Preparation and Application of Tea Leaves In Situ Capping Reactive Materials for Remediation of Lindane-Contaminated Sediments

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Background/Objectives. Contaminated sediments present risk to the environment. However, remediation technologies for this type of environmental contamination are still limited and efforts put forth to seek new technologies are required. Tea is one of the most popular flavored beverages in the world, and has been reported to have anti-radical, anti-inflammatory and anti-carcinogenic functions. These characteristics are based on tea containing rich polyphenols, which combines with ferrous ion to have been confirmed as an effective process (i.e., tea/Fe^{2+} system) for degrading organochlorine pesticides (OCPs) (e.g., lindane). In situ capping (ISC) has been commonly selected as a component of the remedy for contaminated sediments. Tea/Fe^{2+} system may be combined with ISC technology to produce an ISC material for sediment remediation and to achieve both physical isolation and degradation of contaminants. The ISC materials could be synthesized by mixing tea leaves, clay and biodegradable polymer. As soon as they are placed in situ and contacted with water, they will be hydrated to expand and form an isolation barrier above sediments to reduce environmental risk through functions of physical isolation, stabilization, and reductive degradation. Based on the application potential of tea/Fe^{2+} ISC materials, the objectives of this study included: (1) preparation and characterization of tea/Fe^{2+} ISC materials; and (2) investigation of the potential of tea/Fe^{2+} ISC materials for degrading lindane in sediments.

Approach/Activities. Laboratory-scale experiments conducted in this study included preparation and characterization of ISC materials and investigation of ISC materials for degrading lindane in the sediment. Initial phase of experiments was designed to screen suitable polymers for preparing ISC materials and to characterize their properties (e.g., water absorption, expansion rate, surface topography by scanning electron microscope and transmission electron microscope, specific surface area, and release rate of polyphenols). In the second phase of experiments, tea/Fe^{2+} ISC material was examined for its potential application in a sediment-water slurry system.

Results/Lessons Learned. ISC material was successfully manufactured and used to degrade lindane in sediments in this study. During the ISC material preparation, the mixture of clay and biodegradable polymer (sodium alginate) incorporated with tea/Fe^{2+} appeared a suitable stable and reactive capping material. Polyphenols were steadily released in aqueous phase and a reducing environment was maintained. Tea leaves in the ISC material could increase adsorption capacity of lindane, which released from contaminated sediment. Furthermore, a reducing condition with sufficient electron transfer happened for dechlorinating lindane. The preliminary results of this study may serve for OCPs treatment in the sediments or soil and groundwater remediation.