Reusing a Plant Waste for Environmental Remediation: Vetiver Root Biochar Adsorbs Copper

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Copper (Cu) is ubiquitous in the environment. Although Cu is an essential nutrient, it causes stomach and intestinal distress, liver and kidney damage, and anemia at high doses. Likewise, Cu in rivers and oceans at high concentrations has a negative impact on fish and wildlife. Stormwater runoff from highways represents a significant source of dissolved Cu to surface waters. Vetiver grass (*Chrysopogon zizanioides*) is widely used for the extraction of essential oils from its dense root system which is then commercially used in perfumes and cosmetics. Vetiver biomass after oil extraction is treated as waste and is disposed of in landfills. Biochar is a rich source of organic carbon and can be a good adsorbent for metal and organic contaminants. This study investigates Cu adsorption potential of a biochar generated from spent vetiver biomass used for oil extraction. Shoots and roots of spent vetiver were pyrolyzed at 300, 500, and 700°C for 30, 60, and 120 minutes. Biochar yield from shoots was significantly lower (12–23%) than roots (32–56%). The BET surface area was 1–6 m^2/gm for the shoots and 24–308 m^2/gm for the roots. Adsorption isotherm studies were conducted using copper nitrate ($Cu(NO_3)_2$) as the source of copper, for a range of concentrations from 0–100 mg/L on biochar generated from vetiver roots. After 24 hours of equilibration, supernatant samples were filtered through a 0.45-µm syringe filter and analyzed for Cu using ICP-OES. A better fit was obtained using the Langmuir isotherm model (R^2=0.99) compared to the Freundlich isotherm (R^2=0.81). The Cu adsorption capacity of biochar increased with increasing pyrolysis temperature. A batch study is currently in progress evaluating the potential of vetiver biochar in adsorbing Cu from soils contaminated with mine tailings (stamp sands) obtained from a Superfund site in Upper Peninsula, Michigan.

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