Food Waste Composting with The Addition Of Cow Rumen Using The Takakura Method and Identification of Bacteria that Role in Composting

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Food Waste Composting with The Addition Of Cow Rumen Using The Takakura Method and Identification of Bacteria that Role in Composting

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Abstract. The purpose of research to measure and analyse the quality and quantity of food waste composting by adding cow rumen activator and efective microorganisme (EM4).This research do to identify the dominant bacteria that play a role in composting. The composting method applied in this research is Takakura composting. The method for bacterial identification was referred to as the Bergey's manual which consisted of a gram stain test and a biochemical test. Three types of composter variation are being use in this composting, variation 1 consist of (food waste and maturecompost), variation 2 consist (food waste, mature compost and EM4 activator) and variation 3 consist (food waste, mature compost and cow rumen activator). The parameter which include maturity, quality (moisture content, temperature, pH, texture, color, C/N ratio, P and K), and the quantity of compost. The results showed that not all variations met the compost maturity and compost qualitybased on the SNI 19-7030-2004 standart such as organic carbon in variation 1B and C/N ratio in variations 1A and 1B. The affects of addition activators to composter give short time and good quality of compost. Composting with the addition of cow rumen activator is the fastest composting for 7 days with C/N ratiois 19.22%, P is 0.34%, Kis 2.08%. Composting with EM 4 activator occurred for 8 days with C/N ratio is 20.53%, P is 0.30%, K is 1.82%. Composting without the addition of activator is the longest composting which is 11 days with C/N ratio is 23.74%, P is 0.21%, Kis 1.76%. The results show variation 3 with the addition of cow's rumen is the best composting with a score of 15. The results of the identification of dominant bacteria that a role play in composting are some Bacillus sp bacteria which are bacteria that degrade organic matter.

1. Introduction

Being one of the tourist destinations in Indonesia, positively affect the economic sector of Padang City. This is noticeable with the constant emergence of many restaurants, cafes, fast-food restaurants, and various other types of eating places. According to the records of Tourism Destinations in 2017, there are 230 restaurants spread across the city of Padang. This will potentially create a lot of waste from this sector, especially from the food scraps (food waste). Along with the increase in food waste pile, various problems will raise especially environmental pollution. According to the Food and Agriculture Organization (FAO), food waste is a waste produced during the process of making food and after eating activities, which is related to the behavior of sellers and consumers. Globally, the food waste problem is a particular concern to be overcome to improve environmental sustainability.

thecomposition of food waste in Padang City, 70.69% of the total food waste is organic waste (food scraps, vegetables, and fruit peels)[1]. Of all the organic waste, 33.59% is unprocessed food waste and will be disposed into the landfill.

One of the alternative solutions to overcome this waste problem is by processing organic waste into compost and adding the bio-activators to assist the decomposition of food waste. There are many composting methods, one of them is Takakura composting. The takakura composting is a practical method of composting that could be applied on a household scale or by a small restaurant business, because it does not require a wide area of land. The process of compost break down could be accelerated by adding the bio-activators. One of the alternatives that could be used for bio-activator is cow rumen [2].Besides using the cow rumen, materials such as EM4, orgadec, and Stardec and rice mole also can be used as the bio-activators. This study will observe the effect of adding the cow rumen activator and EM4 activator on the quantity of compost result, analyze the level of compost maturity and the compost quality as based on the SNI 19-7030-2004 standard, identify the dominant bacteria that play a role in the composting process and determine the optimum composition of the compost raw material.

2. Materials and methods

This study used a Takakura Composter which was made from a basket measured as 36 cm x 26 cm x 47 cm. The amount of waste placed into the composting basket is 4 kg including the addition of the mature compost. The components of the Takakura composter are cardboard, paddy husk pads, black fabrics, and a basket cover. The raw materials consist of food waste (vegetable waste, fruit peels, and leftover rice), cow rumen, and bio activators. This research was conducted in duplicate. The total raw materials required for each variation can be seen in table 1. The first composting step is chopping the raw materials and preparing the takakura basket. After that, the raw material is added to the Takakura basket according to the variation of the raw material according to Table 2. Then the cow rumen activator and EM-4 are added into the raw material according to the variations. Then, the compost components are well stirred until they became homogeneous, the stirring is conducted once in 24 hours during the composting process.

Table 1 Composition of Raw Materials.

Variation	Composition of rawmaterials (%)		Activator		Weight (kg)	
	FW	MC	EM4	CR	FW	MC
1A 1B	50	50			2 kg	2 kg
2A 2B	50	50	5 ml		2 kg	2 kg
3A 3B	50	50		5 ml	2 kg	2 kg

Note: FW ;Food Waste, MC; Mature Compos ;CR: Cow Rumen

The compost maturity test was carried out daily. As based on SNI 19-7030-2004, the parameters measured are temperature, pH, texture, and color. The composts were stated as mature when the moisture temperature is ≤ 30 ° C, the pH reaches the neutral state (6.8-7.49), and the texture and color are similar to soil. The standard for compost quality test is based on SNI 19-7030-2004, namely the ratio of C/N, nitrogen, phosphorus, and potassium contains[3]. While the quantity test is carried out by weighing the solid compost has been produced. The objective of the bacterial identification test is to observe the dominant bacteria that play a role in composting. The method for bacterial identification was referred to as the Bergey's manual which consisted of a gram stain test and a biochemical test[4]. Identification of bacteria was conducted in the mid-process of the composting (at the peak

temperature), this is the time when microorganisms became more active and playing role in decomposing the organic compounds.

After obtaining the data, it was analyzed for the raw material, compost maturity, quality, and quantity, and the dominant bacteria that play a role in the composting. The data which were analyzed in this study includes the analysis of the effect of adding the cow rumen activator and the EM4 activator towards the raw materials. This analysis is carried out based on the duration of composting time, the amount of material reduction that occurs, and the percentage of material reduction. The level of compost maturity was tested through the compost temperature, color, texture, and pH. Compost quality was tested by examining the moisture content, the parameters of Organic C, Nitrogen, C / N ratio, Phosphorus, and Potassium. The compost quality is compared with the standard of SNI 19-7030-2004 on the Compost Specifications for Household Organic Waste. Furthermore, the analysis and discussion of compost quality are carried out by referring to the standard of SNI 19-7030-2004 regarding the specifications for compost from household. The selection of the best compost variations was based on the highest score. Results of the bacteria identification included the tests of morphological, Gram stain, and biochemistry. Furthermore, the results will be integrated and used to determine the bacteria contained in each existing isolate. Ascertainment of the bacteria is determined by comparing the obtained data of the test results with biochemical test data.

3. Results and discussion

3.1 Effect on Addition of Cow Rumen Bioactivator.

Analysis of the effect of adding the cow rumen bioactivators could be observed from the composting duration and the reduction of food waste during the composting. The fastest composting process occurred in the composter 3A and 3B, which last only for 6 days. Variation number 3 was the cow rumen activator. The C/N ratio obtained for the variation 3 was 19.22% and 19.88% so that the decomposition process runs rapidly. Variation 3 also has adequate moisture content at 29.29%. Humidity plays a very important role in the metabolism processes on the microorganisms and indirectly affects oxygen supply. Microorganisms could utilize organic material if it is dissolved in water. The longest composting process was for the variation 1A that lasts for 11 days, it contains a composition of 100% food waste + finished compost. Variation 2 did not have a too significant difference in composting time as compared to variation 3, which lasts for 7 days. Details should be figure 1 in the text.

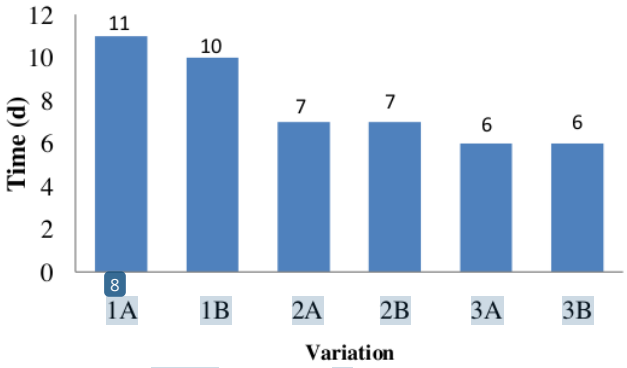

Figure 1. Analysis of Time Duration

Compost maturity occurred simultaneously with the compost shrinkage. Based on figure 2, it can be seen that the material shrinkage on each composter during the composting process. The highest reduction value as 35% was found in variation 3, a variation with the addition of cow rumen activator.

The lowest reduction as 20% occurred in the composter 1, a variation without activator addition. While the variation with EM4 bioactivators addition has experienced a 25% reduction.

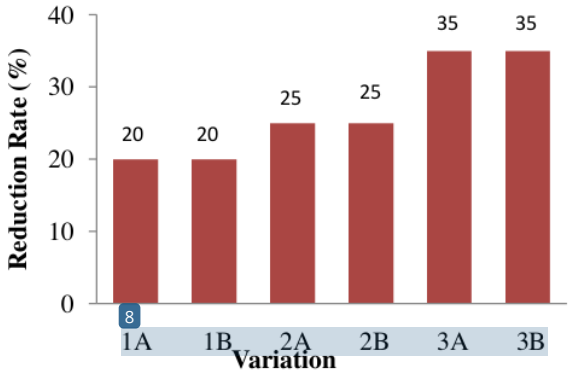

Figure 2. Analysis Material Reduction.

3.2 Compost Maturity Analysis

Analysis of compost maturity was observed from the parameters of moisture content, temperature, color, and pH. The temperature, pH, and color were monitored daily.

3.3 Moisture Content Analysis

Judging from the measurement, the moisture content of all variations has meets the optimum range of moisture content for composting. The highest moisture content was 31.77% for variation with the activator EM4 addition. While the lowest moisture content was 19.98% for variation 1 which is without using any activator.

The decreasing moisture content in each variation is caused by moisture absorption by the rice husks pad so that liquid produced in the composter during the composting proces was absorbed, then the moist status inside the composter could be maintained. This condition was in line with the study results of Widarti et al. (2015) which stated that the decrease of moisture content in each composter was due to the release of moisture from organic matter of the wasted and absorbed by the pads. In the early stages of composting, microorganisms are very active in absorbing organic matter, where the results of this degradation process produce liquid (leachate)[5]. The moisture content of composting should be seen in figure 3.

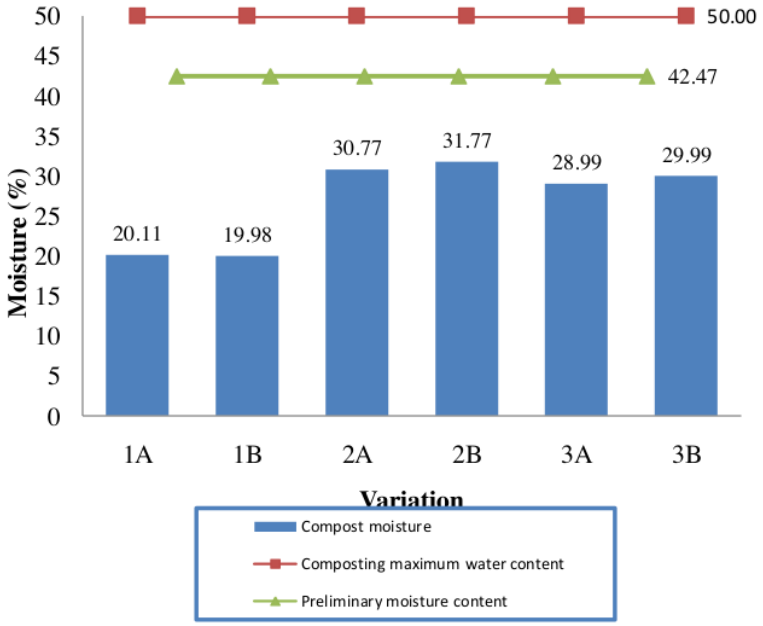

Figure 3. Compost Water Content.

3.4 Temperature Analysis

In the semi-aerobic composting process, the microorganisms involved in the composting process are mesophyll types (composting temperature is below 40° C). In this study, the optimum temperature achieved was 34 ° C for the variations of 3A, 3B, 2A, and 2B on different days during composting. This shows that the compost variation with the addition of cow rumen activator has reached the same optimum temperature compared to the variations 1A and 1B which is without activator addition. The microorganisms that playing role in the composting process are mesophyll bacteria which act at the working temperatures (25ºC - 40ºC). These bacteria break down the cellulose and hemicellulose into more simple sugars. The composting temperature will increase as the activity of microorganism increases until it reaches the peak temperatures and then gradually decreases because there is no more breakdown of the organic substance by bacteria [6].The thermophilic temperature of 34 °C was reached, this thermophilic temperature will cause the microorganisms to be active to degrade the organic substance and kills the pathogenic bacteria in the compost. In the mesophilic phase, the temperature drops to 33° C, which indicates the compost is entering the maturation stage. In this study, it was found that the temperature on final composting has begun to decline at the end of composting. Each research variation has reached a temperature of 26°C averagely. Based on the standard of SNI 19-7030-2004 about compost quality standards, the maximum temperature value is 30 ° C. In this study, the composting temperature of each composter has met the standard value.

3.5 Compost Color Analysis

The starting color of compost is brownish-white since the decomposition process of the material has not occurred yet, while the mature compost that has been changed into blackish as resembling the soil's color.

3.6 pH analysis

At the beginning of composting, the reaction tends to be acidic because the organic materials were broken down to produce simple organic acids such as ammonia[7]. The pH value may change as the composting process occurs. The increase in the pH level was seen on the 3rd and 4th days. The increase in pH also occurs due to the activity of microorganisms. These microorganisms have converted the organic acids that have been formed in the previous stage. The pH value of composting will increase simultaneously with the composting and eventually stable at a neutral pH (7). The change in compost's pH begins with an acidic pH due to the formation of simple organic acids, then the pH increases on further incubation due to protein breakdown and the release of ammonia [8].

Based on the SNI-19-7030-2004 regarding the standards for compost quality, the minimum pH value is 5.4 and the maximum value is 7.4, while in this study as shown by Figure 4, the pH value at the end of the composting day is in the range 7-7.5, has met the SNI-19-7030-2004. The increase in pH level occurred due to the activity of the microorganisms that convert the organic acids that have been formed in the previous stage. The pH value will increase with composting day and will eventually stable at neutral pH (7) [9].

3.7 Analysis of Compost Quality Test

Analysis of the C / N ratio

The C/N ratio is the ratio between carbon and nitrogen content in compost, which is useful for microorganisms for the process of decomposing organic compounds. The microorganisms need carbon and nitrogen as energy sources in the decomposition process. Carbon is a source of energy for microorganisms, while nitrogen is the most important component for building protein.

The C/N ratio in the organic compound is an indicator of nutrient availability. If an organic compound that contains a high C/N ratio is directly applied to the soil (without composted before), the decomposition process will take place in the soil. In the process of decomposing by microorganisms, a combustion reaction occurs between the elements of carbon and oxygen to produce heat and carbon dioxide. This carbon dioxide is then released in the form gas, while the element of decomposed nitrogen is captured by microorganisms. At the time when microorganisms die, this nitrogen element will remain in the compost (along with the dead bodies), so that the C/N ratio decreases. If the C/N ratio is too low, there will be not sufficient compounds as energy sources for microorganisms to bound the free nitrogen. However, if ratio is too high, it can be a factor that restricts the development of microorganisms [2]. The ratio can be seen in table 2.

Table 2. Composting C/N Rasio.

Variation	Rasio C/N	SNI 19-7030-2004 standard	Statement
Variation1 A	23,74	Range 10-20	Does not Meet standard
Variation 1B	23,46		Does not Meet standard
Variation 2A	20,53		Meet standard
Variation 2B	18,45		Meet standard
Variation 3A	19,22		Meet standard
Variation 3B	19,88		Meet standard

Potassium Analysis

Based on the SNI 19-7030-2004 standard on compost quality standards, good compost must contain a minimum value of potassium as 0.2%. At the end of the composting process, all compost variations in the study have meet the standard. Good quality compost contains higher levels of potassium. The highest potassium content was in the 3B variation as 2.20%, and the lowest was in the 1B variation as 1.56%. Potassium levels can also be affected by the addition of activators. In the composting process, the raw material will be decomposed by microorganisms.This process requires optimal conditions

such as the availability of adequate nutrients, sufficient air, and proper humidity[10]. The potassium element is beneficial for plants because it helps the formation of protein and cellulose in plant stems to make it stronger [11].

3.9 Phosphorus Analysis

Based on the standard of SNI 19-7030-2004 regarding the compost quality, good compost should have a minimum phosphorus content of 0.1%. The test results show that all variations meet the quality standards that have been set.The highest phosphorus content as 0.36% is found in the 3A variation. This result is compatible with the study results of Nurdiansyah's (2015), stated that the P content will be higher in the decaying event of the composed organic substance[12]. In the maturation stage, the microorganisms will die and the P content in the microorganisms will merge in the compost and directly will increase the Phosphorus content in compost. Based on the study results on phosphorus[13], the content (P_2O_2) in compost is related to the N content in the compost material.Recapitulation of the total scoring can be seen intable 3.

Table 3. Recapitulation of total compost scoring.

variation	compost maturity	Compost quality	Compost quantity	Total scoring
1A	5	4	3	12
1B	5	3	3	11
2A	7	5	2	14
2B	7	5	2	14
3A	9	5	1	15
3B	9	5	1	15

Base on 3, the highest score in the total monitoring score for compost maturity was found in the variations 3A and 3B, scored as 9. Compared to variation 1, the score was significantly different. The variation 1 scored as 5 because it has the lowest reduction level which results in a low final score in the compost maturity. The variation 2 scored as 7, it was considered quite good based on the composting duration. Based on the length of composting duration, variation 3 got the highest score, because it has the fastest composting time as 7 days. This also proves that adding the cow rumen activator in the compost variation is very helpful to accelerate the decomposition process, but in terms of compost quantity, the variation with the fastest composting time is not certainly being the best compost. The best compost must be seen in terms of quality over the measured parameters of the C/N, P, and K values. Based on the total score for compost quality, the highest score found in the variation 3A and 3B which are the aeration with cow rumen activator scored as 15. This proves that microorganisms play an important role in the composting process. The mixing is considered as reasonable since the organic material can be broken down by microorganisms, then the amount of compost produced at the end of composting was less because the decomposition process runs optimally.

3.10Bacteria Identification

In this study, The biochemical test was conducted to identify a bacterial culture from isolation through their physiological properties and to produce the dominant bacteria that play a role in composting. Based on the biochemical test, the results found that the dominant bacteria for the composting process was Bacillus Sp.Based on the biochemical test, the results found that the genus of bacteria in composting was Bacillus sp 1, Bacillus sp 2, Bacillus sp 3. This Bacillus sp are bacteria that can break down the organic compounds of food waste in its composting process. Bacillus sp can grow and develop in aerobic conditions [14]. Bacillus bacteria are single-celled

bacteria and are structured as rod-shaped bacilli, spherical cocci, or spiral-shaped spirilla, gram-positive bacterial cells that are facultatively anaerobic, capable of fermenting sucrose. Bacillus bacteria also produce gas in their metabolism. Some bacillus bacteria use citrate as a carbon source and are motile. This classification of bacteria is based on the bacterial identification book *Bergey's Manual of Determinative Bacteriology Seventh Edition* [4]these bacteria are classified in Division Bacteria, Classis Schizomycetes, Order Eubacteriales, Family Bacillaceae, Genus Bacillus. Refers to the results study of Supriyatna's (2012) on isolating and identifying cellulotic bacteria in the waste of organic vegetable and fruit peel that producing Bacillus bacteria[15], and other studies conducted by Lynd et al (2002) which also found that 4 isolates belonged to the genus Bacillus. A large number of Bacillus isolates could be found in the garbage because this genus can grow faster in a high number of species, besides that, the Bacillus is scattered in all types of habitat, especially in the garbage[16]. Bacterial identification was carried out using Bergey's Manual method with 12 tests. The results found that the composting also contained the Bacillus sp bacteria.

The addition of activator EM4 and cow rumen have affected the duration of compost maturity and the quantity of compost produced. The fastest composting time which lasts for 6 days was found in variations 3A and 3B that use additional cow rumen activator, producing the compost quantity that resembling soil and black color with a ratio C/N as 19.22%, P as 0.34%, K as 2.08% for the 3A variation, while the 3B variation has the ratio C/N as 19.88%, P as 0.36%, K as 2.22%. Composting using the EM4 activator was lasts for 8 days, the compost quality was resembles soil and black in color with the variation 2A found C/N ratio as 20.53%, P = 0.30% and K = 1.82% while the variation 2B found C/N ratio as 18.45%, P= 0.32% , K= 1.75. Composting without the addition of EM4 and rumen has made the variations 1A and 1B become the longest of the three variations, its composting duration last for 11 days, the compost quality resembled soil and black in color with a C/N ratio = 23.74, P= 0.21 and K= 1.76. Based on the bacteria identification using the Gram stain test and biochemical test, it was obtained that the dominant bacteria in the composting process is the Bacillus sp.

4. Conclusion

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