it can be concluded that the exposure of powdered *R. oligosporus* to solution containing lead caused the lead ions to adsorb on the surface of the cell wall and very little or none was absorbed into the cells. This means that the biosorption of lead ion by *R. oligosporus* cells was mainly an adsorption phenomenon. The sorption isotherms of lead by powdered *R. oligosporus* at different initial pHs also follow the typical Langmuir adsorption pattern, which is based on surface adsorption, indicating that the adsorption increases when the initial lead concentration arises, as long as binding sites are not saturated.

Conclusions

The maximum lead specific uptake by powdered *R. oligosporus* obtained in this study (126 mg/g) at optimal sorption conditions was significantly higher than those obtained by other fungi such as *R. arrhizus*, *P. chrysogenum* and *A. niger*, which has a qmax, value of 55 mg/g, 116 mg/g and 30 mg/g, respectively. However, the maximum lead uptake by *R. oligosporus* was lower than that obtained by *Chlorella fusca* and *Arthrobacter* sp. which has a q_{max} value of 293 mg/g and 130 mg/g, respectively.

References

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