Stability and maturity indexes of compost

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Abstract

The knowledge of stability and maturity degree of compost is of great importance for compost producers and its consumers. The compost stability is associated with the microbial activity, while its maturity is related to the absence of phytotoxic substances for the growth of plants. As a means of evaluating the stability degree of compost, many methods have been proposed, both chemical (pH, relation C/N, etc) and physical (temperature, moisture, etc). However, enzymatic and respiration tests appear to be the most appropriate. Maturity is determined basically by biotests with plants (phytotoxicity tests), in which the germinating power of seeds in a water extract of compost is determined.

The aim of this study consisted basically on the development of methods which allowed to carry out measures with microbial activity and the realisation of germination bioexperiments.

1 Introduction

Only an adequate process of composting and organic waste maturity can guarantee its employment in agriculture with no damaging effects on either soil and plants. For this reason, stability, maturity and quality of a compost are essential facts to be taken into account by producers of compost and its consumers (1)
The degree of compost stability is associated to the microbial activity and the emission of bad smells. At the same time, maturity is associated to the absence of phytotoxic substances for the growing of plants (2).

In order to assess the degree of compost stability many authors have proposed chemical methods (pH, relationship C/N, etc) and physical methods (temperature, moisture, etc.). However, respirometric tests have proved to be the most appropriate (3). Maturity would be determined basically by a series of tests on plants (biogermination test), in which germinating power of seeds in watery extracts of compost is determined (4). Juste describes also a test (ecophytotoxicity) (5), to determine potential toxic effects of samples of compost on the first stages of growing of plants.

This report aims at developing methods to determine the degree of stability and maturity of compost. These procedures have been applied to the monitoring of evolution of the process of compost of different urban waste (6): Pile 1, organic fraction of municipal solid waste (OFMSW); Pile 2, relationship in weight OFMSW/sewage sludge (2:1); Pile 3, relationship weight OFMSW/sewage sludge (1:2); Pile 4, sewage sludge.

2 Materials and experimental procedures

2.1 Microbial Respiration

The method employed in determining microbial respiration is based on the measure of C-CO₂ produced in a closed system as a result of the activity of compost microorganisms for a certain period of time (5 days) in controlled temperature conditions (28 °C). CO₂ produced is attracted by a dissolution of NaOH which is subsequently determined with HCl.

These respirometric tests have been employed by numerous authors and are recommended by several composting councils in the United States as indicators of stability/maturity of compost.

2.2 Biogermination Biological Test

This test consist on determining the germinating power of compost. It is carried out in Petri dish in adequate germinating conditions, employing seeds of Lepidium sativum L. for their rapid germination. Watery extracts of compost are placed on a filter-paper in Petri dish and incubated for six days at 28°C. Subsequently, germination percentage, average length of roots (Lm) and germination index are calculated:

\[ Ig = \left( \frac{\% \text{ germination}}{\text{Lm sample roots}} \right) \times \left( \frac{\text{Lm control roots}}{\text{Lm sample roots}} \right) \]
2.3 Toxicological Test

The selected seed was rye-grass, due to its rapid growing and ample use in bibliography for the assessment of plant response, which would allow a contrast of obtained results.

The experiments were carried out in a greenhouse, using pots of 500 g of capacity provided with lower drainage. Compost samples subjected to study were added to the soil in three doses of 5, 10 and 20 % in weight. Afterwards, 0.2 g of rye-grass seeds were planted in each pot repeating each treatment three times. Pots were placed randomly and were watered daily. Two cuts were taken two and four weeks after the beginning of the experiment. Growing was measured in terms of plant mass.

3 Results and Discussion

3.1 Microbial Respiration

Composting is an aerobic microbial process which combines mesophilic and termophilic stages in order to obtain the transformation of an organic waste into a stable and agronomic value product (compost). Degradation follows the next expression:

\[
\text{Organic Matter} + \text{Microorganisms} + O_2 \rightarrow \text{compost} + H_2O + CO_2 + \text{heat}
\]

Hence there exists a direct relationship between microbial activity and CO\textsubscript{2} production (respiration activity) generated in the fermentation process.

In figure 1, a temporary evolution of respiratory activity and its reduction can be appreciated. This tendency is due to deceleration of microbial metabolic reactions that take place when the amount of biodegradable materials decreases. From the fifth month of the experiment, all the piles appear to have produced a stabilization in values near to 0.5 mg CO\textsubscript{2}/g dry weight, and a similar value can be appreciated in mature sewage sludge compost. Those pile containing OFMSW in its composition (1, 2 and 3) show a slower Kinetics, due to the higher quantity of organic material form the start.
3.2 Biogermination Biological Test

If compost is not sufficiently stabilized, the formation of toxic substances is more frequent in the decomposition process. Those phytotoxic substances are produced by microorganisms what work during the composting process, when product is unstable. Germination index in watery extract has been used by several authors as a parameter to assess phytotoxicity in compost (6).
Results, after five months of composting, show no toxicity at all in any of the pile. On the other hand, germination index are higher to those found in the bibliography for urban waste compost, obtaining thus the best results for compost with higher proportion of sewage sludge.

3.3 Ecotoxicological Test

The object of this study is determining the potential toxic effects of samples of compost on the first stages of English rye-grass seeds growing, after four weeks exposition period and a single application. Inhibition of plant growing, expressed in terms of mass, was used as toxicity criterio.

As shown in figure 3, the addition of each type of compost produces a significant increase of performance, no negative effect on germination was found in any case. Differences found can be due, not to a phytotoxic effect, but to the presence in compost of compounds that favour plant growth.
Likewise, statistical analysis of results do not show a direct relationship between the percentage of compost employed and plant performance.

4 Conclusions

Calculation of respiratory activity of compost leads to values around 0.5 mg CO₂/g dry weight, which can determine an objective level of stability.

Ecotoxicological and biogermination test shows no inhibiting or toxical effect on the growing of shoots in the first stages of growing in all test.

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