Application of Redox Mediators to Accelerate Removal of Selenium from Agricultural Drainage Water

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The redox mediator, AQDS, accelerates the conversion of Se(IV) to elemental selenium thereby increasing the removal rate of total soluble Se from agricultural drainage water.

Agricultural drainage water contributes to selenium (Se) contamination of aquatic systems in California's San Joaquin Valley. The bioaccumulation of Se in aquatic systems creates serious hazards to fish and waterfowl. This project builds on previous work to identify ways to remove or reduce Se from agricultural drainage water before it is disposed into aquatic systems.

Redox mediators have been used as electron carriers to stimulate the reductive biotransformation of environmental contaminants by shunting electrons between an external electron donor and the contaminants. Three redox mediators, anthraquinone-2,6-disulfonate (AQDS), hydroxyl-p-naphthoquinone (HNQ), and naphthoquinone (NQ), were assessed in the reduction of Se(VI) (1000 µg/L) to Se(0) by *Enterobacter taylorae* in drainage water containing a sucrose level of 500 mg/L. The results showed that addition of neither HNQ nor NQ increased the reduction of Se(VI) to Se(0). AQDS was found to enhance the removal of total soluble Se, though not directly through reduction of Se(VI) to Se(0). During an 8-day experiment, about 90% of the added Se was removed from drainage water with AQDS. Addition of AQDS to drainage water only increased the removal of Se(IV), not Se(VI), suggesting that the increase in the removal of total soluble Se in drainage water is caused by rapid removal of Se(IV) in the presence of AQDS.

We will continue this study by using zero-valent iron to enhance bacterial removal of Se from drainage water and to limit the formation of the most bioavailable organic Se.

Publications

Zhang, Y.Q. Z. A. Zahir, C. Amrhein, A. Chang, and W.T. Frankenberger, Jr. 2007. Application of redox mediator to accelerate selenate reduction to elemental selenium by *Enterobacter taylorae*. J. Agric. Food Chem. 55:5714-5717.

Professional Presentations

Invited Presentation: Redox reactions of chromium, uranium, selenium, and arsenic in soils. Universität für Bodenkultur Wien (University of Natural Resources and Applied Life Sciences). Department of Forest- and Soil Sciences, Vienna, Austria. May 8, 2007.

Collaborative Efforts

This project has helped us obtain additional funding from the California Department of Water Resources to study the fate of selenium and nutrients in shallow ponds at the Salton Sea. Collaborators on this project are Professors Michael Anderson and Daniel Schlenk (UCR).

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