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CADMIUM AND ZINC BIOSORPTION BY *CHLORELLA HOMOSPHAERA*

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SUMMARY

Cadmium and zinc biosorption by *Chlorella homosphaera* cells were tested under laboratory conditions, in a range of concentrations from 0.5 to 14.0mg/l. The results indicated two distinct phases for cadmium biosorption: a rapid phase probably associated with metal adsorption around the cell wall and a slower phase associated with the metal transport into the interior of the cells. For zinc biosorption these phases were not well defined probably due to the metabolic use of this metal by the cells.

INTRODUCTION

Many industries, including metallurgical industries, discharge undesirable toxic components in their final effluents, like metallic ions. Among these, lead, zinc and cadmium appear as very toxic elements. Nowadays, many researchers show growing interest in studying a way to remove and/or recover these heavy metals by microbial action.

Several microorganisms have already shown potential utility in metals removal. Among these microbial species, bacteria from the genus *Citrobacter* (Macaskie, 1982), fungi (Muraleedharan, 1990), marine algae (Karez, 1989) and green microalgae from the genus *Chlorella* (Ting, 1989), (Nakajima, 1979) have already been employed in metals biosorption processes. In all cases, uranium, copper, lead, cadmium and zinc (Horikoshi, 1979; Nakajima, 1979), are the most focused metals, certainly due to their toxicity in the environment, with the employement of algae from the genus *Chlorella*, *Scenedesmus* and *Chlamydomonas*.

Some of these heavy metals are present at high concentrations in several regions of Rio de Janeiro State (Malm, 1988), probably due to the presence of specific industries. In the several treatment plants operating in Rio de Janeiro State, the conventional technologies applied to the treatment of residual waters are not able to reduce the metals content to an acceptable final concentration. Many of these metals show high toxicity levels (Azcue, 1988). These facts stimulated the study on the potential employement of green microalgae from the species *Chlorella homosphaera*,in these aqueous systems, minimizing the pollution caused by metallic ions and diminishing the ecological disequilibrium faced by some regions.

MATERIALS AND METHODS

- **Microorganism**: *Chlorella homosphaera*, isolated from a lake at "Quinta da Boa Vista", Rio de Janeiro City.

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- **Algae cultivation** : The cells were mantained in inclined gelose Difco, incubated at 30°C for 72 hours, under continuous fluorescent illumination with an intensity of 13000 lux on the flasks surface. The inoculum was obtained from the cultivation of the species in medium proper to algae cultivation, and was stardardized using an algae dry weight curve against absorbance at 430nm. Algae growth was conducted in 500ml erlenmeyers flasks, on a rotary shaker, under continuous fluorescent illumination at 30°C.

- **Experiments**: The experiments were conducted in 500ml erlenmeyer flasks containing 200ml of cadmium and zinc synthetic solutions in varying concentrations from 0.5 to 14.0mg/l and algae concentrations of 0.1 and 0.5g/l. All the tests were conducted at pH 6.0 with continuous stirring. Periodically, samples were collected for residual metal concentration determination. Before analysis the samples were centrifuged at 2000rpm and the cells discharged. Zinc and cadmium concentrations were determined by atomic absorption spectrofotometry, Equipment Varian Techtron, Model AA6.

RESULTS AND DISCUSSION

From figure 1a, employing an inoculum of 0.1g/l it can be observed that the residual cadmium concentration in solution follows an homogeneous profile over a range of concentrations, from 0.5 to 14.0mg/l. A marked initial cadmium retention was followed by a slower retention in the next hours. With a larger inoculum (0.5g/l), (figure 1b), the same behaviour was detected. However, the initial rapid phase was more marked at the higher cell concentration.

Zinc concentration profiles were broadly similar to the ones observed for cadmium (figures 2a and 2b). The higher cells inoculum promoted a greater absorption and the rapid bioabsorption of this metal was considerably more effective that of cadmium. This kind of selectivity has already been shown by other researchers (Nakajima, 1981; Nakajima, 1986), in experiments with *Chlorella*. A continuous zinc removal could be demonstraded, at almost all concentrations tested, even after the metal adsorption step. In comparison with cadmium biosorption this could be explained by the fact that zinc, a metal with well known metabolic functions for algae, was absorbed with a higher efficiency. Cadmium, with no definite metabolic functions (Ting, 1989), could affect a series of cellular parameters (Trevors, 1986), showing a more pronunced toxic action.

To both metals (figs. 1 and 2) biosorption was readily achieved, without biomass colour changing, in the initial steps of the experiment; later a less effective cadmium removal was associated with biomass colour changing, showing the toxic effects of these metal on the cells. An opposite behaviour has been observed for zinc: continuous removal with no colour change detected. These distinct phases in this process have already been described in the literature (Khummongkol, 1982; Ting, 1989) for the case of zinc and cadmium.

It can be observed that with a higher cell concentration, the inhibition effect is less pronounced, indicating a more effective biosorption of the metals with a higher number of available sites for reaction. The toxic effect of higher metal concentrations is substantially less with a higher inoculum. For both metals, the higher the metal concentration, the less effective was the percent removal of the metals. This fact results from a combination of factors, including metal toxicity on the cells and exhausting of biological reaction sites. At equal metal concentrations, zinc was removed in a higher degree than cadmium.

In the present work, the tested metal concentrations were much higher than the ones already studied by other authors, employing algae from genus *Chlorella* with the same purpose (Khummongkol, 1982; Filip, 1979).

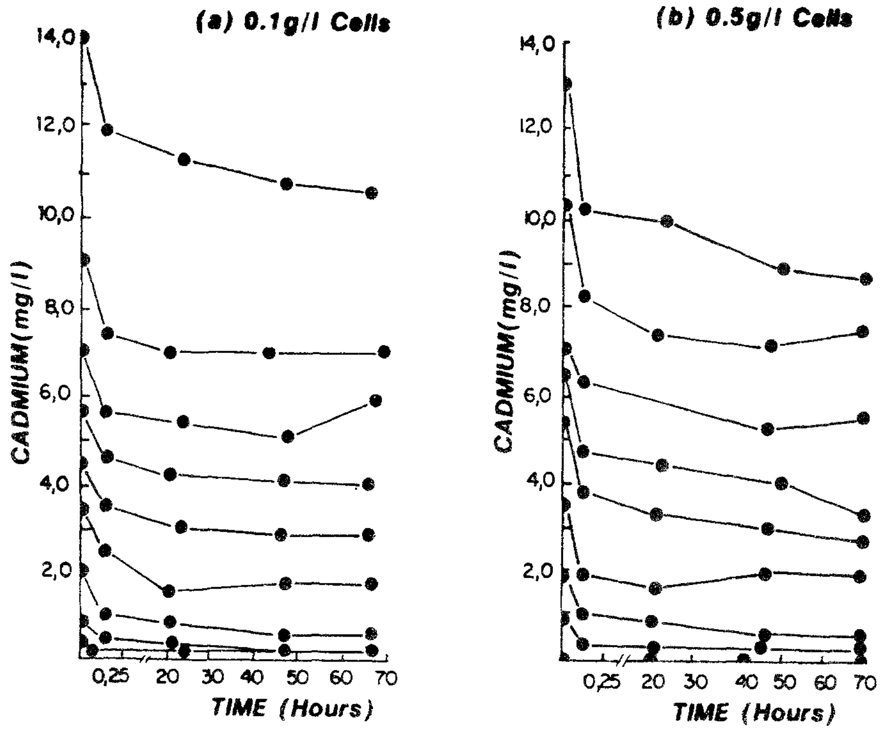

FIG. 1 - CADMIUM BIOSORPTION

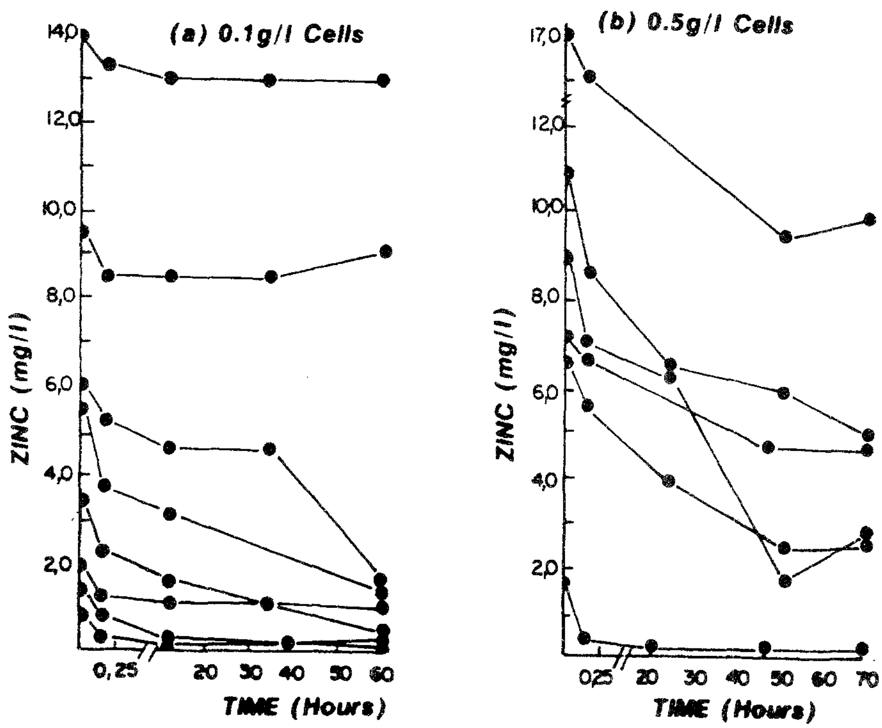

FIG. 2 - ZINC BIOSORPTION

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