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Aerobic reduction of chromium(VI) by Pseudomonas corrugata 28: Influence of metabolism and fate of reduced chromium

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Pseudomonas corrugata 28 represents a microorganism that can potentially be applied for *in situ* bioremediation of Cr(VI) contaminated sites. This strain combines a high resistance toward toxic Cr(VI) with the ability to reduce Cr(VI) to Cr(III) under oxic conditions. In this study, the aerobic reduction of Cr(VI) by *Pseudomonas corrugata* 28 was examined at pH 7 in a Tris minimal medium (TMM) containing varying concentrations of gluconate as the carbon source and sulfate or ethanesulfonate as the sulfur source to assess the influence of microbial carbon and sulfur metabolism on Cr(VI) reduction. The fate of reduced chromium was elucidated by investigating the speciation of chromium in solution as well as the interaction of chromium with bacterial surfaces. For the latter, cells were investigated by scanning transmission X-ray microscopy (STXM) and near-edge X-ray absorption fine structure (NEXAFS) spectroscopy at the C K-edge and the Cr $L_{2,3}$-edge. Additionally, Cr(III) adsorption experiments were conducted. Reduction of Cr(VI) was found to be a metabolic process. Nonmetabolic reduction mediated by bacterial surfaces did not contribute to Cr(VI) reduction to a significant extent. The reduction of Cr(VI) was almost unaffected by the type of sulfur supply under the conditions of our experiments. Our results showed that reduction of Cr(VI) by *P. corrugata* 28 mainly led to the formation of dissolved organic Cr(III)-complexes. Both Cr(VI) reduction experiments and Cr(III) adsorption experiments consistently indicated that small amounts of reduced chromium were weakly associated with the negatively charged bacterial surfaces. This finding was further supported by our X-ray microscopy results. The formation of inorganic Cr(III)-precipitates was not indicated. We conclude that for bioremediation purposes, sufficient nutrient supply is required to maintain effective reduction of Cr(VI) by *P. corrugata* 28 under aerobic conditions and that microbial reduction does not necessarily result in an immediate immobilization of chromium as Cr(III)-hydroxide.