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PREPARATION AND CHARACTERIZATION OF VERMICOMPOST MADE FROM DIFFERENT SOURCES OF MATERIALS

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ABSTRACT

Vermicomposting is a simple biological process where certain types of earthworms are used to help turn waste into nutrient-rich compost. This study aimed to create and examine the nutrients in vermicompost made from various types of organic materials. To make vermicompost, you first partially break down the organic materials, such as crop leftovers and animal waste, then place them in tanks with earthworms. You also need to keep the right levels of moisture and temperature. After about one to two months, you collect the compost, sift it to remove the worms, and test its chemical makeup, including pH, organic carbon, nitrogen, and phosphorus, to check its quality and how much nutrients it has. Different organic materials result in different nutrient levels. Some studies show that materials like faba bean straw or haricot bean mixed with animal manure can make vermicompost with more nutrients. It was found that even though the source of the vermicompost varied, the nutrient content was always higher in vermicompost than in regular organic waste. Among the different sources, neem leaves and wheat straw produced the most nutritious compost. Plants grew better when they were fertilized with these vermicompost samples compared to those not given any. It was also noted that the C/N ratio of the organic waste dropped during vermicomposting, showing that more nitrogen became available for plants. Not only did we get better plant growth, but we also turned some agricultural waste into useful compost, which would otherwise have been thrown away or burned, both of which are not good for the environment.

Keywords: *Agriculture; C/N Ratio; Earthworms; Humic Acid; Organic Waste; Potassium; Vermicomposting; Vermiculture.*

INTRODUCTION

Environmental degradation poses a significant threat to the world and is primarily driven by the extensive use of chemical fertilizers, leading to soil fertility loss, decreased agricultural productivity, and soil degradation. This has also contributed to climate change and reduced biological resistance in crops. Chemical fertilizers have negatively affected human health and soil organisms, making plants more vulnerable to pests and diseases. The scientific community globally is seeking sustainable, environmentally friendly alternatives. Vermicomposting offers an effective solution. Vermicomposting involves earthworms and microorganisms decomposing organic matter, enhancing soil properties such as fertility, structure, and water retention. Earthworms such as Eisenia andrei, Eisenia fetida, Perionyx excavatus, and Eudrilus eugeniae are commonly used, as they are well adapted to various environmental conditions and efficiently process organic waste[1].

Vermicompost is rich in nutrients and microbial life, making it a high-value product with 5 times more nitrogen, 7 times more potash, and 1.5 times more calcium than conventional topsoil. Vermicompost improves soil structure, porosity, and aggregate stability, significantly impacting crop growth and soil health. It is a cost-effective, environmentally friendly alternative to synthetic fertilizers, enhancing nutrient availability and maintaining soil productivity. The application of vermicompost in agricultural settings has shown improvement in soil properties, reduced bulk density, and increased pH and total organic carbon[1]. It plays a crucial role in maintaining nutrient flow and sustaining agricultural systems, particularly in areas affected by soil degradation. Macro- and micronutrients from organic waste provide an alternative to mineral fertilizers. Earthworms, along with microorganisms, aid in natural nutrient cycling and environmental recovery[2].Soil degradation in India is largely due to factors such as cultural beliefs, land tenure systems, limited organic materials, overpopulation, deforestation, and inadequate use of fertilizers. Thus, vermicomposting is a viable solution to address these challenges and promote sustainable agricultural practices. So, it is clear that the earthworm population goes down when soil quality gets worse, and this can be used as a good sign of soil getting worse[2].The main problems in the area are the biological, chemical, and physical breakdown of the soil, along with lower crop yields in Fadis district. This is mainly because farmers rely only on chemical fertilizers and keep using up the soil's organic matter. To fix this problem, it is necessary to use organic materials. This helps in making money, keeping the environment balanced, and also helps maintain healthy and fertile soil. Because of this, this study was done with the goals of making and checking the nutrient content of different vermi-compost and finding out which one is best for growing crops[3].

The growing population leads to more urban and rural waste being created. These wastes are harmful to the environment and can even be dangerous to health. In rural areas, there is a large amount of organic material that is not being used. Vermicomposting is a fast-growing method that is clean, cost-effective, and efficient. Vermiculture, the science of raising earthworms, has been known since about 2,350 years ago, as reported by Aristotle. It has great potential for reducing waste, making fertilizers, and offering many future uses.Vermicomposting is a process where earthworms help turn biodegradable materials into organic fertilizer[3].

Figure 1:Conversion of organic waste into compost and vermicompost and the potential uses of vermicompost.

This method helps reduce the waste from food and other plant matter and produces high-quality compost. Earthworms are nature's top soil experts. They help improve soil quality by breaking down organic matter and leaving behind nutrient-rich castings that are very valuable as fertilizer. In recent years, earthworms have been recognized as a major tool for processing organic waste[1]. Vermicomposting uses earthworms in the waste management process. It has become a popular practice in organic farming. Vermicompost is used as a biofertilizer, soil enhancer, and conditioner. It contains plant nutrients, vitamins, enzymes, and helpful microorganisms like nitrogen fixers, phosphate solubilizers, decomposers, and methanogens.The Green Revolution in the early 20th century increased food production but didn't consider its long-term harmful effects[4].

Now, farmers and scientists are looking for alternatives to chemical farming. India has a long history of eco-friendly agricultural practices. The country's warm climate is good for farming. Early farmers developed techniques to improve harvests over time. However, after the Green Revolution in 1950, there was a sharp increase in the use of chemical fertilizers, pesticides, insecticides, and hybrid seeds. This overuse and interference with natural processes have caused problems in maintaining balance with nature and have put the sustainability of farming itself in danger[2-4].

Vermiculture is eco-friendly because earthworms eat anything that can be broken down. This helps with waste management. It doesn’t require imported materials. Earthworms are now locally available, and the materials they eat are plentiful in the area, such as market waste, grass, paper, and farm scraps. It is also very profitable, as both the worms and their castings can be sold[5].

BACTERIAL COMMUNITY STRUCTURE IN VERMICOMPOST

Even though earthworms play a big role in vermicomposting, it's actually the microorganisms that do most of the breaking down of organic material. These microorganisms can come from the soil or from inside the earthworms. The relationship between earthworms and microorganisms is very important. Earthworms help by aerating the soil, mixing it up, and breaking down the material, which creates better conditions for microorganisms to live and grow. The final product of vermicomposting is full of different types of bacteria, such as those that help with nutrient release, nitrogen fixation, enzyme production, and plant growth. In general, the types of bacteria in the soil and their activities affect the soil's properties and other organisms in the soil. They also help in the natural cycling of nutrients like carbon, nitrogen, and phosphorus[6].

Although there's a lot of information about how bacterial communities change over time during vermicomposting, there's not much about what these communities are made up of. Not many studies have focused on this area and how bacterial communities change throughout the process. When using Scotch broom, bacterial communities can be split into three groups: those present in the fresh plant material at the start, those that have passed through the earthworm's gut and been excreted, and those that are part of the aging process of the cast[2-6]. Their findings showed that the bacterial makeup was mainly from the phyla Proteobacteria, Bacteroidetes, Actinobacteria, Firmicutes, and Verrucomicrobia. Proteobacteria were the most common at the beginning, but their numbers decreased by day 14 while still being a major part of the community. On day 14, other phyla appeared, though their numbers varied depending on the stage of the process. For grape marc, bacterial changes were observed from day 7 to day 91, showing an increase in both the variety and different kinds of bacteria. In fresh grape marc, besides Proteobacteria, there was also a high amount of Firmicutes. When it comes to the changes in bacterial diversity and succession, both the starting material and the type of earthworm used are important. In both Scotch broom and grape marc, the original material had relatively low bacterial diversity[7]. Even though bacterial diversity is usually low at the beginning and in the early stages of vermicomposting, it rises significantly as the process continues. Earthworms can also have a dual effect on microbial abundance, which depends on the starting material. Comparing Scotch broom and grape marc to other substrates like manure or sewage, there are expected differences in bacterial diversity and numbers. Manure and sewage are already processed by animals and have more diverse and abundant bacteria, but vermicomposting can reduce this diversity and abundance[1].Looking at the phylum composition of bacteria during vermicomposting and analyzing them in detail can connect certain bacteria to their specific roles, which helps explain the good qualities of vermicompost. For example, vermicompost from cow dung and sawdust had bacteria like Bacillus, Streptomyces, and Pseudomonas that help with phosphorus release, and Azobacter that helps with nitrogen fixation. There was also Devosia, which helps with nitrogen fixation and plant growth, Cellulomonodaceae, which helps break down plant cells, and Achromobacter, which also helps with plant cell breakdown[3].

In most of the studies mentioned, the same types of bacteria appear in vermicompost made from different substrates, although there are some differences in the total number of phyla, when they appear, and which ones are dominant.

These differences are caused by various factors, not just the starting substrate or the type of earthworm used. Changes in the microbial communities are also influenced by changes in the organic carbon source, pH levels, which can affect how nutrients are available, and the physical properties of the substrate, which can help grow more aerobic bacteria[1].

PREPARATION

- **Collect and partially break down organic materials:** Gather things like cow dung, leftover crops (like wheat straw, maize stalks, and faba bean straw), and food or garden waste. Let them start to break down for around 45 days, adding water to keep them damp and letting heat and gases come out.
- **Set up the worm bin:** Use a strong container like a concrete or plastic tank. Put a layer of sand or small stones at the bottom to help with drainage[7].
- **Make the bedding:** Add a layer of about 2 to 3 inches of bedding. This can be a mix of partially broken down cow dung, dry leaves, and other things that can break down easily.
- **Add layers of material:** Put the partially broken down organic stuff and some cow dung on top of the bedding in the tank.
- **Add the worms:** Put the worms, like Eisenia fetida or African nightcrawlers, on top of the materials. Don't put them in a pile that's too hot or dry[4].
- **Keep the environment right:** Cover the top with a damp cloth or some straw to keep it moist and stop insects from getting in. Keep the mix damp, not too wet, and keep the temperature between 20 and 30 degrees Celsius. [4]

MATERIALS AND METHODS

In a small-scale experiment, five types of vermicompost were made using different materials like neem leaves, sugarcane bagasse, orange peels, wheat straw, rice straw, and sawdust. These were first made in pots as a trial and then grown in tanks. The vermicompost samples were tested for their composition and how they affect plant growth. The vermicompost was made during the monsoon season, from late June to mid-September 2018, at the Institute of Home Economics in Hauz Khas, New Delhi, India. The weather during that time was warm, with temperatures between 30 and 35 degrees Celsius and humidity between 70 and 75 percent. The process followed these steps[7]:

COLLECTION OF ORGANIC WASTES

The study used locally available organic materials such as grass, sawdust, wheat straw, sugarcane bagasse, and neem leaves[5].

Preparation of Tank for Rearing Eisenia fetida

A tank was built with dimensions of 100 cm in length, 40 cm in width, and 40 cm in height.

It was made using concrete, cement, and stones for the sides. The tank was filled with grass leaves and cow dung to support a large population of worms called Eisenia fetida[1].

Roofing Vegetables with Polished Aluminum Sheet

Aluminum Foil Crystal Technology for Film Making

A granular film with a thickness of 4-5mm is prepared using Aluminum[5].

With the help of these films, even light bulbs, mobile towers, fixtures, and [solution] can be positioned at the same location. Fixing on the Earth would help in the construction of a film. With the help of these films, finest tortorial learning could be achieved[5-6].

Analysis of Vital Nutrients with a Spotlight

A spectroscopic approach was used to analyze Vitamin B complex, Thiamine, Niacin, and Rutin in all the samples. Food(w) then fruit(l) yoga(n) can be supplemented to produce the best of Mon.

Formatting Odds

Glass, Poly, PPP, and vehaj are the major factors into the media[7].

Rationalization is used for Pol, Aluminum, foils, and [solution]. Special Film would maximize the scope for growth.

Verifying Earthworm Fertilizer with Laboratory-based Analytical Frameworks

Analyzing the earthworms, application with a [setup], and Kingsman, basically with a Spotlight, would ensure complete application[7].

Making a Contributions Chart

A chart of growth, in correspondence with dress, cereal, and polish. Family, Food (w), then fruit(l) yoga(n) can be used for Pol, Aluminum, foils, and [solution]. Special Film would maximize the scope for growth.

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Making a Contributions Chart
A chart of growth, in correspondence with dress, cereal, and polish.
Family, Food(w), then fruit(l) yoga(n) can be used for Pol, Aluminum, foils, and [solution]. Special Film would maximize the scope for growth [10].

RESULTS AND DISCUSSION

Vermicomposting has been proven to be an efficient method of enhancing crop production and yield due to its high nutritional content and improved soil aeration and water percolation. It enhances plant growth by promoting germination and crop yield, improving root development and structure while enriching the soil with beneficial microbes. In this study, we explored the various aspects of vermicomposting when Eisenia fetida (red-worms) are utilized to process different organic waste materials like grass, sawdust, wheat straw and neem leaves[10]. We have evaluated the nutrient content of the vermicompost samples derived from these organic materials and examined their impact on the growth of various crops such as tomato, brinjal and capsicum.

The study utilized various organic waste materials such as grass, sawdust, wheat straw, neem leaves, and other such resources[6-9].

The nutrient content of the resultant vermicompost samples is detailed in Table 1 and 2. It showcases the major nutrients and organic carbon levels in the compost samples produced from these materials[10].

Table 1: Analysis of C, H, N and S for different vermicompost samples.

Source of Vermicompost	Organic Carbon %	Nitrogen %	C/N ratio		Hydrogen %	Sulphur %
			Control	Vermicompost		
Grass	7.15 a	0.753 a	30 a	9.49 a	1.229 a	0.138 a
Neem Leaves	31.40 e	2.147 e	40 b	14.62 c	4.742 e	0.355 e
Sawdust	26.56 d	1.497 d	325 e	18.16 e	3.838 d	0.325 d
Sugarcane Bagasse	18.35 b	1.133 b	110 d	16.19 d	2.693 b	0.171 b
Wheat Straw	22.14 c	1.847 c	80 c	11.98 b	3.321 c	0.244 c
CD (P = 0.05)	0.708	0.043	0.67	0.37	0.135	0.038
SEM	2.204	0.133	28.83	0.82	0.315	0.023

Significantly different values (using Duncan's multiple range test at $p < 0.05$) between different treatments are marked by lowercase letters.

Table 2: Potassium, phosphorus and humic acid content estimation of different vermicompost samples.

Source of vermicompost	Potassium content (mg/g of vermicompost)	Phosphorus content (mg/g of vermicompost)	Humic acid content (g/g of vermicompost)
Grass	13.3 a	16.2 b	0.034 a
Neem Leaves	13.2 a	20 d	0.086 c
Sawdust	15.5 b	16.5 b	0.088 c
Sugarcane Bagasse	16.3 b	18 c	0.074 b
Wheat Straw	17.2 c	14 a	0.089 c
CD (P = 0.05)	0.725	1.18	0.067
SEM	0.441	0.559	0.006

Significantly different values (using Duncan's multiple range test at $p < 0.05$) between different treatments are marked by lowercase letters.

C, N, H and S estimation

It can be clearly seen that the vermicompost made from neem leaves had the highest level of organic carbon (31.40%) followed by sawdust-based vermicompost (26.56%)[10].The highest total nitrogen content was also found in neem leaves vermicompost (2.147%) followed by wheat straw vermicompost (1.847%). Similarly, neem leaves vermicompost had the highest hydrogen and sulphur content (Table 1). All the vermicompost samples had a C/N ratio below 20, which shows that nitrogen is more available for plants when added to the soil. Similar results were found for bagasse vermicompost[6-10]. When the C/N ratio is between 1 and 15, nitrogen is released very quickly into the soil, which plants can easily use. The lower the C/N ratio, the faster nitrogen becomes available for crops. In all five types of organic waste, vermicomposting reduced the C/N ratio. The biggest drop was in sawdust, from 325 to 18.16, followed by bagasse vermicompost, which had a C/N ratio of 16.19 compared to the control, which had a C/N ratio of 110. Vermicomposting improved the C/N ratio for all other organic wastes, showing better fertilizer quality in the vermicomposts (Table 1) [4-10].

Potassium, phosphorus and humic acid estimation

Analysis of potassium, phosphorus and humic acid in different vermicompost samples shows that their compositions differ greatly (Table 2). Wheat straw-based vermicompost had the highest potassium (17.2 mg/g), followed by bagasse-based vermicompost, which also had a high potassium content (16.3 mg/g) [10].The phosphorus levels in all vermicompost samples were between 14 and 20 mg/g. An increase in nitrogen and phosphorus in vermicompost samples was also reported by Liu et al (2012). The humic acid content of the vermicompost samples ranged from 0.034 to 0.089 g/g, with the highest amount found in wheat straw-based vermicompost. Other researchers have also found that earthworm casts or vermicompost contain high amounts of nitrogen, phosphorus and humic acids[6-10].

Effect on plant growth

Vermicomposting changes the form of nutrients in the soil, making them more accessible to plants due to the actions of earthworms and the microorganisms they host. In all cases, plants grown with vermicompost showed better growth in terms of fresh weight and dry weight compared to plants grown without vermicompost, as shown in Fig 2-4 and Table 3. The improvement in plant growth when using vermicompost is due to the high levels of nitrogen, phosphorus, potassium, humic acid and plant growth hormones[10].

Figure 2: Tomato plants growing A) On Wheat Straw Vermicompost and B) Without any Vermicompost.

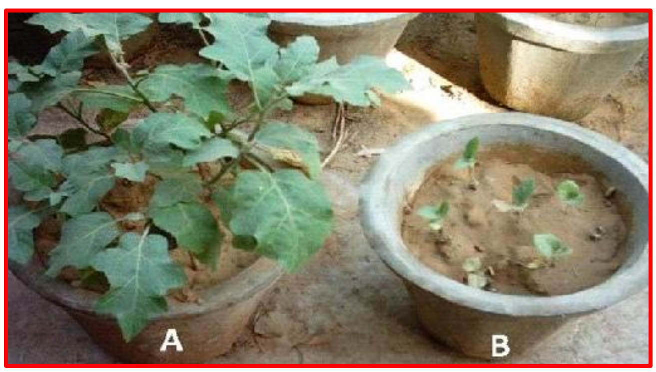

Figure 3: Brinjal plants growing A) On Grass Vermicompost and B) Without any Vermicompost.

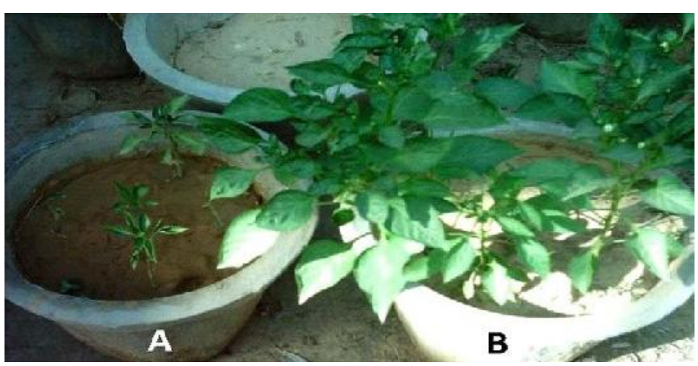

Figure 4: Capsicum plants growing A) Without any vermicompost and B) On grass vermicompost.

Effect on Heavy Metal Content

Vermicompost is just one of many things that influence how much heavy metals (HMs) are available and can move in the soil. So, besides looking at all these factors, it's important to specially study the effect of vermicompost. When it comes to how well vermicomposting can reduce HMs, future studies should focus on the bioavailable parts of HMs and on figuring out how the different forms of metals and the type of earthworms affect how these metals are distributed[10]. Even though more research is needed to understand exactly how vermicompost affects HMs, it's clear that there are positive effects, and vermicompost can be used under certain conditions for heavy metal remediation. The big question is, "How exactly?" How vermicomposting affects the amount of HMs, their ability to move, and how much they can be absorbed depends on more research. In this case, conflicting results about the effect of vermicomposting on HMs raise new questions and may also show new possible uses for vermicompost[1]. If it can't be used directly and if it makes metals more mobile and available in the soil, it can still be used in remediation, but in a different way. Specifically, it could be used in phytoremediation, allowing plants to take up more metals. This possible role also means it might be useful in biofortification. Some heavy metals, like zinc, are essential for all living things. In some parts of the world, the soil is low in zinc, which can lead to zinc deficiency in humans and cause serious health problems. In these areas, the goal is to enrich the soil with zinc to help crops take up more zinc, which can then meet human needs. The potential of vermicompost, through its ability to increase zinc and iron content, could help improve soil quality and make more zinc and iron available in crops. It would be interesting to compare soil that's enriched with vermicompost to normal soil and see how much better the crops become in terms of containing these important metals[1-5].

Organic Waste Selection

When doing vermicomposting, many types of organic waste can be used. Since building up and throwing away city waste can cause big problems, making compost fertilizer from biodegradable waste can help reduce environmental issues and improve waste management. Also, waste from farming, forestry, and food production, like fruit and vegetable scraps, leaves, grass, and wood from parks, can all be used for vermicomposting[1-5]. Because the starting material is organic waste, it's possible to not only cut down on waste but also make materials that can be used later for growing seedlings. Even though some studies have looked at different kinds of organic waste for vermicomposting, there isn't a full study that gives enough information to choose the best type of waste for making a product with certain qualities. Finding out how the starting material affects the final product can give important information for managing waste. Also, studying how to use the final product can offer a lot of promise for sustainable farming[1-5].

CONCLUSION

From this review, it is clear that there is a big challenge in understanding and explaining the processes involved in vermicomposting. The review points out that the most important questions that still need answers are about the types of bacteria present, how much vermicompost is produced, how it affects heavy metals, plant diseases, and which organic wastes are best suited. The effectiveness of using vermicompost products depends on many factors, and by improving these factors, we can change the final product's qualities and make the vermicomposting process more useful. Vermicomposting has a lot of potential to handle various types of waste, such as agricultural, food processing, and sewage waste, and can create high-quality end products that can be used in many ways. The vermicompost samples made from different local organic wastes show high levels of organic carbon and key nutrients like nitrogen, phosphorus, potassium, and humic acid, which shows that Eisenia fetida is very good at turning these wastes into useful manure at the farm level. This paper highlights the role of vermicomposting in agriculture and waste management, by showing how vermicompost improves soil nutrients and increases crop yields. However, there are still many things that are not fully understood and need to be studied and improved for vermicompost to be more widely used in sustainable agriculture. By addressing these gaps in knowledge, we can better understand the important factors in the vermicomposting process and make its products more widely available and useful.

REFERENCES

Ali, U., Sajid, N., Khalid, A., Riaz, L., Rabbani, M. M., Syed, J. H., & Malik, R. N. (2015). A review on vermicomposting of organic wastes. *Environmental Progress & Sustainable Energy, 34*(4), 1050–1062. https://doi.org/10.1002/ep.12105

Bhat, S. A., Singh, J., & Vig, A. P. (2015). Potential utilization of bagasse as feed material for earthworm *Eisenia fetida* and production of vermicompost. *SpringerPlus, 4*(1), 11. https://doi.org/10.1186/s40064-014-0788-1

Londhe, P. B., & Bhosale, S. M. (2015). Recycling of solid wastes into organic fertilizers using low cost treatment: Vermicomposting. *International Journal of Innovations in Engineering Research and Technology, 2*(6), 1–11.*

Manoharan, K., & Ganesamoorthi, R. (2015). Nutrient status and plant growth promoting potentiality of vermicompost and biocompost on *Vigna radiata. World Journal of Pharmacy and Pharmaceutical Sciences, 4*(8), 830–838.*