# Vermicomposting

George W. Dickerson, Extension Horticulture Specialist

Yard and food waste make up a major component of solid waste in most municipalities throughout the United States. Although much of this organic waste can be recycled in the backyard using traditional aerobic backyard composting techniques, these techniques are not appropriate for apartment dwellers and are often inconvenient, particularly during bad weather in the winter.

Vermicomposting, or composting with earthworms, is an excellent technique for recycling food waste in the apartment as well as composting yard wastes in the backyard. Worm bins located near a hot water heater in the garage during the winter will save many a trip through the snow to the backyard compost bin. Letting worms recycle your food waste also saves your back, because you don't have to turn over the compost to keep it aerated.

## Types of Earthworms

The most common types of earthworms used for vermicomposting are brandling worms (*Eisenia foetida*) and redworms or red wigglers (*Lumbricus rubellus*). Often found in aged manure piles, they generally have alternating red and buff-colored stripes. They are not to be confused with the common garden or field earthworm (Allolobophora caliginosa and other species).

Although the garden earthworm occasionally feeds on the bottom of a compost pile, they prefer ordinary soil. An acre of land can have as many as 500,000 earthworms, which can recycle as much as 5 tons of soil or more per year.

Redworms and brandling worms, however, prefer the compost or manure environment. Passing through the gut of the earthworm, recycled organic wastes are excreted as castings, or worm manure, an organic material rich in nutrients that looks like fine-textured soil.

## What is Vermicompost?

Vermicompost contains not only worm castings, but also bedding materials and organic wastes at various stages of decomposition. It also contains worms at various stages of development and other microorganisms associated with the composting processing.

Earthworm castings in the home garden often contain 5 to 11 times more nitrogen, phosphorous, and potassium as the surrounding soil. Secretions in the intestinal tracts of earthworms, along with soil passing through the earthworms, make nutrients more concentrated and available for plant uptake, including micronutrients.

Redworms in vermicompost act in a similar fashion, breaking down food wastes and other organic residues into nutrient-rich compost. Nutrients in vermicompost are often much higher than traditional garden compost (see table 1).

Finished vermicompost should have a rich, earthly smell if properly processed by worms. Vermicompost can be used in potting soil mixes for house plants and as a top dressing for lawns. Screened vermicompost combined with potting soil mixes make an excellent medium for starting young seedlings. Vermicompost also makes an excellent mulch and soil conditioner for the home garden.

## Anatomy of Earthworms

The earthworm has a long, rounded body with a pointed head and slightly flattened posterior. Rings that surround the moist, soft body allow the earthworm to twist and turn, especially since it has no backbone. With no true legs, bristles (setae) on the body move back and forth, allowing the earthworm to crawl.

The earthworm breathes through its skin. Food is ingested through the mouth into a stomach (crop). Later the food passes through the gizzard, where it is ground up by ingested stones. After passing through

**Table 1. Chemical characteristics of garden compost and vermicompost, 1994.**

| Parameter* | Garden Compost[1] | Vermicompost[2] |
|---|---|---|
| pH | 7.80 | 6.80 |
| EC (mmhos/cm)** | 3.60 | 11.70 |
| Total Kjeldahl nitrogen(%)*** | 0.80 | 1.94 |
| Nitrate nitrogen (ppm)**** | 156.50 | 902.20 |
| Phosphorous (%) | 0.35 | 0.47 |
| Potassium (%) | 0.48 | 0.70 |
| Calcium (%) | 2.27 | 4.40 |
| Sodium (%) | < .01 | 0.02 |
| Magnesium (%) | 0.57 | 0.46 |
| Iron (ppm) | 11690.00 | 7563.00 |
| Zinc (ppm) | 128.00 | 278.00 |
| Manganese (ppm) | 414.00 | 475.00 |
| Copper (ppm) | 17.00 | 27.00 |
| Boron (ppm) | 25.00 | 34.00 |
| Aluminum (ppm) | 7380.00 | 7012.00 |

[1]Albuquerque sample
[2]Tijeras sample
*Units, ppm=parts per million m mhos/cm=millimhos per centimeter
** EC, electrical conductivity is a measure (millimhos per centimeter) of the relative salinity of soil or the amount of soluble salts it contains.
*** Kjeldahl nitrogen is a measure of the total percentage of nitrogen in the sample including that in the organic matter.
**** Nitrate nitrogen that nitrogen in the sample that is immediately available for plant uptake by the roots.

the intestine for digestion, what's left is eliminated.

Earthworms are hermaphrodites, which means they have both male and female sex organs, but they require another earthworm to mate. The wide band (clitellum) that surrounds a mature breeding earthworm secretes mucus (albumin) after mating. Sperm from another worm is stored in sacs. As the mucus slides over the worm, it encases the sperm and eggs inside. After slipping free from the worm, both ends seal, forming a lemon-shape cocoon approximately 1/8 inch long. Two or more baby worms will hatch from one end of the cocoon in approximately 3 weeks. Baby worms are whitish to almost transparent and are 1/2 to 1 inch long. Redworms take 4 to 6 weeks to become sexually mature.

## How to Construct a Worm Bin

Bins can be made of wood or plastic, or from recycled containers like old bathtubs, barrels, or trunks. They also can be located inside or outside, depending on your preferences and circumstances.

As red wigglers tend to be surface feeders, bins should be no more than 8 to 12 inches deep. Bedding and food wastes tend to pack down in deeper bins, forcing air out. Resulting anaerobic conditions can cause foul odors and death of the worms.

The length and width of the bin will depend on whether it is to be stationary or portable. It also depends on the amount of food waste your family produces each week. A good rule of thumb is to provide one square foot of surface area per pound of waste in your bin.

Wooden bins have the advantage that they're more absorbent and provide better insulation. Do not use redwood or other highly aromatic woods that may kill the worms. Plastic tends to keep the compost too moist. Plastic, however, tends to be less messy and easier to maintain. Be sure containers are well cleaned and have never stored pesticides or other chemicals. Drilling air/drainage holes (1/4- to 1/2-inch diameter) in the bottom and sides of the bin will ensure good water drainage and air circulation. Place the bin on bricks or wooden blocks in a tray to catch excess water that drains from the bin. The resulting compost tea can be used as a liquid fertilizer around the home landscape.

Each bin should have a cover to conserve moisture and exclude light. Worms prefer darkness. Bins can be covered with a straw mulch or moist burlap to ensure darkness while providing good air ventilation. Outside bins may require a lid to exclude scavengers and other unwanted pests.

Outdoor bins should be insulated from the cold to protect the worms. One option is to dig a rectangular hole 12 inches deep and line the sides with wooden planks. The bottomless box can then be filled with appropriate bedding material, food wastes, and worms. Food wastes can be continually added as they accumulate. The pile should be kept damp and dark for optimum worm activity. During the winter, soil can

be piled against the edges of the bin and straw placed on top to protect the worms from cold weather. Do not add food waste to outdoor bins during the winter because this could expose the worms to freezing weather.

## Bedding Materials

Bedding for bins can be made from shredded newspapers (nonglossy), computer paper, or cardboard; shredded leaves, straw, hay, or dead plants; sawdust; peat moss; or compost or aged (or composted) manure. Peat moss should be soaked for 24 hours in water, then lightly wrung out to ensure it is sufficiently moist. Grass clippings should be allowed to age before use because they may decompose too quickly, causing the compost to heat up. Bedding materials high in cellulose are best because they help aerate the bin so the worms can breathe. Varying the bedding material provides a richer source of nutrients. Some soil or sand can be added to help provide grit for the worms digestive systems. Allow the bedding material to set for several days to make sure it doesn't heat up (and allow to cool before adding worms).

The bedding material should be thoroughly moistened (about the consistency of a damp sponge) before adding the worms. Fill the bin three-quarters full of moist bedding, lifting it gently afterwards to create air space for the worms to breathe and to control odors.

## Adding the Worms

Under optimum conditions, redworms can eat their own weight in food scraps and bedding in one day. On the average, however, it takes approximately 2 pounds of earthworms (approximately 2,000 breeders) to recycle a pound of food waste in 24 hours. The same quantity of worms requires about 4 cubic feet of bin to process the food waste and bedding(1 cubic foot of worm bin/500 worms).

Composting worms can be purchased from dealers listed in the ad sections of many garden magazines. Some dealers sell worms as pit-run worms, which consist of worms of all ages and sizes. Add worms to the top of the moist bedding when they arrive. The worms will disappear into the bedding within a few minutes.

## Adding Food Waste

Earthworms eat all kinds of food and yard wastes, including coffee grounds, tea bags, vegetable and fruit waste, pulverized egg shells, grass clippings, manure, and sewage sludge. Avoid bones, dairy products, and meats that may attract pests, and garlic, onions, and spicy foods. Limited amounts of citrus can be added, but too much can make the compost too acidic. The compost should be kept at a pH of 6.5 if possible, with upper and lower limits at 7.0 and 6.0, respectively. Overly acidic compost can be corrected by adding crushed eggshells.

Avoid adding chemicals (including insecticides), metals, plastics, glass, soaps, pet manures, and oleanders or other poisonous plants, or plants sprayed with insecticides to the worm bin.

Food wastes should be added to the bin by pulling back the bedding material and burying it. Be sure to cover it well to avoid attracting flies and other pests. Successive loads of waste should be buried at different locations in the bin to keep the food wastes from accumulating. Grinding or blending the food waste in a food processor speeds the composting time considerably.

## Controlling Temperature and Moisture in the Bin

Redworms can survive a wide range of temperatures (40-80°F), but they reproduce and process food waste at an optimum bedding temperature range of 55-77°F. The worms should never be allowed to freeze. Bins kept outside may have to be insulated with straw in the winter to keep the worms from freezing. Portable bins can be kept by a hot water heater in the garage during the winter to keep them warm.

The bin contents should be kept moist but not soaked. Do not allow rainfall to run off a roof into the bin. This could cause the worms to drown. A straw covering may be needed in exposed sites to keep the bin from drying out during hot summer weather.

## Maintaining the Bin

Food scraps can be continually added to the bin for up to 2 to 3 months, or until you notice the bedding material disappear. When the bedding disappears, harvest the worms and finished compost, then refill the bins with new bedding material.

Overloading the bin with food wastes can result in foul odors. If you notice these odors, stop adding the waste until the worms have a chance to catch up. Overly moist food waste and bedding also cause odors. To relieve this problem, fluff up the bedding to add air and check the drainage holes. As a general rule of thumb, keep the bedding material moist, but never soggy. Make sure the food waste is buried properly in the bedding. Exposed food wastes can attract fruit flies, house flies, and other pests. Keeping the bin covered with straw or moist burlap also deters these pests.

Garden centipedes can be a problem in the worm bin, especially outside. These predators should be destroyed. Overly wet beds also can attract the earthworm mite, which may cause the worms to stop eating.

## Harvesting the Compost and Worms

There are three basic ways to separate the worms from the finished compost. One way involves moving the finished compost and worms over to one side of the bin and adding new bedding material and food waste to the other side. Worms in the finished compost should move over to the new bedding with the fresh food waste. The finished compost can then be removed.

A second way to remove the worms is to build a small harvester frame of 2 x 4s with a 3/16-inch mesh bottom. Place the worm compost on the frame and sift the worms out. Larger pieces of compost can be returned to a new batch of bedding and worms.

The compost also can be placed in small piles on a tarp in the sun (or under bright lights inside). Because worms don't like light, they will wiggle to the bottoms of the piles. After waiting 10 minutes, remove the upper inch or more of finished compost from each pile until you run into the worms. Allow the worms to again wiggle to the bottom of the pile and repeat the process. Combine whats left of the small piles into one big pile and again repeat the process. You should eventually end up with a pile of finished compost and a ball of worms. The worms can be added back to a new bin of bedding and food waste. Larger worms also can be used as bait for fishing.

## References

Appelhof, Mary. 1982. Worms Eat My Garbage. Flower Press, Kalamazoo, Michigan. 100 p.

Martin, Deborah L. and Gershung, Grace. 1992. The Rodale Book of Composting. Rodale Press, Emmaus, Pennsylvania. 278 p.

Shields, Earl B. 1982. Raising Earthworms for Profit. Shields Publications, P.O. Box 669, Eagle River, Wisconsin. 128 p.

# Index