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Meat waste as feedstock for home composting: Effects on the process and quality of compost

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ABSTRACT

Home composting is a powerful tool, which is spreading in different parts of the world, to reduce the generation of municipal waste. However, there is debate concerning the appropriateness, in terms of domestic hygiene and safety, of keeping a composter bin in the household deputed to kitchen waste of animal origin, such as meat or fish scraps and pet droppings. The purpose of our work was to study how the addition of meat scraps to household waste influences the composting process and the quality of the final compost obtained. We compared four raw material mixtures, characterized by a different combination of vegetable and meat waste and different ratios of woody bulking agent. Changes in temperature, mass and volume, phenotypic microbial diversity (by Biolog™) and organic matter humification were determined during the process. At the end of the experiment, the four composts were weighed and characterized by physicochemical analysis. In addition, the presence of viable weed seeds was investigated and a germination bioassay was carried out to determine the level of phytotoxicity. Finally, the levels of pathogens (*Escherichia coli* and *Salmonella* spp.) were also determined in the final compost.

Here we show that the presence of meat waste as raw feedstock for composting in bins can improve the activity of the process, the physicochemical characteristics and maturity of the compost obtained, without significantly affecting its salinity, pH and phytotoxicity. Pathogen levels were low, showing that they can be controlled by an intensive management and proper handling of the composter bins.

1. Introduction

The last report of The World Bank estimates that the current worldwide average generation rate of Municipal Solid Waste (MSW) per capita in urban areas corresponds to approximately 1.2 kg per person per day and that by 2025 this will likely increase to 1.42 kg/person/day, reaching 2.2 billion tons of waste per year on a global scale (Hoornweg and Bhada-Tata, 2012).

In accordance with the last trend of environmental policies, composting is a valuable way of waste treatment that contributes to reduce organic waste destined to landfill disposal or incineration. Home and community composting have proven to be a sustainable strategy for food waste management that can reduce costs and environmental impact due to collecting, transport and treatment of MSW (Barrena et al., 2014). In addition, home-made compost usually presents better characteristics than full-scale compost because it is made by source-separated household waste (Dimambro et al., 2007). However, in general a long duration time is required in home composting to fulfill the typical reference quality limits that are adoptable for compost (Tatàno et al., 2015).

A handful of studies exist concerning meat waste as feedstock for composting. In fact, the presence of meat scraps in household compost is the subject of extensive debate that needs to be further investigated.

Concerning the legal aspects, the disposal of meat waste for composting at a home-scale is more or less regulated in the majority of countries. In European countries it is controlled under the Animal By-Products regulation (Regulation EC 1069/2009 and subsequent amendments thereto). According to this regulation, only a few European countries prohibit the inclusion of meat waste in home composting, while most countries do not regulate the utilization of meat waste when it is composted at home or on a community scale. It is quite obvious that specific legal rules for self-composting are needed to clear the picture. In the United States, instead, single state regulation concerning home composting is missing, since the utilization of meat waste for composting *in situ* is at the discretion of the local authorities that can either allow it or not (Platt et al., 2014).

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On the downside, the possible development of odors or presence of insects and rodents are the main issues of some local authorities and composters associations that often discourage the use of meat waste as feedstock for home composting (Duplessis and Nova Environcom, 2006; MAGRAMA, 2008; VLACO, 2012; USDA, 2016). Moreover, although the compost obtained from source-separated food waste is generally considered a high quality compost, some authors have reported problems concerning the quality of the compost obtained by kitchen and catering waste containing meat scraps in terms of sanitation (Harrison, 2004), phytotoxicity, heavy metals (Zheljazkov and Warman, 2004), pH and salinity (He et al., 1995; Dimambro et al., 2007).

On the bright side, however, home and community composting can be considered as a legitimate alternative for the treatment of meat waste, which constitutes a traditional component of household food waste. To ensure the effectiveness of home composting as an efficient management tool of organic waste it is essential, in fact, that more kinds of household organic waste can be processed, including waste of animal origin. The composting of meat scraps could thus be added to the various kinds of household organic waste that are already efficiently composted at a decentralized level, relieving the community from the costs and management of such a problematic source of organic matter.

Moreover, the utilization of meat waste as composting feedstock may also improve the composting technique. As previously described (Smith and Jasim, 2009; Adhikari et al., 2012; Barrena et al., 2014), thermophilic temperatures were frequently not reached in home composting, entailing subsequent problems like pests and a deficient control in the vitality of weed seeds. Thus, the presence of meat waste in household composting may be an opportunity to increase the temperatures during the process with positive consequences on the control of weed germination and diffusion of pathogens and vectors of plant diseases in the final composts. An experiment of synthetic food composting (Chang and Hsu, 2008) demonstrated that increasing the protein ratio on feedstock materials promoted high temperature and CO_2 production during the process, increasing microbial activity. In addition, the intake of high-protein feedstock shortened the initial acidification that brought, in turn, to a higher final pH of the compost.

Currently, the composting of animal by-products at an industrial-scale has been proven to be successful on a larger kind of animal feedstock, such as butchery and household meat waste (Schaub and Leonard, 1996; Vidussi and Rynk, 2001; Arvanitoyannis and Ladas, 2008), livestock carcasses (Imbeah, 1998; Stanford et al., 2000; Kalbasi-Ashtari et al., 2005) or fishery offal (Liao et al., 1997; Laos et al., 2002). The way in which this model can be applied to small–scale composting and the best practices to ensure a correct and safe composting process need to be investigated.

The opportunity to use meat waste in home composting requires scientific studies that endorse it to guide users concerning the aspects behind a better management of the composting operation. Here we show the effects of the utilization of household meat waste as feedstock for composting at a small scale on the evolution of the composting process and quality of the final compost obtained.

2. Materials and methods

2.1. Experimental design and setup

The experiments were conducted at the experimental farm of the Public University of Navarre, in Pamplona, Spain. In this experimental trial 320 L composter bins (Komp 320, Container Trading WFW GmbH, Austria) were used. Each bin was characterized by 4 trapezoidal dark-green plastic sides with vents to provide improved aeration, a hinged lid at the top to fill the bin and an open panel at the bottom to retrieve the compost. Each bin presented a square base of 76 × 76 cm and was 86 cm high.

The composter bins were fed with food waste: vegetal food waste and meat waste (if required by the treatment). Vegetal food waste was delivered from a local street market and from the farm and composed of fruit and vegetable scraps, mixed with leaves and grass clippings (dry content matter of mix 15–85%). The composition of vegetal waste was very heterogeneous depending on the availability of fruit and vegetables in the market, which simulated household behavior. Meat waste consisted in raw meat scraps of edible parts, fat and bone of cattle, pigs and poultry, suitable for human consumption similar to household food waste.

Food waste was mixed with vegetal bulking agent. Chipped pruning residues of winter wood were provided by the garden service of the Pamplona City Council and were added as bulking agent (dry matter 55–60%) to favor aeration and prevent leachate formation. For all treatments the bulking agent was replaced, following the first addition of waste, by commercial compost without sifting to promote the activation of the composting process (5 kg/bin).

Four different raw material mixtures of waste were evaluated and compared:

- "M0B1" (Meat0, Bulking agent1): only vegetal feedstock. Vegetal food waste was mixed with the bulking agent in a volume ratio of 1:0.6.
- "M1B1" (Meat1, Bulking agent1): low dosage (5%) of meat waste (fresh weight) was added to the vegetal food waste (ratio food waste/bulking agent 1:0.6 of volume).
- "M2B1" (Meat2, Bulking agent1): high dosage (15%) of meat waste (fresh weight) was added to the vegetal food waste (ratio food waste/bulking agent 1:0.6 of volume).
- "M2B2" (Meat2, Bulking agent2): like M2B1, but with a double ratio of bulking agents (ratio food waste/bulking agent 1:1.2 of volume). The double amount of woody materials was introduced as treatment with the aim to observe if it produced an improvement in the composting conditions, by increasing aeration and avoiding leachate formation. A good aeration and porosity of material during composting usually prevents the establishment of anaerobic conditions and increases ventilation and aerobic respiration activity of microorganisms.

Four repetitions for each treatment were performed on a randomized-block experimental scheme. The experimental unit was a single composter bin; a total of 16 bins were employed throughout the experiment.

Food waste was weighed and added to the bins on a weekly basis during the first 6 weeks ("feeding phase"). In total 120 kg of food waste was added to each bin. The total amount of meat waste was 6 kg per bin in M1B1 treatment and 18 kg in M2B1 and M2B2. The amount of food waste added weekly decreased during the course of the experiment due to the progressive reduction of empty space in the bin. A summary of the amount of weekly additions of food waste is reported in Table 1.

The experimental trial evaluated the first 24 weeks of the composting process. The 6 weeks of the feeding phase followed by the 18 weeks when no waste was added to the compost for all treatments. Moisture content during composting was monitored qualitatively twice a week using the "fist test". This involves squeezing a compost sample in the fist; if water emerges from the fist, then the sample is too wet. The moisture content is suitable (approximately 50–60%) if the pressed sample does not release water but remains compact; if it crumbles apart when released, it is too dry (FCQAO, 1994). During the last weeks of the process the handling of the bins was reduced to the minimum, consisting only of manual turning