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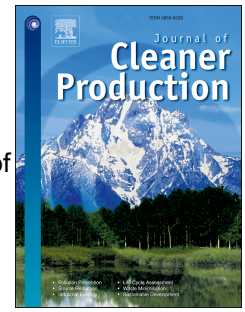

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Characterization of fungal-mediated carbonate precipitation in the biomineralization of chromate and lead from an aqueous solution and soil

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Abstract: While microbially induced calcite precipitation (MICP) has been extensively studied by using bacteria for the mineralization of heavy metals, this process is still not completely characterized regarding the remediation of metals from solution and soil using fungi. Thus, in the present study, a ureolytic fungal strain, *Penicillium chrysogenum* CS1, isolated from cement sludge was, firstly, utilized for the biomineralization of chromate and lead from an aqueous solution. Although this fungal strain immobilized a relatively lower amount of Cr(VI) than Pb in solution, at 200 mg L^{-1} Pb, fungal-based MICP removed 98.8% of Pb in 12 days. The biomineralization process was characterized by SEM-EDX, which confirmed the typical shape of carbonate crystals precipitated by the fungal strain in addition to the presence of the main elements in the form of metal carbonates. FTIR spectroscopy predicted the functional groups that were responsible for the formation of metal carbonates, while XRD identified biominerals in the form of calcite, vaterite, calcium chromium oxide carbonate and hydrocerussite. Further, when this fungal strain was utilized for metals remediation in soil, an increase in the carbonate-bound fraction of metals in soil was observed. The percentage of exchangeable Cr(VI) decreased from 41.60% to 1.95%, while exchangeable Pb decreased from 41.27% to 2.19% in contaminated soil. This is one of the few studies in which fungal-mediated calcite precipitation is characterized in the remediation of heavy metals.

Keywords: Biomineralization; *Penicillium chrysogenum*; Urease; Heavy metals; Calcite

1. Introduction

Chromium (Cr) and lead (Pb) are considered to be heavy metals pollutants as are other heavy metals. The large amount of Cr/Pb-containing waste adds stress to safe disposal in China, and improper treatments have enhanced their levels in the soil (Wei and Yang, 2010). Chromium mainly exists in two environmentally important oxidation states (+3 and +6), among which Cr(III) is considered to be non-toxic, while Cr(VI) (chromate) is considered to be highly toxic. In nature, lead exists at an