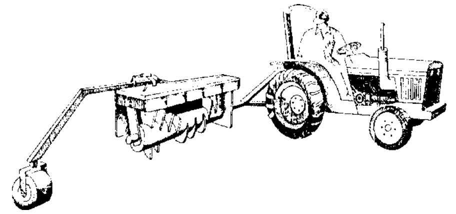
Utah State University
EXTENSION

AG-WM 01

The Composting Process



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Composting is the aerobic, or oxygen-requiring, decomposition of organic materials by microorganisms under controlled conditions. During composting, the microorganisms consume oxygen (O_2) while feeding on organic matter (Figure 1). Active composting generates considerable heat, and large quantities of carbon dioxide (CO_2) and water vapor are released into the air. The CO_2 and water losses can amount to half the weight of the initial materials, thereby reducing the volume and mass of the final product.

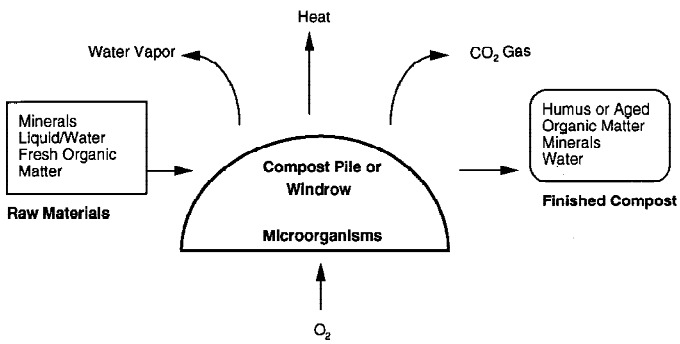

Figure 1. The Composting Process

What Happens During Composting

Composting may begin as soon as the raw materials are mixed together. During the initial stages of the process, oxygen and the easily degradable components of the raw materials are rapidly consumed by the microorganisms.

The temperature of the windrow or pile is directly related to the microorganism activity of the windrow and is a good indicator of what is going on inside. The temperature of the composting materials generally follows a pattern of rapid increase to 120-140°F where it is maintained for several weeks depending on the materials (Figure 2). As active composting slows, temperatures will gradually drop until the compost reaches ambient air temperatures.

A *curing* period usually follows the active composting period. During the curing period, the materials will continue to slowly decompose. Materials continue to break down until the last easily decomposed raw materials are consumed by the remaining microorganisms. At this point, the compost becomes relatively stable and easy to handle.

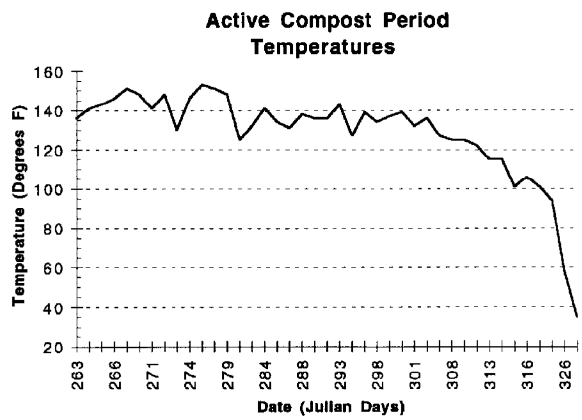

Figure 2. Compost Temperature

Factors Affecting the Composting Process

1. Oxygen and Aeration

Aerobic composting consumes large amounts of oxygen, particularly during the initial stages. If the supply of oxygen is limited, the composting process may turn anaerobic, which is a much slower and odorous process. A minimum oxygen concentration of 5% within the pore spaces of the compost is necessary for aerobic composting. Oxygen levels within the windrows or piles may be replenished by turning the materials over with a front-end loader, or by means of mechanical agitation with a special compost turner.

2. C:N Ratio

Carbon (C), nitrogen (N), phosphorous (P), and potassium (K) are the primary nutrients required by the microorganisms invol-ved in composting. Microorganisms use carbon for both energy and growth, while nitrogen is essential for protein production and reproduction. The ratio of carbon to nitrogen is referred to as the C:N ratio. An appropriate C:N ratio usually ensures that the other required nutrients are present in adequate amounts.

Raw materials blended to provide a C:N ratio of 25:1 to 30:1 are ideal for active composting, although initial C:N ratios from 20:1 up to 40:1 consistently give good composting results. For C:N ratios below 20:1, the available carbon is fully utilized without stabilizing all of the nitrogen which can lead to the production of excess ammonia and unpleasant odors. For C:N ratios above 40:1, not enough N is available for the growth of microorganisms and the composting process slows dramatically.

Table 1. Guidelines for composting parameters.

Condition	Reasonable Range*	Preferred Range
Carbon to nitrogen (C:N)ratio	20:1-40:1	25:1-30:1
Moisture content	40-65%**	50-60%
Oxygen concentrations	Greater than 5%	Much greater than 5%
Particle size (diameter in inches)	1/8-1/2	Varies**
pH	5.5-9.0	6.5-8.0
Temperature (°F)	110-150	130-140

Source: On-Farm Composting Handbook, Northeast Regional Agricultural Engineering Service (NRAES-54)
*The recommendations are for rapid composting. Conditions outside of these ranges can also yield successful results.
**Depends on the specific materials, pile size, and/or weather conditions.

3. Moisture

Moisture is necessary to support the metabolic processes of the microbes. Composting materials should be maintained within a range of 40% to 65% moisture. Experience has shown that the composting process becomes inhibited when the moisture content is below 40%. Water displaces much of the air in the pore spaces of the composting materials when the moisture content is above 65%. This limits air movement and leads to anaerobic conditions. Moisture content generally decreases as composting proceeds; therefore, you may need to add additional water to the compost. As a rule of thumb, the materials are too wet if water can be squeezed out of a handful and too dry if the handful does not feel moist to the touch.

4. Particle Size

The rate of aerobic decomposition increases with smaller particle size. Smaller particles, however, may reduce the effectiveness of oxygen movement within the pile or windrow. Optimum composting conditions are usually obtained with particle sizes ranging from 1/8 to 2 inches average diameter.

5. Temperature

Composting will essentially take place within two temperature ranges known as mesophilic (50-105°F) and thermophilic (over 105°F). Although mesophilic temperatures allow effective composting, experts suggest maintaining temperatures between 110° and 150°. The thermophilic temperatures are desirable because they destroy more pathogens, weed seeds and fly larvae in the composting materials.

If the temperature of your compost pile is in the mesophilic range, try mixing the pile. If the temperature still does not reach the thermophilic range, review the factors described above to determine whether one or more of the factors is limiting the composting process. If you are still unable to increase the compost's temperature, the active stage of composting may be complete.

6. Time

The length of time required to transform raw materials into compost depends upon the factors listed above. In general, the entire decomposition and stabilization of materials may be accomplished within a few weeks under favorable conditions; but, research at Utah State University has shown that 10-14 weeks of active composting for dairy cattle waste is more common. Active composting will change depending upon the amount of natural moisture or water added to the compost, turning frequency, materials being composted, and temperatures reached.

Curing

When windrows or piles no longer reheat after turning, the curing stage begins. The curing stage of compost usually lasts 3 to 4 weeks. Curing is a very important and often neglected part of the composting process. Curing occurs at mesophilic temperatures. The importance of curing increases if the active composting stage is either shortened or poorly managed. Immature compost can contain high levels of organic acid, a high C:N ratio, and other characteristics which can be damaging to crops and plants.

Compost as a soil amendment vs. fertilizer

Most plant nutrients in compost are in an organic form. Although compost is not high in nitrogen, phosphorous, or potassium, (it contains approximately 2% of each) these nutrients are released slowly over a long period of time. Nutrients become available to plant roots at a slower rate with compost compared to inorganic fertilizers, therefore the nutrients are less likely to leach out of the soil. Only a fraction of the nitrogen, phosphorus, and potassium applied as compost is usable by the crop the first year with more becoming available in the years that follow.

The real benefit of adding compost to the soil lies in its ability to increase soil organic matter levels. Research studies at the Connecticut Agricultural Experiment Station[a] have shown that a 1 inch thick layer of leaf compost annually applied and incorporated into the soil over a 12 year period increased the organic matter content from 5.9% to 12.6%. The same studies have shown that the water holding capacity of the soil was increased from 1.3 inches to 1.9 inches of water per foot of soil after seven years of compost applications.

Other Benefits of Compost include:

- Improved manure handling
- Improved land application
- Pathogen destruction
- Excellent soil conditioner
- Possible saleable product
- Weed seed destruction
- Lower risk of pollution problems
- Possible revenue from tipping fees

[a] Maynard, A. A. & Hill, D. E. (1994). Impact of compost on vegetable yields. *Biocycle, 35*(3), 66-67.

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