Mariprofundus ferrooxydans: Life in a harsh toxic environment.

1. Introduction

Mariprofundus ferrooxydans, strain PV-1, is a bacteria that obtains energy from reduced iron, an inorganic substance that is abundant in hydrothermal vents [1]. Its global impact on iron oxidation makes this organism very relevant to aquatic environments where iron is ubiquitous. Bioinformatic analysis showed the presence of a gene in M. ferrooxydans capable of arsenite detoxification. Therefore, we hypothesize that M. ferrooxydans must be capable of withstanding high levels of arsenic in its growth medium. To test the functionality of this genetic trait in vivo, we exposed M. ferrooxydans to various concentrations of arsenic-spiked media.

Figure 1. Hydrothermal vent activity in the ocean provides dissolved iron to iron oxidizing bacteria. [2]

Figure 2. Mariprofundus ferrooxydans under light microscope. Characteristic iron stalks filaments are readily apparent. [1], [3].

2. Questions?

What is the highest arsenic concentration that Mariprofundus ferrooxydans can tolerate?

Can arsenic-spiked media be used to isolate other Fe-oxidizing bacteria?

Is Mariprofundus ferrooxydans capable of using arsenic as a energy source?

3. Methods

• Log-phase M. ferrooxydans cultures were used for inoculation of arsenic-spiked media.

• Arsenic-free controls were inoculated and labeled control A and control B. 100uM, 500uM and 1000uM arsenic-spiked media were monitored for growth delay.

• Following inoculation, data was collected for 113 hours (~4 days). Cell counts and arsenic measurements were performed at 15 hours, 38 hours, 65 hours, 90 hours and 113 hours after inoculation.

4. Data

Figure 3. Molybdenum Blue Method for Arsenate Quantification in Seawater.

Figure 4. Arsenate Standard Curve.

Equation of the Standard Curve

\[ y = 0.0343x - 0.0238 \]

Therefore;

\[ y + 0.0238 = 0.0343x \]

\[ x = (y + 0.0238) / 0.0343 \]

Figure 5. Tracking the oxidation of arsenite to arsenate via the molybdenum method.

5. Interpretation

• We determined that M. ferrooxydans is capable of adapting/tolerating a high concentration of arsenic in its environment. Initially, we thought that growth was inhibited at 1000uM but subsequent observations at 60h post-inoculation, showed that M. ferrooxydans was capable of growth at this high arsenic concentration.

• The lag-phase observed for the 100uM and 500uM arsenic test were significantly shorter than the growth delay observed in the 1000uM sample (2 and ~0.5 days, respectively).

• We hypothesize that once M. ferrooxydans is exposed to a sub-lethal arsenic concentration they can easily adapt/tolerate higher arsenic concentrations since they are already familiar with the substance.

• This investigation leads us to suggest that arsenic spiked media can be employed to selectively culture iron oxidizing bacteria that hold similar detoxifying gene sequence as M. ferrooxydans.

6. Conclusions

• M. ferrooxydans can adapt/tolerate high concentrations of arsenic. We tested up to 1000uM but the inhibitory arsenic concentration is likely higher.

• We did not see any oxidation of arsenic which means that they do not use arsenic as a source of energy.

• The use of arsenic is a method that can be helpful in the process of isolating a bacteria with similar putative arsenic detoxification genes as M. ferrooxydans.

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References:

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