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Using Mercury Transformative Digestive Microbes for Wastewater, Soil and Dental Applications

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Abstract

Mercury is a Global Contaminant known for its high Toxicity and Extensive Presence in various Environmental media. It enters the Environment through Diverse Pathways, including combustion, Industrial and mining effluents, septic discharge, and dental procedural waste. It may appear as elemental mercury (Hg0), inorganic mercuric compounds (Hg2), or organic mercury compounds such as methylmercury (MeHg). Although potentially hazardous in all forms, methylmercury poses the greatest concern due to its extreme neurotoxicity, high solubility, and ability to bioaccumulate within the food chain. This neurotoxin can cause a spectrum of adverse health effects, from subtle neurodevelopmental disorders to severe neurological impairments. Moreover, methylmercury exhibits significant environmental mobility, traversing from atmospheric and terrestrial systems into aquatic ecosystems, where it bioaccumulates and biomagnifies from plankton to fish, impacting human and wildlife health. In terrestrial environments, methylmercury can contaminate soil, disrupting beneficial microbial communities and entering the food web through agricultural products intended for human and animal consumption. In nature, mercury compounds interact with microbes in several ways. Certain microbes methylate Hg0 into MeHg, which increases environmental toxicity. However, most microbes are adversely affected by mercury ions as they disrupt cellular functions by binding to essential biomolecules. Mercury is particularly detrimental to a microbe's ability to produce protease, an enzyme crucial for breaking down proteins into amino acids. Protease plays a significant role commercially in wastewater treatment, vacuum system maintenance, animal nutrition, soil health, and agricultural applications. Many commercial processes depend on non-denuded proteases for protein degradation. When microbes are utilized to produce protease for commercial applications, the presence of mercury in any form other than Hg0 can potentially diminish their functionality through protease disruption. Although not only the microbe's ability to create and release protease is inhibited, but any extracellular fluid or soil borne protease is irreversibly denatured through mercuric interaction, particularly Hg2. In a mercury-contaminated environment such as an industrial or mining area, some bacteria, fungi, and mold have adapted to transform mercury into its nontoxic elemental form. The merA and merB genes produce the enzymes; mercuric reductase, and organomercurial lyase, which convert toxic forms of mercury into elemental mercury. This process produces non soluble mercury which is easier to capture through filtration methods and lessens environmental discharge. The patented Mereduce TM technology fosters a microbe's ability to create transformative enzymes for both microbial and protease protection. Through novel methods for downstream enzyme presentation, it creates an environment for the growth and adaptation of transformative microbes while generating active protease enzymes.