Co-Pyrolysis of Rice Husk with Nitrogen-Rich Waste to Make Nitrogen Enrich Biochar

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Biochar has a growing demand for soil application as a soil amendment that improves the soil's physicochemical and biological properties while sequestering carbon. Conventional biochar is not generally recognized as a potential source of nutrients because most of the nutrients in feedstock biomasses are lost, volatilized, or leached out during the thermochemical conversion process. This research aimed at developing a novel method for manufacturing nitrogen-enriched biochar by pyrolyzing Torrefied Rice Husk (TRH) with three nitrogen-rich waste biomasses: Fish Waste (FW), Chicken Feather (CF), and Human Hair (HH). First, 20 kg of rice husk were torrefied to biochar at 300°C in a double-chamber batch pyrolysis reactor at the Meewatura experimental station. The waste biomasses were air dried and ground into <0.25 mm particles before being co-pyrolyzed with torrefied rice husk. Using the muffle furnace, co-pyrolysis was done in a mini-tubular reactor at six different temperatures, from 300°C to 550°C, by mixing TRH and one of the waste biomasses at a 4:1 ratio. The produced biochar was evaluated for its mass recovery, physicochemical properties, and nitrogen content. Results revealed that co-pyrolysis of TRH with dried biomass increased the biochar yield by 20–30% compared to biochar made from raw rice husk. The total nitrogen content of biochar increased from 0.25% in rice husk biochar to 2.18% in TRH-CF co-pyrolyzed biochar produced at 350°C. The relative nitrate content of all biochar types is reduced with increasing pyrolysis temperatures, while the ammonia content increases. The produced biochar had a slightly elevated pH between 8 and 10, which is an increasing trend with the higher pyrolysis temperatures. The co-pyrolysis of nitrogen-rich waste with torrefied rice husk biochar increased the total nitrogen content of the biochar from 0.22% to 2.18% at the optimum temperature of 350°C. It was also found that the chicken feather co-pyrolysis with TRH at 350°C gave the biochar the highest total nitrogen content. The outcome of this research implies that the co-pyrolyzing of nitrogen-rich organic biomass with torrefied rice husks can be developed into a new method for manufacturing biochar with high nitrogen content.

Keywords: Co-pyrolysis, Nitrogen-enriched biochar, Nitrogen rich waste, Torrefaction

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