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Conversion of Various Agricultural Feedstocks to Biochar under Different Pyrolytic Temperatures

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Abstract

Globally, biochar is utilized as a soil amendment technology to enhance carbon storage and to improve soil functioning. However, biochar characteristics and related improvements of soil functioning depend on biochar production conditions. This study assessed the physical and chemical properties of biochars produced from rice husk, maize cob, groundnut husk and cassia tree residues at pyrolysis temperatures of 400, 600, and 800 °C. The physical and chemical properties of biochars were determined. This included bulk density, porosity, water holding capacity, moisture content and organic carbon, organic matter, pH, electrical conductivity (EC), magnesium, sulfur, sodium, calcium, total nitrogen, potassium and phosphorus respectively. The findings from the study reveal that increasing pyrolysis temperature decreased biochar yield, and the values of the analyzed properties varied depending on the type of biochar and pyrolysis temperature. The water holding capacity (WHC) significantly increased with increasing pyrolysis temperature. Increasing the pyrolysis from 400 to 800 °C increased the water holding capacity from 13.46 to 24.65, 21.33 to 25.66, 25.59 to 28.56, and 21.86 to 25.83 g water/g dry for rice husk, maize cob, groundnut husk and cassia tree residues, respectively. The maize cob biochar produced at a pyrolysis temperature of 800 °C obtained highest value of bulk density (241.59 kg/m^3). The porosity values of biochars ranged from 48.07 to 66.74%. The cassia tree residues biochars produced at 800 °C recorded the highest values of pH and EC (10.8 and 3.62 dS/m). Total carbon, total organic matter and total nitrogen ranged from 40.70 to 60.60%, 64.24 to 100.6%, and 0.3 to 2.4% respectively. The groundnut husk biochar produced at 800 °C recorded the highest values of phosphorus (137.4 mg/kg) and calcium content (653.3 mg/kg). The sulfur, sodium and magnesium content ranged from 1234-13263, 1032-1695 and 13.2-54.3 mg/kg respectively.
The study highlights that biochar properties are significantly influenced by feedstock type and pyrolysis temperature, suggesting that optimizing these factors can enhance biochar's effectiveness as a soil amendment for improving soil fertility and structure, contributing to SDG 2 and 15 by promoting sustainable agriculture and ecosystem conservation.

Key Words: *Pyrolysis temperature, biochar, feedstock, yield, soil amendment, physicochemical properties*