Valorization of organic waste from primary sector through composting: an example of sustainable management

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

[1] CIAGRO, University Miguel Hernández, EPS-Orihuela. Orihuela, Alicante, Spain.
[2] Dep. of Agricultural Production, Public University of Navarre (UPNA-NUP). Pamplona, Spain.
[3] Politecnic University of Catalunya (UPC), Baix Llobregat Campus. Castelldefels, Barcelona, Spain.

Introduction

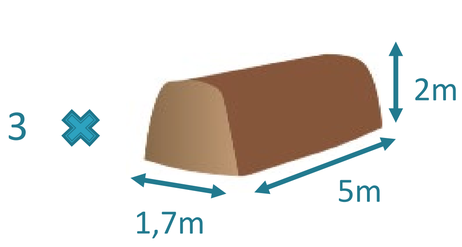
In recent years, the social development has implied the **increase** in the production of **organic wastes** from primary sector, which is not only harmful to the environment, but also represents a wasted source of resources. The nature of this type of waste, together with the bad practices in the sector, its large production volume, seasonality and geographical dispersion, pose **difficulties** for its **sustainable management**.

Composting 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**.

Material & methods

Characteristics of the initial materials

	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})	113	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



	Pile 1 & 2	Pile 3
• Cow manure (kg)	9250	450
• Cereal Straw (kg)	10000	450

Process control:

- M1 Initial
- M2 Thermophilic phase
- M3 End of Bio-oxidative
- M4 Maturity

Parameters

- Physico-chemical
- Chemical
- Biological
- Self-heating test

The duration of the bio-oxidative phase of the process was **106 days** for the 3 piles

Mature time: 1 month

Aim

- Sanitized
- Stable
- Humidified
- Pathogen free

Results & Discussion

Thermal process characteristics

Thermal parameters	Pile 1	Pile 2	Pile 3
No. Days >40ºC	80	81	79
No. Days >50ºC	80	79	66
No. Days >60ºC	37	41	46
Max. temperature	67	71	67
Average temperature	43.3	42.6	40.8
Bio-oxidative days	106	106	106
No. Days >40ºC/Bio-oxidative	0.755	0.764	0.745
EXI^2 Cumulative	200304	208113	197190
EXI^2 Ratio/No. Days Bio-oxidative	1890	1963	1860

Rapid increase of temperatures during the first days of the process, reaching temperatures above 60ºC. **High degree** of **exothermicity** as demonstrated by the EXI^2 index. All piles comply with the requirements of EU Regulation 2019/1009 which guarantees **sanitization**.

Evolution of physico-chemical and chemical parameters

Composting phases	Moisture %	BD kg l^{-1}	pH	CE dS m^{-1}	Na g kg^{-1}	OM %	TOC/TN	TN %	K_2O %	P_2O_5 %
Pile 1: 60% Cow manure + 40% cereal straw										
M1	67.2	0.423	8.6	4.6	1.4	65.1	17.5	2.0	2.0	0.8
M2	68.7	0.580	8.8	4.4	1.6	50.8	14.1	2.2	2.3	1.0
M3	39.2	0.667	7.7	4.4	1.8	37.6	10.9	2.5	2.6	1.1
M4	40.9	0.698	8.3	3.9	1.2	36.0	10.8	1.9	2.0	0.9
Pile 2: 60% Cow manure+ 40% cereal straw										
M1	65.6	0.324	8.6	5.1	1.5	68.2	17.1	2.1	2.2	0.9
M2	58.9	0.432	8.6	5.1	1.6	53.5	15.6	2.1	2.3	0.9
M3	40.6	0.619	8.3	3.5	1.6	31.8	11.6	1.8	2.4	0.8
M4	44.7	0.598	8.1	4.1	1.3	31.4	11.2	1.7	2.2	0.9
Pile 3: 62% Cow manure + 38% cereal straw										
M1	67.9	0.372	8.8	4.8	1.4	68.8	17.2	2.2	1.9	0.8
M2	66.1	0.506	9.0	4.0	1.2	51.4	14.1	2.0	1.9	0.7
M3	34.4	0.506	8.2	3.9	1.7	36.0	11.8	2.3	2.4	0.9
M4	34.6	0.430	8.4	3.8	1.4	33.9	11.6	1.8	2.1	0.9

pH and EC decrease due to irrigation and abundant rainfall. **Decrease** in **OM** and in the **TOC/TN ratio**, with final values below 20 (maximum value established for mature compost). The amounts of **P and K** remained **constant** in the 3 piles.

Maturity and stability parameters

	Germination Index %	Humic Acds %	Fulvic Acids %	Thermal stability degree (Brinton et al., 1995)
Pile 1	109	3.5	1.6	V, Stable
Pile 2	80	3.6	1.7	V, Stable
Pile 3	100	4.2	2.0	V, Stable

Adequate maturity and stability of all composts (GI>50%, Cha/Chf>1.6 and degree of thermal stability V).

Environmental and health risks

	Cd	Ni	Cu	Zn	Cr	Pb	*Salmonella/25g*	*E. coli* (NMP/g)
Pile 1	0.2	12	25	135	41	12	Ausencia	<3
Pile 2	0.2	13	22	122	43	13	Ausencia	<3
Pile 3	0.2	11	24	114	38	12	Ausencia	23

No risk, values below those set by RD 506/2013, complied with fertilizer regulations **Class A**

Conclusions & Acknowledgements

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 increases circularity. The mixtures studied made it possible to obtain a final product with agronomic quality, sanitized, with good physico-chemical and biological characteristics, as well as adequate maturity and stability.

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.