CHARACTERIZATION OF ORGANIC MATTER AT DIFFERENT STAGES OF A COMPOSTING PROCESS

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ABSTRACT
The characterization of the organic matter from raw organic wastes, unmatured compost and maturated compost was performed by different techniques: gravimetric, FTIR-ATR, TGA and from the ability of their extracts to bind Cd^{2+} (evaluating the free cadmium ion by AGNES). Although the amount of humic-like and fulvic-like acids did not change significantly, the structure and properties of the organic matter changed with composting and maturation. These changes resulted in an increase of the stability of the organic material toward thermal decomposition and in an increase of the capacity to bind cadmium.

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

INTRODUCTION
Food waste is the main fraction (45%) of total municipal solid waste in Europe [1]. The valorization of this type of residue, either by anaerobic digestion or by composting is relevant for circular economy.
Composting has many environmental benefits, besides decreasing the emissions of greenhouse gases contributes to the improvement of soil properties through compost application. The production of compost of high-quality requires that the process is managed and controlled at different stages, including selection of the feedstock (e.g., nature, heterogeneity, impurities), control of the operational conditions (e.g., temperature, oxygen, humidity) and compost maturation.
The chemical and biochemical reactions that occur during composting lead to important changes in the organic material with production of chemical species that are more stable towards degradation. The properties of compost are closely related to the presence of humic-like substances (HS), such as fulvic acids (FA), humic acids (HA) and humin. The presence of significant amount of carboxylic acids and phenolic groups in the HS imparts relevant properties such as hydrophilicity and ability to complex metal ions [2].
In the scope of the project Res2ValHum [3] an organic waste (OW), the resulting unmatured compost (UC) and maturated compost (MC) were characterized. The impact of composting and maturation on the formation of HS was evaluated using gravimetric, spectroscopic (FTIR-ATR) and thermogravimetric (TGA) results and also from the ability of these substances to bind Cd^{2+}, evaluating the free cadmium ion in equilibrium with the organic extracts by the electroanalytical technique AGNES (absence of gradients and Nernstian equilibrium stripping) [4].

RESULTS AND DISCUSSION

The amount of fulvic-like and humic-like acids obtained from extractions performed to OW, UC and MC, following the recommended procedure by the IHSS [5] is presented in Table 1. These results show a slight increase in the amount of FA accompanied by a slight decrease in HA with composting and maturation.

Table 1 – Quantification of humic-like and fulvic-like acids obtained from the organic waste (OW), unmatured compost after a 30-day composting cycle (UC) and maturated compost (MC).

	Humic acid [% compost]	Fulvic acid [% compost]
OW	3.29	0.22
UC	2.19	0.24
MC	2.11	0.35

Although the amount of HS did not change substantially, the chemical and biochemical reactions involved in composting and maturation produced modifications that are visible in FTIR and TGA results. Fig.1 displays the FTIR-ATR spectra obtained for OW, UC and MC. The increase of the complexity of organic matter is confirmed by the aromaticity indices I_{1650}/I_{2925}; I_{1650}/I_{2845}; I_{1525}/I_{2925} and I_{1425}/I_{1050}, calculated by the ratio between the intensities of peaks characteristic of aromatic and aliphatic groups.

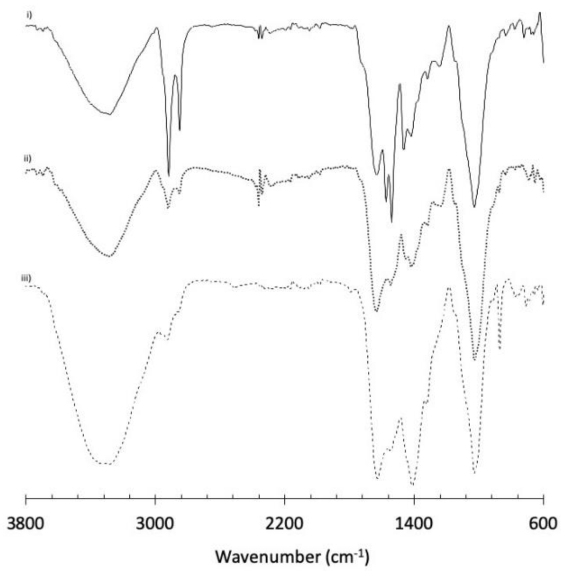

Fig. 1 FTIR-ATR spectra of: i) OW; ii) UC and iii) MC.

The transformation of the organic matter resulted in a change of its capacity to bind metal ions. The experimental results obtained by AGNES, for cadmium binding by fulvic and humic acids from OW, UC and MC that demonstrates this effect are displayed in Fig. 2. The cadmium binding capacity of fulvic-like acids increases after composting and after maturation (Fig. 2(A)). For humic-like acids an increase of the binding capacity was only observed after composting, as the free concentration of cadmium in equilibrium with humic-like acids from UC and MC are similar (Fig. 2(B)).

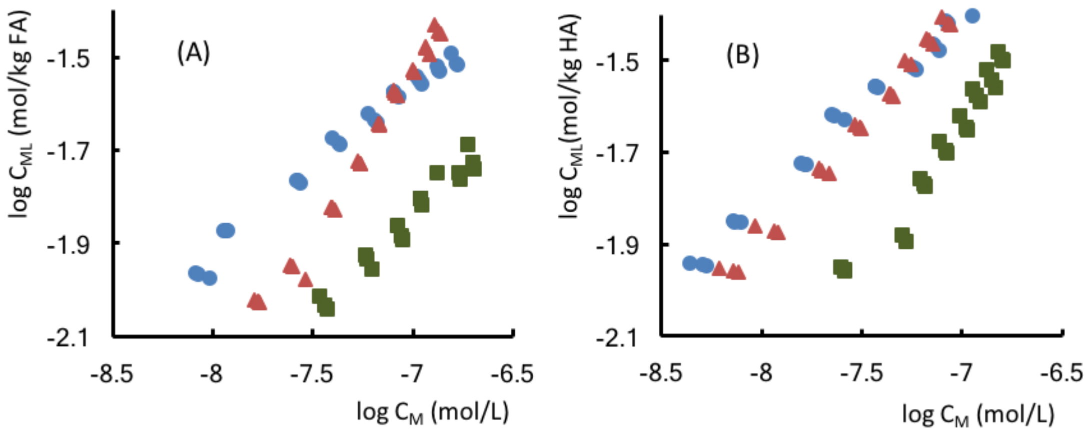

Fig. 2 Experimental data, obtained by AGNES, for cadmium binding by fulvic-like (A) and humic-like (B) acids from OW (■), UC (▲) and of MC (●).

This work shows that composting and maturation produce significant modification on the organic material, increasing the ratio of aromatic vs. aliphatic moieties and enhancing the stability towards thermal decomposition. The capacity to bind cadmium increases either due to an increase in the number of complexing groups or to an increase in the strength of the complexation. Further studies are in progress to elucidate this behavior.

References

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