PHYSICAL, BIOLOGICAL AND CHEMICAL QUALITY OF COMPOST USING BANANA EXCRESCENCE BIOACTIVATOR

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PHYSICAL, BIOLOGICAL AND CHEMICAL QUALITY OF COMPOST USING BANANA EXCRESCENCE BIOACTIVATOR

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ABSTRACT

Composting is an effort to overcome soil pollution that is caused by waste. Local microorganism (MOL) solvent is useful as a bioactivator for composting. A local material to make MOL is banana excrescence. This study aims to identify the potential of microbes and quality contained in banana excrescences. The local microorganism (MOL) solvent made of banana excrescence as a bioactivator for composting had different concentrations and fermentation period. This study is experimental and used a factorial Randomized Block Design (RBD). The first factor was the concentration of banana *excrescence*; this study used 2 different concentrations, 150 g and 250 g. The second factor was the fermentation periods, which were 10 days and 20 days. The observed parameters were biological and chemical characteristics. The microbial potential observed in this study was the species and amount of microbes. Meanwhile, the quality of bacteria included pH, temperature, N, P, K, C, and C/N ratio. The data were analyzed using ANOVA. The results show that in terms of physical characteristics, the sample with 250-g concentration was oxidized faster than the 150-gram sample. The microorganisms contained in banana excrescence were *Lactobacillus* sp., *Saccharomyces*, and photosynthetic bacteria. The largest bacterial population in the treatment of banana excrescence was *Saccharomyces*, which was found in the 250-g sample that was fermented for 20 days with 30.5×10^{6}. The highest pH was 7.1 (250 g, 20 days). The highest temperature was 28°C (250 g, 10 days and 20 days). The highest content of organic C was 6.77 (250 g, 20 days), total N was 0.97 (250 g, 10 days), phosphorus was 0.33 (250 g, 10 days), and potassium was 0.74 (150 g, 20 days). The highest C/N ratio was 0.8 (150 g, 20 days).

KEYWORDS: Concentration, Fermentation period, Bioactivator quality

INTRODUCTION

Composting is one the effort to reduce domestic solid waste. About 81,9% organic waste direct dispose to the landfill (Prajnawita *et al*., 2020) and based on Maulani and Fatimah (2020), the community already have knowledge about separating organic and inorganic waste. Composting in a controlled environment reduces the dissemination of pathogens by killing many harmful microorganisms (Lodha *et al*., 2002; Sinha *et al*., 2002, and Tanski, 2006). Many workers have reported the disappearance or a decrease of specific bacterial species of public health concern from composted materials. Compost may inoculate the soil with a vast number of beneficial microbes (bacteria and fungi) whose activities enhance soil systems. For example, the use of composted materials raises the number of nitrogen-fixing and phosphate-solubilizing bacteria in soil (Lodha, 2002).

MOL can also be called a bioactivator that consists of a group of local microorganisms. It utilizes the potential of local natural resources. MOL can break down organic materials and be used as liquid fertilizer through the fermentation process. Organic waste can be utilized as materials to produce organic fertilizer with economic value. The conservative process of organic fertilizer production takes 8-12 weeks. On the other hand, if MOL is used, it only takes 4-8 weeks with a better result. The microbes contained in a bioactivator will help to break down complex chemical compounds into simpler ones. The difficulty of obtaining fertilizer results in the use of expensive chemical fertilizer. Therefore, a solution must be found in order to reduce dependency on chemical fertilizers (Setiawan, 2013).

Treatment strategies such as composting, anaerobic digestion, incineration, thermolysis, and gasification are the most common treatment methods. Composting as an economical technology does not only remove organic waste and recycle nutrients, but also converts organic matters into stable soil conditioners (Keeling *et al.*, 2003; Devault, 2004; Grigatti, *et al.*, 2004; Adhikari, 2009; and Monson, 2010). Compost application to agronomic soils increases crop production due to its nutrient content and moisture retention properties (Connell *et al.*, 1993; Wong *et al.*, 2001).

Banana excrescence has the potential to be used as a source of local microorganisms because its nutrient content can be used as a source of food so that microbes develop well. Banana excrescence contains 66.2 % of carbohydrates, protein, water, and important minerals (Wulandari *et al.*, 2009; Bolqisti and Prasetya, 2010; Budiyani *et al.*, 2016). According to Widiastuti (2008), 100 g of dried banana excrescence contains 66.2 g of carbohydrate and fresh banana excrescence contains 11.6 g of carbohydrate. According to Nasreen and Qazi (2012), 76% starch and 20% water. The content of banana excrescence is great for the development of decomposing microorganisms.

Banana excrescence contains a quite high level of nutrients with complete composition. It contains carbohydrate (66%), protein (4.35%), and a source of microorganisms that decompose organic materials or decomposers (Bolqisti, 2010). The species of microorganisms that have been identified in the MOL solvent made of banana excrescence are *Bacillus sp., Aeromonas sp., Aspergillus nigger, Azospirillum, Azotobacter,* and cellulolytic microbes. These microbes usually decompose organic materials. The microbes in the MOL made of banana excrescence function as decomposers of organic materials that are composted.

Banana excrescence contains microbes that decompose organic materials. The decomposing microbes are found in the outer part and inner part of the banana excrescence (Suhastyo, 2011).

MATERIALS AND METHODS

This study was conducted from May 2017 to August 2017. It took place in the Environmental Health Laboratory at Surya Mitra Husada Academy of Health, Kediri, Regional Health Laboratory of Kediri City, and Biology Laboratory and Soil Laboratory at Brawijaya University.

The utilized tools were plastic bottles, a scale, a jerrycan, a knife, an Erlenmeyer flask, a measurement glass, test tubes, a pipette, pH meter, a mixing machine, a beaker glass, petri dishes, an oven, an autoclave, a Kjeldahl flask, a destruction tool, and a laminar airflow cabinet.

The materials used in this study were the rotten excrescence of Ambon banana, brown sugar, coconut water, cow urine, cotton pad, tissue paper, a plastic hose, nutrient agar (NA) media, physiological saline solution (0.85%), aluminum foil paper, plastic bag, distilled water, and chemical substances for the analysis of total N content with Kjedhal method, the analysis of available P content with Bray 1 method, and the analysis of organic C with Walkey and Black method.

The design of this study is a true experiment. It used a factorial randomized block design (RBD) as follows.

- First factor: concentration of banana excrescence
- B_1 (150 g of banana excrescence + 100 grams of brown sugar + 100 mL of cow urine + 1 liter of coconut water).
- B_2 (250 g of banana excrescence + 100 g of brown sugar + 100 mL of cow urine + 1 liter of coconut water).
- The second factor is the fermentation period that consists of:
- F1 (10-day fermentation)
- F2 (20-day fermentation)

MOL Solvent Production

MOL solvent was made by mixing the chunks of Ambon banana excrescence that has been softened and adding brown sugar, cow urine, and coconut water based on the treatment. The MOL solvent that has been mixed was fermented based on the treatment, for 10 days and 20 days.

Parameters of Observation

The observed parameters were:

- Biological characteristics of the MOL solvent, which comprise the total bacterial population.
- Chemical characteristics of MOL solvent, which

comprises pH, N, P, K, C, and C/N ratio.

Data Analysis

The data obtained from the observation were analyzed using analysis of variance with a factorial randomized block design. If the treatment showed a significant effect, the analysis would be continued with a 5% BNT test.

RESULTS AND DISCUSSION

Physical Quality

The data of compost color as a physical parameter shows that the treatment of banana excrescence with 250-gram concentration was oxidized faster than the treatment with 150-g concentration.

Table 1. Compost color

Sample Type	Time	
	10 days	20 days
B1 (150 g)	Chocolate	Faded chocolate
B2 (250 g)	Faded chocolate	Blackish chocolate

The smell of compost indicates that the treatment of banana excrescence with a concentration of 250 grams was oxidized faster than the sample with 150-gram concentration.

Table 2. Compost smell

Sample Type	Time	
	10 days	20 days
B1 (150 g)	Smelly	Somewhat smelly
B2 (250 g)	Smelly	Somewhat smelly

In terms of smell, both treatments with 150-g and 250-g concentrations that were fermented for 20 days no longer had a strong smell.

The data on the compost texture parameter show that the 250-gram samples were decomposed faster than the 150-gram samples.

Total Bacterial Population

Banana excrescence contains microbes that decompose organic materials. The microbial decomposers are located in the outer and inner parts of the banana excrescence (Suhastyo, 2011). The microbes that have been identified in the MOL made of banana excrescence were *Lactobacillus sp.* And photosynthetic bacteria. These microbes are the microbes that commonly decompose organic materials. The microbes in the banana excrescence acted as decomposers of organic materials that would be decomposed.

Table 3. Compost texture

Sample Type	Time	
	10 days	20 days
B1 (150 g)	Has not been decomposed	Decomposed roughly
B2 (250 g)	Decomposed roughly	Decomposed

According to Wulandari *et al.*, (2009), banana excrescence contains 66.2% of carbohydrate. In 100 grams, dried banana excrescence contains 66.2 grams of carbohydrate and fresh banana excrescence contains 11.6 g of carbohydrate.

Fig. 1. *Lactobacillus sp.*

Table 4. Total population of *Lactobacillus sp.*

Sample Type	Time	
	10 days	20 days
B1 (150 g)	4.05 x 10[illegible]	11.15 x 10[illegible]
B2 (250 g)	7 x 10[illegible]	16 x 10[illegible]

Fig. 2. *Saccharomyces*

Table 5. Total population of *Lactobacillus sp.*

Sample Type	Time	
	10 days	20 days
B1 (150 g)	4.4 x 10^{6}	14 x 10^{6}
B2 (250 g)	4.5 x 10^{6}	31 x 10^{6}

Fig. 3. Photosynthetic bacteria

Table 6. Total population of *Lactobacillus sp.*

Sample Type	Time	
	10 days	20 days
B1 (150 g)	0.95 x 10^{6}	5.35 x 10^{6}
B2 (250 g)	3.5 x 10^{6}	14 x 10^{6}

Table 7. Overall total of bacteria

Sample Type	Time	
	10 days	20 days
B1 (150 g)	15.4 x 10^{6}	30.3 x 10^{6}
B2 (250 g)	17 x 10^{6}	41 x 10^{6}

The results of the study on the MOL solvent shows the effect of concentration and fermentation period. The largest bacterial population was found in the banana excrescence treatment with 250 g concentration and the species was photosynthetic bacteria. On average, the total number of bacteria was 36 x 10^{6}.

Overall Total of Bacteria

In this study, the largest number of bacteria was found in the sample with a concentration of 250 grams that was fermented for 20 days. The largest bacterial population was *Saccharomyces*.

According to Marsiningsih (2014), many factors affect the growth of bacteria in a fermentation, which include substrate, temperature, pH, oxygen, and microbes that are used. The substrate as a source of carbohydrates is the main material of fermentation that contains nutrients needed by microorganisms for plants. The main sources in MOL solvent production are carbohydrate, glucose, and the source of microorganisms itself. The source of carbohydrates in this study is banana excrescence, glucose from brown sugar, and cow urine as the source of microorganisms.

Table 8. pH of compost

Sample Type	Time	
	10 days	20 days
B1 (150 g)	7.6	7.5
B2 (250 g)	7.2	7.1

pH of Solvent

The most acidic pH of compost was 7.1. It was found in the banana excrescence sample with the 250-g concentration that was fermented for 20 days.

The pH decrease during the first stage of fermentation was due to the activities of microorganisms in the MOL that generates H^{+} ions. The fermentation period based on the 0.05 BNT test had a significant effect on the pH compared to other levels. With 20-day fermentation, the main materials of MOL have been completely decomposed. The acidity degree (pH) is a critical factor for the growth of microorganisms that are involved in the composting process (Simamora and Salundik, 2006). If the pH is too acidic, oxygen consumption increases and it creates a negative impact on the environment. Besides, it also causes nitrogen in the compost to turn into ammonia (NH_3). Conversely, an acidic condition (low pH) causes death to some microorganisms (Djuarnani, 2005). A breakdown results in nitrogen and ammonia. Therefore, this breakdown increases the pH value.

Temperature

Temperature increase is related to the activities of microorganisms in decomposing organic materials, which generates energy, namely heat, CO_2, and steam. The heat that is generated from the fermentation process correlates with the curve of microorganism growth (Djuarnani *et al.*, 2005). After reaching the peak, the fermentation temperature starts to decrease presumably due to the declining activities of microorganisms in decomposing organic materials.

Table 9. Temperature of compost

Sample Type	Time	
	10 days	20 days
B1 (150 g)	27 °C	27 °C
B2 (250 g)	28 °C	28 °C

The results of the study show that the highest temperature of compost made of banana excrescence was found in both samples with the 250-gram concentration that were fermented for 10 days and 20 days. Nevertheless, there is not much difference with the temperature of the sample with 150-gram concentration. This means that the change is insignificant.

Table 10. Organic C content in compost

Sample Type	Time	
	10 days	20 days
B1 (150 g)	6.69	6.39
B2 (250 g)	3.45	6.77

Organic C content

The highest content of organic C in compost was found in the banana excrescence sample with the 250-g concentration that was fermented for 20 days.

The results of the study indicate that the concentration and fermentation period affected the organic C content of the MOL solvent. The fermentation process of the MOL solvent went well because there was adequate organic C content to help the growth of microorganisms in the MOL.

Organic N content

The value of N increased and decreased during the process of bioactivator production because a characteristic of N is that it fluctuates. Overall, the nitrogen content in each bioactivator had an increase. Nitrogen is needed by microorganisms to maintain and form body cells. The higher the nitrogen content, the faster organic materials are decomposed because microorganisms that decompose compost materials require nitrogen to develop (Sriharti and Salim, 2008).

Table 11. Organic N content in compost

Sample Type	Time	
	10 days	20 days
B1 (150 g)	0.70	0.83
B2 (250 g)	0.97	0.64

The highest content of total N in compost was found in the banana excrescence sample with 250-gram concentration and 10-day fermentation. Meanwhile, the sample with the same concentration that was fermented for 20 days had the lowest content.

The results of the study point out that the concentration and fermentation period had an insignificant effect on the total N content of the MOL solvent as seen in Table 2. This occurred due to an anaerobic fermentation process that causes a nonoptimal nitrification process. On the contrary, the denitrification process was more dominant. The concentrations that were not much different resulted in insignificant effects (Marsiningsih, 2014).

Table 12. Available P content in compost

Sample Type	Time	
	10 days	20 days
B1 (150 g)	0.26	0.29
B2 (250 g)	0.33	0.28

Available P content

The highest content of P in the compost samples was found in the banana excrescence sample with 250-gram concentration and 10-day fermentation.

Microorganisms play an important role in the formation of phosphorus. Organic P substances are transformed and mineralized into organic compounds. Since P is an organic matter, it is highly essential for soil fertility. Nutrients from organic materials can increase fertility intensity to an optimal degree. This substance is very significant in the photosynthesis process and chemical physiology of plants.

Table 13. Available K content in compost

Sample Type	Time	
	10 days	20 days
B1 (150 g)	0.64	0.74
B2 (250 g)	0.57	0.60

Available K content

The compost that has the highest content of K was the banana excrescence sample with a concentration of 150 grams that was fermented for 20 days.

Microorganisms that fix potassium come from the organic materials that have been decomposed. Compost material that is fresh and organic contains potassium in the form of complex compounds that cannot be directly used by the plant to grow. However, with the activities of decomposing microorganisms, the complex compounds can be transformed into simple compounds that eventually generate potassium substances that can be absorbed by plants. Essentially, potassium has a significant role in photosynthesis to form proteins and cellulose. Besides, it can also strengthen the stem of a plant, which also makes it able to increase plant resistance (Budiyani *et al.*, 2016).

C/N Ratio

C/N ratio is a ratio of carbohydrate to nitrogen contained in a material. The higher the total N content, the lower the C/N ratio. Thus, mineralization occurs. Mineralization of N is the formation of inorganic nitrogen from the ammonification and nitrification process.

Table 14. C/N ratio

Sample Type	Time	
	10 days	20 days
B1 (150 g)	0.64	0.74
B2 (250 g)	0.57	0.60

Based on the obtained results, the banana excrescence compost sample with a concentration of 150 g that was fermented for 20 days had the highest C/N ratio.

CONCLUSION

The results of the study point out that microorganisms from banana excrescence and cow rumen generate various and a large number of microorganisms. Based on this study on quality analysis of compost made of banana excrescence, it can be concluded that the concentration and fermentation period had an insignificant effect on the sole factor. They also had insignificant effects on the parameters of total bacterial population, pH, organic C, total N, available P, and C/N ratio in the MOL made of banana excrescence. Meanwhile, the effects for the compost quality varied; some were significant, some were not.

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