

Properties of Pyrolysis Residues Produced and their Utility as Biochars

Embrapa Soils – Etelvino Henrique Novotny

Introduction

Charcoal (Biochar) could contribute to carbon sequestration and work as a soil amendment.

Charcoal presents the condensed aromatic groups, that guarantee its recalcitrance in the soil, being an efficient material for C sequestration.

However it doesn't present the carboxylic groups, important for its reactivity and contribution for soil CEC, like the organic matter found in Terra Preta de Índios, archaeological soils enriched by pyrogenic carbon (carbonised biomass) by human activity.

The application of charcoal (Biochar) to the soil, and consequent chemical and biological alterations, will end up generating those acid groups, however that process can delay decades.

Preliminary studies indicate that is possible the functionalisation of those materials by chemical, biological (compost) or enzymatic ways.

Additionally, the application of charcoal to the soil propitiates other benefits, such as: increase of the productivity; suppression of the emissions of CH₄ and N_xO; reduction of the need of fertilizers and; reduction of the nutrients leaching.

Brazil produces about 200 million tons of sugar-cane bagasse, most of that bagasse is used in the own distilleries for energy generation, however is still a surplus of 12%, what it could produce 2.3 million tons of charcoal.

Besides this, other pyrolysis techniques, and in special employing the biorefinery concept, core of DIBANET project, can supply the energy needs of the distilleries and this having as by-product the biochar.

There is several other materials that can be feed the biorefineries, such as: residues of the wood and cellulose industry; of the agro-industry (coffee husks, banana residues, coconut fibers etc); biofuels; sewage sludge etc.

Results and Discussion

The acid hydrolysis was very effective to remove the carbohydrates from the biomass (Figure 1), since the main signal from the NMR were from alkyl and lignin, however the contribution of furanyl structures, product of thermal decomposition of cellulose, cannot be excluded.

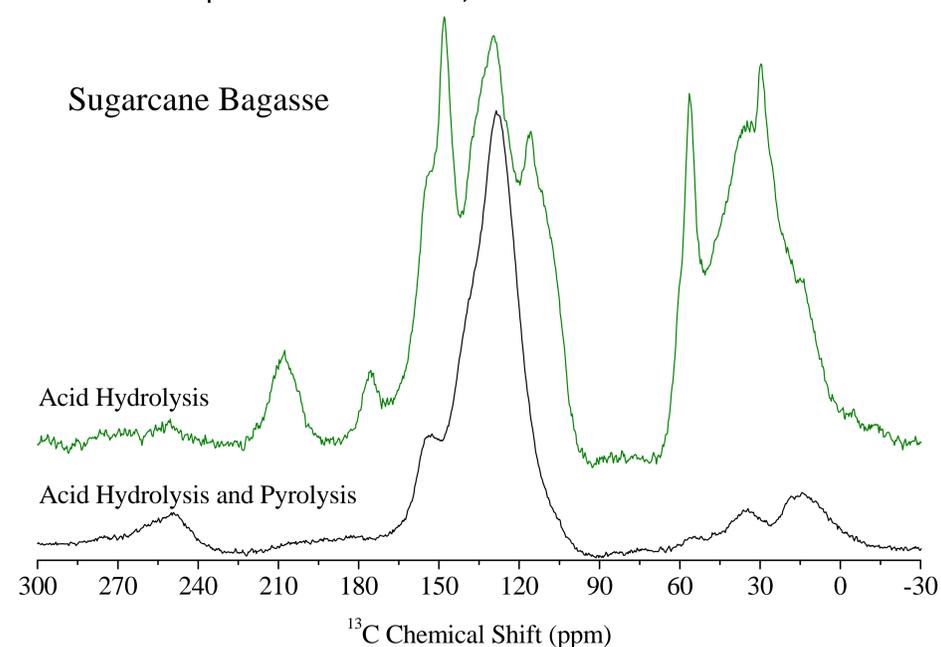


Figure 1 - Solid state ¹³C NMR spectra of acid hydrolysis residue from sugarcane bagasse and of the biochar produced from this residue.

On the other hand, the AHRs obtained by Unicamp (Figure 2) presented significant amounts of residual carbohydrates (O-alkyl at 72 ppm and di-O-alkyl at 105 ppm), indicating that the laboratory scale acid hydrolysis is not so effective as the pilot one.

Interesting is the strong signal of O-aryl at 144 ppm in the AHR of coffee husk. Since this signal is not accompanied by one equivalent signal at 56 ppm from methoxyl, probably it is not from lignin. Possible compounds are polyphenols (strong aryl signals at 116 and 130 ppm), another interesting product in the biorefining concept. The banana stem also present important O-aryls signals, however, in this case, the strong methoxyl signal indicates lignin.

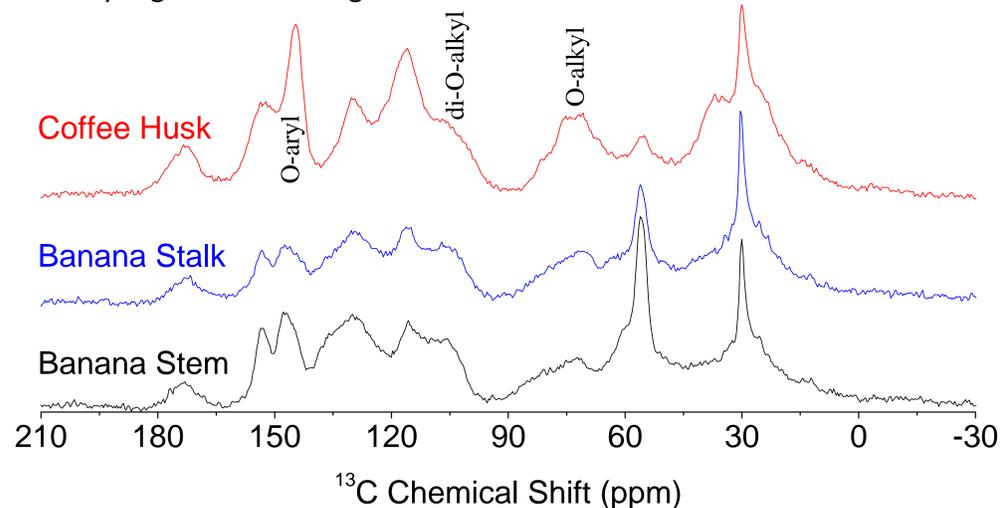


Figure 2 – Solid state ¹³C NMR spectra of acid hydrolysis residue from banana and coffee residues, prepared at Unicamp.

The crude biomass (sugarcane bagasse) and the AHR resulted in accumulated soil CO₂ emission of 173% and 123%, respectively, of the soil emission without organic amendment (Figure 3).

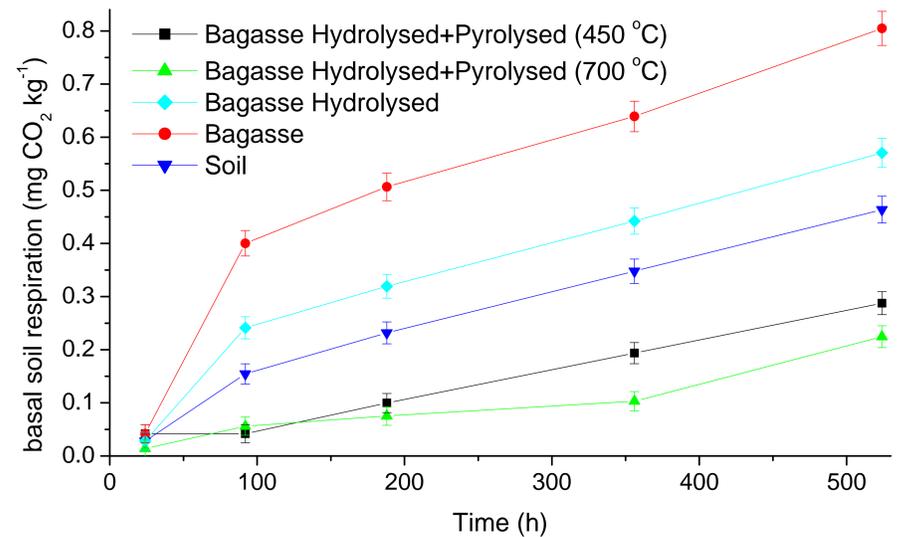


Figure 3 – CO₂ emission from the soil treated with crude sugarcane bagasse; AHR of this sugarcane bagasse; and biochar produced from this AHR.

The pyrolysis of the AHR reduced the accumulated CO₂ emission at 62% (biochar produced at 450 °C) and 48% (700 °C), compared with the soil without organic amendment (Figure 3). The pyrolysed AHR, produced at 450 and 700 °C, emitted 36 and 28% of the CO₂ emitted by the crude biomass, showing the potential of the pyrolysis to stabilize the C in the soil and provide C sequestration, with best results with higher carbonisation.

However, the observed decrease, below the control, could be due to the Cr contamination of the AHR and biochar (Tabel 1) that could inhibit the soil microorganism activity. But it is still unclear if this chromium is in a bioavailable form, further analysis of the plant issue will be confirm this.

Table 1 - Trace metals contents (mg kg⁻¹) of the sugarcane bagasse

Sample	Cu	Fe	Mn	Zn	Cr	Ni
AHR sugarcane bagasse	262	347	3	3	465	119
Biochar from AHR	430	582	5	6	730	201