ISSN 2808-9545 | e-ISSN 2808-9340
Journal of Mathematics and Natural Sciences
Volume 4(1): 22-27, 2024

Processing of Cow Feses and Banana Tree Stemp *(Musa Paradisiaca)* with Vermicomposting Method using Decomposer *Lumbricus rubellus*

Wanti Maisa Br Keliat [1], Purwo Siswoyo[1*] & Andhika Putra [1]
[1] Department of Animal Science, Faculty of Science and Technology, Universitas Panca Budi, Medan
*Email: Purwoyo@dosen.pancabudi.ac.id

Received 21 April 2024; Received in revised from 10 may 2024 ; Accepted 01 June 2024

Abstract
Vermicompost is the result of the decomposition of organic materials by earthworms, producing fermented worm castings. In addition to the texture and moisture content of the organic material, temperature and pH also play crucial roles in determining the efficiency of the decomposers, leading to optimal vermicompost production. This study aims to evaluate the processing of cow manure and banana tree stems using the decomposer Lumbricus rubellus with the vermicomposting method. The study also hopes to reduce environmental pollution and provide value from livestock and agricultural waste management activities. The research employed a Completely Randomized Design (CRD) with five treatments and four replications. Cow manure and banana tree stems were used as the main materials with different formulations for each treatment. The study results indicated that the temperature values of vermicompost in each treatment showed no significant differences (p>0.05) across all treatments, the pH values of vermicompost in each treatment also showed no significant differences (p>0.05) across all treatments and the production of vermicompost showed significant differences (p<0.05) across all treatments. Treatment P3 had the highest vermicompost production value at 1462.5 g, with a waste degradation rate of 46%. The processing of cow feses and banana tree stems has potential as a raw material for vermicompost production. [PROCESSING OF COW FESES AND BANANA TREE STEMP *(MUSA PARADISIACA)* WITH VERMICOMPOSTING METHOD USING *LUMBRICUS RUBELLUS*] ***(J. Math. Nat. Sci., 4(1): 22-27, 2024)***

***Keywords*:** Vermicompost, Decomposer, Temperatur, pH, Production

Introduction

Livestock is very important role in human life as it produces food. Food products from livestock have a high nutritional content, serving as a source of animal protein that is essential for the body. Therefore, many people in Indonesia still rely on livestock farming as their livelihood, particularly cattle farming. The increasing demand for livestock products drives the growth of livestock populations and productivity. However, in addition to its positive impacts, the expansion of livestock farming also brings negative effects, particularly in the form of waste that can cause serious problems if not properly managed (Hazra et al., 2018).

Waste is material discarded from human activities or natural processes that has no or not yet any economic value and negatively impacts the environment (Djaja, 2008). One example is waste from banana plantations and cattle farms. Banana stems and cattle feces are organic materials that have the potential to be used as raw materials for compost (Purnomo et al., 2017).

Manage of organic waste by utilizing it as a medium for earthworm cultivation is a highly effective and perfect recycling method. This method is not only cost-effective but also natural and environmentally friendly (Gaddie and Douglass, 1975). In this process, earthworms act as the primary biodegraders, completing the degradation of organic material that has already been partially broken down by microorganisms. The type of earthworm used in vermicomposting is *Lumbricus rubellus*, which is an active surface-degrader (Dwiyantono et al., 2014).

Organic fertilizers are very beneficial for improving agricultural production, both in terms of quality and quantity, reducing environmental pollution, and sustainably enhancing soil quality. The natural composting process to obtain organic fertilizer takes quite a long time, approximately five months, making it less efficient (Sinha, 2009). According to research data, the natural composting process to produce organic fertilizer from cow manure and market waste takes a significant amount of time and is considered insufficient to meet the increasing demand. Composting with cow manure involves microbes that degrade components in the manure into compost (Mashur, 2001). The lengthy compost production process is due to the cellulose content in cow manure, which cannot be degraded by composting microbes. Undegraded cellulose can also inhibit plant root growth, making this technology economically inefficient. The most practical solution for degrading cellulose is by adding earthworms (*Lumbricus rubellus*) to the composting process (Aziez and Budiyono, 2018).

Vermicompost is a type of organic fertilizer produced from the digestive process within the bodies of earthworms, resulting in fermented waste (Hazra et al., 2018). Parmelee et al. (1990) stated that earthworms consume organic material equivalent to their body weight per day. Therefore, earthworms can be utilized as excellent producers of vermicompost. In this study, the compost was made from banana stems and cow feces as the raw materials. Banana stems contain essential elements needed by plants, such as nitrogen (N), phosphorus (P), and potassium (K). Moreover, plants grown in soil enriched with compost tend to grow better (Purnomo et al., 2017).

Based on the background above, it is important to evaluate the results of processing livestock waste and banana tree waste using *Lumbricus rubellus* with the vermicomposting method, considering the pH, temperature, and compost production. This can help reduce environmental pollution in the community and add value to waste management activities in livestock and agriculture.

Materials and Methods

This study was conducted over 34 days, from February 2024 to March 2024, in Sukaraya Village, Pancur Batu District, Deli Serdang Regency, North Sumatra. The research involved a 14-day fermentation period for the living medium of *Lumbricus rubellus* worms and a 20-day period for processing vermicompost fertilizer.

The study was carried out using a Completely Randomized Design (CRD) with five treatments and four replications. The focus of this research was to formulate the ratio between cow feces and coarsely chopped banana tree stems as a food source for worms in the composting process. The ratios used were:

P0 = 100% cow feces + 0% banana tree stems
P1 = 75% cow feces + 25% banana tree stems
P2 = 50% cow feces + 50% banana tree stems
P3 = 25% cow feces + 75% banana tree stems
P4 = 0% cow feces + 100% banana tree stems.

Fermentation of Banana Stem Media and Cow Feces

The process of preparing the *Lumbricus rubellus* worm cultivation medium begins by chopping banana tree stems using a machete into pieces approximately 0.5-1 cm in size. The chopped banana stems are then weighed using a digital scale and mixed with cow feces according to the predetermined formulation until the mixture is homogeneous. Molasses and EM4 are dissolved in water with a ratio of 1:1:100, where 1 ml of EM4, 1 ml of molasses, and 100 ml of water are used (Roslim et al., 2013).

The homogeneous mixture of cow feces and banana tree stems is then sprayed with the EM4 and molasses solution and fermented anaerobically in plastic bags for 14 days. The 14-day fermentation period was chosen because, during this time, the medium is ideal for worm cultivation, as evidenced by research conducted by Tallo and Sio (2019) and Priyanty et al. (2023). Their results showed a normal pH between 6-7, a temperature of 25-32°C, and humidity ranging from 30%-50%, which aligns with the optimal environmental factors for earthworm survival.

After 14 days of fermentation, the medium's temperature is checked using a thermometer and the pH using a pH meter to ensure that the medium is ready to be used as a habitat for the worms in the subsequent research.

Implementation of vermicomposting

The treatment begins after all the waste has been fermented and is ready to be used as a medium for earthworm cultivation. The medium is then placed into plastic baskets lined with burlap sacks to prevent the worms from moving downward and escaping from the cultivation container. The ratio between the medium and the earthworms is 1:1 (500 kg of medium: 500 kg of earthworms). Additional medium is added every five days, adjusted according to the weight of the worms produced. The variables observed in each treatment include pH, temperature, and vermicompost production at the end of the research period (day 30) (Putra et al., 2022).

The worms, which have been placed into their respective prepared media, are covered with clear plastic and left undisturbed for 20 days. During this process, the medium is watered every two days in the morning after the medium's temperature has been checked. This is done to maintain the moisture of the medium and to dissolve the nutrients contained within it (Roslim et al., 2013).

Measurement of pH, Temperature and Vermicompost Production

The pH was measured using a pH meter, and the temperature was measured using a thermometer. Temperature measurements were taken by inserting the thermometer into the vermicompost medium every two days. For pH measurements, a small amount of vermicompost medium, without earthworms, was taken every five days. The pH and temperature readings were then recorded. The vermicompost production was calculated by weighing the vermicompost medium using the following formula:

$$Ds=(T-P)/P$$

Ds = waste degradation (%)
T = Final compost weight (g)
P = Initial compost weight (g)

Data analysis

The data obtained were then presented in the form of tables. The data presentation included pH, temperature, and vermicompost production. The data were compared with the compost quality standards according to SNI 19-7030-2004. Subsequently, the data were analyzed using one-way ANOVA (Analysis of Variance). If the data among the treatments showed significant differences, the analysis was followed by Duncan's Multiple Range Test at a 95% confidence level ($p<0.05$).

Results

The processing of cow feces and banana tree trunks using the decomposer Lumbricus rubellus for 34 days produced data on temperature, pH, and vermicompost production.

Vermicompost Temperature Measurement

Based on Table 1, the vermicompost temperature values in each treatment showed no significant correlation ($p>0.05$) in all treatments.

Table 1. Vermicompost temperature from processing cow feces and banana tree trunks using the decomposer *Lumbricus rubellus*

No	Formulation	Average temperature (°C)
1	P0	27.25±0.43
2	P1	28.00±0.35
3	P2	28.13±0.22
4	P3	27.38±0.41
5	P4	28.00±0.61

The temperature of vermicompost with cow feces and banana tree trunk decomposer Lumbricus rubellus processing in each treatment is in accordance with the SNI standard: 19-7030-2004 concerning the Specification of compost from domestic organic waste with a temperature in groundwater of no more than 30 ° C and in an aerobic atmosphere so that it can still be absorbed by plant roots. The ideal temperature in the composting process has a range of 30 - 50 ° C. This is related to the presence of microorganisms that have a temperature tolerance in that range and can work optimally.

The composting process using *Lumbricus rubellus* has an optimum temperature equivalent to room temperature. This is related to the presence of *Lumbricus rubellus*, which has a low temperature tolerance, ensuring that these worms do not leave the medium to search for a place with their preferred temperature. Low temperatures can cause microorganisms to be dormant while high temperatures can kill the presence of these microorganisms. In addition, several things that can affect the temperature in the composting process are the type of raw material, humidity and type of microorganisms as bioactivators in the composting process (Patanga and Yuliarti, 2016).

The speed of composting is influenced by factors such as temperature and the activity of decomposing microorganisms present in the composting process. During the mesophilic phase (10-40°C), microorganisms work to reduce the size of organic material particles, thereby increasing the surface area and accelerating the decomposition process. In the thermophilic phase (40-60°C), decomposers utilize carbohydrates and proteins, which speeds up the composting process (Djuarnani *et al*, 2008).

Measurement of Vermicompost pH

Based on Table 2, the pH values of vermicompost in each treatment showed no significant differences ($p>0.05$) across all treatments.

Table 2. Value pH of Vermicompost from Processing Cow Manure and Banana Tree Stems Using the Decomposer *Lumbricus rubellus*

No	Formulation	Average
1	P0	6.9±0.11
2	P1	6.9±0.08
3	P2	6.8±0.13
4	P3	7±0.05
5	P4	7±0.04

The pH values of vermicompost from processing cow manure and banana tree stems with the decomposer *Lumbricus rubellus* in each treatment are in accordance with the SNI: 19-7030-2004 standard for compost from domestic organic waste, with a pH range of 6.80 - 7.49. The process of making vermicompost differs from general composting because vermicompost relies on earthworms as the main decomposers. The results from maintaining these decomposer earthworms produce worm castings, also known as vermicompost. Composting typically occurs at a normal pH range of 6.5–7.5. The acidity (pH) at the beginning of composting usually ranges from 5.0 to 5.5. At this stage, various microorganisms release acids during decomposition, making this pH range optimal for the composting process (Nisa et al., 2016). High-quality vermicompost is indicated by normal pH conditions. This not only makes it a good compost but also improves soil quality (Arif et al., 2007). Additionally, vermicompost contains various nutrients essential for plant growth and development (Liptan, 2017).

The application of vermicompost in increasing doses can improve soil pH values. The most optimal application of vermicompost is at a rate of 21 tons per hectare, which can increase soil pH by 0.08. Adding vermicompost to the soil has the potential to neutralize soil aluminum and iron, thereby reducing soil acidity (Rohim et al., 2012).

Production of Vermicompost

Based on Table 3, the production of vermicompost showed significant differences ($p<0.05$) across all treatments.

Table 3. Production of Vermicompost from Processing Cow feses and Banana Tree Stems Using the Decomposer *Lumbricus rubellus*

Formulation	Initial Weight (g)	Final weight (g)	Waste degradation (%)
P0	1000	1276.25±17.81^{a}	28
P1	1000	1336.25±28.59^{b}	34
P2	1000	1330±12.25^{b}	33
P3	1000	1462.5±12.99^{d}	46
P4	1000	1417.5±20.46^{c}	42

Based on Table 3, P3 had the highest production of vermicompost with a waste degradation rate of 46%. This is due to the balanced composition of organic materials in P3 and favorable conditions of the medium, which allow the decomposers to more easily digest the organic material. The comparison of the main materials in P3 provides an optimal source of fiber and microorganisms, resulting in the highest vermicompost production and waste degradation.

The digestibility of the decomposer (*Lumbricus rubellus*) is influenced by the fiber content in its medium. Earthworms find it challenging to digest raw materials with high fiber content. While they can degrade organic materials with high fiber content, it requires a significant amount of time (Liberty et al., 2022). Additionally, high levels of coarse fiber are difficult to degrade due to the presence of lignin compounds that encase cellulose and hemicellulose components. The presence of cellulolytic bacteria in the digestive tract of earthworms and cow feces contributes to the production of compounds necessary for plant growth and other organisms (Hazra et al., 2018).

Conclusion

The temperature values of vermicompost in each treatment showed no significant differences ($p>0.05$) across all treatments, the pH values of vermicompost in each treatment also showed no significant differences ($p>0.05$) across all treatments and the production of vermicompost showed significant differences ($p<0.05$) across all treatments. Treatment P3 had the highest vermicompost production value at 1462.5 g, with a waste degradation rate of 46%. The processing of cow feses and banana tree stems has potential as a raw material for vermicompost production.

References

Arif, S., Triastuti R., Mukhlissual F. (2007). Pemanfaatan Limbah Tomat Sebagai Pengganti EM-4 pada proses Pengomposan Sampah Organik, *Jurnal Penelitian Sains & Teknologi.* 8(2), 128

Aziez, A.F., Budiyono, A. (2018). Vermikompos, Pestisida Dan Pupuk Organik Cair Berbasis Kearifan Lokal.

Djaja, W. (2008*). Langkah Jitu Membuat Kompos dari Kotoran Ternak dan Sampah*. Jakarta: Agro Media Pustaka.

Djuarnani, N., Kristiani., Setiawan, B.S. (2008). Cara Cepat Membuat Kompos. Jakarta: Agromedia Pustaka.

Dwiyantono, R., Sutaryo., Purnomoadi, A. (2014). Perbandingan Kualitas Vermikompos Yang Dihasilkan Dari Feses Sapi Dan Kerbau. *Animal Agriculture Journal*. 3(2): 147-154.

Gaddie, SRRE., Douglas D.E. (1977). Earthworms For Ecology and Profit: Scientific Earthworm Farming, Vol. I. California: Bookworms Publishing Company.

Hazra, F., Dianisa, N., Widyastuti, R. (2018). Kualitas Dan Produksi Vermikompos Menggunakan Cacing Afrikan Night Crawler (Eudrilus Euganinae). *Jurnal Ilmu Tanah dan Lingkungan*. 20(2): 77-81.

Liptan. (2017). Pertanian Organik. Balai Pengkajian Teknologi Pertanian (BPTP).

Mashur. (2001). Vermikompos Pupuk Organik Berkualitas dan Raah Lingkungan. Instalasi Penelitian dan Pengkajian Teknologi Pertanian dan Pengembangan Pertanian.

Nisa , K. (2016). Memproduksi Kompos Dan Mikro Organisme Lokal (MOL). Jakarta: Bibit Publisher.

Parmelee, R.W., M.H. Beare, W. Cheng, P.F. Hendrix, S.J. Rider, D.A. Crossley., D.C. Coleman. (1990). Earthworm And Enchytraeids in Conventional and No Tillage Agroecosystems: *A Biocide Approach to Asses Their Role in Organic Matter Breakdown. Biology Fertility Soils,* 10: 1–10.

Patanga N., Yuliarti N. (2016). Pembuatan Aplikasi Dan Bisnis Pupuk Organik Dari Limbah Pertanian Peternakan Dan rumah Tangga. Jakarta: Gramedia.

Priyati, S.A., Suwondo, Dan Wulandari, S. (2023). Pengaruh Lama Fermentasi Dengan Bioaktivator Em4 Terhadap Kandugan N dan C/N Pupuk Bokashi Ampas Tebu (*Saccharum Officinarum L*). *Jom Fkip*. 10(1): 5-9

Purnomo, E., Sutrisno, E., Sumiyati.S. (2017). Pengaruh Variasi C/N Rasio Terhadap Produksi Kompos Dan Kandungan Kalium (K), Pospat (P) Dari Batang Pisang Dengan Kombinasi Kotoran Sapi Dalam Sistem Vermicomposting. *Jurnal Teknik Lingkungan*. 6(2): 1-15.

Putra, H. K., Rahayu, N., dan Kusmayadi, A. (2022). Pengolahan Feses San Limbah Kol Dengan Metode Vermokompos Menggunakan Dekomposer *Lumbricus Rubellus* Ditinjau Dari Ph, Suhu, Dan Produksi Vermikompos. *Jurnal Ilmu Pertanian Dan Peternakan*. 10(2): 245-28.

Rohim, A.M., Napoleon, A., Imanuddin, M.S. Rossa, S. (2011). Pengaruh Vermikompos terhadap Perubahan Kemasaman (pH) dan P-tersedia Tanah. Universitas Sriwijaya.

Roslim, D.I., Herman. (2013). Karakter Morfologi Dan Pertumbuhan Tiga Jenis Cacing Tanah Lokal Pekanbaru Pada Dua Macam Media Pertumbuhan. *Biosaintifika*. 5(1): 6-7.

Sinha, R.K., (2009). Earthworms Vermicompost: A Powerful Crop Nutrient over the Conventional Compost and Protective Soil Conditioner againts the Destructive Chemical Fertilizers for Food Safety and Security. Am-Euras. *J. Agric.and Environ. Sci.* Vol.5: 1-55.

Tallo, M. L.L. dan Sio, S. (2019). Pengaruh Lama Fermentasi Terhadap Kualitas Pupuk Bokashi Padat Kotoran Sapi. *Journal Of Animal Science*. 4(1): 12-14.