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Sorption interactions of heavy metals with biochar in soil remediation studies

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The search for new materials in soil remediation applications has led to new conversion technologies such as carbonization and pyrolysis. Biochar represents the pyrolytic product of different biomass input materials processed at 350-1000°C and anoxic conditions. The pyrolysis temperature and feedstock have a considerable influence on the quality of the charred product and also its main physico-chemical properties. Biochar as porous material with large specific surface and C-stability is utilized in various environmental and agricultural technologies. Carbon sequestration, increase of soil water-holding capacity and pH as well as sorption of different xenobiotics present only a fraction of the multitude of biochar application possibilities. Heavy metals as potential sources of ecotoxicological risks are characterized by their non-degradability and the potential transfer into the food chain. Carbonaceous materials have been used for a long time as sorbents for heavy metals and organic contaminants in soil and water technologies. The similarity of biochar with activated carbon predetermines this material as remediation tool which plays an important role in heavy metal immobilization and retention with a parallel reduction in the risk of ground water and food crop contamination. In all this processes the element-specific sorption behaviour of biochar creates new conditions for pollutant binding. Sorption interaction and separation of contaminants from soil solution or waste effluent can be affected by wide-ranging parameters. In detail, our study was based on batch-sorption comparisons of two biochars produced from wood chips and green waste residues. We observed that sorption efficiency of biochar for model bivalent heavy metals (Cd, Zn, Cu) can be influenced by equilibrium parameters such as pH, contact time, initial concentration of metal in reaction solutions, presence of surfactants and chemical modification by acid hydrolysis, esterification and methylation. The study of sorption mechanisms showed differences in the sorption of the targeted heavy metals in relation to the contribution of ion-exchange and precipitation processes. We confirmed the effectivity of physico-chemical artificial aging on sorption capacity of biochar in terms of changes in surface structure. Based on these results, the application potential of biochar as sorption material for stabilizing heavy metals in soils is discussed.