



Recycle Organic Waste through Vermicomposting

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Home gardeners are familiar with recycling garden wastes such as wood chips, grass cuttings and sawdust through thermophilic composting which is the practice of breaking down biological waste with thermophilic (heat-loving) bacteria. Although thermophilic composting is advantageous as its high temperature kills human pathogens, it also kills off beneficial, non-thermophilic (mesophilic) bacteria. Vermicomposting is an important technique of converting organic waste into nutrient rich compost by earthworms without compromising the population of beneficial bacteria. This article will talk about recycling kitchen waste by vermicomposting.

Vermicomposting

Vermicompost is the end product of non-thermophilic decomposition of organic materials by certain species of earthworms and their associated microbes. As earthworms consume organic substances, they excrete tiny pellets called worm castings.

Vermicompost is a nutrient-rich fertilizer as well as a soil conditioner. It has been shown to increase plant growth and yield as well as suppressing key pests and diseases of horticultural plants in the greenhouse and in field soils. Vermicompost is generally of finer structure, contains more plant available nutrients, has higher microbial activity, and possesses better plant growth promoting properties than conventionally produced thermophilic compost.



Fig.1. Red wigglers are a commonly used earthworm species in a vermicompost bin.

Most remarkably, it holds nutrients such as N, P, K, Ca, Mg and many other micronutrients or trace elements in plant available forms.

You can buy vermicomposting worms e.g. red wigglers (*Eisenia fetida*) or blue worms (*Perionyx excavatus*) to start the vermicomposting. Construct your worm bin either using wooden planks or plastic tubs. You can use any light organic material that is high in carbon to provide bedding for the earthworms. Bedding helps to keep moisture in the bin, and protects the worms from drying out. Materials for beddings include shredded office paper cardboard, paper towel and coconut coir.

You can feed a wide range of organic substances to the vermicomposting worms including vegetable and fruit scraps, peels, bread grains, teabags, coffee grounds, non-greasy leftovers, crushed egg shells, napkins, paper towels and etc. Use of citrus and pineapple waste should be limited. Meat, fish, greasy

foods, dairy products, papaya seeds, twigs, branches, and animal feces are not recommended in vermicompost bin.

One could strategize to feed the earthworms by partitioning the vermicompost bin into seven sections and feed the worms in each section by rotating sequence. For example, on day one, bury food scraps in section one at least 4-6" deep, and cover the compost with shredded paper as bedding. On day 2, only feed the worms in section two, and so on. This allows you to add the food again into the day one section after seven days. To keep the earthworms and ecosystem of the worm bin healthy and productive, it is important to provide constant supply of food stock, not to under or over feed the vermicomposting worms, and always keep the compost and food stocks covered with bedding materials.

Depending on worm population and type of feedstock used, it may take 3-4 months to produce a significant amount of good vermicompost. At 5-6 months, the vermicompost will be more mature, containing a larger amount of worm castings and should look and smell much like the earth. Vermicompost should be cured prior to use. Curing vermicompost means to allow harvested vermicompost to sit for 8-10 weeks in a cool and dark, partially vented place. Vermicompost should be kept moist and aerated throughout the curing phase (Fig. 2 A). Curing allows the organic matter in vermicompost to break-down further, drastically increasing the consistency of the texture (Fig. 2B) and amount of plant available nutrients in the vermicompost.



Fig. 2. Harvested vermicompost is cured in vented drums in cool and dark places until use.

What happens during vermicomposting?

During vermicomposting, earthworms facilitate two sets of processes: 1) gut associated processes and 2) cast associated processes. In gut associated processes, several events happen: fractionation and homogenization of materials, addition of sugars, modification of microbial populations and addition of mucus and excretory compounds (e.g. urea and ammonia). In cast associated processes, decomposition by

mesophilic bacteria (bacteria that grow best at moderate temperatures, between 25°C and 40°C), mineralization (break down of organic form of nutrient into plant available form) and stabilization of organic material take place under moist and dark conditions. Both of these processes result in high number and diversity of bacteria, relatively high maturity indicators of the composted materials and thus contribute to plant growth promoting response. The most commonly found bacteria in matured vermicompost are *Pseudomonas*, *Bacillus* and *Microbacterium* species. However, the bacteria associated with the vermicompost vary depending on the feedstock that is added into the vermicompost bin.

Some functions of these bacteria in the vermicompost include:

- ▶ producing plant growth promoting agents e.g. auxins, cytokinins and gibberellic acid
- ▶ producing enzymes that dissolve organic nutrients e.g. phosphatase dissolves organic phosphorus in soil into a plant available form
- ▶ enhancing enzymes activities that inhibit growth of pathogenic fungi or insect pests e.g. chitinase, protease and cellulase that suppress fungal and insect pests, aminocyclopropane carboxylate (ACC) deaminase that has broad spectrum anti-fungal activities, hydrogen cyanide (HCN) which is antagonistic to many root infecting fungi
- ▶ producing siderophores which have high affinity to iron (Fe) in the soil making siderophore-forming bacteria outcompete other microbes.

The reason why vermicompost possesses better plant growth promoting properties than thermophilic compost is because it contains a considerable amount of organic acids such as plant growth promoting hormones and humic acids. It also has high water holding capacity, low C: N ratio and low phytotoxicity (toxicity to plants). However, vermicompost quality varies depending on many factors including earthworm species, raw material used as feed stock, and the age of the compost.

Vermicompost Tea

Besides soil application, an effective way of utilizing vermicompost is making vermicompost tea (VCT). Vermicompost tea is prepared by soaking freshly harvested or cured vermicompost in water with or without continuous aeration to extract its soluble nutrients, as well as beneficial microbes into water. Generally, 1: 10 ratio of vermicompost to water is used. There has been a great interest in the use of VCT in the last 5-10 years. Higher levels of soluble nutrients and plant growth regulators obtained from applying VCT compared to solid vermicompost made VCT gain in popularity. Also, the practice of using VCT allows growers to apply a small amount of material over a larger area through the liquid extract. In other words, extraction can make a little go a long way. This is valuable because transporting compost can be expensive and applying solid vermicompost might require large quantity.

The water extractable components present in VCT include:

- ▶ active microorganisms, primarily bacteria, fungi and some protozoa
- ▶ mineral nutrients, organic acids and other microbial byproducts

Aeration during the VCT extraction process is beneficial as it maximizes the biological activities and thus the tea quality. Some advantages of aeration of include:

- ▶ supporting the population of beneficial microorganisms to multiply rapidly,
- ▶ enhancing the mineralization of the nutrients presents in the vermicompost.

Extraction process usually takes 12-24 hours resulting in high quality aerated tea, thus aeration reduces the VCT extraction time which will normally take 7-10 days if not aerated.

The Benefits of using Vermicompost Tea

Graphs to the right show benefits of using vermicompost tea for crop production.

- ▶ Drenching aerated VCT prepared at 1:10 vermicompost to water ratio from 2 month cured chicken manure-based vermicompost enhanced growth and nutrient quality of vegetable crops (Fig. 3).
- ▶ Drenching tea plants with aerated VCT prepared from uncured food waste based vermicompost at biweekly interval reduced mite damage significantly (Fig. 4).
- ▶ Drenching aerated VCT prepared from vermicompost cured over different lengths of time suppressed infection of root-knot nematode, *Meloidogyne incognita*, differently. VCT from uncured vermicompost suppressed the nematodes better than that from 6-month cured vermicompost (6-MVC) (Fig. 5).

Summary

Vermicomposting is an ideal approach to recycling kitchen and garden wastes to produce a high quality natural fertilizer. Vermicompost is a fine structured, nutrient rich soil amendment with high microbial population and diversity. Researchers are continuing to study the mechanisms and factors that

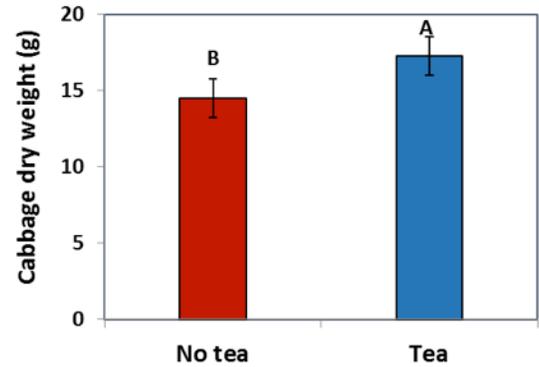


Fig 3. Plant weight of pak choi grown with and without weekly drenching of vermicompost tea. Columns followed by different letters are significantly different.

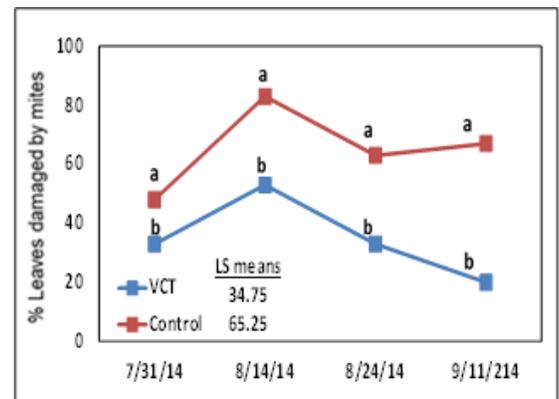


Fig 4. Effect of vermicompost tea (VCT) drenching on mite damage on tea plant. Means on each sampling date followed by the same letter are not different.

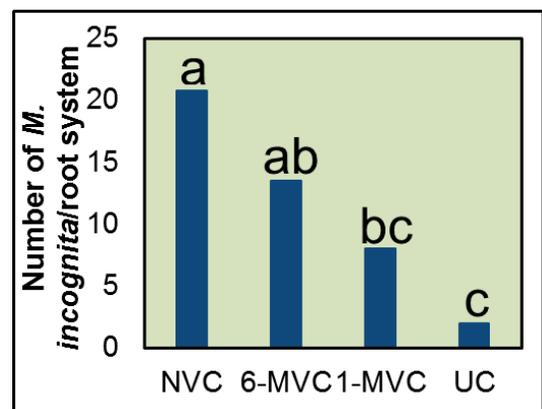


Fig 5. Effect of vermicompost tea on numbers of *Meloidogyne incognita* penetrated zucchini roots 7 days after inoculation of the nematodes. n-MVC = tea prepared from n-month cured vermicompost. NVC = no vermicompost tea. UC = tea prepared from uncured vermicompost. Columns followed by the same letter(s) are not different.

contribute to the pest suppressive properties of vermicompost and its extract. Evidence is accumulating on the benefits of using vermicompost as soil amendment or drenching its water extract for plant growth promotion or plant protection. Therefore, it will be a good idea for organic farmers or home gardeners to practice vermicomposting to recycle food or farm waste while reducing the reliance on external farm or garden inputs.

For more information please visit:

The benefits of vermicomposting (Video)

<http://www.youtube.com/watch?v=7pQBWyQYum0&feature=youtu.be>

Vermicompost in Hawaii (Video)

<http://www.youtube.com/watch?v=loblB5DvzMI>

Acknowledgement



This project is supported in part by USDA AFRI on Small- and Medium Size Farms Program (project # 2014-68006-21860) entitled “Center of Rural Agricultural Training and Entrepreneurship (CRATE) for the Pacific” and in part by CTAHR Hatch project (HAW09022-H).



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