**Diversity of the Microbial Populations used to transform Arsenic in   
natural and industrial situations**

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**Highlights**

* Extreme natural and industrial environments are a source of microorganisms with unique potential.
* An acidophile consortium was isolated from effluents of a mining operation.
* The consortium is capable of oxidizing high arsenic concentrations.
* A metabolic reconstruction of the consortium was developed to study its metabolic capabilities.

**1. Introduction**

A permanent challenge for the mining industry is the development and application of metal recovery technologies that are efficient, low cost and ecologically friendly, since during the process many contaminating elements are released [1]. Most of the minerals present in the rock represent a rich source of elements of high economic value, but some may contain toxic metals or metalloids, such as arsenic.

Northern Chile has a variety of poly extreme natural and industrial ecosystems, with high rates of solar radiation, low relative humidity, extreme temperature variations and the presence of high concentrations of metals. Microbial life develops under these challenging environmental conditions, which makes it an ideal place to search for extremophile microorganisms with specific physiological and metabolic adaptations.

Our aim is to describe and understand the metabolic capabilities of the microorganisms that are able to resist, reduce or oxidize different metals and metalloids commonly associated with the mining industry, in particular arsenic. In this context, we present a unique opportunity for the discovery and development of technologies that will carry out the transformation of arsenic.

**2. Methodology**

Microorganisms were isolated from geothermal sites in northern Chile and also from samples of industrial effluents from an arsenic treatment plant. The isolates were identified by Illumina sequencing techniques.

The determination of the diversity of microorganisms present in the samples, allowed the generation of strategies to enhance their growth and oxidative activity, through two approaches:

• Experimentally, optimizing the growth conditions according to the reported nutritional requirements of the microorganisms present.

• Through *in silico* optimization. The consortium's metabolism was reconstructed and modeled, according to the genomic information obtained from the sequencing.

**3. Results and discussion**

The industrial consortium showed the best oxidation results (about 80% of As(III) oxidized) in solutions with high arsenic and acid content (around 1-3 gpl of As (III) and 20-40 gpl of H2SO4). The most likely species in the consortium according to the experimental and metabolic analysis are *Acidithiobacillus, Rhodanobacter, Leptospirillum, Thiobacillus, Terracoccus* and *Acidianus.*

The metabolic model was simplified by depuration and *gap-filling,* and is composed of about 176 reactions representing the consortium. Main pathways of the model are reverse TCA cycle for carbon fixation, energy uptake by iron metabolism and arsenic resistance by detoxifying mechanisms and dissimilatory oxidation of As (III).

We are presently using both the metabolic model and the experimental results necessary for the oxidation of arsenic in order to design a process that takes advantage of the microbial oxidation of arsenic.

**4. Conclusions**

A consortium was isolated from industrial effluents, which showed high tolerance to mining operation conditions and elevated capacity to oxidize arsenic (III) from acid effluents.

The development of a metabolic model of an industrially isolated consortium was useful to describe and represent the capabilities of these microorganisms to oxidise arsenic in solutions with high acidity and high ion concentrations. This model is being used to simulate growth under different conditions and, in this way, perform mathematical analyzes for optimization.

**References**

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