Nanoscale characterization of biochars-mineral complex

Chia, CH*; Munroe, P; Joseph, S; Lin, Y

School of Materials Science and Engineering, University of NSW, Sydney, NSW 2052 Australia

*E-mail: c.chia@unsw.edu.au

Amazonian Dark Earths (Terra Preta – or TP) are unique soils that exhibit outstanding fertility by promoting and sustaining plant growth. Prior studies of TP, where the focus has been characterization of microstructure, have revealed that they are composed of microagglomerates formed by the interaction of a variety of organic matters, clay particles and other minerals. These microagglomerates comprise regions of amorphous carbon surrounded by mineral phases that are rich in aluminum, silicon, iron, calcium and phosphorus. Examination of aged biochar particles, following field trials in soils, reveals similar structures compared to TP.

Inspired by these findings, biochar-mineral complexes (BMC) have been produced to mimic the properties of TP. BMC is produced by combining wood biochar, clay, sawdust, chicken manure and several other mineral compounds followed by torrefaction at low temperatures (180-220°C) in an oxidizing environment. BMCs perform well during field trials due to the unique properties of their interfaces and surfaces. It has been found that BMC's increase plant uptake of nutrients through increases in microbial activity, cation exchange capacity and acid neutralising capacity. It also appears that BMC's have high redox potential promoting the breakdown of organic matter and reducing the energy required for cations to migrate through the cell walls of the roots. Initial investigations indicate that the BMC's change the microbial and microfauna population resulting in greater resistance to disease. It is also relatively inexpensive to manufacture BMC's due to their low torrefaction temperature.

BMC particles from both before, and after, field trials were examined using a range of analytical tools including scanning transmission electron microscopy (STEM) coupled with electron energy loss spectroscopy (EELS), transmission electron microscopy (TEM), and scanning electron microscopy (SEM). Characterization of such materials on a nanoscale provides information about the interactions that take place at the interface between the organic and inorganic phases in the BMC. This provides a basis to understand and predict the reactions that will take place at the micro and macroscopic level, especially between organic and mineral phases. Experimental results shows that the BMC's exhibit a similar nanostructure compared to TP. STEM and TEM examination reveals a complex aggregation of phases and nanopores, together with evidence of the interfacial reactions.

This presentation details the findings of various techniques used in the characterization of BMC's. Moreover, the possible mechanisms underpinning the formation of BMC will be described, together with comparisons between aged biochars and BMC's.

Liquid phase characterization of biochar derived from Lluta valley vegetable, as a function of the sequential aqueous leachate

Figueroa, L*; Vera, D; Molina, P; Urbina, NL; Zapata, Y; Escobar, H

Universidad de Tarapacá Departamento de Química

*E-mail: lfiguero@uta.cl

The biochar is in its raw material, one of the determinants of its quality as a modifying agent to the soil properties that may eventually be added. In the Region XV in northern Chile, there are alluvial valleys embedded in the macro region of the Atacama Desert, one of the world's driest, with no precipitation, all stocked with low flows of surface water and salt, mostly endorheic basin with high rates of evaporation. Saline soils and saline water Lluta Valley, inserted in the arid zone, allows the development of different plant species native and cultivated, all adapted to these conditions and are mostly subject to burning or combustion process to facilitate cultivation of plants of economic interest on the one hand or as a waste management plant after harvest. Being so these species, an alternative raw material for the production of biochar. The treated material via pyrolysis, with a production of elemental carbon, also makes a product to some extent mineralized, ie some fraction of their original inorganic chemicals but transformed, being labile to reaction with water. To verify this lability Batch experiments were conducted in a ratio of 1:10 (biochar: distilled water), generating solubilization and hydrolysis by an electrolyte solution, the latter characterized by a significant degree of salinity, measured by electrical conductivity (EC) and a basic pH, with significant presence of alkali cations. The biochar subjected to a sequential leachate reacts with a significant change in the slope of the EC from first to second trial and therefore tends to decrease gradually in value of EC and in the degree of its subsequent negative slope in leachates. However, sequential leaching generates a slight change in pH value, but there is no significant change, remaining constant as the basic character of the solution. The nature of the original plant, developed physiological saline substrates, directly affects the quality of saline input char.

The authors acknowledge the funding provided by the Foundation for Agrarian Innovation (FIA) Code Project PYT-2009-0072, and the Performance Agreement UTA – MINEDUC.