Activation of indigenous sulfate-reducing bacteria to immobilize heavy metals and arsenic in agricultural soils

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Microbiological stabilization of heavy metal is an advantageous technique including low process cost, low energy input, and less hazardous byproducts compared to physical or chemical treatment methods. In this study, stabilization of cadmium, lead and arsenic was investigated through bacterial reduction of sulfate and subsequent formation of insoluble sulfide precipitates. Behavior of heavy metals and arsenic in polluted arable soil was examined after activation of anaerobic indigenous sulfate-reducing bacteria through supply with carbon source (electron donor) and sulfate (electron acceptor) in batch-type experiments. Indigenous sulfate-reducing bacteria were isolated from the contaminated soil at depth of 60 cm and the optimum growth conditions of the bacteria were determined including sulfate concentration and available carbon sources such as glucose, lactate, and methyl alcohol.

According to the results of batch experiments, the carbon source and sulfate were periodically applied to the field site and long-term monitoring over 23 weeks was conducted. After 23 weeks incubation of the indigenous sulfate-reducing bacteria, the total concentrations of heavy metals and arsenic in the soil, which were determined after aqua-regia digestion, appeared to be similar between before and after amendment process. However, partial extraction of arsenic from the soil using 1 N HCl revealed that the fraction of readily extractable arsenic decreased to 75% in the soil after stimulation of the indigenous sulfate-reducing bacteria. Conceivably, stimulation of indigenous bacteria in the contaminated soil with supply of appropriate carbon source and sulfate might lead to effective stabilization and long-term stability of heavy metals and arsenic.