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Study Of The Nutrient Quality Of Vermicompost From Different Organic Waste Raw Materials

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ABSTRACT

Most of the organic waste produced is still not managed properly so it can hurt environment. The easiest technology that can be in liquid or solid form and is used to deliver organic matter to improve the physical, chemical, and biological qualities of the soil, largely or entirely consist of organic materials derived from plants or animals that have undergone an engineering process. This study used vermicompost from vegetable waste, tofu dregs and cow manure as reference material to assess the nutritional content of vermicompost for composting. The composting process lasted for 28 days. Based on the test results or nutrient analysis or vermicompost, the chemical quality parameter of tofu waste compos had pH 5,89 Nitrogen 0,20%, Phosphorus 2,03% and Potassium 11,95%. On the chemical quality of compost C/N, the ratio of vegetable waste had the highest value of 27,02. Tofu vermicompost had the best value on the physical quality of the compost with a blackish color, temperature of 30^0C and water content of 13,89%. This composting was done by using earthworms *Lumbricus rubellus* and the raw materials used were vegetable waste, tofu dregs and cow manure

Keywords:

Organic waste, vermicompost, worms, organic fertilizer

INTRODUCTION

Excessive use of inorganic fertilizers can cause pollution and disturb the balance of nature and increase the cost burden for farmers [1]. A good alternative solution to the problem is to reduce the dependence of farmers and the community on inorganic fertilizers and use organic fertilizers. Processing of organic materials originating from organic waste such as municipal organic waste, household organic waste and organic waste from industrial activities needs to be intensified, in addition to overcoming the problem of environmental impacts from increasing waste, it is also necessary to obtain organic fertilizers that contain sufficient nutrients and can easily and cheaply be managed by farmers. According to [2],

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the use of organic waste is one of the right actions to create ecological sustainability.

Organic fertilizers mostly or wholly consist of organic matter derived from plants and or animals that have gone through an engineering process, which can be in solid or liquid form which is used to supply organic matter to improve soil physical, chemical and biological properties. Before being applied to the soil, organic matter of animal waste and plant waste should be matured for some time. The process of composting animal and plant waste can improve the quality of organic fertilizers for the better [3].

Vermicompost is a product of the composting process of organic waste that utilizes earthworms and microbial activity [4], has a high ability to hold water so that the water needs of plants are met, and contains nutrients that can support plant growth and production [5, 6]. Vermicompost is considered a long-term source of available macro and micro nutrients that can be absorbed by plants very easily [7]. Apart from this, vermicompost contains nitrogen-fixing bacteria and phosphate solubilizing bacteria [8].

In recent years, the concept of composting with worms (vermicompost) has received attention in the study and application of a sustainable environment. [9] stated that vermicompost received more attention because it has extraordinary physicochemical and biological characteristics that support soil fertility, and soil improvement [10].

Vermicompost has a dual role, namely as an organic fertilizer which is a source of plant nutrients, and as a soil conditioner which improves the physical properties of the soil, such as creating conditions of aeration, porosity and better structure [11]. The application of vermicompost to the soil can significantly increase the pH and soil organic matter, and the gradual release of nutrients slowly so that plants can absorb nutrients optimally, the implication being an increase in plant growth and production [12]. The results of the study [1] state that the use of vermicompost as an organic soil amendment that is environmentally friendly, acts as a substitute for inorganic pesticides and fungicides so that plant diseases and pests can be managed successfully without affecting human health and the environment [13].

The quality of vermicompost varies and depends on various factors including the species of earthworms, the raw materials used, and the age of the compost. Previous research examined factors that affect compost quality such as compost maturity factor [14], raw material source factor [15], organic matter decomposition rate factor, physicochemical and biological properties of compost, time of manufacture, the addition of microbes and nutrients [16, 17].

Organic matter apart from being a raw material as well as a food source for earthworms can come from waste, such as vegetable waste, tofu dregs, cow manure and others [18]. It is important to process tofu dregs into something useful and of high economic value, namely by composting. [19] stated that tofu dregs contained 8.69% dry matter, 18.67% crude protein, 24.43% crude fiber, 9.43% crude fat, 3.42% ash and 41.97% BETN. According to [20] that vermicompost derived from

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animal manure is very good at fertilizing the soil and suppressing plant diseases.

METHOD

The research was carried out in February 2022. Screen house production will be carried out by the Faculty of Agriculture, University of Borneo Tarakan. While the analysis of the physical and chemical properties of vermicompost will be carried out at the Laboratory of Soil Science, Faculty of Agriculture, University of Borneo Tarakan. There are 3 types of raw materials used, namely vegetable waste, tofu waste and cow dung, while the worms used are *Lumbricans rubellus*, so the treatment is C1 = soil + earthworms (*L. rubellus*) + vegetable waste, C2 = soil + earthworms (*L. rubellus*) + Dregs tofu, and C3 = soil + earthworms (*L. rubellus*) + cow manure. The media preparation process and vermicompost manufacturing process are modified methods from Ismail [21].

*Vermicompost Media Material Preparation*a.

1. Container for making vermicompost is prepared, namely a rectangular plastic tub with a size of 50 cm x 40 cm and a height of 25 cm
2. Put about 1500 g of soil into the vermicompost

Vermicompost Process

1. Fill the media that has been filled with soil with earthworms as much as 300 grams
2. Leave it for 30 minutes to make sure the earthworms have all entered the soil.
3. After that, add each organic waste raw material, each vegetable waste, tofu dregs and cow manure as much as 3 kg/container. Giving is done by placing the organic waste raw material on the edge of the container, as shown in Figure 1.
4. The composting process will be carried out for 28 days

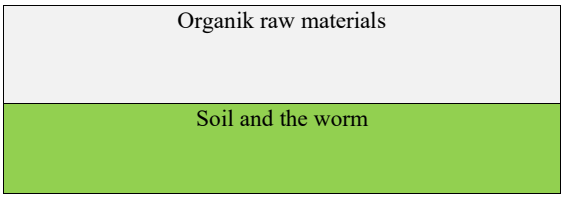

Figure 1. The composition of materials and soil and worms in the manufacture of vermicompost

Observation parameters

The vermicompost parameters observed were in the form of physical and chemical characteristics, then matched with the standards or technical requirements of organic fertilizers in Table 1. The parameters are as follows:

1. Changes in pH and temperature of materials in the media during the vermicompost production process, which were measured every week until week 4.
2. The water content, color, temperature and pH of the vermicompost were measured and observed after the vermicompost was finished.
3. Vermicompost nutrient levels were in the form of C-organic content, total N, P-total, K-total, C/N ratio, which were measured after the vermicompost was finished (28) days.

Table 1. Standard technical requirements for organic fertilizers

No.	Parameters	Standard technical
1	OC (%)	15%
2	C/N rasio	10-25
3	Moisture (%)	10-25%
4	pH	4 - 8%
5	N-total	<2%
6	Fosfor (P2O5)	<2%
7	Kalium (K2O)	<2%

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8	Temperaturs	27-30^{0}C
9	Colours	Blackies

Source: Kementerian Pertanian RI (2019)

RESULT AND DISCUSSION

1.1. Changes in pH and Temperature of Materials During The Vermicompost Process

Soil temperature and pH were observed every week during the vermicompost production process (28 days). During the process of making vermicompost, there were changes in the temperature and pH of the material, which showed that the process was going well until at the end of the vermicompost process it produced a temperature and pH value that complied with technical standards for organic fertilizers. Changes in pH and temperature during the vermicompost process are presented in Figures 2 and 3.

Changes in pH occur during decomposition, in the early stages of composting mesophilic microbes will utilize oxygen and easily degradable compounds, at this stage the pH decreases slightly due to the accumulation of organic acids. After that the organic acids are used as substrates by thermophilic microbes and the pH will increase, then it becomes stable. According to [22] during the composting process, there will be a change in pH, the implementation of the acid containment process will cause a decrease in pH, in the next phase the production of ammonia from nitrogen-containing compounds will increase the pH, the pH of mature compost is usually close to neutral.

The pH value of the media during the vermicompost production process generally increased for both vegetable waste, tofu dregs and cow manure raw materials. As for the minimum compost standards according to SNI 19-7030-2004, compost must have a pH of 6.80-7.49 [23]. However, based on the technical requirements of vermicompost, the pH value is around 4-8. [23] further said that a pH of around 5-6 shows good quality vermicompost because it can increase the availability of soil nutrients for plants.

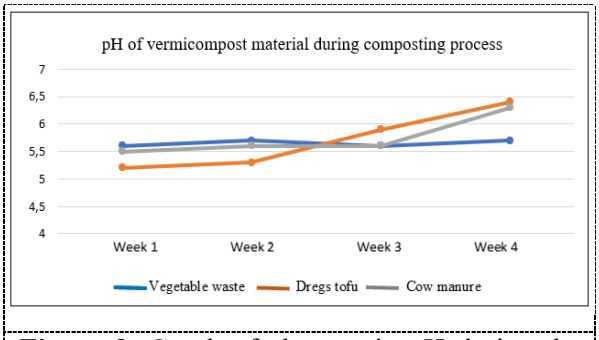

Figure 2. Graph of changes in pH during the composting process

The temperature of the material during the vermicompost production process is different between vegetable waste, tofu dregs and cow manure. The temperature measured on vermicompost from vegetable waste was around 30^{0}C, tofu dregs were around 30^{0}C and cow manure was around 31^{0}C. During the vermicompost production process, the temperature of each raw material increases and decreases with a temperature range of 27-31^{0}C. According to [24] this is because during the composting process, the raw materials have not been able to decompose completely. After all they are still in the early stages of composting and the temperature will increase again until the raw materials decomposed by microorganisms run out from there the temperature will drop again. Several factors can affect the temperature drop in the compost, including the surrounding environmental conditions and aerated.

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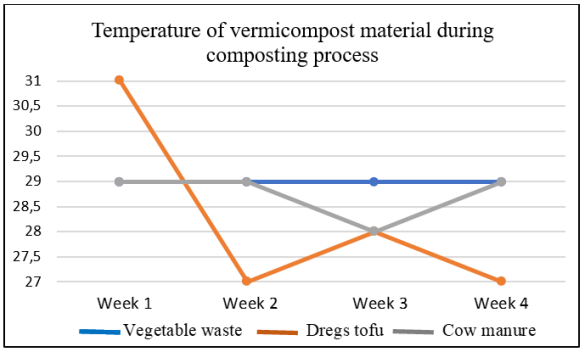

Figure 3. Graph of temperature changes during the composting process

1.2. Vermicompost Chemical Quality

Vermicompost compost is the result of the decomposition of organic materials broken down by earthworms, compost has the nutrients needed by plants. The nutritional quality of vermicompost is determined primarily by the type of substrate (raw material) and species of earthworms used for composting, together with microbial inoculant, liming, aeration, humidity, pH and temperature. Vermicompost nutrient values are presented in Table 2.

The pH value of vermicompost made from different raw materials shows differences. The pH value of vermicompost from vegetable waste is around 5.17, tofu dregs are around pH 5.89 and cow dung is around pH 4.93. The pH value of tofu dregs vermicompost is the highest compared to the others, but overall the pH range obtained still meets technical standards for organic fertilizers. According to [25] that the difference in the pH value of each treatment has a different combination of basic ingredients, causing different chemical reactions during the vermicompost process.

Table 2. Vermicompost nutrient quality value

Parameters	Vermicompost raw materials			Standard technical requirements for vermicompost
	Vegetable waste	Dregs tofu	Cow manure	
pH	5,17	5,89	4,93	4 - 8
N (%)	0,13	0,20	0,15	<2%
P2O5 (%)	1,21%	2,03%	1,12%	<2%
K2O (%)	6,92%	11,95%	8,81%	<2%
CO (%)	4,29%	5,49%	4,39%	15%
C/N Rasio	27,02	21,41	23,68	10 – 25

Source: Research data, 2022

Vermicompost contains many nutrients in forms available to plants, including nitrate (N), phosphate (P), soluble potassium (K), magnesium (Mg) and exchanged calcium (Ca) [26]. Vermicomposts have a large particulate surface area which provides many microsites for microbial activity and strong nutrient retention [27].

In this study, the N value sequentially from vermicompost of tofu dregs has a value of 0.20%, cow dung has a value of 0.15% and vegetable waste has a value of 0.13%. The highest N value in this study was tofu dregs of 0.20%, greater than cow dung and vegetable waste vermicompost, this was because the composting of tofu dregs produced more ammonia and nitrogen so that the N element content in the tofu dregs compost know bigger. This is by the statement [28] that the total N in the material has increased due to the decomposition process of the compost material by microorganisms that produce ammonia and nitrogen so the total N content of the compost increases.

The fermentation process from vermicompost of tofu dregs as a medium and followed by decomposition by earthworms [28]. Vermicompost has been modified both physically and chemically so that it contains high enough nitrogen to trigger the growth of microorganisms

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such as nitrogen-nitrifying bacteria [25]. In general, the N content in all types of vermicompost meets compost quality standards based on vermicompost technical requirements.

The content of P vermicompost from cow manure is around 1.12%, vegetable waste is 1.21% and tofu waste is 2.03%. The content of P and vermicompost of tofu dregs was higher than the others. According to [28] the P content in vermicompost increased due to the presence of acetobacter which acts as a phosphate-solubilizing bacteria. The results of the three vermicompost treatments of tofu dregs complied with the P value based on the criteria for vermicompost technical requirements. The K nutrient content in the three types of vermicompost produced successively around 6.92% vegetable waste, around 8.81% of cow manure and around 11.95% of tofu waste. Based on the requirements of vermicompost technical criteria regarding compost quality standards, the K vermicompost value in this study was quite good. The standard set is a minimum of <2%. then the K vermicompost value of the three treatments fulfilled the value requirements based on vermicompost technical criteria. The raw material used in the manufacture of vermicompost compost already contains the element potassium.

Organic carbon plays an important role in agriculture, improving various soil properties, and as a buffer for nutrients available to plants, and influencing soil structure. The quality of organic raw materials greatly determines the speed of the process of decomposition and mineralization of organic matter. Based on the results of chemical analysis of vermicompost, it showed that the organic carbon content of the three types of raw materials, respectively, vegetable waste vermicompost was around 4.29%, cow manure vermicompost was around 4.39% and tofu dregs vermicompost was around 5.49%. According to [29] the organic carbon content in the soil must be maintained at not less than 2% so that the organic matter content in the soil does not decrease over time due to the mineralization decomposition process. Based on SNI vermicompost technical standard number 19-7030-2004, the organic carbon content is >6%, thus the organic carbon content of the vermicompost produced meets the technical requirements, namely around 27-58%.

The C:N ratio is an indicator of the maturity of the organic waste decomposition process, it will decrease during the vermicompost manufacturing process [30]. According to [31], the decrease in the carbon/nitrogen ratio is caused by the rapid decomposition of organic wastes, and the mineralization and stabilization during the vermicompost process. A decrease in C:N to less than 20 indicates an increase in the maturity level of organic waste. [32] noted that microbial respiration and nitrogen excretion reduce the C/N ratio of the substrate (a carbon source of dry plant material and cow dung provides nitrogen input during the vermicomposting process) during the decomposition process. The C/N ratio for three types of vermicompost successively for vegetable waste was around 27.02, cow manure was around 23.68 and tofu waste was around 21.41. The C/N values allowed are based on the requirements for casting technical criteria, namely 10-25.

1.3. Vermicompost Phisics Quality

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The physical quality of vermicompost made from vegetable waste, tofu dregs and cow manure is presented in Table 4. The color of vermicompost can be seen in Figure 4. The vermicompost from vegetable waste has a blackish brown color, while that of cow manure is black to gray and tofu dregs are colored black. The vermicompost color obtained from the results of an analysis of the physical properties of the resulting vermicompost has the characteristics of the color of ripe compost with a black or black-brown color (figure 4). According to [22] the color of mature compost is blackish brown, if the compost is still green or the color is similar to the raw material, it means that the compost is not yet ripe. It was further said that during the composting process some organic materials experience decomposition and weathering, changes in fresh material. Based on the technical requirements of vermicompost compost, mature compost has blackish color criteria and a texture that easily crumbles.

Table 3. Vermicompost physical quality

Parameters	Vegetable waste	Dregs tofu	Cow manure	Standard technical requirements for vermicompost
Colour	Dark brown	Black	Dark gray brown	Black
Temperatures	30^{0}C	30^{0}C	31^{0}C	27-30^{0}C
Humidity	17,34%	13,89%	14,80%	10-25%

Source: Research data, 2022

The resulting vermicompost contains almost the same amount of water. The water content of vermicompost from vegetable waste is around 13.89%, vermicompost from cow manure is around, and vermicompost from tofu waste is around 17.34%. According to [33] stated that the water content in compost should not exceed 10 – 25%, the lower the water content, the better the quality of organic fertilizer. The quality of the water content obtained from the three treatments of vegetable waste raw materials, tofu dregs and cow dung based on the technical requirements of vermicompost compost has met the standard with a value of 10-25%.

Dregs tofu Vegetable waste Cow manure

Figure 4. Color vermicompost produced from different organic wastes

CONCLUSION

Vermicompost from different raw materials has different nutritional qualities. Vermicompost from tofu dregs has the best quality than vegetable and cow manure raw materials, atc: pH 5.89, N-total 0.20%, P 2.03%, K 11.95%, OC 5, 49%. Vermicompost from tofu dregs has the best value on the physical quality of the compost with a blackish color, temperature of 300^{o}C and 13.89% moisture content.

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