

The Effect of Compost Raw Materials (Market Waste, Yard Waste and Cow Rumen) To Quality and Quantity of Compost

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Abstract

This study combines market waste (MW), yard waste (YW) and cow rumen (CR) as raw materials to obtain the optimum C/N ratio of compost raw materials. Composter consists of 6 variations, namely variation 1 (70% MW: 30% YW), variation 2 (60% MW: 20% YW: 20% CR), variation 3 (50% MW: 30% YW: 20% CR), variation 4 (40% MW: 40% YW: 20% CR), variation 5 (30% MW: 50% YW: 20% CR) and variation 6 (20% MW: 60% YW: 20% CR). This study aims to analyze the effect of variations in compost raw material composition so that the most optimum variation is obtained for the composting process. The method used was semi-aerobic composting. The results of observations on compost maturity for temperature, pH, texture, color and odor parameters have met SNI 19-7030-2004 standards with composting time of 12-21 days. The results of compost quality analysis including water content, organic C, nitrogen, C/N ratio, phosphorus, and potassium have not all variations fulfilled the SNI 19-7030-2004 standard, namely the value of the C/N ratio in variation 6 which exceeds the standard. Of the total compost as much as 3 liters, the solid compost yields of 0.5-1.25 liters and liquid compost from 0.05 to 1.5 liters were obtained. Based on the results of scoring on maturity, quality, and compost quantity, the best variation was found in variation 2

Keywords

cow rumen, market waste, maturity, quality, quantity, yard waste

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1. INTRODUCTION

Solid waste is a major problem in Indonesia. The presence of waste from domestic, commercial and industrial activities cannot be avoided, even more complex in tandem with economic development and population growth. However, the government has not had a proper strategy in solving this waste problem, especially in urban and densely populated areas. Solid waste is still a tricky problem in Indonesia.

The dominant type of waste in Indonesia is organic waste reaching 70% of the total waste. To process organic waste optimally required to apply a technology to solve the solid waste is by using the technology of recycling solid waste into valuable compost product. Based on research of Marpaung (2014), potentially as a cow rumen waste bio-activator in composting organic waste composting seen from a long time and the percentage of reduction of material at the composter with the addition of bio-activator.

One of the ways to reduce waste generation is by treating it into compost product. Solid waste that can be composted is an organic waste in the form of vegetable residue, fruits,

and foliage. Compost is the decomposition of organic materials or the process of overhauling complex compounds into simpler compounds with the help of microorganisms. Compost can reduce the density of the clay soil and help the sandy soil to hold water. In addition, compost can serve as a stimulant to improve the health of plant roots. This is possible because the compost can provide food for microorganisms that keep the soil healthy and balanced (Isroi, 2008). This composting method is very suitable to be applied in Indonesia because the composition of waste in Indonesia is dominated by organic waste.

The process of maturation composting can be accelerated by the addition of bio-activators. Bio-activators are a source of simple microbial inoculum which then undergoes mineralization so that it becomes available in the form of minerals that can be absorbed by plants or other organisms. The main composition of the bio-activator is the medium for the growth of microorganisms and living microbial cells. One alternative bio-activator that can be used is cow rumen (Tarigan, 2012).

The content of rumen is one of the slaughterhouse wastes

that has not been utilized optimally, and some are thrown away to cause environmental pollution. This waste can be used to breed bacteria/microbes in it as a starter of compost/organic fertilizer even also increase the content of microorganism decomposers in the soil. Cow rumen bacteria consists of a collection of several microorganisms that are very useful in the processing of manure, compost, liquid organic fertilizer, and at the same time able to improve the level of soil fertility and provide life in the soil (Darsono, 2011).

The composting process can be affected by the C/N ratio. The C/N ratio is the sum of the carbon element composition with the nitrogen contained. Microorganisms break down carbon compounds as energy sources and use nitrogen for protein synthesis. The C/N ratio will affect the composting process and the results of the composting itself. An important parameter of the composting process is the availability of carbon elements for microorganisms. Microorganisms require about 30-40 carbon units for each nitrogen unit used for protein production processes. Organic waste in the Central Market of Padang City is dominated by vegetable and fruit waste. Vegetables and fruit waste have a fairly low C/N ratio of about 25.5, whereas yard waste dominated by leaves has a fairly high C/N ratio of about 55 (Suryati, 2014). Therefore, this research conducted a combination of market waste composition with yard waste as compost raw material. The composting process will be accelerated by the addition of cow rumen that serves as a compost raw material as well as a bio-activator. In this research will be determined the composition of the optimum raw materials in composting to obtain the compost that meets the requirements according to SNI 19-7030-2004 (SNI-19-7030-2004, 2004), so it can be used for all types of plants. The composting process was done semi aerobically using a simple composter. Organic compost could be applied by the government and the community to reduce the amount of waste.

2. EXPERIMENTAL SECTION

This study utilizes market waste with the addition of yard waste and cow rumen as bio-activator. This research was conducted to determine the appropriate composition between market waste and yard waste the addition cow rumen as bio-activator.

Samples of the market waste form of Central Market of Padang City, West Sumatra, while samples of yard waste were taken from Iman Bonjol Park of Padang City and cow rumen was taken from slaughterhouse at Bandar Buat, Padang City. Analysis of compost samples was carried out at the Laboratory of Solid Waste Department of Environmental Engineering of Universitas Andalas and enumeration of market waste, and yard waste was carried out at the Integrated Solid Waste Management Center of Universitas Andalas.

The steps taken in this study include literature studies,

preliminary tests, primary data collection, secondary data collection, analysis, and discussion of experimental results.

The composter used is a modification of the designed composter from the Center for Settlement Research and Development under the Research and Development Board of Department of Public Works, Bandung. Comparison of the composter used in this study was 1:10 from the composter design of the research center. For more details, see Figure 1.



Figure 1. Composter

Each composter has a total volume of 3 liters of raw material. Each composter has a difference in the composition of the raw material used. Detail of variation can be seen in Table 1.

2.1 Preliminary Test

One of the keys to success in carrying out the composting process is how to obtain a mixture of raw materials in such a way that the final product is compost which has a C/N ratio of 10-20. Based on Isroi (2008) it is known that there are two important parameters in determining the selection of raw materials, namely: the C/N ratio and the moisture content of the raw materials to be composted.

2.2 Main Research

The main research consists of compost maturity test, compost quantity measurement, and compost quality measurement.

Compost maturity test was done every day. The parameters tested were temperature, texture & color, odor, and pH of compost. Compost reaches its maturity when it reaches the groundwater temperature of $\leq 30^{\circ}\text{C}$, pH reaches neutral (6.8 - 7.49), texture and color resemble the soil, and the odor smells of soil. Stirring of compost is done every day until the compost matured.

Measurement of the quantity of compost was done by calculating the volume of compost after the compost matured. Solid compost is the result of composting of raw materials that have been sifted, while liquid compost is liquid that is collected under the composter produced from the composting process of raw materials. The solid compost obtained

Table 1. Raw material mixture variation

Variation	Percentage variation (%)			Volume variation (Liter)		
	MW	YW	CS	MW	YW	RS
Variation 1	70	30	0	2.1	0.9	0
Variation 2	60	20	20	1.8	0.6	0.6
Variation 3	50	30	20	1.5	0.9	0.6
Variation 4	40	40	20	1.2	1.2	0.6
Variation 5	30	50	20	0.9	1.5	0.6
Variation 6	20	60	20	0.6	1.8	0.6
	100	100	100	8.1	6.9	3

Note: MW= Market Waste; YW= Yard Waste; CR= Cow Rumen

has a smooth and homogeneous structure. The rough structure and foreign material that is still left in the composting process does not pass the sieve is a compost residue. The volume of liquid compost is obtained by calculating the volume of water in the container.

Compost quality measurement was done at the Solid Waste Laboratory of the Department of Environmental Engineering, Andalas University. The measured parameters were based on SNI 19-7030-2004.

3. RESULTS AND DISCUSSION

This study examines how the influence of the comparison of the composition of raw materials used. In this study, the maturity parameters, quality, and quantity of compost will be tested to get the most optimum raw material composition.

3.1 Preliminary Test

3.1.1 C/N ratio analysis

The C/N ratio is the ratio between the levels of carbon and nitrogen contained in compost which is useful for microorganisms for the decomposition of organic compounds. Carbon and nitrogen are needed by microorganisms as a source of energy in the decomposition process of organic compounds. The initial C/N ratio must be in the range of 25-50 (Suryati, 2014).

The C/N ratio for compost variations in the preliminary test can be seen in Figure 2

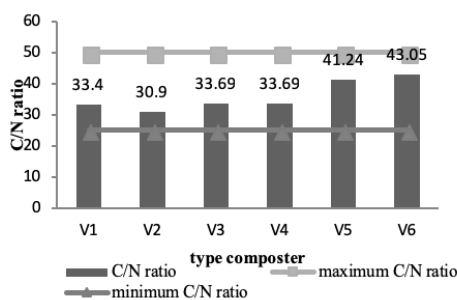


Figure 2. Initial C/N ratio

3.1.2 Moisture Content analysis

Moisture content is important in the composting process because moisture or moisture content affects the activity of microorganisms in the compost. The initial moisture content of composting must be in the range of 40-60%. The initial moisture content of compost material can be seen in Figure 3.

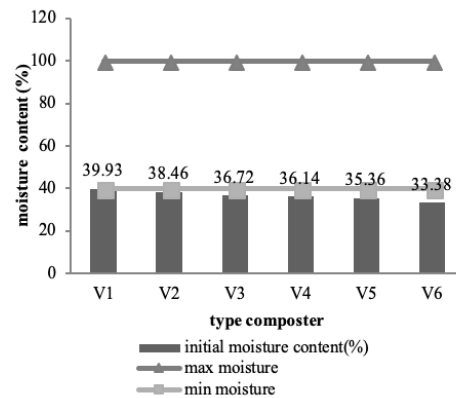


Figure 3. Moisture content value of composting

The initial moisture content of the composting process was not within permissible moisture content standard. The low moisture content can be caused by the addition of dry leaves that have low moisture content into the composter. To overcome the low moisture content in the raw material, water was sprinkled to the composting material until the moisture content meets the permissible range.

3.2 Analysis of Cow Rumen Utilization

Analysis of the effect of the use of cow rumen waste used as raw material as well as bio-activator in composting organic waste can be seen from the composting time and percentage of organic waste reduction that occurs during the composting process. Composter that uses cow rumen (composter type V3) as its raw material has a faster composting time than composter without cow rumen. The composting time that occurs can be seen in Figure 4.

Temperature is one of the composting parameters to see the maturity of compost. The temperature was measured every day from the initial day of composting until the compost is matured. The final temperature of compost should not exceed 30°C. Increased microbial activity will produce energy in the form of heat so that the resulting temperature will also be higher. Composting temperature can be seen in Figure 4.

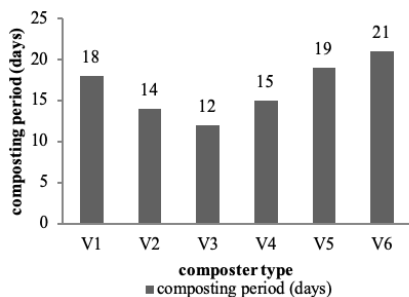


Figure 4. Composting period

The effectiveness of cow rumen waste utilization is seen from the level of reduction that occurs during the composting process of organic waste. The level of reduction is known to be in line with the time of compost maturity (Isroi, 2008). Compost is considered matured if the reduction rate has reached 20-40% or the volume has been reduced by one-third of the initial volume of compost (CPIS, 1992). Comparison of changes in the level of composting reduction can be seen in Figure 5.

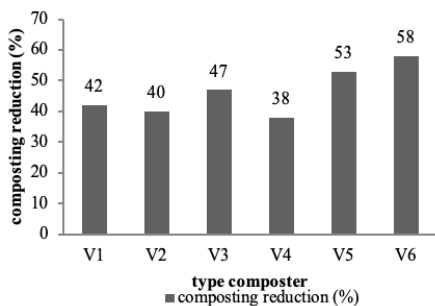


Figure 5. Composting reduction

The difference between the reduction value of pure waste compost and compost using cow rumen is not too significant. The value of material reduction is more influenced by the composition of the raw material used.

3.3 Compost Maturity Test

Compost maturity was involved by composting time. For this reason, it is necessary to analyze the parameters of temperature, pH, texture and color and odor. This test was carried out every day until the compost matured. Recapitulation compost maturity can be seen in Table 2.

Temperature is one indicator that indicates changes in the activity of microorganisms in decomposing organic matter. Compost is declared mature if the temperature reaches groundwater temperature of ≤ 30 °C. Temperature plays an important role in composting. Temperature is an indicator of the dynamics of microbiological activity in composting. Temperature is measured daily during composting. The level of maturity of compost and the characteristics of composting that is running can be known through temperature. The level of cold heat that occurs due to the activity of microorganisms on compost raw materials. Increased temperature is produced by the metabolism of microbes that produce energy in the form of heat (Sembiring, 2010). In this study, the increase in temperature seen from the presence of water vapor is closed by the composter. Water vapor is produced from heat in the composting process. In this study, the final compost temperature ranged from 26-27 °C. Based on SNI 19-7030-2004 regarding compost quality standards, the maximum temperature value is not more than 30°C. So in this study, the composting temperature has met the standard values that exist in each composter.

According to SNI 19-7030-2004, the final color of compost when ripe is black like soil. During the composting process, there will be a color change in the compost material. The beginning of the composting process is that the compost is brownish green and after reaching the final stage of maturity it will be blackish.

Composted organic waste has not changed in texture and color until the 3rd day. After the 3rd day, the market's waste texture has begun to disintegrate; it can be seen from the discoloration of the vegetable waste on the composter which begins to turn black. As for park waste, it began to disintegrate on the 7th to 12th days. Whereas in the composter with pure waste, color changes occur on the tenth day and the texture begins to disintegrate.

The composting process itself will cause changes to the organic material and the pH of the material itself. At the start of composting all variations of compost material are at a relatively acidic pH of 5-6. pH will increase with the decomposition process by organic compounds. The increase in pH can be caused by ammonia produced during composting (Sembiring, 2010). Ammonia increases pH because of its alkaline nature. In addition, according to Yuwono [9], the process of mineralization of base cations such as K^+ , Ca^{2+} , and Mg^{2+} also influence the increase in pH. The final pH of composting can be seen in Figure 6.

3.4 Compost Quality Test Analysis

All variations of compost meet the requirements of compost quality according to SNI 19-7030-2004, except the parameter of C/N ratio in variation 3 which exceeds the standard set. Recapitulation of compost quality test results can be seen in Table 3.

Analysis of the compost quantity includes the quantity of the volume of solid compost and liquid compost. Solid

Table 2. Recapitulation composting maturity

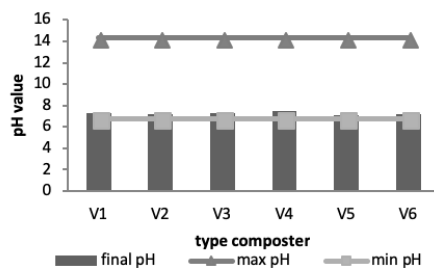
Variation	V1	V2	V3	V4	V5	V5
Composting time (days)	18	14	12	15	19	21
Compost reduction (%)	42	40	47	38	53	58
Temperature (°C)	26	26.5	26.5	26.5	27	27
pH	7.31	7.22	7.27	7.48	7.14	7.19
Texture and color	Soil	Soil	Soil	Soil	Soil	Soil
Odor	Soil odor	Soil odor	Soil odor	Soil odor	Soil odor	Soil odor

Note: V= variation

Table 3. Recapitulation of compost quality

Parameter	Standard	V1	V2	V3	V4	V5	V6
Moisture (%)	< 50	42.98	30.29	33.53	48.26	29.42	22.39
C-Organic (%)	9.8-32	22.31	16.66	16.63	23.51	16.45	11.38
Nitrogen (%)	> 0.4	1.14	1.02	1.15	1.24	0.97	0.76
C/N	20-Oct	19.86	16.34	14.42	19	17.01	20.57
Phosphor (%)	> 0.1	6.03	5.53	5.24	5.67	6.39	6.17
Potassium (%)	> 0.2	0.43	0.48	0.52	0.63	0.76	0.61

Note: V= variation

**Figure 6.** Final pH value

compost is a mature compost that has been sifted using a sieve with a size of 7.5 mm sieve. The liquid compost is the leachate produced by composting process, was collected and measured for its volume. The recapitulation of the quantity of compost can be seen in Table 4.

3.5 Determination of Optimum Raw Material Composition

Determination of the optimum raw material composition is done using a scoring system. The scoring system was done by comparing the results of research on each variation of compost with SNI 19-7030-2004. Recapitulation of scoring results for each compost variation can be seen in Table 5.

Based on the total score obtained, variation 2 has the highest score with a value of 42 so that the best variation was variation 2, it can be caused by raw materials in variation 2 has an optimum C/N ratio and moisture content which is good enough so that the microbes in the composter can work properly, and the composting process runs faster, which was

for 14 days. Compost results in variation 2 also meet SNI 19-7030-2004 standards regarding compost maturity and compost quality. The quantity of compost produced by variation 2 was also quite a lot, namely 1.2 liters of solid compost and 1.3 liters of liquid compost.

4. CONCLUSIONS

Based on the results of research it can be concluded that the combination of yard waste and market waste as raw material for composting affects the process of compost maturity, quality and quantity of compost. The less yard waste used, the better the compost resulted. Based on compost maturity test, all variations of raw material composition have met the existing standards, SNI 19-7030-2004, while for all compost quality tests not all variations meet the standards, namely the C/N ratio on variation 6 (20% market waste: 60% of yard waste: 20% of cow rumen) which exceeds the standard set.

The quantity of solid compost ranges from 0.5 to 1.25 liters, while liquid compost ranges from 0.05 to 1.5 liters with a material reduction rate between 38-58%. Based on scoring results regarding compost maturity, compost quality, and compost quantity, the composition in variation 2 (60% market waste: 20% yard waste: 20% cow rumen) is the best composition variation that can be used as composting raw material.

5. ACKNOWLEDGEMENT

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Table 4. Recapitulation of compost quantity

Quality standards	V1	V2	V3	V4	V5	V6
Raw material (L)	3	3	3	3	3	3
Product (L)	1.75	1.8	1.6	1.85	1.4	1.25
Solid compost (L)	1.25	1.2	0.95	1.25	0.6	0.5
Liquid compost (L)	1.5	1.3	0.86	0.55	0.2	0.05
Residue (L)	0.5	0.6	0.65	0.6	0.8	0.75

Note: V= variation

Table 5. Recapitulation of compost scoring

Scoring	V1	V2	V3	V4	V5	V6
Compost Maturity	16	18	17	16	14	14
Compost Quality	17	18	18	17	18	15
Compost Quantity	6	6	5	5	3	3
Total	39	42	40	38	35	32

Note: V= variation

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