Decentralized composting models for organic waste management II: a case study of agro-composting

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Introduction

The organic wastes generated from the primary sector, principally from the agricultural and livestock activities, constitute important residual organic streams that can represent an important environmental, economic and social problem if are not properly managed. In this context, the management and valorisation of these organic waste fluxes by composting are progressively shifting to new models based on a decentralized composting, such as the composting of agricultural and livestock wastes in situ (agro-composting). However, the lack of information regarding the characteristics of the composts obtained in these new composting scenarios requires their assessment to assure the obtaining of safe and quality composts that fulfil the conventional requirements and also the identification of emerging potential risks to guarantee their hazard-free use. Therefore, the main objective of this work was to study the viability of the management and valorisation of two-phase olive mill waste ("alperujo") and pig slurry by its co-composting with urban pruning waste and to evaluate the quality of the compost obtained.

Material and methods

Two composting piles were prepared using the agro-industrial and livestock wastes from the area where the composting process were developed, such as two-phase olive mill waste, also called "alperujo" (OMW), and pig slurry (PS), mixed with urban pruning waste (PW). The principal properties of the raw materials used in the composting mixtures are shown in Table 1.

Table 1. Characteristics of the initial materials used in the composting mixtures expressed on a dry weight basis.

	OMW	PS	PW
Dry weight (%)	43.0	57.7	79.4
pH	8.2	7.0	7.3
Electrical conductivity (dS/m)	6.20	6.3	2.70
Organic matter (%)	56.9	66.6	76.0
Total organic carbon (%)	32.3	35.3	41.1
Total nitrogen (%)	2.27	2.42	0.97
TOC/TN	14.2	14.6	42.3
P (g/kg)	23.9	24.6	1.20

OMW: olive mill waste; PS: pig slurry; PW: urban pruning waste.

The composting mixtures were prepared at the treatment plant of pig slurry located at Todolella (Castellón, Spain). The proportions of the raw materials used to prepare the composting piles, on a fresh weight basis were the following:
Pile 1: 30 % OMW + 50 % PS + 20 % PW
Pile 2: 40 % OMW + 40 % PS + 20 % PW

The composting heaps (about 18 m^3) were composted in tunnels by the turned windrow composting system, with mechanical turnings weekly until the end of the bio-oxidative phase. The bio-oxidative was considered finished when the temperature in the mixtures was close to ambient temperature and a difference between the pile temperature and the ambient temperature was ≤ 10ºC during at least 10 consecutive days after a whirl. This phase had a duration of approximately 60 days in both piles. Then, composts were left to mature during two months, approximately. The moisture of the piles was maintained at levels not lower than 40% during the composting process. The piles were sampled in five occasions during the bio-oxidative phase and twice during the maturation stage (at 30 and 60 days) and processed following the methodology described by Vico *et al*. (2018). In the initial wastes and the composting samples, dry matter, pH, electrical conductivity (EC), organic matter (OM), total

organic C (TOC) and total N (TN) were determined according to the methods used by Vico *et al.* (2018). In the acid extract obtained after $HNO_3/HClO_4$ digestion, macro and microelements were determined by ICP-OES. The germination index (GI) was determined according to the method of Zucconi et al. (1981). In addition, several pathogenic groups (*Salmonella*, *Listeria monocytogenes* and faecal Coliforms (*E. coli*)) were studied in the mature composts (Morales *et al*., 2016).

Results and discussion

The composting mixtures showed a good development of the thermophilic phase, maintaining values higher than 55 ºC for more than two weeks, which verifies the criteria established by the European legislation concerning compost sanitation (EU Regulation 2019/1009), and a long duration of the thermophilic phase, behaviour also reported in previous studies of composting of OMW (Cayuelas *et al*., 2016; Tortosa *et al*., 2012). Throughout the composting process, the pH and the electrical conductivity values increased in both mixtures, observing a slight increase of pH with the proportion of OMW in the mixture. The concentrations of organic matter decreased during the process in both piles. However, the pile with higher proportion of OMW had a lower decrease in the organic matter contents, probably due to the more recalcitrant nature of this waste compared to pig slurry (Tortosa *et al.*, 2012). At the end of the process, both composts had suitable agronomic characteristics, an adequate degree of maturity and sanitary conditions, according to the requirements for human pathogens of the European legislation (EU Regulation 2019/1009), as well as absence of phytotoxicity.

Conclusions

The *in situ* composting or agro-composting of agro-industrial and livestock wastes, such as olive mill waste and pig slurry, constitutes a viable management model for the treatment and valorisation of these types of organic wastes, which reduces the impact of the disposal of these wastes and allows to close the organic matter circle obtaining a quality organic fertiliser that can be incorporated without any risk into the soil.

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