

Biosorption of lead by Gram-ve capsulated and non-capsulated bacteria

Saleh M Al-Garni

Biological Sciences Department, Faculty of Science, King Abdulaziz University, PO Box 80203, Jeddah 21589, Saudi Arabia

Abstract

The biosorption of lead by two Gram-ve bacteria, either non-capsulated (*Citrobacter freundii*) or capsulated (*Klebsiella pneumoniae*) was characterised. Lead biosorption was found to be influenced by the pH of the solution, initial metal concentration, and amount of the dried powdered cells and contact time. Thus, the optimum biosorption capacity, by the two tested bacteria, was attained at pH 4, initial lead concentration of about 481.2 mg/l and contacted with 2 g dried cells/l for 100 min. However, the dried powdered cells of both organisms can be safely stored for long periods (125 d) at room temperature (25 ± 2°C) without any loss of their biosorption efficiency, i.e. their binding sites not affected by storage. The results revealed that the presence of capsule (*K. pneumoniae*) increased the biosorption efficiency of the bacterium.

Keywords: biosorption, Gram-ve bacteria, capsulated bacteria, *Citrobacter freundii*, *Klebsiella pneumoniae*

Introduction

Mobilisation of heavy metals in the environment due to industrial activities is of serious concern due to the toxicity of these metals in humans and other forms of life. Removal of toxic heavy metals from industrial waste waters is essential from the standpoint of environmental pollution control (Puranik and Pakniker, 1999; Guangyu and Thiruvengkatachari, 2003). Among the toxic heavy metals, mercury, lead and cadmium, "called the big three" are in the limelight due to their major impact on the environment (Volesky, 1994). Many industries, especially plating and those manufacturing batteries, pigments and ammunition, release heavy metals such as lead, cadmium and zinc in wastewaters. Lead and cadmium are potent neurotoxic metals (Puranik and Pakniker, 1997).

Chemical oxidation, reduction, precipitation, adsorption, solidification, electrolytic recovery, and ion exchange are some of the physicochemical wastewater treatment processes which are being used for metal removal. Application of such methods, however, is sometimes restricted because of technical or economical constraints. (Bossrez et al., 1997; Yu and Kaewsarn, 1999). Biological metal removal (biosorption) has distinct advantages over conventional methods: it is non-polluting and it can be highly selective, more efficient, easy to operate, and hence cost-effective for treatment of large volumes of wastewaters containing low metal concentrations (Puranik and Pakniker, 1999).

Various biomass materials including microbial biomass have been identified and documented as effective metal-removing agents (Veglio and Beolchini, 1997; Volesky and Holan, 1995). The present work aimed to characterise lead biosorption by local Gram-ve bacteria, either non-capsulated (*Citrobacter freundii*) or capsulated (*Klebsiella pneumoniae*).

Materials and methods

Micro-organisms

Citrobacter freundii and *Klebsiella pneumoniae* were kindly provided by Microbiology Lab, King Abdulaziz Medical City, Jeddah, Saudi Arabia, and their identification was routinely assessed using Sin: Desca 5744 Vite apparatus and API 20E indicator for Gram-ve bacteria.

Growth and preparation of the powdered dried dead cells

The tested bacteria were maintained on nutrient agar slants. The stock cultures were transferred weekly and stored at 10°C in a refrigerator.

Biomass of the tested bacteria was developed by growing in MacConky broth medium (Nentech, LTD, UK), pH 7.0 at 37±1°C for 48 h, under shaken conditions (120 r/min). Cells were harvested by centrifugation at 8 000 r/min for 10 min (J-2/C plus centrifuge). Harvested cells (biomass) were washed twice with deionised distilled water and dried in an oven at 80°C for 48 h. To assess complete death of the dried cells, samples of the dried cells were inoculated to Petri-dishes containing MacConky agar medium, absence of any growth indicating positive results (complete death of the bacteria). The dried cells were then ground in a porcelain mortar to obtain a fine powder (0.2 mm), and stored at 5°C, until use.

Metal solution

A stock solution of lead (1 200 mg/l) was prepared by dissolving 0.0113 M of lead nitrate in deionised distilled water, shaking it for 15 min and then leaving it to stand for 24 h to obtain complete dissolution. Stock solution was diluted with deionised distilled water to obtain the necessary concentrations. Solutions were adjusted to desired pH values with 0.1 M sodium hydroxide and 0.1 M nitric acid. The initial lead concentration was measured at the beginning of all experiments carried out using an atomic

* To whom all correspondence should be addressed.

☎ +96626952291; fax: +96626952290;

e-mail: saleh895_4@hotmail.com

Received 21 January 2005; accepted in revised form 29 April 2005.