Understanding the Composting Process

Suzanne Smith Hirrel
Extension Specialist - Waste Management

Tom Riley
Extension Specialist - Environmental Policy, Section Leader - Environmental and Natural Resources

An understanding of composting, the biological decomposition of organic matter, is necessary for both the backyard and municipal system composter. Time, volume, type, use and end product quality are considerations in the composting process.

Another consideration is the long-term survival of composting as a workable solution to the waste management dilemma. Slight mismanagement on the scale of a municipal composting operation can result in an odor problem that threatens the entire concept of composting for the public. For the purpose of this discussion, consider the anaerobic decomposition process undesirable. Anaerobic digestion (occurring in the absence of oxygen) can be an acceptable method of organic decomposition if done in a controlled environment. A sealed process allows the control of odors that would otherwise result in unacceptable public reaction.

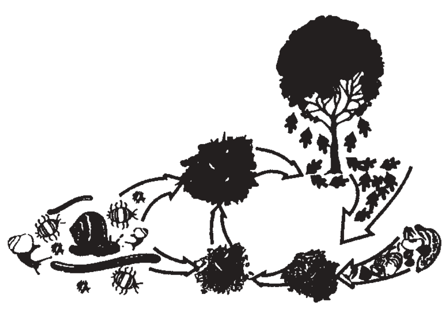

Figure 1. Composting Process in Action

Proper management and a complete understanding of the composting process, along with some level of environmental control, is the best situation. Such a project can result in a high-quality compost that has value both as a product for home use and commercial market demand for landscapers, golf courses, nurseries, etc. Research with poultry litter and poultry litter compost indicates potential in rice-producing areas where soil salinity limits normal crop production. Excellent results have also been experienced with application to cut or leveled rice fields.

The System

The compost world is an ecosystem all its own. Understanding the decomposition process and what does the work in each stage will help this ecosystem function at peak performance and produce a high-quality product.

In an aerobic composting process (occurring in the *presence* of oxygen), the microorganisms (bacteria, fungi, actinomycetes) and invertebrates (worms, millipedes, sowbugs) that decompose yard and food wastes require oxygen and water. Products of the composting process include compost, carbon dioxide, heat and water.

The heat produced increases the temperature in the compost pile to as high as 160°F. This increased temperature results in increased water evaporation. As the process nears completion (1 month to 2 years), the pile temperature lowers. The conversion of carbon (C) in waste to carbon

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dioxide results in reduction in weight and volume of the pile. Nitrogen (N) in food and yard waste is necessary for microorganisms to carry out decomposition effectively. Finished compost takes on many of the characteristics of humus. The rate at which the final compost is achieved depends on factors discussed here.

Microorganisms in Composting

Microorganisms such as bacteria, fungi and actinomycetes account for most of the decomposition, as well as the rise in temperature that occurs in the composting process.

Tiny millipedes, insects, sowbugs and earthworms are primary agents of physical decay. They break up waste debris and transport microorganisms. The speed at which organic materials decompose depends on the decomposers, type of organic materials and composting method used. The food web of the compost pile on page 4 shows the relationships in the process.

Aerobic vs. anaerobic microorganisms. Aerobic organisms thrive at oxygen levels greater than 5 percent (air is about 21 percent oxygen). They are the preferred microorganisms since they provide the most rapid and effective composting. Anaerobic microorganisms thrive when the compost pile is oxygen deficient. Anaerobic conditions are undesirable. The products of anaerobic decomposition cause compost piles to smell badly.

Aerobic bacteria are the most important initiators of decomposition and temperature increase within the compost pile. Several types of bacteria thrive between the temperatures of 55°-155°F. The initial temperature of the compost pile is usually related to air temperature. At temperatures below 70°F, helpful bacteria do not thrive.

While high temperatures (above 140°F) kill most pathogenic organisms and weed seeds, the most effective decomposing bacteria are those that grow at moderate temperatures 70°-100°F. Temperature changes during the process depend on materials being composted, compost method and the water available. Pile temperatures between 90°-140°F indicate rapid decomposition. A temperature probe or a soil thermometer can be used to keep track of pile temperature. The management of the compost process is the determining factor in the destruction of weed seeds, disease organisms and other pathogens. Well-managed systems result in excellent control. Ill-managed systems result in an inconsistent product.

Carbon to nitrogen ratios. When combining organic materials to make compost, the carbon-to-nitrogen (C:N) ratio is important. Microorganisms in compost digest (oxidize) C as an energy source and ingest N as a protein source. The C:N proportion should be approximately 30 parts C to 1 part N by weight. Table 1 lists C:N ratios for commonly used materials.

Table 1. Carbon to Nitrogen Ratios for Selected Materials (by weight)

Material	C:N
Materials with High N Values	
Vegetable wastes	12-10:1
Coffee grounds	20:1
Grass clippings	12-25:1
Cow manure	20:1
Horse manure	25:1
Poultry litter	13-18:1
Materials with High C Values	
Leaves	30-80:1
Corn stalks	60:1
Straw	40-100:1
Bark	100-130:1
Paper	150-200:1
Wood chips & sawdust	100-500:1

See composting fact sheet FSA 2087 for a more detailed list.

When the C:N ratio is too high, there is too little N and decomposition slows. When the C:N ratio is too low, there is too much N and it will vaporize as ammonia gas and lead to odor problems.

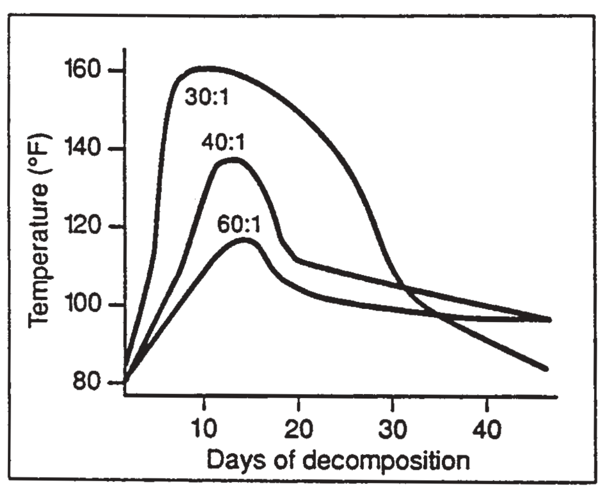

Figure 2. Carbon:Nitrogen Ratio Effects on Composting

Most materials available for composting do not fit the ideal 30:1 ratio, so blending of different materials is needed.

In general, coarse, dried-out materials contain little nitrogen. Woody materials are high in C, low in N. Green wastes such as grass clippings, fresh weeds and kitchen wastes contain high proportions of N. Keep in mind that the C:N ratios in Table 1 are estimates and are provided as a guide. With experience, composters develop procedures resulting in workable mixtures for materials available.

Particle size. Microbial activity occurs on the surface of particles. Breaking particles into smaller pieces allows the microorganisms to digest more material, multiply faster and generate more heat. Chopping, shredding or chipping materials accelerates the composting process.

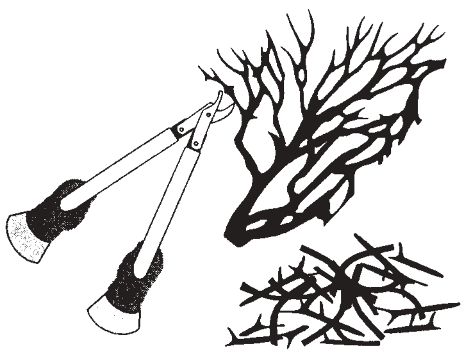

Figure 3. Smaller Particles Compost Faster Than Larger Ones

Aeration replaces oxygen-deficient air in the center of the compost pile with fresh air. Rapid aerobic decomposition occurs only when there is enough oxygen present. Air movement throughout the compost pile is affected by spaces between particles in the compost pile and by moisture content. If the material becomes water saturated, the air movement decreases. Regular mixing or turning of the pile fluffs up the material and increases air movement, enhances aeration and decreases compaction.

Moisture is needed for bacterial decomposition. A moisture content of 40-60 percent provides adequate moisture without limiting aeration. Too much moisture causes nutrients to leach out, odors are produced and decomposition slowed. A “squeeze” test is an easy way to gauge moisture content. The material should feel damp to the touch, with just a drop or two of liquid expelled when the material is squeezed tightly. Turning a “too wet” compost pile allows air to circulate. Adding dry material can fix excess moisture problems. Piles too dry can be watered while turning.

Temperature

Heat generated by the decomposing microorganisms increases the compost temperature. Temperatures between 90° and 140°F indicate rapid composting. Temperatures greater than 140°F reduce the activity of most organisms. A temperature probe or soil thermometer can be used to keep track of compost temperatures. While the backyard composters may not be interested in monitoring pile temperatures, it is an excellent tool for demonstrations and large-scale composters.

Under optimum conditions and with frequent turning, usable compost might be produced in as little as one month. However, composting can survive most forms of neglect, especially if a one- or two-year wait for finished compost is acceptable. The composting method you choose will be influenced by when the finished product is needed and the investment dollars available to the project.

References

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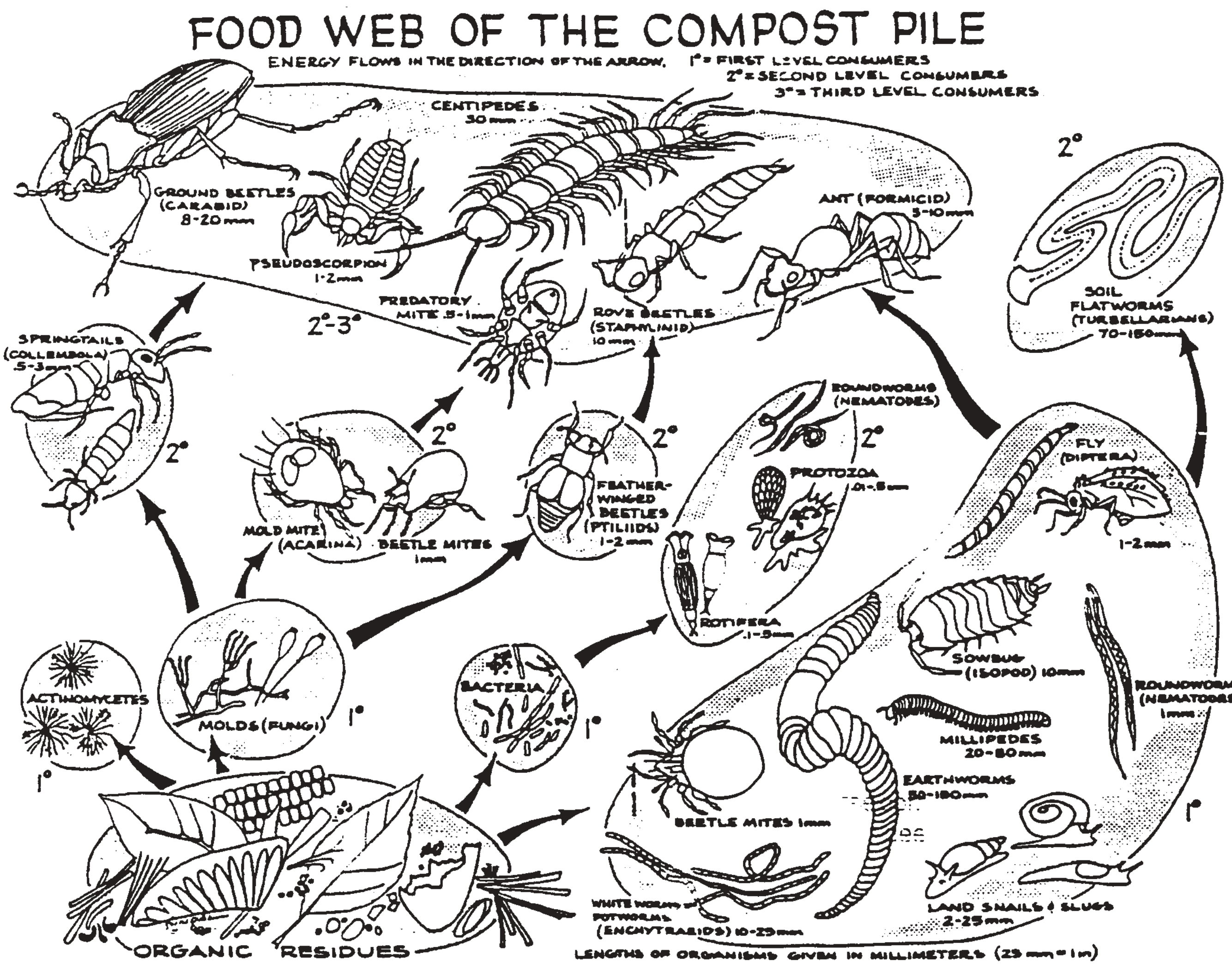
Composting: Waste to Resources, Cornell Cooperative Extension Service.

The Rodale Guide to Composting, Rodale Press.



Source: Dr. Daniel L. Dindal

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SUZANNE SMITH HIRREL is Extension specialist - waste management and **TOM RILEY** is Extension specialist - environmental policy, section leader - environmental and natural resources, University of Arkansas Division of Agriculture, Cooperative Extension Service, Little Rock.

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