1001 Worms:
A Vermicomposting Primer

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"It may be doubted whether there are many other animals which have played so important a part in the history of the world, as have these lowly organized creatures."

Charles Darwin, The Formation of Vegetable Mould through the Action of Worms, With Observations on their Habits, 1881

What is vermicomposting?

Vermicomposting is also known as red worm composting. It is a process of turning kitchen scraps into compost as worms eat the food and bedding and produce castings which serve as soil conditioner and rich source of plant nutrients. Vermicomposting is done all over the world and is being used on a large scale in India and Cuba. It is also fairly common in California. Vermicomposting can be done indoors or outdoors, but with Maryland's hot summers and cold winters, red wiggler worms would likely die outdoors, so this paper will focus on setting up and maintaining an indoor worm bin.

vermis is Latin for worm

Why vermicompost?

-It reduces waste.
-It's a good way to compost for people who don't have space for a compost pile (or who don't like to go out to the compost pile to dump their food scraps in the middle of winter).
-It's easy, inexpensive to set up, and educational.
-The first results of composting become visible in about a month.
-It is a great project for children.
-It produces very high quality compost.

Materials needed to set up a worm bin:

Bin
Bedding material
Worms
Food

Shredded newspaper + food scraps + worms + time = vermicompost

Bin:

•Various commercially produced models are available (Can of Worms, Worm Factory, etc.)
•It is easy and inexpensive to make your own bin. Directions for making a simple homemade bin or a stacking bin can be found at the end of this paper*.
•Location for the worm bin: Red wigglers do best in a location where the temperature range is between 55 and 77 degrees and is out of direct sunlight. The kitchen and basement are common locations for worm bins. In areas with milder summers and winters, worm bins are often kept in garages or on
porches.
•It may take the worms a few days to "settle in" to their new home and for the bacteria in the bin to reach the levels preferred by the worms. During those first couple of days, it is normal for worms to crawl on the sides and top of the bin. Leaving a light on outside the bin for a couple of days will discourage worms from exploring outside the bin.

Bedding material:

-Newspaper, shredded or torn into 1" strips, soaked in water for a few minutes and then squeezed until only a few drops of water drip out;
-Coir;

-Shredded corrugated cardboard; or
-Leaves/hay.

Fluff the bedding materials after adding to the bin.

Worms-

Eisenia foetida. Also known as red wigglers, manure worms, compost worms, or redworms. They are epigeic worms, which means they live in surface litter and feed on decaying organic matter. They do not make permanent burrows.
-One pound (approximately 1000 worms) is a good amount to start a home worm bin.
-Do not use night crawlers as they make deep, permanent burrows and are not well suited to living in an indoor bin.

Food scraps-

-One pound of worms can process approximately 3.5 –7 lbs./week. Start out somewhat slowly—you don't want to overload the bin and create anaerobic conditions. Gradually increase the amount of food.
-Worms prefer food that has already been worked on by bacteria and protozoa, so they will eat the food in the bin after it has been in there about one week.
-The worm population will increase if the food is plentiful and will decrease if the worms need to compete for food.
-Feed worms 2-3 times a week. Bury the food shallowly under the bedding or pocket-feed. Add extra dry shredded newspaper on top of (or mixed in with) the food if the food has a lot of moisture in it. Food should be covered by a 3-4 inch layer of bedding. Rotate locations for food. Add new food as soon as you see that the worms are beginning to "work" the food you previously buried.

Appropriate food for worms:

•Vegetable and fruit scraps (banana peels, melon rinds, apple cores, cucumber peels, etc):
-Freeze for 3 days or microwave until it bubbles to kill fruit fly eggs and larvae. Bring to room temperature and drain excess liquid before placing in worm bin.
-Chopping the food provides more surface area for the bacteria.
-Don't put in excessive amounts of raw onions or garlic and avoid too much citrus.
•Coffee grinds and filters, tea bags.
-Excessive amounts of coffee grinds may lower the pH of the bin.
•Eggshells-dried and pulverized.
-The eggshells will help keep the bin from becoming too acidic and may be an important factor in worm reproduction.
•Bread/cereals/grains.
-Too many grains may cause the bin to "heat up".

-Do NOT put the following in worm bin:
•Meat, fat, bones,
•Oils/grease,
•Pet waste or litter,
•Dairy products.

A healthy worm bin

In setting up a worm bin, you are setting up a small eco-system. There will be other critters in the bin. Most aid in decomposition.

•Good worm bin residents:
-Bacteria
-Protozoa
-Millipedes
-Pillbugs
-Sow bug
-Springtails
-Collembola
-Mites-White or brown mites won't hurt the worms. Large populations may indicate that the bin is too wet, so add more dry bedding and/or leave the lid off the bin for a while to let it dry out a bit. Large populations may also indicate that the pH is too low. Red mites can kill worms. (Red mites are bright red).
-Soldier flies/soldier fly larvae- The larvae are voracious composters. If you don't mind having them in the bin, you'll need to add extra food to accommodate their eating habits. They'll fly away when they've reached the adult stage.

•Undesirables:
-Centipedes will kill worms. Remove and put in regular compost pile. Centipedes are territorial, so you usually won't find more than one.
-Ants -Bedding may be too dry. Moisten it a bit. Bin's pH may be too low-add eggshells. Smear a line of Vaseline or chalk under the line of ventilation holes where the ants might be entering. Put the bin's legs in a moat of water.
-Fruit flies. -Pre-treating food usually prevents fruit flies from coming in with the food. If some enter from ventilation holes, try using traps from yellow sticky paper. Vinegar traps may help too. Severe infestations can be cured using beneficial nematodes (Steinernema feltiae or Steinernema carpocapsae) or Bt (Bacillus thurungiensis var. israelsis). An "envelope" of mosquito netting will prevent fruit flies from entering the bin from the outside, or will contain an unruly infestation while you are getting it under control.
-Fungus gnats.-Fungus gnats look like fruit flies, but their eyes are not red. They are also slower and easier to catch than fruit flies. They prefer environments exactly like the worm bin—moist with lots of decaying matter. Beneficial nematodes or repeated applications of Bt will cure a serious infestation. An "envelope" of mosquito netting will prevent any from entering the bin from the outside, or will contain an unruly infestation while you are getting it under control.
-Soldier flies/soldier fly larvae- Some people love having them in the bin; others hate them. They will fly away once they reach the adult stage.

Worm anatomy:

-Worms are annelids.
-Red wigglers are photophobic (sensitive to light).
-Worms' skin is sensitive to both moisture levels and light.
-Worms have no lungs and breathe through their skin.
-Worms have no eyes or ears.
-Worms have no teeth and use their gizzards to grind food.
-Worms may have up to 5 pairs of hearts.

-Worms are segmented. Worms can be identified by counting segments and by the location of the sexual organs.
-Red wigglers can live up to 4 years.
-Worms' bodies are 75-90% water.

Worm Reproduction

-The worm population will increase if food is plentiful and will decrease if they need to compete for food.
-Worms are hermaphrodites.
-The presence of a clitellum (light colored band around the middle of the worm) indicates that the worm is sexually mature.
-Red wigglers produce lemon shaped cocoons which change color as they grow. -After about 21 days, 2-3 worms hatch from each cocoon.
-Under ideal conditions, worm populations may double in about 2-4 months.

Problem solving:

•Check bin regularly to note any problems and to observe worms, their cocoons and baby worms.
•Worms trying to escape indicates that the bin is too wet or too dry.
•Bin smells bad
-Too much food has been added at one time. Remove some food and cut back on the amount of food that worms are fed. It takes some time to get a worm system up to full production.
-Something has been put in the bin that doesn't belong there and it has become rancid.
-The bin needs more air. Add more ventilation holes and fluff up the bedding.
-Leachate may have accumulated in the catch-bin under the drainage holes and needs to be emptied out.
•Bin is too wet
-Add extra bedding. Leave lid off for a while. Add more drainage holes.

-Harvesting the compost

Although some sources say that the castings are toxic to the worms, other sources say that the worms can, and do, ingest the castings without harm. The worms often prefer to live in the part of the bins that is richest in castings. Nonetheless, after about 3-4 months you can begin to harvest the castings by one of the following methods:

•Dump and sort: Harvest by dumping contents of bin onto a tarp. Separate the contents into small piles. Shine a light on the compost piles. The worms will move toward the bottom of the piles to avoid the light and you can remove the compost from the top. Continue removing compost as the worms continue to move to the bottom to avoid the light. Allow an hour or two for this process. If you feel the need to take a census, this method is the best.

•Lateral migration: Harvesting can also be done by moving the contents of the bin to one side, putting fresh bedding in the other side and beginning to feed in the new side. Worms will gradually migrate to the new side and the other side, which will be mostly castings, can be harvested. This takes a very long time and a lot of patience, but requires little effort on your part.

•Vertical migration/Layers: After a while of feeding the worms, begin feeding in layers. Lay a piece of fiberglass window screen on top of the layers and continue feeding on top, adding a layer of new bedding along with the food.. Worms will gradually move to the upper layers, which can then be lifted off and put into a new bin. In theory, what remains behind should be mostly worm castings.
Some commercially available worm bins rely on this vertical migration system.
Also, a homemade stacking bin system uses vertical migration to facilitate harvesting.

•Stop feeding. Worms will finish processing the food and bedding and will die off and their bodies will decompose. You can harvest several month later. If you wish to continue vermicomposting, you will have to purchase new worms. Plus, it's not very humane.

How to use vermicompost-

•Some people say to use the vermicompost right away; others say to let it "cure" a bit. There may be cocoons in the vermicompost that may hatch and the worms can then be put back into the worm bin. (Some people choose to freeze the vermicompost or put it in a black plastic bag and put it in the sun for a few days to kill any remaining worms. The black plastic bag/sun method may result in bad smelling vermicompost).
•After harvesting, the castings may be pretty wet. It is not necessary to dry the castings before use, however drying them slowly will produce a nice, fluffy soil amendment. Be careful not to let the castings dry out to quickly or too completely, otherwise you may produce a hard rock-like substance that is difficult to re-wet.
•Store casting in a Rubbermaid bin or large bucket with holes drilled in the lid until you ready to use.
•The castings can be used on houseplants as well as in the garden.
•You can also make compost tea to use to water plants. (Add some castings to water, mix, aerate for about 24 hours and use within 12 hours).

•Research has shown that vermicompost has higher levels of plant available nutrients than does regular compost and higher levels of beneficial microbial activity. Studies have also shown that vermicompost stimulates plant growth, suppresses disease and may repel pests.

A note:

There is a surprisingly large amount of information available about vermicomposting. Some of the information is conflicting: "Never feed worms banana peels or potatoes"; "Worms love bananas and potatoes". "Never use the leachate on plants"; "The leachate is as beneficial as compost tea for plants". "Worms will die in cold temperatures;" "Worms can survive having their bodies partially encased in frozen bedding and cocoons can survive extended periods of deep freezing."
So, while there are some basic principles that will keep your worms happy, healthy, and productive, there are few hard and fast rules. You will need to experiment to find out what works best for you and your worms.

***Directions for making a worm bin:**

The very simplest homemade bin
-You need an opaque plastic storage bin with a lid(approximately 10-14 gallons -- not larger than approximately 18x24x18t. The bin should not be not too deep or too big.
-Add ventilation holes - small holes drilled in the sides (beginning about 4" from bottom, at 2" intervals).
-If the bin gets too wet inside, you may need to add ¼" drainage holes, as described below.

Simple homemade bin

-You need an opaque plastic storage bin with a lid (approximately 10-14 gallons -- not larger than approximately 18x24x18t. The bin should not be not too deep or too big.
-Add ventilation holes - small holes drilled in the sides (beginning about 4" from bottom, at 2" intervals).
-Add drainage holes (About 24 holes in the bottom of the bin- about 1/4 in diameter).
-Elevate the bin on little legs and put it in another shallow bin catch the leachate, or stack it inside another same-sized bin with some ventilation holes drilled in the sides, about 3" from the bottom.

A stacking homemade bin with holes in the bottom of each bin is also easy to make. This bin design facilitates harvesting.

-Use 3 opaque 10 gallon bins with lids (Rubbermaid roughneck totes, which measure 15"x21"x8", work well).
-Bins 1 and 2: Drill approximately 30 1/4" drainage holes in the bottoms of 2 of the bins. Also drill a row of drainage holes on the lower edge of the sides of these 2 bins. Space these holes about 2"from the bottom of the bin and about 2" apart. Also put a row of ventilation holes about 2" from the top edge of the bins (these holes can be smaller in diameter).
-Bin 3: Drill 1/4" ventilation holes on the bottom third of the sides of this bin. The lowest row of holes should be about 2" from the bottom of the bin. Do NOT drill any drainage holes in the bottom.
-Stack bin 1 inside of bin 3. Place bedding material, worms and food inside of bin 1 and cover with lid. After 3-4 months of feeding, put bin 2 on top of bin 1 with bedding material. Continue feeding in bin 2. After several months, the many of the worms will have migrated to bin 2 and you can harvest bin 1.

Resources:

www.hgic.umd.edu/pubs/online/redworm_composting (simple description of vermicomposting with enough information to set up a worm bin.)

www.ciwmb.ca.gov/Schools/curriculum/worms/ (The Worm Guide: 48 page vermicomposting guide for teachers.)

www.ciwmb.ca.gov/Schools/curriculum/Worms/98Activities.pdf (34 page guide with classroom activities on vermicomposting.)

http://whatcom.wsu.edu/ag/compost/Redwormsedit.htm (useful and kid-friendly information on worm bins.)

www.wormwoman.com (source for red wiggler worms and lots of useful information on vermicomposting.)

www.klickitatcounty.org/solidwaste/ContentROne.asp?fContentIdSelected=991251662&fCategoryIdSelected=965105457 (has a link to a pdf file with directions for building a worm bin)

Worms Eat My Garbage: How to Set up and Maintain a Worm Composting System, Mary Applehof (a vermicomposting classic)

The Earth Moved: On the Remarkable Achievements of Earthworms, Amy Stewart, Algonquin Books of Chapel Hill, 2004 (Lots of interesting and historical information about worms).