PHYSICO-CHEMICAL QUALITIES AND POTENTIALS FOR BIOCHAR AGRO-ENVIRONMENTAL VALORISATION

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The contribution of biochars is an opportunity to sequestrate carbon[1] and improve soil fertility[2,3] without major changes in cultivation practices. The project entitled QUALICHAR funded by ADEME (French Agency of Environment and Energy Management) focuses on the valorization of selected conventional lignocellulosic biomasses (LBs) (Oak, Douglas, Pectin fir, Beech, Spruce), Crop residue (Corn raids) and unconventional biomasses (UB) (Digestate, Poultry Droppings and Cattle manure) into biochars by pyrolysis in order to assess their agro-environmental as function of their physical and chemical properties. In this study, characterizations of biochar, produced in a tubular furnace under flushing inert gas at two different temperatures (500 and 800°C) for slow (10°C/min) and fast (~1°C/s) pyrolysis will be presented. Indeed, the fate of organic material (mainly carbon structure) and inorganic material are studied by various characterization techniques (FTIR, Raman, BET surface area, Ultimate and Proximate analysis, Scanning Electron Microscopy - EDX, ^{13}C solid-state NMR, Calorimetry). Affinity of water for biochar surface is evaluated by ^{1}H NMR relaxometry. As expected, biochars from LBs exhibit conventional composition and structures (*i.e.* for biochars at 800°C: ~95%wtC, ~85%wt fix carbon, H_D/H_G=0.75 in Raman spectroscopy). Moreover, ^{1}H NMR relaxometry results show that heating rate and temperature play a significant role on the surface affinity between biochar and water. Concerning UB and crop residue, the composition and structure present a significant heterogeneity mainly due to high initial mineral content. Primary results on these biochars show that the fate of mineral content (*i.e.* P, Ca, Si, Na) is function of temperature treatment (Figure 1). For instance, due to the temperature increase, Silica particle tends to agglomerate in crop residue and minerals (especially Na) agglomeration is observed for biochar from digestate. The structure and shape of minerals in crop residue and unconventional biomasses will determine their agro-environmental (i.e. Impact on Nitrogen volatilization and Phosphorous bioavailability) potential but also could lead to high-added value application (Catalyst, Adsorbents).

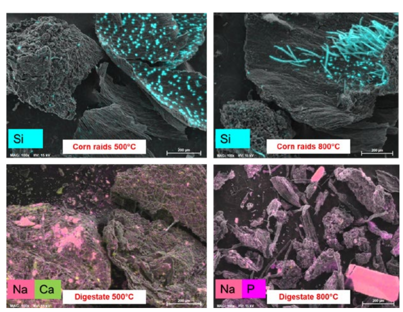

Figure 1: Scanning Electron Microscopy (MEB) coupled with Energy Dispersive X-ray (EDX) analysis of Corn raids and Digestate biochars produced at 500 and 800°C by fast pyrolysis.

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[3] Dominic Woolf et al., « Greenhouse Gas Inventory Model for Biochar Additions to Soil », Environmental Science & Technology 55, nº 21 (2021): 14795-805, https://doi.org/10.1021/acs.est.1c02425.