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# Tailoring biochars from different feedstock and produced at different temperature and time of pyrolysis for their use as soil amendments

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Biochar used as a soil amendment to improve soil quality and fertility and increase soil carbon sequestration has been the focus of much research in the recent past. Unlike most conventional soil organic materials, which are readily decomposed, the recalcitrant nature of biochar increases its potential value as a soil amending material for the longer term. However, many biochars can be hydrophobic, and added to soil can aggravate water availability in areas where water scarcity is a major limiting factor for agriculture or forestry. It has been shown that biochar characteristics are influenced by production variables, especially feedstock, pyrolysis temperature and time of pyrolysis. Although there have been different studies characterizing biochars prepared from different sources, there are few studies comparing different types of biochar produced from domestic residues, manures or crop residues pyrolysis; there are, in addition, fewer studies dealing with the hydrophobic properties of the biochars. The different feedstock can have different properties which would result into different biochars even produced at the same operational factors. The main objective of this experiment was to study the influence of feedstock properties and pyrolysis temperature and time on nutrient contents, heavy metals, recalcitrance, thermal stability and hydrophobicity of biochars from cotton crop residues (CR), pig manure (PM) and domestic waste (DW). Biochars were obtained by pyrolysis under oxygen-limited conditions in a muffle furnace. The temperature was increased at 5ºC min-1 to 300°C, 400ºC, 500ºC and 700ºC and then maintained for 1h, 2h, 4 and 5 h at this temperature. All biochar properties were strongly influenced by feedstock source except for pH, the recalcitrance index and hydrophobicity. Nutrient contents were normally higher in the PM biochar, except for Cu and Ca which were higher in the DW biochar and B in the CR biochar. Heavy metal contents were significantly higher in the DW biochar. Biochar yield was higher in the DW biochar owing to the higher content of ashes. The temperature of pyrolysis did not significantly influence the level of nutrients. However, biochar yield decreased with increasing temperature, while pH increased with increasing temperature. All biochars produced at 300ºC and 400ºC were highly hydrophobic. Hydrophobicity totally disappeared in all biochars produced over 500ºC at 2 h. Thermal stability was highly influenced by pyrolysis temperature, increasing with increasing temperature. Biochar produced at 300ºC and 400ºC showed presence of different pools of labile and recalcitrant pools, while biochar produced over 500ºC showed an acute recalcitrant phase, with low content of labile pools. The disappearance of hydrophobicity was associated with the decreased in the labile pools of the biochar and increased thermal stability. No significant influence of the pyrolysis time was observed in any of the properties studied except for hydrophobicity, which tended to decrease with decreasing the time of pyrolysis. Our results showed that biochars can be tailored for different purposes in terms of the needs of specific nutrients, C sequestration, reduction of the content of toxic heavy metals, or absence of hydrophobicity to avoid negative hydrological processes in the soil.

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