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"Assessment of Microbial Flora and Nutrient Dynamics in Vermicompost of Some Dominant Weeds in Wastelands of Malwa Region, Madhya Pradesh".

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Abstract

Vermicomposting is a sustainable and efficient technique for transforming organic waste into nutrient-dense compost through the utilization of earthworms. This study focuses on analyzing the microbial flora and nutrient composition of vermiculite prepared from selected weed species found in the wastelands of the Malwa region, Madhya Pradesh. The weeds that were picked were *Lantana camara, Alternanthera spp., Achyranthus aspera, Parthenium hysterophorus,* and *Cassia tora.* The study looked at the different types of microbes (bacteria, fungi, and *actinomycetes*) and nutrients (macronutrients: N, P, K; micronutrients: Zn, Cu, Fe, Mn) that were found in the vermicompost that was made.Vermicomposting was done in concrete tanks with a mixture of 60:40 weed biomass and cow dung. *Eisenia foetida* earthworms helped the decomposition process along. Microbial analysis was performed with the pour plate method, and nutrient calculation adhered to established analytical protocols. Our results showed that there were a lot more beneficial bacteria, fungi, and actinomycetes in the prepared vermicompost compared to the control group. The fungal species *Mucor* and *Rhizopus* were predominant, although Gram-positive *Bacillus* and *Streptococcus* bacteria were the most frequent. We identified elevated amounts of *Actinomycetes*, thereby enhancing decomposition.The nutrient analysis showed that the vermicompost had higher amounts of nitrogen (N), phosphorus (P), and potassium (K) than the control group. The maximum amounts of macronutrients observed were nitrogen (248 kg/hec.), phosphorus (57.64 kg/hec.), and potassium (640 kg/hec.). Similarly, the vermicompost had higher concentrations of the micronutrients Zn, Cu, Fe, and Mn compared to the control.The results indicate that vermicomposting these weeds improves soil fertility through increased microbial diversity and nutrient availability while also offering a sustainable approach to weed management and organic agriculture. The study shows that vermicompost made from weeds in wastelands is a good organic fertilizer that improves the health of the soil and raises agricultural productivity in the Malwa region.

Keywords: *vermicomposting, Microbes, nutrients, actinomycetes, gram positive bacteria, Parthenium hysterophorous.*

Introduction

Microbes are the most essential biotic factor in soil for various significant purposes. Fungi, bacteria, and actinomycetes enhance the growth and yield production in numerous crops. These microorganisms increase soil fertility by decomposition and nitrogen fixation in the soil environment. Thus, we should increase the population and diversity of these beneficial microbes for soil fertility. Several authors have noted that the earthworm plays a major role in affecting the population of soil organisms, especially in causing changes in the soil microbial community (Coleman, 1985. and Parmelee, 1998). We can increase the diversity and growth of microbes by preparing vermicompost by utilizing some weed species like *Casia tora, Casia oxidentalis, Alternanthera* spp., *Achyranthus aspera, Parthenium hysterophorous, Lantana camara*. It has been attributed to the additional availability of N, P, and K nutrients in the soil due to the application of organic manures and also the conversion of unavailable forms of nutrients into available forms (Raghuwanshi and Umat, 1994, and Zhao and Haung, 1991). Hand *et al*. (1988) have already reported that *Eisenia foetida* in cow dung slurry increased the nitrate-nitrogen content. Losses of organic carbon might be responsible for nitrogen addition in the form of mucus nitrogenous excretory substances, growth stimulatory hormones, and enzymes from the gut of earthworms (Tripathi and Bhardwaj, 2004; Viel *et al*. 1987).

These nitrogen-rich substances were not originally present in feed and might have contributed additional nitrogen content. A decrease in pH may also be an important factor in nitrogen retention, as this element is lost as volatile ammonia at higher pH values (Hartenstein and Hartenstein, 1981). Atiyeh *et al*. (2000) reported that by enhancing nitrogen mineralization, earthworms have a great impact on nitrogen transformation in manure so that nitrogen is retained in the nitrate form.

Vermicomposting is a simple biotechnological method of composting in which certain species of earthworms are used to enhance the process of waste conversion and produce a better end product. The process of producing vermicompost is called vermicomposting. Vermicompost is a nutrient-rich, natural fertilizer and soil conditioner. Vermicompost contains a high biodiversity of microbes. Together with microbes, earthworms are the major catalyst for decomposition in a healthy vermicomposting system. Vermicompost is much richer in microbial diversity, population, and activities (Subler et al., 1998).

Various weed species like *Euphorbia geniculata*, *Cassia sp., Achyranthus aspera, Pennisetum sp., Ipomea fistulosa,* etc., were used to prepare vermicompost, including dung as a check and *Eudrilus euginix* as the earthworms.

Vermicomposts are rich in microbial population and diversity, particularly fungi, bacteria, and actinomycetes (Brown G.G., 1995) and (Chaoui H.I., Zibilske L.M., and Ohno T., 2003). The vermisphere microflora comprising bacteria, fungi, actinomycetes, azotobacter, and solubilizing microorganisms were also estimated.

Earthworms inevitably consume the soil microbes during the ingestion of litter and soil. It has been recently estimated that earthworms necessarily have to feed on microbes, particularly fungi, for their protein/nitrogen requirement (Ranganathan and Parthasarathi, 2000).

Materials and Methods

The following weed species were used in this study to make vermicompost: *Cassia tora, Cassia occidentalis, Alternanthera spp., Achyranthus aspera, Parthenium hysterophorus,* and *Lantana camara*. This was done throughout the summer season of the 2022-2023 session. In this study we used the method developed by Rajkhowa D.J., Gogoi A.K., and Yaduraju N.T.,2005. for vermicomposting.

We collected weed biomass by cutting wasteland, grassland, and the sides of roads in the local area of the city Shajapur Madhya Pradesh. A mixture of vermicompost and weed biomass from several species was made. These species include *Casia tora, Casia oxidentalis, Alternanthera spp., Achyranthus aspera, Parthenium hysterophorus,* and *Lantana camara*.

A single ordinary concrete tank, which has a width of 3 feet and a height of 1.5 to 2.0 feet, was used to prepare the compost. The procedure involved using a 60:40 ratio of weed biomass and cow manure, respectively. We used *Eisenia foetida*, sometimes known as red wigglers, for vermicomposting.

Gathered and piled the weed biomass in the sun for approximately 7 to 10 days. We chopped the biomass as needed. The heap was covered with cow dung slurry. At the bottom of the tank, a thin layer of surface dirt (1-2 inches) was added. The earth was covered with fine bedding material, which included dried leaves and cow manure that had begun to degrade. The chopped bio-waste and partially decomposed cow manure were layered in the tank to a depth of 1.5 to 2.0 feet. The ratio of bio waste to cow manure was 60:40 when measured by dry weight.

We released approximately 2-3 kg of the earthworm species *Eisenia foetida* over the mixture. The compost mixture was covered with dry straw. Water was sprinkled as needed to keep the moisture level between 70 and 80 percent.

We provided shelter over the compost mixture to protect it from rainwater and bright sunlight. We stopped the water spraying when 80-98% of the bio-waste had decomposed. The granular structure on the tank's surface indicates compost maturity. We collected the vermicompost by scraping it layer by layer off the top of each tank and then stored it in a shaded area. Every month during the vermicomposting process, we conducted a microbiological study on the prepared vermicompost using the pour plate method. We created three different types of culture media for the growth of bacteria, fungi, and *Actinomycetes* in this investigation. These media were nutrient agar, PDA, and starch-casein agar, respectively. To study different microorganisms, suspension samples of vermicompost were put on culture media and looked at under a microscope.

$$\text{Total P (ppm)} = \frac{\text{ppm P (from calibration curve)} \times A}{\text{Wt}} \times \frac{50}{V}$$

$$\text{Extractable K (ppm)} = \frac{\text{ppm K (from calibration curve)} \times A}{\text{Wt}}$$

$$\text{Iron (mg/g) in soil sample} = \frac{F \times V}{10 \times W} \times \frac{1}{100 - M}$$

Macro nutrients (N, P and K) and micro nutrients (Zn, Cu, Fe and Mn) were also estimated in all three types of vermicompost. Total Nitrogen was estimated according to Kjeldahl method in prepared Vermicompost.

$$\text{Nitrogen (mg/g)} = \frac{\text{1ml } H_2SO_4 \text{ used (sample} - \text{blank titration)} \times N \times 14}{\text{weight of material (gm)}}$$

Total Phosphorus, Potassium, Zinc, Copper, Iron and Manganese were estimated according to APHA, AWWA, WEF (1998). And Saxena M.M. (1998). Environmental Analysis: Water, Soil and Air. Agro Botanical Publishers, India.

ppm of Zn in soil = ppm in extract ×4
ppm of Cu in soil × ppm in extract × 10
ppm of Mn in soil = ppm in extract × 10.

Results and Discussion

1. Microbial analysis of vermicompost -

In this study, we found that the prepared vermicompost had a high biodiversity and population of beneficial bacteria during the composting process.

Fungi - Different types of beneficial fungi were isolated from samples of vermicompost and identified on media plates. This compost was shown to contain a large population of fungus, with 18 colonies per cm^2 observed in comparison to the 7 colonies in control on culture media (Table-1).

Table- 1. Microbial analysis of prepared vermicompost with control.

S. No.	Microbes	prepared vermicompost	Control
1.	Fungi	High population of Mucor, *Rhizopus and Aspergillius.*	Low population of *Mucor and Rhizopus.*
2.	Bacteria	Large population of gram positive *Bacillus, Diplococcus, Streptococcus* and *Cocci* bacteria.	Low population of gram positive *Bacillus, Diplococcus* and *Streptococcus* bacteria.
3.	Actinomycetes	Large population of gram positive filamentous bacteria (*Actinomycetes*).	Low Population of gram positive filamentous bacteria (*Actinomycetes*) or absent.

In the prepared vermicompost, there were similar fungal species, Mucor and Rhizopus, with 15 and 12 colonies per cm^2, respectively. Nagavallemma K.P., Wani S.P., Stephane Lacroix, Padmaja V.V., and others reported similar results in 2004 while conducting vermicomposting. They found Aspergillus, Mucor, and Trichoderma in vermicompost from 66 different species.

According to a recent estimate, earthworms must consume microorganisms, especially fungi, in order to meet their protein and nitrogen needs (Ranganathan and Parthasarathi 2000).

Bacteria- A large number of gram-positive bacteria were found in the produced vermicompost. In the prepared vermicompost, there were 24 colonies of bacteria per cm^2 in comparison to the 13 colonies in control on the culture medium shown in Figure 1. In the prepared vermicompost, the following bacteria were isolated: Gram-positive Bacillus, Cocci, Gram-positive *Diplococcus*, and Streptococcus. In compost, fungi break down trash and assist bacteria in speeding up the decomposition process. The majority of the fungus are located on the edges of the vermicompost bed, and the rise in their population corresponds to the quicker breakdown of the pressmud (Trautmann and Olynciw, 1997; Antonella et al., 2005).

According to Teotia et al. (1950) and Parle (1963), the bacterial count in fresh vermicompost was 32 million per gram, while the surrounding soil had a count of 6-9 million per gram. Scheu (1987) reported a 90% increase in respiration rate in fresh vermicast, which indicates a corresponding increase in the microbial population.

Actinomycetes - The population of *actinomycetes* was higher in prepared vermicompost than in the control group. In the produced vermicompost, 20 colonies per cm² were seen on the culture medium, as compared to the 6 colonies in control as shown in Figure 1. The results has been shown in table no. 1 and 2 respectively. Vermicompost has a number of remarkable biological characteristics. They are rich in bacteria, actinomycetes, fungi (Edwards, 1983; Tomati et al., 1987; Werner and Cuevas, 1996), and cellulose-degrading bacteria (Werner and Cuevas, 1996). The microorganisms associated with vermicompost were compared to those in standard composts. Compared to typical composts, the vermicompost contained a substantially greater population of bacteria (5.7 X 10^7), fungus (22.7 X 10^4), and actinomycetes (17.7 X 10^6). Vermicompost has good physical, chemical, and biological qualities, which makes it a great component for greenhouse container media, organic fertilizers, and soil amendments for a variety of field horticulture crops.

Table- 2. Microbial analysis of prepared vermicompost.

		No of Colonies observed on culture medium	
S.No.	**Type of Microorganism**	**Vermicompost**	**Control**
1	Bacterial	24	13
2	Fungal	18	7
3	Actinomycetes	20	6

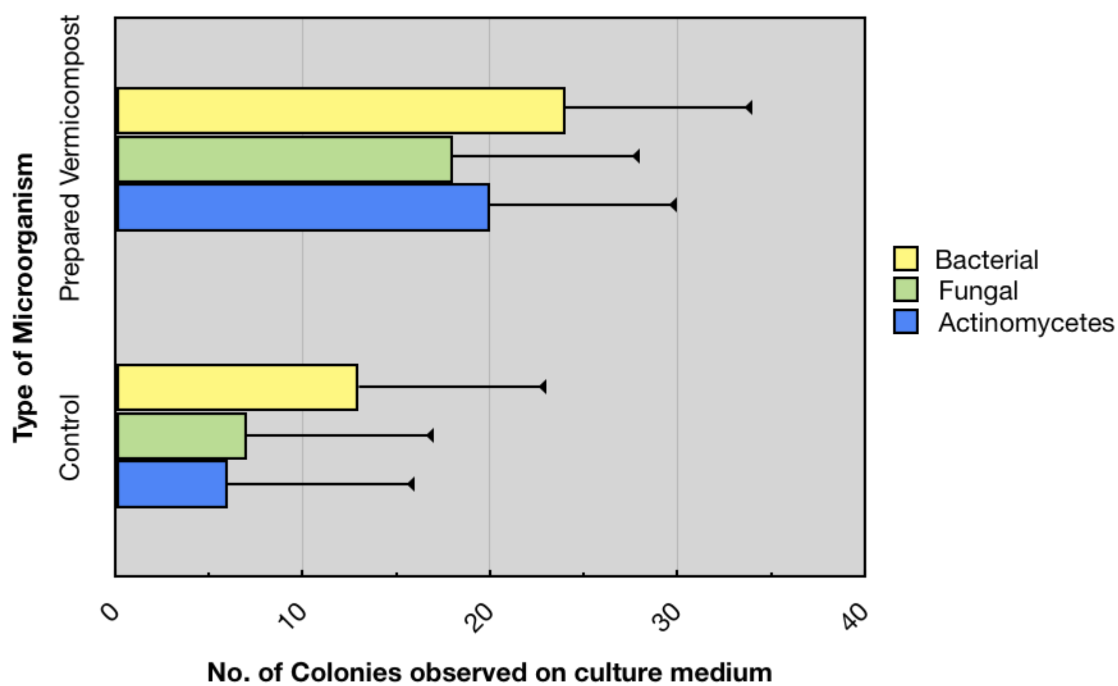

Figure - 1. Microbial analysis of prepared vermicompost

2. Nutrient analysis of vermicompost-

All prepared vermicompost contains macro and micro nutrients at higher levels than the control. The amount of macronutrients in the prepared vermicompost was examined.

Macronutrients- The highest amounts of macronutrients were found in the prepared vermicompost compared to the control. The amounts were as follows: N (248 kg/hec.), P (57.64 kg/hec.), and K (640 kg/hec.). When compared to the control, all macronutrients (N, P, and K) in vermicompost rose significantly (89, 6.8, and 136.4 kg/hec., respectively). The results have presented in Table no.3, and shown graphically in Figure 2, respectively.The data was reported as a mean ±standard deviation.

Table – 3. Nutrient [Macronutrients (Kg./Hec.)] analysis of prepared vermicompost. with control.

S.No.	Macronutrients (Kg./hec.)	prepared Vermicompost	Control
1	N	248±3.158	89±2.314
2	P	57.64±1.575	6.80±1.134

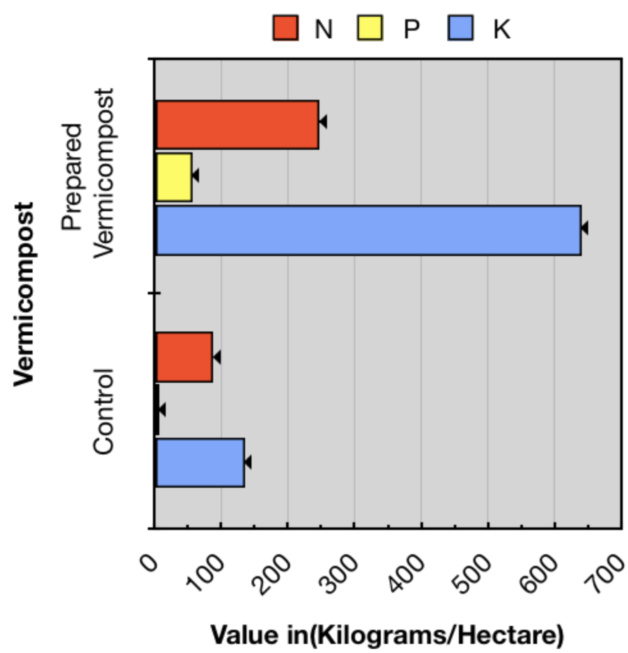

Figure - 2. Analysis of Macro-nutrients in Vermicompost.

Micronutrients-In the prepared vermicompost, the micronutrients (Zn, Cu, Fe, and Mn) were found in the following maximum concentrations: 320, 284, 245, and 240 ppm/hectare, respectively. As a result, the levels of all micro-nutrients (Zn, Cu, Fe, and Mn) in the prepared vermicompost were considerably higher than those in the control group (43, 89, 33, and 69 ppm/hec, respectively). The results have shown in table no.4 and shown graphically in Figure 3, respectively. The data was presented as a mean ±standard deviation.

Table – 4. Micronutrients Nutrient (ppm./Hec.) analysis of prepared vermicompost with control.

S.No.	Micronutrients (ppm./hac.)	prepared Vermicompost	Control
1	Zn	320±3.081	43±1.119
2	Cu	284±3.934	89±2.912
3	Fe	245±2.890	33±1.677
4	Mn	240±3.629	69±3.102

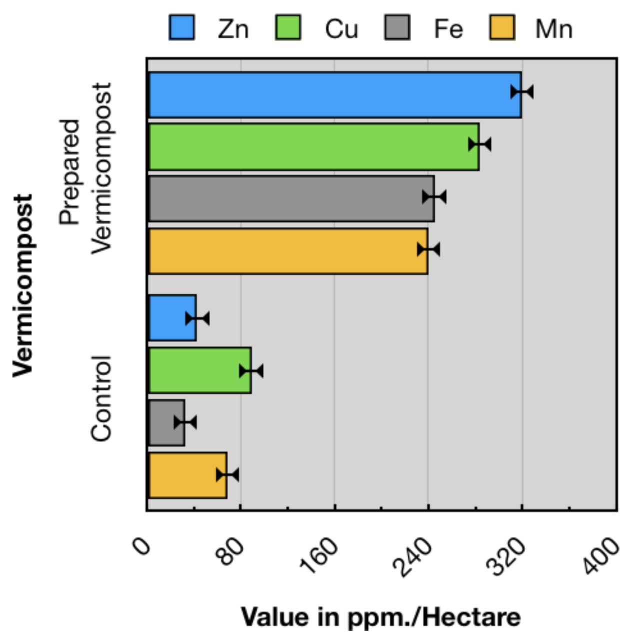

Figure - 3. Analysis of Micro-nutrients in Vermicompost.

According to Sharma Vivek et al. (2008), the highest amount of accessible nitrogen that was observed with lantana vermicompost was 397 kg/hec. This was 5-9 percent greater than the amount of nitrogen that was observed without the application of manure. The amount of nitrogen available in the soil grew dramatically and continuously as the amounts of fertilizer dosages increased, regardless of the varied sources of organic manures. This could be because a higher dose of nitrogen fertilizer gets turned into a greater amount of accessible nitrogen during the process of mineralization in the soil. It was determined that the interaction effect between organic manures and fertilizer dose on the available nitrogen status of soil was considerable.

According to Dinesh and Dubey (1999), the soil that was treated with organic matter had a much higher level of net nitrogen mineralization than the soil that was not altered. Nethra et al. (1999) also found similar outcomes when they used vermicompost. Among the composts generated from the different weed species, compost of Parthenium prepared before flowering had higher N, P and K. These findings are consistent with those of Raghuwanshi (1994) and Chadwick et al. (2000). The extra availability of nitrogen, phosphorus, and potassium in the soil is thought to be the result of the use of organic manures and the conversion of nutrients from an unavailable form to an available one (Raghuwanshi and Umat, 1994; Zhao and Haung, 1991).

Rahul and Shukla (1979) and Vasanthi and Kumarswamy (1999) similarly observed similar findings when they applied vermicompost and farmyard manure. As the levels of vermicompost grew, the amount of nitrogen accessible in the soil also increased dramatically. The maximum nitrogen uptake was achieved by using 50% of the recommended fertilizer rate along with 10 tons of vermicompost per hectare. In a similar way, the rice plant (*Oryza sativa*) absorbed the most nitrogen, phosphorus, potassium, and magnesium when fertilizer was used together with vermicompost (Jadhav et al. 1997).

Conclusion

Microbial investigation shows that there are no hazardous bacteria in the prepared vermicompost. The findings of this study demonstrate that the vermicompost of all the selected weeds is an appropriate organic fertilizer for farmers to use. As a result, it is evident that the produced vermicompost of all selected weeds improves the quality of soil by boosting microbial activity, biomass, and macro- and micronutrients. Compared to composting, this is a preferable option because earthworms speed up the process of waste conversion and provide a higher quality product. It enhances the physical, chemical, and biological characteristics of the soil. We can boost the crop productivity of native crops in the Malwa region by preparing this form of vermicompost after treating the soil.

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