

Effect of Seeding during Thermophilic Composting of Sewage Sludge

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The effect of seeding on the thermophilic composting of sewage sludge was examined by measuring the changes in CO₂ evolution rates and microbial numbers. Although the succession of thermophilic bacteria and thermophilic actinomycetes clearly reflected the effect of seeding, no clear difference was observed in the overall rate of composting or quality of the composted product.

Inoculation or seeding has been reported to be effective in some composting procedures (2, 3, 6). On the other hand, some negative results have also been reported for inoculation (2, 4, 5). The subject is still contentious. In a previous paper (7), changes in microbial numbers and patterns of CO₂ evolution rates were observed during the thermophilic composting of sewage sludge at different seeding ratios. As a result, there were different patterns of time courses of CO₂ evolution rates and of the succession of microorganisms for every seeding ratio (see Fig. 2 through 4 in reference 7). However, the chemical and physical properties of the starting materials for composting were not the same for each run. In this work, to gain a clearer understanding of the effect of seeding, we prepared the starting materials for composting by mixing gamma-irradiated compost product or nonirradiated compost product as the seed with the raw sludge but at different ratios to retain similar physical and chemical properties.

The composting reactor (300 mm in diameter, 400 mm in depth), composting materials, seed, composting procedures, and analytical methods were the same as those used in the previous paper (7). A part of the seed was sterilized by gamma irradiation with ⁶⁰Co for 3 h at a dose of 1 Mrad/h. The raw sludge, seed, and sterilized seed were mixed at different ratios in three experimental runs (Table 1). The initial weight of the composting materials was the same for the three runs. Gel chromatographic fractionation of the water extracts of raw sludge or compost products was carried out with Sephadex G-15 by monitoring the absorbance at 280 nm (1). The ratio of the total carbon content to the total nitrogen content in solid compost was obtained by elemental analysis of the dry compost sample.

Changes in CO₂ evolution rates, conversion of the volatile matter (VM) in raw sludge, moisture content, temperature, and microbial numbers during the composting operations are shown in Fig. 1 for run 2-A and run 2-C. At the early stage, at 60°C, there was a large peak in the rate of CO₂ evolution, which was defined as the moles of CO₂ evolved per hour per dry solid of compost. This was followed by a smaller peak. The effect of seeding on microbial numbers was characteristically shown, especially with regard to the numbers of thermophilic bacteria and thermophilic actinomycetes. In run 2-A, in which there was no seed, initial concentrations of thermophilic bacteria and actinomycetes were considerably low. The number of thermophilic bacteria increased rapidly

with an increase in temperature and then leveled off when the temperature reached 60°C. Although the growth of thermophilic actinomycetes was not observed at the initial stage of composting, it increased after the number of thermophilic bacteria had leveled off. In run 2-C, in which the seed contained large numbers of both thermophilic bacteria and thermophilic actinomycetes, the numbers of both thermophiles increased only slightly during composting (Fig. 1). On the other hand, the change in the number of mesophilic bacteria was almost the same as that observed in run 2-A.

From the data on CO₂ evolution rates and numbers of microorganisms, the specific CO₂ evolution rates for thermophilic bacteria and thermophilic actinomycetes at a constant temperature of 60°C were estimated by the procedures used in the previous paper (7). The estimated specific activities of CO₂ evolution for each of the thermophiles and the tendency for similar changes were similar to those in the previous paper (7). CO₂ evolution at the early stage of composting was mostly attributed to the thermophilic bacteria, and that at the later stage was attributed to the thermophilic actinomycetes. The contribution by actinomycetes increased in proportion with the increase in the amount of seed.

Some data obtained in the experiments are summarized in Table 1. The time required for the temperature to rise from 30 to 60°C and the amount of time required to maintain 60°C showed no remarkable differences at different ratios. This result indicates that an increase in the amount of seed does not enhance the rate of attainment of the setting temperature. The total amounts of CO₂ evolved and the final conversion of the VM in raw sludge among the three runs were quite similar. There was no significant difference in the moisture content or in the ratios of carbon to nitrogen in the compost products. The gel chromatographic patterns of the water extracts of raw sludge or compost products are shown in Fig. 2, indicating that the quality of the composting materials was similar. However, further investigation is needed for judging whether these products are well matured and noninhibitory to the growth of plants (1).

From the results, it can be deduced that the rate of composting of sewage sludge is mainly controlled by the degradability of solid substrates and not by the kinds of microorganisms inhabiting the compost.

In conclusion, the seeding of compost products at the start of sewage sludge composting is unlikely to have any appreciable effects on the rate of composting or on the quality of the final product, although the degree of the contribution of

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TABLE 1. Ratios of composting materials and experimental results of three runs

Run	% Raw sludge (dry wt)	% Seed (dry wt)	% Sterile seed (dry wt)	% Moisture content		% Initial VM (dry wt)	% Final conversion of VM (dry wt)	Total amt (mol) of CO ₂ evolved	C/N ratio ^a		Time (h) required to reach 60°C from 30°C	Amt of time (h) required to maintain 60°C
				Initial	Final				Initial	Final		
2-A	80	0	20	57.1	41.5	62.2	31.7	10.4	9.9	11.8	10.3	56.0
2-B	80	8	12	58.3	39.6	63.5	27.9	10.2	9.7	11.6	9.2	57.9
2-C	80	20	0	57.4	37.9	63.0	26.8	10.7	9.7	11.0	9.0	55.4

^a C/N ratio, Ratio of the total carbon content in solid compost to the total nitrogen content in solid compost.

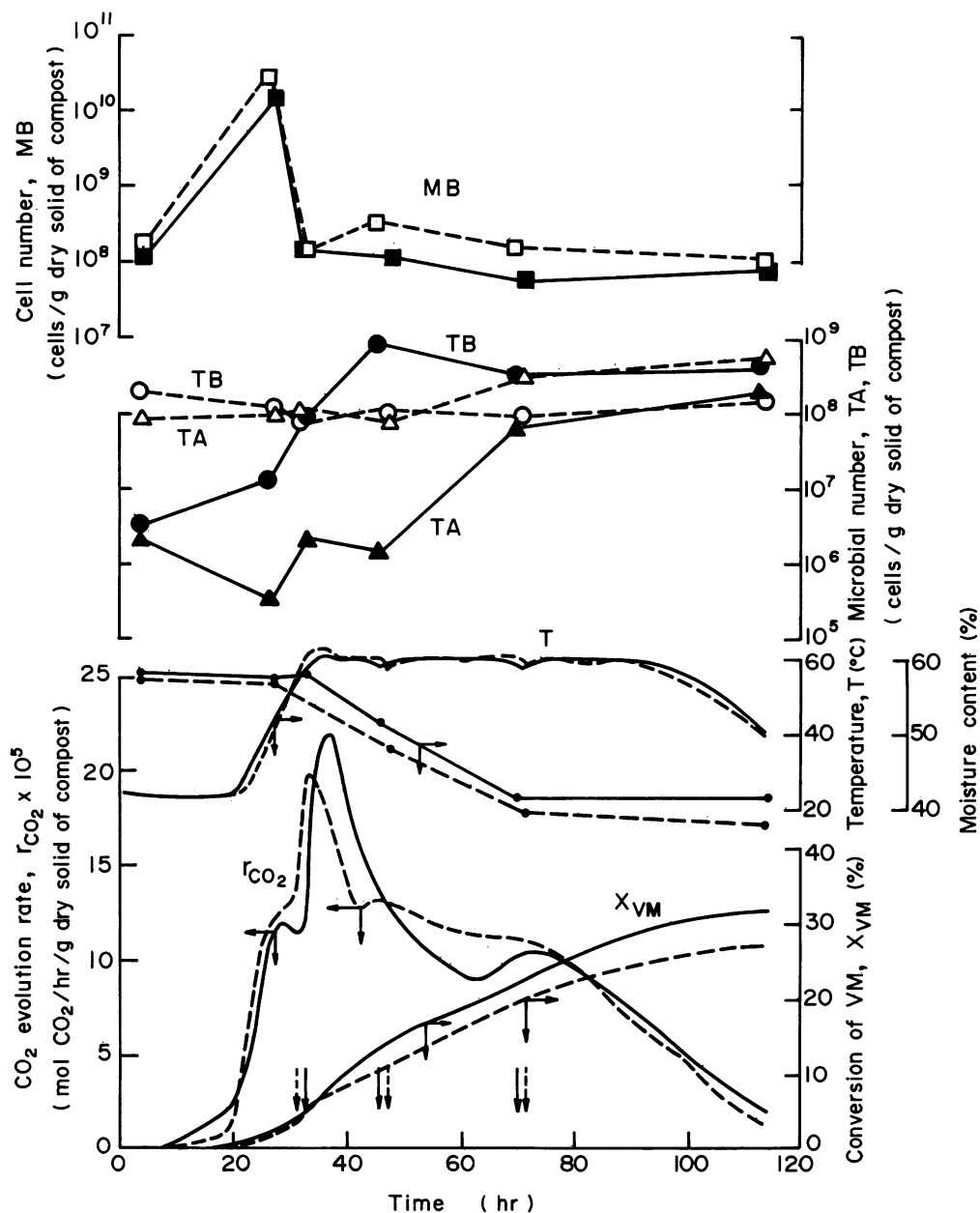


FIG. 1. Time courses of composting in run 2-A (solid lines), in which 20% sterile seed was added, and in run 2-C (broken lines), in which 20% seed was added. Shown are microbial numbers in run 2-A of mesophilic bacteria (MB) (■), thermophilic bacteria (TB) (●), and thermophilic actinomycetes (TA) (▲) and in run 2-C of mesophilic bacteria (MB) (□), thermophilic bacteria (TB) (○), and thermophilic actinomycetes (TA) (△). T, Temperature; r_{CO_2} , CO₂ evolution rate; X_{VM} , conversion of VM. Arrows indicate the turning points of composting material.

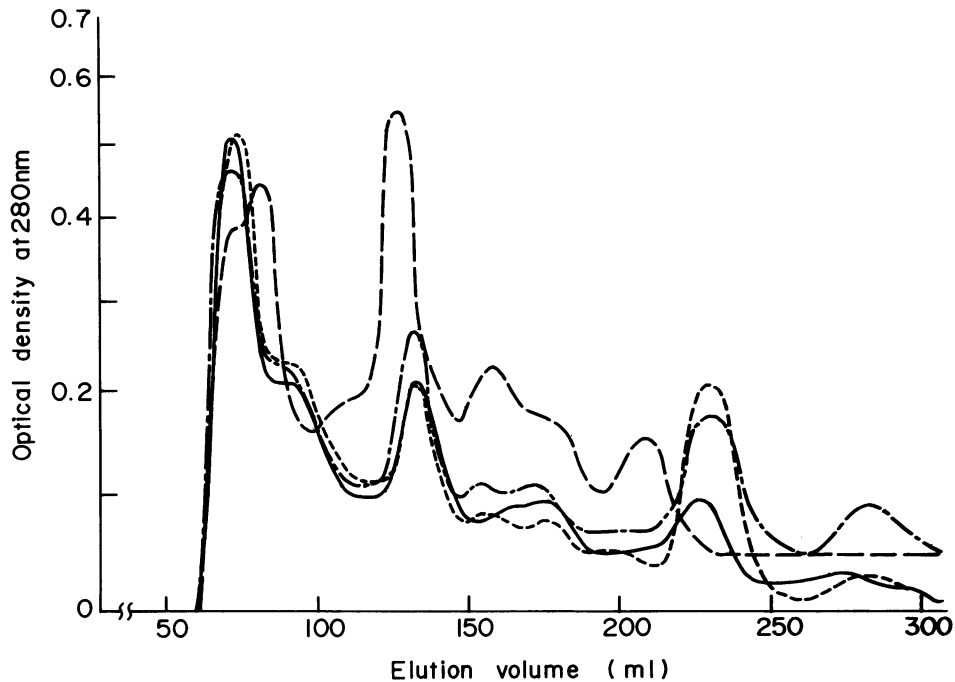


FIG. 2. Gel chromatograms of the water extracts of raw sludge or compost products in three runs on Sephadex G-15. Symbols: ---, raw sludge; —, product in run 2-A; ·····, product in run 2-B; - · - · - ·, product in run 2-C.

thermophilic bacteria and thermophilic actinomycetes to the CO_2 evolution rate depends heavily on the amount of seed added.

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