Cr(III) Oxidation Coupled With Microbially-Mediated Mn(II) Oxidation

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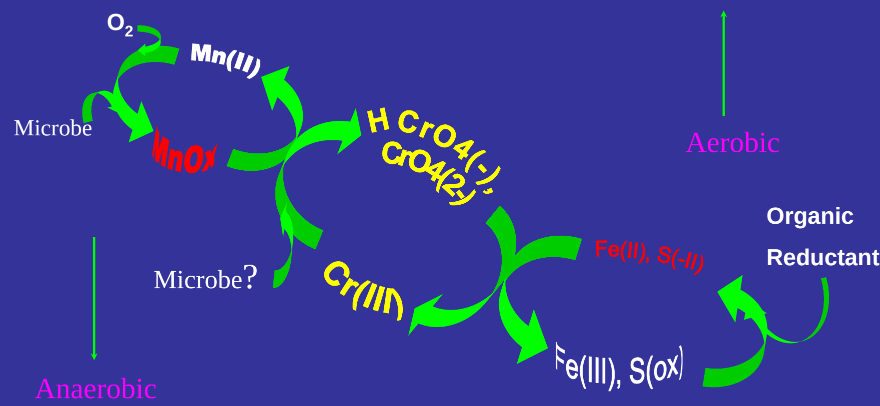
Introduction

- Cr(VI) can be reduced to less toxic and mobile Cr(III) species through abiotic and biological processes. Reductive immobilization of Cr(VI) has been widely explored as a cost effective technology for site remediation;
- Mn oxides are regarded as primary oxidants for Cr(III) oxidation in the environment;
- Generation of Mn oxides from Mn(II) in natural environments is believed to be biologically catalyzed.



(adapted from Kotas and Stasicka 2000)

Hypothesis

The presence of Mn-oxidizing bacteria can enhance Cr(III) oxidation to Cr(VI).

Methods

Pseudomonas putida was obtained from ATCC. Microbial experiments were conducted in modified LEP medium with 10mM HEPES buffer (pH 7) in a shaker at 150 rpm at 26ºC. Cell density was determined with spectrophotometric method at 600 nm. Mn oxides were detected using modified LBB assay (Boogerd and de Vrind, 1987). Aliquots of sample were filtered through 0.2 µm Anotop filters. Cr(VI) was measured using diphenyl carbazide (colorimetric). Total soluble Mn and Cr were measured with ICP.

Experiments and Results

Experiment 1: Cr(III) oxidation by *P.putida*

Goal: to compare abiotic and biotic Cr(III) oxidation.

A: *P.putida*+Cr(III)+Mn(II); B:*P.putida*+Cr(III); C:Sterile A (Figs. 1 & 2)

Experiment 2: Effects of Mn(II) addition

Goal: to determine the effect of Mn(II) concentrations on Cr(III) oxidation

Initial Cr(III): 0.05 mM; data used from analyses of samples at the 8th day of incubation (Fig. 3). T-Cr(VI)=S-Cr(VI) (soluble) + adsorbed Cr(VI)

Experiment 3: Cr(III) concentrations

Goal: to determine the effect of Cr(III) concentrations on formation of Mn oxides by *P.putida*

Initial Mn(II): 0.1 mM for all treatments. Data calculated from analyses of samples at the 6th day of incubation (Fig. 4)

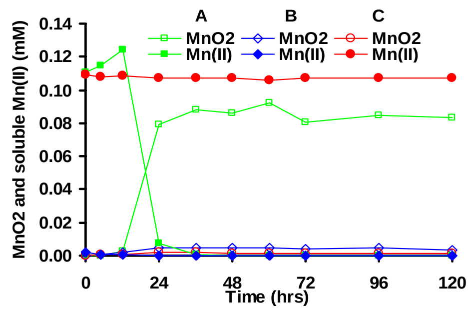


Fig. 1. Changes of Mn(II) and Mn oxides.

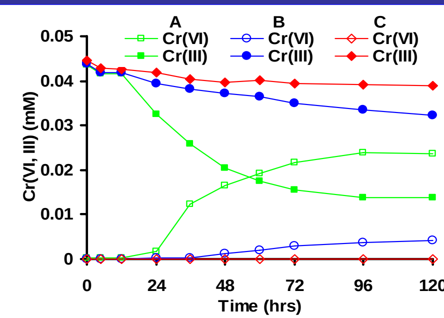


Fig. 2. Changes of Cr(III) and Cr(VI)

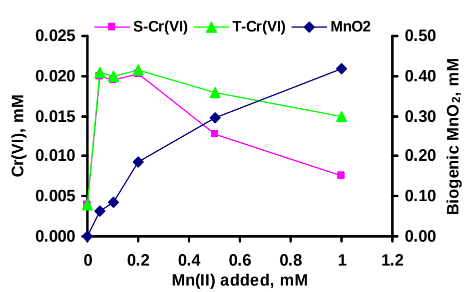


Fig. 3. Effects of Mn(II) concentrations on Cr(VI) and MnO_2 production.

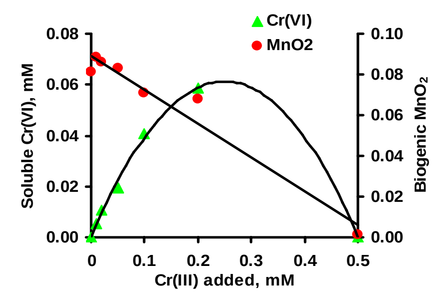


Fig. 4. Effects of Cr(III) on Cr(VI) and MnO_2 production.

Conclusions

- Mn-oxidizing bacteria can accelerate Mn-oxidation, thus increase the rate of Cr(III) oxidation
- Cr(III) oxidation is not in direct proportional to initial amount of Mn(II) in the concentration range of 0.05-1.0 mM. Cr(III) oxidation and Cr(VI) mobility are inhibited to some extent due to Cr(VI) adsorption by biogenic MnOx.
- Cr(III) oxidation is approximately proportional to initial Cr(III) concentrations up to 0.2 mM but is suppressed at 0.5 mM Cr(III) due to no MnOx biogeneration.

Future work

- Can the reduced compounds such as FeS affect Cr(III) oxidation? Do clay minerals such as FeOOH, kaolin affect Cr oxidation?
- Can the Mn(II)-oxidizing bacteria directly oxidize Cr(III) to Cr(VI) without pre-formation of MnOx?
- Mechanism of Cr(III) oxidation in presence of metal-oxidizing bacteria

Acknowledgements

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