# Optimization of Organic Waste Composting in Diponegoro University with the Use of *Pterocarpus indicus* as Bio-activator

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**Abstract.** Currently, Diponegoro University has been composting dry leaves with conventional methods through a facility called TPST. Even so, the processing which have been carried out has not been able to process all the organic waste in the location. Seeing these conditions, it is necessary to look for alternatives that are better and more economical to apply. Bioactivators are used from the leaves of *Pterocarpus indicus* which serve to accelerate the composting process. The bioactivators was made by making a solution of the leaves of Pterocarpus indicus which has been mashed, then mixed with molasses and rice flour and then left for 15 days. By using experimental method, the composting process is observed. This study aims to analyze the quality of compost with applicable standards. The quality of compost is assessed by looking at the pH, temperature, and macro nutrient percentage such as C-organic, N-total, and C / N ratio. During the composting process, variations in the stirring frequency are carried out, which is once every 2 days, 4 days and 7 days. After doing laboratory test, not all reactors meet the standards for pH, temperature, C-organic, N-total, and C / N ratio according to SNI 19-7030-2004.

Keywords: **bio-activator; solid organic compost; Diponegoro University.**

## 1 Introduction

Waste problems in Indonesia are currently faced with the over-accumulation of solid waste generation, where the volume of waste produced every day is often greater than the volume of waste that can be reduced and processed [1]. Such problems are also experienced by one of the higher education institutions located in Semarang City, namely Diponegoro University. In order to accommodate and process the waste generated from lecture activities, Diponegoro University has a facility in the form of an Integrated Waste Treatment Site (TPST) that serves all faculties, institutions, and work units. According to data held by TPST in 2015, the garbage entering the place was 11.82 $m^3$/day, with a percentage composition of organic waste of 43.68% and inorganic waste of 56.32%. Organic waste will then be processed into compost at 3.75 $m^3$/day, while inorganic waste that is still feasible will be resold. Residues from both types of waste that cannot be processed or resold will be transported to the Jatibarang landfill.

The organic waste treatment which is carried out in TPST is by using the conventional composting method on leaf waste with the help of bio-activator in the form of EM4. Composting time usually takes 4-5 weeks. The finished compost products will be packaged in bags with a capacity of 15 kg and sold to each faculty at Diponegoro University. This existing condition signifies the potential for independent organic waste treatment by Diponegoro University and if done well, it can be a business opportunity. However, the processing of organic waste carried out in TPST has not been able to reduce leaf waste. From the 5.16 $m^3$ of dried leaf waste produced in one day, only 73% were able to be treated. Not to mention if the compartment as a composting container is already full, the composting process cannot be done every day. In addition, there is only one field worker who has responsibility for treating organic waste. This

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problem has hampered the processing of organic waste in the TPST. Thus, another alternative is needed as a composting method that is faster, more efficient, and does not require many workers during the process.

In this study, a bio-activator is needed to accelerate the composting process which is able to improve the performance of microorganisms in fermenting dried leaves. Thus, a bio-activator is used which is made from the leaves of *Pterocarpus indicus* which is very easy to find in the campus area of Diponegoro University. The nutrients contained in it can be utilized by various beneficial microorganisms such as bacteria and fungi that play a role in the composting process [2, 3]. This decision was taken to reduce TPST's dependence on commercial bio-activators such as EM4. In addition to requiring additional costs, it turns out EM4 also has not been able to process dried leaf waste in TPST with a fairly fast duration.

The decomposition process can be accelerated by conditioning the composting process to be aerobic [4]. This is due to the presence of sufficient oxygen condition, so that aerobic bacteria can stay alive [5]. One way is to do stirring on the garbage pile [6]. The parameters to be tested include pH, temperature, water content, organic C, total N, and C/N ratio. From the test, it can be seen on the day that the compost is matured.

## 2 Methodology

This research is conducted by using experimental methods, namely observation under artificial conditions which are arranged by the researchers. The aim is to examine whether or not there are a cause and effect relationship and how much the cause and effect relationship is by giving several treatments. In addition, there are several experimental groups and control to be used as a comparison based on the frequency of stirring performed. The reactor used in this study was coded in the form of X, Y, Z, and K with stirring frequency for 2 days, once every 4 days, 7 days, and control (without stirring) respectively.

The stages of the research carried out were divided into making bio-activators, making compost, measuring in the field, and testing in the laboratory. The bio-activators was made by making a solution of the leaves of *Pterocarpus indicus* which has been mashed, then mixed with molasses and rice flour. The whole mixture is then left to stand for 15 days. The ingredients composition in making bio-activators are as follows:

**Bio-activator** = 150 grams of *Pterocarpus indicus* leaves + 50 grams of rice flour + 1 litre of water + 100 millilitres of molasses

In the making of compost, a reactor with the shape of cylinder or barrel made of plastic with a height of 1.5 meters and a diameter of 0.5 m is used. The leaf waste that has been collected is then placed in the reactor, then doused with bio-activator evenly. The composting process is carried out for 28 days until the compost is completely matured. The ingredients composition in the process of composting are as follows:

**Compost** = 5 kilograms of leaf waste + 200 millilitres of bio-activator + 1 litre of water

## 3 Results

### 3.1 pH

PH measurement during the process of composting is carried out once a day in the morning, around 8-10 AM. The pH measurement tool used in this study is a pH meter with the brand of HANNA HI 8424. The pH measurement is done by dissolving a sample of compost into distilled water, then dipping the tip of the probe from a pH meter to obtain a pH value. The results of pH measurements are shown in Figure 1. From the data obtained, it is known that all four reactors have a tendency to rise and fall on different days, depending on the frequency of stirring. Every time a stirring is carried out, the pH of the compost will decrease. While when allowed to remain unstirred, the pH tends to rise. The highest pH value during the process of making compost is on the 7th day in the Y reactor, with a pH value of 8.5. While the lowest pH during the process of making compost is found on the 28th day in the X reactor, with a value of 7.4.

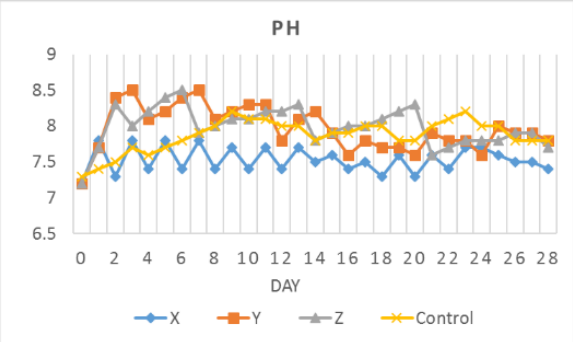


**Fig. 1.** pH value

Changes in pH during the composting process are closely related to the compounds produced during the process. The increase in pH can be caused by the formation of NH3 compounds from N elements contained in compost material [7]. On the other hand, there is also the formation of acidic volatile organic compounds in the lower trash pile which tends to be anaerobic [8]. Therefore, after stirring, the pH value will drop because the compound is released and spread evenly throughout the rubbish pile. The pH value of matured compost was shown on 28th day. According to SNI 19-7030-2004, the optimal pH value of the compost is 6.8 to 7.5. Thus, compost that has an optimal pH value is only in reactor X.

### 3.2 Temperature

Temperature measurement during the composting process is carried out once a day in the morning, around 8-10 AM. The temperature measurement tool used in this study is an alcohol thermometer. The thermometer is left in the leaf waste pile until the process of composting is finished. The results of temperature measurements during the composting process are shown in Figure 2. From the data obtained, it is known that the highest temperature is 38ºC on day 1 in Z and K reactors, while the lowest is 27ºC on 27th and 28th days in reactor X and Y. In this study, the temperature during the process of making compost is closely related to weather and ambient temperature.

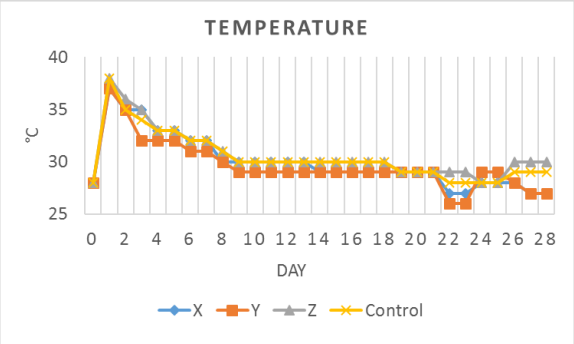


**Fig. 2.** Temperature value

In the composting process, there are 4 phases that occur, namely mesophilic (30-37ºC), thermophilic (38-60ºC), mesophilic 2 (30-37ºC), and maturation (ambient temperature) [9]. In this study, the mesophilic phase occurred on day 0, the thermophilic phase occurred on day 1, the mesophilic phase 2 occurred on days 2 to 21, and the maturation phase occurred on days 22 to 28. The temperature of matured compost can be seen from the temperature value on the 28th day. The condition of compost that can be applied to plants is when the temperature is similar to the surrounding environment [10].

### 3.3 C-Organic

The method used in C-organic test is by using spectrophotometry based on SNI 6989-79-2011. The results of C-organic value are shown in Figure 3. Broadly speaking, the value of C-organic percentage is fluctuating but tends to decrease. From the data, it is known that the highest C-organic value obtained during the composting process is 25.57% on day 14 in reactor X. While the lowest C-organic value is at 14.40% on the 21st day at the K reactor.

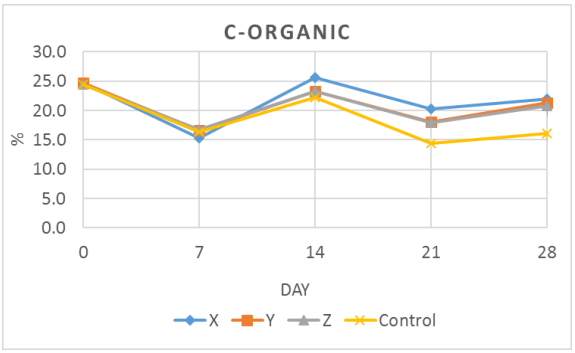


**Fig. 3.** C-organic value

The decrease in the value of C-organic value is because the compound is used by microorganisms as an energy source during the fermentation process [11]. While an increase in the value of C-organic value as seen on 21st to 28$^{th}$ day is caused by the death of microorganisms which then turn into biomass [11]. Levels of C-organic value from matured compost were shown on 28th day. Thus, it can be seen that the value of C-organic percentage in all reactors meets the standards according to SNI 19-7030-2004, which is between 9.8-32%.

### 3.4 N-Total

The method used in the N-total test is spectrophotometry SNI 6989-79-2011. The results N-total value in compost samples is shown in Figure 4. Broadly speaking, N-total percentage is rising from beginning to end. From the test results, it is known that the highest N-total value during the composting process is 0.94% on the 28th day in reactor X. While the lowest N-total value is 0.094% at day 0 in reactor X.

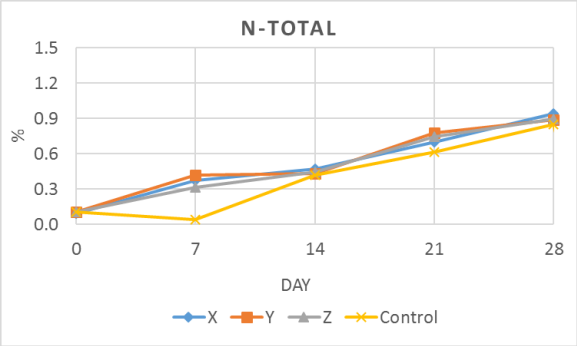


**Fig. 4.** N-total value

The continuous increase in N-total value can occur because the protein was breaking down into amino acids during the fermentation process [12]. After that, amino acids will turn into ammonia and undergo oxidation to become nitrate [13]. The N-total value of matured compost was shown on 28th day. Thus, it can be seen that the N-total value in all reactors meets the standards according to SNI 19-7030-2004, which is above 0.4%.

### 3.5 C/N Ratio

After obtaining the results of C-organic and N-total value, then C / N ratio could be obtained by dividing those values on the same day and reactor. The graph of the C / N ratio during the composting process is shown in Figure 5. From the test results, it is known that the highest C / N ratio is 262.6 on the day 0 in reactor X. While the lowest value is 18.9 on the 28th day at the K reactor.

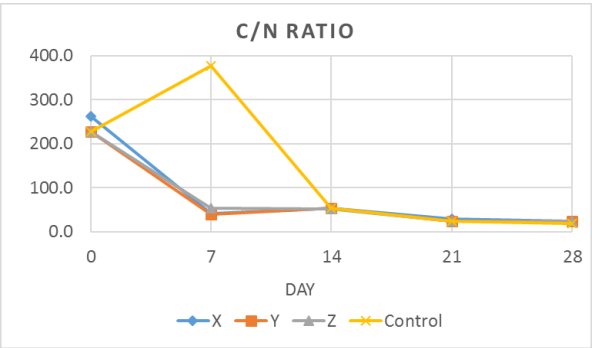


**Fig. 5.** C/N ratio

The C / N ratio of matured compost is shown on 28th day. Thus, it can be seen that there is only one reactor that meets the C / N ratio according to SNI 19-7030-2004, which is in the reactor K with a ratio of 10-20%. The value of the C / N ratio indicates whether the C and N compounds in the compost can already be directly used by plants [14].

## 4 Conclusion

Based on the results of the research that has been done, it can be concluded not all reactors meet the standards for pH, temperature, C-organic, N-total, and C / N ratio according to SNI 19-7030-2004. In the temperature parameter, the entire reactor produces compost that complies with the standard. Besides that, only reactor X which is able to meet the standard of pH value because the Y, Z and K reactors have a pH value above 7.5. On the other hand, all reactors have a value of C-organic and N-total that is in accordance with the standard, but for the C / N ratio it turns out that only the K reactor which meets the standards because the X, Y and Z reactors have a ratio value exceeding 20 %.

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