Identification of the Iodate Terminal Reductase in Metal-Reducing Bacteria

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Background/Objectives. An attractive method for remediation of radioactive iodine-contaminated subsurface environments is liquid extraction and trapping of volatile iodine gases via microbially-catalyzed iodine redox transformation and methylation reactions. Microbial iodate (IO_3^-) reduction is a major component of the iodine biogeochemical reaction network in iodine-contaminated subsurface environments. We previously discovered that the metal (but not nitrate) reduction pathway is required for IO_3^- reduction by the metal-reducing bacterium *Shewanella oneidensis*. The identity of the terminal IO_3^- reductase, however, remains unknown. In the present study, a variety of metal (*mtr*) reduction pathway paralog mutants of *S. oneidensis* were examined for IO_3^- reduction activity to identify potential candidate enzymes catalyzing the terminal IO_3^- reduction reaction by *S. oneidensis* and other metal-reducing members of the *Shewanella* genus.

Approach/Activities. Six *S. oneidensis mtr* paralog mutants (D*mtr*A-D*mtrDEF,* D*mtr*A-D*dms*EF, D*mtr*A-DSO_4360, D*mtrF,* D*dms*B and DSO_4357-4358) were constructed by in-frame gene deletion mutagenesis. The IO_3^- reduction activity of the six *mtr* deletion mutants was tested in batch liquid cultures containing defined minimal medium amended with either formate or lactate as electron donor and IO_3^- as anaerobic electron acceptor.

Results/Lessons Learned. The *mtr* deletion mutants D*mtr*A and D*mtr*B were unable to reduce IO_3^- with lactate as electron donor, but retained wild-type IO_3^- reduction activity with formate as electron donor. This result indicated that one of *mtr* paralogs may be required for IO_3^- reduction with formate as electron donor. Among the three mtr paralog mutants (D*mtr*A-D*mtrDEF,* D*mtr*A-D*dms*EF and D*mtr*A-DSO_4360), only D*mtr*A-D*dms*EF mutant displayed a deficiency in IO_3^- reduction activity with formate as electron donor. This finding suggests that the DMSO reductase system is also involved in IO_3^- reduction. Subsequent IO_3^- reduction activity tests of three mtr paralog mutants (D*mtrF,* D*dms*B and DSO_4357-4358) demonstrated that D*dms*B was unable to reduce IO_3^- while D*mtrF* and DSO_4357-4358 retained wild-type IO_3^- reduction activity. Together these results provide complementary genetic and phenotypic evidence that the *S. oneidensis* DMSO terminal reductase displays broad substrate specificity and reduces IO_3^- as an alternative terminal electron acceptor.