Worm Composting Revisited

If "worm bin" makes you think of bad smells and pesky fruit flies, think again: new vermiculture systems and strategies make it easy to succeed with worm composting

by Jennifer Kusmanoff

Subject areas: science, art, math, language arts

Key concepts: vermiculture, worm compost, nutrient cycling, anatomy

Skills: journal writing, data collection

Location: indoors

Time: varies

Materials: worm bin(s) (purchased or classroom-built), red wiggler worms

Classroom composting with worms — or vermicomposting — is a unique way to capture the attention and interest of students while teaching them the importance of recycling. Vermicomposting has been used in agriculture for many years, with vermiculture farms worldwide producing large amounts of vermicompost as rich plant fertilizer. Many individuals use worms to compost leftover food scraps in their homes, perhaps placing a makeshift worm bin under the sink or in the garage. Only in recent years has composting with worms become a popular recycling activity in schools. In the beginning, rudimentary bins and such problems as fruit flies, rotten smells, and mold presented many challenges to teachers. Some were ordered to give up vermicomposting in their classrooms because entire schools became infested with fruit flies. Today, with new worm bins and new strategies for vermicomposting, these problems are eliminated.

Composting in the classroom continues to be a wonderful tool for introducing environmental education and for taking a hands-on approach to recycling. Worm composting activities have cross-curricular applications within science, math, language arts, home economics, and ecology. Through vermicomposting experiments, students develop skills in teamwork, observation, record keeping, reporting, and measuring. They also make the connection that they are aiding the environment by recycling leftover food scraps that would normally go to a landfill. Furthermore, students of all ages learn to use the nutrient-rich vermicompost produced by the worms as fertilizer for plants in outdoor and contained gardens, indoor plant stands, and science experiments. Overall, starting or restarting a worm composting program in your classroom can bring satisfying rewards to you and your students.

Jennifer Lippmann, Gateway Greening

Classroom vermiculture basics

To begin, it's important to note the four basic needs of every organism: shelter (in vermicomposting, the worm bin), air, water, and food.

Shelter: the worm bin

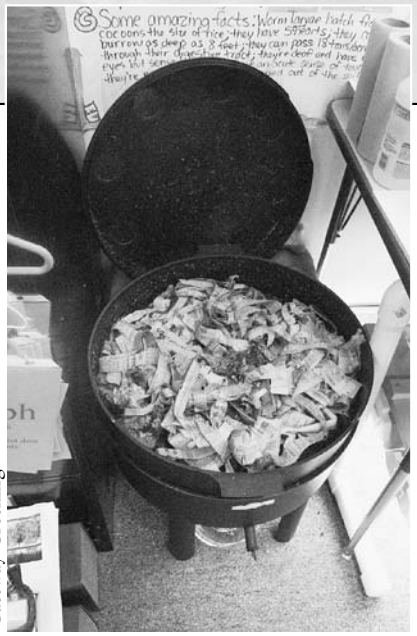
Great strides have made in recent years to refine the design of vermicomposting systems, so that many worm bins on the market today are wonderful to use. There are numerous styles of worm bins to choose from, ranging from complex multi-level bins to basic rectangular plastic bins; each has its own advantages and disadvantages. The larger multi-level bins — with built-in drainage and more than one feeding level — are well designed, sophisticated, and require little maintenance. In addition, they can process large amounts of food waste and are esthetically pleasing. The only disadvantages to educators of these larger bins are their size and higher cost,

Worm bins

The Cadillacs of worm bins are multiple-level models (e.g., the Can-O-Worms) that make it easy to separate the worms from the finished vermicompost at harvest time. Worms, bedding, and food scraps are initially added only to the bottom tray. Once the lower tray is full of rich castings, feeding shifts up to a second tray. The worms migrate upward in search of more food, leaving the vermicompost behind. As the worms reproduce and all the trays come into production, the system can handle 3 to 4 kilograms (5 to 8 pounds) of food per day and produce a full tray of vermicompost each month.

Many simpler, less expensive models are available commercially. Or teachers can make their own worm bins by drilling air and drainage holes in large plastic storage containers or a homemade wooden bin.

Reln Plastics Ltd., Australia



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A new layer of bedding and food scraps has just been added to this multi-level bin at Crestview Middle School in St. Louis, Missouri.

given the limited space and small budgets of most classrooms. Smaller bins are usually simpler in design, cheaper, not quite as attractive, and require more maintenance than the larger bins, especially to drain and harvest the vermicompost. However, they work well where small amounts of food waste are produced, or where a simple and inexpensive way for students to experience recycling is preferable.

Our program uses two types of bins: a circular multi-level type and a simple rectangular bin with a lid. Both are available at some gardening stores, at vermicomposting specialty outlets, and through the Internet. However, teachers on a tight budget could use a simple plastic bin or construct a bin from wood.

Air

The worm bins available commercially have air holes to meet the worms' requirement for air. If you choose to design your own worm bin, you'll need to drill holes 3 millimeters (⅛ inch) in diameter in all sides and in the lid. Regardless of the type of bin you use, you may find some escapees on the floor near the bin until the worms are used to their new home.

Water

The skin of worms is a moist membrane through which they exchange air to breathe. It is crucial for this membrane to remain moist. If the inside of their bin becomes too dry, the exchange of air through their skin cannot take place and they will suffocate. Creating optimal moisture conditions in the worm bin is fairly easy to do. If you purchase a multi-level bin, the worms will live in a medium of coir (i.e., coconut fiber). With some bins you can buy, this coir comes prepackaged in the form of a dry brick; once soaked in a bucket of water, the coir becomes the moist bedding in which the worms live. A layer of wet newspaper strips is then added on top. Other worm bins will need only the wet strips of newspaper distributed evenly throughout. Keep a spray bottle near the worm bin to add moisture every day as the newspaper strips or the coir dry out. The bedding should be moist yet fluffy, not sopping wet or in clumps.

Food

As a general rule, vermicomposting worms will eat anything that is organic. In a classroom, however, this rule has to be adjusted to maintain a healthy bin with which students can be actively involved. It's best to feed worms in a classroom bin a diet of fresh fruit and vegetable scraps, such as banana peels, apple cores, lettuce, grapes, celery, carrots, and broccoli. You may also put coffee grinds, tea bags, and eggshells in a school worm bin. Foods that may spoil, smell, or attract mold, fruit flies, and other pests should not be fed to worms. (See table.) No teachers or students want their classroom to smell like rotten trash!

Worms will eat half of their own weight in food every day. So, when feeding worms, it's important to know the total weight of worms that you have in order to gauge how much food to put in the bin. As a general rule, start

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Through vermicomposting experiments, students develop skills in teamwork, observation, record keeping, reporting, and measuring.

a worm bin with 450 grams (one pound) of worms and feed them 225 grams (one-half pound) of food per day.

A worm bin tends to sustain itself, which means that, even with the worms reproducing, the population and the amount of food consumed will remain relatively stable. If the worms are eating more than half their weight in food, the easy solution is to add more food. You could invite students to calculate how much their original worm population will eat and how quickly they will consume the food provided.

Chop food for worms into small pieces — about 3 to 6 millimeters (⅛ to ¼ inch) — or use a blender or food processor to create "worm soup," so that worms can more readily consume it.

Another tip is to designate a different area of the bin for feeding each day of the week, using the four corners of the bin for Monday, Tuesday, Wednesday, and Thursday, and the middle of the bin for Friday. When adding food to the bin, bury it rather than laying it on top, and mark the area with a small flag indicating the day of the week. Feeding this way ensures that feedings are not skipped; it also allows students and teachers to observe what worms like to eat and how quickly they are consuming food.

Students in many classes construct charts and graphs to measure the amounts and types of foods consumed by their worms. One teacher had students in art class create an illustrated worm "cookbook" that included recipes featuring the worms' favorite foods.

With teachers' guidance to prevent harm to the worms, students can conduct experiments with organic and nonorganic items. For example, some educators have put nonfood items in the worm bin, such as cotton T-shirts (no dyes), leather items, and junkmail envelopes. One teacher in St. Louis put in the cardboard from the back of a battery package to see if the worms would eat it: they didn't. Another teacher placed a small leather purse in the worm bin and, over time, the worms ate everything except the plastic handle.

Maintaining a healthy bin

Maintaining a healthy worm composting bin is fairly simple if you follow a few easy rules.

- *Liquid drainage:* Drain the worm bin weekly of the liquid produced by the worms, which is frequently called worm "tea." Draining is fairly easy with models that have a built-in spigot for this purpose. With other bins, the easiest way is to hold back the moist bedding and tilt the bin to pour the liquid out. You can also siphon out the liquid with a turkey baster. While you wouldn't want to drink this "tea," it makes an excellent fertilizer for plants when it is diluted with water to produce a 50:50 solution.

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Foods to Avoid Feeding to Worms

Food	Examples	Reason to avoid feeding to worms
meat	beef, chicken, fish, pork	They spoil quickly, smell bad, and may attract pests.
citrus rinds	orange, lemon, lime	The acidity is harsh on the worms' skin.
pineapple		It ferments over time into alcohol, which can poison worms.
starches	bread, potatoes, cereal	They can easily grow mold.
fruit stems	stems of apples, bananas, grapes	The stems could contain fruit fly eggs.
clippings	grass or leaves	They could contain pesticides or insect eggs.
condiments	ketchup, mustard, mayonnaise	They're not good for worms' skin; worms won't eat most of them.
dairy foods	cheese, milk, butter	They smell bad and may attract pests.

- *Mold:* Whenever you see any mold or slime in the bin, remove it immediately. You simply can't afford to let it get out of control in the bin if you wish to avoid smells and pests.
- *Fruit flies:* If at any time you observe fruit flies in or around the worm bin, take action immediately! Remove all food from the bin, and consider using fly traps in the room. If these strategies do not eliminate the problem, you may need to separate the worms from the bedding, rinse the bin with water, and start over with fresh newspaper strips. The easiest way to avoid fruit flies is to remove stems from fruit scraps and to remember to bury food underneath the newspaper or coir bedding.
- *Feeding:* Observe the consumption of food by the worms daily and adjust accordingly. Perhaps your 450 grams (pound) of worms are not big eaters, and 225 grams (half pound) of food a day is just too much. Do not be afraid to scale back or to increase the amount of food you put in. After the first couple of weeks, you should have a pretty good grasp of how much to feed to keep the system balanced.
- *Moisture:* Remember to keep the bedding in the worm bin moist.

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Harvesting the vermicompost

Depending on the type of bin you have and how many worms your system is sustaining, the bin could be ready for harvest between three and six months after you added the original worms. In this time, all the bedding will have turned into a rich, dark, finely textured material called vermicompost. Essentially, vermicompost is the castings or waste from the worms. Students' responses to finding out what vermicompost is usually range from disgust to amusement.

At harvest time, separate the worms from the vermicompost, and then rinse out the bin with water and add fresh bedding material. The worms can then be returned to the bin. Take care not to leave any worms in the vermicompost because it provides them no nourishment and, in time, can be toxic to them. Teachers can make arrangements for parents and other teachers to take surplus vermicompost to ensure that it will not be wasted.

Vermicompost and worm "tea" and are both valuable plant fertilizers because they are very rich in nitrogen, which aids in plant growth. In fact, they are so nitrogen-rich that they must be diluted before use or they will actually burn plants. It's best to dilute them by half, combining vermicompost in a 50:50 mixture with potting soil, and mixing worm "tea" in a 50:50 solution with water. These fertilizers can then be fed to plants as any other high-nitrogen fertilizer would be.

Students can design and carry out many experiments to investigate ways in which vermicompost helps plants to grow. An easy experiment would be to test the effects of three different treatments on plants: give one plant water only, another a 50:50 solution (i.e., worm "tea" and water), and the third undiluted worm "tea."

There is truly no age limit for classroom worm composting. In our program in St. Louis, the age groups span pre-school to college. While most of the activity and curriculum resources cater to K–8, there are many ways to incorporate vermiculture activities into curriculum for older students. One high school teacher in St. Louis keeps worm bins in his science classroom and encourages students to do independent studies and experiments with the worms, usually as a research project

or for science competitions. Another teacher recycles all the food waste from the high school cafeteria using five circular multi-level bins. A home economics teacher uses a worm bin to dispose of food waste from each cooking class. A college horticulture professor uses vermicompost produced in her worm bins as fertilizer.

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For most middle school teachers, the worm bin is a wonderful teaching tool for units on decomposition or invertebrate biology. Educators who are not directly involved in science can bring the worm bin into their classrooms to teach the value of recycling. Regardless of what you teach, a worm bin is a truly valuable addition to any classroom, as vermicomposting holds limitless possibilities and rewards. As well as aiding in the teaching of required curriculum, vermiculture provides an opportunity for teachers and students to be environmentally conscious.

Jennifer Kusmanoff was an education coordinator for Gateway Greening, traveling throughout the St. Louis area for two years, teaching children of all ages the value and fun of vermicomposting. She now works as a grant coordinator for the Department of Biology at Washington University in St. Louis, Missouri.

RESOURCES

Books

Appelhof, Mary. *Worms Eat My Garbage*. Kalamazoo, MI: Flower Press, 1982.

Appelhof, Mary, Mary Fenton, and Barbara Harris. *Worms Eat Our Garbage: Classroom Activities for a Better Environment*. Kalamazoo, MI: Flower Press, 1995.

Kyle, Cori. *Worms are a Class Act*. Viscor Distribution Inc, 1996.

Websites

<http://stlouis.missouri.org/gatewaygreening> Gateway Greening in St. Louis, Missouri, has instructions and helpful links to other vermiculture sites; staff are available to answer questions about worm composting. 314–577–9484.

<www.composters.com> This site displays and sells many types of worm composting bins.

<www.wormwoman.com> Mary Appelhof's site has articles on worm composting and a catalog of excellent worm composting books, videos, and classroom guides, including her own Flower Press publications.

<www.worms.com> On this site, you can buy a variety of vermiculture resources, including worm bins and the live worms to go in them. The site also has information on do-it-yourself bins.