Valorisation of organic wastes from the primary sector through composting: an example of sustainable management

C. Álvarez-Alonso[1], M.D. Pérez-Murcia[1], E. Martínez-Sabater[1], A. García-Randez[1], C. Gómez[1], V. Blay[1], L. Orden[1], S. Sánchez-Méndez[1], I. Irigoien[2], M. López[3], Raúl Moral[1], M.A. Bustamante[1]

[1]CIAGRO, Miguel Hernández University, EPS-Orihuela, ctra. Beniel, Km 3.2, 03312, Orihuela, Alicante.
[2] Department of Agricultural Production, Public University of Navarre (UPNA-NUP), Pamplona, Spain
[3] Universitat Politècnica de Catalunya (UPC), Campus del Baix Llobregat, Edifici D4, C. Esteve Terradas, 8 08860, Castelldefels, Spain

Keywords: organic waste, cattle manure, waste recovery, added value, compost.
Presenting author email: cristina.alvareza@umh.es

Introduction

In the recent years, the social development has implied the increase in the production of organic wastes from the primary sector, which is not only harmful to the environment, but also represents a wasted source of resources (Xie et al., 2019). The nature of this type of waste, together with the bad practices common in the sector, its large production volume, seasonality and geographical dispersion, pose difficulties for its correct management (Assandri et al., 2021). Composting, as a method for agricultural and livestock waste management, avoids the environmental impacts derived from inadequate management, reduces the weight and volume of organic wastes, introduces the materials considered waste into the circular economy cycle by defining them as new resources and allows obtaining a stable end-product, compost, with high added-value, free of phytotoxicity and pathogens and rich in nutrients that help to maintain and improve soil fertility and quality (Assandri et al., 2021). The aim of this study is the environmentally sustainable valorisation of organic wastes from the primary sector by composting, controlling the indicative parameters of the process to obtain a sanitised, stable, highly humified, pathogen-free final product with physico-chemical and biological properties that allow its use as organic amendment in agriculture.

Material and methods

Three co-composting piles were prepared using manure from cattle aged between 9 and 15 months and barley straw and other cereals from the COWVET cattle breeding centre located in Titaguas (Valencian Community, Spain). The main characteristics of the initial materials are shown in Table 1.

Table 1: Characteristics of the initial materials on a dry weight basis.

	Cattle manure	Cereal straw
Bulk density (kg L^{-1})	1.033	0.042
Moisture (%)	74.1	24.0
pH	8.9	7.8
EC (dS m^{-1})	4.4	7.1
OM (%)	68.2	88.4
TOC (%)	38.4	40.0
TN (%)	2.6	1.9
TOC/TN ratio	14.9	24.8
P (%)	0.4	0.2
K (%)	1.9	2.7
Na (%)	0.2	0.2
Zn (mg kg^{-1})	112.6	74.9
Cr (mg kg^{-1})	22.6	13.1
Cd (mg kg^{-1})	0.1	0.1
Ni (mg kg^{-1})	6.3	4.4
Pb (mg kg^{-1})	2.5	2.3
Cu (mg kg^{-1})	22.6	13.1

EC: electrical conductivity; OM: organic matter; TOC: total organic carbon; TN: total nitrogen.

Piles 1 and 2 were prepared mixing 9,250 kg of manure and 450 kg of straw, while pile 3 was formed with 10,000 kg of manure and 450 kg of straw. The dimensions of the piles were 5.0 x 2.0 x 1.7 m (length x height x width), which were turned and watered periodically. The duration of the bio-oxidative phase of the process was 106 days for the 3 piles studied and they were left to mature for one month. The evolution of the composting process was monitored by taking four samples at different stages: at the time of pile formation (M1), during the thermophilic phase (M2), at the end of the bio-oxidative phase (M3) and at maturity (M4). The physico-chemical, chemical and biological parameters in the initial materials and the composting samples were determined according to the methods described by Vico et al. (2018), also developing in the mature compost the self-heating test (Brinton et al., 1995).

Results and discussion

All the piles showed a rapid temperature increase during the first days of the process, reaching values above 60ºC. The composting mixtures showed temperatures above 55ºC: in Pile 1 during 60 days, 59 days in Pile 2 and 58 days in Pile 3, reflecting a high exothermicity, as indicated by the EXI^2 index (quadratic summation of the daily difference between the average temperature of the pile and the ambient temperature) (Vico et al., 2018). All the piles verified the requirements of EU Regulation 2019/1009 ensuring the sanitisation of the composting mass. The pH decreased slightly in the three piles, as did the EC, probably due to the abundant irrigation or to the rain when the treatment was carried out outdoors (Paredes et al., 2001). The concentration of OM also decreased during the process in the three piles, especially in the first stages, as did the TOC/NT ratio, with final values below 20, the maximum value established by Moreno et al. (2015). In contrast, the amounts of P and K remained practically constant in the 3 piles. All composts showed adequate maturity and stability, with absence of phytotoxicity (GI>50%), as well as a higher amount of humic acid-like C versus fulvic acid-like C (Cha/Chf>1.6) and grade V according to the self-heating test (Brinton et al. 1995). The mature composts studied did not imply any environmental or health risks, as they showed lower values in the heavy metals and microorganisms analysed (absence of *Salmonella* and < 1000 NMP *E. coli*) than those established by RD 506/2013 of the Spanish legislation on fertiliser products, which allows to classify all the composts as Class A fertiliser products.

Conclusions

Composting as a treatment for the management of the organic wastes from the primary sector is an environmentally sustainable and recovery method, as it avoids the management using less sustainable techniques and favours the circular economy. The mixtures studied made it possible to obtain a final product with agronomic quality, sanitised, with good physico-chemical and biological characteristics, as well as adequate maturity and stability.

Acknowledgements

This research has been financed in the framework of the research project NEOCOMP (ref. PID2020-113228RB-I00) funded by MCIN/ AEI /10.13039/501100011033 and, also it was supported by the Spanish Ministry of Science and Innovation with a PhD scholarship to the first author (FPU21/01207). The authors would also like to thank the company COWVET Gestión y Servicios Veterinarios S.L. for their help in this study.

References

Assandri D., Pampuro N., Zara G., Cavallo E., Budroni M. 2020. Suitability of Composting Process for the Disposal and Valorization of Brewer's Spent Grain. Agriculture. 11, 2.

Brinton W.F., Evans E., Droffner M.L., Brinton R.B. 1995. A standardized Dewar test for evaluation of compost self-heating. Biocycle. 36.

Moreno J., Moral R., García-Morales J.L., Pascual J.A., Bernal M.P. 2015. De residuo a recurso. El camino hacia la sostenibilidad. Residuos orgánicos. Residuos agroalimentarios. Ed. Mundi Prensa, Madrid.

Paredes C., Bernal M.P., Roig A., Cegarra J. 2001. Effects of olive mil wastewater addition in composting of agroindustrial and urban wastes. Biodegradation. 12, 225-234.

Vico A., Pérez-Murcia M.D., Bustamante M.A., Agulló E., Marhuenda-Egea F.C., Sáez J.A., Paredes C., Pérez-Espinosa A., Moral R. 2018. Valorization of date palm (Phoenix dactylifera L.) pruning biomass by co-composting with urban and agri-food sludge. Environ Manage. 226, 408-415.

Xie X., Gao X., Pan C., Wei Z., Zhao Y., Zhang X., Sheng L., Cao J. 2019. Assessment of multiorigin humin components evolution and influencing factors. Agric. Food Chem. 67, 4184-4192.