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A chemometric study on the effect of feedstock choice and pyrolysis conditions on biochar production and its influence on the remediation of pharmaceuticals from aqueous solutions

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Removal of antibiotics and non-steroidal anti-inflammatory drugs (NSAIDs) from aqueous ecosystem is a serious concern due to their extensive usage and resulting the adverse effects on human and ecological health. Biochar (BC) is a ubiquitous carbonaceous adsorbent which is an excellent promising adsorbent for removal of antibiotics and NSAIDs such as tetracycline (TC), sulfonamides (SA), ibuprofen (IBP), and diclofenac (DF) due to their unique surface functionality and porosity. Discriminant analysis of approximately 380 data sets based on 151 peer-reviewed articles, in this study we elucidated the choice of feedstock category, pyrolysis temperature, and modification type that influence the physiochemical properties of BC. Through meta-analysis, it was found that with increasing pyrolysis temperature, the BC physiochemical properties such as specific surface area (SSA), carbon (C) content, aromaticity and BC stability increased, whereas hydrogen content, oxygen content, and polarity decreased. Additionally, wood-based feedstock and pyrolysis temperature of 651-850 °C, was found to be the optimum conditions to obtain a BC with greater SSA, C content, and stability. Furthermore, with increasing SSA and pore volume of biochar led to greater adsorption capacities of TC, SA, IBP, and DF. It appears that highest maximum adsorption capacity shows by animal & algae-based BC, and acid modified BC for TC; wood-based BC and magnetized BC for SA; sludge-based BC and base modified BC for IBP; sludge-based BC and magnetized BC for DF. Overall, 651-850 °C TR has the highest maximum adsorption capacity for all four antibiotics and NSAIDs. These predicted relationships can link biochar production to help make more well-developed biochar choices to enhance performance in remediation of given antibiotics and NSAIDs or similar molecules.

Keywords: biochar; meta-analysis; feedstock; antibiotics; physiochemical properties.