Clean Techn Environ Policy
DOI 10.1007/s10098-013-0611-9

ORIGINAL PAPER

Biosorption of heavy metals and cephalexin from secondary effluents by tolerant bacteria

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Received: 29 June 2012 / Accepted: 26 March 2013

Abstract The biosorption of heavy metal ions and the antibiotic cephalexin from secondary effluents by the cell biomass of tolerant bacterial strains was investigated in this article. A total of 67 bacterial strains were isolated from a secondary effluents generated by sewage treatment plants. These strains were adapted to tolerate 6 mM nickel ions (Ni^{2+}) and 10 g L^{-1} cephalexin. Bacterial cell biomass that has more than 150 mg g^{-1} biosorptive capacity was used for the biosorption under optimal conditions. The biosorption process was efficient in removing heavy metals: 87.63 % of cadmium, 74.61 % of copper, 58.32 % of nickel, 61.9 % of lead, and 94.26 % of zinc, respectively. The maximum biosorptive capacity of the bacterial cell biomass for cephalexin was 60 mg g^{-1}. The efficiency of cephalexin biosorption was reduced by more than 40.83 and 82.88 % (living and dead cells, respectively) in the presence of 1 mg L^{-1} Ni^{2+} ions compared with the control, whereas no biosorption by dead cell biomass was recorded in aqueous solutions contaminated with cadmium, zinc, copper, and lead ions. In conclusion, biosorption which efficiently removes metal ions, but not cephalexin, from secondary effluents is explained.

Keywords Biosorptive capacity · Cephalexin · Heavy metal · Secondary effluent · Tolerant strain

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Introduction

Sewage treatment plants (STPs) are seriously contaminated with toxic metal ions, such as nickel (Ni^{2+}), zinc (Zn^{2+}), copper (Cu^{2+}), cadmium (Cd^{2+}), and lead (Pb^{2+}) (McLaren and Smith 1996). Ni^{2+} is one of the most frequently encountered heavy metals in raw wastewater streams (Padmavathy et al. 2003). The removal of Ni^{2+} is a major concern because Ni^{2+} compounds are carcinogenic and can cause asthma (Aslam et al. 2010). Zinc is a toxic element with high to moderate importance as a trace element and copper is an essential metal for many organisms but also very toxic. Cadmium and lead are both classified as toxic metals (Nasrazadani et al. 2011). The presence of lead in drinking water above the permissible limit (5 ng mL^{-1}) causes adverse health effects such as anemia, encephalopathy, hepatitis, and nephritic syndrome (Lo et al. 1999).

Conventional technologies for removing heavy metals, including ion exchange, reverse osmosis, evaporative recovery, and chemical precipitation is often inefficient and very expensive. Sewage treatment processes can remove about 50 % of zinc, 60 % of copper, 79 % of lead, 80 % of cadmium, and 1 % of nickel (Leung et al. 2000). Therefore, new methods for the removal of metals from effluent or their reduction to very low concentrations must be developed.

On the other hand, the treatment techniques used in STPs are insufficient to remove antibiotics as it have been detected in large quantities in secondary effluents and activated sludge (Spongberg and Witter 2008). Cephalexin is one of the most popular antibiotics that are ubiquitously present in effluents in high concentrations due to its resistance to biodegradation (Lin et al. 2009; Guo et al. 2010). Thus, alternative treatment methods for the removal of antibiotics from wastewater systems need to be

Published online: 14 April 2013