Bacterial Tellurate Reduction is Catalyzed by a Molybdenum-Containing Enzyme

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Introduction: Tellurium (Te) is a metalloid element used for a variety of industrial applications including metallurgy, chemical manufacturing, electronics, and nanotechnology. The disposal of mine tailing and tellurium-containing wastes has led to an increase in environmental contamination. When released into the environment, tellurium undergoes redox transformations and can be mobilized as the dissolved Te oxyanions tellurate [Te(VI), TeO_4^{2-}] and tellurite [Te(IV), TeO_3^{2-}]. Bacteria are known to catalyze the reduction of toxic tellurite into sparingly soluble and less toxic elemental tellurium [Te(0)]. Currently, the genetic identity and cofactor composition of enzymes that catalyze bacterial tellurate reduction are unknown. In this study, we examined the tellurate reduction activity of *E. coli* mutants that were impaired in molybdenum metabolism and were unable to form molybdenum-containing enzymes.

Materials and Methods: Experiments were carried out to investigate the reduction of Te(VI) to Te(0) by the *E. coli* K-12 wild type strain and mutants carrying single mutations in the molybdopterin biosynthesis (*moa-mog*) and molybdate transporter (*modABC*) gene systems. Cultures were grown in LB media containing 50 μM Na_2TeO_4. Samples were taken then at periodic intervals, and the black Te(0) precipitate formed by the cells were removed by filtration (0.45 μm). The total dissolved tellurium remaining in the media was analyzed using Inductively Coupled Plasma Optical Emission Spectrometry. Genetic complementation by the wild-type sequences was also performed to restore activity in the mutant strains that lost the ability to reduce Te(VI).

Results and Discussion: *E. coli* K-12 wild type cells reduced over 70% of the Te(VI) to Te(0) within 48 h. Conversely, mutants carrying deletions of the *moaA*, *moaB*, *moaE*, or *mog* gene in the molybdopterin biosynthesis pathway lost the ability to reduce tellurate. Deletion of the *modB* or *modC* genes in the molybdate transport pathway also resulted in complete loss of tellurate reduction activity. Genetic complementation by the wild-type sequences restored tellurate reduction activity in the mutant strains. These results provide genetic evidence that tellurate reduction in *E. coli* is catalyzed by a molybdenum-containing protein.