Novel washing agents for efficient sediment remediation; selection, comparison and optimization study

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Introduction: Sediment pollution has been a major environmental concern for several decades and remediation of sediments contaminated with heavy metals is critical for the protection of river ecosystems. Heavy metals are among the most persistent pollutants in aquatic ecosystems, and they cannot be removed from water by self-purification.[1,2] Current treatment methods aimed at restoring normal function to contaminated sediment are similar to those used for soil and include: physical (centrifugation, flocculation, hydrocyclones, sieving, sedimentation, etc.), chemical (chemical leaching, chemical oxidation, chemical fixation, electrokinetic remediation, etc.) and biological processes.[3,4,5]

Results: The characteristics of sediments can differ significantly from those of soils, technologies that work for soils may not be as effective for sediments. Compared to other remediation technologies, soil washing is a relatively inexpensive and efficient method, including sediment remediation. The key to sediment washing lies in the choice of washing agent and process optimization. A variety of compounds (acids, surfactants, redox agents, and chelating agents) have been shown to be effective in remediating contaminated soil and sediment.[4,6,7] However, many of them also have drawbacks (e.g., high price and disruption of soil structure). For example, strong acids (e.g. HCl, H_2SO_4, H_3PO_4, HNO_3) and in some cases also organic acids (e.g. oxalic acid, citric acid, tartaric acid) can destroy the basic properties and structure of soil/sediment, thereby affecting soil fertility and microbial activity. Synthetic chelating agents such as EDTA or DTPA, as common washing agents, are persistent in the soil environment and can negatively affect microbial activity.[8,9] Moreover, these agents are mainly used in soil remediation; few studies have investigated the use of other washing agents in sediment remediation. Sediment washing may require more attention and care because sediments tend to be richer in organic matter than soils. The use of biosurfactants to improve the removal of contaminants from soils and sediments has gained increasing attention in recent years.[7,10] Therefore, this work investigated cost-effective, efficient and environmentally friendly means for remediation of heavy metal contamination.

Discussion: In this work special attention was paid to sustainable substances such as humic and phytic acids, rhamnolipid and saponin. All were tested on Drava River sediments in different washing procedures and their efficiency was compared with the synthetic chelating agent EDTA.

Methods: The metal removal efficiency for different washing methods/agents was followed by metal concentration analysis (AAS, ETAAS, ICP/OES or ICP/MS) of the aqueous phase. Metal standard solutions for AAS were typically prepared in the range of 1 to 10 mg/L by serial dilution of commercial standards (Zn, Pb, Cd). Absorbance was measured using Varian AA 240 instrument. For ICP, multimetal standard solutions were prepared by serial dilution of the standard Merck Multi VI with 2% HNO_3. Using multi-point calibration curves, typically at 10 µg/L, 30 µg/L, 100 µg/L, 300 µg/L, and 1000 µg/L, the ICP/OES instrument Varian AX Vista was used.

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