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Use of Fungal-Derived Enzymatic Cocktail Encapsulated in Biodegradable Shell for Degradation of Environmental Contaminants

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Background/Objectives. Microbially-mediated breakdown of environmental pollutants is typically limited to aromatic compounds up to 4-rings and saturated compounds up to 25 carbons. Fungal-based bioremediation proves to be effective in scenarios where more complex and highly polar molecules need to be treated. Ligninolytic enzymes, with their low substrate specificity, include mainly laccase (Lac), manganese peroxidase (MnP) and trace amounts of lignin peroxidase (LiP), showed extensive degradation of variety of phenolic and non-phenolic compounds. Moreover, the in vitro enzymes are not limited by microbial growth or public health concerns and studies have shown that complete degradation of typically recalcitrant PAHs (e.g., 3-5 ring PAHs) using Lac or MnP can be achieved. Our research focuses on the ability of ligninolytic enzymes to degrade larger molecular compounds through the use of radical reactions, with the potential to enhance degradation of variety of environmental contaminants.

Approach/Activities. A patented cocktail composed of enzymatic activities (Lac, MnP and LiP) derived from fungal species and encapsulated in biodegradable bi-layer shell was applied to crude contaminant solutions as well as to soil matrix contaminated with: heavily weathered hydrocarbons, polychlorinated bisphenols (PCBs), polycyclic aromatic hydrocarbons (PAHs), dioxanes, xylenes and perfluorooctanesulfonic acid (PFAS).

Results/Lessons Learned. The vast amount of data collected from experiments with several environmental contaminants listed above showed their significant degradation. Treatment of weathered crude samples spiked with crude enzyme extract, and contaminated soil spiked with encapsulated enzyme cocktail indicated that addition of fungal oxidoreductases breaks down heavy TPHs (>C38) as well as PAHs. The results from degradation of weathered crude oil with crude enzyme show more than 80% degradation of heavy TPH fractions (C28-35) and PAH fractions such as: asphaltenes, napthalenes, chrysenes and fluoroethenes. Experiments with PCB contaminated sediments indicated that addition of Lac and MnP reduced concentration of congeners up to 66%.