Single composting as an essential part of waste management

Contractor: Technical University of Graz, Institute fot Waste Technology and Microbiology
Dr. Arnold Stuhlbacher

Customer: Styrian Provincial Government - Specialised Division 1c

Date of Publication: December 1994

1. Summary

On the premises of the companies of the City of Gleisdorf, seven composting systems for single and joint composting were studied as to their operational and functional stability, their hygienic aspects as well as the quality of the produced composts for 2 years.

The composting systems had a different concept and design and formed a representative selection of customary composting systems at the time of the start of the project. In the studied parameters, namely in decomposable organic matter, ignition loss, water content, ammonium, Kjedahl's nitrogen, nitrate, phosphate, heavy metals, conductivity and pH value, all the composts from all the systems met the requirements specified by ÖNORM S2022 (ÖNORM - Austrian Standard).

According to this, the studied systems produced composts that did not differ significantly, i. e. that open compost silos or composting in stacks will have the same compost quality as composting systems that are more expensive.

This means that the functionality of all the systems and thus the quality of the composts proved to be independent from the system. Nevertheless, it does depend on the intensity and quality of the operation by the user. This can only partly be compensated by "technical equipment" as it is available in the different systems or cannot be compensated at all.

Furthermore, the results of the study, which also included standardised plant compatibility studies, show that no negative phytotoxic impacts need to be expected to be caused by using any of the produced high-quality composts as substrates or fertiliser additives.

As far as specific germ reduction during intensive rotting is concerned, what is stated is that it is exclusively at a discontinuous feeding of the composters that sufficient temperature maxima, which had a germ killing effect, were measurable. This means that hygienisation that was sufficient to be relevant in terms of epidemic related hygiene could only be found at a static rotting management. Positive salmonella results in the composts are due to the fact that the material won't always be homogenised sufficiently despite the transplantation of the rotting material so that boundary layers are not subjected to the high temperatures.

In order to achieve sufficient hygienisation, it is recommended to feed composters in longer intervals and to blend the rotting material conscientiously.

It is true that the different designs had a certain influence on the reaction kinetics of microbial conversion. As, however, the rotting process implies a long-term conversion of the substrates, these differences will be fully compensated by long-term incubation. This is also reflected in the quality of the composts.

Closed compost silos, above all those whose water household is not controlled sufficiently, increasingly tend to lead to the colonisation with insects. For example, massive maggots and marginal dipterene developments were found in the closed plastic containers and steel lamellae. If the systems are used correctly, odour emissions are not perceptible or, if at all, only for a short time.

2. Starting Position

The collection and recycling of bio-waste in Styria is based upon the legal background of the "Steirische Müllwirtschaftskonzept" ("Styrian Waste Management Concept") from July 1989, the "Novelle zum Steiermärkischen Abfallwirtschaftskonzept" ("Amending Statute to the Styrian Waste Management Concept") or the "Verordnung über die getrennte Sammlung biogener Abfälle (BGBL. 68/1992)" ("Regulation on the Separate Collection of Biogenous Waste (BGBL. - Bundesgesetzblatt - Federal Law Gazette 68/1992)").

On the average, household waste contains an organic share of 30 to 40 per cent. This share, which used to be mainly put on landfills until the early 90's, can be significantly reduced by biotechnological techniques (composting) and the reaction product (matured compost) can help to close the cycle by its use in agriculture.

Both decentral and central variants of composting are considered as strategic measures allowing to achieve area-wide composting in Styria. In this context, facilities for single and joint composting form an essential part of waste management.

3. Procedure

The City of Gleisdorf provided premises on the terrain of the "Wirtschaftshof" for the execution of the study. The composting systems were relatively protected from the wind and were put on compact soil grown with thin grass.

The following six composting systems were compared: The fast composter of Otto Graf GesmbH (Ltd.), the fast composter of Ökofreund Co., the compost silo of Heckele Co., the solar composter of Normstahl Co., the compomate according to the System Dr. Schmidl as well as an open compost silo in wire grating. An open stack rotting system covered with pebbles served as a reference for the overall evaluation.

The composting systems were either fed once by admixing structural material or continuously twice a week by also admixing structural material. The rotting process was assessed in terms of microbiology, hygiene and soil biology

The samples were taken manually from a depth of appr. 20 cm in the middle of the composter as well as on the border, blended and screened acc. to DIN 4188. For the further processing of the samples, they were dried and ground.

The chemical parameters used were decomposable organic matter, ignition loss, water content, ammonium, Kjedahl's nitrogen, nitrate as well as the content of phosphate and heavy metals. The physical parameters studied were the humidity, the conductivity and the pH value as well as the temperature, atmospheric humidity and precipitation. The plant compatibility was checked by sowing cress seeds.

4. Goals

The present study was aimed at elaborating experimental values for small-scale composting systems with a cubature of up to 1m³ as they are offered in trade and commerce for single and joint composting facilities. The selection of these composting systems was based upon their differences in concept and design and was to give a representative survey of the offer available.

What should be prioritised was the creation of nutrient balances, studies for operational and functional stability, hygienic assessments as well as quality inspections of the produced matured composts.

5. Result / Benefits

The main advantages of decentralised and small composting units are the low investment and operating expenditure and the simultaneous significant reduction in the amount of waste at the site. Furthermore, the separating quality relating to the bio-waste fraction will, as experience has shown, be all the better the smaller the unit is. Decentralised composting allows the citizen to cooperate in the large tasks for mastering the problems with waste in a useful way.

Even the open systems are very stable and independent from the weather. After composters had been shifted to different sites, the measured values did not change. All the composts from all the systems met the requirements specified by ÖNORM S2022 (ÖNORM - Austrian Standard).

The results of the study in detail:

- Organic matter (decomposable organic matter, ignition loss): Determining decomposable organic matter in connection with the ignition loss can be used to estimate bacterial activity. In the final products of all the systems, no significant differences in the quantities of organic matter could be found. The demand area required for the quality criteria for waste compost was kept in all the cases.
- Dry substance and water content:
  Open composting systems tend to dry out in longer periods of beautiful weather, closed systems often have a high water content. Throughout the series of studies, none of the systems used achieved the required demand areas in all the cases. In the open systems, the demand areas were reached at a percentage of 53%; in the closed systems, the percentage only amounted to 30%.
- Nitrogen (ammonium, Kjehldahl, nitrate):
  At rotting, an ammonium content that is as low as possible and a correspondingly high nitrate content is striven for as a result of a sufficient nitrification potential. In static conditions, the nitrification performance was excellent for all the studied systems, being between 62.5 and 77%. At a continuous feeding, the nitrification performance was significantly lower while the ammonium concentrations still were below the demand values.
- Phosphate:
  The demand value of phosphates that can be eluted and are thus available to the plants acc. to ÖNORM S2022 (ÖNORM - Austrian Standard) were considerably exceeded in all the composts of all the systems.
- Heavy metals:
  The content of heavy metals of compost is not modifiable in view of the system but only depends on the quality of the input material.
- Conductivity and pH value:
  Conductivity is a measure for the content of water soluble salts. The measured values were between 2.31 mS/cm and 4.47 mS/cm and thus were quite high as compared to the values stated in literature. Nevertheless, they did not influence the germal capacity of sample planting.
- Biological results of the study:
  The mean germinating duration of garden cress on the studied composts was between two and four days in all the systems. Another fact that may be derived from the results of the study is that no negative phytotoxic impacts need to be expected to be caused by using any of the produced high-quality composts as substrates or fertiliser additives.
- Microbiological and hygienic assessment:
  At static tests, typical temperature profiles with temperatures above 65°C for at least one week were acquired in practically all the repetitions and in all the studied systems. This means that the temperatures that are principally necessary to extinguish infectious germs in the compost were achieved. The concentration of germs fed artificially (salmonellae, streptococci) was reduced by five powers of ten. The requirements for epidemic related hygiene specified by ÖNORM S2023 (ÖNORM - Austrian Standard) were thus met. What is important for an efficient germ reducing effect in addition to temperature is a good blending of the rotting material, i. e. successive feeding of boundary layers into the core area. At continuous rotting, the temperature maxima were in a range between 30°C and 40°C, in which no bactericidal effect needs to be expected. In this feeding method, the specific germ reduction rates were below the required reduction. This feeding modality also led to the increased presence of mould fungi. In order to achieve sufficient hygienisation, it is recommended to feed composters in longer intervals and to blend the rotting material conscientiously.
- Studies in terms of soil biology:
  The qualitative and quantitative studies of the mesofauna did not allow logical conclusions on the extent to which the different designs of the compost silos also influenced the development of the fauna or compost quality.