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Mn oxide-biochar composites for remediation of soils contaminated with metal(loid)s and polyaromatic hydrocarbons (PAH)

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Biochars have been recognized as highly versatile materials for the remediation of soils contaminated with either organic or inorganic contaminants. Combining biochars with other types of materials for the preparation of composite materials can improve their properties and enhance their effectiveness towards targeted contaminants while maintaining the inherent benefits of biochar application, such as an increase of soil organic matter (SOM) content or higher water retention.

In the current study, novel composites of biochar and amorphous Mn oxides (so-called AMOchars) were synthesized using cost-effective raw materials, including biochar derived from waste woody biomass, waste molasses, and white sugar. The synthesis process aimed to maximize production efficiency and achieve desirable material properties—specifically, the highest adsorption capacities for the target metal(loid)s while minimizing Mn leaching, which can act as another source of soil contamination.

The newly prepared materials, AMOchars synthesized using molasses (BCM) and sucrose (BCS), were tested in three different contaminated soils with different contents of metallic contaminants (As, Cd, Cu, Pb, Zn), pH, SOM, texture, etc. The tested amendments were added to soils at a ratio of 0.5%, 1% and 2% (w/w), and incubated for a period of up to 6 months. Soil solutions were periodically collected and analyzed for their physico-chemical characteristics and content of metal(loid)s. In addition, the influence of added amendments on the content of polyaromatic hydrocarbons (PAH) in soils was investigated. In general, the BCS composite showed to be a better candidate both for metal(loid) immobilization and PAH degradation, being effective for As, Cd, Pb and Zn while causing generally lower Mn leaching. On the other hand, AMOchars seem as not suitable candidates for Cu immobilization, especially under lower pH values, when higher amounts of Mn and Cu are mobilized together with the released organic complexes.