Using mercury-resistant bacteria to examine the effects of thiol complexation and thiol and Mer transporters on the microbial bioavailability of inorganic Hg and methylmercury

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Mercury bioavailability experiments were conducted using broad spectrum mercury-resistant strains of the bacteria Pseudomanas stutzeri and Escherichia coli that are capable of converting MeHg into inorganic Hg(II) and methane, and subsequently reducing Hg(II) to elemental mercury. These strains allowed us to quantify intracellular accumulation of Hg by monitoring the loss of volatile Hg(0) over short-term (hours) incubations. We used these strains to examine the bioavailability of thiol complexes of inorganic Hg and MeHg and the roles of thiol and Hg transporters in their uptake. Thiol complexation generally lowered intracellular uptake of inorganic and MeHg, but they were still bioavailable. We measured higher levels of Hg uptake in an E. coli strain with Hg transport proteins (MerT, MerE, and MerP) than in the same strain in which the genes for these transporters had been knocked out. However, there was no difference in Hg uptake rates for strains with or without functioning glutathione transporters. These results indicate that thiol-bound Hg is available to mercury-resistant bacteria and its uptake is facilitated by Mer transporters, but that glutathione transporters are not involved in the uptake of the Hg(GSH)2 complex in E. coli.

Thiol complexes of MeHg (MeHg-cysteine and MeHg-glutathione) were bioavailable in mercury-resistant strains of P. stutzeri and E. coli. As was the case for inorganic Hg, when exposed to thiol complexes of MeHg, higher rates of intracellular accumulation of MeHg were observed in an E. coli strain with a functioning Mer transport system than in a strain in which genes for all three Mer transport proteins had been deleted. A similar level of suppression of MeHg uptake was observed in strains in which only the periplasmic component of the Mer transport system, merP, was knocked out, indicating a critical role for this protein in modulating the transport of thiolated-Hg into the cell. We conclude that the complexes MeHgOH and MeHg-cysteine are equally bioavailable to mercury-resistant bacteria, and that Mer transporters facilitate the uptake of MeHg.