MICROBIAL KINETICS OF HYDROGEN SULFIDE PRODUCTION AND ARSENIC BIOPRECIPITATION IN BATCH SYSTEMS

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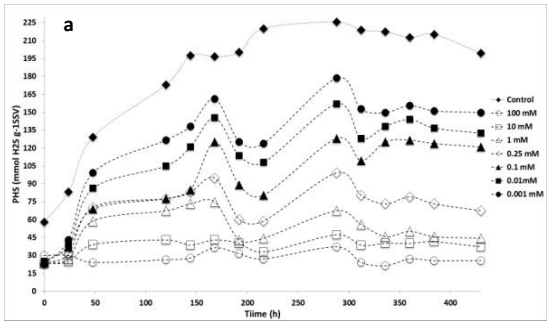
Introduction. Environmental remediation technologies in which are used sulfate reducing bacteria are based on the production of biogenic hydrogen sulfide (H_2S_{biog}) and constitute a feasible alternative for the remediation of sites contaminated with heavy metals including arsenic (As). In the present study, it was evaluated the effect of different concentrations of As (V) and As (III) on the production of H_2S_{biog} of two microbial consortia that present sulfate reducing activity.

Methodology. It was evaluated the kinetics of production of H_2S_{biog} of microbial consortia JH and M2 using batch systems, containing Postgate medium at 100, 10, 1, 0.25, 0.1, 0.01 and 0.001 mM of As (V) and As (III), the systems were inoculated with 90 mg/L of biomass (1). H_2S_{biog} concentration was determined using a turbidimetric method (2). At the end of the kinetics the biomass concentration was determined and it was performed by the logistic decay model, it was quantified the total concentration of As in each system to determine the percentages of bioprecipitation and determine the H_2S production rate using the sigmoidal growth model of Gompertz (3).

Results. The kinetics of sulfide production in the presence of As (V) showed a series of oscillations in the production, which may be associated with a bioprecipitation process of As, it given by the existent redox conditions in the system that generates the coexistence of As (III) and H_2S in solution. The kinetics of production of specific sulfide in the presence of As (III) the concentration of H_2S_{biog} increases gradually during 288 or 336 hours depending on the initial concentration of arsenic, to kept constant and begin to decrease. Initial concentrations of 100, 10 and 1 mM of As (V) and As (III) generate an inhibition in the production of H_2S_{biog} and in the microbial growth.



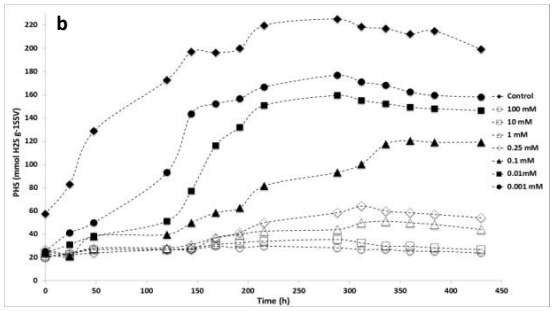


Fig. 1. Kinetics of H_2S production of JH microbial consortium in presence of: (**a**) As (V) and (**b**) As (III).

Table 1. Results of fit with the Gompertz model, logistic decay model and precipitation rates of As.

Microbial consortium	V_{max} of production of H_2S_{biog} (mmol H_2S•g SSV^{-1}•h^{-1})	[As V] $_{\theta=0.50}$ (mM)	[As III] $_{\theta=0.50}$ (mM)	Precipitation of As V (%)	Precipitation of As III (%)
JH	1.437	0.21	0.20	12 to 93	17 to 92
M2	1.348	0.22	0.16	12 to 94	10 to 91

The percentage of precipitation varies depending on the initial concentration of arsenic added.

Conclusions. The bioprecipitation process of As (V) could be associated to a mixed process, in which occurs a reduction of As (V) to As (III), an incomplete oxidation of sulfide to elemental sulfur, an accumulation of H_2S_{biog} and bioprecipitation of As; whereas bioprecipitation process of As (III) depends on the concentration of H_2S_{biog} present in the system. Bioprecipitation percentages of As are similar for both consortia, reaching percentages of up to 94% of As (V) and 92% of As (III). The microbial consortium JH had a higher production rate H_2S_{biog} (1.437 mmol H_2S • g VSS^{-1}•h^{-1}) compared with the consortium M2 (1.384 mmol H_2S•g VSS^{-1}•h^{-1}).

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References

1. Eaton, A. D., Clesceri, L. S., Rice, W. E., Greenbe, A. E., & APHA. (2005). Standard Methods for the Examination of Water and Wastewater. *APHA, AWWA, WEF*, 20th ed., Baltimore. 55-58.
2. Cord-Ruwisch R. (1985). A quick method for the determination of dissolved and precipitated sulfides in cultures of sulphate-reducing bacteria. *Journal of Microbiological Methods*. Vol. (4): 33-36.
3. Labastida N.I. (2008). Evaluación a escala laboratorio de bacterias sulfato reductoras en la estabilización de la fracción bioaccesible de plomo en un suelo impactado por la minería. *Tesis de Maestría del Posgrado en Ingeniería de Minerales*. Universidad Autónoma de San Luis Potosí. Octubre, 166.