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Small-Scale Vermicomposting

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Vermicomposting uses earthworms and other microorganisms to digest organic wastes, such as kitchen scraps. Vermicomposting is faster than traditional composting methods, requires less space, and creates little odor. Making a "worm bin" stocked with composting worms and feeding them plant scraps from the kitchen and garden is a convenient, low-maintenance waste-processing method usable almost anywhere people live, including urban environments. Vermicomposting is an easy way to make a positive environmental impact by reducing the amount of green-waste that finds its way into landfills, incinerators, and sometimes the ocean. The resulting nutrient-rich compost endproduct is an environmentally sound amendment to enrich soil for plant growth.

Composting with worms is practiced all over the world. Composting and soil-dwelling worms are not the same—they are related species, but they have different roles in nature. Any worms that are naturally attracted to fresh organic wastes can be used in a vermicomposting system. One particularly effective composting worm found in Hawaii is *Perionyx excavatus*, the blue worm. Although Hawaii Department of Agriculture quarantine regulations currently prohibit importing earthworms, several types of composting worms are available from suppliers within the state.

Vermicomposting is a promising biotechnology for many waste management applications. The description here of a small-scale vermicomposting system is meant to introduce the basic principles of vermicomposting.

Composting worms

Over 4,400 distinct species of earthworms have been identified and named by researchers. Only a few of these worms are found in Hawaii, and not all of these are useful for vermicomposting. The most familiar worms are soil-dwelling worms, and their primary job is soil aeration. Commonly known as "earthworms," they live 2–8 inches down in the soil. If you dig a hole in your garden and find a large worm, it is most likely a soil-dweller. Soil worms eat soil minerals and some organic matter in the soil or on its surface. They prefer the cooler temperatures found in the soil and often come to the surface to consume organic matter after a heavy rain. Soil worms require soil to survive—do not put them in a worm bin. It is difficult to duplicate their preferred environment in a worm bin, and they will not process food scraps as effectively as compost worms.

The primary job of compost worms is composting. *Perionyx excavatus* worms, for example, are small, red-purple worms that prefer an environment of decaying organic matter rather than soil. Compost worms reproduce quickly, consume large amounts of organic material, and tolerate the environment of a worm bin.

The worm bin

Some type of container is needed to house compost worms for vermicomposting. Systems can be as simple as a stack of plastic food-storage containers or as complex as an automated unit capable of processing hundreds of pounds of organic matter daily. Generally, each square foot of bin area can process 1 pound of food waste per week.

Preparing the bin

Worms need bedding in addition to food. Shredded paper or newspaper, coir (coconut husk fiber), and shredded cardboard are good bedding materials for worm composting. Soak the bedding well with clean water and then squeeze it to remove excess liquid. The bedding should be damp, like a wrung-out sponge. Here are basic directions for a stacked worm bin system with three bins:

- Spread a 1–2 inch layer of damp bedding on the bottom of the top bin (the middle bin is empty).

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- Add compost worms to the bedding; you do not need to spread them out.
- Add a small amount of food scraps to the bin, about 1–2 cups.
- Cover the scraps with another layer of damp bedding. Do not block the side air vents. Make sure all food scraps are covered with bedding material.
- Replace the lid. Excess moisture will drain to the lower bin. Remove any excess liquid from the lower bin as it accumulates (use it in your garden or outdoor compost pile).
- Make note of the date you started the worm bin.
- If you purchased the worm bin, follow the directions that came with it.

Bin maintenance

The worms will get settled in their new home, your worm bin. Worm eggs (cocoons) in the worm "starter" (inoculant) will hatch. Feed the worms a small amount (1–2 cups of kitchen fruit and vegetable scraps) when you start a bin and then nothing for two weeks. This helps the worm population to begin to grow without initially overwhelming the system. As the mature worms eat and grow, they will begin to lay eggs. Juvenile worms will appear, and the population will increase. In about 6 weeks, the immature worms will be mature and lay eggs of their own. Observing this population explosion can be an exciting and fascinating biology lesson.

You will notice worm castings (rich, gray-brown, soil-like material) in the bin. The worms produce castings as they eat, filling the bin as they go. Continue feeding the worms. If you purchased a worm bin system, follow the directions, because feeding schedules and amounts vary from model to model. When the worms have worked through the green waste, you will be left with rich, organic worm compost, ready to enrich your garden soil.

Over time, you may wish to buy another set of bins or share worms with your friends to start bins of their own. Compost worms will never "outgrow" your bin. If the population gets too large, the worms will stop reproducing and their numbers will decrease naturally according to the bin size and the food supply.

Worms like the "3 Ds"

Damp, Dark, and Dinner! First, worm bin bedding should be damp, like a wrung-out sponge, but not soggy. Worms will die or try to escape if the bin is too wet or dry. Check the drainage holes and clear any clogs with a toothpick. Second, worms are sensitive to light and should be kept in a *dark* environment. In commercial stacking bin systems, the two bins that hold worms are dark-tinted. If worms are trying to escape, it is a signal that conditions are not ideal inside the bin (see the troubleshooting table on page 3 for help).

And finally, *dinner*—worms love to eat! Check the bin contents. Spread the feedings around to encourage worm population growth. Watch food disappear: some things will go faster than others, and useful worm castings and compost will be left. Worms eat best when the bin system is well maintained. A pound of worms can eat up to 2 pounds of food scraps each day. As the worm population grows, the amount of food that you can give them increases.

Illegal worms

Hawaii's environment is under constant threat from alien plants, animals, and microorganisms that arrive here, mostly introduced by humans. State law has established restrictions on importing potentially harmful organisms, and strict quarantine protocols are in place. These protections make it *illegal to import worms* into the state of Hawaii. Do not mail-order worms from the U.S. mainland or any other location outside Hawaii. Fines for violating quarantine regulations can be as much as $25,000. These restricted worms are marketed as "red worms" or "red wigglers" and are commonly sold in the continental USA for fishing bait and other purposes. Within Hawaii, various suppliers of compost worms have recently appeared; they should be familiar with the regulations and able to provide worms that are approved for sale and transport to your location.

Temperature and ventilation

Compost worms can tolerate a wide range of temperatures, but most work best at temperatures between 70 and 80°F. The worms available locally are suited to our warm climate. Although most areas of Hawaii need not worry about freezing, you should protect your worms from temperature extremes. Keep the bins out of direct sunlight (a covered porch or carport is a good location). Temperatures inside the bin are generally lower than the surrounding air because the bedding is moist and evaporation creates a cooling effect, creating a mini weather system in the bin. Ventilation, in the form of air vents, keeps oxygen in the bin. Worms need oxygen and produce carbon dioxide, just like we do. Each time you open the bin to feed the worms you also refresh the air in the bin.

Acidity

Compost worms tolerate a wide range of acidity in their environment, but the ones found in Hawaii prefer a just slightly acidic condition. It is possible for a bin to become too acidic, killing adult worms and preventing eggs from hatching. To be safe, limit amounts of acidic food scraps, such as pineapple, citrus, and tomatoes.

Other organisms associated with compost

Depending on where you keep your bin, you may notice other critters in with the worms. These worm "friends" are usually beneficial organisms in small numbers; they include springtails, mites, rove beetles, and millipedes, as well as microscopic bacteria and fungi, and these associated organisms enhance the composting process. Centipedes, however, are predators and should *not* be in your worm bin—if you find one, remove it carefully to avoid being bitten.

Using the compost

In a stacking bin system with bins that are rotated, the worms will feed on organic material in the middle bin. After the conversion to compost is finished, the worms will be attracted to the new feeding bin above them by the food added to it. A few worms may remain in the old bin to finish consuming all the available food before it becomes finished compost. Eventually, all the worms will leave, moving to the new feeding bin above, and you will be left with finished worm compost.

A good potting soil recipe is 1 part vermicompost and 3 parts soil. Vermicompost is best used moist, as it loses nutrients as it dries. In the garden, use it at root level, digging it into the soil. The liquid that drains into the lowest bin is called leachate. It is not uncommon for it to have a slight odor. It can be used full-strength or mixed with water. Use it to water plants or dispose of it on your compost pile. Worm compost "tea" is made from finished compost and involves a separate process.

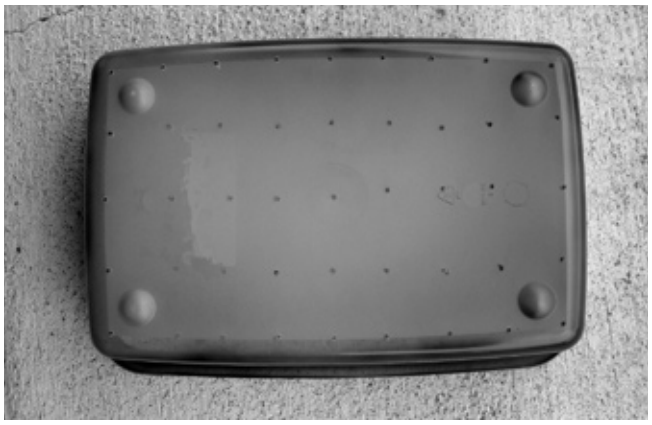
Worm bin troubleshooting

Problems	Causes	Solutions
Bin smells bad	Overfeeding	Stop feeding for two weeks.
	Food scraps exposed	Bury food completely.
	Bin too wet	Mix in dry bedding; leave lid off.
	Not enough air	Fluff bedding; clear drainage holes.
Bin attracts flies	Food scraps exposed	Bury food completely.
	Rotten food	Cover with clean bedding.
	Too much food; esp. citrus	Don't overfeed worms.
	Black soldier fly larvae*	Pick out larvae, add them to backyard compost pile; bury food completely; reduce acidic foods.
	Black soldier fly adults*	Release from bin.
Bin attracts ants, centipedes		Remove centipedes; change bin location.
Worms are dying or crawling away	Bin too wet	Mix in dry bedding; leave lid off.
	Bin too dry	Thoroughly dampen bedding.
	Extreme temperatures	Move bin to 70–80°F location.
	Not enough air	Fluff bedding, check for blocked vents.
	Not enough food	Add more bedding and more food scraps.
	Bin conditions not right	See above; leave lid off (worms will burrow into bedding).
Excess mold	Conditions too acidic	Cut back on acidic foods.
Bedding drying out	Too much ventilation	Dampen bedding; keep lid on.
	Extreme temperatures	Move bin to 70–80°F location.
Excess drainage	Poor ventilation	Fluff bedding; add dry bedding.
	Too much water in food	Cut back on coffee grounds and watery scraps

*Note: Flies are naturally occurring pests that can be avoided if food is buried. Black soldier flies can be beneficial insects that assist in rapid decomposition of organic materials, but they compete with worms for food in a vermicomposting bin. The adults look like black wasps but are harmless. Remove the larvae and add them to your backyard compost pile, where they will assist in the composting process.

Vermicomposter with three nesting bins. Bottom bin collects drainage. Initially, bedding, food, and starter worms are placed in the top bin, while the center bin remains empty.

Top bin prepared with bedding and food scraps. Bins shown are approximately 17 x 12 inches.



Bottom of bin, with drainage holes. The top and center bins have holes; they also have holes in the sides for ventilation.

Finished compost, a uniform, loamy material in which no food scraps are identifiable.

Worm composting is easy, fun, and educational. If done correctly, the composting system will have a pleasant, earthy smell. In fact, the worms eat the bacteria that cause bad odors. If there is a smell, conditions are not right in the bin (see the troubleshooting table on page 4). Check the drainage bin regularly. Worm leachate should be discarded and never allowed to back up into the center bin.

Always bury the food scraps in the bedding, and spread the food around. Should fru it fly maggots or adults appear, stop adding feed for a week. Harvest the bin when most of the bedding material has been converted to vermicompost and looks like soil.

Be sanitary—wash your hands after working with a worm bin.

Bottom bin has no holes, so drainage water is contained and can be added to compost or used for irrigating plants.

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