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Biochar effect on the humification dynamics of chicken manure compost

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Introduction

Agricultural use of biochar would have positive effects on yield and physico-chemical properties of soil (1;2), however, on the dynamics humification during composting process are still unknown.

With the refinement of spectroscopic techniques such as Fourier transform infrared (IF-TR), nuclear magnetic resonance (NMR) of ^{13}C, beyond the methods termodegradativos, much has been advanced in the analysis of changes in the molecular structures of organic fractions during the composting process, which allows inferences about maturity and stability of the compounds (3).

The objective of this study was to evaluate the humification dynamics and the maturation degree of of the composting process of chicken manure with biochar, by employing the technique of thermogravimetry and analyzing the spectral signatures of humic substances in IF-TR e NMR ^{13}C.

The piles of compost were prepared using chicken manure and charcoal, obtained by pyrolysis of Eucalyptus grandis in an oven with ambient atmospheric pressure and temperatures ranging from 300 ° - 450 °C.

Subsamples of waste were collected at 0, 60, 120 and 210 days after the start of the composting process. At each sampling time, samples were extracted humic acids (HA) according to the recommended methodology by the International Humic Substances Society (4).

Thermograms were obtained using the analyzer SDT-2960 *simultaneous* DSC-TGA (TA *instruments*), determining the thermogravimetric index (ITG) (5).

The spectra of IF-RT were obtained using a spectrophotometer Perkin Elmer, Spectrum 1000. After obtaining the spectra were determined, the hydrophobicity indices (HI) and condensation (CI) (6).

We obtained ^{13}C NMR spectra of the solid-state cross-polarization and magic angle rotation seconds. The intensity of the signals and the proportional contribution of each type of carbon were determined by integrating the spectral regions, the index of aromaticity was calculated by the relationship between the intensity of absorption in the region of the aromatic C region of aliphatic C (3).

Results and Discussion

The ITG calculated increases with the composting process (Tabela 1) showing a gradient of resistance to thermal degradation of samples from the beginning of composting, less ITG, until the stabilized compound, higher ITG. It is observed the highest values after 210 days of composting, which can be related to the higher proportion of highly condensed aromatic groups derived from the charcoal, because the HA of pyrogenic origin have a higher resistance to thermal oxidation, due to the occurrence of nuclei aromatic hydrocarbons in the same (5).

Table 1. Thermogravimetric index (ITG), hydrophobicity (HI), condensation (CI) and aromaticity of organic waste during the composting process.

Índex	Composting time (days)			
	0	60	120	210
ITG	1,11 c	1,24 b	1,21 b	1,39 a
IH	0,49 a	0,37 b	0,25 c	0,23 c
IC	0,44 c	0,64 b	0,84 a	0,81 a
IA	16,4 b	23,53 a	17,50 b	21,06 a

*Means followed the same letter in the row did not differ for the time of composting, by Tukey test, P <0.05.

In general, changes in the spectra of IF-RT obtained from composted organic wastes indicate that the constituents of the more easily degradable organic matter, have been

chemically or biologically oxidized with increasing time of composting, as can be seen through the hydrophobicity indices (HI) and condensate (JI), which are presented in Table 1.

Significant differences were observed for the values of HI obtained at different times of composting, and the highest rates observed for the first days of composting for all mixtures evaluated, with a reduction to the maturation phase of the compound. Thus, according to the results observed, it can be deduced that the degradation is occurring more aliphatic compounds, the lower the HI, is the lowest concentration of C-aliphatic (7).

Regarding the CI, there were higher at the end of the composting process, it can be inferred that the organic matter has more humified structures.

The ^{13}C NMR indicated a small increase in the content of aromatic groups and a reduction in the content of aliphatic groups during the composting process. The aromaticity index obtained in the composting of chicken manure with coal showed little significant increments after 210 days (Table 1), indicating that some aliphatic components were degraded during the composting process and, consequently, there was an enrichment of aromatic structures, but the more aliphatic character of humic acids was more pronounced.

Conclusion

Thermogravimetry showed an increased resistance to thermal degradation of humic materials with advancing humification. The rates of condensation and hydrophobicity showed a greater degradation of labile compounds and an increase in the degree of humification. The ^{13}C NMR indicated a small increase in the content of aromatic groups and a reduction in the content of aliphatic groups during the composting process.

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