RESEARCH ARTICLE

Nutrient analysis of vermicompost using different feeding media

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Unito GL. Nutrient analysis of vermicompost using different feeding media. AGBIR.2023;39(4):678-681.

This study focused on the analysis of macronutrients (NPK) present in vermicompost using different feeding media. The materials used in the study were the 3 kilograms vermiworm (African night crawlers), 15 plastic containers (worm bins), rice straw, grass clippings, food left over, Madre de Cacao leaves, and cow manure. Vermiworms were divided into five according to the kind of substrate they received as their food. One hundred grams of air-dried vermicost was packed from each bin for laboratory test and total nitrogen was measured using Modified Kjeldhal Method, Flame Photometer Method was used for measuring total potassium, and total available phosphorus using (Bray P2 Method) Spectrophotometer. The study conclusively asserts that the different feeding media used in the production of vivmicompost yielded a higher level of macro-nutrients based on the parameters mentioned by ICAR Research Complex for NEH Region. Other research will focus on the identification of micronutrients present.

Key Words: *Nutrient analysis; Vermicompost; Feeding media; Composting*

INTRODUCTION

Yard and food waste make up a major component of solid waste in most municipalities. Although much of this organic waste can be recycled in the backyard using traditional aerobic backyard composting techniques, these techniques are not appropriate for urban dwellers and are often inconvenient. Vermicomposting, or composting with earthworms, is an excellent technique for recycling food wastes as well as composting yard wastes in the backyard. Letting worms recycle one's food waste also saves one's back, because one doesn't have to turn over the compost to keep it aerated [1]. Furthermore, the rapid decomposition and raised temperatures during composting produce a relatively homogeneous, odor-free, pathogen-free and easy-to-handle product [2].

In addition, an appropriate waste recycling technology is necessary to develop in order to protect and preserve the environment. Yi-Wei, et al. [3] stressed that burning of huge amounts of organic waste is a common practice in developing countries to return complex organic resources back into the soil. This scenario can be seen especially in rice cultivation where rice straws are chopped and openly burnt in the rice field after harvesting. For example, in Thailand, a major global exporter of rice, and 8 to 14 million tons of rice straws are burnt in the rice field each year. In India, 170 million tons of rice straw is openly burnt each year. Open-burning of rice straw is also a problem in many other countries. Recycling large amount of organic wastes in an environmentally manner helps contribute significantly towards sustainable agricultural practices. During vermicomposting, earthworms fragment the initial organic waste and increase its surface area for the consumption by microbes and ultimately altering the biological activity. Microbial activity has been reported to be greatly stimulated in vermicompost. Through the incorporation of enzymes such as phosphatase, glucosidase and protease, the nutrient availability in vermicompost is relatively high. Consequently, this promotes growth and yield of various horticulture and green house crops. Vermicomposting process shows great potential in the degradation of wastes converting some portions of waste into earthworm biomass and respiration product and expelling the remaining wastes as earthworm cast. The excreted vermicast is reported to contain high amounts of mineral nutrients, vitamins, plant growth hormones, proteins and enzymes. Based on reports, earthworms can consume 2 to 5 times its body weight and only uses 5 to 10% of the nutrient from the feed stock for its growth.

Studies need to be conducted using specific feed substrates and earthworm species to provide accurate design for efficient and economical vermicomposting system. By using a common and locally found feed substrate, the production of vermicompost with the identification of its nutrient content can be performed [3]. Therefore, the current research is carried out to evaluate the nutrient content of vermicompost using different feeding media.

The place where the researcher earns her living is a known organic town since it uses organic materials like banana leaves as wrappers in buying goods and it also preserves the culture of Dumingagnons. Organic farming, as its topmost priority, is introduced to farmers and the town received awards and recognitions internationally.

Vermicomposting is one of the organic processes introduced in the community aside from the usual composting to produce organic fertilizers which a common individual can do. This condition opted the researcher to conduct an investigation which analyzed the nutrient value of vermicompost to help the community members determine the kinds of food they will provide to the vermiworm to produce a nutrient-rich organic fertilizers. This leads to the satisfaction of each individual in the community hence strengthening the organic farming program.

Vermicomposting is a simple biotechnological process of composting, in which certain species of earthworms are used to enhance the process of waste conversion and produce a better end product. Vermicompost is nutritionally rich natural organic fertilizer, which releases nutrients relatively slowly in the soil and improves quality of the plants along with physical and biological properties of soil. It has a more beneficial impact on plants than on soil.

The nutritional quality of vermicompost is determined primarily by the type of the substrate (raw materials) used for composting, along with aeration, humidity, pH and temperature [4]. The present study aimed to analyze the nutrients of vermicompost using different feeding media.

Statement of the problem

This study investigated the nutrient content of vermicompost using different feeding media. This study was conducted from October 2015 to January 2016 at Dumingag, Zamboanga del Sur. Specifically, the study answered the following questions:

1. To what level are the macro-nutrients (nitrogen, phosphorus, potassium) present in the vermicompost using the following feeding media?

- Rice straw
- Rice straw with food left over

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Received: 31-Aug-2023, Manuscript No. AGBIR-23-100854; **Editor assigned:** 02-Sep-2023, Pre QC No. AGBIR-23-100854 (PQ);**Reviewed:** 16-Sep-2023, QC No. AGBIR-23-100854; **Revised:** 23-Sep-2023, Manuscript No. AGBIR-23-100854 (R);**Published:** 30-Sep-2023, DOI:10.35248/0970-1907.23.39.678-681

- Rice straw with grass clippings
- Rice straw with Madre de Cacao and
- Rice straw with cow manure

2. Is there a significant difference on the levels of macro-nutrients (nitrogen, phosphorus, potassium) present in the different feeding media used in the production of vermicomposting?

3. Based on the findings, what laboratory activity can be designed for instructional use?

MATERIALS AND METHODS

This study is a quantitative research which employed the experimental research design method in investigating the nutrient contents of vermicompost using different feeding media.

To determine the nutrient contents of vermicompost using different feeding media, research subjects were considered experimental and divided into five treatments. Each treatment received a specific type of feeding media namely rice straw, rice straw with food leftovers, rice straw with grass clippings, rice straw with madre de cacao and rice straw with cow manure. Nutrient analyses were focused only to the percentage of nitrogen, phosphorus and potassium.

The study was conducted in the backyard of the researcher's residence at San Pablo, Dumingag, Zamboanga del Sur. San Pablo is the second largest among the 44 barangays of Dumingag. It is situated at the Poblacion with an area of 67.399 hectares and a total population of 2,345. The backyard has an area of 150 square meters covered with sand. Vegetables and fruit trees are planted in the area. The plastic bins were placed under the fruit trees to conserve moisture and to avoid excessive heat from the sun since vermiworm processed food with enough moisture at an average temperature.

The specimen of this research was the vermiworms known as African nightcrawler with the scientific name of Eudrilus eugeniae. Vermiworms live in soil with 40-60% organic matter with pH of 5-9, temperature of less than 30°C and moisture content of 60%-75%. They are capable of breeding weekly and producing up to three fertilized eggs per capsule. Vermiworms mature within a month to attain the length of more than 20 cm with a weight of 3 g each. About 2-3 kg of earthworms per ton of biomass or 100 numbers of earthworms per square foot [5].

The materials used in this study were the vermiworm (African night crawlers); plastic containers (worm bins); rice straw; cow manure; grass clippings; food left over; and Madre de Cacao leaves.

The methods included the preparation of bin and substrates, care and management of the earthworms, harvesting the cast, data gathering through laboratory test and the statistical treatment of the collected data.

The bin

The bin was made from plastic measuring 17 by 12 by 6 inches. The sides of the bin had holes to allow proper aeration and good water drainage which are needed by earthworms.

Preparation of substrates

Bedding is any material that would provide the worms a relatively stable habitat. Strips of non-glossy paper were used as bedding before the substrates would be added to the bin. Research subjects were divided into five according to the kind of substrate they received as their food. Treatment 1 received 100% rice straw. Treatment 2 received 50% rice straw and 50% food wastes. Treatment 3 received 50% rice straw and 50% grass clippings. Treatment 4 received 50% rice straw and 50% Madre de Cacao leaves while Treatment 5 received 50% rice straw and 50% cow manure. All substrates were chopped and thoroughly moistened (about the consistency of a damp sponge) before adding the worms. Each bin was covered to conserve moisture and exclude light since worms prefer darkness. 250 grams of worms were added to the top of the moist bedding and disappeared within a few minutes.

Care and management of earthworm: Vermiworm could survive a wide range of temperatures, but they process food wastes at an optimum bedding temperature of 30°C. The different bedding materials in each bin were watered occasionally to maintain the required moisture. The substrate in the bin was turned once a week to allow aeration to provide the required oxygen to the earthworms and to prevent the substrates from being compact.

Harvesting: Eighty five days after feeding, vermicompost were produced, and then the worms were harvested. Manual method of harvesting was done by picking the worms by hand. The vermicompost were sieved to separate the compost from the cocoon.

One hundred grams of vermicompost from each bin were collected and stored in a plastic container for nutrient analysis.

One hundred grams of vermicompost were extracted from each bin. The samples were packed using polyethylene bag and were brought to Soil Department, Central Mindanao University (CMU), Bukidnon, for nutrient analysis.

The data on the levels of nitrogen, phosphorus and potassium obtained from the different samples were treated through Analysis of Variance (ANOVA) with Duncan Multiple Range Test for comparison on the significant difference on the nutrient contents of the different feeding media used. Statistical Package for Social Sciences was utilized to ensure accuracy of computation.

RESULTS AND DISCUSSION

Percentage of nitrogen (N) content of vermicompost as affected by different feeding media

The level of nitrogen present in vermicompost as affected by different feeding media is shown in Table 1.

The analysis of nitrogen content present in vermicompost shows that the percentage of nitrogen present in the five treatments had the mean ranges from 1.32 to 1.58. Treatment 1 received the lowest mean of 1.32; Treatment 2, 1.42; Treatment 3, 1.51, Treatment 4, 1.58, which is the highest mean; and Treatment 5, 1.47. Treatment 4, with 50-50 mixture of rice straw and madre de cacao, got the highest percentage of nitrogen. The result is in consonance with the idea of Simons, et al., [6] that raw materials from Madre de Cacao contain high amount of nitrogen. They further stated that 1 ton dry weight of leaves of Madre de Cacao is equivalent to 27 kg of nitrogen. They also emphasized that up to 15 t/ha/year of gliricidia leaf biomass could be produced on good soils in Nigeria providing the equivalent of 40 kg N/ha/year.

Percentage of phosphorus (P) content of vermicompost as affected by different feeding media

The chemical analysis on the total phosphorus content of the vermicompost produced from the different feeding media is reflected in Table 2.

With regard to phosphorus content of vermicompost, Treatment 1 had a mean of 0.211; Treatment 2, 0.171; Treatment 3, 0.277; Treatment 4, 0.245; and Treatment 5 had a mean of 0.436. As reflected, the Treatment 2, rice straw with food wastes, generated the lowest phosphorus content while Treatment 5, rice straw with cow manure, has the highest phosphorus content. This affirms the idea of Pettygrove et al., [7] who stated that cow manure is relatively rich in phosphorus and when it is used as the sole fertilizer nutrient source and applied at an appropriate rate based on its nitrogen content, inevitably, phosphorus would accumulate in the soil.

Percentage of potassium (K) content of vermicompost as affected by different feeding media

The data on the total potassium content of vermicompost produced using different feeding media are shown in Table 3.

As reflected on the table, the data shows that the Treatment 1 yielded the highest mean of 1.21; followed by Treatment 3, 1.18; Treatment 5, 1.12; Treatment 4, 0.65; and Treatment 2, 0.46. The finding is consistent with the idea of Dobermann and Fairhurst that straw is the only organic material available in significant quantities to most rice farmers. About 40% of the Nitrogen (N), 30% to 35% of the Phosphorus (P), 80 to 85% of the Potassium (K), and 40 to 50% of the Sulfur (S) taken up by rice remain in vegetative plant parts at crop maturity.

TABLE 1

Percentage of nitrogen (N) content of vermicompost as affected by different feeding media

Treatment/Media	Replications			Total	Mean
	I	II	III		
T1 (100%Rice straw)	1.25	1.45	1.25	3.95	1.32
T2 (50% Rice straw, 50% Food wastes)	1.51	1.38	1.45	4.34	1.45
T3 (50% Rice straw, 50% Grass Clippings)	1.58	1.91	1.45	4.94	1.51
T4 (50% Rice straw, 50% Madre de cacao)	1.51	1.51	1.71	4.73	1.58
T5 (50% Rice straw, 50% Cow manure)	1.19	1.84	1.38	4.41	1.47
Total	7.04	8.09	7.24	22.37	

TABLE 2

Percentage of phosphorus (P) content of vermicompost as affected by different feeding media

Treatment/Media	Replications			Total	Mean
	I	II	III		
T1 (100%Rice straw)	0.027	0.197	0.229	0.633	0.211
T2 (50% Rice straw, 50% Food wastes)	0.201	0.108	0.205	0.514	0.171
T3 (50% Rice straw, 50% Grass Clippings)	0.264	0.298	0.270	0.832	0.277
T4 (50% Rice straw, 50% Madre de cacao)	0.262	0.243	0.230	0.735	0.245
T5 (50% Rice straw, 50% Cow manure)	0.451	0.408	0.450	1.309	0.436
Total	1.385	1.254	1.384	4.023	

TABLE 3

Percentage of potassium (K) content of vermicompost as affected by different feeding media

Treatment/Media	Replications			Total	Mean
	I	II	III		
T1 (100%Rice straw)	1.2	1.2	1.23	3.63	1.21
T2 (50% Rice straw, 50% Food wastes)	0.55	0.28	0.55	1.38	0.46
T3 (50% Rice straw, 50% Grass Clippings)	1.15	1.15	1.23	3.53	1.18
T4 (50% Rice straw, 50% Madre de cacao)	0.75	0.6	0.6	1.95	0.65
T5 (50% Rice straw, 50% Cow manure)	1.1	1.15	1.15	3.4	1.13
Total	4.75	4.38	4.76	13.89	

Summary of the macronutrient contents of vermicompost as affected by different feeding media

Table 4 presents the summary data on the macronutrient contents of vermicompost as affected by different feeding media.

TABLE 4

Summary of the macronutrient contents of vermicompost as affected by different feeding media

Treatment/Media	Percentage composition (Average from 3 replicates per treatment)		
	Nitrogen (N)	Phosphorus (P)	Potassium (K)
T1 (100%Rice straw)	1.32	0.211	1.21
T2 (50% Rice straw, 50% Food wastes)	1.45	0.171	0.46
T3 (50% Rice straw, 50% Grass Clippings)	1.51	0.277	1.18
T4 (50% Rice straw, 50% Madre de cacao)	1.58	0.245	0.65
T5 (50% Rice straw, 50% Cow manure)	1.47	0.436	1.13

As clearly presented on the table, nitrogen content ranges from 1.32 to 1.58 in which Treatment 1 had 1.32; Treatment 2, 1.45; Treatment 3, 1.51; Treatment 4, 1.58; and Treatment 5, 1.47. For phosphorus content, Treatment 1 had a mean of 0.211; Treatment 2, 0.171; Treatment 3, 0.277; Treatment 4, 0.245; and Treatment 5, 0.436. In terms of potassium level, the result shows that Treatment 1 has the highest potassium content with a mean of 1.21; Treatment 2, 0.46; Treatment 3, 1.18; Treatment 4, 0.65; and Treatment 5, 1.13.

The table also indicates that each feeding media contain different amount of macronutrient. This is parallel to the findings of Guerrero [8] that the nutrient and biotic compositions of vermicomposts vary depending on such factors as the nutrient composition of the original organic materials, other materials in the compost bed, environmental conditions within the compost bed, type of composting or degree of care to exclude other organisms, and many more.

Vermicompost produced from pure grass has less amounts of NPK and other nutrients as compared to those from grass mixed with manure or madre de cacao (Gliciridia) [8].

Testing of the hypothesis

The hypothesis below was tested for validity at 0.05 level of significance using one-way Analysis of Variance (ANOVA) along with Duncan Multiple Range Test.

As shown on the Table 5, the testing of the hypothesis for the nitrogen yielded an F-stat value of 1.214 with the probability value of 0.364 which is higher than the 0.05 level of significance which resulted to the rejection of

the hypothesis which states that there is a significant difference on the level of nitrogen present among the different feeding media used in the production of vermicompost and establishment of a non-significant difference on the levels of nitrogen present in vermicompost using different feeding media. The result indicates that adding different kinds of food to vermiworm did not significantly increase the nitrogen present in vermicompost.

TABLE 5

Test of significant difference on the levels of macro-nutrients content on the 5 different feeding media used in the production of vermicompost

Predictors	F-stat value	Probability value	Decision of the hypothesis	Interpretation
Nitrogen	1.214	0.364	Reject	Not Significant
Phosphorus	34.846	0	Accept	Significant*
Potassium	51.31	0	Accept	Significant*

Note: *Using Duncan Multiple Range Test: Phosphorus-Significant in all the five treatments. Potassium-Significant in all the five treatments.

Meanwhile, the phosphorus level earned an F-stat value of 34.846 with the probability value of 0.000 which is lower than the 0.05 level of significance which led to the acceptance of the hypothesis and establishment of the significant difference on the levels of phosphorus present in vermicompost. The analysis shows that different feeding media significantly differ in terms of phosphorus content.

On the other hand, the analysis of potassium level appeared an F-stat value of 51.310 and probability value of 0.000 that is lower than 0.05 level of significance which resulted to the acceptance of the hypothesis and establishment of a significant difference on the level of potassium present in vermicompost as affected by different feeding media.

The findings of the study are in consonance with the concept of Guerrero [8] which indicated that the nutrient and biotic compositions of vermicomposts vary depending on such factors as the nutrient composition of the original organic materials, other materials in the compost bed, environmental conditions within the compost bed, type of composting or degree of care to exclude other organisms, and many more. Vermicompost produced from pure grass has lesser amounts of NPK and other nutrients as compared to those from grass mixed with manure or madre de cacao (Gliciridia).

CONCLUSION

The study conclusively asserts that the different feeding media used in the production of vermicompost yielded a higher level of macronutrients based on the parameters mentioned by ICAR Research Complex for NEH Region (http://vikaspedia.in/agriculture/farm-based- enterprises/vermicompost-production-and-practices) that vermicompost has an available Nitrogen of 0.50%, Phosphorus-0.30% and Potassium-0.24%. The study mainly indicated that the nutrient and biotic compositions of vermicomposts vary depending on such factors as the nutrient composition of the original organic materials and many more.

RECOMMENDATIONS

Based on the foregoing conclusions, the following recommendations are hereby offered:

- That vermicomposting is a good method in recycling waste materials and in producing fertilizers;
- That in vermicomposting, Madre de Cacao mixed with rice straw is best to use as feeding media if nitrogenous fertilizer is highly desired while pure rice straw is for potassium and cow manure mixed rice straw for phosphorus;
- That other researchers conduct studies using other feeding materials specifically those found in the environment to further determine what feeding materials contain higher macro-nutrients;
- That another study will be conducted and nutrient analysis will focus on the identification of micronutrients present;
- Those other methods of vermicomposting will be explored to discover more valuable vermicompost.

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