

## Impacts of biochar nanoparticles on the toxicity of cadmium to aquatic model organism

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Biochar has been widely introduced not only as a soil amendment to enhance plant growth but also as a sorbent material for soil, water remediation and contamination removal. The diverse sources of biomass and pyrolysis methods applied during biochar production profoundly impact the physicochemical properties of biochar and their fate-transport in the environment. Natural processes can degrade biochar and generate biochar nanoparticles (BCNPs); however, the impacts of these BCNPs to ecosystems, including aquatic organisms, is not well understood. In both soil and aquifers, biochar and BCNPs have a strong affinity toward a range of heavy metals and organic contaminants. The negatively charged surface functional groups on these materials provide adsorption sites for potentially toxic metals and, through cation bridging, can lead to the aggregation of BCNPs. The purpose of the research is to determine the impact of two types of BCNPs (willow and bamboo), on the toxicity of a common heavy metal cation, cadmium (Cd) toward the model organism *Daphnia magna*. Experiments were conducted by pyrolyzing feedstocks at 500°C, followed by mechanical-grinding to produce a range of biochar particle sizes. The size distribution and net surface charge of the yield was confirmed through zeta-sizer and zeta-potential analyses. Toxicity tests were conducted by exposing *Daphnia* to systems containing Cd, BCNPs, and BCNPs+Cd at several different treatment levels to determine the lethal concentration 50 (LC50). The results show that in general bulk biochar is an effective sorbent for Cd removal; however, BCNPs derived from the same bulk materials are better sorbents for Cd, in line with their elevated surface reactivity and surface area. The LC50 results show BCNPs alone do not result in substantial toxicity toward *Daphnia*, and in only a modest increase in the observed toxicity of Cd. However, due to their smaller size and higher mobility, BCNPs may be a substantial transport vector for contaminants including Cd in soils and water, and may present risks to other organisms. Ongoing work is exploring the impact of metal-loaded BCNPs toward *Bacillus subtilis*, to develop a broader understanding the impacts of biochar application to contaminated sites that may have on ecosystem health.