International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 1 Jan-Feb 2021, pp: 373-379 www.ijaem.net ISSN: 2395-5252

The Effect of Energy from Aerobic Compost Making from Using Vinasse, Bulking Agent and Organic Waste

Dr. Ir. Hadi Saroso, MT, Dr.Luchis Rubianto
LRSC. MMT; Drs. Mufid, MT.

Submitted: 15-01-2021 Revised: 27-01-2021 Accepted: 30-01-2021

ABSTRACT: Waste generation in Malang City is 659.21 tons/day which the biggest waste generation is organic waste at 61.5%. Waste have a negative impact on human health. Bioethanol industry from molasse produces hazardous liquid waste that is vinasse. Vinasse is a liquid waste from the distillated bottom product in the process bioethanol. The addition of bulking agents is used to support the aeration during composting. The aim of this research was to determine the effect of ratio bulking agent and vinasse to the quality of compost with parameters C-Organic, N-Total, C/N rasio, moisture content, temperature, and pH as well as energy balance calculations. Composting is carried out aerobically for 6 weeks. The research variable is the addition of bulking agent by 20% and 30% of the weight of organic waste while the addition of vinasse by 0%, 10%, 15%, and 20% of the total weight. The peak temperature on all variables was obtained at 0% vinasse, which is 43^{o}C. pH during composting has increased to stable in the range 6-8. Moisture content on final composting has decreased and according to the criteria of SNI 19-7030-2004 which is below 50%. C-Organic and N-Total increased with the addition ratio of bulking agent and vinasse. C/N ratio of the 20% bulking agent doesn't according to the criteria of SNI 19-7030-2004, which is below 10. Energy balance calculation is used to determine the amount of energy that must be released in the composting process.

Keywords: Energy, Organic waste, vinasse, bulking agent, composting.

I. INTRODUCTION

According to the Ministry of Environment in a study by Sahwan, F. L., et al. (2011), waste is the residue of human daily activities, while household waste is garbage that comes from daily activities in the household. Malang City has an area of 110.06 km consisting of 5 sub-districts, 57 urban villages, with a permanent population of 867,832 people and a number of migrants around +300,000 people. As well as having a daily waste generation of 659.21 tons / day. The amount of waste transported to the TPS is +492.35 tonnes / day, when viewed from the type of wet / organic waste generated is 405.41 tonnes / day while dry / inorganic waste is 253.79 tonnes / day (DKP Kota Malang, 2013). From the data above, organic waste has the largest pile of inorganic waste, amounting to 61.5%: 38.5%.

Currently, the demand for ethanol in the world is increasing. Apart from functioning as an organic solvent, a raw material for the chemical industry, as well as a material for the cosmetic and pharmaceutical industries, nowadays ethanol is also used as a motor vehicle fuel to replace petroleum, which is known as bio-premium or bioethanol. On the other hand, the bioethanol industry from molasses produces hazardous liquid waste which is commonly called vinasse (Kusumaningtyas, R. D., et al. 2015).

Widiarti (2010) states that there are several bulking agents such as sawdust, dry leaves, straw and compost. The research material used includes organic waste, which is leftover rice and vegetables, while for the bulking agent, "Fine Compost" compost is used, produced by Lembah Hijau Multifarm, Solo. The variation of the weight of the bulking agent is 10%, 20% and 30% of the waste weight. The results obtained that the final C / N ratio of the product does not meet the SNI, which is smaller than 10.

Harjanti (2017) states that there is a possibility of producing organic fertilizers from blotong and vinasse. Meanwhile, to optimize the composting process in this study, microbial decomposers were added, namely EM-4 and X-compost. Blotong and vinase were mixed by adding the percentage of vinasse, namely 0%, 10%, 15%, 20% and 25% of the weight of the blotong.

This study uses organic waste as the main research material and vinasse as an additional material. The additional material, namely vinasse, is mixed with organic waste in the form of food waste, vegetable scraps and rice husks into a container with an aerobic process. This composting process is carried out for 6 weeks.

The purpose of this study was to determine the effect of the ratio of the amount of bulking agent

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 1 Jan-Feb 2021, pp: 373-379 www.ijaem.net ISSN: 2395-5252

and vinasse on compost quality with the parameters C-organic, N-Total, C / N ratio in the final composting result and moisture content, pH, temperature during the composting process and also to know the energy balance in the process. composting. This research is expected to be a solution to overcome vinasse and organic waste

According to the Big Indonesian Dictionary, waste is defined as goods or objects that are discarded because they are no longer used. Vinasse waste has a reddish brown color and a strong odor. The color and smell of vinasse waste also has a negative impact if disposed of directly into the environment. Vinasse contains macro and micro nutrients, including: N, P, K, Ca, Mg, Fe, Mn, Zn, Cu (Aziz, 2014) . Compost is the result of partial / incomplete decomposition of a mixture of organic materials that can be accelerated artificially by a population of various kinds of microorganisms in a warm, humid, and aerobic or anaerobic environment (Kusuma, M. A 2012).

Composting is a process of decomposition of organic matter by microorganisms in a controlled environment with the final results in the form of humus and compost. (Murbandono, 2006). The process of aerobic decomposition of organic matter can be presented with the following reaction. Aerobic microbial organic matter →CO2 + H2O + Humus + Energy + Nutrients

The results of the aerobic composting process are dry material and 30-40% humidity, dark brown color, and crumbs. Factors that influence the composting process are the C / N ratio, the size of the material, decomposing microorganisms, the degree of acidity, the reversal of the pile of materials, and the bulking agent. (Djuarnani, 2005).

Compost quality from compost must meet the quality of the compost. The quality standard used is the Indonesian National Standard (SNI) 2004 which contains compost specifications from domestic organic waste including:

The purpose of this study was to determine the effect of the ratio of the amount of bulking agent and vinasse on compost quality with the parameters C-organic, N-Total, C / N ratio in the final composting result and moisture content, pH, temperature during the composting process and also to know the energy balance in the process. composting. This research is expected to be a solution to overcome vinasse and organic waste.

Table 1. Indonesian National Standard for Compost

No	Parameter	unit	Minimum	Maksimum
1	Water content	%		50
2	Temperature			groundwater temperature
3	color			black
4	Aroma			Earthy scent
5	Nitrogen	%	0,4	
6	Carbon	%	9,8	32
7	C/N rasio		10	20

(Source: [BSN] National Standardization Body. 2004. SNI 19-7030-2004)

Neraca Energi :

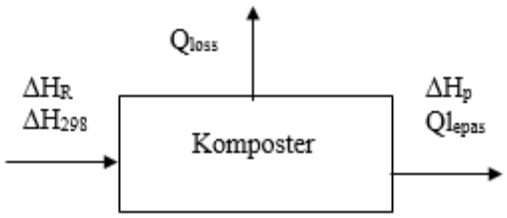

Figure 1. Batch Energy Balance System

Composting reactions in general (Gaur, 1980)

$C_6H_{12}O_{6\,(s)} + 6O_{2\,(g)} \rightarrow 6CO_{2\,(g)} + 6H_2O_{\,(l)}$

Energy balannce equation:

$Q = \Delta H_{298} + \Delta H_R + \Delta H_p + Q_{loss}$

Information:

Q released = Heat released

ΔH_R = Change in enthalpy in reactants

ΔHp = Change in enthalpy in the product

ΔH_{298} = Heat of standard reaction

Q_{loss} = Heat loss

II. RESEARCH METHODOLOGY

This scientific work is experimental and a literature study, where researchers will conduct laboratory-scale experiments using organic waste as the main research material and vinasse as an additional material. The additional material, namely vinasse, is mixed with organic waste in the form of food waste, vegetable scraps and bulking agent into the composter with an aerobic process. This research was conducted in AQ Building, 1st floor of the Department of Chemical Engineering. Parameters to be observed in the form of pH, temperature and water content were carried out at

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 1 Jan-Feb 2021, pp: 373-379 www.ijaem.net ISSN: 2395-5252

the State Polytechnic of Malang. This composting process is carried out for 6 weeks. Meanwhile, the parameters of C-Organic, N-Total, C / N ratio, and water content that had not been tested were carried out based on literature studies.
The variables used in this study are as follows:

Table 2. Research variables

Sampah Organik (kg)	Bulking Agent (%)	Vinasse (%)
2,5	20	0
		10
		15
		20
	30	0
		10
		15
		20

Data collection in the form of temperature and pH parameters was carried out every 3 days, while for data collection in the form of water content it was carried out every 7 days.

III. RESULTS AND DISCUSSION

3.1. pH

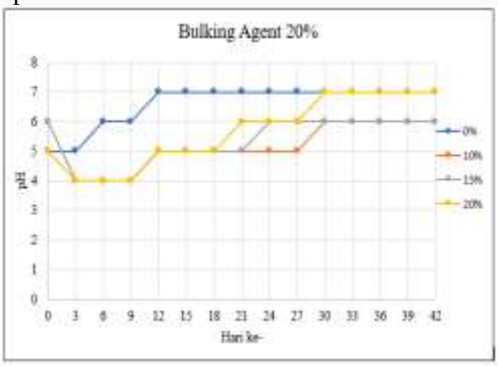

Figure.2. Graph of 20% Bulking Agent pH Measurement Results

Figure 3. Graph of the Results of pH Measurement of Bulking Agent 30%

For bulking agents 20% and 30%, the pH tends to rise closer to neutral. The pH value during composting greatly affects the growth of degrading microorganisms. The process that occurs at the beginning of composting is the decomposition of complex and reactive organic materials such as sugar, flour, carbohydrates, fats into simple organic acids. After that there will be an increase in pH so that the situation changes to alkaline. This is because the simple organic acids formed in the initial decomposition are converted to ammonia and CO2 (Zaman, B., and E. Sutrisno, 2007). It can be concluded that all samples on the bulking agent 20% and 30% tend to increase and produce a neutral pH according to SNI 2004 standards. Bulking agent variations and the addition of vinasse do not have a significant effect on pH changes. This is because the pH of the material has a neutral pH.

3.1. Temperature

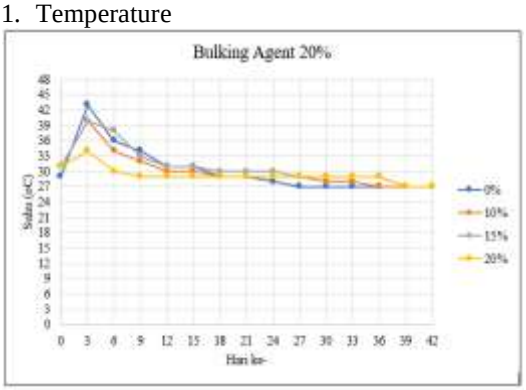

Figure 4.Graph of 20% Bulking Agent Temperature Measurement Results

Figure 5. Graph of 30% Bulking Agent Temperature Measurement Results

At the beginning of decomposition, the microorganisms involved in the composting process are mesophilic types (composting temperature is still below 40oC). Mesophilic microorganisms work at a temperature of 10-40oC. Vinasse 0% in the bulking agent 20% and 30% compost initial temperature was 29˚C then increased until the 3rd

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 1 Jan-Feb 2021, pp: 373-379 www.ijaem.net ISSN: 2395-5252

day of composting to 43˚C. At a temperature of 43˚C, compost has entered the thermophilic type microorganisms. In the bulking agent 20% and 30% vinasse 10%, 15% and 20% only experienced a mesophilic phase on the 3rd day and at the same time was the peak temperature.

The addition of variations of the bulking agent in this study did not have a significant effect on temperature changes. The variation of adding vinasse cannot undergo a thermophilic phase because the pile of material is too wet due to the addition of vinasse. The optimal water content in the composting process is 45% -55% (Hoitink and Harry A.J, 2008). When the moisture content exceeds 60% the air volume is reduced, odors will be generated due to anaerobic conditions, and decomposition slows down.

3.2. Water content

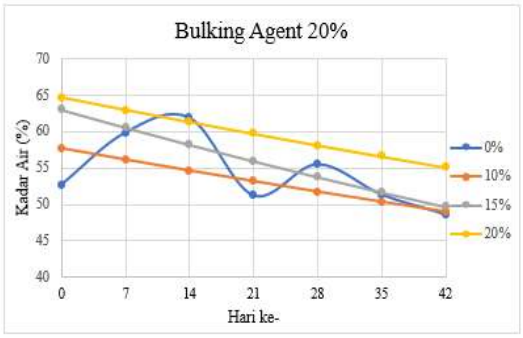

Figure 6. Graph of Moisture Content of a 20% Bulking Agent

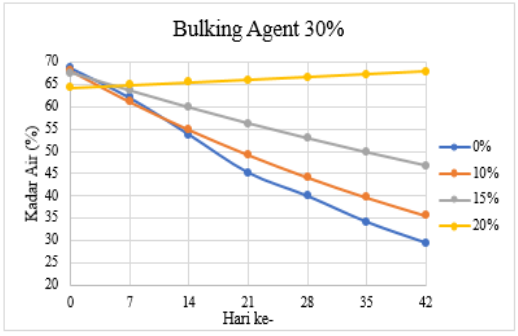

Figure 7. Graph of Moisture Content of a Bulking Agent 30%

The increase in water content in the composting process is caused by the formation of leachate. According to Ayuningtyas and Nurhati, D (2009), the decrease in water content in aerobic composting occurs because the water content in the compost material evaporates due to heat and stirring.

The addition of a bulking agent at the beginning of composting has an effect on differences in water content, this is because the bulking agent has a moisture content of around 10%, so that when the initial composting the water content of the bulking agent variation is 30% higher than 20%. Meanwhile, at the end of composting, the water content of the bulking agent is 30% lower. The addition of a bulking agent causes the cavity between materials to be enlarged and aeration can run well (Dewi et al, 2007). At the end of the composting process, it shows that the aeration system is able to reduce the moisture content of the material during the composting process. (Cahyani and Pramudya, 2013) The addition of vinasse has an effect on water content, namely the higher the addition of vinasse, the higher the water content in the compost, because the moisture content of vinasse is very high, namely 89.543%.

3.3. C-Organik

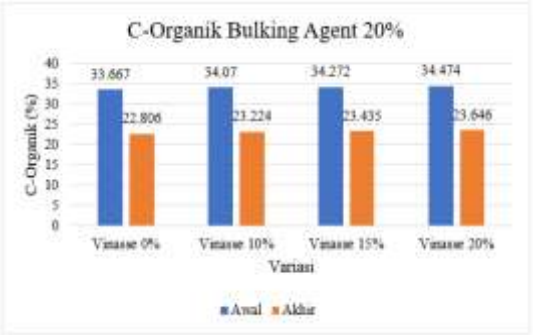

Figure 8.Graphic C-Organic on Bulking Agent 20%

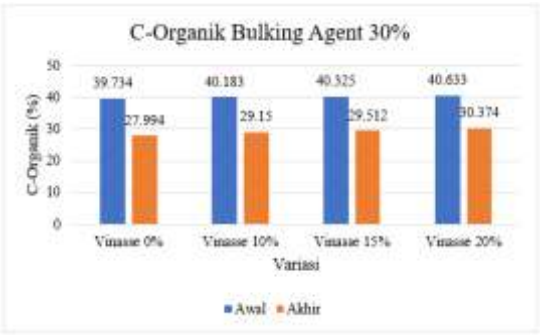

Figure 9.Graphic C-Organic on Bulking Agent 30%

The C-Organic calculation uses a calculation approach that refers to Tom Richard and Nancy Trautmann in cornell composting. The addition of the bulking agent in this study can increase the C-Organic content produced at the end of composting, it can be seen that the 30% variation of the bulking agent produces higher C-Organic levels than the 20% variation. This is in accordance with the research of Widiarti, I. W., that the 30%

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 1 Jan-Feb 2021, pp: 373-379 www.ijaem.net ISSN: 2395-5252

variation of bulking agent gives C-Organic levels higher than 20%. The increase in C levels occurs due to the addition of the volume of the bulking agent (Graha et al, 2015). The level of C-Organic bulking agent was 30% higher, this was due to the content of rice husks and bran as a provider of C elements. The addition of vinasse variations had an effect on increasing levels of C-Organic. This can be seen in the two variations of the bulking agent, that the more vinasse is added, the C-Organic content increases.

3.4. N-Total

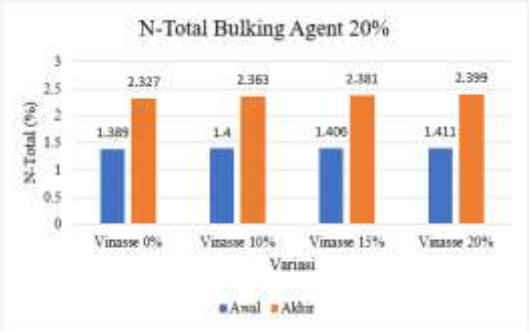

Figure 10.Graph of N-Total for Bulking Agent 20%

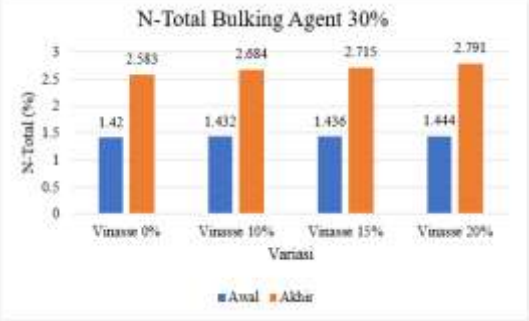

Figure 11. Graph of N-Total for Bulking Agent 30%

The calculation of N-Total uses an approach that refers to the research of Harjanti, R. S (2017). The addition of the bulking agent in this study can increase the levels of N-Total produced at the end of composting, the 30% variation of the bulking agent results in higher N-Total levels than the 20% variation. N levels (%) have increased due to the addition of a bulking agent (Graha ddk, 2015). This is because bran contains protein, namely 13.11-17.19% (Wulandari and Handarsari, 2010). Vinasse variation affected the increase in N-Total levels. This is because vinasse is a provider of N elements. The higher the N content of the basic material, the easier it is to experience the level of decomposition, and the higher the compost N-Total content (Supadma and Arthagama, 2008).

3.5. Ratio C/N

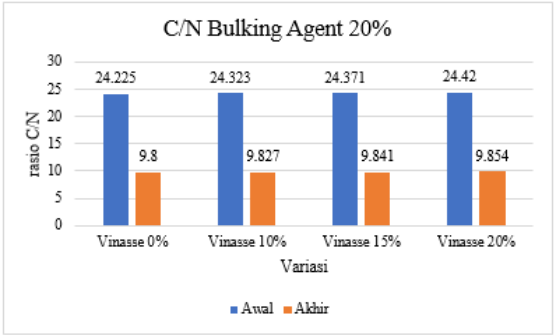

Figure 12. Graphic C / N Ratio for Bulking Agent 20%

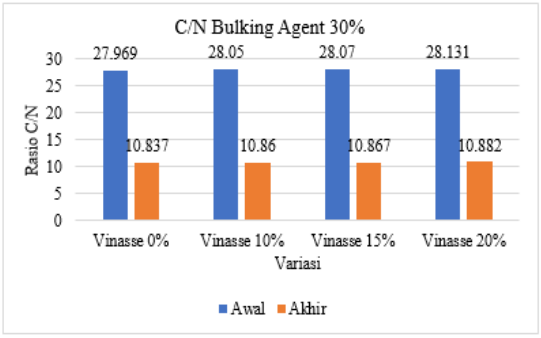

Figure 13. Graph of C / N Ratio in Bulking Agent 30%

The C-Organic calculation uses a calculation approach that refers to Tom Richard and Nancy Trautmann in cornell composting. The results of composting in the 20% bulking agent study had a lower C / N ratio than the 30% bulking agent, this was due to the composition of the bran and rice husks used more. The addition of rice bran and husk causes an increase in the C / N ratio (Rezagama and Samudro, 2015). Meanwhile, the higher the addition of vinasse, the resulting higher C / N ratio. This is because based on the research of Kusumaningtyas, R. D., et al. Vinasse has high C / N.

3.6. Energy Balance

The energy balance calculation begins with finding the heat capacity per component. The heat balance calculation is continued by calculating the heat entering and leaving the system. The heat entering the system consists of ΔH298 and ΔHR. Meanwhile, the heat that comes out of the system consists of ΔHP, QLoss, and QLepas. The heat entering the system is the total calorific value of each component or raw material that enters the reactor, namely C6H12O6 and O2. The heat that leaves the system is the total heating value of each component that leaves the system, namely H2O and CO2. QLoss is heat lost because the operating temperature is higher than the ambient temperature. Based on the overall energy balance calculation on

the bulking agent 20%, including 20% blank 9388.167 kJ; vinasse 10% 4490,492 kJ; vinasse 15% 2965,208 kJ; and vinasse 20% 1117,676 kJ. Meanwhile, the bulking agent 30% of them are in the blank 30% 8233.109 kJ; vinasse 10% 5612,253 kJ; vinasse 15% 5750,127 kJ; and 20% vinasse 1842,172 kJ.

IV. CONCLUSION

- A bulking agent ratio of 30% can increase levels of C-Organic, N-Total, C / N ratio at the end of composting compared to a bulking agent ratio of 20%
- The ratio of bulking agent, either 20% or 30%, does not have a significant effect on temperature and pH changes
- Bulking agent ratio at the beginning of composting has an effect on differences in moisture content. The initial moisture content of the composting variation of the bulking agent was 30% higher than 20%. Meanwhile, at the end of composting, the water content of the bulking agent is 30% lower.
- The levels of C-Organic, N-Total, C / N ratio at the end of composting have increased directly proportional to the addition of vinasse variations.
- The addition of a higher variation of vinasse makes the composting peak temperature lower.
- The addition of vinasse variations at the end of composting is directly proportional to the high moisture content
- The addition of vinasse variations did not have a significant effect on changes in pH
- Based on the overall energy balance calculation on the bulking agent 20%, including 20% blank 9388.167 kJ; vinasse 10% 4490,492 kJ; vinasse 15% 2965,208 kJ; and vinasse 20% 1117,676 kJ. Meanwhile, the bulking agent 30% of them are in the blank 30% 8233.109 kJ; vinasse 10% 5612,253 kJ; vinasse 15% 5750,127 kJ; and 20% vinasse 1842,172 kJ.

Suggestions

- For further research, in order to obtain more valid results, it is necessary to test C-Organic, N-Total, C / N Ratio, and moisture content.
- It is necessary to add samples without a bulking agent in order to know the effect of adding a bulking agent accurately.

REFERENCES

[1]. Ayuningtias and Nurhati, D. 2009. Effect of Oxygen Availability and Aeration System on Composting Process Rate and Quality of Compost Made from Washing Fermented Cocoa Beans, Leaf Litter, and Cow Manure. Bogor: Bogor Agricultural University. A

[2]. Aziz, M. N. 2014. Treatment of Vinasse Waste, Filter cake, and Boiler Ash into Organo-Mineral Fertilizer (OMF) for Tomato Plants (Solanum lycopersicum). Semarang State University.

[3]. National Standardization Agency. 2004. SNI 19-7030-2004. Compost Specifications from Domestic Organic Waste.

[4]. Cahyani, D. A and Pramudya, M. A. 2013. Aeration Rate in Composting Vegetable Waste Using Composter with Rotary Stirrer. Journal of Science and Technology. Vol. 10. No.2.

[5]. Dewi et al. 2007. Aerobic Compost Making with Rice Husk Bulking Agent. Widya Teknik Journal. Vol. 6. No. 1: 21-31.

[6]. Department of Sanitation and Gardening Malang City 2013

[7]. Djuarnani, et al. 2005. How to Quickly Make Compost. Jakarta: AgroMedia Pustaka.

[8]. Gaur, A. L. 1980. A manual of Rural Composting Improving Soil Fertility through Organic Recycling. Project Field Document No. 15. FAB / UNDP.

[9]. Graha, et al. 2015. Utilization of Jackfruit Waste (Artocarpus Heterophyllus) in Anaerobic Composting Process by Adding EM4 Concentration Variations and Bulking Agent Weight Variations. Journal of Tropical and Biosystem Engineering. Vol. 3. No.2: 141-147.

[10]. Harjanti, R. S. 2017. Organic Fertilizer from Waste of Madukismo Sugar Factory with Decomposing Microbial Starter to Increase the Content of N, P, K. Journal of Chemica Vol. 4, No. 1: 1-7, ISSN: 2355-8776.

[11]. Harjanti, R. S. 2017. Organic Fertilizer from Waste of Madukismo Sugar Factory with Decomposing Microbial Starter to Increase the Content of N, P, K. Journal of Chemica Vol. 4, No. 1: 1-7, ISSN: 2355-8776.

[12]. Hoitink, and Harry A.J. 2008. Control of the Composting Process: Product Quality. The Ohio State University

[13]. Kusuma, M. A. 2012. Effect of Water Content Variation on Decomposition Rate of Organic Waste Compost in Depok City. Thesis. Environmental Engineering Study Program. University of Indonesia.

[14]. Kusumaningtyas, R. D., et al. 2015. Preparation of Solid Organo-Mineral Fertilizer (OMF) Fertilizer from Bioethanol Industrial Waste (Vinasse). Journal of Renewable Natural Materials Vol. 4, No.2: 46-54, ISSN: 2303-0623.

[15]. Kusumaningtyas, R. D., et al. 2015. Preparation of Solid Organo-Mineral Fertilizer (OMF) Fertilizer from Bioethanol Industrial Waste (Vinasse). Journal of Renewable Natural Materials Vol. 4, No.2: 46-54, ISSN: 2303-0623.
[16]. Murbandono, L. 2006. Making Compost. Jakarta: Independent Trading Spreader.
[17]. Rezagama, A., and Samudro, G. 2015. Takakura Optimization Study with Addition of Husk and Bran. Journal of Precipitation Vol. 12, No. 2, ISSN: 1907-187X.
[18]. Sahwan, F. L, et al. 2011. Quality of Household Waste Compost Made Using Aerobic "Composter". Journal of Environmental Engineering. Vol. 12. Number 3: 233-240. Jakarta.
[19]. Supadma, N and Arthagama D, M. 2008. Test of the Quality Formulation of Compost Fertilizer from Organic Waste with the Addition of Poultry, Cattle, Pig, and Pahitan Plant Waste. Bumi Lestari Journal. No.8: 113-121.
[20]. Widiarti, I. W. 2010. The Effect of Bulking Agent Weight Variation on Time of Composting Organic Waste at Restaurants. Journal of Environmental Science and Technology Vol. 2, No. 1: 43-54, ISSN: 2085-1227.
[21]. Wulandari, M and Handarsari E. 2010. Effect of Addition of Bran on Protein Content and Organoleptic Properties of Biscuits. Journal of Food and Nutrition. Vol. 1. No. 2. Muhammadiyah University Semarang.
[22]. Zaman, B., and E. Sutrisno. 2007. Study of the Effect of Mixing Domestic Waste, Rice Husk, and Sugarcane Dregs with the Mac Donald
[23]. Method on Compost Maturity. Precipitation Journal. Vol. 2. No. 1.

International Journal of Advances in Engineering and Management
ISSN: 2395-5252

IJAEM

Volume: 03 Issue: 01 DOI: 10.35629/5252

www.ijaem.net
Email id: ijaem.paper@gmail.com