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Impact of Fungal Manganese Oxides on Zinc Mobility

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Manganese (Mn) oxides are widespread minerals in natural environments and are predominantly formed through microbial activities. These biogenic Mn oxides occur as highly reactive phyllomanganates and can affect the fate of a variety of trace metals. Fungal Mn oxides are of special interest due to the additional presence of fungal hyphae, they contribute significantly to metal adsorption and biogeochemical cycling.

Zinc (Zn), a common co-contaminant in metal-polluted environments, is an essential element for biological processes but becomes toxic at elevated concentrations. The filamentous fungus *Curvularia lunata* TC1, isolated from wastewater at the Tar Creek Superfund site in northeast Oklahoma, has demonstrated the ability to oxidize 200 μM Mn(II) within 14 days in liquid AY media. While low Zn concentrations (20 μM) had no effect on Mn oxide formation, high Zn concentrations (80 μM) significantly inhibited it. Remarkably, fungal growth was not inhibited under high Zn concentration, a phenomenon rarely reported in fungi.

To understand this phenomenon, we integrated morphological, elemental, and transcriptomic analyses. Scanning electron microscopy (SEM) revealed extracellular Mn oxides formed by strain TC1, and synchrotron-based X-ray fluorescence (XRF) mapping demonstrated co-localization of Zn and Mn. Transcriptomic analysis (Illumina NovaSeq) further revealed significant gene expression changes under high Zn conditions.

These findings demonstrate that biogenic Mn oxides play a greater role in Zn adsorption than fungal hyphae. This insight advances our understanding of microbially mediated redox processes and offers a new perspective on how trace metal mobility is regulated in natural and contaminated environments. Results from this study has important implications for elucidating novel pathways in the biogenetic Mn oxidation process, and providing valuiable guidance in the development of effective bioremediation strategies.