Physical and Chemical Characteristics of Compost from Pterocarpus indicus Using Banana Hump Local Microorgansim, Eisenia foetida and Eudrilus eugeniae Earthworms

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Abstracts. The higher the generation of *Pterocarpus indicus*, the higher the environmental pollution. This can be overcome by vermicomposting. To improve the quality of the compost, it is necessary to add cow dung and sawdust to the compost. In this study, vermicomposting used the earthworms *Eisenia fetida* and *Eudrilus eugeniae* with a composting time of 21 days. The purpose of this study was to analyze the chemical and physical characteristics of the quality of the compost produced from the composting process. The compost material in this study was consist of *Pterocarpus indicus*, cow dung, and wood powder. Parameter values of Nitrogen, Carbon, Phosphorus, C/N ratio, Potassium, moisture content and C/N ratio will be compared with SNI 19-7030-2004 Concerning Compost Specifications from Domestic Organic Waste. The results of this study indicated that the type of worm and the adding of Banana Hump Local Microorganism affected the physical parameters of the compost yield, as well as affect the chemical parameters, namely pH, potassium, C/N ratio in the compost yield. The type of worm did not affect the value of phosphorus content in the compost. Moisture content, temperature, pH, potassium in the compost of all reactors complied with SNI 19-7030-2004. The ratio of C/N and phosphorus in compost produced from composting using earthworms Eisenia fetida and Eudrilus eugeniae complies with SNI 19-7030-2004. In addition, the compost produced the highest shrinkage compared to compost without earthworms.

Keywords: banana hump ; cow dung; Local Microorganism; Pterocarpus indicus; vermicomposting

1. INTRODUCTION

Port of Indonesia Region III East Java has a park facility as a greening area. One of the plants that grows in this park is *Pterocarpus indicus*. *Pterocarpus* indicus is widely planted in the port area to reduce air pollution. The leaves of the Pterocarpus indicus

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plant can be used to reduce ozone that occurs due to human activities [15]. In addition to reducing ozone, *Pterocarpus indicus* can also reduce carbon dioxide emissions [3]. *Pterocarpus indicus* planted in the port area produces quite a lot of leaves waste. Therefore, further treatment of

Pterocarpus indicus leaves is required to reduce *Pterocarpus indicus* leaves waste. One of the technologies that can be used to reduce *Pterocarpus indicus* waste leaves is composting.

Composting is one of the methods used to reduce *Pterocarpus indicus* leaves waste. Parameters that need to be considered in composting are temperature, C/N ratio, pH, and other nutrients including the presence of heavy metals in the compost material [9]. *Pterocarpus indicus* leaves contain 46.22% C-organic and 3.69% total Nitrogen [12]. Based on these data, *Pterocarpus indicus* leaves have a C/N ratio of 12.53. To accelerate the rate of composting, it is necessary to modify the technology in composting. One of the modifications that can be done is composting with worms or called vermicomposting.

Vermicomposting is composting using the help of worms. This method can convert organic waste such as food waste, garden waste, and agricultural waste into quality compost. Earthworms also play a role in absorbing heavy metals that are still contained in the compost material. Worm skin tissue produces extracellular polymeric substances that can bind heavy metals. Heavy metals bound to these substances will be retained in the worm's skin [2]. Earthworms can also increase the value of nitrogen which can be beneficial for plants [17], the vermicomposting method is very suitable for reducing leaves waste of Pterocarpus indicus. The type of worm that can be used in vermicomposting is *Eisenia foetida and Eudrilus eugeniae*.

Eisenia foetida and Eudrilus eugeniae are non-burrowing worms that lives on the soil surface. The life span of these worm is 28 days. Although the life span of this worm is short, these worms can increase the rate of composting process[17]. The composting process carried out by *Eisenia foetida and Eudrilus eugeniae* worms together with microorganisms can reduce the value of C-organic. The C-organic content in the compost material will turn into carbon dioxide. The C/N ratio in vermicomposting needs to be considered. If the C/N ratio is too low, the waste decomposition will run slowly [7]. Therefore, this research analyze the compost characteristics of *Pterocarpus indicus* leaves resulting from vermicomposting using *Eisenia foetida* and *Eudrilus eugeniae* worms. Banana humps are used in this research as a material for local microorganism production.

2. MATERIALS AND METHODS

2.1. Determination of the compost material characteristics

Compost materials that have been used in this study were pteurocarpus indicus, cow dung and sawdust as bedding. Before determining the composition of the waste variant that has been used, a preliminary test must be carried out by calculating the C/N ratio of the compost material (equation 1). Result of the calculation of the C/N ratio, the percentage composition of the compost material were obtained 40% pteurocarpus indicus, 40% cow dung and 20% sawdust.
The ideal C/N ratio = 10-20(Indonesian National Standard 19-7030-2004)

$$C/N = \frac{C\,(1\ Kg\ pteurocarpus\ indicus) + xC(\ 1Kg\ cow\ dung) + xC(sawdust)}{N\,(1\ Kg\ pteurocarpus\ indicus) + xN(\ 1Kg\ cow\ dung) + xN(sawdust)} \quad (1)$$

TABLE 1. CHARACTERISTIC OF MATERIAL COMPOST

Compost Material	**C-organic (%)**	**N-total (%)**	**C/N ratio**	**Moisture content**
Pteurocarpus Indicus	40,58	3,36	12,08	17,47
Sawdust	52,94	0,48	110,29	12,36
Cow dung	45,42	0,47	96,64	82,16

According to Biruntha (2020) the use of a high initial C/N ratio in composting the C/N ratio becomes the main role where the correct ratio will provide nutrients for earthworms. In previous studies, 9 grams of biomass of eisenia fetida and eudrilus eugeniae were used for every 600 grams of organic waste (Rahmawati, 2016). Based on these data, this study used 15 grams of worms per 1000 grams of organic waste. According to Rahmawati and Herumurti (2016), using eisenia fetida and eudrilus eugeniae worms weighing 9 grams per 600 grams of waste has been able to increase the degradation of garden waste in the composting process. the worm that used is 4 months old. Therefore, in this study using worms weighing 15 grams per 1000 grams of waste.

TABLE 2. RESEARCH VARIABLE

Research Variable	**Pteurocarpus Indicus 42% + Sawdust 16% +Cow Dung 42%**		
	WithoutWorm	***Eisenia fetida Worm* (15 g/kg)**	***Eudrilus Eugeniae Worms* (15 g/kg)**
Without MOL	R1	R2	R3
MOL Banana Hump (10 mL/kg)	R4	R5	R6

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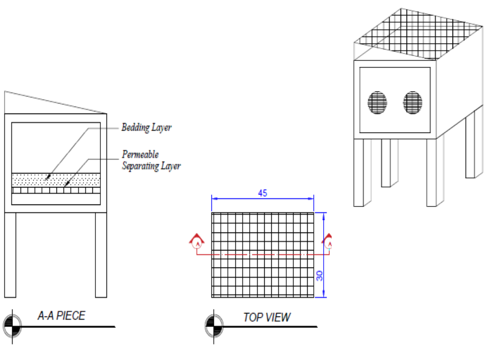
Without MOL	R1	R2	R3
MOL Banana Hump (10 mL/kg)	R4	R5	R6

2.2. Making Composting Reactor

The reactor that has been used in vermicomposting is a box-shaped composter made of wood which was lined with used sacks to reduce operational costs. In addition, used sacks could function to drip leachate so that it did not pool in the compost and did not interfere with the moisture of the compost. The outside of the reactor uses used plywood and paranet at the top of the reactor to provide air circulation and good oxygen addition for the worms. The use of a roof on the reactor made of bionet or paranet material could control the temperature, reduce ammonia and prevent the reactor from being disturbed by insects such as flies.



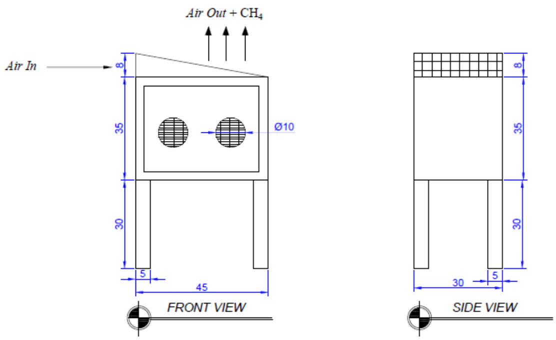


FIG 1. VERMICOMPOSTING REACTOR

2.3. Composting Garbage

2.3.1. Production Of Local Microorganisms (MoL)

In this study, MOL was made from banana weevil waste as an effective substitute for microorganisms (EM4). The following are the stages of making Banana Cob MOL (Inrianti, 2019)

1. The banana weevil waste has been washed thoroughly, then chopped until smooth and put into a closed container.
2. Brown sugar has been dissolved and redeemed until it boils
3. The mashed banana hump waste is mixed with the sugar solution and the rice washing water is added to a closed container
4. Finally, the mixed solution has been fermented for 12 days (2 weeks) in a closed container.

2.3.2. Calculation Of Initial Weight Of Worms

The initial weight of worms used in each reactor is a ratio of 15 grams of worm biomass to 1000 grams of organic waste. The purpose of calculating the initial and final weight of worms is to determine the growth of worm weight on waste reduction.

2.3.3. Acclimatization Process

This acclimatization process aims to prepare worms to be used before the composting process and also so that bedding as a medium for worms to grow is in a stable state. The acclimatization of the worms was carried out on Pteurocarpus Indicus compost media, cow dung and sawdust by allowing the bedding to be mixed in the reactor for 48 hours. In this study, 1000 grams of organic waste were used with a population of 15 grams of worms in each reactor.

2.3.4. The Process Of Making Compost Using The Vermicomposting Method

The compost material has been chopped to size 3-5 and mixed with MOL of banana hump (10 mL/Kg). Then, the mixture has been added with Eisenia worms Fetida (10g/Kg compost material) and Eudrilus Eugenia (10g/Kg compost material). Bedding waste has been mixed with compost material that has been mixed.

2.3.4. Compost Quality Measurement

Compost parameter measurements that have been carried out in this study consisted of pH, moisture content, temperature, C/N ratio, potassium, phosphorus, waste shrinkage and final weight of worms.

TABLE 4.MONITORING COMPOSTING

Parameter	**Monitoring**	**Methods**
pH and temperatur	Every day	In situ
Moisture content	Every 3 day	Gravimetry
C-organic	Start dan ending composting	Gravimetry
Total Nitrogen	Start dan ending composting	Total khejal Nitrogen
Phospor	Ending composting	Spektrophotometry
Kalium	Ending composting	Atomic Absobtion Spectrophotometry

2.3.5. Data Analysis And Discussion

Based on measurements of pH, temperature, and water content in the compost, data analysis has been carried out by managing data from research results. Determination of compost yield will be compared with SNI 19-7030-2004 regarding compost specifications from domestic organic waste.

3. RESULTS AND DISCUSSION

3.1. Temperature

The temperature of compost measurements were carried out every day using a thermometer. The results of the compost temperature parameter test for 21 days is shown in Fig.2. At the beginning of the composting process the temperature in all reactors was in the range of 30°C to 32°C. This indicates that the beginning of the composting process took place in the mesophilic phase. According to [13], The composting process has a mesophilic phase with an increase in ambient temperature to 45°C, a thermophilic phase with a temperature range of 45°C to 60°C, and a maturation phase that takes place at a temperature of 20°C to 30°C. On the 10th to the 17th day the compost temperature fluctuated in the range of 30°C to 27°C. An increase in temperature in the composting process indicates a greater reproductive activity of worms, because an increase in worm biomass requires higher temperatures [14]. At the end of composting, the temperature measurements of all reactors were in the range of 28°C to 27°C. This is in accordance with the mature compost standard according to ISN 19-7030-2004 concerning the specifications of compost from domestic organic waste.

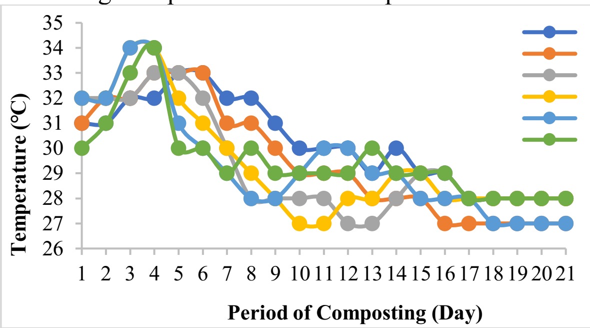


FIG 2. TEMPERATURE MEASUREMENTS IN THE COMPOSTING PROCESS

3.2. pH

At the beginning of composting the pH at R4, R5 and R6 had a lower value than R1, R2 and R3. This is because R4, R5 and R6 were treated with the addition of MOL (local microorganism) banana weevil. According to [11] a good pH for MOL which will be used as a starter for the formation of organic fertilizers is between 4-5. The pH value increased until the 6th day in all reactors. The increase in pH is due to the breakdown of protein into ammonia (NH3). The change in compost pH starts from a slightly acidic pH due to the formation of simple organic acids, then the pH increases during the incubation period further due to the breakdown of protein and the release of ammonia [10]. On the 6th day until the end of composting the pH value measurement in all reactors was 7. This was in accordance with ISN 7030-2004 which showed that the ideal compost pH was in the range of 6.8 to 7.49.

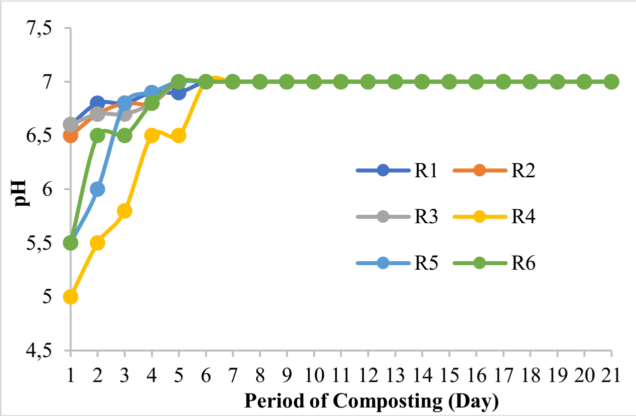


FIG 3. PH MEASUREMENTS IN THE COMPOSTING PROCESS

3.3. Moisture Content

Measurement of water content in composting was conducted every day using a soil moisture meter. At the beginning of composting, all reactors had a fairly high water content, reaching 96% to 99%. This is in accordance with the media needed by worms, the best water content for earthworm growth is at 80% to 90% humidity [4]. The Fig. 4 shown that all reactors experienced a steady decrease in water content from the beginning to the end of composting and there was no fluctuation. The water content at the end of composting has met ISN 19-7030-2004 concerning compost specifications, which is less than 50%. During the composting process, compost organic matter is also mixed. Stirring was conducted every day in each reactor to increase oxygen and introduce air into the compost heap. The activity of stirring or turning the compost aims to provide air circulation in the compost which can also release temperature. So that the water content in the compost can be decomposed homogeneously [18].

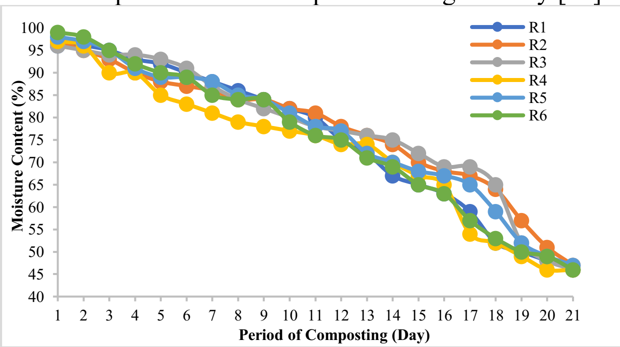


FIG 4. MOISTURE CONTENT MEASUREMENTS IN THE COMPOSTING PROCESS

3.4. C/N Ratio

C/N Ratio is the most important factor in the composting process. This is because the composting process depends on the activities of microorganisms that require carbon as an energy source and form cells [8]. According to ISN 19-7030-2004, a good composting process will produce an ideal C/N ratio of 10-20. The fig. 5 illustrated the value of the lowest C/N ratio, namely R2 with the addition of *Eisenia fetida* worms and without the addition of MOL. Meanwhile, the highest value of C/N ratio is R1 which is a control reactor which contains organic waste of pterocarpus indicus, cow dung and sawdust without the addition of MOL and worms. The value of the C/N ratio in R1 and R4 which is a reactor without the addition of worms is higher than the reactor with the addition of worms. This is due to the low nitrogen content available in the compost. The low nitrogen content is caused by the lifting of substances in the form of nitrogen gas or the formation of ammonia during the composting process[5]. When compared with ISN 19-7030-2004, the value of the C/N ratio at R2, R3, R5 and R6 which is a reactor with the addition of worms has met the standard of mature compost. According to [16], earthworms can play a role in lowering the C/N ratio of organic matter, and converting unavailable nitrogen into nitrogen after being removed in the form of manure (vermicompost).

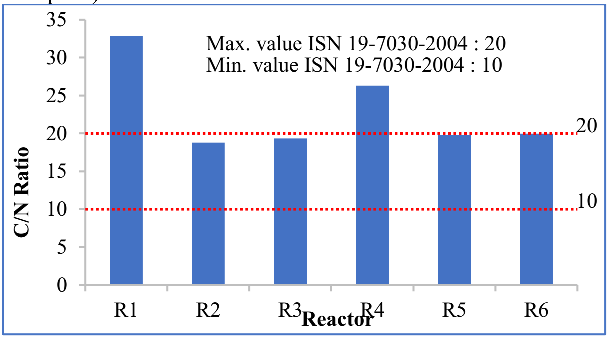


FIG 5. C/N RATIO OF THE COMPOSTING PROCESS

3.5. Waste Shrinkage Percentage

The highest percentage of waste shrinkage occurred in R6 of 77.6% which is a reactor with the addition of Eudrilus eugeniae worms and MOL banana weevil. The lowest waste shrinkage occurred in R1 which is 58.88% which is a control reactor, without the addition of worms and without the addition of MOL. This shows that the earthworm along with microorganisms accelerates the decomposition and stabilization of organic material and turns it into stable humus [6]. According to [1] compost shrinkage is caused by worm activity in consuming media as its nutrient source. The organic matter eaten by earthworms will be broken down into molecular particles in the worms' digestion. After being digested, the unusable components will be expelled into manure or castings. It can be concluded that the best reactor is a reactor with the addition of worms. Because it has a higher percentage of shrinkage than the reactor without the addition of worms.

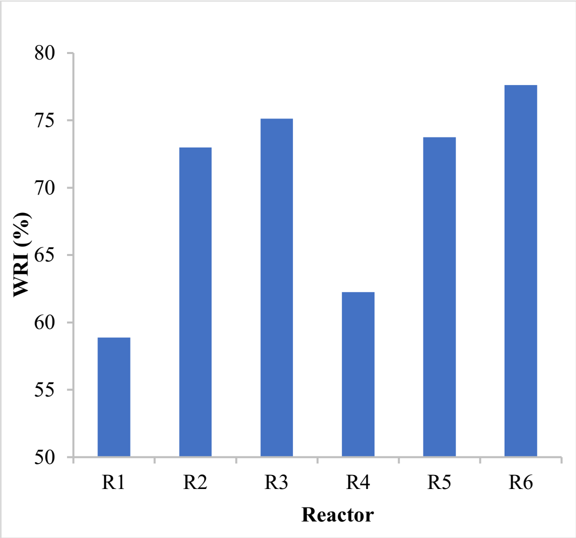


FIG 6. WASTE SHRINKAGE PERCENTAGE OF THE COMPOSTING PROCESS

4. CONCLUSION

The results of the composting process using the vermicomposting method in this study showed that all compost in R1, R2, R3, R4, R5 and R6 complied with SNI 19-7030-2004 on physical parameters. Compost has a moisture content of less than 50% and compost temperature was in the range of 27°C to 28°C. While the chemical parameters of all compost in R1, R2, R3, R4, R5 and R6 have complied with SNI 19-7030-2004 for pH and potassium parameters. Compost has a pH value of 7 and a potassium content greater than 0.20%. The ratio of C/N and phosphorus content of compost in R2, R3, R5 and R6 complies with SNI 19-7030-2004. However, the compost produced in R1 and R4 did not meet SNI 19-7030-2004 and experienced lower compost shrinkage than other reactors. The further research that composition of material compost adding waste animal as cow dug.

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