SIDEROPHORES FOR SELECTIVE SOLID PHASE EXTRACTION OF STRATEGIC ELEMENTS

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All over the world, industrial mining is leaving contaminated areas and dumps that, although being full of valuable metals, have high concentrations of toxic heavy metals that pollute the environment. The development of sustainable alternative biomining and bioremediation processes offers the potential to fully exploit these unexploited mining sites.

To overcome metal limitation and metal stress bacteria have developed different strategies to inhabit such habitats. They excrete mixtures of low molecular organic acids and biomolecules with high metal affinity called metallophores, which allow them to dissolve and complex metals from minerals for a selective uptake of necessary trace elements through membrane pores or siderophore selective membrane receptors.

Interestingly, these molecules can be used for metal extraction processes of metals of industrial interest, and although these extremely strong metal-complexing molecules have been known for years, no industrial application in the field of biomining has been found yet, due to the challenging process of production and separation of these molecules, making this potential process too expensive.

Here we present a cost-effective way to exploit the high metal affinities of siderophores for the mobilization and extraction of metals from solid materials such as soils. Seven different bacterial strains were cultivated under iron-limiting conditions, the supernatant was extracted, and used in a 2-fold concentration for the following experiments. A complex soil matrix with natural levels of element mineralization from “El teniente” mine in Chile was employed as source of elements to study mobilization of the containing metals. After mobilization, metallophore-metal complexes were adsorbed on Amberlite XAD-16 resin and then eluted with a mixture of EDTA and acetic acid. As a reference, we used highly concentrated solution of the commercial metallophore desferrioxamine B (DFOB), EDTA and the culture media.

As a result, we obtained successful mobilization of especially iron, phosphorus and silicon, but also other metals / metalloids of interest as aluminium, molybdenum, manganese, copper, arsenic, zinc and vanadium. The extraction method with XAD shows about 80% recovery rate, dependent on the tested strain. Our results show that expensive purification processes are not necessarily needed to use siderophore for industrial purposes.

Keywords: Biomining, Bioremediation, Metallophores, Trace Elements, “El Teniente” Mine (Chile)