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INFLUENCE OF THE FEEDSTOCK MATERIAL ON THE COMPOST MATURITY, STABILITY AND REACTIVITY

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ABSTRACT

Compost samples from different origins have been characterized in order to obtain information about their composition, humic-like substances content, maturity and stability. The composts used in the present study were obtained from manure (CAP), algae (CA), domestic waste (VCRU), sewage sludge (CT) and animal waste (CE). Different techniques have been used to gather physical-chemical parameters of the raw composts, their equilibrium solutions and the extracted humic-like substances. The analysis of the parameters collected in the characterization process allowed to stablish the degree of maturity and stability of the composts. Results indicate that the compost originated from algae exhibits the highest degree of maturity. Also, metal complexation was analyzed in the CE compost with the aim of assessing the contribution of the different fractions of dissolved organic matter.

Keywords: Compost, organic matter stability, humic-like substances, fulvic acid, humic acid

INTRODUCTION

Composting has become a worldwide waste management strategy for processing and reusing organic waste, thus reducing the environmental impact of their landfill disposal. The use of compost as an organic fertilizer resulted in higher content of soil organic matter, total N and productivity than the use of chemical fertilizers [1]. These aspects make compost a suitable and economic organic amendment to stabilize the soil structure and to improve its productivity.

During the composting process, the organic matter is degraded and qualitative transformed into a more stable form by the microbiological activity. The quality of compost is normally assessed by its degree of stability or maturity, which is related to a stable organic matter content and the absence of phytotoxic compounds and pathogens. Chemical methods widely used to measure the degree of maturation include C/N ratio in solid and water extract, inorganic N, cation exchange capacity (CEC) and degree of humification of the organic matter. Values of C/N < 12 or water soluble C_{org}/total N_{org} < 0.07; levels of NH_4^+ < 0.04 % or CEC > 60 meq/100 g have been accepted as a good maturity degree [2]. Several studies have been conducted to elucidate the crucial factors that affect the quality of the resulting compost [3-5]. Among these factors, chemical composition of the raw materials, ratio of different materials in the mixture, composting conditions or composting time can be considered.

In the present study, composts from different origins were analyzed within the frame of the Interreg POCTEP project Res2ValHUM, funded by EU – FEDER. The objective of this project is to stablish the quality of the composts produced and to correlate their quality with different factors involved in the composting process. More specifically, in the present study, the effect of the biomass used for compost production was analyzed.

MATERIALS AND METHODS

Five commercial composts from different origins were used in the present study to assess their maturity and stability degree, their humic-like substances content and their ability to retain metals. The origins of the composts were manure (CAP), algae (CA), domestic waste (VCRU), sewage sludge (CT) and animal waste (CE). Characterization analyses were conducted on raw composts, equilibrium solutions and fulvic and humic-like acid fractions. Different techniques were used for the characterization: FTIR, UV-visible, elemental analysis, thermogravimetric analysis, ICP-OES, TOC, etc. The humic-like substances were extracted from the composts using the IHSS extraction protocol for soils [6]. Major and trace elements were determined by microwave assisted digestion with *aqua regia*. The equilibrium solution was obtained with 7.5 g of compost suspended in 150 mL of distilled water for 5 days. Acid-base functional groups were determined by potentiometric titrations and metal complexation was studied in the compost and the equilibrium solution using ion selective electrodes (ISE).

RESULTS

Aromaticity indices were obtained from FTIR spectra (Fig. 1) as the ratio between the intensities of peaks characteristic of aromatic and aliphatic groups: I_{1650}/I_{2925}; I_{1650}/I_{2845}; I_{1525}/I_{2925} and I_{1425}/I_{1050}. According to these indices, samples can be classified, according to aromaticity, as: CA > CE > VCRU > CT > CAP, and according to maturity, as: CA > CT > VCRU > CAP > CE. Apparently, the compost obtained from algae shows the highest degree of maturity and aromaticity. Also, the ratio HA/FA resulting from the extractions (Table 1) lead to the following order: CA > VCRU > CE > CAP ≈ CT, which is in good agreement with the aromaticity order of the samples as determined by FTIR. During the composting process a loss of aliphatic and peptidic structures occurs, which is reflected in an increase of aromatic structures. Results found here indicate that the composting process is more efficient in the algae compost.

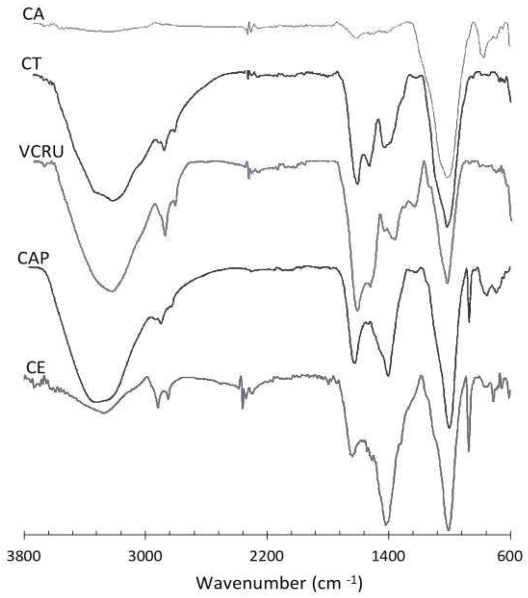

Figure 1. FTIR spectra of the compost samples from different origins. (CA: algae; CT: sewage; VCRU: domestic waste; CAP: manure; CE: animal waste)

The amount of NH_4^+ determined in the equilibrium solution of the composts (Table 1) varied between less than 0.01 and 1.04 %. Although a limit of 0.04 % NH_4^+ was established for mature city refuse compost [7], it must be considered that some composts used in the present work have a different origin. Also, since the oxidation and humification of the organic matter during the composting process increases the CEC, values of CEC > 60 meq/100 g have been proposed as an index of maturity. The composts analyzed in the present work comply with this requirement or are slightly below.

Table 1. Parameters determined as indicators of maturity and/or stability of the composts.

	AH/AF	$\%NH_4^+$	CEC [meq/100 g]
CA	7.37	< 0.01	45.9
CT	4.96	1.04	51.5
CE	5.09	0.04	101
CAP	4.99	0.05	150
VCRU	6.33	0.01	167

Metal complexation expressed as mg $M_{complexed}$/g compost was higher in the solid compost sample than in the equilibrium solution. However, when the complexation is expressed as per gram of organic C, the organic matter present in the equilibrium solution is able to complex more metal. This could be explained on the basis of the availability of C, which seems to be higher when the soluble fraction is considered. However, the determination of the acid-base functional groups could help to better explain this behavior.

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