

# Processes in Compost Making

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## How compost forms

Composting is a method of speeding natural decomposition under controlled conditions. Raw organic materials are converted to compost by a succession of organisms (Figure 2). During the first stages of composting, bacteria increase rapidly. Later actinomycetes (filamentous bacteria), fungi and protozoans go to work. After much of the carbon in the compost has been utilized and the temperature has fallen, centipedes, millipedes, sowbugs, earthworms and other organisms continue the decomposition.

As microorganisms decompose the organic materials, their body heat causes the temperature in the pile to rise dramatically. The center of a properly made heap should reach a temperature of 110 to 140 degrees Fahrenheit in four to five days. At this time the pile will begin "settling," which is a good sign that the pile is working properly. The pH of the pile will be very acidic at first, at a level from 4.0 to 4.5. By the time the process is complete, the pH should rise to approximately 7.0 to 7.2.

The heating in the pile will kill some of the weed seeds and disease organisms. However, this happens only in areas where the most intense temperatures develop. In cooler sections toward the outside of the pile, some weed seeds or disease organisms may survive. Proper turning is important to heat all parts of the pile.

The organisms that break down the organic materials require large quantities of nitrogen. Therefore, adding nitrogen fertilizer, or other materials that supply nitrogen, is necessary for rapid and thorough decomposition. During the breakdown period, the nitrogen is incorporated into the bodies of the microbes and is not available for plant use. This nitrogen is released when the decomposition is completed and the compost is returned to the garden.

## What materials may be composted?

Many types of organic materials can be used for compost. Sod, grass clippings, leaves, hay, straw, weeds, manure, chopped corncobs, corn stalks, sawdust, shredded newspaper, wood ashes, hedge clippings and many kinds of plant refuse from the garden are some of the possibilities.

Weed plants heavily laden with seeds might be better left out of the compost pile if the compost is to be returned to the garden. Even though some seeds are killed during composting, those that survive might create an unnecessary weed problem.

Most kitchen scraps also may be used in the compost heap. Some items that should not be used are grease, fat, meat scraps and bones. These materials may attract dogs, rats or other animals. They also may develop an unpleasant odor during decomposition. Fats are slow to break down and greatly increase the time required before the compost can be used.

Unless compost is completely and thoroughly turned during its formation or allowed to remain unused for several years, it is best not to place diseased plants from the flower or vegetable garden on the compost heap. Even though some diseases may be killed by the heating during the compost formation, there is a chance of returning some of these disease organisms to the garden.

## The composting process

The length of time necessary for the composting process depends on several conditions:

- Carbon-to-nitrogen ratio
- Surface area of particles
- Aeration
- Moisture
- Temperature

### **Carbon-to-nitrogen ratios**

All organic material contains carbon and nitrogen. Carbon is a major component of the cellulose and lignin that give cell walls their strength. Nitrogen is found in proteins and many other compounds inside plant cells. The carbon-to-nitrogen ratio (C:N) of a material is an estimate of the relative amounts of these two elements it contains. It is usually based on the percent dry weight of carbon and nitrogen in the material. A ratio of about 30:1 is ideal for the activity of the microbes in the compost. This balance can be achieved by controlling the materials included in the compost or by adding nitrogen either from fertilizer or from organic materials high in nitrogen, such as manure or grass clippings.

Table 1 shows the approximate ratios for some materials commonly added to compost piles. The items at the beginning of the list are highest in nitrogen; those at the bottom are highest in carbon.

These ratios represent comparative weights. Therefore, in the first example, 5 to 7 pounds of dry pig manure would contain one pound of nitrogen, while near the other extreme, 500 pounds of sawdust might contain only 1 pound of nitrogen.

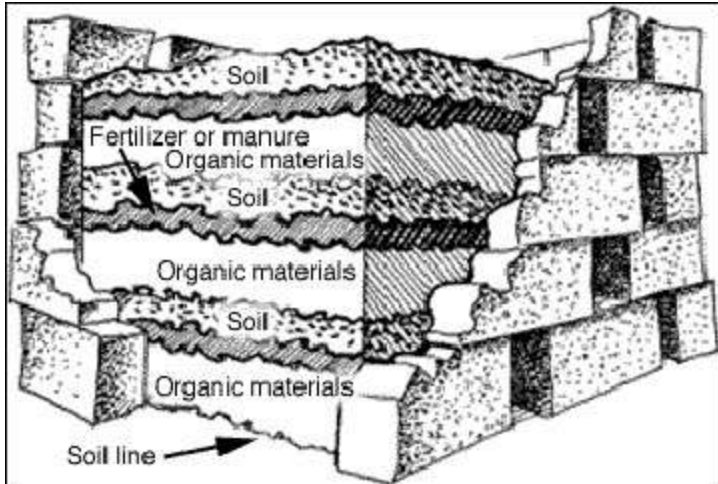
The 30:1 ratio in compost is the most desirable to supply the microorganisms with the proper amount of carbon they need for energy and the proper amount of nitrogen they need for protein synthesis so they can function efficiently and quickly. To estimate the C:N of a mixture, average the ratios of the individual materials. For example, a mixture of equal parts grass clippings and leaves might have a C:N of  $(20 + 50) \div 2 = 35$ .

**Table 1**  
***Carbon to nitrogen ratios in various materials.***

- **Pig manure**  
5 to 7:1
- **Poultry manure(fresh)**  
10:1  
(with litter)  
13 to 18:1
- **Vegetable wastes**  
12 to 20:1
- **Coffee grounds**  
20:1
- **Cow manure**  
20:1
- **Grass clippings**  
12 to 25:1
- **Horse manure(fresh)**  
25:1  
(with litter)  
30 to 60:1
- **Tree leaves (and miscellaneous foliage)**  
30 to 80:1
- **Corn stalks**  
60:1

- **Straw**  
40 to 100:1
- **Bark**  
100 to 130:1
- **Paper**  
150 to 200:1
- **Wood chips, sawdust**  
200 to 500:1
- **Wood**

700:1



**Figure 3**  
Proper layering in a compost bin.

## Constructing the pile

Compost piles develop best if they are built in layers (Figure 3). Layering is a good way to ensure that the materials are added in the proper proportion. Once several layers are formed, however, composting will be most rapid if the layers are mixed before making new layers. It is usually best also to add water to each layer of dry material rather than try to wet the entire pile after it is built. The entire pile should be as wet as a well-wrung sponge. It may not always be practical to build a pile in this way if available materials are limited. When organic materials are accumulated rather slowly, they may be stockpiled until enough are available to layer properly.

The pile normally may be started directly on the ground. However, to provide the best aeration to the base and improve drainage, dig a trench across the center of the base and cover it with stiff hardware cloth before you begin the layers. Branches or brush may be placed on the bottom as another means of improving lower aeration. However, they may interfere with removal of the finished compost since they will decompose more slowly than finer materials.

Begin the pile by placing a 6- to 8-inch layer of organic matter in the enclosed area. Shredded or chopped materials decompose faster, so if a shredder is available, coarse, organic matter should be run through it. Materials that tend to mat, such as grass clippings, should be placed in layers only 2 to 3 inches thick or mixed with coarser materials for thicker additions. After the organic layer is built, moisten but do not soak it.

Over the layer of plant material, add a layer of a material high in nitrogen, such as manure, or a sprinkling of a high-nitrogen garden fertilizer. A layer of animal manure 1 to 2 inches deep should be satisfactory. If organic materials high in nitrogen such as grass clippings are used, these should be layered to about a 4-inch depth. Although adding grass clippings or other materials that have been treated with herbicides may cause concern, most pesticides break down quickly in a compost pile.

If garden fertilizers such as 12-12-12 are used as a nitrogen source, use about 1 cup per 25 square feet of the top surface of each layer.

When using fertilizer materials, about 0.8 ounce of actual nitrogen per bushel of organic matter such as leaves is needed. Since one cubic yard (3 feet x 3 feet x 3 feet) of leaves contains about 23 bushels, it would require about 18 ounces (1.1 pounds) of nitrogen or about 5.5 pounds of a fertilizer containing 20 percent N. It is best to add fertilizer to the pile in several doses as the pile is turned to avoid overwhelming the microorganisms. More uniform distribution on each layer can be obtained if a water-soluble fertilizer is mixed with water and sprinkled over the surface. Table 2 shows the amount of each material needed to apply 1 pound of actual nitrogen.

It was once thought that ground limestone should be added to the compost pile. This is no longer considered necessary since the organisms function well with a pH of between 4.2 and 7.2. The compost naturally will become less acid as it matures. Adding lime helps convert ammonium nitrogen to ammonia gas, which can create an odor problem as it escapes from the pile and can reduce the nutrient content of the finished compost. Adding lime may also cause the pH of the finished compost to be higher than optimal for plant growth.

Next, add a layer of soil or sod about an inch thick. The soil contains microorganisms that help to start the decomposition process. If there is not an adequate source of soil, a layer of finished compost may be used as a soil substitute. Compost activators may also be used to introduce organisms into the pile.

Continue to develop and alternate the layers until a height of 3 to 5 feet is developed. Firm each layer of organic material as it is added, but do not compact it so much that air cannot move freely through it. Water each layer lightly as it is added. Homogenize the layers as you go for faster results. During construction of the pile, remember the C:N ratios and that it will take about one pound of actual nitrogen for each 30 pounds of lightly moist organic matter for best decomposition.

Build the heap in a convenient but inconspicuous place. If the compost is to be used mainly in the garden, then a nearby location would be logical. Since the compost pile may need to be kept moist during dry weather, a convenient source of water should be available. Don't locate the pile where water may stand. Excess moisture in the bottom of the pile can cause the process to stop or lead to odor problems. Locate the pile where occasional earthy odors are not likely to offend neighbors.

A shaded area is generally desirable for best composting. If possible, do not locate the pile or structure close to trees. Tree roots may be attracted to the loose moist organic material in the bottom. During summer, roots of some trees may invade the lower areas of the bin and make the compost difficult to dig and use.

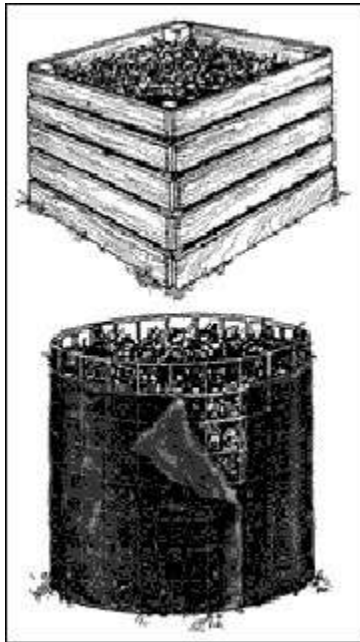
**Table 2**  
***Quantities of nitrogen sources to provide a pound of nitrogen***

- **Ammonium nitrate**  
33 percent nitrogen  
Apply 48 ounces for a pound nitrogen
- **Calcium nitrate**  
15 percent nitrogen  
Apply 106 ounces for a pound nitrogen
- **Urea**  
46 percent nitrogen  
Apply 34 ounces for a pound nitrogen
- **Dried blood**  
12 percent nitrogen  
Apply 133 ounces for a pound nitrogen

- **Fish meal**
  - 10 percent nitrogen
  - Apply 160 ounces for a pound nitrogen

## Heaps

Making compost does not require a structure and can be done simply in a pile. However, piles will require more space. The minimum size of a pile should be 5 feet by 5 feet and 3 feet high. Materials can be added as they become available, but when the first pile is high enough, a second one should be started until the first has decomposed enough to be used. Piles may be turned regularly or not at all. However, if they are not turned, the upper portions will not be totally decomposed and will have to be pulled off when the compost is used.



**Figure 4**

You can build a composter from available materials. Wrap the bin with weed-barrier fabric or perforated plastic sheeting to reduce moisture loss.

## Containing the pile

Although it is possible to stack the compost in a pile, decomposition is best and space is used more efficiently if it is placed in some type of bin or enclosure (Figure 4). The sides should allow air movement through them. The pile may be round, square, rectangular or any other convenient shape. An open side or a fastener will facilitate pile turning and removal of finished compost.

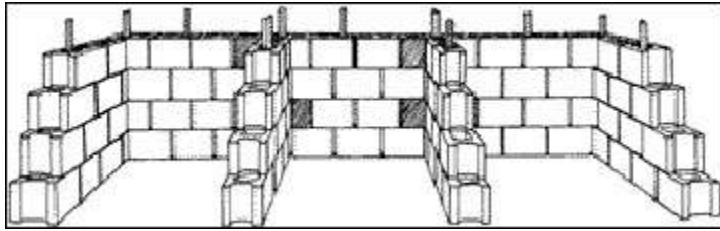
## Slow and fast composting methods

The speed at which compost forms depends on the conditions already discussed. Controlling these factors, along with frequent turning of the compost, speeds up the process. But many gardeners are content with the slower, more traditional methods that require less attention.



**Figure 5**

Compost bin constructed from landscape timbers. To turn the compost, disassemble the bin and restack the timbers close by; then fork the compost into the new enclosure.



**Figure 6**

A three-compartment turning unit constructed with concrete blocks and metal ties.

### **Fast method**

Fast composting methods depend on the use of turning units. They can create good compost in as little as six weeks, depending on how the compost pile is managed. Materials that can be used include nonwoody yard waste, nonfat kitchen waste and similar materials. Structures or containers that allow frequent, easy turning are essential.

Turning units for the fast method are of two general types: a series of bins (usually three) that allow manual turning of the compost from one bin into the next (Figures 5 and 6); or a rotating, horizontally mounted drum, such as a 55-gallon barrel. The materials for fast composting should be added in larger amounts rather than frequent additions of small amounts. Therefore, organic matter should be collected until there is enough to properly fill a barrel composter or other unit such as a bin 3 feet square. To reduce odor problems, grass clippings should be spread to dry before stockpiling, and food wastes should be covered or buried in the compost.

### **Traditional or slow method**

In this system, material may be added to the enclosure at any time. Turning can help, but it is not required. When only one unit is developed, finished compost may be taken from the bottom while new materials are still being added to the top. Two bins are always better where space permits, since one bin can be allowed to mature while new materials are being added to the other.

Woven wire fencing, chicken wire, chain link, hardware cloth, wood slat fencing (snow fence), concrete blocks, bricks or lumber can be used to enclose the compost heap. Fencing wires need corner supports, although some can be used to make cylinders that need little or no support. If woven wire fencing is too loose to contain finer materials, line the enclosure with plastic that contains some aeration holes to keep the pile neat and speed decomposition. The plastic lining will also prevent excessive drying of the vertical pile surfaces.

Bricks or concrete blocks may be piled without mortar, but 1/2-inch spaces should be left between them to allow adequate air movement through the sides. Line up the holes facing upward as you stack them and drive metal posts down through a few of the holes to make the bin more stable (Figure 6).

Lumber, whether new or scrap, is suitable for sides of compost bins. Allow enough space between the boards for air movement. Lumber is gradually ruined by exposure to the damp compost, and boards occasionally have to be replaced as they decay. Discarded pallets can be used to make an inexpensive, yet durable composting enclosure.

## **Care of the pile**

Decomposition will take place even if a compost pile is ignored after it has been built, but at a slower rate. Adding water to maintain moist conditions and turning the pile to improve aeration will speed the process. To check the moisture content of the pile, squeeze a handful of compost. If a few drops of water can be squeezed out, moisture is about right. If no drops fall, it is too dry. If water trickles out, it is too wet. The pile should be covered with plastic or other materials during wet weather to avoid excessive moisture buildup.

A properly built pile should develop a temperature of at least 110 degrees Fahrenheit at the center in about a week during summer or up to a month in cooler seasons. When that temperature is reached, the pile should be opened, any

compacted materials should be loosened, and the material should be turned or stirred so that the material previously on the top and sides is moved to the center. During warm weather, the pile may need another turning after a second week. The optimum temperature in an active compost pile is 135 to 140 degrees Fahrenheit. Compost piles occasionally reach temperatures as high as 170 degrees, hot enough to kill some of the microorganisms. This usually happens when excessive amounts of wet, high-nitrogen materials are added to the pile.

The rate of heat buildup and decomposition also will depend on external temperatures. In winter, little decomposition occurs except in the center of large piles.

Piles may be turned by slicing through them with a spade and turning each slice over. The main objective in turning is to aerate the pile and shift materials from the outside closer to the center, where they may also be heated and decomposed.

As materials decompose, the pile heats up and should also shrink, eventually becoming no more than half its original height. Often the pile's volume may shrink by 70 to 80 percent.

Compost is ready to use when it is dark brown, crumbly and has an earthy smell. For those who want a very fine product, it can be run through a 1/2-inch screen and the coarser material can be used for mulch or returned to the pile for continued decomposition with other materials.

## Diagnosing composting problems

- **The pile is producing a bad odor**

The pile may be too wet, too tight, or both. Turn it to loosen and allow better air exchange in the pile. If too wet, also turn the pile, but at the same time, add dry new materials. Odors also may indicate that animal products are in the compost pile.

- **No decomposition seems to be taking place**

The pile is too dry. Moisten the materials while turning the pile.

- **The compost is moist enough and the center is warm but not hot enough for complete breakdown**

The pile is too small. Collect more materials or add those available to make a larger pile. Turn and mix the old ingredients that may have only slightly decomposed into the new pile. If the pile is not small, more nitrogen may be needed.

- **The heap is moist, sweet smelling, with some decomposition, but still does not heat enough**

There is not enough nitrogen available for proper decomposition. Mix a nitrogen source such as fresh grass clippings, manure or fertilizer into the pile.

## Using compost

When compost is ready to use, it should be dark and crumbly, and you should not be able to recognize the original composted items. If compost is not used promptly, it still makes a good soil amendment, but nitrogen may be lost through leaching.

Fast composting may produce good compost in three to eight weeks. Conventional composting methods will produce a product in three to nine months, depending on the types of organic materials used, temperatures, and how often the compost is turned.

In some cases, screening compost through a 1-inch wire mesh will help sort out incompletely decomposed materials before use. Twigs decompose slowly, and if they have become a part of the debris, they may have to be removed from finished compost to be returned to the heap.

Compost is also very suitable to use for potting houseplants or starting many types of seeds. Recent research has shown that microorganisms found in mature compost can actually suppress plant diseases such as those causing "damping off" as effectively as fungicides. Generally, best results are obtained when compost is mixed with other materials such as perlite and vermiculite with about 30 percent of the volume being compost.

Compost should be added annually if you are using it to build good soil. The best time to add compost to the vegetable or flower garden is during fall or spring tilling. It can be added to the soil when planting trees, shrubs, annuals or perennials. Compost is an excellent mulch or topdressing around flowers, vegetables, shrubs and trees. If used as a mulch, the compost need not be completely finished.

Compost may be used as a lawn topdressing, but it should not be applied more than 1/4 inch thick. For this purpose, the compost should be screened so that only the finer particles are used.

### **>Further information**

- Dickinson, N., T. Richard, and R. Kozlowski. NRAES-43. Ithaca, N.Y.: Cooperative Extension, 1991. (44 pp.)
- Rynk, R., editor, NRAES-54. Ithaca, N.Y.: Cooperative Extension, 1992. (186 pp.)