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Removal of lead by exopolysaccharides from *Paenibacillus peoriae* strainTS7 isolated from rhizosphere of durum wheat

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ABSTRACT

This work aimed to study the removal of heavy metal ions in aqueous solution by extracellular polysaccharides (EPS) extracted from bacterial strain coded TS7. The 16S ribosomal RNA gene sequencing allowed us to identify this strain as *Paenibacillus peoriae*. The EPS were defined by GLC-MS and ^{1}H NMR as a homopolysaccharides of fructose. The effect of contact time, initial metal ions concentration, mass of the polysaccharide and pH on the metal uptake were investigated by employing batch adsorption technique. The results showed that the maximum removal percentage was achieved at 180 min with an initial lead concentration of 100 ppm and the mass of 0.5 g L^{-1} EPS at pH 6.8. The maximal metal uptake (q_{max}) value in Dubinin–Radushkevich (D–R) adsorption isotherm of EPS was found 277.54 mg g^{-1}. The adsorption surface of the metal at surface of TS7 EPS was confirmed through scanning electron microscopy. Besides, FT-IR analysis indicated that some functional groups of TS7 EPS may play an important role in lead biosorption.

1. Introduction

Pollution of the environment with toxic elements, especially heavy metals, is considered as one of the most important environmental problems (Akpomie et al., 2012). Heavy metals are difficult to eliminate from the environment and, contrary to many other pollutants, cannot be chemically or biologically degraded, so they become ultimately indestructible (Mejáre et al., 2001). Lead, for example, is recognized to be extremely toxic heavy metal; it can complex with Oxo-groups of enzymes to affect practically all steps of hemoglobin biosynthesis and porphyria metabolism. Lead poisoning causes serious health problems including kidney, reproductive system, nervous system, liver and brain diseases (Akpomie et al., 2012). In response to these issues, a variety of methods are used to treat heavy metal toxicity including chemical precipitation, electrodialysis, complexation, floatation, ultrafiltration, coagulation, evaporative recovery, ion exchange, flocculation, reverse osmosis, nanofiltration, complexation, etc. (Ahalya et al., 2003; Shao et al., 2011; Gupta and Diwan, 2016). However, these methods usually cost too much due to their high power consumptions and reagent requirements. Furthermore, they contain several disadvantages such as incomplete removal of heavy metals, low selectivity, and the generation of toxic slurries which are hard to remove (Gupta and Diwan, 2016). The search for new technologies concerning the toxic metal elimination from wastewater has taken awareness of biosorption. It can be defined as the capacity of natural materials to eliminate heavy metals from wastewater through metabolically mediated or physicochemical process of uptake (Ahalya et al., 2003). These biosorbents contain bacteria, yeast, fungi, and algae (Gupta, 2015). Compared to the conventional methods applied for heavy metal removal, the potential benefits of biosorption process include: low price, high efficiency, reduction of chemical and biological sludge, no need to introduce any additional nutrients and opportunity of metal recovery and regeneration of biosorbent (Ahalya et al., 2003). Particular attention has been devoted in recent years to the uptake of heavy metal ions from aqueous solution by adsorption employing bacterial exopolysaccharides (EPS). These latter are extracellular polymeric substances with high molecular-weights that constitute good biosorbents, taking in to consideration their ample diversity of structures and properties as well as their facility of implementations. They are secreted out of self-defense against environmental stress which does not only provide protection to the cells against dewatering or toxic elements, but is considered as a carbon and energy source as well (Pal and Paul, 2008). The main objectives of this study

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