Obtaining of added-value organic materials by composting of agri-food waste

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Introduction

The agri-food industry constitutes the principal activity of the manufacturing sector in Europe, this activity being mostly concentrated in the Mediterranean area (Pascual *et al.*, 2018). The increasing production of the agri-food sector has led to an important rise of the wastes generated by this activity (Morales *et al*., 2016). Composting is a viable technology to manage and recycle organic waste, since the compost obtained is a useful organic amendment and/or organic growing medium that can be reintroduced into the economic system, helping to solve the disposal problem and its associated potential environmental impact. This constitutes the basis of the circular economy concept, which tries to extend the life of products as long as possible and to eliminate or at least reduce waste. In addition, the suppressive capacity against phytopathogens constitutes a property that is present in some composts, which provides an added value to this organic material (Bustamante *et al*., 2012). Therefore, the aims of this work were to study the feasibility of the management and valorisation of agri-food wastes by its co-composting with vine shoot pruning and to evaluate the potential suppressive capacity against the phytopathogen *Phytium irregulare.*

Material and methods

Six composting piles were prepared using different agri-food wastes (tomato soup waste (TSW), leek waste (LW), olive mill waste (OMW), and vine shoot pruning (VP) as bulking agent) (Table 1).

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

	TSW	OMW	LW	VP
pH	5.2	5.1	6.0	6.1
EC (dS/m)	3.37	4.51	9.95	1.33
OM (%)	94.1	89.9	78.6	93.9
TOC (%)	52.6	51.7	40.3	46.7
TN (%)	2.99	1.49	2.50	0.63
TOC/TN	17.6	34.8	16.1	74.1
P (g/kg)	5.09	0.84	3.59	0.35

EC: electrical conductivity; OM: organic matter; TOC: total organic carbon; TN: total nitrogen. TSW: tomato soup waste. LW: leek waste; OMW: olive mill waste; VP: vine shoot pruning.

The mixtures were elaborated at the composting pilot plant (Compolab) of the Miguel Hernández University, located in Orihuela (Alicante, Spain). The percentages of the initial materials used to prepare the composting piles, on a fresh weight basis were the following (dry weight basis between brackets):
Pile 1: 39 % TSW + 47 % LW + 14 % VP [34:19:47]
Pile 2: 76 % TSW + 24 % VP [46:54]
Pile 3: 77 % LW + 23 % VP [28:72]
Pile 4: 57 % LW + 28 % OMW + 15 % VP [21:34:45]
Pile 5: 42 % TSW + 39 % OMW + 19 % VP [25:33:42]
Pile 6: 30 % TSW + 26 % LW + 29 % OMW + 15 % VP [21:8:30:41]
These mixtures (about 5000 kg) were composted in trapezoidal piles by the turned windrow composting system. Mechanical turnings were carried out weekly until the end of the bio-oxidative phase, which lasted between 157 and 166 days and was considered finished when during 10 consecutive days after a whirl the difference between the pile temperature and the ambient temperature was ≤ 10ºC. Then, composts were left to mature over a period

of two months, approximately. The moisture of the piles was controlled weekly by adding the necessary amount of water to obtain a moisture content not less than 40%. The piles were sampled (Bustamante *et al*. (2012) in four occasions corresponding the samples to the initial stage, thermophilic phase, end of the bio-oxidative stage and maturity phase of composting. Subsequently, the samples were processed according to the procedure followed by Vico *et al*. (2018). In the raw materials and the composting samples, electrical conductivity (EC), pH, dry matter, organic matter (OM), total organic C (TOC) and total N (TN) were determined according to the methods used by Bustamante *et al.* (2012). In addition, in these samples, after $HNO_3/HClO_4$ digestion, P was analysed colorimetrically as molybdovanadate phosphoric acid, Na and K were determined by flame photometry. The germination index (GI) was calculated using seeds of *Lepidium sativum* L. (Zucconi *et al.*, 1981). All the analyses were made in triplicate. The potential suppressive capacity of the compost against the phytopathogen *Pythium irregulare* was studied through *in vitro* and *in vivo* assays (Giménez *et al.*, 2019).

Results and discussion

All the composting mixtures showed an adequate evolution of the temperature, maintaining thermophilic values more than a month, which guarantees the maximum pathogen reduction according to the European requirements on compost sanitation (Gavilanes-Terán *et al*., 2016). The piles containing OMW (piles 4, 5 and 6) showed a longer duration of the thermophilic stage, whereas the piles with TSW reached the highest temperature values. Concerning the physico-chemical and chemical parameters parameters, all the mixtures showed an increase of the pH and electrical conductivity values, as well as a decrease of the organic matter concentrations, observing the lowest contents in the pile with leek waste and vine shoot pruning (pile 3) at the end of bio-oxidative phase. The nitrogen contents increased in all piles, showing the highest values the final composts that contained tomato soup waste (piles 1, 2, 5 and 6). At the end of the composting process, all the composts verified the criteria established by the Spanish and European legislations (Gavilanes-Terán *et al*., 2016) and showed a suitable maturity degree with absence of phytotoxicity. Regarding the potential suppressive capacity against *P. irregulare*, the results obtained showed a clear inhibitory effect on the growth of the phytopathogen in *in vitro* conditions.

Conclusions

The composting of agri-food wastes not only constitutes an efficient method to manage these wastes, but also to obtain end-products with an adequate maturity degree, suitable physico-chemical and chemical characteristics, absence of phytotoxicity and potential added-value properties, as the potential biocontrol capacity against *P. irregulare*, aspects that provide environmental benefits in the circular economy framework.

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