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Biochars From Solid Organic Municipal Wastes For Soil Quality Enhancement

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Abstract

The overall municipal organic waste in Qatar accounts for 57% of municipal waste generated annually. Organic solid wastes such as food, newspapers, packaging, furniture woods and wood from building demolition have traditionally been placed in landfill, which create issues of sustainability for a country like Qatar with small land mass. While the recently opened Doha solid waste treatment facility contributed to alleviating the pressure on Landfill sites through composting and incineration, new value-added use of solid organic waste are needed for environmental and economic sustainability. Fortunately, biochars from mixed organic solid wastes can be used in soil amendment for food security and long term carbon sequestration for environmental sustainability. We hypothesize that deficiencies in depleted Qatari soils can be remedied by the application of biochars that are custom-designed to possess the right physicochemical characteristics suitable to improve soil fertility. Hence, this study was conducted to (1) Optimize production of biochars from mixed organic waste for desired physicochemical characteristics as soil enhancers. (2) Produce and characterize designer biochars using optimum production conditions for testing in soil incubation experiments. Select municipal organic wastes (newspaper, cardboard, woodchips and landscaping residues) individually and in a 25% blend were used as a precursor for biochar preparation. These residues were chosen due to their commonality in municipal solid waste streams. A complete 5 x 3 x 3 factorial design was used in this study with five biochar precursors (the 4 solid waste materials and a 25% blend/mixture), 3 sets of pyrolysis temperatures (350, 500, and 750°C) and 3 sets of pyrolysis residence time (2, 4 and 6 hrs).

Data obtained showed that biochar yield was in the range of 21- 62% across all feedstocks and pyrolysis conditions. The highest yield was observed in newspaper-based biochars pyrolized at 350 C for 2 hrs. Key parameters such as pH, electrical conductivity bulk density and surface area, which positively improve water and nutrient-holding capacity in biochar-amended soil, varied depending on the precursors and production conditions. Bulk density was high in woodchips-based biochars but was similar among all other biochars, irrespective of precursors and pyrolysis conditions. The total surface area of biochars was low but showed dramatic increase in all feedstocks at 700°C pyrolysis temperature. The highest electrical conductivity observed in cardboard-based biochars pyrolized at 700 C. Biochars produced from selected waste precursors were acidic except those produced at 700 C temperature where pH became alkaline. The wide range of biochar pH suggests potential tailoring to remediate the specific soil acidity. Cumulatively, biochars showed promising results for improving soil fertility parameters such as better water holding capacity, pH stabilization, and increased electrical conductivity of soil for better aggregation. These findings indicate that solid organic municipal wastes hold promising potential as precursors for manufacturing of value-added biochars with varied physicochemical characteristics allowing them to be used not only as an alternative to bio-waste management and greenhouse gas mitigation but also as means to improve depleted Qatari soil as the country embarks on its ambitious goals of ensuring food security and environmental sustainability.