High School Students for Agricultural Science Research

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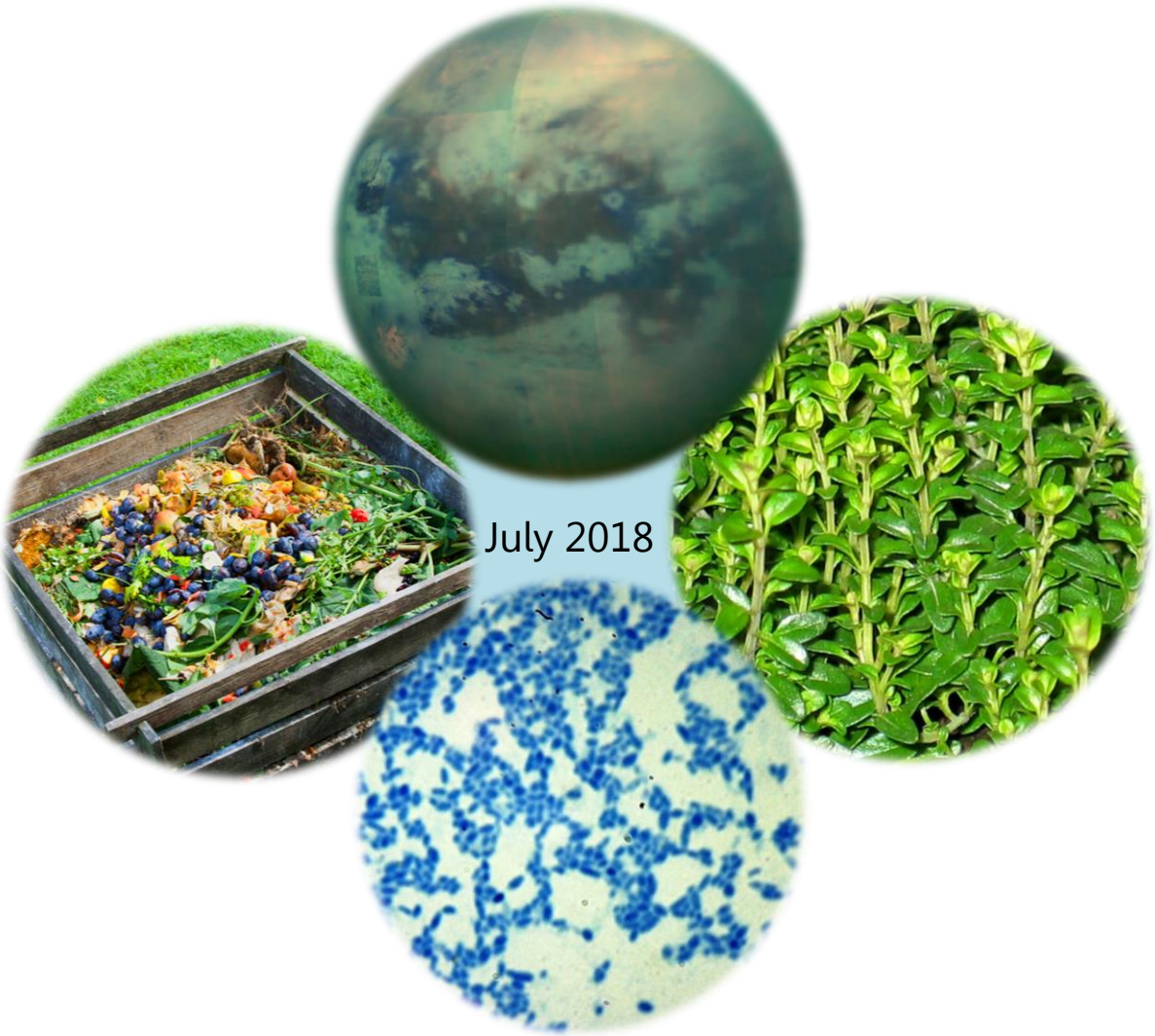

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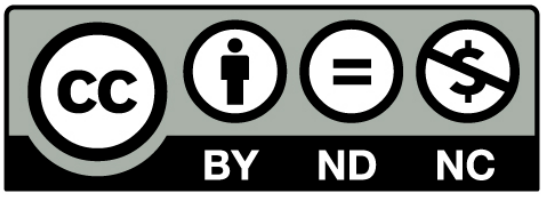

Recycling bio-waste by small-scale composting

Cristina Roldán Segura[1], *Catherine Walkley*[1] *and Germán Tortosa Muñoz*[2]*

[1] Colegio Internacional de Granada, Urbanización Cañadas de Parque, s/n, 18152, Otura-Dílar, Granada, Spain.
[2]Department of Soil Microbiology and Symbiotic Systems, Estación Experimental del Zaidín, CSIC, Profesor Albareda 1, 18008 Granada, Spain.
*Corresponding author: german.tortosa@eez.csic.es

HIGHLIGHTS

- Composting at small scale is a feasible methodology for the bio-waste treatment.

- Thermophilic temperatures of 50ºC were registered in the composting reactors.

- A reduction of 17 and 50% of the initial composting mixture mass and volume of the composting substrate were recorded.

SUMMARY

Bio-waste is a biodegradable organic waste composed by garden and park cuttings, and food and kitchen residues from households and catering establishments. Composting is an effective biological process for its treatment and recycling, converting this organic waste into an organic amendment. In this research, some small-scale composting reactors have been design using recycled materials. Also, the biological process has been studied by monitoring the temperature, mass and volume evolution of the composting substrate during two months. Thermophilic temperature (50ºC) and a significant reduction of mass (17%) and volume (50%) of the bio-waste mixture was found during the process. The main conclusion was that small-scale composting reactors can be effectively used for the bio-waste treatment.

INTRODUCTION AND OBJECTIVES

The generation of organic waste is directly related to human activity and as a consequence, these residues are increasing. Bio-waste is an example of such organic waste, which includes garden and park cuttings and food and kitchen wastes from households and catering establishments, among others [1]. The annual production of bio-waste in the European Union is estimated at 118-138 million tonnes [2]. Furthermore, global warning and climate change are contributing to desertification, which lead to a decrease in the organic matter of soils compromising their fertility, especially in Mediterranean countries. Composting bio-waste is a feasible strategy to both reduce the environmental impact of bio-waste generation and to produce high-quality organic amendments which can be used for increasing the organic matter within soils.

Composting is a biological process in which, a succession of microorganisms (mainly fungi and bacteria) transform the organic matter from the raw waste into a humified organic matter called compost. Composting is a low-cost technology for organic matter recycling, being nowadays the principal treatment technology for municipal organic waste in the European Union.

The aim of this project was to design small composting reactors for bio-waste composting and to study the biological process of organic matter degradation.

MATERIALS AND METHODS

Bio-waste collection.

The experiment was carried out by the students of 5º of Primaria and 1st of E.S.O. of the Colegio Internacional de Granada in their school grounds. The bio-waste collection was undertaken by the students and consisted in food wastes from their morning snaks and meals prepared in the school canteen (mainly fruit peels and vegetable scraps), as well as dry leaves from the school garden. In order to improve the composting process, the bio-waste was chopped into small size using scissors. Also, soil from the school garden was used as a microbial inoculant.

Reactors design and construction.

The composting reactors used in this experiment were adapted from those described previously [3]. The composting reactors were done using a recycled 25L water bottles of polyethylene terephthalate (PET). For each composting reactor, the water bottles were divided in two parts: the former was used as the base and to collect leachate (Part A) and the latter, to store the composting mixture (Part B). An example of a composting reactor is shown in Figure 1.

Figure 1. Construction of a small-scale composting reactor used in this experiment.

The initial bio-waste mixtures consisted in equal volumes of food scraps, dry leaves and sieved garden soil. The composting reactors were filled by adding consecutive layers of 2-3 cm of soil, dry leaves and food scraps until 80 % of the Part B volume capacity. In order to avoid insect proliferation, the last layer added to the composting reactors was soil, which covered the food scraps. Small holes were punched randomly in the part B of the reactors to ensure aeration of the composting mixture. 200-300 ml of tap water was added to composting mixtures to ensure a moisture of 30-40 %. The composting reactors were stored at classroom during the experiment (Figure 2).

Figure 2. Small-scale composting reactors used at the beginning of the process.

Monitoring the composting process.

The biological process of composting was studied during 2 months, from October 2017 to December 2017. Throughout the process, the temperature was registered at different heights and depths with a digital thermometer probe (Figure 3). Also, room temperature was recorded. The mass of the composting reactors were measured using a 5000 g electric mass balance with a precision of 100 g. The compost volume was calculated as the difference between initial volume level and the volume at each measurement.

Figure 3. Measuring temperature in a small-scale composting reactor.

RESULTS AND DISCUSSION

The temperature profile of a small-scale reactor is showed in Figure 4. The temperature rose from ambient values to 50-30ºC in the first three weeks of the process, which indicates that the thermophilic phase occurred. The biological process was also noted by a reduction in the mass of 17% (Figure 5) and a volume reduction of 50% (data not shown). These reductions can be related to CO_2 emissions from microbial development in the composting substrates [4]. The composting process lasted 30 days and the composting mixture turned into a brown compost with wet soil small by the end of the process.

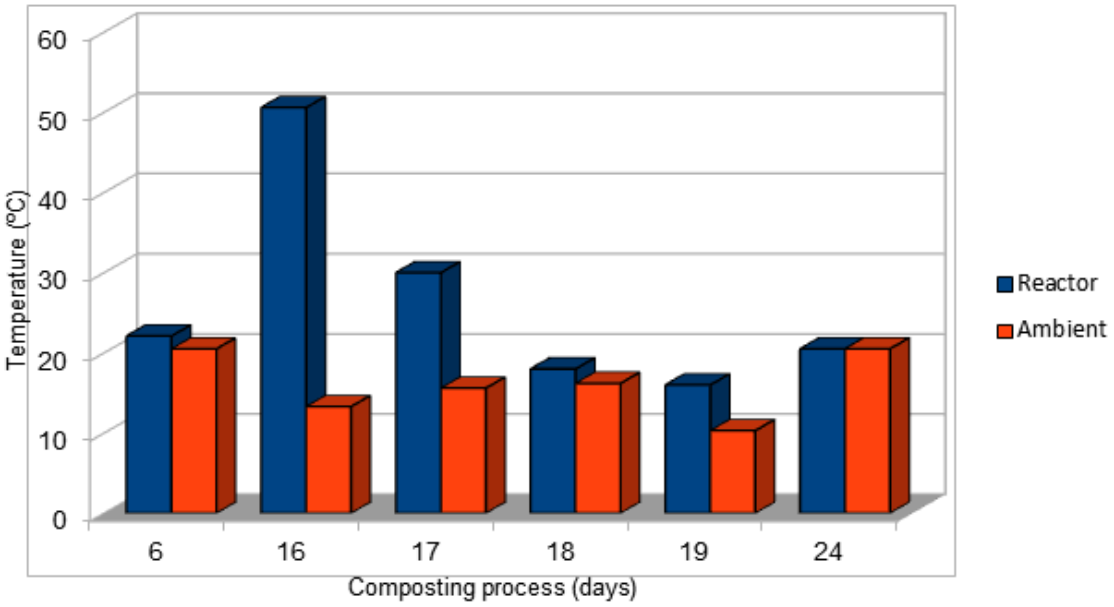

Figure 4. Temperature profile of a small-scale composting reactor.

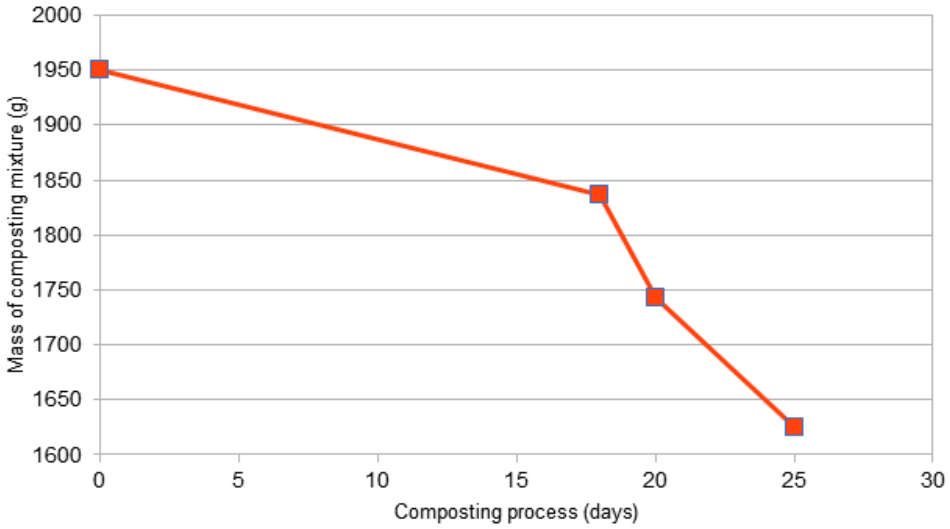

Figure 5. Mass evolution of a small-scale composting reactor during the process.

CONCLUSIONS

- The small-scale composting reactors can be used for the bio-waste treatment.

- The biological process of composting was noted with an increase of temperature (50ºC) and a significant reduction of mass (17%) and volume (50%) of the bio-waste mixture occurred.

Acknowledgements

This experiment was included in ¡Apuesto por el compost!, an educational scientific project for primary students supported by Fundación Descubre and co-financed by Fundación Española para la Ciencia y la Tecnología (FECyT) and Consejería de Economía y Conocimiento from Junta de Andalucía. More information of ¡Apuesto por el compost! project can be found in:

- Blog of the project:

https://andaluciamejorconciencia.fundaciondescubre.es/apuesto-por-el-compost-dilar-cig/es/

- Book: Buenas prácticas educativas en las iniciativas ANDALUCÍA,mejor con ciencia. 2017. Edita: Descubre, Fundación Andaluza para la Divulgación de la Innovación y el Conocimiento. ISBN: 978-84-09-01205-3.
- Project video: Cómo hacer compost en mi colegio (https://youtu.be/tAKO80V6VDc).

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