# EVOLUTION OF CHEMICAL AND PHYSICOCHEMICAL PROPERTIES OF MSW COMPOST DURING THREE LONG-TERM MATURING TREATMENTS

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## ABSTRACT

Whereas the changes of analytical properties of municipal wastes during their composting are well-known, those occurring during the maturing stages have not been extensively studied. In a middle-scale (300 kg) experiment, we have measured the evolution of different chemical and physicochemical properties of MSW compost (pH, electrical conductivity, total, water-soluble, humified and humic carbon, $E_4/E_6$ ratio of humic acids, and organic nitrogen) during one year of three different treatments: maturing (product kept at optimal moisture and aireation levels), stocking (product compressed and uncontrolled, simultaing the usual handling at composting plants) and vermistabilizing (compost digested by *Eisenia foetida*). The results showed a larger degradation of organic matter during maturing and vermistabilization, increasing density and nutrient concentration of the compost, together with the stabilization of pH and salinity levels. Only small differences were found as for humic substances concentration and $E_4/E_6$ ratio.

***Keywords:*** *compost, stability, humic acids, maturing.*

## INTRODUCTION

Although usually neglected in modern composting systems, maturing remains a key stage in compost production, most particularly when it is aimed for agricultural use. However, the increasingly large amounts of organic residues to be treated daily, and a bussiness model based in treatment fees rather than earnings from the elaborated product, have led to very short processing times and clearly immature composts. Sometimes these are immediately sold and applied, with uncertain results, but in most cases the stocking period is supposed to complete the treatment. Since the duration of this period is changing, and the conditions are typically uncontrolled, the final quality of the products is unpredictable.

The objective of our work is twofold: (1) to evaluate stocking as a procedure to ensure stability of municipal solid wastes (MSW) composts and (2) to compare changes in compost analytical properties during three different alternatives of maturing treatment: uncontrolled stocking, controlled maturation, and vermistabilization (digestion by *Eisenia foetida*). The obtained results may prove useful to show the potential of these three techniques to improve the stability and agronomical quality of the composts.

## MATERIAL AND METHODS

Three 600-l plastic recipients were filled with about 300 kg of freshly-produced MSW compost from a commercial plant at Guadassuar (Valencia) to evaluate, during one year, three different treatments:

- Uncontrolled stocking. The compost was compressed in the box and left to degrade without any turning or water addition (other than rainfall), simulating the usual stocking conditions at the plant.

- Controlled maturation. The compost was aerated by turnings on a monthly basis, and its moisture content was kept between 40-50% at all times by means of irrigation.
- Vermistabilization. The compost was inoculated with 4000 adult individuals of California red worms (*Eisenia foetida*), keeping its moisture content between 60-70%. The material was turned once after six months due to excessive compactation.

Samples from the three treatments (six subsamples per box) were taken every month, cleaned, dried at 60ºC, ground and sieved through a 2-mm mesh, previously to their analysis. For all determinations, the Official Methods of the Spanish Ministry of Agriculture (MAPA, 1986) were used, save the humic acids $E_4/E_6$ ratio, which was measured according to Chen et al. (1977).

## RESULTS AND DISCUSSION

The setting-up of the experiment was followed by a steep increase of temperature in the composts, demonstrating the clear unstability of the product. Values higher than 65ºC were measured, killing about 1500 worms of the initial 2000 individuals inoculation, and mesophilic temperatures were not recovered after the third turning of the maturing treatment. After the initial rise, lack of aeration and excessive moisture reduced temperatures in the stocking and vermistabilization treatments, respectively. At the end of the trial, the temperature of the stocked compost rised again up to 55ºC three days after being remoistened, showing that this product was not totally stable after one year of treatment, contrarily to the matured and vermistabilized ones.

All treatments gave rise to losses of dry matter, larger in vermistabilization (52.4%) and maturing (47.6%) than stocking (35.9%). The initial bulk density of the compost (443 g/l) was increased after vermistabilization (674 g/l) and maturing (654 g/l), but reduced after stocking (414 g/l).

The evolution of selected chemical properties of the compost during the three different treatments are displayed in Figure 1. Data variability was usually higher in samples from stocking and vermistabilization, given that no turnings were involved in the treatments and the much larger particle size of the stocked material.

Even though the starting product was slightly acid, pH increased rapidly to alkalyne values (8.2-8.7). Salinity (measured as electrical conductivity of 1:5 water extracts) decreased after the first sampling in all cases, and kept on decreasing during vermistabilization due to some drainage of the irrigation needed to maintain mosture level in the high values California red worms require to thrive. The final salinity of the vermistabilized compost was therefore much lower than that of the stocked and matured products, which in turn were lower than the initial level, probably because of salt precipitation, since no drainage occurred in these treatments.

A clear decrease of organic matter was observed in the first months of the three treatments, when the amounts of easily-degradable substances were larger, vermistabilization giving rise to the largest and fastest losses. This period corresponded to that of high temperatures generation. No relevant losses were found after this period even where good conditions for degradation were ensured, as in the controlled maturing process, suggesting the exhaustion of the most degradable matter and the close end of the active composting phase. More precise information could be extracted, nonetheless, from the content of water-soluble carbon of the samples, an indicator of the amounts of easily-degradable substances remaining in or being generated from the organic materials. From initial values higher than those reported by García et al. (1987) and Canet and Pomares (1995), there was a very steep decrease during the three initial months, indicating exhaustion of this pool of organic matter or low biological activity. In the case of stocked compost, rain-remoistenings of the compost gave rise to clear increases of this parameter, which sho-

wed a final value much higher than those in matured and vermistabilized products. This, together with the rapid heating of the material after the final remoistening cited above, showed that stocking was unable to ensure the stability of the compost even after one year of treatment.

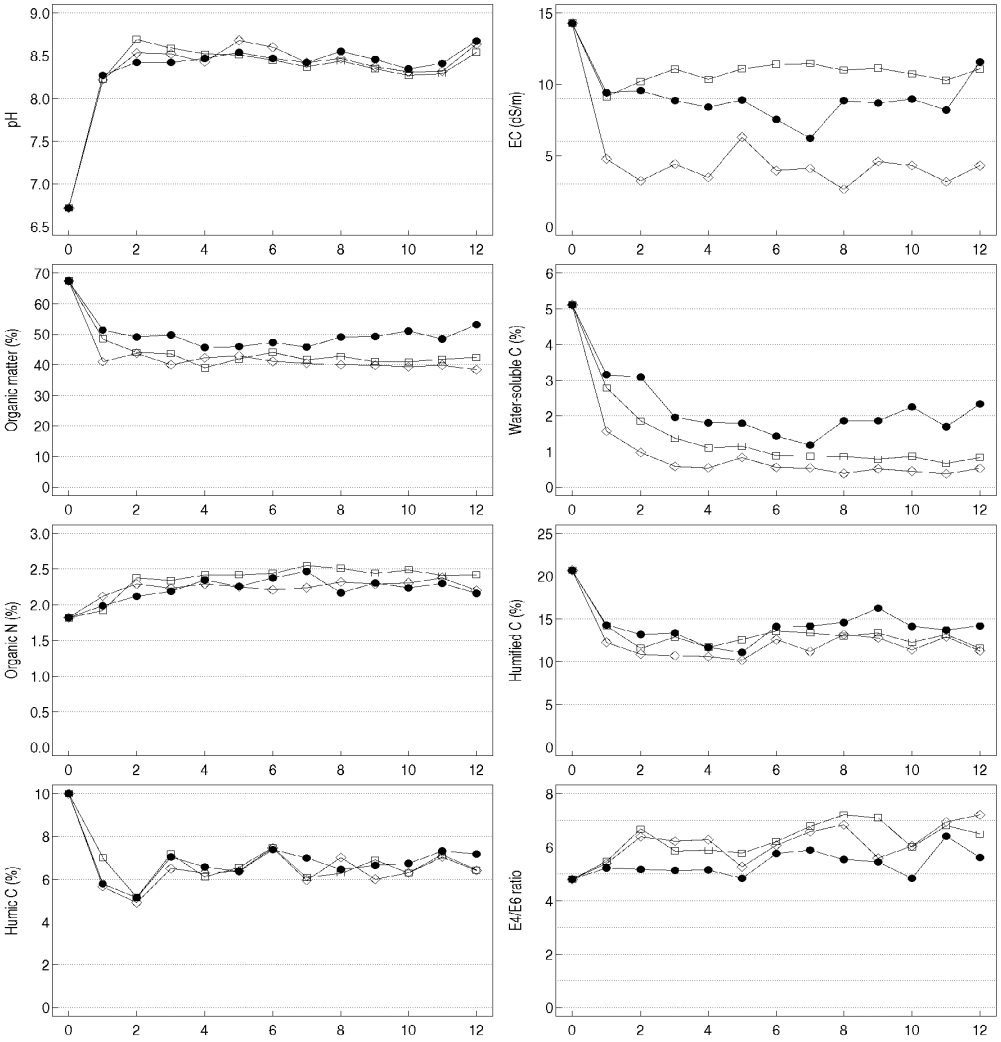


***Figure 1***. *Evolution of chemical parameters during the three maturing treatments. stocking, maturing, and vermistabilization treatments are indicated by circles, squares and triangles, respectively. X-axis indicates time in months. pH measured in 1:25 water extract. EC: electrical conductivity 1:5 water extract*

Nitrogen content of the three composts rised from 1.7% to about 2.3% given the loss of carbon in the degradation, thus increasing their fertilizing value. This concentration process was logically more evident in the first months of active decomposition. In this initial stage, all the treatments also gave rise to decreases in the contents of total humified matter (extracted by 0.1M

sodium pyrophosphate+0.1 sodium hydroxide) and humic acids in the three organic products. Data variability was however too high to show a clear pattern of evolution after this initial decreases. The $E_4/E_6$ ratio, indicator of size and polimerization degree of the humic acids (Chen et al., 1977), clearly increased during the three treatments, even through the initial degradation stage, vermicomposting and maturing giving the highest values. Data variability was again too high to relate any evolution pattern to the rest of results obtained.

## CONCLUSIONS

The very active degradation observed during the first months of the experiment showed the poor stability of the initial compost. Uncontrolled stocking during one year partially improved the characteristics of the final product, but was unable to ensure its stability after such a long time. On the contrary, controlled maturing and vermistabilization gave rise to stable products in about 2-3 months. Higher bulk density and nutrient contents, together with much better granulometry and aspect undoubtely increase their agronomic value, thus justifying a more carefully controlled maturation of the final products elaborated in the fast-composting plants of today.

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