# Soils amendments production from composting of digestate of agroforestry wastes

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## INTRODUCTION

The agroforestry wastes valorization plays an important role in the soil nutrients cycling. Anaerobic digestion has been gathering the attention to recycle these wastes into renewable energy, with the biogas recovery, and a soil amendment production (digestate). Application of solid digestate into the soil is beneficial to increase soil properties, digestate can provide essential nutrients, carbon, and bio-stimulants to soils and increase yield and is an alternative essential to obtain a circular bioeconomy (O'Connor et al., 2022). However, it should be carefully operated because it has risks of nitrate leaching and soil pathogens (Riya et al., 2020). Thus, it is important submitted this digestate to a stabilization and hygienization process such as composting. In this sense, establishing a safe way of organic waste valorization can lead to a sustainable recovery. Thus, the present study aimed to evaluate the potential production of soils amendments resulting from composting of an anaerobic digestate of agroforestry waste.

## METHODOLOGY

To fulfil the work purpose, a dry anaerobic digestion (pilot scale) of agroforestry waste was conducted for 20 days, followed by a composting process of digestate for 30 days. Three digestor of 7 L each were used to carry out the anaerobic digestion. The composting process was made in an open vessel. The agroforestry wastes were green biomass (European Waste Code (EWC) 20 02 01) and manure (EWC code 02 01 06). These wastes were mixed in a proportion of 80% of green biomass and 20% of manure. The electrical conductivity (EC), pH, total organic matter (TOM), total organic carbon (TOC), total nitrogen (TN), humic substances (HS) and humic acids and fulvic acids, were measured before and after composting. These parameters were analysed based on the European Standards. To determine the composts quality, physical, chemical and biological analyses were carried out as indicated in the Ordinance nº185/2022, the degree of maturation and presence of weed plants. Maturation degree was measured by self-heating test and the weed seed test was adapted from CEN/TC BT TF 151 (2007), with results expressed in number of seeds per liter of sample.

## RESULTS

Table 1 shows the physical, chemical and biological parameters of the 2 materials under analysis, digestate and compost. Overall, the 30 days of composting were not enough for significant changes in the parameters analyzed. There was a slight decrease in organic matter, pH and EC content. The alkaline character of digestate was also found by Chiumenti et al. (2017) using agricultural wastes and cattle manure, where the input mixture had a pH of 7.84 and the digestate an alkaline character (9.07). The EC value decrease can also be considered an indication of the stability of the material and its safety for future use as an organic corrective for plants.

Table 1. Digestate and Compost characterization.

| Parameters | Digestate | Compost |
|---|---|---|
| **Moisture (%)** | 66.9 ±0.59 | 66.6 ±0.75 |
| **TOM (%)** | 72.2 ±0.43 | 70.6 ±1.80 |
| **TOC (%)** | 40.1 ±0.24 | 39.2 ±1.00 |
| **TN (%)** | 1.72 ±0.100 | 1.62 ±0.05 |
| **C/N** | 23.3 ±1.43 | 24.2 ±1.05 |
| **pH** | 8.55 ±0.04 | 7.89 ±0.05 |
| **EC (mS/cm)** | 1.98 ±0.11 | 1.58 ±0.87 |
| **Humic Substances (%)** | 3.32 ±0.38 | 13.3 ±0.25 |
| **Humic Acid (%)** | 1.05 ±0.350 | 5.77 ±0.20 |
| **Fulvic Acid (%)** | 2.27 ±0.730 | 7.51 ±0.43 |
| **Stability Class** | - | V |
| **Weed Seed Test (%)** | - | 0 |

The presence of humic substances indicates the quality and maturation of the organic matter. According to the data obtained, it can be seen that the digestate underwent maturation during the 30 days of composting, as there was a 4-fold increase in the humic substances amount, which can be compared with commercial Humus Organic Corrective. The humic compounds quantification in digested showed 3.32% of total humic extract, where 1.05% are fulvics acids and 2.27% are humic acids. The compost presented 13.28% of total humic extract, 4 times higher than digestate, with 5.77% of fulvics acids and 7.51% of humic acids. The increase in HS content observed may explain the high GI obtained after composting (data not shown), as HS have biostimulant properties. These results were lower than those obtained by Wang *et al.* (2021), using a mixture of poultry manure with corn stover in a wet anaerobic digestion, with a retention time in the digester of 16 and 40 days, showed humic acid amounts of 20% and 40%, respectively. Slepetiene *et al.* (2020) report 10.2% of humic acids in solid digestate of agricultural wastes, but the digestate had only 20% of organic matter and 10% of organic carbon. This confirm that the percentages of organic matter and carbon are linked to the percentage of humic acids, when the digestate is matured. On the other hand, the behavior observed in this study with the ratio of 70.56%, 39.2% and 7.51% for organic matter, organic carbon and humic acids, respectively, may indicate that the compost still needs more time to mature so that a higher percentage of organic matter can be humified.

A self-heating test was carried out with Dewar vessels, in which the compost reached a temperature of 26.4ºC, indicating a degree V of maturation. The weed seed test showed a satisfactory result demonstrated by the non-germination of weed seeds (0%) and germination of 88% of the seeds of sowing watercress. The results allow to conclude that no viable weed seed was detected in the compost, since there was no germination during the 21 days test. The growth value of watercress in the control trial validated the test since more than 80% of the watercress seeds germinated (88%). This result demonstrates that the composting process was sufficient to inactivate the weed seeds that could be contained in the digestate.

It was verified that an anaerobic digestion followed by composting of agroforestry wastes with manure allowed to obtain a soil amendment with a positive effect for plants, contributing to sustainable development.

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