WHAT IS A QUALITY VERMICOMPOST ?

AG WISE

A Natural Heritage Trust funded project

Pam Pittaway
National Centre for Engineering in Agriculture
University of Southern Queensland, Toowoomba

Can do Sheet No. 7

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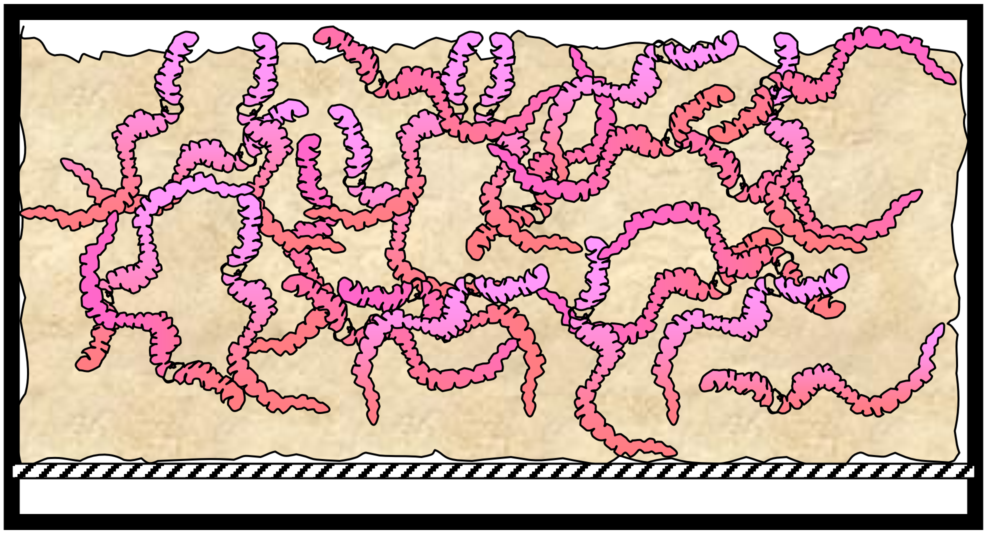
Vermicasts are the waste products of earthworms excreted by some species at the soil surface. In such species, chemical analysis of the casts gives a good indication of changes directly caused by the worms. Unfortunately **compost worms** do not separate their casts from the medium around them. Therefore the term **vermicompost** (casts integrated with other biologically processed material) is a more accurate description of the product.

Worms as Intensive Livestock

Worms are **animals**, and like other **intensive livestock** operations their environmental conditions and feed rations must be managed to maximise worm production. **Compost worms** cannot tolerate temperatures in excess of 25^{o} C, and as a consequence the microbial processes are not the same as conventional composting (optimal temperature range 45-65^{o}C). Worms are much larger than most of the other organisms in the compost, capable of physically pushing particles apart as they move through the medium. Therefore, a well-worked **vermicompost** will have a much smaller, more even **crumb structure** than that of a mid-temperature compost (**mesocompost**) produced in the absence of worms**.**



Compost worms do best under **moist** conditions, but are very sensitive to elevated **carbon dioxide** levels. Suspending the worm bed to promote **aeration** through the medium, improves both temperature and gas control. The best rations for worms are **simple organic carbon** compounds, with low levels of **ammonia nitrogen**. Pre-composting material before feeding to worms reduces the ammonia toxicity, but also reduces the amount of simple organic carbon compounds. Using the material directly, **if necessary** adding clay minerals (eg. zeolite) to reduce the ammonium concentration, conserves the organic carbon and avoids double handling!

Working out what compost worms do, and don't do to organic materials

Many claims have been made about the benefits that compost worms confer to vermicompost. To clarify which of these have merit, two trials were conducted on pig manure composted both with and without tiger worms (*Eisenia foetida*). The four compartments used had a maxiumum capacity of about 0.1 m^3, with air circulated at the base of each bed (compartment). A **mass balance** was only undertaken for the second trial, where each compartment was seeded with 4.5 kg of mesocompost from the previous trial (Trial 1) and 4.5 kg of pig manure (farrowing sow manure scraped from the slatted floor of the pens). The two **no worms** compartments had another 4.54 kg of mesocompost added and the two **with worms** compartments had 4.54 kg of vermicompost added (from Trial 1, average worm density of 310 worms per litre).

Each week 2.3 kg of fresh farrowing sow manure and one litre of water was added to each compartment. When the volume of the compartments was close to capacity, watering continued but no further manure was added for a fortnight (at 26 weeks for trial 1, 17 weeks for trial 2). Final weights and volumes for trail 2 were recorded. Physical, biological and chemical tests were undertaken for both trials, after worms had been counted and removed from subsamples.

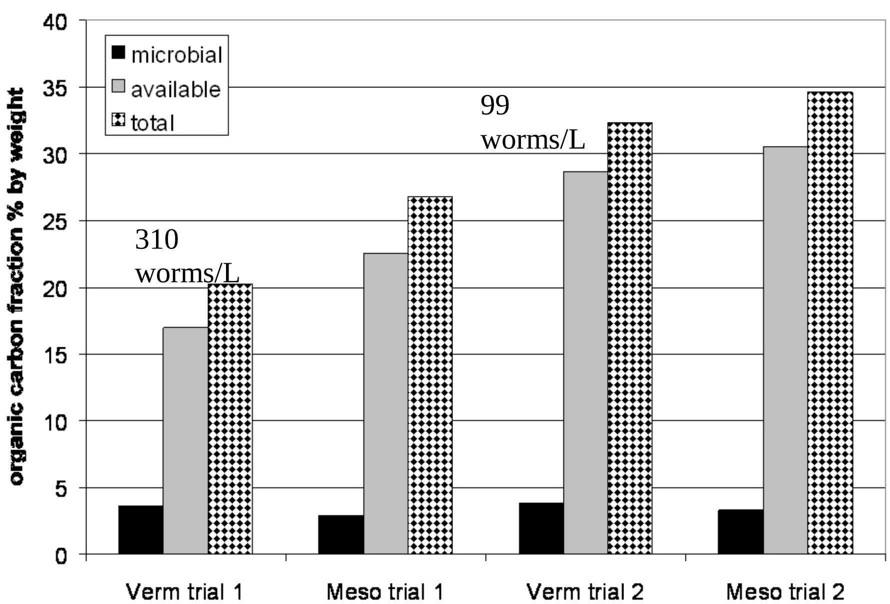


Figure 1: Concentration of organic carbon forms in vermi and meso composts. More total and available organic carbon remained in trial 2, but despite the higher worm counts in trial 1 there was no significant difference in the microbial carbon present in the two trials.

Compost worms, changes in organic carbon fractions, and volume reduction

Remove the worms from the compost immediately before chemical testing, and there is no evidence of a **significant** increase in the microbial activity relative to the mesocompost (see **figure 1**). Worms **do** reduce the amount of organic carbon present. However, we recorded a volume reduction of **only 12%** over the no-worms (mesocompost) treatment.

The large difference in organic carbon concentrations between the two trials is explained by changes in the **diet** fed to the pigs! Only the proportions of sorghum, wheat fines and cracked wheat changed (trial 1 15%, 32% and 12%, trial 2 27%, 13% and 17% respectively). Sorghum is **not** the feed of choice for pigs, because the starch granules in the grain are very tightly packed around the protein, making it much less digestible. As shown in **figure 1**, this explains the higher organic carbon content **and** the lower worm density obtained in Trial 2!

Vermicompost quality is controlled by the quality of the feed

In our two trials, the protein, fibre, phosphorus, calcium and amino acid content fed to the sows was the same. However due to the tighter internal packaging in sorghum grain, neither the organic carbon, nitrogen, nor phosphorus, was readily available to either the sows or the worms. The undigested sorghum is also more difficult to extract chemically. As a result, the total and available P in the composts is more affected by the diet fed to the pigs than by the presence of or population density of the worms (see **Table 1**).

Like pigs, worms need nitrogen to make muscle and other body tissues. In our trial the presence of worms did reduce the concentration of **available** nitrogen (ammonia, nitrate and nitrite) in Trial 1. However the **lower density** of worms and the **indigestibility** of the diet in Trial 2, meant that the presence of worms made no difference! Pig manure with low levels of urine present is considered to be one of the best diets for compost worms. Yet in our trials, there is no evidence of worms increasing the **mineralisation rate** of the compost. If this were true, then the **with worms** rows in Table 1 should have higher levels of **available** P, N and K than the **without worms** rows. In contrast, the higher temperature processes that occur in a **conventional compost** do cause a significant increase in the mineralisation rate as the compost matures (refer to Can Do sheet 4 *A Practical Guide to On-Farm Co-Composting).*

	Total P %	Available P %	Total N %	Ammonia N %	Nitrate + Nitrite N%	Total K %	Available K %
With worms 1	5.31a	1.43a	2.66a	0.01a	0.08a	1.54a	1.30a
Without worms 1	5.31a	1.36a	3.70b	0.05b	0.30b	1.34ab	1.22a
With worms 2	2.41b	0.85b	3.19c	0.02ac	0.01a	1.81ac	1.69b
Without worms 2	2.22b	0.75b	3.00ac	0.03c	0.02a	1.47ab	1.38a

Table 1: Concentrations (percent per ton dry weight) of the main plant nutrients in the composts. If worms are the main effect, then the *with worms* rows should have the same letter by each. If the diet is the major effect, then the *trial pairs* (1 and 1 or 2 and 2) should have the same letter by each.

Vermicompost as a potting medium for container-grown plants

It is possible that vermicomposts stimulate plant growth by increasing the populations of **plant growth promoting bacteria**. However in our tests using *Rhagodia* (native saltbush) cuttings, there was no evidence of any stimulation of root initiation. In our seedling assays, both vermi and meso compost filtrates (filtered 1:5 volume :volume compost plus water) **did not** inhibit seed germination, but most certainly **did inhibit** root growth (**see figure 2**). This toxicity is also a recognised property of **immature** conventional composts, and is most likely due to phenolics and other defense compounds common to plant-based residues (ie pig manure).

Fresh vermi and meso compost both have a very high **water holding capacity (0.8 cm^3/cm^3)**. However if you dry both composts to about 60% wet weight, they **will not readily re-wet!** Once dried, seedlings grown in such mixes can suffer drought after planting out, even if they are well watered. Including a **wetting agent** in the potting mix should avoid this problem.

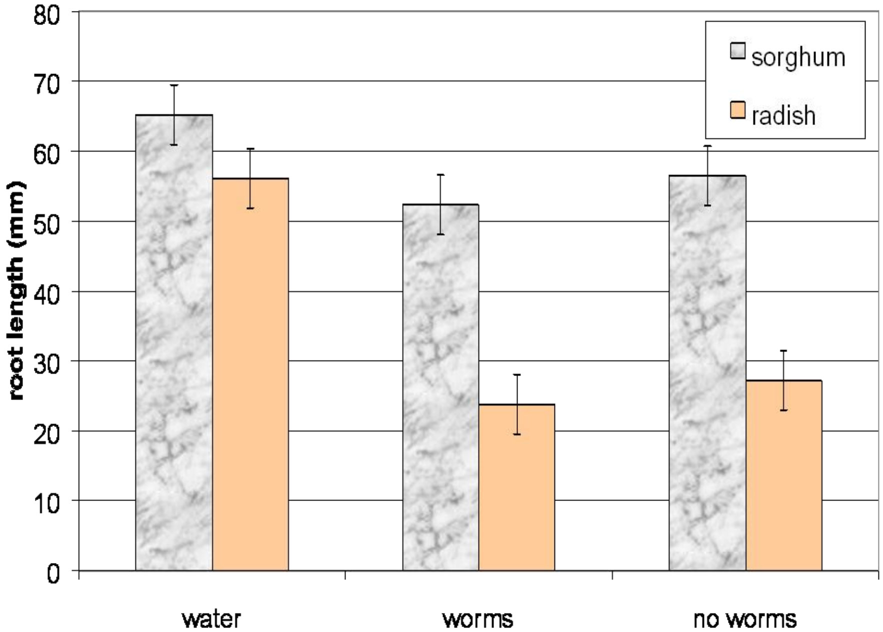


Figure 2: Root length in germinating sorghum and radish seedlings grown on filter paper moistened with water only, or filtered vermi or meso compost slurry (1:5 volume:volume compost:water). Total root length was measured after 7 days

Quality Assurance and making the most of Vermicomposts

Maintaining as **uniform** a **feed** as possible, and maintaining as **uniform** a **population** of worms as possible is the only way to standardise the properties of a vermicompost. However the fertiliser value is only **slow-release** (not immediate). Plants only fed vermicompost or vermicompost slurry (**worm 'juice'**) may suffer from **nutrient shortage** (particularly N and P) in the short-term (6-18 months). **Dried vermicompost** that does not readily re-wet will further slow down the mineralisation process, extending the time frame of any nutrient shortage.

The good **crumb structure** and high **water holding capacity** of vermicompost makes it a desirable component of potting mixes. However a **wetter** must be added to avoid drying out, and the vermicompost must be **diluted** with other media if root growth inhibition is to be avoided. **Plant-available nutrients** must also be added, to avoid nutrient starvation.

Vermicomposting is a good way to produce **worm bait**, and offers a **low-tech.** method to reduce the particle size and odour generation potential of organic wastes. However compost worms are **livestock**, and require **intensive management!** As a diluted component of conventional plant growing media, vermicompost has been shown to reduce the **severity of plant diseases** such as onion white rot. Vermicompost and worm juice do have potential plant growth benefits, but view many of the claims made with a **large dose of skepticism**!

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