

# METHODS AND PROCEDURES TO ASSESS COMPOST MATURITY AND STABILITY

Olli Venelampi, Minna Vikman, Anu Kapanen and Merja Itävaara

## Introduction

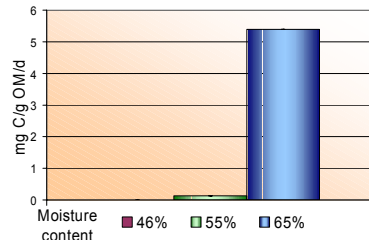
Compost maturity tests can be roughly classified into physical, chemical, plant, and microbial activity assays<sup>1</sup>. Due to the complicated nature of compost maturity, our approach was not to identify one test but instead a pattern of relatively simple test methods that can be used to verify the safe use of compost, i.e. its state of maturity<sup>2</sup>.

A stability test is needed to obtain information on the stage of compost processing. Chemical characterization gives important additional information that can be used in combination with the other data to estimate the aerobicity or degradation stage of the compost and is not affected by physical treatments such as drying or heating the compost. The toxicity arising from immature compost is considered to be phytotoxicity, and testing can be carried out using a plant growth or seed germination test.

## Testing strategy

Using only a single method to assess compost maturity may cause erroneous results. Respirometric methods are especially sensitive to the characteristics, e.g. moisture level or anaerobicity of the sample. Therefore we developed a procedure to assess the maturity of compost<sup>3</sup>.

The first step in the strategy is proper balancing of the moisture content of the samples. Chemical analyses give valuable information on sample properties and are useful when estimating compost maturity. To confirm that compost is suitable for use, its toxicity should be tested<sup>3,4</sup>.

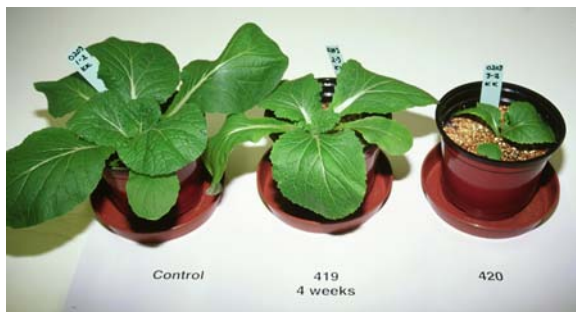


**Figure 1.** Effect of moisture balancing to carbon dioxide production. The sample consisted of biowaste composted 2 months in a windrow. Incubation period was 24 hours at 35°C.

## Methods and materials

Several respirometric methods were compared. In the ASTM O<sub>2</sub> consumption test the sample is mixed with an equal amount of stable compost and O<sub>2</sub> consumption is measured at 58 °C for 4 days. The Solvita test determines CO<sub>2</sub> evolution over a 4 hours period at room temperature. In the Rottegrad test temperature evolution in an insulated flask is detected during a 10-day period, while in the VTT CO<sub>2</sub>-test the evolution of CO<sub>2</sub> is detected in an airtight vessel after a 24-hour incubation at 37 °C or 25 °C, using gas-detection tubes or an IR analyzer.

NO<sub>3</sub>-N and NH<sub>4</sub>-N amounts were detected from an aqueous suspension consisting of one part compost and five parts water, using Merckoquant test strips (Merck KGaA, Germany). Toxicity was determined using the OECD plant growth test and flash luminescent bacteria test<sup>4-6</sup>. A total of 18 compost samples from several composting processes and different waste materials were examined to establish a correlation between the chosen methods.



**Figure 2.** The growth of Chinese Cabbage (*Brassica pekinensis*) in 4 weeks. Samples were peat (control), output from drum plant (419) and biowaste from nonaerated pile after 2 months composting (420).



**Figure 3.** VTT CO<sub>2</sub> test and ASTM O<sub>2</sub> consumption test.

## Results

The effect of moisture content is demonstrated in Figure 1. Microbiological stability was analyzed from the balanced sample. In general, a low level of microbial activity is an indication of well-degraded mature compost, but it may also be due to the inhibition of microbial activity. Reasons for reduced activity may include toxicity, low pH, drought, or anaerobicity.

The correlation between most methods tested was good (Table 1). Any of these methods is suitable for assessing the state of stability or maturity. However, these methods have different features, and the properties of the method used, whichever chosen, should be well understood. Determining the NO<sub>3</sub>-N/ NH<sub>4</sub>-N -ratio is a rough method, but it is easy to perform and is a good complement to respirometric tests. In our experience, the appearance of nitrate is a good indication of the state of maturation, and when the amount of NO<sub>3</sub>-N exceeds that of NH<sub>4</sub>-N the compost is well matured.

The flash luminescent bacteria test is especially useful when a large number of samples need to be tested for toxicity. The plant growth test requires a long period of time (2- 4 weeks) to give results, but it is widely used because the final goal is to use compost in plant cultivation.

**Table 1.** Correlation coefficients of tested methods. Large values (near +/-1.0) means that data sets are associated with each other and values near 0 means that data sets are unrelated.

	ASTM O <sub>2</sub> test	CO <sub>2</sub> -test	Solvita	Rottegrad	NO <sub>3</sub> -N/NH <sub>4</sub> -N	Flash	Plant test, Cress	Plant test, Chinese Cabbage
ASTM O <sub>2</sub> test	1,00							
CO <sub>2</sub> -test	0,98	1,00						
Solvita	-0,71	-0,67	1,00					
Rottegrad	0,97	0,94	-0,67	1,00				
NO <sub>3</sub> -N/NH <sub>4</sub> -N	-0,51	-0,39	0,65	-0,43	1,00			
Flash	0,73	0,86	-0,59	0,70	-0,30	1,00		
Plant test, Cress	-0,61	-0,76	0,52	-0,69	0,52	-0,67	1,00	
Plant test, Chinese Cabbage	-0,48	-0,73	0,13	-0,60	0,07	-0,63	0,69	1,00

## Conclusions

- A selection of different types of methods is needed to gain reliable assessment of compost maturity.
- Preparation of the samples greatly impacts on the response of stability analyses.
- To select suitable methods for analyses and enable to interpretation of the results, the characteristics of different methods must be known.

## References

1. Itävaara, M., Venelampi, O., Samsøe-Petersen, L., Lystad, H., Bjarnadóttir, H. and Öberg, L. 1998. Assessment of compost maturity and ecotoxicity, Nordtest, Espoo Finland, NT Techn Report 404. 84 pages. NT Project No. 1363-97.
2. Itävaara, M., Venelampi, O., Vikman, M. and Kapanen, A. 2002. Compost maturity - Problems associated with testing. Proceedings of Microbiology of Composting Innsbruck Austria 18.-21.10.2000, In Press.
3. Itävaara, M., Venelampi, O., Kapanen, A., Samsøe-Petersen, L., Lystad, H. and Jónsdóttir, H. 2001. Tests for compost maturity and ecotoxicity, 58 pages. Nordic Council of Ministers Project nr. 651044-90141.
4. Kapanen, A. and Itävaara, M. 2001. Ecotoxicity tests for compost applications. Ecotoxicol. Environ. Saf., Environ Res. Sect. B 49, 1-16.
5. Degli-Innocenti, F., Bellia, G., Tosin, M., Kapanen, A. and Itävaara, M. 2001. Detection of toxicity released by biodegradable plastics after composting in activated vermiculite. Polym. Degrad. Stab. 73, 101-106.
6. Lappalainen, J., Juvonen R., Vaajasari, K. and Karp M. 1999. A new flash method for measuring toxicity of solids and colored samples. *Chemosphere* 38 (5): 1069-1083.