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Use of Pyrogenic Carbon Geosorbents to Decrease the Mobility and Bioavailability of Pharmaceuticals in the Soil-Water-Biota Continuum

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Pharmaceuticals are emerging contaminants widely detected in soil and water environments, and concerns are mounting over their potential impact on human and ecosystem health. In particular, overuse of antibiotics (an important group of pharmaceuticals) in human medicine and animal agriculture and rapid emergence of antibiotic resistant bacteria on a global scale are threatening the health of humans, animals, and the environment. We have investigated interactions of pharmaceuticals with pyrogenic carbon geosorbents (e.g., biohar and activated carbon), bacteria, and vegetable crops in order to better understand sorption, uptake, and translocation of pharmaceuticals in the soil-water-biota continuum. Sorption of antibiotics by biochars was studied to assess the effect of biochar soil amendment in reducing the transport and bioavailability of antibiotics. Pyrogenic carbonaceous materials such as biochars and activated carbon had strong sorption capacities for antibiotics, and drastically lowed the uptake of antibiotics by an Escherichia coli, therefore demonstrating soil amendment with pyrogenic carbon geosorbents as an effective remediation strategy to reduce antibiotic transport and selection pressure for antibiotic resistant bacteria. Additionally, because consuming pharmaceutical-tainted food is a direct human exposure pathway, it is critical to investigate the residue levels of pharmaceuticals in food crops grown in contaminated soils or irrigated with reclaimed water. Therefore, we have studied the uptake and accumulations of pharmaceuticals in greenhouse-grown lettuce under overhead or surface irrigations. Preliminary results indicate that pharmaceuticals of large molecular weight and low water solubility had greater concentrations in lettuce shoots under overhead irrigation than surface irrigation. Pharmaceuticals of low molecular weight and high water solubility are less clearly influenced by irrigation methods. These results implies that irrigation scheme needs to be optimized when using the reclaimed water for crop irrigation. In summary, scientifically-sound soil and water management practices are needed to minimize the transfer of pharmaceuticals from soil and water to crops and microorganisms.