Biowaste recovery by co-composting. Limiting factors of the process and agronomic final product quality.

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Introduction

In Spain, Castellón province produce 542 ton year^{-1} of municipal solid waste (MSW), which represents 15% of the entire of Valencian Community (PIRCV, 2020). The organic fraction of MSW is biostabilized through a mechanical biological treatment. Fulfilling quality requirements according to standards (decrete 7/2022), the bioestabilized it can be used in agriculture soils for a circular economy (BOE, 2022), resulting an important source of organic matter due to the almost generalized deficiency in Spain´s soils (Gil et al., 2008).

The quality of the biostabilized have led to its rejection by farmers, which currently means a non-optimized organic waste flow that is transferred to landfills. The valorization of this biostabilized can be carried out through local co-composting processes with other agrifood waste flows, obtaining stabilized compost oriented for agricultural use. The aim of this work is evaluated the co-composting process of bioestabilized MSW organic fraction to obtain high value composts oriented to agricultural systems.

Materials & Methods

The field experiment was carried out in Sant Mateu, Castellón, Spain (40°28'19.2" N 0°13' 17.8" W), from march 2022 for 180 days. Six windrow composting piles in large-scale of 6.5 m× 1.5 m× 3 m (7,800 kg f.m). All the materials were chosen following criteria of proximity and availability (Table 1): olive mill waste (OMW) (65 % f.m.), two biestabilized MSW organic waste from Guadassuar, Valencia (MBT1) and Algimia, Castellón (MBT2) as a source of N (15 % f.m.) and three different bulking agent (20 % f.m.): olive leaves waste (OLW), urban pruning residues (UPR) and OLW+UPR (1:1, w/w). The treatments were labeled as follows: 1) OMW+UPR+MBT1, 2) OMW+OLW+MBT1, 3) OMW+UPR+OLW+MBT1, 4) OMW+UPR+MBT2, 5) OMW+OLW+MBT2, 6) OMW+UPR+OLW+MBT2.

Table 1. Physico-chemical properties initial mixed compost raw material.

	OMW	UPR	OLW	MBT1	MBT2
Moisture (%)	58.9	29.4	28.5	26.4	30.1
BD (g cm^3)	0.87	0.18	0.10	0.32	0.37
pH	6.7	7.5	6.1	6.9	7.6
EC (dS m^{-1})	3.05	2.71	1.34	6.50	5.07
TOC (%)	50.6	37.1	45.5	33.8	31.3
TN (%)	0.81	1.22	1.21	1.65	1.73
TOC/TN	62.5	30.3	37.7	20.5	18.1
PPH (mg kg^{-1})	5757	2492	6295	1458	2680

BD: Bulk Density; EC: electrical conductivity; TOC: total organic C; TN: total N; PPH: polyphenols

The piles were managed as an industrial compost pile, within a period of 20 days turning using a mechanical windrow turner machine and periodic pressurised watering. The entire composting process lasted for 150 days of bioxidative phase followed by 30 days of maturation. The temperature was monitoring daily with dataloggers. The thermal EXI2 index was calculated for each of the treatments (Vico et al, 2018).

Data analysis was performed with Infostat® (Di Rienzo et al., 2020). One-way analysis of variance (ANOVA) and the least significant difference (LSD) test at $P<0.05$ were used to assess the significance of differences among the values of each parameter studied during composting.

Results & Discussion

Table 2 shows the significant differences thermal parameters of the six compost processes. Pile 1 and 2 showed the highest value of temperature and accumulated EXI2. For both MBT´s piles, temperatures were lower in the treatments were UPR+ OLW was used as bulking agent (Piles 3 and 6). These results could be due to the higher content of water-soluble polyphenols found in MBT2, which have an antimicrobial effect (Scalbert, 1991)

Table 2. Thermal parameters of the composting process.

	Pile	Temperature (ºC)	Cumulative EXI^2 index (C°^{2})	EXI^2 index Bioxidative days $^{-1}$
MBT 1	1	59.7 D	150856 C	1006 C
	2	60.7 D	153361 C	1022 C
	3	55.9 C	138761 C	925 C
MBT2	4	56.0 C	121062 B	807 B
	5	54.0 B	105899 B	706 B
	6	50.5 A	83151 A	554 A
	F anova	31.37 ***	21.53 ***	21.53 ***

Different letters within the same column represent significant differences at $p < 0.05$. *** significant at p-value 0.001.

Temperature changes recorded for all treatments are illustrated in Figure 1. Thermal profiles were evaluated during the bioxidative phase grouped according to the biostabilized raw materials. Significant differences were found ($p<0.0001$) for MBT1 (1, 2, 3) and MBT2´s piles (4, 5, 6), in the study of composting average temperature and for the EXI2 index. Temperatures of MBT1 treatments rapidly increased and reached the thermophilic phase (>50 °C) on the first week of composting remaining above this level during 145, 147 and 129 days in piles 1, 2 and 3, respectively.

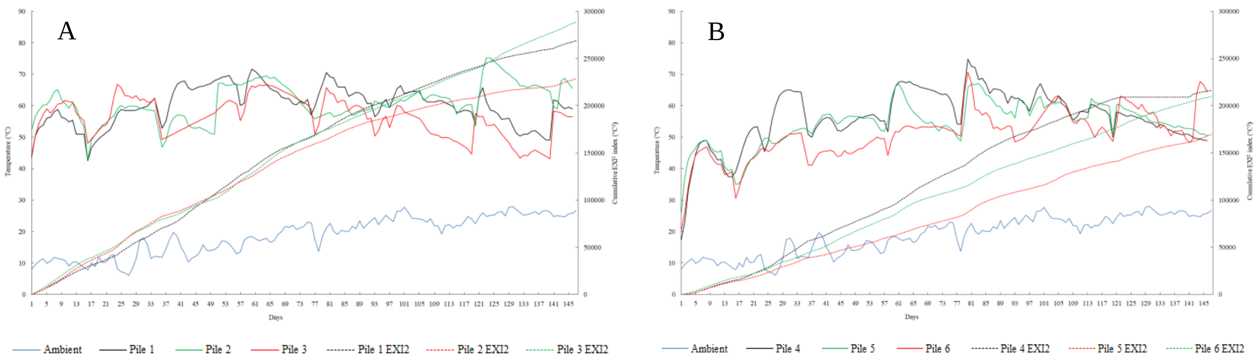

Figure 1. Evolution of the temperature and of the cumulative quadratic exothermic index (EXI^2): A) MBT1 (Piles 1, 2 and 3; B) MBT2 (piles 4, 5 and 6).

Conclusions

The results obtained during the composting process allow us to conclude that the presence of bioestabilized did not have a limiting effect on the process: all the piles reached high temperatures and composting was carried out satisfactorily. More tests should be carried out to define the difference in thermal parameters between the different bioestabilized piles.

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