

**The analysis of decomposition rate of Vermigot fertilizer (vermicompost and kasgot) by utilizing of Black Soldier Fly larvae and earthworms with and without technique feeding**

Analisis laju dekomposisi pupuk Vermigot (vermikompos dan kasgot) dengan pemanfaatan larva Black Soldier Fly dan cacing tanah dengan dan tanpa teknik pemberian pakan

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**ABSTRACT**

*The use of insects in composting is also one of the new technologies, namely the Black Soldier Fly larvae. The combination of two types of decomposing organisms that are synergistic can increase the effectiveness of the decomposition process. The purpose of this study was to analyze the rate of decomposition of vermigot fertilizer in the treatment of cow manure and banana stem waste by utilizing a combination of BSF larvae and earthworms. This study used a non-factorial randomized block design method with 2 techniques (feeding and without feeding), namely D<sub>0</sub> = without decomposers; D<sub>1</sub> = earthworm (100%); D<sub>2</sub> = BSF larvae (100%); D<sub>3</sub> = earthworms: BSF larvae (50% : 50% kg); D<sub>4</sub> = earthworms : BSF larvae (25% : 75%); D<sub>5</sub> = earthworms: BSF larvae (75% : 25%). The results of this study showed that the composting process cannot run perfectly due to the addition of organic matter so that the decomposition process continues in the treatment with the feeding technique, while in the treatment without feeding, the composting process goes well as the composting stage in general, which starts with the mesophilic, thermophilic and cooling stages and the pH becomes neutral.*

**Keywords :** vermigot, BSF larvae, earthworm

**ABSTRAK**

Penggunaan serangga dalam pengomposan juga merupakan salah satu teknologi baru yaitu larva Black Soldier Fly. Kombinasi dua jenis organisme pengurai yang sinergis dapat meningkatkan efektifitas proses dekomposisi. Tujuan penelitian ini adalah menganalisis laju dekomposisi pupuk vermigot pada pengolahan kotoran sapi dan limbah batang pisang dengan memanfaatkan kombinasi larva BSF dan cacing tanah. Penelitian ini menggunakan metode Rancangan Acak Kelompok Non Faktorial dengan 2 teknik (dengan feeding dan tanpa feeding), yaitu D<sub>0</sub> = tanpa dekomposer; D<sub>1</sub> = cacing tanah (100%); D<sub>2</sub> = larva BSF (100%); D<sub>3</sub> = cacing tanah: larva BSF (50% : 50% kg); D<sub>4</sub> = cacing tanah : larva BSF (25% : 75%); D<sub>5</sub> = cacing tanah: larva BSF (75% : 25%). Hasil penelitian ini menunjukkan bahwa proses pengomposan tidak dapat berjalan dengan sempurna karena adanya penambahan bahan organik sehingga proses dekomposisi berlanjut pada perlakuan dengan teknik feeding, sedangkan pada perlakuan tanpa feeding, proses pengomposan berjalan dengan baik pada tahap pengomposan. secara umum yang dimulai dengan tahap mesofilik, termofilik dan pendinginan dan pH menjadi netral.

**Kata kunci :** vermigot, larva BSF, cacing tanah

**INTRODUCTION**

Waste is organic or inorganic material that is no longer used, so it can cause serious problems for the environment if not handled properly. Waste can come from various sources of waste from a production process, one of which is agricultural waste, namely livestock waste and plant waste. The waste can come from abattoirs, livestock production processing, results from livestock business activities

or residue from crop production. This waste can be in the form of solid, liquid, and gaseous waste which if not handled properly will have a negative impact on the environment. Waste originating from these gardens and plants will have high economic value if treated with the right treatment (Adityawarman *et al*, 2015).

One solution to overcome the waste problem is to compost the resulting biodegradable organic matter. According to Novien (2004) the composting

technique is the right alternative to reduce the volume of organic waste and use it as plant fertilizer. Compost is a product of organic waste processing that is safe for the environment. its availability is very necessary for the use of chemical fertilizers, because chemical fertilizers in the long term can cause environmental pollution (Mulyani, 2014). One of the composting processes that can be done is by using earthworms that break down organic matter into vermicompost.

The role of earthworms is very important in the process of decomposition of soil organic matter. Together with other soil microbes, especially bacteria, earthworms play a role in biogeochemical cycles. Earthworms feed on leaf litter and other dead plant material, thereby breaking down and breaking down the material. Earthworms also play a role in lowering the C/N ratio of organic matter, and converting unavailable nitrogen into nitrogen after being expelled in the form of manure (vermicompost). Aristotle called earthworms the earth's intestine (intestine of the earth) (Morarka, 2005) because of its very important role in digesting and decomposing plant remains that have died so that plants or other organic wastes do not accumulate. Plants that have been killed by earthworms are digested and converted into humus and natural nutrients.

Efforts to overhaul organic matter using earthworms to produce vermicompost have been carried out, especially abroad such as in Australia and in India (Morarka, 2005). The speed of the decomposition process of organic matter contained in plant and animal remains is determined by environmental conditions suitable for the life of decomposing organisms, including the level of availability or pH. The expected pH setting can accelerate the decomposition process so that the fertilizer matures faster.

Insect-based organic waste processing using Black Soldier Fly (BSF) *Hermetia illucens* L. larvae is not yet popular and has not been widely studied in Indonesia. BSF larvae are an innovative strategy and one of the sustainable methods for organic waste management that can reduce the burden of landfill waste and can open new profitable economic opportunities for city dwellers and small-scale entrepreneurs in developing countries (Diener *et al*, 2011). BSF larvae are very active in eating various materials, such as fruits and vegetables, market waste, kitchen waste, fish waste, oil palm cake, and animal and human waste so that they become organic as bioconversion agents (Fahmi, 2015). The results of composting from BSF larvae are called cassava or former maggots.

The main factors that affect the rate of decomposition of organic matter, namely the type and size of particles of organic matter, type and number of organisms, availability of C, N, P and K, soil moisture, temperature, pH and aeration. The decomposition process can be accelerated by increasing the number of organisms by increasing the population of one or two species of decomposer organisms. The administration of two types of decomposing organisms that are synergistic can increase the effectiveness of the decomposition process. Based on this statement, research was conducted to manage organic waste by combining the two decomposer agents for bioconversion into organic fertilizer called Vermigot fertilizer (Vermikompos and Kasgot). This study aims to measure the rate of decomposition of vermigot organic fertilizer in the processing of cow manure and banana stem waste by utilizing the decomposer agent of BSF larvae and earthworms.

## MATERIALS AND METHOD

This research was conducted in August 2021 for 21 days in Tanjung Sari, Medan, North Sumatra with an altitude of  $\pm 25$  m above sea. The materials used in this study were earthworms (*Lumbricus rubellus*), Black Soldier Fly (BSF) larvae, cow manure, mushroom bends, tofu pulp, and banana stems. The tools used are baskets, wooden shelves, burlap sacks, scales, pH moisture-meter, compost thermometer, thermohygrometer, bucket, hand sprayer, stationery and others. The following is a comparison of variations in this study:

D<sub>0</sub> = without decomposer

D<sub>1</sub> = earthworm (100%)

D<sub>2</sub> = BSF larvae (100%)

D<sub>3</sub> = earthworms : BSF larvae (50% : 50%)

D<sub>4</sub> = earthworms : BSF larvae (25% : 75%)

D<sub>5</sub> = earthworms : BSF larvae (75% : 25%)

The composting container in the form of a basket with a basket size of 30cm x 45cm is made of plastic to avoid rust due to compost leachate. Try to use burlap for the bottom layer of the composting container so that water can seep in, so that the humidity of the media is maintained and appropriate.

The initial process of making compost is to prepare the raw materials in the form of cow manure and banana stems which are first cut manually until they reach the appropriate size ( $\pm 5$  cm). The next step is to prepare the media into a basket with a ratio of tofu dregs: mushroom bend (50% : 50%). Then, the application of organic matter with a ratio of cow manure and banana stems (50% : 50%) was carried

out and a decomposer application was carried out according to the treatment so that the total material contained in the basket was 3 kg consisting of media: organic material: decomposer (1kg : 1kg : 1kg). The composting process was carried out for 21 days. The feeding technique is carried out with the concept of without feeding and feeding for 7 days so that there are 3 times the feeding process.

The next process is to measure the temperature of the compost media with a thermometer. How to monitor the temperature is to plug a thermometer into the compost medium and leave it until the temperature pointer does not change its position anymore.

Parameters observed in this study were compost temperature, compost pH, room temperature, room humidity and feed consumption.

This research was carried out with 2 types, namely without feeding and with feeding 3 times with organic waste which was carried out periodically every 7 days so that during the 21th day study three feedings were carried out (0, 7th and 15th days).

## RESULTS AND DISCUSSION

### Temperature of Compost (°C)

The temperature of vermicot compost measurements were carried out every day using a thermometer. The results of the compost temperature parameter test for 21 days without feeding is showed in Figure 1.

In the study without feeding, it was found that the temperature of the compost in the treatment using the decomposer agent increased, indicating that the decomposer agent worked to treat the waste causing heat, except for the D<sub>0</sub> treatment (without the decomposer) which showed that the temperature was decreasing and tended to be flat. that without decomposer agents there is no perfect mineralization process. In the first day D<sub>0</sub> treatment until the seventh day the temperature tends to decrease which indicates that the presence of microbes in organic waste does not play a role in the mineralization process if it is not combined with worms or BSF larvae.

The temperature in the D<sub>2</sub> treatment (100% BSF larvae) resulted in the highest compost temperature compared to other treatments. This indicates that BSF larvae produce higher heat than worms when feeding. In addition, the number of 1kg BSF larvae was more than the number of 1kg worms, so that in the basket there was a buildup of BSF larvae which also caused higher heat. While in the

treatment of worms, the optimal temperature limit for the decomposition process is 34°C. This is reinforced by According to Saraswati *et al* (2006) that compost with a slightly higher temperature than 25°C is still good for the growth of earthworms. However, at the end of the study (day 21) the temperature decreased to 28°C, according to the SNI 19-7030-2004 standard regarding compost specifications, the reference temperature is a temperature that resembles ground water temperature, which does not exceed 30°C.

In the combination treatment, D<sub>3</sub>, D<sub>4</sub> and D<sub>5</sub>, the initial composting temperature was the same (35°C) and the final compost temperature was also the same (30°C), but the dynamics of temperature differed every day because the ratio of the composition of the decomposer agents in it was also different. On the fifth day, the D<sub>4</sub> treatment reached a temperature of 35.75°C this was due to the higher composition of BSF larvae compared to worms. On the 21st day of composting, all BSF larvae had entered the prepupa stage to pupa, so that the decomposition process was stopped and the compost could be harvested. Meanwhile, the worms entered the mating period and several small young worms were found.

In composting with the feeding technique carried out for 3 times, it was found that the daily compost temperature data increased on the first day to the fourth day and decreased in temperature on the fifth and sixth days, but on the seventh day due to the feeding process (addition of organic matter) there was an increase in temperature. back due to the decomposition process of organic matter carried out by decomposer agents and microbes contained in organic matter (cow manure and banana stem) which produces carbon and results in an increase in temperature. Saraswati *et al* (2006) also said that the early mesophilic stage is a condition where the process temperature rises to around 40°C due to the presence of fungi and acid-forming bacteria. The process temperature will continue to rise to a thermophilic stage between 40-70°C. However, in the composting process with a decomposer agent, the average temperature produced is not more than 40°C because the composting process carried out is aerobic composting, the container is not closed and left open, besides that the application of the decomposer agent has been calculated so that it is not too dense and hot.

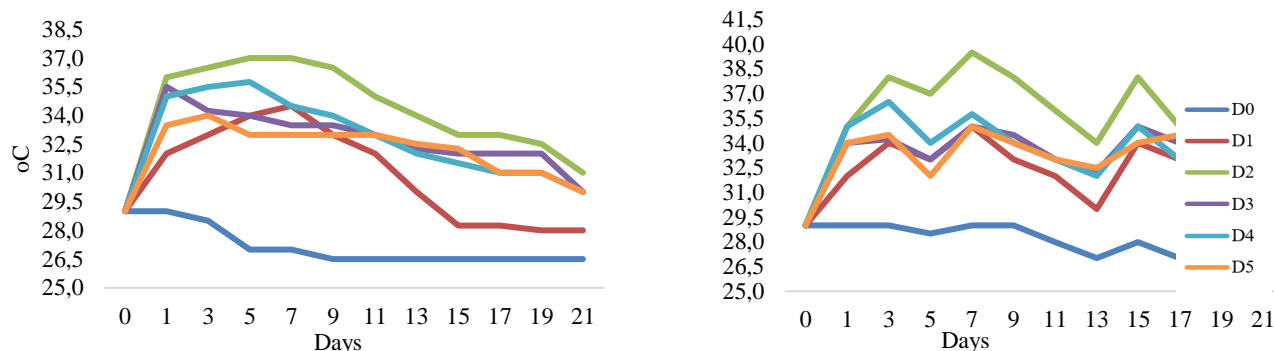


Figure 1. The temperature of compost in 21 days with feeding (right) and without feeding (left)

An increase in temperature occurs at every feeding process, except for the control treatment, because there is no decomposer agent, the decomposition process is not going well because it only relies on microbes (bacteria and fungi) contained in organic matter, so the temperature is more likely to decrease and slow down. Gradually the microbes die, then the decomposition process does not occur perfectly.

### pH of Compost

The pH of vermigot compost in the technique without feeding decreased in all treatments and increased again the next day. This is due to the presence of microbial activity in organic matter so that the formation of organic acids causes the pH to tend to be slightly acidic (down). The comparison of pH vermigot compost is showed in Figure 2.

In the treatment without decomposers (D<sub>0</sub>) the pH value at the end of composting was 6.4 (slightly sour), this was due to the absence of a decomposer agent that helped the decomposition process to be complete. In treatment with 100% worm decomposer agent (D<sub>1</sub>) the pH became neutral (7.5) on day 21. In treatment D<sub>2</sub>, D<sub>3</sub> and D<sub>4</sub> the pH became neutral on day 11 (6.5 - 6.8) and increased to slightly alkaline on day 11. 21 (7.8).

This proves that in the presence of a decomposer agent, it can neutralize the pH of the compost, but if the composting process is continued for up to 3 weeks, the pH will become slightly alkaline. The pH of the feeding technique experienced dynamics from the first day of observation to day 21. In the treatment without a decomposer agent, the pH decreased from 6.1 to 5.7 while in the treatment with a decomposer agent (D<sub>1</sub>, D<sub>2</sub>, D<sub>3</sub> and D<sub>4</sub>) the pH fluctuated, on the first day The pH was around 6.0 - 6.1 but until the third day it, decreased to 5.6 - 5.9 on the fifth day organic matter (feeding) was carried out so that the pH fell again due to the ongoing decomposition process which caused the formation of organic acids to be around 5.8 - 6.0, then the pH returned increased on day 13 but pH decreased on day 15 due to the third feeding process so that at the end of composting (day 21), the pH of all treatments became slightly acidic (5.7 - 5.8). This is due to the disruption of the decomposition process due to the feeding technique carried out, in accordance with the results of research by Nursaid *et al* (2019) in the composting process, it is carried out continuously in which organic waste is added periodically using fresh garbage on a regular basis so that it interferes with the composting process.

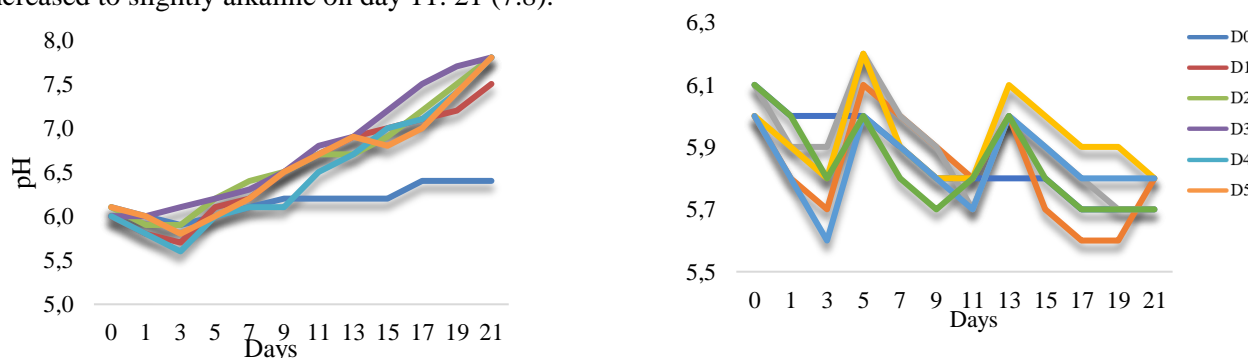


Figure 2. The pH of vermigot compost in 21 days with feeding (right) and without feeding (left)



In the treatment without decomposers ( $D_0$ ) the pH value at the end of composting was 6.4 (slightly sour), this was due to the absence of a decomposer agent that helped the decomposition process to be complete so that there was no increase in pH to neutral. In treatment with 100% worm decomposer agent ( $D_1$ ) the pH became neutral (7.5) on day 21. In treatment  $D_2$ ,  $D_3$  and  $D_4$  the pH became neutral on day 11 (6.5 - 6.8) and increased to slightly alkaline on day 11. 21 (7.8). This proves that in the presence of a decomposer agent, it can neutralize the pH of the compost, but if the composting process is continued for up to 3 weeks, the pH will become slightly alkaline.

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### Humidity (%)

Air humidity in the experimental room is one of the supporting factors in the composting process from the first day to the 21st day fluctuates between 40%-79%. It is showed in Figure 3.

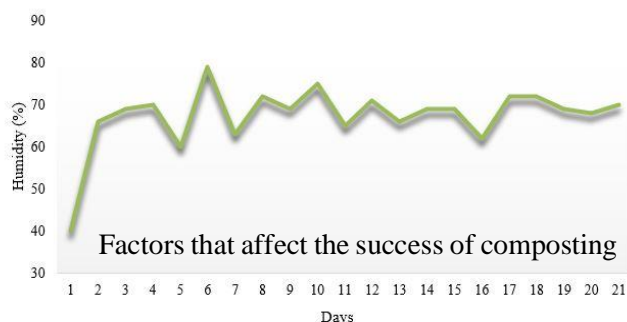


Figure 3. The Humidity of Composting Room

are C/N of raw materials, type and size of raw materials, aeration, humidity, temperature, microorganisms and activator. In this experiment, humidity measurements were carried out because humidity is one of the factors that affect the composting process.

### Weight Index (%)

The biomass of BSF larvae and earthworms was weight or weight (g). Weight measurement of BSF larvae and earthworms was carried out at the end of the study and recorded in the weight monitoring journal. Weight index is needed by looking at the comparison between the initial weight and the final weight. The weight index of earthworms and BSF larvae from all treatments is presented in Table 1.

That all weights of decomposer agents have decreased, in treatment  $D_1$  (100% earthworms) it is known that there is a decrease in weight of 17%, this occurs because earthworms experience stress conditions so that some of them die and come out of the composting box.

Treatment  $D_2$  (100% BSF larvae) also experienced a weight loss of 24%, this was due to the presence of larvae that turned into adult BSF flies that went through a pupa stage in the composting box, this is a consideration in research to select the age of BSF larvae in detail. In this study, 1 kg of BSF larvae were used with a total of about 4000 individuals so that there was an age difference.

Likewise with the combination treatment of BSF larvae: worms ( $D_3$ ,  $D_4$  and  $D_5$ ), there was a decrease in the weight of earthworms and BSF larvae because the decomposer agents experienced double adaptation, namely adaptation to the media and adaptation to other agents.

In the  $D_3$  and  $D_4$  treatments, the weight index that experienced the highest decrease was 60% in earthworms, this happened because earthworms were easily stressed to the environment, the thin and sensitive skin of earthworms made the worms experience stress and get out of the box. composting.

Moreover, the body of BSF larvae turns out to consist of feathers that resemble small needles, this makes earthworms uncomfortable and the ratio of the number (tails) of worms to BSF larvae is very far, where 1 kg of BSF larvae consists of 4000 tails while 1 kg of earthworms consists of from 700-800 heads.

Table 1. Weigth Index of Earthworm and BSF Larvae

Treatment	Initial weight (g)		Final weight (g)		Weight Index (%)	
	Earthworm	BSF	Earthworm	BSF	Earthworm	BSF
D <sub>0</sub>	-	-	-	-	0	-
D <sub>1</sub>	1000	-	830	-	17	-
D <sub>2</sub>	-	1000	-	760	-	24
D <sub>3</sub>	500	500	270	300	46	40
D <sub>4</sub>	250	750	100	700	60	6.6
D <sub>5</sub>	750	250	520	100	31	60

## CONCLUSION

In the treatment with the feeding technique, the composting process cannot run perfectly due to the addition of organic matter so that the decomposition process continues, while in the treatment without feeding, the composting process goes well as the composting stage in general, which starts with the mesophilic, thermophilic and cooling stages and the pH becomes neutral. to slightly alkaline. The difference in the composition of the decomposer agent is also one of the factors that need to be considered so that the composting process runs faster and is profitable for the lives of the two decomposers.

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