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Vermicompost and vermiwash: Sustainable bioinputs for soil health and crop productivity

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Abstract

The overuse of chemical fertilizers has led to declining soil organic carbon and the destruction of beneficial soil organisms, highlighting the urgent need for sustainable alternatives. Vermicomposting, the biological process of composting organic waste using earthworms such as *Eisenia foetida*, offers a natural, eco-friendly, and cost-effective solution. This document details the methods of preparing vermicompost, including pit, heap, kacha pit, and portable vermibed techniques, and explains the key environmental parameters necessary for optimal composting. It also highlights the collection, properties, and agricultural benefits of vermicompost and vermiwash—a nutrient-rich liquid extract produced during the process. Vermicompost enhances soil fertility, increases microbial activity, improves soil structure and water retention, and boosts crop yields and resistance to pests and diseases. By recycling organic waste into high-quality organic fertilizers and biostimulants, vermicomposting supports sustainable agriculture, environmental conservation, and rural livelihoods, positioning it as an essential practice for modern organic farming.

Keywords: Vermicompost, vermiwash, soil fertility

Introduction

With the increasing use of chemical fertilizers, the amount of organic carbon in the soil is steadily declining, and the indiscriminate use of chemicals is also destroying soil organisms. Therefore, in order to sustain soil fertility and continuity in the future, organic fertilizers are desperately needed. Among organic fertilizers, vermicompost (earthworm compost) holds an unique space due to its easy preparation and high quality (Edwards *et al.*, 2004) ^[4].

- **Vermicompost:** The organic matter like dung, straw, garbage etc. swallowed by the earthworm comes out in a ground state from its digestive system and is called earthworm compost. (Sinha, Bharambe, & Chaudhari, 2008) ^[7]
- **Selection of place for making earthworm compost Shady:** A moist environment is required. Therefore, earthworm compost should be made under a dense shady tree or under an airy thatched roof. While selecting the place, special attention should be paid to proper drainage and proximity to a water source.
- The right time to make earthworm compost is to make earthworm compost. Anyway, farmers brothers can make earthworm compost throughout the year. Can be made, but earthworms are more active at a temperature of 15-20 degree centigrade.
- **Selection of earthworm species:** Although many species are used in making earthworm compost. It is used, but for farmers the species 'Eisenia foetida' is always suitable. Maintenance of this species is also easy.
- **Organic matter useful for making vermicompost:** In making earthworm compost all organic substances that can easily decompose are suitable. For this purpose, animal dung, crop residues, vegetable residues etc. are used. Generally, half dung and half garbage etc. are mixed to prepare a mixture as food material for earthworms.
- For making earthworm compost, the pit is constructed, usually 3-4 feet wide. A cemented pit of required length and 1.5-2 feet depth needs to be made. The floor (surface) of the pit is

- cemented with concrete. A hole is made in the pit for water drainage. To make it more effective, two pits are made together and holes are left in the middle wall, so that the earthworm can easily go from one pit to another.
- **Leaving earthworms in pits:** Put cow dung and crop residue in the prepared pits. Fill the mixture of 1:1 to almost the height of the pit. Spread this mixture 20-25 times. Let it rot partially by sprinkling water continuously for several days. Remove the upper layer of the heap and put 1000 earthworms (1 kg) in it at the rate of per square meter length so that the earthworms are again covered with the upper layer and immediately sprinkle water as per requirement on the pit and cover it with a wet jute sack. To maintain 40-50 percent moisture in the pit, sprinkle water daily as per requirement. In this way, earthworm compost is ready in six to seven weeks.

Heap method of making vermicompost

- Construction of kacha floor as per requirement.
- Construction of a thatched shed or a permanent shed.
- A bed (pile) on the floor, 1 meter wide, as required long and 1.5 and 1.5 to 2 feet high.
- Use of partially decomposed dung and organic waste in a mixture (1:1).
- 1 kg Releasing earthworms per square meter.
- Covering the heap with wet jute sack or hay, straw etc.
- It takes 2 to 2.5 months for the compost to prepare.

Kacha Pit method



For making vermicompost, cow dung, manure, dung, paddy straw, maize, millet straw, farm residues, dairy/poultry waste, dry and green leaves, grass, urban garbage, dry biogas slurry, industrial waste etc. are used. From this raw material, non-degradable materials such as stone, glass, plastic, ceramics and metal fragments are separated and large lumps of garbage are broken and leaves etc. are cut into 3"-4" pieces so that composting/decomposition takes less time. Before filling these materials in the vermicompost bed, they are made into heaps and sprinkled with water and kept for 15-20 days to rot so that it becomes half-decomposed. As per requirement, the wet garbage is also turned over so that there is no heat in it. The above action is essential. Compost is made by filling this semi-digested waste in earthen pits or cemented beds made above the ground or transportable plastic beds and releasing earthworms in it. Generally the size of the pit bed is kept 3 X 1 X 0.5 meter. The waste is filled in the prescribed structure up to 50 cm height, after 3-4 days of which earthworms are released in it and after sprinkling water, it is covered with wet sacks. It is necessary to apply a coating of cow dung and soil on the bottom and inner walls of the earthen pits. The filled waste should be kept in compost for 30-40 minutes until it is ready. (Prakash, M., & Karmegam, N. 2022) [6].

It is essential to maintain 40-50 percent moisture and 20-27 degree centigrade temperature. Also, to protect from strong

sunlight, termites, ants, birds etc., arrangements should be made for curtains made of sacks, thatch and twigs/green net. Keep in mind that at least 20 percent cow dung should be included in the organic waste, which should not be fresh but should have been cooled for 3-4 days. For rapid decomposition, cow dung slurry or 50-100 grams of Trichoderma powder can be added and by adding 50-100 grams of Azotobacter and PSB powder, the product matures quickly and becomes more effective. Never use any type of insecticide while making compost, you can sprinkle charcoal to protect from red ants. Garg, V.K., & Suthar, S. (2020) [10].

Vermicompost is ready in 45-60 days, which is as odorless as tea leaves. After 45 days, sprinkling of water is stopped and the sacks used as lids are removed, as a result of which the upper compost dries up and the earthworms go down into the moisture. Then the dry compost on top is separated. After 4-5 days, the upper compost dries up again, which is separated from the top. In this way, the entire compost is removed in 3-4 times and finally the earthworms are left. By filtering the dry compost through 3-4 gas-shaped sieves, earthworms, their eggs and decomposed material are removed. Keep in mind that while making or removing compost, do not use hoe, spade, hoe etc. The extracted compost can be dried in the shade and filtered and stored in a shady place. About 60-70 percent vermicompost is prepared from the filled waste. (Suthar, S. 2010) [9].

Portable Vermibed



1. Selection of site

- The most important factor to be taken into consideration is locating a site under shade or artificially created shade.
- The site for construction of the vermibed preferable is chosen to the organic waste to be used.
- Soil surface of the site selection should be hard.

2. Preparation of Ground

- Area selected must have the dimension of 6ft x 15ft.
- The area must be upland or elevated with a slope of 4" to 6" towards the drain so as to allow the liquid produced by the earthworms to accumulate in the pit.
- Sharp stones should also be removed to prevent the bed from being damaged.

3. Fixing poles on the site

- The unfolded bed must be placed on the site to correctly mark the locations for fixing poles.
- Marking for digging is required along the pockets provided with the bed.
- Markings must be accurate.
- Holes with a diameter of 3" and depth minimum 18" should

be dug at the markings made.

- Take 14 straight wooden-poles of 39" each.
- The top ends of the poles must be smoothened and rounded. Care to be taken that no pointed ends remain on the surface of the poles.
- Pole diameter should be maintained at around 1.5".
- Now the poles should be inserted in the holes.
- The poles should be fixed with 18" below the ground.
- Care to be taken that they should be at a height of 21" from the floor.
- A pit must be dug as shown in the picture to collect the vermiwash in a container placed in it.
- Vermiwash produced is collected via a pipe

4. Installation of Bed

- Open the bed by choosing the vermiwash drain on the lower slope of the ground.
- Lift the bed from all sides opened vertically.
- Insert simultaneously pockets of the bed through the poles fixed.
- Move bed carefully down the poles till the bed surface touches ground completely.
- It should fit correctly and accurately as shown in the picture.

5. Partly decomposed waste

- Sort the waste properly making sure that the hard substances are removed as earthworms are not friendly with hard material.
- Please note culture is extremely friendly with dung.
- It is advisable to use partly decomposed water for better results.

6. Filling the waste

- The garbage and dung should be placed in alternate layers.
- Put stored garbage in the first layer with 6" thick.
- Place next layer of dung again with 6" thickness.
- Repeat this process once again.

7. Watering the contents

- Water the contents placed in the bed.
- This process is required to remove the heat accumulated in the decomposed material as they do not function in extra heat.
- Keep watering the contents till you feel that the heat has been satisfactorily removed.
- It is likely that layers of decomposed material may settle down by 6 to 8" after pouring.
- Additional layer of dung can be added till the contents reach the height of the bed.

8. Important parameters

- **Temperature:** It is preferred that the temperature be between 25-35 °C for vermicomposting efficiency. In general warmer temperatures 20 °C stimulate reproduction.
- **Aeration:** Earthworms cannot survive under anaerobic conditions.

Excessive moisture combined with poor aeration conspires to cut off oxygen supply, thereby killing the worms quickly. Not only the worms deprived of oxygen, they are also killed by

toxic substances like ammonia.

Nevertheless, the worms operate best when ventilation is good and the material they are living in relatively porous and well aerated.

- **Moisture:** The decomposed material used must be able to hold moisture. As the earthworms breathe through their skin, moisture content less than 50% is dangerous. The ideal moisture content range for the materials is preferred between 70-80%.
- **pH:** Worms can survive in a pH level of 7 to 9. But most experts feel that worms grow best at a pH level of 7 or slightly higher. If the food source is alkaline, the pH rises above 7 and if the food is acidic, the pH drops below 7. The pH can be raised by adding calcium carbonate. The compost mix can be made acidic by introducing peat moss.
- **Salt and Urine content:** Worms are very sensitive to salts, preferring salt contents less than 0.5%. If animal wastes are used for composting, it contains excessive urine. As a result the decomposed material must be leached by watering or precipitation to reduce the salt and urine contents.

9. Letting earthworms in the bed

- Once the bed has been cooled down, small basins of about 3" to 4" deep should be made from all the sides.
- The earthworms should be allowed to mix with the mix and then the basins must be closed.

9.1 Letting in the earthworms-food

- After three days, repeat the process of making basins as mentioned above and place the earthworm-food and close the basins.
- Make sure that the heat generated is removed by watering the mixture frequently as earthworms require moisture to grow.
- Allow the earthworms to act upon the mixture for a period of 2 months.

10. Vermiwash

- The liquid obtained from the outlet given in the bed is called as vermiwash.
- It is a mixture of the liquid ejected by the earthworm and excess water in the bed.
- The vermiwash produced should be collected in a container.
- It should be inspected properly.
- Vermiwash diluted with water can be sprayed on plants to function as an effective foliar spray and pesticide.

11. Visit and Observation

- Earthworm-Manure, Earthworms and VERMIWASH should be inspected from time-to-time.
- A constant check should be kept on the bed and the activities of the earthworms.
- The temperature of the bed should also be monitored from time to time as earthworms require a moist and cool temperature to grow and function.

12. Obtaining the manure

- The manure will be completely ready in approximately forty days.

- Gather the produced manure from all sides of the bed.
- Stack a pile of the manure obtained.
- As a result, the earthworms are collected at the bottom leaving the manure at the top. It allows easy and efficient segregation of manure and the earthworms.
- The manure must be collected and sifted it by using a sieve.

13. Packaging

- Pack the sieved manure in bags.

14. Inspection

- The manure produced should simultaneously be sent for inspection.

Collecting Vermicompost: After adding earthworms, the colour of the heap starts turning black and powdery in about six-seven weeks. When this stage is reached, watering of the pit is stopped. After four-five days, the earthworms move towards the moisture at the lower surface of the pit, hence the upper layer of the prepared manure is collected and taken out slowly in two-three times. The lower layer in which earthworms are present is collected at one place and the pit is again filled with a mixture of partially rotten cow dung and garbage and the lower layer of the prepared manure in which earthworms are present is left on the upper layer of the heap as before and the heap is covered with jute sacks. The earthworm compost taken out is filtered and filled in sacks and kept in a shady place till use (Arancon *et al.*, 2004) [2].

Properties of Vermicompost

A. Physical properties

- Earthworm compost is a granular, dark brown, black colored soft humus substance. It is free from foul smell, weeds and harmful bacteria.
- It increases air movement and water holding capacity in the soil and helps in drainage in heavy soils.

B. Chemical properties

The chemical properties of earthworm compost depend on the quality of the raw material (organic matter) used in preparing it.

S. No.	Nutrients	Amount
Key Elements		
1.	Nitrogen	1.8 percent
2.	Phosphorus	2.0 percent
3.	Potash	1.4 percent
Trace Elements		
1.	Iron	21.6 (ppm)
2.	Zinc	12.7 (ppm)
3.	Manganese	19.2 (ppm)
4.	Copper	5.8 (ppm)

C. Biological properties

- The number of bacteria (Azotobacter, Phosphate solubilizer and nitrobacter) - More than 10^{10}
- Actinomycetes - About 10^5 to 10^7
- Gibberellins, Auxins and Cytokinins - A variety of beneficial fungi in adequate quantities

Comparison of earthworm compost with DAP

S. No.	Description	Vermicompost	DAP (Chemical Fertilizer)
1.	Composting time	1.5 to 2.0 months, which the farmer can prepare himself on the farm.	It is prepared in the factory.
2.	Production	36 quintals/pit/pit filling work can be done three times in a year. (3×10×1.5 feet)	DAP production depends on the market requirement and factory capacity.
3.	Raw material	Animal dung and organic matter	Chemical substances
4.	Nutrients	Along with N, P, K, S, Fe, Zn, Me, B, Mn, Cu and other nutrients, organic acids are also obtained.	Only Na P
5.	Percentage of 5 main nutrients	Nitrogen - 1.8% Phosphorus - 2.0% Potash - 1.4%	Nitrogen - 18% Phosphorus - 46%
6.	Price	The farmer earns Rs. 1.25 per kg of earthworm compost. 10 quintals of earthworm compost is prepared for Rs. 1250/-.	One for Rs. 1250 Bags (50kg) of DAP are available from the market
7.	Availability of nutrients per Rs. 1250.00 spent	Nitrogen 18 kg. Phosphorus - 20 kg. Potash 14 kg Along with this all the nutrients are also available.	Nitrogen- 9 kg. Phosphorus - 23 kg
8.	Availability of 8 elements	Available for plants for 3 to 4 years.	For one crop only.
9.	The fertility potential of the soil	Along with increasing the fertility of the land, organic carbon is also supplied.	Only supply of nitrogen and phosphorus elements to plants.

Precautions in making Vermicompost

- Earthworm is sensitive to both low and high moisture, hence always maintain proper moisture (40-50 percent).
- Protect the heap from chickens, rats and termites. To protect from termites, use 4% neem insecticide or soak 500 grams of neem leaves in water overnight, grind them finely and mix them in one liter of water and spray.
- Do not put fresh dung on the bed because fresh dung generates heat which may cause the death of earthworms.
- Provide shade by making a platform over the pit and protect the pits from rain and flowing water.
- Do not allow water containing soap, medicines or any chemical to enter the pits.
- During the whole process, the upper surface of the bed must be howed twice, so that air circulation should remain

smooth.

- Earthworms should be protected from frogs, snakes, birds, ants etc.
- The prepared earthworm compost should be kept in a shady place.

Use of Vermicompost

Vermicompost manure is completely organic manure. With its use, not only the yield of the crop but also the disease and pest resistance capacity increases, there is exponential development in biochemical capacity (Arancon *et al.*, 2007) [3]. Amount of earthworm manure to be used: 3-5 tonne/hectare for food grain crops, 4-6 tonne/hectare for vegetable crops, 2-3 kg/tree for small fruit trees, 4-5 kg/tree for big fruit trees, 100-150 gram trees for pots, 2-3 kg/sq.metre for vegetable nursery.

Benefits of Vermicompost

- Vermicompost is a complete and balanced food/nutrition for crop plants, fruit trees, vegetables etc.
- Deteriorating soil fertility resulting from continuous and exorbitant use of chemical fertilizers can be Improved by the use of Earthworm compost.
- Humic acid, microbes and hormones found in earthworm compost. Regulate soil pH and Improves soil health, (including saline-alkali reclamation).
- Earthworm compost activates microbial population in soil, helps in keeping down weeds, pests and diseases by increasing resistant power and improving plant health resulting in increased yield.
- Earthworm compost helps plant to take macro and micro nutrients and preserves these nutrients.
- Increased water absorbing and holding capacity due to compost use in the field cuts short irrigation requirement.
- Multifarious influences of earthworm compost improve yield as well as the quality and taste of the produces and helps fetching higher price.
- Safe disposal of organic waste/debris saves environment from pollution.
- Use of compost relieves pressure on fertilizers and agro-chemicals and provides a safeguard against their ill effects on human health.
- Generate employment for rural youths and women.
- Increasing income through reduced input cost by saving expenses on chemical fertilizers and pesticides, irrigation and medical aid, additional employment and higher returns due to premium prices Sinha *et al.* (2014)^[8].

Vermiwash (Worm-Tea)

Vermiwash is a liquid extract obtained from vermicomposting beds, rich in nutrients and beneficial microbes, making it an excellent organic fertilizer. (Ansari & Sukhraj, 2010)^[1]

Agriculturally Important Microbes in Vermiwash

Vermiwash contains various beneficial microbes, including:

- Nitrogen-fixing bacteria like *Azotobacter sp.*, *Agrobacterium sp.*, and *Rhizobium*.
- Phosphate-Solubilizing bacteria (PSB) that help make phosphorus available to plants.
- Beneficial fungi and actinomycetes that aid in soil health and plant growth.

Benefits of Vermiwash

- Acts as a natural fertilizer and pesticide.
- Enhances plant growth by providing essential nutrients.
- Increases microbial activity in soil, improving decomposition.
- Boosts photosynthesis and flowering in plants.
- Forms a protective layer against bacterial infections.

Principle of Vermiwash Preparation

The principle is based on earthworm activity. Earthworms create burrows, and water passing through these burrows extracts nutrients, enzymes, and microbial secretions, forming vermiwash. (Ismail, 2005)^[5]

Method of Preparation

- Set up a vermiwash unit using a container with a tap at the bottom.
- Layer the container with stones, sand, hay, and pre-

decomposed organic waste.

- Introduce earthworms (about 1000-1500 adult or juvenile worms).
- Moisten the setup daily with water.
- Collect vermiwash after a few weeks by draining the liquid from the tap

Conclusion

Vermicomposting is an eco-friendly, cost-effective, and highly efficient method of converting organic waste into nutrient-rich compost and vermiwash. The process not only recycles agricultural and organic residues but also enhances soil fertility and structure, improves water retention, and supports sustainable agriculture by reducing dependency on chemical fertilizers. Through careful management of moisture, temperature, and proper selection of earthworm species like *Eisenia foetida*, farmers can produce high-quality vermicompost that supplies essential macro and micronutrients, beneficial microbes, and plant growth hormones. Additionally, vermiwash serves as an excellent liquid bio-fertilizer and natural pesticide. Together, these organic inputs boost crop yield, improve produce quality, protect the environment, and generate additional income and employment opportunities—making vermicomposting a valuable practice for modern, sustainable farming.

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