

The immobilization and adsorption mechanisms of agro-waste based biochar: A review on the effectiveness of pyrolytic temperatures on heavy metal removal

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Abstract

The multifunctional properties of biochar make it a promising adsorbent of heavy metals for environmental bioremediation. Pyrolytic temperature is a key factor that impacts the properties, performance, and mechanisms of agro-wastes-derived biochar because of the physiochemical transformation of its structural composition. It has been deliberated that increased pyrolysis temperatures strongly enhance specific surface area, pH, and high microporosity as well as carbon and ash content with low cation exchange capacity and volatiles content. The reason for different properties from different pyrolysis is related to the variations in the lignin-cellulose structures as well as moistures in different agro-waste biomasses. Biochar has been considered a low-cost material that has shown its convenient applicability in rural areas of developing countries where environmental contamination of heavy metals is emerging. A wide range of pyrolytic temperatures has shown distinctive properties and characteristics of biochar from different biomass and their capacities to remove heavy metals. Higher pyrolysis temperatures can exhibit higher specific surface areas, enhanced functional groups, and stability than modified biochar. Different pyrolysis temperatures exhibited diverse adsorption capacities on biomass such as rice husk and corncob, as efficiency increases with temperatures on selective heavy metals such as hexavalent chromium [Cr(VI)], cadmium [Cd(II)] and zinc [Zn(II)]. This review aimed to understand the physiochemical and structural properties, and the transformation of pristine biochar that can enhance the environmental bioremediation of heavy metals. The deliberations on the mechanisms of diverse biomasses obtained from different pyrolysis for decision-making processes as well as production costs were reviewed. The authors propose future investigations on heavy metal immobilization to unlock the full potential of biochar in environmental bioremediation.

Keywords: Adsorption, Pyrolysis temperature, Non-engineered biochar, Heavy metals, Bioremediation