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"Vermiculture and Vermicomposting with Comparison to Conventional Composting"

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ABSTRACT

This experimental study on Vermicompost involves innovative approach on vermiculture and vermicomposting process undertaken atRNB Global University, Bikaner. This paper includes the methodology of vermicomposting and experiments conducted by the students of Agriculture in their six months module course. Vermicomposting is a significant method of reducing biowastes, producing fertilizers and maintaining the balance of the ecological environment.Vermicomposting is a technique that uses earthworms to break down organic waste, producing a superior final product called Vermicast. Because it is nutrient-rich and acts as a soil conditioner.Vermicompost is regarded as an organic fertiliser due to the presence of water-soluble nutrients in vermicompost, there are more readily available nutrients, better soil drainage, and overall better soil structures. Before turning organic wastes into beneficial products like worm meal, vermicast tea, and worm casting, the earthworm consumes organic wastes like grass clippings, farmyard manure, crop residues, residual food residues, and scarp papers. Additionally, vermicompost works as an organic fertiliser and a biological control agent to combat a variety of plant diseases caused by soil-borne plant pathogens and pests. Vermicomposting can be used to boost other soil indicators including nitrogen and the C/N ratio. Heavy metals' negative effects can also be lessened to some extent. Additionally, it supplies a large number of beneficial microorganisms. However, there are also downsides, such as the production of harmful greenhouse gases eg; nitrous oxide and methane. It has been evidented by research that vermicompostcontains approximately 4 times as many nutrients as bovine dung compost, hence is still preferable to traditionally produced composts.

Keywords: **Vermicast, vermicompost, vermiculture**

INTRODUCTION

Earthworms are the bowels of the planet, as Aristotle once remarked about 2,350 years ago. This statement's accuracy has only been confirmed and determined to be true in the twentieth century. He lived more than two and a half millennia before our time. No other organism has contributed to the formation of the world as much as earthworms, according to Darwin. The study of producing and rearing earthworms is known as vermiculture. It outlines the fascinating possibilities for waste reduction and fertiliser generation, as well as a variety of potential uses in the future. (Entre Pinoys, 2010).

One of nature's top "soil scientists" is the earthworm. Liberated earthworms provide affordable agriculture assistance. The worms are responsible for a number of things, including improving the quality of ordinary soil. When they feed, they digest organic stuff and leave behind castings, which are a very useful kind of fertiliser. (www.bjmp.gov.ph, 2010).

Agrochemicals have been widely used since the "green revolution" of the 1960s to enhance food production, but they also kill beneficial soil organisms and reduce crops' natural fertility by reducing their "biological resistance," making them more susceptible to diseases and pests. That food that is chemically cultivated has a negative impact on human health as well. [Sinha *et al*, 2010].

Organic materials, such as yard wastes, human waste, animal manure, sewage sludge, food wastes, and composts, have been proven to be beneficial for plant development and production as well as the maintenance of soil fertility. The new methods for using organic amendments in farming have been shown to be successful in boosting crop yields, improving soil fertility, and upgrading soil structure. [Arancon and Edwards, 2004].

Vermicomposting has been cited as a practical, quick, and affordable method for the effective use of agricultural residues and organic waste. Vermicomposting is a non-thermophilic biodegradation process that uses earthworms and microorganisms to break down organic waste. [Suthar S. 2009]

According to literature, earthworms function like mechanical blenders. The organic matter is broken down by earthworms, which also change its physical, chemical, and biological condition and eventually lower its C:N ratio. It expands organic matter's surface area, making it easier for microbes to attach to it, which is much more conductive to microbial activity and further degradation. [6,7].

This research paper described the methodologies as well as the laboratory experiment conducted by the B.Sc. (Hons.) Agriculture students of RNB Global University on their innovative approach on Vermicomposting.

EARTHWORMS

Earthworms are vertebrates that belong to the class Oligochaeta and phylum Annelida. The name "earthworm" refers to the fact that these creatures are almost invariably terrestrial, burrow into damp, fertile soil, and emerge at night to feed. The earthworms are cylindrical, long, thread-like, soft-bodied, elongated creatures with homogeneous ring-like features along the length of their bodies. These bodies are composed of segments that are arranged in linear series and are outwardly accentuated by annuli, or circular grooves. [8]. Nearly 4,400 different species of earthworms have been identified worldwide. But only a small percentage of these earthworms are used in vermicomposting. [9]. Earthworms are categorized in two groups:

(1) Burrowing (2) Non- burrowing.

Non- burrowing produce vermicompost from organic waste more quickly than the earthworms that burrow. Earthworms of the non-burrowing variety include *Eiseniafoetida* and *Eudriluseugenae*. They reside in the soil's topmost layer. They have a 28-month lifespan. These earthworms are either red or purple in colour. They measure between 10 and 15 centimetres.

METHODOLOGY

The science of worm composting is known as vermiculture. Worms may consume their entire weight in fruit and vegetable scraps each day, leaving castings as the only byproduct. Worm castings are called worm compost (www.gardens.com).

Preparation of Beds: The group of students of our university started this vermiculture experiment on March 2, 2022 with the preparation and cleaning of the beds located at the RNB GlobalUniversity campus. The bottom of the cement ring, is coveredby a polythene sheet. Here they take 4 beds (2 x 3 size) for this experiment, and started gathering some organic waste such as pruned leaves, cow dung, crop residue and household waste.

After few days of gathering, we put the substrates to all thevermi beds on March 10. On the polythene sheet, we spread 15-20cm layer of organic waste material. We put a mixture of pruned leaves, rice straw, wheat straw, household waste, coconut husk, cow dung etc. The trash should first have rock phosphate applied to it before cow dung slurry. In layers, thoroughly fill the beds. Fill the bed's top with dirt or cow manure. We made sure the materials were chopped or broken into little pieces before placing the substrate. Better materials could readily degrade. Within 10 to 15 days complete anaerobic decomposition occurs and they are solely prepared for worm ingestion at that point.

Inoculation of Worms: The vermi worms are added to the substrate on March 25 and after 15 days they were placed in the vermi beds. We employed red worms (Eiseniafoetida).Depending on the materials utilised and the ratio of the worms to the substrate, aerobic decomposition lasts between 8 and 15 days. We have enough substrate in our experiment—200 kilograms—for each bed to support one kilogramme of worms for two months.

We cover the beds with the netting or gunny sack to stop birds from stealing the earthworms. We spray water every three days to keep the earthworms' bodies sufficiently wet and at a comfortable temperature.

Collection: We have used agricultural waste so, within about 2 months the vermicompost is ready. The prepared vermicompost is free from bad odor, black in colour and light in weight. To make it easier to separate the castings from the worms and avoid the castings from becoming compact before harvest, we stopped watering the substrate for the previous three days. On May 10, we began to collect the vermicompost, or worm dung; in all, we obtained 200 kg of organic fertiliser from only one bed, and then from the remaining beds. We gather the compost in little piles and let it sit in the open for few hours until all the worms have shifted to the bottom of the pile to the ground. The top layer of the manure is taken and filtered to remove the earthworms.

Maintenance of Worms: After the harvest of the vermi compost, we again applied substrates and vermi worm in the same way for subsequent production of vermicompost.

Application of Prepared Vermicompost: We transplanted vegetable seedlings in the shed net house using our gathered vermicompost as organic fertiliser, and part of the organic fertilisers were kept for later use.

Importance of Vermicompost

Nitrogen Mineralization

Earthworms significantly increase soil fertility, and the result is a significant increase in the quantity of mineralized nitrogen that is available for plant development. An increase in soil nitrogen occurs after earthworm rearing [12,13,14]. The body of an earthworm is composed of 65 percent protein, 3 percent ash, 14 percent lipids, and 14 percent carbs [15]. About 0.01 g of nitrate, or 72% of the dry weight of the soil, is released at the death of one earthworm [16,17]. Additionally, earthworms consume a lot of plant organic matter that contains a lot of nitrogen, and they release a lot of this nitrogen back into the soil. According to reports, N mineralization would be preferable if it was reserved in the areas in form of nitrate where earthworms are found in the soil [18].

Effect onthe C: N Ratio

The carbon/nitrogen (C: N) ratio must be in the range of 20:1 or below for plant roots to be able to adjust to the mineral N [19]. Earthworms assist in lowering the C:N ratio of new organic materials during respiration [20,21]. To assess the impact of earthworms on lowering the C: N ratio, the carbon consumption must be generally estimated by calculating respiration. The main drawback of laboratory investigations is that they don't always accurately reflect the actual condition. There were significant differences in the C:N ratio, NPK (nitrogen, phosphorus, and potassium), electrical conductivity (EC), and organic carbon content in a trial of vermicomposting using leaf litter and cow dung combination in ratio 1:1 as compared to controls without earthworms. [22]. Vermicompost's C:N ratio was reported to have decreased dramatically from that of compost.

Effect on Heavy Metals

Due to their extensive substrate consumption, earthworms are exposed to heavy metals both through their skin and gut. They thus build up heavy metals in their bodies [23]. Vermicomposting can therefore be utilised to remove harmful metals that will ultimately transform into non-toxic forms [24]. According to a claim made in response to an extended composting period, heavy metal absorptions in vermicompost are reduced [25]. During the vermicomposting process, earthworms (Eiseniafoetida) have the capacity to build heavy metals at greater absorption [26]. In soils with copper contamination, a significant decrease in earthworm reproduction has been seen [27]. When exposed to 200 mg of Cu concentrations, it was found that E. foetida did not generate any cocoons [28]. Vermicompost has also been employed practically as a natural absorber for heavy metals [29]. Mangold and Arruda have effectively demonstrated the benefit of using vermicompost as an absorbent for managing wastewater that contains heavy metals and recommended its usage in the future [30].

Effectiveness ofVermicompostover Conventional Compost

According to studies, locally produced earthworm vermicompost is "exceptionally superior" than internationally recognised brands of traditionally prepared and marketed composts. Vermicompost is proved to be at least four times more nutritive than traditional cattle dung compost [31].

It was discovered by farmers of Argentina who utilisedvermicompostand found that it is seven times richer in nutrients and growth-promoting qualities than standard composts [30,31]. This is mostly caused by the 'humus' content of vermicompost that is expelled by earthworms, as it takes a very long time for organic matter to slowly decompose in a typical composting system to produce humus. The 'humic acid' in vermicompost activates a modest amount of plant growth. [32].

In comparison to ordinary compost, vermicompost retains nutrients for a longer period of time, but the latter does not contain enough macro- and micronutrients. Vermicompost also provides essential N, P, and K to plants more quickly than the other method.

The more bio-available type of nitrogen for plants—nitrates—is seen to be greater in vermicompost than in ordinary compost, which is richer in "ammonium" [33]. Vermicompostwas found to significantly increase the supply of several other plant nutrients such as phosphorus (P), potassium (K), sulphur (S), and magnesium (Mg) when added to the same soil as conventional compost. It is also claimed that vermicompost has higher N availability than conventional compost on a weight basis.

Although the traditional composting process takes around 8 weeks to complete, an extra 4 weeks are needed for "curing." After composting, certain chemicals, organic acids, and big particles need to be "cured" by undergoing further aerobic decomposition. During curing, less oxygen and water are needed. Crops may be harmed by compost that hasn't undergone enough curing. Vermicompost doesn't need to be aged; it may be put to use right away.

Conclusions

Comparing vermicomposting to composting, an advantage may be shown. This is often caused by the 'humus' content in vermicompost that earthworms expel, and in traditional composting systems, humus does not accumulate for a very long time due to the slow decomposition of organic materials. Vermicomposting organic waste, will be extremely helpful in finding a solution to the problem of biowaste disposal. The consumption of inorganic fertilisers is decreased via the recycling of plant nutrients. African earthworm species outperform Indian ones in this regard. Vermicomposting is an effective, convenient, eco-friendly, and practical technique. The grape marc may readily be expanded to provide a range of beneficial products for commercial usage. Paralleling this production with the appropriate industrial use of coffee by-products is crucial. By valorizing these byproducts, value might be fixed from an environmental standpoint. Vermiwash revealed potential applications for sustainable development in agriculture biotechnology based on its provenance, affordability, accessibility, time-saving, repeatability, reliability, and ecofriendliness. By enhancing microbial activity and microbial biomass, which are essential elements in nutrient cycling, the generation of plant growth regulators, and protecting plants from soil-borne illnesses and insect-pest assaults, vermicompost application improves soil quality in the field. The practise of vermiculture and vermicomposting is very rewarding and thrilling. Particularly with regards to the methodology, advantages, and importance of this activity, we have learned a great deal.

References

1. Atiyeh RM, Subler S, Edwards CA, Bachman G, Metzger JD, Shuster W. Effects of vermicomposts and composts on plant growth in horticultural container media and soil. Pedobiologia. 2020;44(5): 579590. Vermicompost. Publication of Rajendra Agriculture University, Pusa, Bihar, India, 88.
2. Atiyeh RM, Subler S, Edwards CA, Bachman G, Metzger JD, Shuster W. Effects of vermicomposts and composts on plant growth in horticultural container media and soil. Pedobiologia. 2020;44(5): 579590. Vermicompost. Publication of Rajendra Agriculture University, Pusa, Bihar, India, 88.
3. Bureau of Jail Management and Penology (2010). Retrieved on October 2, 2010 from http://www.bjmp.gov.ph/pdf%20and%20html/verm/vermiculture.htm.
4. Canellas LP, Olivares FL, Okorokova AL, Facanha RA. Humic acids isolated from earthworm compost enhance root elongation, Lateral Root Emergence, and Plasma

Membrane H+ ATPase Activity in Maize Roots. Journal of Plant Physiology. 2002;130(4):19511957.

5. Daniel T, Karmegam N. Bio-conversion of selected leaf litters using an African epigeic earthworm, Eudriluseugeniae. Ecology Environment and Conservation. 1999;5: 273–7.
6. Domínguez J, Sanchez-Hernandez JC, Lores M. Vermicomposting of winemaking by-products. In Handbook of Grape Processing By-Products. 2017;55-78. Academic Press.
7. Edwards CA, Arancon N (2004) Interactions among organic matter, earthworms and microorganisms in promoting plant growth. In: Edwards CA, Magdoff F, Weil R (eds) Functions and management of organic matter in agro-ecosystems. CRC Press, Boca Raton, pp 327–376 https://www.crcpress.com.
8. Edwards CA, Lofty JR. Biology of earthworms. Bookworm Publishing Company, Crawfordsville, Indiana; 1976. ISBN: 0-916302-20-2.
9. Entre Pinoys (2010). Retrieved on September 29, 2010 from http://www.mixph.com/2006/12/vermiculture-the-management-of-worms.html.
10. Gajalakshmi S, Abbasi SA. Earthworms and vermicomposting. Centre for Pollution Control and Energy Technology, Pondicherry University, Pondicherry 605 014, India; 2004. Received 24 January 2003; Accepted 15 October 2003.
11. Govindan VS. Vermiculture, Vermicomposting. In: Trivedy RK, Arvind Kumar, editors. Ecotechnology for pollution control and environmental management. Karad: Enviro Media. 1988;49–57.
12. Hand P, Hayes WA, Frankland JC, Satchell JE. The vermicomposting of cow slurry. Pedobiologia 1988; 31:199–209.
13. Jain K, Singh J. Modulation of fly ash induced genotoxicity in viciafaba by vermicomposting. Ecotoxicology and Environmental Safety. 2004; 59:89–94.
14. Landgraf MD, da Silva SC, Rezende MOO. Mechanism of metribuzin herbicide sorption by humic acid samples from peat and vermicompost. AnalyticaChimicaActa. 1998;368(1–2):155–64.
15. Matos GD, Arruda MAZ. Vermicompost as an adsorbent for removing metal ions from laboratory effluents. Process Biochemistry. 2003;39(1):81–8.
16. Morgan JE, Morgan AJ. The accumulation of metals (Cd, Cu, Pb, Zn and Ca) by two ecologically contrasting earthworm species (Lumbricusrubellus and Aporrectodeacaliginosa): Implications for ecotoxicological testing. Applied Soil Ecology. 1999; 13:9–20.
17. Munroe G. Manual of onfarm vermicomposting and vermiculture. Publication of Organic Agriculture Centre of Canada, Nova Scotia; 2007.
18. Nagavallemma KP, Wani SP, StephaneLacroix VV, Vinnela C, Babu Rao M, Sahrawat KL. Vermicomposting: Recycling wastes into valuable organic fertilizer, Global Theme on Agrecosystems report no. 8. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi- Arid Tropics. 2004;20.
19. Ozawa T, Risal CP, Yanagimoto R. Increase in the nitrogen content of soil by the introduction of earthworms into soil. Soil Science and Plant Nutrition. 2005; 51(6):917–20.

20. Pajon S. The worms turn argentina. Intermediate Technology Development Group. Case Study Series 4; Quoted in Munroe; 2007. Available: http://www.tve.org./ho/doc.cfm? aid= 1450&lang=English
21. Pierre V, Phillip R. Margnerite L, Pierrette C. Antibacterial activity of the haemolytic system from the earthworms Eisiniafoetida Andrei. Invertebrate Pathology. 1982; 40(1):2127.
22. Rajendran M, Thivyatharsan R. Performance of different species of earthworms on vermicomposting. Department of Agricultural Engineering, Faculty of Agriculture, Eastern University, Sri Lanka; 2004.
23. Reinecke AJ, Reinecke SA. The influence of heavy metals on the growth and reproduction of the compost worm Eiseniafetida (Oligochaeta). Pedobiologia. 1996; 40:439–48.
24. Ronald EG, Donald ED. Earthworms for ecology and profit. Earthworm and the Ecology'. Ontario, California: Bookworm Publishing Company. 1977b;2. ISBN: 0-916302-01-6.
25. Ronald EG, Donald ED. Earthworms for ecology and profit. Scientific Earthworm Farming. Ontario, California: Bookworm Publishing Company. 1977a;1. ISBN: 0-916302-05-9.
26. Ruz-Jerez BE, Ball PR, Tillman RW. Laboratory assessment of nutrient release from apasture soil receiving grass and clover residues, in presence and absence of Lumbricusrubellus or Eiseniafetida. Soil Biology and Biochemistry. 1992; 24:1529– 34.
27. Saxena M, Chauhan A, Ashokan P. Fly ash vermicomposting from non-ecofriendly organic wastes. Pollution Research 1998; 17:5–11.
28. Shahmansouri MR, Pourmoghadas H, Parvaresh AR, Alidadi H. Heavy metals bioaccumulation by Iranian and Australian Earthworms (Eiseniafetida) in the sewage sludge vermicomposting. Iranian Journal of Environmental Health, Science and Engineering. 2005;2(1):28–32.
29. Sinha R, Agarwal S, Chauhan K, Chandran V, Soni B (2010) Vermiculture technology: reviving the dreams of Sir Charles Darwin for scientific use of earthworms in sustainable development programs. Technol Invest 1(3):155–172. https://doi.org/10.4236/ti.2010.13019.
30. Spurgeon DJ, Hopkin SP. Extrapolation of the laboratory-based OECD earthworm toxicity test to metal-contaminated field sites. Ecotoxicology. 1995;4:190–205.
31. Suhane RK. Vermicompost. Publication of Rajendra Agriculture University, Pusa, Bihar, India. 2007;88.
32. Suthar S. Vermicomposting of vegetable market solid waste using Eiseniafetida: impact of bulking material on earthworm growth and decomposition rate. Ecological Engineering. 2009;35(5):914–920.
33. Yadav, Garg VK. Recycling of organic wastes by employing Eiseniafetida. Bioresource Technology. 2011;102(3): 2874–2880.