Potential application of X-ray absorption spectroscopy in Environmental Biogeochemistry and remediation

Yu-Ting Liu[1,*], Liang-Ching Hsu[2], Yen-Lin Cho[1], and Heng Yi Teah[3]

[1]Department of Soil and Environmental Sciences, National Chung Hsing University, Taichung, Taiwan
[2]Scientific Research Division, National Synchrotron Radiation Research Center, Hsinchu, Taiwan
[3]Division of Environmental Studies, Graduate School of Frontier Sciences, The University of Tokyo, Chiba, Japan
yliu@nchu.edu.tw

Abstract

Soil is a mixture of minerals, organic matter, and organisms that support life. The poorly crystalline Fe mineral, i.e. ferrihydrite, that ubiquitously distributes over soil and natural environments generally has greater surface areas compared with many crystalline minerals and thereby serve as major sorbents for nutrients (e.g., phosphate, PO_4), heavy metals (e.g., cupper), and metalloids (e.g., arsenic). In addition, poorly crystalline Fe hydroxides also show the ability to stabilize soil organic matter and thus potentially increase carbon sequestration in soil systems [1]. Composites formed during the coprecipitation and/or coagulation of dissolved organic matter and Fe in natural and waste water systems might be potential scavengers for Cr(VI) in terms of sorption and reduction [2]. Regarding the crystalline soil clay minerals, the modifications using eco-friendly nonionic surfactants for new application have received much scientific attention. Our study has evidenced that the addition of such organo-clay composites in chicken feeds substantially mitigated aflatoxin accumulation in chicken tissues, providing an alternative method to reduce the risk of human consuming aflatoxins from contaminated chicken products [3]. In addition to soil minerals, microalgae have attracted considerable interests as alternative materials for environmental remediation. Thermoacidophilic Cyanidiales are capable to survive in extreme environments (20–56 °C; pH 0.5–5.0) with concentrated metals, allowing them to serve as promising green materials applied in metal remediation. Lead tolerance on Cyanidiales was modulated according to four mechanisms: the defense line provide by polysaccharide, the inorganic Pb-PO_4 precipitation, the organic Pb complexation concomitant with the transport to cell vacuoles, and the specific thiol-Pb chelation involved in disruption of protein secondary structures. Despite Cyanidiales generally performed all mechanisms against Pb toxicity, individual defense responses were highlighted by specific Cyanidiales species. The redistribution of Pb-polysaccharide species and inorganic Pb-PO_4 precipitates toward organic complexation promoted Pb(II) ions sorption capacity of Cyanidiales, accounting for the significant sorption capacity for Pb (298.4 mg g^{-1}). The knowledge provided here could improve the application of the Cyanidiales in environmental remediation as an innovative green technology.

Keywords – Soil mineral, phosphate, organic matter, microalgae, remediation

References

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