Information Sheet No. 5-9

Composting Science for Industry

The compost recipe, processing time and curing

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The compost recipe

Ideal compost recipes allow for rapid microbial breakdown of the organic fraction, whilst minimising impacts on the environment through the generation of odour, leachate and attraction of pests and vermin.

Minimising the time that feedstocks are retained on site means that the processing capacity of the site can be increased.

Well managed commercial composting operations that have good compost recipes can process significantly more material — into quality products — than those that are poorly managed and have poor compost recipes.

The formulation of good compost recipes, therefore, is essential so that a composting operation can maximise revenue generated from the sale of products in the market place.

Key factors that influence the composting recipe are (as discussed in previous Information Sheets):

- C:N ratio
- moisture content;
- particle size and porosity
- pH; and
- other nutrients such as phosphorus.

Processing time

The length of time it takes to convert raw materials into mature compost depends upon many factors, including:

- feedstocks used;
- temperature;
- moisture; and
- frequency of aeration.

To achieve the shortest possible composting period, sufficient moisture, an adequate *C:N ratio* and good aeration is required.

Recommended conditions for rapid composting are shown in Table 1.

Table 1. Recommended conditions for rapid composting (modified from Rynk *et al.,* 1992).

Condition	Reasonable range [a]	Preferred range
Carbon to nitrogen ratio (C:N)	20:1 – 40:1	25:1 – 35:1
Moisture content	40 – 65% [b]	50 – 60%
Oxygen concentrations	Greater than 5%	Greater than 12%
Particle size (diameter in mm)	3 – 13	Varies [b]
pH	5.5 – 9.0	6.5 – 8.0
Temperature (°C)	45 – 65	55 – 60

[a] These recommendations are for *rapid composting*. Conditions outside these ranges can also yield successful results.
[b] Depends on specific materials, pile size and/or weather conditions.

Table 2. Typical composting times for selected combinations of materials and methods (modified from Rynk *et al.,* 1992).

Method	Materials	Active composting time: Range (weeks)	Active composting time: Typical (weeks)	Curing (weeks)
Windrow – infrequent turning [a]	Garden organics Manure + amendments	26 – 52 12 – 32	36 24	16 4 – 8
Windrow – frequent turning [b]	Garden organics + manure	4 – 16	8	4 – 8
Passively aerated windrow	Manure + bedding or Food organics + garden organics	10 – 12 8 – 10	– –	4 – 8 4 – 8
Aerated static pile	Biosolids + woodchips	3 – 5	4	4 – 8
Rectangular agitated bay	Biosolids + garden organics or manure + sawdust	2 – 4	3	4 – 8
Rotating drums	Biosolids / food organics + garden organics	0.5 – 2	–	8 [c]
In-vessel (vertical configuration)	Biosolids / food organics + garden organics	1 – 2	–	8 [c]

[a] For example, with a front-end loader;
[b] For example, with a specialised windrow turner;
[c] Often involves a second composting phase (for example, windrows or aerated static piles).

Conditions which slow the process include a lack of moisture, a high C:N ratio, low temperatures, insufficient aeration, large particles and a high percentage of resistant materials (such as woody materials) (Rynk *et al.,* 1992).

For instance, if the compost is to be applied to cropland well before the growing season, it can be cured and finished in the field.

The duration of the composting process is somewhat governed by the type of composting used, and the level of *process control* the operator can exercise over the process.

A guide to typical composting times for selected combinations of methods and materials is given in Table 2.

Curing

Curing is a critical and often neglected stage of composting during which the compost matures (Plate 1).

Curing occurs at low, *mesophilic* temperatures (<45°C) for periods of up to 6 months, depending on the material composted. In this process, the rate of oxygen consumption, heat generation, and moisture evaporation are much lower than in the active composting phase (Rynk *et al.,* 1992).

Curing is normally performed in piles, preferably under cover and on an impermeable surface. Protection of the compost from rain is necessary for the material to slowly dry out, thereby allowing for easier handling.

During the curing phase, mesophilic microorganisms re-invade the

Definitions*

Carbon to Nitrogen (C:N) Ratio
The ratio of the weight of organic carbon (C) to that of total nitrogen (N) in an organic material.

Process Control
Stringent and documented monitoring of all critical control points in a composting operation so as to minimise defects and make products which can be guaranteed to customers.

Curing
Final stage of composting in which stabilisation of the compost continues but the rate of decomposition has slowed to a point where turning or forced aeration is no longer necessary. Curing generally occurs at lower, mesophilic temperatures. See stability.

Mesophilic
A temperature range of 20-45°C. Mesophilic microorganisms grow well at these temperatures and are also important for decomposition during the cool-down or maturation stage of composting. Most pathogenic microorganisms grow in this temperature range, and are thus destroyed under high temperature (thermophilic) conditions during composting.

Aerobic
In the presence of, or requiring oxygen.

Phytotoxic
Toxic to plants. Partially decomposed organic materials or immature composts are often phytotoxic, but this usually decreases with time. Such products may be phytotoxic due to a number of factors, including: low nutrient content; high oxygen consumption; presence of fatty acid or alcohol metabolites formed by microorganisms under anaerobic conditions; or due to excessive concentrations of salts, heavy metals and other organic compounds.

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compost, often enhancing its plant disease suppressive properties.

Curing also furthers the *aerobic* decomposition of resistant compounds, large particles and clumps of material that remain active after composting (Rynk *et al.,* 1992).

Importantly, *phytotoxic* organic acids formed during the composting process are broken down during curing as well.

Because curing continues the aerobic decomposition process, adequate aeration in necessary. If piles are to be naturally aerated (i.e. no active means of aeration), pile size needs to be relatively small (height ~1 m) and moisture must be within an acceptable range.

When available space is limiting, thus necessitating the use of large curing piles, or if the moisture content of the compost is high, *anaerobic* conditions can form, leading to a slowing of decomposition and the production of odour.

Larger piles of moist material can be cured in an *aerated static pile* with forced aeration. *Forced aeration* assists in moisture removal and maintenance of aerobic conditions.

Plate 1. Photograph of a curing pile of compost prepared from food and garden organics. The material shown had been composted in an in-vessel (vertical configuration) system for approximately three weeks. The material is heaped in a small curing pile for another six weeks before being used as a composted mulch.

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Anaerobic
In the absence of oxygen, or not requiring oxygen. Composting systems subject to anaerobic conditions often produce odorous compounds and other metabolites that are partly responsible for the temporary phytotoxic properties of compost. Anaerobic conditions are important for anaerobic digestion systems.

Aerated Static Pile
Forced aeration method of composting in which a free standing pile is aerated by a blower moving air through perforated pipes located beneath the pile.

Forced Aeration
Means of supplying air to a composting pile or vessel which relies on blowers to move air through the composting materials.

* Recycled Organics Unit, (2002).

Important references

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