Analytical pyrolysis of biochar to predict the stability of biochar

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Biochar is a carbon-rich solid residue obtained by thermochemical conversion of biomass in an oxygen limited environment. Thus biochar is resistant to degradation processes and suitable for carbon sequestration. Biochar stability prediction measurements vary from simple to most sophisticated methods. Alpha methods are routine estimations of the biochar stability at low costs (proximate analysis, H:C and O:C ratio). Gamma methods provide the physiochemical understanding for the alpha methods and give better insight about the physicochemical properties of biochar, are however not much cost effective. Therefore alpha methods must be calibrated through comparison with gamma methods. Py-GC-MS method as a gamma method is used to provide rough estimations of the proportions of charred and non-charred compounds and to track the thermal degradation of main biocomponents. In this study a set of 12 biochar samples produced from the pyrolysis of different biomass feedstocks with potential applications as soil amendments were analysed by Py-GC-MS. Biochar production temperature was varied from 300 °C to 750 °C. The resulted pyrolysis yields of biochar were compared with the biochar production temperature and the existing biochar stability indicators such as C:H ratio, O:C ratio and proximate analysis. The intensity and variety of the pyrolysis products (in Py-GC-MS) were decreased with the increased pyrolysis (i.e. production) temperature and with decreasing of H:C ratio. The proportion of aromatic compounds in the (Py-GC) pyrolysis products vary with the feedstock material and production conditions used for the biochar production. There was a good positive linear correlation between H:C ratio, O:C ratio, Toluene to Benzene ratio with biochar production temperature. Also there was a good positive linear correlation between H:C ratio, O:C ratio with the Toluene to Benzene peak area ratio. The strong negative correlation was observed between the volatile matter content and the Toluene and Benzene peak area ratios. These results suggest that analytical pyrolysis can be considered as a proxy to determine the stability of biochar and there was a good correlation with existing biochar indicators such as proximate analysis, H:C and O:C ratio.

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