

EGU2020-3075

<https://doi.org/10.5194/egusphere-egu2020-3075>

EGU General Assembly 2020

© Author(s) 2021. This work is distributed under the Creative Commons Attribution 4.0 License.



Do chemical characteristics affect the potential of biochars to adsorb cations?

Heike Knicker¹, Jose Maria Garcia Castro de Barragan^{1,2}, Elena Elena Fernandez-Boy², Michael Knicker³, Regina León-Ovelar⁴, and Marta Velasco-Molina¹

¹IRNAS-CSIC, Sevilla, Spain (knicker@irnase.csic.es)

²Departamento de Cristalografía, Mineralogía y Química Agrícola, Universidad de Sevilla, Sevilla, Spain

³Consult Michael Knicker (CMK), München, Germany

⁴Laboratorio de Química, Universidad Nacional de Asunción, San Lorenzo, Paraguay

Since peatlands are valuable habitats and provide important environmental services, the policy of several European countries is to decrease the use of peat in potting mixtures to preserve peat bogs as nature areas. As a consequence, alternative growing media are needed. Therefore, the impact of biochar addition to gardening soil on tomato plant growth has been investigated previously (García de Castro Barragán, 2018). Those studies revealed a positive effect on seed germination and plant development during the first growing stage. However after three months, leaf discoloration was observed and associated to the lack of macro or micronutrients. It was hypothesized that adsorption of nutrients onto the biochar may have decreased their availability for plants. For a first evaluation of this hypothesis, we tested the adsorption of Cu^{2+} to three biochars derived from feedstocks with different chemical composition, aromaticity and content of polar groups. We produced biochar from shrimp chitin which was highly aromatic and contained considerable amounts of N-heterocyclic aromatic structures. The biochar of shells of the oil seed of *Acrocomia aculeata* derived from a woody feedstock with high contribution of cellulose, but had a low charring degree. The peat biochar was prepared at a pyrolysis temperature of 500°C which resulted in a highly aromatic material. The difference in the organic matter (OM) quality of the biochars went along with differences in their pH and electrical conductivity (EC); elemental composition and ash content. Concomitantly, different specific surface areas were measured using the BET method.

For the absorption test, copper nitrate solutions were used at increasing concentration, brought into contact with the biochar for 24 hours at 25 °C. In the equilibrium solution, the Cu^{2+} content was analyzed. The solid biochar was separated from the solution and dried. Due to the paramagnetic nature of Cu^{2+} , solid-state NMR relaxometry was used to identify preferential adsorption sites within the organic network of the biochars.

Our results showed low Cu^{2+} adsorption for all three biochars. Neither biochar porosity, nor polarity could be identified as a responsible for Cu-adsorption. As revealed by NMR relaxation times (T_{1H} , T_{1C} , T_{1roH} and T_{1roHC}), all organic C and H groups were affected by the interactions

between OM and Cu^{2+} , although no preferential adsorption site was revealed. We found indications that adsorbed Cu^{2+} act as bridging agent, lowering the mobility of aromatic domains. Based on our preliminary results, we suggest that in our biochars, metals are mainly adsorbed via bonding to π -orbitals of the aromatic rings. Based on the low adsorption potential of the studied cation, we conclude further that our biochars do not sequester Cu^{2+} (or other metals with comparable characteristics) sufficiently strong for preventing their uptake by growing plants. However, to which extent our findings may be generalized, has to be unveiled by ongoing studies.