Earth-Kind® Landscaping

Chapter 2, Composting Fundamentals

Raw material quantity and composition

In the homeplace are many sources of raw materials for the compost pile. From the kitchen comes coffee and tea grounds, and vegetable and fruit trimmings, which amount to 0.2 to 0.9 pound (90 to 400 g) per capita per day. From the landscape comes leaves, grass clippings, brush trimmings, old plant material, and many weeds, yard trimmings that represent 15 to 20% of the municipal waste stream. Leaves present less of a challenge in both collection and composting than do other organic sources while representing a major portion of the waste stream. In most cases the home compost pile will be built with landscape trimmings and rakings. Starting with leaves and grass clippings, for example, and adding some brush or wood chips for a bulking agent could prove to be the right mix to begin composting in the first year. Kitchen wastes can be added to the pile as they occur (see Chapter Four).

Most all organic materials will compost, but not all of them should be put in the pile. Some organic wastes will attract rodents, dogs and cats, while weeds and pathogen-infected materials may survive the composting process. Also, fatty foods and bones should be avoided because they will attract rodents and create odor problems. Cat and dog fecal materials as well as cat litter should not be used in the pile due to harmful pathogens.

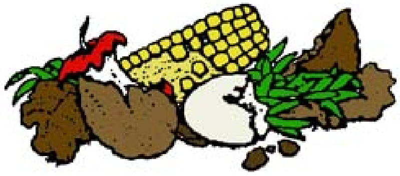
In looking at compostable materials one consideration should be the amount of time each material needs for breakdown. High nitrogen materials, like grass, will break down very readily while wood chips may take up to two years to reach the humus stage. The higher or wider the carbon:nitrogen ratio (C:N), the longer time it will take for breakdown to occur. Coarse materials, such as straw, nut shells, corncobs and stalks, will also take longer to breakdown. However, the greener and more succulent the material, the quicker the breakdown period. All materials that are high carbon should be cut or shredded into small pieces and mixed with high nitrogen materials, such as manure or fresh grass clippings.

Do not discount the rough or coarse materials because they can be used as bulking agents in the pile. Coarse matter will break down slowly in the pile and will improve the pile structure by allowing air circulation. A bulking agent is very important when there is not a good mixture of materials or when raw materials tend to pack together.

It might take several attempts to get the right mixture of materials that will give you the perfect recipe for composting. Mixing different types and sizes of organic materials will provide a well- drained and arable compost pile. The more varied the materials going into the pile, the better chance of maintaining the proper C:N ratio and efficient decomposition.

Leaf Composting

Microorganisms need nutrients, primarily carbon and nitrogen, for both energy and growth. The ideal carbon:nitrogen (C:N) ratio is not found in any one organic source. However, it is possible to create compost out of primarily one raw material, such as leaves. Due to their high carbon content leaves may take 5 months to 2 years to compost by themselves. However, leaves will compost and turn out a good finished product if moisture is adequate and if the pile is turned frequently, ensuring a good supply of oxygen.



Mixing other organic wastes with leaves to utilize these other sources in recycling is important. The high nitrogen source, such as grass clippings or other plant wastes, animal manures, food scraps or other high nitrogen materials can speed up the decomposition process and increase the nitrogen content of the end product making it more suitable for use as a soil amendment. The high nitrogen component must be carefully controlled because the addition of too much nitrogen can result in the formation of ammonia, creating an odor problem. The rapid decomposition also uses up oxygen, causing further problems as the aerobic microorganisms are replaced by anaerobic ones.

Grass clippings are high in nitrogen and can be added to the leaf pile. However, high moisture and high nitrogen content in the grass clippings require that they be mixed into the pile with other materials in order to reduce the anaerobic conditions that can occur from grass being "clumped together" in the pile. Research conducted at Rutgers University by Dr. Peter Strom indicates a mix of 2-3:1 (leaves:grass clippings) as being the optimum for decomposition in the compost pile.

However, as the material decomposes, the problem of maintaining an optimum leaves:grass ratio increases. After leaves are collected in the fall and wind-rowed, they undergo a substantial reduction in volume due to the burst of microbial activity that occurs within the first month of composting. By the time grass clippings are being collected the following spring and summer, the leaves have been reduced in volume as much as 50%.

If leaf/grass clipping mixes are to be composted, leaves collected in the fall should be stockpiled without turning until grass collection begins. At that time, form a pile with the appropriate mix of stockpiled leaves and grass clippings. The leaf piles will likely be anaerobic and some short term odors may be generated when the piles are disturbed.

Leaves act as a bulking agent, allowing more oxygen into the windrow to maintain aerobic conditions. Grass clippings, because they are high in nitrogen and moisture provide needed nitrogen and speed the decomposition, and restore vigorous composting activity to pile. Again, experimenting with mixes is a good way to find the mix that works for you.

It should be noted that grass clippings do not need to be removed from the lawn when mowing. If lawns are mowed frequently, and the clippings allowed to fall back into the lawn, their collection is not necessary. Grass clippings, being high in nitrogen, will decompose rapidly and actually return nitrogen to the soil, reducing the need to apply nitrogen in the form of fertilizers. This is discussed in more detail under Grasscycling in Chapter 5.

Grass Clippings/Woody Materials Mixture

Due to the potential problems associated with leaf/grass clipping compost mixes, a viable alternative may be a chipped woody materials/grass clipping compost. The wood chips would provide the needed air spaces to prevent anaerobic conditions in the pile or windrow, while the grass clippings would supply a nitrogen source to maintain active decomposition. The wood chips would not break down entirely, but would take on a weathered dark-brown color and result in an attractive mulch when finished.

Leaves/Grass/Pruning Mixture

It would be an ideal situation if all of the yard trimmings produced could simply be mixed together and composted. However, since woody materials, such as prunings, decompose so slowly this may not advisable. Woody materials in the compost pile can also cause problems with the turning.

Another alternative in certain situations, is to grind the woody wastes to mix with the grass and leaves. Woody materials should make up no more than one-third of the pile. Remaining ground woody materials should be kept separate to be used as a mulch, while the leaf/grass mix is used as a compost.

Animal Manures

Other solid organic wastes, such as livestock manures, can be added to leaf compost piles as a nitrogen source. This will speed up the composting process, but must be carefully monitored to maintain aerobic conditions and prevent odors. The addition of livestock manures to the piles will also increase the nitrogen content of the finished product.

A C:N ratio of 25-30:1 is optimum for efficient composting. It is important when blending raw materials to create a mixture that will approximate this ideal and provide the proper characteristics for aerobic composting. A higher C:N ratio will result in a slower rate of decomposition. A lower ratio results in excess nitrogen loss and possible odors if the mix is not turned often. Leaves have a C:N ratio of about 40-80:1, and manures typically have a C:N ratio of about 10-18:1 in the fresh state. Addition of carbonaceous bedding such as sawdust, straw or newspaper will increase the C:N ratio. Other factors, such as moisture content and turning schedule will affect the blend of materials, so some experimentation will be necessary.

Compost contains less nitrogen than fresh manure, because much of the nitrogen is volatilized during the composting process. Much of the remaining nitrogen is incorporated into organic compounds and is released slowly when the compost is applied to the soil.

Carbon: Nitrogen Relationships

There are two chemical elements that are of utmost importance in all phases of organic matter – Carbon (C) and Nitrogen (N). Of even greater importance is their proportion or ratio to each other. This relationship is called the C:N ratio. In order to better understand this ratio suppose that a material is made up of 60 parts C and 2 parts of N by weight. It would have a C:N ratio of 30:1. This means that the material has 30 times as much C as N. If you are trying to compost leaves with an 60:1 C:N ratio for every 60 pounds of leaves, you willneed 2 pounds of N. It is important to remember that a small percentage of the carbon and nitrogen may not actually be available for decomposition. The decomposition of organic matter is brought about by living organisms which utilize the carbon as a source of energy and the nitrogen for building cell structure. More carbon than nitrogen is needed. However, the amount of nitrogen needed varies with the type of organic materials and the type of micro-organisms present. When the nitrogen content is too low for the amount of carbon (for example, 80:1, C:N), organisms will have to recycle the nitrogen through many generations in order to breakdown the carbon containing material. As organisms die, their stored nitrogen is then used by other organisms to form new cell material. (The average C:N ratio of the bodies of bacteria and fungi falls between 4:1 and 10:1.) In the process more carbon is used. Thus the amount of carbon is reduced to a more suitable level while the nitrogen is recycled. More time is required for the process, however, when the initial C:N ratio climbs above 30:1.

Table 1: Carbon/Nitrogen Ratios for Composting Organics

Material	Carbon/Nitrogen Ratio
Sandy loam (fine)	7:1
Humus	10:1
Food scraps	18:1
Alfalfa hay	10:1
Grass clippings	12-25:1
Coffee grounds	20:1
Vegetable trimming	12-20:1
Cow manure	20:1
Horse manure	25:1
Horse manure with litter	60:1
Rotted manure	20:1
Poultry manure (fresh)	10:1
Poultry manure with litter	18:1
Sandy loam (coarse)	25:1
Oak leaves (green)	26:1
Leaves, varies	35-85:1

Material	Carbon/Nitrogen Ratio
Peat moss	58:1
Corn stalks	60:1
Straw	80:1
Pine needles	60-110:1
Farm manure	90:1
Newspaper	50-200:1
Douglas fir bark	491:1
Sawdust, weathered 2 months	625:1

The presence of nitrogen in the soil can cause a slightly different process when soil and composting materials mix, as in sheet or trench composting or in mulching. When the C:N ratio is too great, living microbial cells make maximum use of the available carbon by drawing on any available soil nitrogen in theproper proportion. This condition is known as “robbing” the soil of nitrogen and has the effect of delaying the availability of nitrogen as a fertilizer for growing plants, until some later season when it is no longer being used in the lifecycles of soil bacteria. (As a result of this process, additional nitrogen may be needed when partially decomposed compost around plants as a mulch or soil amendment.) On the other hand, when the energy source, carbon, is less than that required for converting available nitrogen into protein, organisms make full use of the available carbon and get rid of the excess nitrogen as ammonia. This release of ammonia can produce a loss of nitrogen from the compost pile if the ammonia escapes to the atmosphere.

A C:N ratio of 20:1 (also known as a ratio of 20), when C and N are available, has been widely accepted as the upper limit at which there is no danger of robbing the soil of nitrogen. If a considerable amount of carbon is in the form of lignins or other resistant materials, the actual C:N ratio could be larger than 20. Because of the potential for robbing the soil of nitrogen and the need for conserving maximum nitrogen in the compost, the C:N ratio is obviously a critical factor in composting.

Since living organisms utilize about 30 parts carbon for each part of nitrogen, an initial C:N (available quantity) ratio of 30 would seem most favorable for rapid composting and would provide some nitrogen in an immediately available form in the finished compost. Some research workers have reported optimum values from 20 to 31. A majority of investigators believe that for C:N ratios above 30 there will be little loss of nitrogen. The University of California studies on materials with a initial C:N ratio varying from 20 to 78 and with nitrogen contents varying from 0.52% to 1.74% indicated that initial C:N ratio of 30 to 35 was optimum. These reported optimum C:N ratios may include some carbon which was not available. The composting time will increase considerably with increases in the C:N ratio above the range 30. If the unavailable carbon is small, the C:N ratio can be reducedby bacteria to as low a value as 10. Fourteen to twenty are common C:N ratios depending upon the original material from which the humus was formed. These studies showed that composting a material with a higher C:N ratio would not be harmful to the soil, however, because the remaining carbon is so slowly available that nitrogen robbery would not be significant.

Materials should be proportioned on a 30:1 ratio by weight in order for optimum decomposition to occur. However, C:N of 25:1-35:1 will result in proficient decomposition. If the compost pile is maintained at a steady ratio of 30:1 microorganisms will reach their optimum decomposition rates and materials will quickly decompose. When the C:N ratio becomes too high (too much C) decomposition slows down. When the C:N ratio becomes too low (too much nitrogen), N will be lost to the atmosphere as ammonia gas and can lead to odor problems.

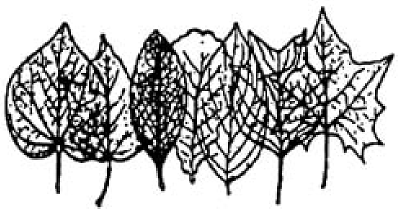
The C:N ratio of 30:1 is an ideal. However, this ratio is usually given for materials on a dry weight basis, but composting materials are usually not completely dry. Though composting is not exact, the composter must use judgement in combining compostable materials. Generally, the dry, coarse materials such as straw, wood chips, etc. are high in C and low in N. Opposite to this, the “green” materials such as grass clippings, fresh plant material, kitchen scraps and manures, are high in N and lower in C.

The proper blending of these materials will come about over time as you try recipes and add to others and as materials become available for your use. Achieving the exact ratio of 30:1 may never happen, but composting will take place in and around this magical number. Over time and with experience, you will develop your own mixes that work and compost well.

The C:N ratio of plant material is dependent on its growth stage, conditions under which it has been grown, plant parts (leaves vs. limbs), and dryness of materials.

Blending of Materials

Most people tend to use the materials that are easily accessible for composting. Most homes have leaves, trimmings of some kind, vegetable scraps from the kitchen, coffee and tea grounds. Composting works best when different materials, both wet and dry, are mixed together.



Each day or every other day you will be taking some type of material out to the compost pile. Most of the everyday materials that come from the kitchen are listed as high N materials. Even if you start with mainly C material, this everyday adding will lead to a suitable C:N ratio. When adding material from the kitchen, make a hole in the pile and bury the debris. Move the burying site around throughout the pile. With this method you will bring about the proper C:N ratio if you cannot achieve it in the beginning.

Shredding of Refuse

Shredding or grinding the raw materials for composting can produce several beneficial results, particularly when using leaves, woody plants, corn stalks, and other bulky materials. Shredding or grinding organic materials makes it more susceptible to beneficial bacteria in the pile because a greater surface area is exposed and the natural defense resistance of vegetation against microbial invasion is disrupted. Moreover, a piece of wood, a pile of corn stalks, or leaves packed together take much longer to compost than do small particles of materials. Packed materials can also block sufficient oxygen from reaching the pile, slowing aerobic decomposition.

Shredding the material makes it more homogenous, produces better aeration and controls moisture. Shredded refuse heats more uniformly. It withstands excessive drying at the surface of the pile, is insulated against heat loss, and resists moisture penetration from rain better than does unshredded refuse. Fly control is also more easily accomplished when refuse is pulverized or shredded. Also, users of compost as mulch find that a shredded or ground material can be applied more readily and uniformly to the land.

The most desirable size of particles for composting is less than 2 inches, but larger particles can be composted satisfactorily. The particle size of the material being composted depends on the final use of the compost.

However, on farms and large gardens, it is doubtful whether the advantages of shredding will be sufficient to justify the additional cost and labor. In ordinary composting any particles that are too large can be forked or screened out and broken up when necessary. If the material is to be used on lawns or flower gardens, it can be screened after composting through a 1-inch or smaller screen to give it a better appearance and to make it easier to apply and work into the soil. The individual farmer or gardener may not be necessarily particular about the uniformity of the compost structure when preparing the compost. Nor is the uniformity as important for agriculture fields as for the hobby gardener.

Initial shredding of all the material is not necessary in the composting operation. It is often the best practice to limit the initial shredding to large pieces of organic materials. Some composters believe that permitting some larger irregular pieces to remain tends to create greater air spaces in the mass and entrap more oxygen. Undecomposed pieces can be screened out of the final compost and put back through the decomposing process.

Vegetative and herbaceous matter should not be ground because it becomes soggy. The high moisture content of these materials makes them useful in small quantities throughout the composting process.

Environmental Factors

Microbes are working on the surface of the decomposing materials and are easily subject to drying out, temperature fluctuations, and oxygen depletions.

The compost pile should be kept moist but not soaked. This environment provides comfortable and conducive conditions for microorganisms, mainly bacteria and fungi, to accomplish the decomposition process.

Moisture Content

Aerobic decomposition proceeds best between 40% and 70% moisture with good aeration. A high moisture content must be avoided because water displaces air from between the particles and gives rise to anaerobic conditions which limit composting organisms. However, too low a moisture content deprives the organisms of the water needed for their metabolism, and, consequently, also inhibits their activity.

Maximum moisture content for satisfactory aerobic composting will vary with the materials used. If the material contains considerable amounts of straw and strong fibrous material, the maximum moisture content can be much greater without destroying the structural qualities or causing the material to become soggy, compact, and unable to contain enough air in the interstices. But if the material has little structural strength when wet, or if it is granular, like ash and soil it may be difficult to maintain aerobic conditions at a moisture content above 70%.

If the moisture content falls much below 40%, many of the organisms will cease to function. Moisture content above 70% may cause the pile to go anaerobic, thereby producing foul odors. Also, nutrients may be leached and decomposition will be very slow at the higher moisture content. When the composting materials are picked up in the hand and squeezed, just a few drop of water should come out. If excess water comes out, the pile is too wet. The pile should be turned to remove excess water, to loosen materials and to oxygenate the pile. Also, the addition of dry materials will soak up the excess moisture.

In hotter climates, covering a compost pile will help retain moisture. Also, covering compost piles in the summer may conserve moisture, while in very rainy winter areas covering the pile may help to keep it from becoming too soggy.

If the compost pile is not in a structure and is left freestanding, it will develop an "A" shape. When this occurs water will be shed just like old haystacks and the pile may become dry. An unstructured pile will need to be checked for dryness more often than a structured pile.

Temperature

Microorganisms, which cause the generation of heat in a compost pile, are classified into two categories: mesophilic, those that live, function and reproduce in temperatures between 50° -113°F, and thermophilic, those that thrive between 113° – 158°F.

The term "critical mass" is often used in conjunction with heating of compost piles. This term has to do with the size of the compost pile. The minimum size for proper composting to occur is usually 1 cubic yard (3′ X 3′ X 3′). This size allows heating to occur; anything less in size will not have enough mass to generate internal temperatures high enough.

Proper temperature is a very important factor, particular in the aerobic composting process. In Georgia, the winter months temperatures will slow the process but most of the year temperatures will be sufficiently high enough for the intense microbial activity to take place.

Considerable amounts of heat are released by aerobic decomposition. Since the composting material has relatively good insulation properties, a sufficiently large composting mass will retain the heat of the biological reaction and high temperatures will develop.

High temperatures are essential for the destruction of pathogenic organisms and undesirable weed seeds. Decomposition also proceeds much more rapidly in the thermophilic temperature range. The optimum temperature range is 135°-175°F, with 150°F usually being the most satisfactory. Since only a few of the thermophilic organisms actively carry on decomposition above 170°F, it is undesirable to have temperatures above this for extended periods.

Although the eggs of parasites, cysts nematodes and flies are usually destroyed in a short time at temperatures above 135°F, these eggs and cysts have been found to survive in cooler parts of compost stacks for days though the temperature in the interior of the stack is above 135°F. Turning the pile exposes cooler materials to the interior heat of the pile. All the material should be subjected to a temperature of at least 150°F.

High temperatures vaporize ammonia, produced when the C:N ratio is low. Any small nitrogen loss due to high temperature is outweighed by the advantages of destroying pathogenic organisms and weed seeds, controlling flies, and providing better decomposition.

A drop in temperature in the compost pile before the material is stabilized indicates that the pile is becoming anaerobic and should be aerated (high temperatures do not persist whenthe pile becomes anaerobic). The temperature curve for different parts of the pile varies somewhat with the size of the pile, the ambient (surrounding) temperature, the moisture content, the degree of aeration, and the character of the composting material. Aerobic conditions, however, are important in maintaining high temperatures during decomposition. The size of the compost pile or windrow may be increased to provide higher temperatures in cold weather or decreased to keep the temperatures from becoming too high in warm weather. Experience will show that turning or aeration releases the heat of compost piles which have become so hot (170°-180°F) that bacterial activity is inhibited. When the material is actively decomposing, the temperature, which falls slightly during turning, will return to the previous level in two or three hours. However, it is usually not effective to reduce temperatures by watering the material because the mass may become waterlogged.

Variations in the moisture content between 30% and 70% have little effect on the maximum temperature in the interior of the pile. The initial temperature will rise a little more rapidly when the moisture content is 30% to 50% than when it is 70%. Studies, however, show an important and significant correlation between the moisture content and the temperature distribution within the pile. When the moisture content is high, the temperature near the surface will be higher, and the high temperature zone will extend nearer to the surface than when the moisture content is low. For example, in experiments at the University of California during mild weather when the air temperature fluctuated between 50° and 80°F, the zone of maximum temperature in a pile with a moisture content of 61% extended to within about one inch of the surface while the maximum temperature zone in a pile containing 40% moisture began 6 inches below the surface.

It is seen that the deeper pile caused higher temperatures and better temperature distribution and subjected a much higher proportion of the material to a high temperature at any one time. Hence, the actual mass of the material evolving heat is important in providing adequately high temperatures.

Shredding or pulverizing the material will also provide better temperature distribution and less heat loss. However, materials with a high C:N ratio or containing large amounts of ash or mineral matter will usually attain high temperatures more slowly in the compost pile.

Aeration and Oxygen

The compost pile must have a structure that allows for the movement of air. Sufficient air space within the organic material ensures an adequate oxygen supply, the removal of carbon dioxide and uniform moisture content throughout the organic material. Research indicates that 30%-35% of the initial volume of a pile should be made up of air spaces for optimum composting to occur. Bulking materials may need to be added to increase the porosity of fine-textured materials such as soil and livestock manure. Once air space has been provided, the finer the organic material is in structure, the more surface area will be immediately exposed to the microorganisms. The concern for maximum exposed surface area must always be balanced with the requirement for adequate free air space.

Keep over 5% oxygen throughout the entire pile. Typical oxygen percents range from 6% -16% in the pile and 20% at the exposed portions of the pile. Failure to keep all parts of the compost pile above the 5% oxygen level will cause the pile to "go anaerobic", with the accompanying odor problems. The more oxygen, the more quickly the composting will take place.

Aeration is also useful in reducing a high initial moisture content in composting materials. Several different aeration techniques have been utilized with varying degrees of success. Turning the material is the most common method of aeration when composting is done in piles. Hand turning of the compost piles is most commonly used for small garden operations. The most important consideration in turning compost, apart from aeration, is to ensure that the material of the outside of the pile of units is turned into the center where it will be subject to high temperatures. If desired, piles can be combined when they are being turned, particularly if long composting periods are used.

The frequency of aeration or turning and the amount of aeration or the total number of turns are governed primarily by the moisture content and the type of material, the moisture content being the most important. A high moisture content reduces the pore space available for air as well as reducing the structural strength of the material. This permits greater compaction and less interstitial or air space in the pile. Materials with a high C:N ratio may not have to be aerated as often as material which decomposes more actively and rapidly.

Studies at the University of California indicate that turning at fairly frequent intervals during the first 10 to 15 days of composting achieved approximately the same degree of stabilization as making the same number of turns over a longer period. Greater aeration during the initial stages of decomposition intensifies the activity of the microorganisms, shortens the period of active decomposition, and, consequently, reduces the time needed for composting.

Experience soon enables the composter to estimate the need for adding water and the need for turning. A good rule of thumb is to turn the pile daily if foul odors of anaerobic and putrefactive conditions are evident when the pile is disturbed either by turning or by digging into it for inspection purposes. The pile should be turned daily until odors disappear. No matter how anaerobic a pile may become, it will recover under a schedule of daily turning which reduces the moisture and provides aeration. A temperature drop during the first 7 or 10 days of composting is a good indication that turning for aeration is necessary.

Daily turning apparently inhibits the development of molds and actinomycetes, characteristic of piles disturbed less often. In piles turned daily these organisms develop only sporadically. This effect of daily turning is probably due to the daily exposure of the microorganisms to inhibitory temperatures within the interior of the pile. Such exposure prevents their accumulation in the cooler outer shell.

In summary, the avoidance of anaerobic conditions, and the maintenance of hightemperatures, are the important criteria for the degree of aeration.

Climatic Conditions

Climatic conditions, particularly temperature, wind, and rainfall, influence the composting operation. The effect of atmospheric temperatures, particularly the lowest temperature at which composting might be satisfactorily done, is not fully known. However, having a larger compost pile in cooler weather will reduce the heat loss.

Temperature

Organic refuse has excellent insulation properties. Research has shown that a steep temperature gradient exits between the outer and inner surface of compost piles. The difference in temperature between the outer and inner parts of the compost pile may be several degrees Fahrenheit difference per inch of material. It seems reasonable to believe that composting can be satisfactorily conducted even during severe freezing temperatures. It is probable that turning is not as advantageous in cold as in warm weather, because there would be a longer temperature recovery period after each turn when the colder exterior of the pile was turned into the interior.

Wind

Strong winds markedly lower the temperatures on the windward side of the compost pile. Two factors play an important role in temperature reduction by winds: (a) the coarseness of the material, which affects the porosity of the pile and the evaporation, and (b) the moisture content. Unshredded or coarsely shredded material has a greater porosity and permits greater penetration of wind into the pile. Consequently, more evaporation takes place, and when the material becomes too dry, bacterial activity is inhibited.

Shredding or grinding to produce a maximum particle size of about 2 inches provides a more homogeneous mass which is not as easilypenetrated by winds. Thoroughly wetting the exterior of the pile, particularly on the windward side, will reduce wind penetration and permit the interior high-temperature zone to extend nearer to the surface of the pile. Wind cooling and drying of compost piles is of little significance when piles or bins are used, since the material is protected on all sides except the top, which wetting will protect.

Rain

Rain usually does not seriously affect composting. If drainage at the bottom of the pile is inadequate, the pile should be finished with a rounded top so that the rainwater can run off. If the compost piles or bins are adequately drained so that water does not stand around the piles and penetrate the bottoms, then a slight depression helps maintain moisture in the pile (and will occur naturally anyway as the material decomposes). Heavy rains accompanied by high winds will penetrate a pile of coarsely shredded material as much as 12 to 15 inches on the windward side, but the resulting effect on large piles can be readily overcome by subsequent turning.

Turning should not be done in the rain, because the material may become waterlogged. If the material cannot be turned on the regular schedule due to rain, it is better to let it become deficient in air for a short time than to have the material soaked. Rainy weather can present more of a problem when composting is done in pits or bins. The top of the pit should be rounded to turn the water, which will, however, seep along the edges to the bottom. The bottom should therefore be adequately drained to remove the water and to allow a minimum of penetration into the compost.

Destruction of Harmful Elements

The destruction of harmful elements is a most important problem of compost containing weeds, grass seed and other plant pathogenic organisms.

An analysis of the typical temperature and of the thermal death points of a number of pathogenic micro-organisms and parasites indicates the unlikelihood of survival of some of the common disease-bearing organisms. The magnitude and duration of the high temperatures, results in very few pathogens or parasites surviving the aerobic composting process.

As previously described, the high temperature zone usually extends only to within 4 to 8 inches of the surface. Turning materials is therefore necessary, for ensuring pathogen and parasite destruction, particularly if a composting period under six months is used. In some composting operations the material is turned only once or not at all. A thermophilic temperature is developed after the initial aerobic stacking. This is considered to be sufficient to destroy the pathogens and parasites.

Is it safe to use compost from yard wastes that have come in contact with pesticides or other toxic chemicals? The major route of breakdown of pesticides is through microbial degradation, which is also the process of decomposition. Most pesticides will be broken down in the compost pile before the end of the process. The general belief is that most turf and garden pesticides that are currently permitted, and applied at label rates will be broken down and degraded more quickly in a compost pile than they will be in most other environments.

Slug bait:
: Most commercial slug baits contain metaldehyde which, when exposed to water, quickly breaks down to a harmless alcohol. (Fresh metaldehyde is toxic to slugs, snails, birds, cats, dogs, raccoons, rabbits, and humans).

Herbicides:
: Composting, an accepted decomposition process, biodegrades many compounds faster than soil degradation. Therefore, if organic materials are composted at least one year, pesticide residues should not be a problem when compost is used. (See Table 1.)

Insecticides:
: All contemporary insecticides will break down during the decomposition process.

Fungicides:
: Vegetation recently sprayed with a fungicide may suppress the development of decomposing fungi if added to the compost pile. A few weeks of composting will degrade the fungicide enough so that it will not affect the decomposition process.

Composting bins are often made of pressure treated wood to prevent rot from destroying the compost bin. Contrary to what you might intuitively expect, it’s apparently safer to use wood treated with CCA than wood treated with either creosote or pentachlorophenol. Several studies have found no evidence that CCA migrates from treated wood into garden plants growing in planter boxes of CCA treated wood. It seems reasonable to assume that CCA would not migrate into compost either.

Other Factors

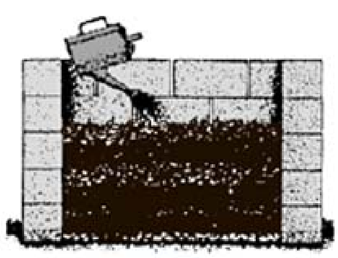
Anything that kills or inhibits the growth of the microorganisms should be kept out of the compost material.

The composting process has no affect on inorganic materials in the compost. This includes metals, glass, stones, etc. The composing process has very little decomposition affect on synthesized organic compounds such as most plastics. Some of these materials pose a safety threat to people and therefore should be kept out of the compost material as much as possible.

Reclamation of Nitrogen and Other Nutrients

Two of the most important purposes for home composting of organic wastes are (1) decreasing the amounts of usable organic materials that are being deposited in landfills, and (2) reclamation or conservation of the nutrient and fertilizer values of the organic materials. Of the major nutrients–nitrogen (N), phosphorus (P), and potash K)– nitrogen conservation is the most important. Nitrogen is more difficult to conserve in the compost pile than phosphorus and potash. Nitrogen may be lost by leaching, but the major loss of nitrogen in the compost pile comes from the escape of ammonia or other volatile nitrogenous gases from the compost material to the atmosphere.

Nitrogen loss as ammonia in aerobic composting is affected by the C:N ratio, the pH, the moisture content, aeration, temperature, and the initial form of nitrogen compounds in the organic materials.



A ratio of available carbon to available nitrogen of about 30 or more permits minimum loss of nitrogen. A C:N ratio of considerably over 30 may be necessary to provide maximum conservation of nitrogen. On the other hand, nitrogen losses of around 50% were observed in the University of California studies when the C:N ratio was in the range 20 to 25.

Ammonia escapes as ammonia hydroxide as the pH rises above 7.0. In the later stages of composting the pH may rise to between 8.0 and 9.0. At this time there should not be an excessive amount of nitrogen present as ammonia. Materials which contain large amounts of ash will have a high pH and may be expected to lose more nitrogen.

Some compost operators have suggested the addition of lime to improve composting. This should be done only under rare circumstances, such as when raw material to be composted has a high acidity due to acid wastes or contains materials which give rise to highly acid conditions during composting. It is recommended that when the pH remains above 4.0 to 4.5, lime should not be added. The pH will be increased by biological action and nitrogen will be conserved.

The moisture content of compost affects nitrogen conservation but to a much less extent than the C:N ratio and the pH. Ammonia escape is greater when the moisture content is low. The water serves as a solvent and diluent for the ammonia, thereby reducing the vapor pressure and volatilization. A moisture content range of 50% to 70%, which is also satisfactory for other aspects of composting, will assist in conserving nitrogen.

If ammonia is present, it will escape more easily when the material is disturbed and exposed to the atmosphere. However, if the initial C:N ratio is sufficiently high, the nitrogen losses during turning will be small.

High temperature increases volatilization and escape of ammonia. Since high temperatures are fundamental in aerobic composting and destruction of pathogen, there is little to be done about controlling temperatures other than to avoid temperature above 170°F.

Some materials, such as cellulose and porous fibrous matter, have the capacity to absorb or hold moisture and volatile substances, thereby reducing the tendency to escape. There is considerable evidence that material of this type plays a part in reducing nitrogen loss from compost. Materials containing considerable quantities of horse or cow manure seem to exhibit less nitrogen loss at a low C:N ratio than other materials and should be considered to be nitrogen carriers.

Loss of nitrogen by leaching may occur in rainy weather or if the composting material has too high an initial moisture content and excess liquid drains away. Loss by leaching depends on the amount of soluble nitrogen in the compost and on the amount of rainfall. Leaching may be minimized by arranging the compost piles so that water is prevented from entering the material.

Conservation of phosphorus and potash in composting is not difficult since about the only loss occurs through leaching during rainy weather.

Time

There is no time period after which you can say you have “total”, “perfect”, “complete”, “finished” compost. The current rule of thumb is that organic materials must be composted correctly and aged for at least one year, before the resulting compost can be called “safe for most uses.” Some composting methods will produce “finished compost” before twelve months, and some of the very low maintenance methods may take up to two years, or more, to produce “finished compost.”

How long it takes to turn organic materials into compost depends on many factors including the techniques used, seasonal temperatures (both outside and inside the pile), the balance of brown to green materials or C:N ratio, the size of the material, and moisture levels. In general the more time the compost material has had to “age,” the more stable and fully decomposed it will be. Time is one indicator that the compost is “mature.” With present methods “completely finished” compost is not likely in less than 120 days.

Assuming that the moisture content is in the optimum range, that the compost is kept aerobic, and that the particles of material are small enough to be readily attacked by the organisms present–all factors that can be controlled in the composting operation–the C:N ratio determines the time required for stabilization. Low C:N ratio materials are decomposed in the shortest time because the amount of carbon to be oxidized to reach a stabilized condition is small. Also, in low C:N ratio compost, a larger part of the carbon is usually in a more readily available form, while in higher C:N ratio materials more of the carbon is usually in the form of cellulose and lignin which are rather resistant to attack. As the breakdown process nears completion, cellulose and lignin are attacked last by the changing biological population. When the available C:N ratio is above 30, additional time is required for the recycling of nitrogen present. (See Carbon:Nitrogen Relationships)

If the material is not kept aerobic so that hightemperatures can be maintained during the active decomposition period, or if the particle size is so large that the bacteria cannot readily attack the material, longer composting periods are required.

Under aerobic conditions at high temperatures when the initial C:N ratio is in the optimum range or below, some of the material in the interior of the pile may take on the appearance and odor of humus after 2 to 5 days of active decomposition. However, active decomposition is not complete at this stage, and the C:N ratio may not have been lowered to the level desired for plant use. Moreover, in the average compost pile, materials on or near the outside of the pile probably would still be uncomposted.

The actual composting time sufficient for pathogens and parasites to be destroyed and for nitrogen to be conserved is not exact. (See Heat-Destruction of Pathogenic Organisms). So long as satisfactory compost can be produced, the turning, time of composting, storage, and other factors is generally flexible for home composting.

Unwanted Guests: The Pests of the Pile

Animal Pests

Given a comfortable or even marginally nourishing environment, pests, as well as beneficial species will show up to “get in on the action.” Rats are probably the least wanted guests of all. With a hospitable environment and plenty of food, their numbers can increase quickly. Because rats can be transmitters of disease, measures should be taken to discourage them from visiting or inhabiting composting areas. It is important to keep high protein and fatty food wastes out of the compost pile, such as meat and fish scraps, bones, cheeses, butter and other dairy products. As an additional precaution, bread and other high-carbohydrate wastes should not be composted.

Dogs, cats, and raccoons won't usually attempt nesting in the compost, as rats might do, but they are interested in much the same foods. Thus the same restrictions on food wastes are appropriate if a problem exists. Processing raw compost materials within simple structures, such as wire cages and wooden pallet bins is usually sufficient to discourage domestic animals from digging in the pile.

Flies and Related Pests

One of the most important considerations in composting is the control of flies. Many flies, including houseflies, can spend their larval phase as maggots in compost. Though they play an important part in the recycling and breaking down of all types of organic debris, they are unwanted guests around human households.

Garbage, livestock manure, and food scraps can be a media for the breeding and development of a fly population. If adequate control measures are practiced, and materials are covered there will not be a problem.

It is well to note that the life cycle of the ordinary housefly, musca domestica is usually from about 7 to 14 days when conditions are favorable. The time of the various life stages varies with the temperature and other conditions, but on the average, stages are as follows: egg, 1 to 2 days; larva 3 to 5 days; pupa, 3 to 5 days; emergence of young fly, 7 to 10 days; and egg laying by new fly, 10 to 14 days. Fly control measures must interrupt this cycle and prevent the adult flies from emerging so that no new eggs can be laid.

The composting procedures, turning, and systematic cleanliness, which are useful in providing compost of good quality and in destroying parasites and pathogens, are also effective for controlling flies. Initial shredding or grinding to produce a material which can be more readily attacked by bacteria destroys a large number of the larvae and pupae in the raw material. Also, the texture of material shredded to a particle size no larger than 2 inches seems to discourages fly breeding.

To control the numbers of these pests, keep attractive food wastes out of the compost pile, turn compost piles frequently (larvae die at high temperatures), cover piles with a dry material that has a lot of carbon in it such as straw or old grass clippings, or bury your food wastes. Fly-breeding can be satisfactorily controlled in most home composting operations during the fly season with a little more effort than is normally necessary for good sanitary composting.

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