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Steven A. Banwart

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METALS RECOVERY FROM MINE LEAD CONCENTRATES: SCREENING OF BIOLEACHING MICROBIAL COMMUNITIES

JC Duarte*, MC Sáágua, SM Paixão, L Baeta-Hall, C Nogueira, P Sá Pereira, and AM Anselmo

INETI, Estrada do Paço do Lumiar 22, 1649-038 Lisboa, Portugal
*Corresponding author: José Cardoso Duarte, INETI - DB - Unit of Monitoring and Ecotoxicity, Estrada do Paço do Lumiar 22, 1649-038 Lisboa, Portugal. Phone: 351 210 924 690, Fax: 351 21 716 69 66. Email: jose.duarte@ineti.pt.

ABSTRACT

Presently, the recovery of metals from concentrates by biometallurgy processes using acidophilic bacteria as being seen as an interesting and more economic alternative to more conventional metallurgical techniques. This work concerns to the utilization of microorganisms collected from different extreme environments, including Azores hot springs and S. Domingos acid mine drainage samples, and their application for bioleaching a lead concentrate contaminated with zinc and copper from S. Domingos mine in Portugal.

The screening of iron-oxidising acidophiles, which are known to have a key role in the bio-oxidation of the sulfide minerals regenerating the oxidant ferric iron, was made by enrichment techniques at different temperatures (35°C – mesophilic bacteria and 60°C - thermophiles bacteria) with 0.5-2% (w/v) lead concentrates as substrate and shaking at 150 rpm.

The best inoculum for bioleaching of lead concentrate was the Achada Sludge sample (S. Domingos mine), at 35°C, with a % metals recovery of 65% Fe, 82% Cu and 100% Zn, at 2% lead concentrate after 2 months. In the controls the % metals recovery ranged from 0% (Cu, Fe) to 10% (Zn). In the bioleaching assays at 60°C, the % metals recovery was very low (< 10%) after 2 months. The consortia with the highest bioleaching potential is being genetically characterized.

Optimization studies of the bioleaching conditions of the lead concentrates by Achada Sludge sample are being carried out.

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SULPHATE REDUCING BACTERIA FOR METALS BIOREMEDIATION

José Duarte¹, Sárgua M. C. ¹, Paixão S. ¹, Baeta-Hall L. ¹, Clara Costa²
¹INETI-Biotechnology Department, Pato do Lumiar 1649-038 Lisboa Portugal
²Universidade do Algarve- FERN- Faro Portugal
Corresponding author: Jose.duarte@ineti.pt

ABSTRACT

Metal contamination represents an important environmental problem due to the toxic effects of metals, and their accumulation throughout the food chain leads to serious ecological and health problems. The main sources of heavy-metal pollution are mining, milling and surface finishing industries, discharging a variety of toxic metals (Cd, Cu, Ni, Co, Zn and Pb) into the environment, posing significant disposal problems that require urgent solution. Environmental contamination has led to decreased biodiversity, extinction of sensitive species and an artificial selection of better adapted ones.

Several conventional treatment technologies for removing metals are available. These techniques, based on chemical methods of neutralisation and precipitation, even though quick and effective, present several disadvantages, such as the need for building additional treatment plants, the high cost of the chemical reagents used and the generation of an important volume of sludges which need further treatment.

Acid mine drainage (AMD) is one of the most important source of heavy metal environmental pollution. AMD is characterised by its high acidity (pH < 3), high concentration of metals (for instance, Cu, Fe, Zn, A1, Pb, As, Cd, etc.) and high concentration of dissolved sulphates (≥ 3,000 ppm).

Microbiological diversity associated with mining environments is a very well proven fact. One of the communities appearing in these environments is that formed by anaerobic sulphate-reducing bacteria (SRB) which can be used for the decontamination of AMD waters. So, a possible alternative to the chemical treatment of these effluents is bioremediation using anaerobic sulphate-reducing bacteria (SRB), taking advantage of the fact that these microorganisms grow in mining environments and can mediate the direct and indirect reduction of heavy metals (also at lower concentrations) and contribute to the biodegradation of organic pollutants.

We are using SRB’s from local inocula for the design of reactors for AMD and soil bioremediation. Growth of these bacteria in matrices column reactors is done using ethanol as an electron donor source for the production of H2S from sulphates. The produced H2S can then be used for metals precipitation in situ or in a second stage column. Nevertheless, the efficiency of bioremediation strategy depends on the activity of SRB which, in turn is affected by environmental conditions, operational parameters and the local composition of the overall microbial community. Understanding the mechanisms of H2S production, the reactors microbiology and kinetics is of primordial importance for processes controlling and to increases the probability of success for its application.


KINETICS OF A PACKED-BED BATCH REACTOR FOR THE TREATMENT OF OLIVE OIL WASTEWATERS FROM A PORTUGUESE MILL

José Cardoso Duarte, Belina Ribeiro, Ana Correia, Lina Bacta-Hall, Susana M. Paixão, M.C. Sááguia
INETI, Departamento de Biotecnologia, Lumiar, 1649-038 Lisboa, Portugal

ABSTRACT

In this work a 60 litter’s vessel filled with a packaging of plastic material consisting of a cubic geometry (Biological Carrier Media from Rauschert) and pebbles was filled with effluent from an olive mill farm (from Alfarrobeira da Fé, Três-os-Montes) and the effluent was re-circulated daily for homogeneity. COD, polyphenols, colour, nitrogen, solids and phosphorous were measured to follow the evolution of the system. Microbial composition was also followed. Methods: Chemical oxygen demand (COD), total suspended solids (TSS), volatile suspended solids (VSS), nitrogen and colour : Standard Methods for the Examination of Water and Wastewater (1995). Phosphorous : Phosver 3 (Ascorbic Acid) Method HACH. Phenol : method of Singleton & Rossi. Microbiological characterization : colony-forming units (cfu) of aerobic viable microbial population: heterotrophic bacteria, yeasts and fungi and phenols degrading bacteria. Incubation at 28°C. Ecotoxicological evaluation : growth inhibition test in 96-well microplates (NUNCTM, Denmark) using a culture of a bacterium, Pseudomonas putida (MIGULA DSM 50026), according to ISO 10712 (1995). IC50-16h values were estimated from the sigmoidal concentration - inhibition curves fitted by the maximum likelihood - logit method using the ToxCalc V5.0.23F (Tidepool Scientific Software, McKinleyville, CA, USA).

A good removal of COD and phenol content from OMW was obtained. The presence of an active microbial community was detected in two olive oil wastewater samples and an effective degradation and mineralization of the complex organic matter took place. A significant decrease in the chronic toxicity of the treated OMW to P. putida, after 140 days of treatment, was also observed, highlighting the detoxification potential of the system studied. This type of reactor of relatively low cost and with a rather important degradation potential of the organic load may become an interesting solution for the remediation of the olive oil waste waters.