MICROBIAL INOCULATION AND USE OF *EISSENIA FOETIDA* IN HOUSEHOLD ORGANIC WASTE COMPOSTING

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1 INTRODUCTION

1.1 Background

Organic household waste domestic composting is an alternative way to prevent the generation of municipal wastes. Aware of the importance of household waste domestic composting, "Servicios de la Comarca de Pamplona" has developed a program that encourages more than 1,000 families to compost kitchen and garden wastes on site. Different techniques to improve the composting process, like inoculations, should be tested with Kitchen-Garden wastes at domestic scale.

The effectiveness of microbial inoculation on the degradation of organic matter during composting process is showed in many studies. Raut (2007) conducted an investigation to determine the dynamics of microbial and enzymatic activities during composting of municipal solid waste. The application of microbial inoculums (*Phanerochaete chrysosporium* and *Trichoderma reese)* increased temperature during the process and improved the degradation of cellulose. Gonzales-Villa et al (2009) and Nakai *et al.* (2004) suggested that the microorganisms present in a commercial microbiological preparations, functioned efficiently as an accelerator for the decomposition of organic wastes. A research of Vargas-García *et al.* (2007) concluded that the utility of inoculation in composting depends on the conditions under which the process is carried out, particularly the interaction between the characteristics of raw materials and the inoculants.

The positive effect of the presence of earthworms and their influence on the establishment of a microbial biota effective on the degradation of organic matter has been demonstrated in numerous studies (Singh and Sharma 2002; Domínguez, 2004; Vivas *et al.*, 2009).

1.2 Research objectives

The aim of this study is to test the inoculation of a microbial prepared called MM (Mountain Microorganism) and of worms *'Eissenia Fetida'* in domestic compost bins.

2 MATERIALS AND METHODS

2.1 Experiment design

A random experiment with four treatments and four blocks was performed. Under outdoors conditions 16 plastic composts bins (320 L capacity each) were fed with organic matter obtained from a local street market. Each bin received 300 kg of wastes at four different moments 0, 7, 39 and 52 days after the beginning of the experiment. Treatments tested were: Control without turning (C), Control with Turning (CT), inoculated Mountain Microorganism with turning (MM) and Worms without turning (W). In addition to this, on the 52nd day 36 Kg of pine bark were added to each compost bin. CT and MM treatments were hand turned once a week. On the 91st day (May 2009) the experiment was finished. Compost was sifted (20 mm) and samples were submitted to a range of chemical, physical and biological analysis.

The first day each MM compost bin received 9 kg of a microbial preparation. This preparation was obtained through the multiplication, during one month, under anaerobic conditions of microorganisms collected in the forests. For this preparation 40 Kg of oak forest mulch collected in Ultzama Valley (Navarra, Spain), were added to a substrate for the activation of microorganisms. Substrate was made with 40 Kg of wheat bran, 12 Kg of ground charcoal, 10 Kg of sawdust, 4 kg of sugar, and water until reaching 30% of humidity.

The same day each W compost bin received 5 kg of substrate composed by 40% (weight) of earthworm (*Eisenia foetida)* and 60% of sheep manure.

2.2 Sampling and analysis

Fresh and dry (75ºC during 72 hours) weights of all the wastes added to each compost bin and of the resulting composts were measured. In each compost bin temperature and volume changes (height) were measured every week. The physical-chemical analysis carried out on resulting composts were: pH, EC, volatile matter, organic C, N Kjeldahal, C/N ratio, levels of P, K, Ca, Mg, Fe, Al, Mn, Cd, Cu, Cr, Ni and Pb.

The stability of composts was determined with two methods: the first one was with Solvita® test kit. This test classifies the compost in 3 classes of activity according to the measured values of CO_2 and NH_3 produced. The second method was self-heating test (Brinton *et al.* 1992). Beside this, a single sample for each treatment was analyzed to detect Escherichia coli.

Additionally the microbial profiles of use of carbon sources consumption were determined by mean of Biolog Eco Plats TM kit. This method is based on the number of phenotypes present in a microbial community. The test determines the level of microbial activity by measuring the oxidation of NADH in the presence of different substrates, and analyzing the color variation of tetrazol by spectrophotometry (Modini *et al.* 2004).

Obtained data were analyzed with one-way ANOVA ($P<0.05$). Statistic treatment was performed using software Statixtic 8.0.

3 RESULTS AND DISCUSSION

Composting process was developed appropriately in all the treatments. However temperatures were generally lower than 40ºC (Fig.1). These temperatures are much lower than those indicated in literature (Tuomela *et al.* 2000). However this is usual in domestic composting specially in winter cycles. Temperatures of MM treatment showed a rise in temperature higher than the other treatments, especially in the first 10 days. It would be reasonable to assume that the effect of inoculum MM could not only have been developed by the contribution of new saprophytic organisms, but also by some residual energy supply in the substrate used in the production of inoculum. No statistically significant differences were observed between W and CT or between C and CT treatments. Turning did not produce a significant temperature change. Slightly differences in enzymatic activity were only recorded in MM treatment.

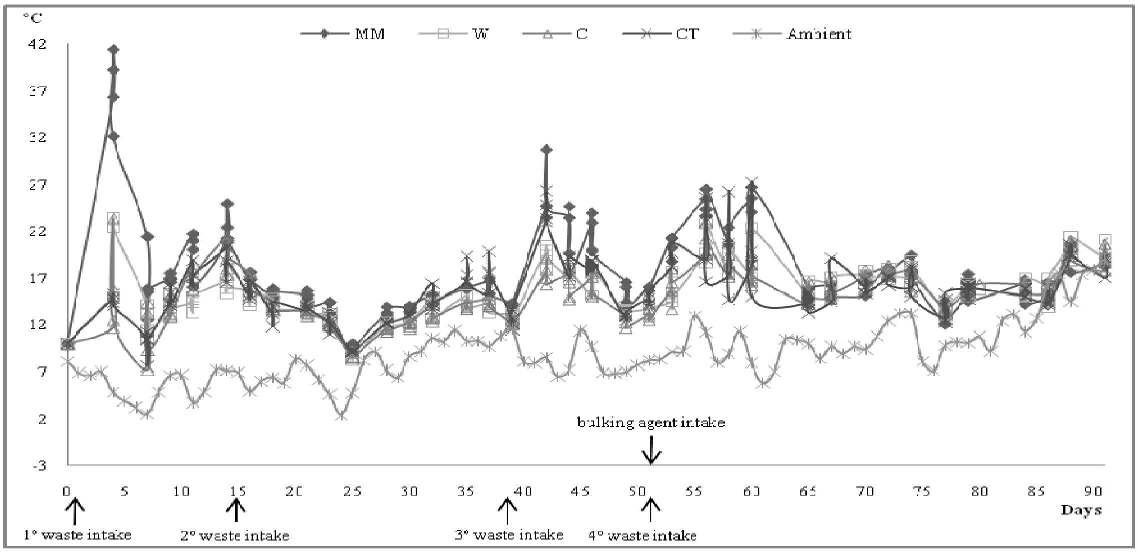

FIGURE 1 **Temperature variation during composting**

Volume reduction during composting process was significantly higher in CT and MM treatments (Table 1). Mass balance shows that 80% of the original mass vanished during the process and there were not found significant differences between treatments.

TABLE 1 **Volume reduction (treatments followed by different letters were significally different *p<0.05*)**

	C	CT	MM	W
initial height/final height	0.32 ± 0.03 (ab)	0.28 ± 0.01(d)	0.3 ± 0.01(c)	0.34 ± 0.05 (a)

Resulted compost had a homogeneous appearance, was brown in color and fungi in odor. Nevertheless Solvita® test showed still a high activity. Control treatment presented a 3 solvita value, while the most matured treatment was W with 5 solvita value. However self-heating test indicated that compost was matured (Rotting degree V) and there were no differences between treatments. High variability of experimental conditions, the difficulty of achieving high temperatures, the abundance of factors influencing the process of small-scale composting have made difficult to reach consensus on an specific method to evaluate the stability of compost (Benito et al., 2003).

There were no significant differences in dry matter content between treatments (Table 2). Also significant differences were found between MM and CT for the parameters EC, C/N ratio and N Kjeldahl. pH in W treatment was the highest while the lowest was in MM treatment. Probably this low pH in MM treatment prevented ammonia losses, resulting in a richer N content and in a lower C / N ratio. All treatments showed similar amounts of nutrients (K, P, Mg, Ca, Fe, Na). In all sample heavy metals were very low. The highest value of each metal were: Al 2% DM, Zn 78 ppm, Cu 75 ppm , Ni 32 ppm, Cr 133 ppm, Pb < 10 ppm, Cd < 3 ppm. Resulted composts seemed adequate to be employed as organic fertilizer.

Spanish limit value of 1,000 coli form NMP/g DM was surpassed in no turned treatments (W and C). It should be noted that the inoculum of worms was composed in part of sheep manure and temperatures did not reach sufficient higher to sanitation

TABLE 2 **Characteristic of compost of each treatment**

	C	CT	MM	W
pH	8.33	8.17	8.10	8.67
EC (µS/cm)	4,483	4,383	5,743	5,093
Dry Matter (% total weight)	85	89	83	78
Volatile Matter (% dry matter)	20	19	24	25
Organic C (C/dry matter)	10.1	9.4	11.9	12.6
N Kjeldahl (%N/dry matter)	1.2	1.1	2.1	1.5
C/N	8.4	8.9	5.7	8.7

4 CONCLUSIONS

The 320L composting bins have proved to be a useful devise for the reduction of organic domestic waste on site. A decrease between 85% and 90% in the fresh weight of the organic waste was found in the first thirteen weeks after starting the composting process.

The inoculation of MM could be very useful to improve the composting process, especially considering the statistical differences found in the initial temperature and enzymatic activity. This investigation does not provide enough grounds for a precise recommendation about worm inoculation in domestic compost bins.

The quality level of the compost is acceptable, with very low heavy metal content. The turning process helps to keep the product hygienic especially after the inoculation with MM microbial.

In conclusion, the use of 320L compost devices for the organic kitchen–garden waste management is strongly advisable.

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