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The Effect of Bioactivator Variation and Doses of Cow Dung on Quality of Coffee Exocarp Waste

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Abstract

Coffee exocarp waste produced from the harvest can be used as raw material for compost. The composting can be added with other ingredients to add organic material. Cow manure is the one ingredient that can be added to enrich organic materials. In the composting process, the time required will be longer, but the time can be accelerated by adding a bio activator. The finished compost can be applied at the plant to meet crop nutrient elements. The purpose of this research was to determine the effect of bio activator variation and doses of cow manure on the quality of compost from coffee exocarp waste. This research was conducted at compost house of Assessment Institute for Agricultural Technology (AIAT) and was held on February - April 2017. This research used factorial Randomized Block Design (RBD) with two factors; there is a variation of bio activator and doses of cow manure with three replication. Total number of treatment this research were 12 treatment, there are D1S1 = EM4 + 2 kg cow manure ; D2S1 = Moebillin + 2 kg cow manure; Petrofast + 2 kg cow manure; Decoprima + 2 kg cow manure; D1S2 = EM4 + 4 kg cow manure; D2S2 = Moebillin + 4 kg cow manure; D3S2 = Petrofast + 4 kg cow manure; D4S2 = Decoprima + 4 kg cow manure; D1S3: EM4 + 6 kg cow manure; D2S3 = Moebillin + 6 kg cow manure; D3S3 = Petrofast + 6 kg cow manure; D4S3 = Decoprima + 6 kg cow manure. The data obtained will be processed using Analysis of Variance (ANOVA). If there is a real effect, it will be continued using the BNT test (Least Significant Differences/LSD) with a 5% level. The Results showed the application of bio activator Decoprima (D4) and a dose *of 6 kg cow manure (S3) could increase and shows the highest value of pH compost 6,01 (D4) and 6,06 (S3). The dose of 2 kg cow manure (S1) showed the highest compost shrinkage value (34.64%) compared to the 4 kg dose cow manure (S2) (32,22%) and 6 kg (S3) (25,68%). On the other hand, the application of bio activator variation and doses of cow manure did not significantly affect the quality of compost, including N-total (2,15% -2,60%), C-organic (21,40% -24,91%) and C/N ratio (8,81-11,15). The physical properties of the aroma compost show the smell of soil, and the color of the compost is dark brown*

1. INTRODUCTION

The coffee yield processing has resulted by-product, coffee exocarp wastes. Wastes resulted from such processing are solid wastes from sorting the exocarp and the seeds, as well as the endocarp wastes during the sterilization process (Pujiyanto, 2007). Wastes from the coffee exocarp range 50-60%. Fresh coffee seeds have some components, such as exocarp, mesocarp, mucous membrane, endocarp, and silver skin (epidermis). In each 100 kg of coffee fruits, we may get 29 kg dried coffee logs, which comprise of 15.95 coffee seeds and 13.05 dried exocarp logs. Dried exocarp logs as a result of coffee fruit processing will produce shells, mucous, and exocarp, as long as their dry weight for about 11.9; 4.9; 28.7 kg, respectively (Widyotomo, 2013). Coffee exocarps contain essential mineral elements, such as N, P, K, Ca, Mg, pH and C-organic, therefore compost made of coffee exocarp wastes could improve physical, chemical, and biological properties of the soil (Nduka et al., 2015). According to Puslitkoka (2004) in Sunjoto et al. (2014), C-organic level in coffe exocarp wastes is 45.3%, N is 2.98%, P is 0.18%, and K is 2.26%. Results of analysis from Puslitkoka offer some opportunities against coffee exocarp wastes to be utilized as basic materials of compost. Well processed compost will show some changes in odor, color, and volume of the resulted composting. Results of the research by Sunjoto et al. (2014) suggested that significant effect was found on water content in each treatment, following the application of Trichoderma spp. and Pseudomonas sp., both solely and in combinations. During the decomposition process of coffee exocarp wastes, C-organic may decline 24-30% at 4 WAI (week after incubation). Other research showed that the highest C/N ratio was shown by the treatment 80% coffee wastes + 20% manure by value 15.99 at 4 WAI (Afrizon, 2015). According to Kassa et al. (2011), result of mixture 60% coffee grounds, 30% coffee exocarp, 20% cow dung, and 20% Millettia ferruginea showed the best quality in comparison with other treatments in composting process of the coffee wastes. Coffee exocarp wastes are not only used as material in producing organic fertilizer, but also used as material to improve soil (ameliorant) naturally. According to Pujiyanto (2007), composition of ameliorant 90% coffee exocarp along with 10% mineral (Zeolit: Natural Phosphate) have excellent physical and chemical characters in improving soil.

Coffee exocarp waste can be reused as basic material because it contains 45.3% C-organic and N-total 2.98% (Puslitkoka, 2004 in Sunjoto, Setiawati and Winarso, 2014). Superiority of such compost is due to it contains complete nutrients, both macro-and-micronutrients. Compost application will support the plant growth because it can provide essential nutrients, which are needed by the plant, so that it will increase growth and production of the plant. Well processed compost has C/N ratio 15-25. C/N ratio of the compost, which conforms to C/N ratio of the soil will facilitate in providing nutrients for plants. Declining C/N ratio in coffee exocarp wastes on composting can be done by adding mixture material, such as cow dung.

Complete nutrients contain in cow dung will be very helpful in providing nutrients in the soil. Besides that, cow dung will be useful in improving physical, chemical, and biological properties of the soil. Moreover, cow dung contains high fibrous cellulose and C-organic (Hartatik and Widowati, 2006). It is potential to use cow dung as source of organic fertilizer, however, its processing still require decomposing microorganism to accelerate the composting process. Today, many bioactivators used as decomposer and contain specific microorganism, such as Trichoderma pseudokoningi, Cytopaga sp., Trichoderma harzianum, Pholyota sp., and Agraily sp. (Krismawati and Hardini, 2014).

The composting process may occur naturally, but it takes much time. Adding bioactivator in composting process will increase the decomposing of compost materials, so that it takes short time. According to Sukanto (2013), bioactivator is an activating agent, living things, which play their roles in initiating the reorganizing process of organic materials, both physically and chemically, so that they have different properties. According to Saraswati, Santosa, and Yuniarti (2006) activities of the decomposing microorganism will accelerate the composting process and improve quality of the resulted compost. Microorganism activities will be affected by temperature and humidity during the composting process. According to Sentana (2010), microorganism will work optimally if the compost has humidity < 60% and temperature 30-50°C. Research by Sunjoto *et al.* (2014), yield of C/N ratio following 4 WAI showed the lowest C/N ratio on the treatment of coffee exocarp mixed with bacteria of *Trichoderma* spp and *Pseudomonas* sp for about 14.79 and the highest C/N ratio was shown by the treatment of coffee exocarp mixed with phosphate for about 17.27. Utomo (2010) stated that adding 100 g *Aspergillus* sp will increase plant height, diameter of stem, leaf area of the breadfruit in comparison with the application of bioactivator 10 mL L^{-1} EM4, 100 mL L^{-1} MOD-71 + 1 g L^{-1} sugar, 2 g L^{-1} Supernasa, and 10 mL L^{-1} Puja-168. Objective of the study was to find out the effect of bioactivator variation and dose of cow dung on quality of compost made of coffee exocarp wastes.

2. MATERIALS AND METHODS

a) Time and Location

The research was conducted at the compost house and Agronomic Laboratory of East Java Assessment Institute for Agricultural Technology (AIAT), Karangploso, Malang, East Java. Parameter analysis of the research was conducted at Chemical Laboratory of Brawijaya University. This research was performed from February to July 2017.

b) Design of the Research

The research was conducted using Randomized Block Design (RBD) method by 2 factors, the first factor is bioactivator, and the second one is dose of cow dung, however, the research was performed by 3 replications and generated 36 combinations of treatment.

Factor 1 includes 4 kinds of bioactivator, which comprises of:

a. EM_4 (D_1) : 40 ml/500ml air
b. Moebillin (D_2) : 40 ml/500ml air
c. Petrofast (D_3) : 40 ml/500ml air
d. Decoprima (D_4) : 30 gram/500ml air

Factor 2 dose application of cow dung, such as:

a. Dose of Cow Dung (S_1) : 2 kg/5 kg coffee exocarp
b. Dose of Cow Dung (S_2) : 4 kg/5 kg coffee exocarp
c. Dose of Cow dung (S_3) : 6 kg/5 kg coffee exocarp

c) Implementation of the Research

1. Making Compost

The compost was processed by chopping the coffee exocarp wastes, making the compost from coffee exocarp wastes, stirring, and analyzing the resulted compost.

2. Chopping the Coffee Exocarp Wastes

Dried coffee exocarp wastes were chopped using Disc Mil. It was intended to accelerate the decomposition process. 2 mm sieve was used to strain the chopped wastes.

3. Making Compost from Coffee Exocarp

Fine coffee exocarp wastes were mixed with the cow dung in a given dose. Composting has been accelerated by adding diverse bioactivators in accordance with the given treatment. Coffee exocarp wastes required for the research were 5 kilogram x 36 treatments = 180 kilogram. 5 kg coffee exocarp wastes were mixed with different doses of cow dung, for instance, 2 kg, 4 kg, dan 6 kg, so that total amount of the cow dung was 144 kilogram. The application of bioactivator EM4, Petrofast and Moebillin were 40 ml and mixed with 500 ml water. Bioaktivator Decoprima is in a powder form, so that it was applied for about 30 g and diluted with 500 ml water. When the materials were mixed, 40 ml molase was added and diluted with 500 ml water.

Stirring process of the compost was performed to regulate temperature of the compost and to assist the ripening process of the compost. Also, it was intended to provide space for the compost pile, so that the decomposing process of the organic matters will be well-done evenly. It was conducted by turning over the compost pile, three times a day.

d) Analysis of the Compost

Result analysis of the compost includes measuring the temperature, pH, C-organic, N-total, C/N ratio, color, and depreciation. Temperature of the compost is measured everday, while pH, C-organic, N-total and C/N ratio were analyzed at 7, 14, 21, and 35 Days After Incubation (DAI), but parameter of color was tested using organoleptic at 10, 20, and 30 DAI. Organoleptic test was conducted by 25 individuals by age range 17-60 years old. Weighing weight depreciation of the compost was done at 25 DAI.

Observation of the research was conducted on two samples, compost and plant. On compost sample, preliminary and final analysis will be done, as well observation on color and aroma of the compost. Parameters of observation, which will be analyzed, are as follow:

Table 1. Parameter of Observation in the Research

Sample	Type of Analysis	Time Observation
Compost	Temperature	One Day
	pH	7, 14, 21, 28, dan 3 DAI
	C-Organik	7, 14, 21, 28, dan 3 DAI
	N-Total	7, 14, 21, 28, dan 3 DAI
	C/N ratio	7, 14, 21, 28, dan 3 DAI
	Color	10, 20, dan 30 DAI
	Reduction	35 DAI (7 WAI)

Parameters, which will be observed in making the organic fertilizer from coffee exocarp wastes, include temperature, Acidity Level (pH), organic Carbon (C-organic), total Nitrogen (N-total), ratio C/N, color, initial and final weights of the compost must be taken into account to find out depreciation/reduction of the fertilizer, color, and aroma.

1. Temperature of the Composting

Temperature during the composting process will effect on microorganism activities in decomposing the composting materials. Higher temperature will exterminate the microorganism. Temperature of the composting is observed every day during the composting process.

2. Acidity Level (pH)

Acidity level (pH) is concentration of ion H^+ in a solution, which is stated in –log [H^+]. The increase concentration of H^+ will increase potential solution, which is measured by specific tool and it will be conversed in pH scale. The specific tool used to measure pH of the compost is pH meter. pH is measured using glass electrode, a specific electrode H^+, to measure potential H^+ as a result of the increase concentration of H^+. The applied pH meter must be calibrated first using buffer solution by pH 7.0 and pH 4.0. Furthermore, 5 gram samples, which are going to be analyzed, are put into vial bottle and added with 12.5 ml aquades. After mixing the samples and aquades, the vial bottle was tightly closed and shaken for 30 minutes and allowed to stand for 24 hours and measured using pH meter.

3. C-organik level

C-organik contained in compost was tested using Walkley's and Black's ways. The available Carbon in the sample will be oxidized by chromate in acidic atmosphere. The sample was put into Erlenmeyer flask for about 0.01 gram. And then it was added by 10 ml $K_2Cr_2O_7$ and shook first. After that, added 20 ml H_2SO_4 and shook again. Such shaking was intended to create homogenous atmosphere inside the Erlenmeyer flask. After the sample was well-mixed with $K_2Cr_2O_7$ and H_2SO_4, the solution was allowed to stand for 30 minutes. Furthermore, the solution was mixed with aquades to stop the reaction of H_2SO_4 and added with H_3PO_4 solution to eliminate the effect of Fe^{3+}. After that, 30 drops of diphenylamine were applied and then titrated using $FeSO_4$. Such titration was conducted to find out ml of the sample.

4. Nitrogen level (N-total)

Organic nitrogen compounds will be oxidized in concentrated sulphuric acid and catalyst mixed with Selene and form $(NH_4)_2SO_4$. Ammonium level in extract can be determined through distillation or spectrophotometri on distillation. The extract was alkalized by adding NaOH. And then, the released NH_3 will be bond by boric acid and titrated by standard solution of H_2SO_4 using *Conway* indicator. The spectrophotometri used the indophenol method.

5. C/N ratio

C/N ratio is one of maturity factors of composting. C contains in compost will be used by microorganism as energy to support the growth (Djaja, 2008). The principle in composting is reducing C/N ratio in order to be parallel with C/N ratio of the soil. Higher C/N ratio of the compost means that the composting process will last longer.

6. Color

Color of the ripe compost is blackish brown. If the color is similar to its raw material, it means that the compost has not well-processed or immature. Color test of the compost is conducted by panelist.

7. Reduction

Reduction/depreciation of compost material is calculated to find out the material reduction after the compost is ready to be used. Such calculation is conducted by measuring initial weight of the fertilizer and final weight of the ripe compost.

$$\text{Reduction} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100\%$$

8. Quality of Organic Fertilizer

Quality of organic fertilizer has been regulated by regulation from Minister of Agriculture Number 70/Permentan/SR. 140/10/2011. The regulation states that the appropriate value of C-organic is minimum 15% and C/N ratio is 15-25, pH ranges 4-9, and water content is 8-20%.

e) Data Analysis

Data obtained from the making process and application of the coffee exocarp compost was analyzed statistically to study the effect of treatment on parameters that being observed by Analysis of Variance (ANOVA) at significant level 0.05 (5%). If significant effect was found, it will be followed by a test using The Least Significant Difference (LSD) test at level 5% (Gomez and Gomez, 1993; Sastrosupadi 2005).

3. RESULT

a) Temperature of Compost from Coffee Exocarp Wastes

Observation on compost temperature is one of indicators in determining ripeness/maturity of the compost. Ripeness/maturity of the compost is shown by decreasing compost temperature until it reaches stable temperature (Widawati, 2005). Based on result from analysis of variance at 1 Day After Incubation (DAI), an interaction was found between treatments of bioactivator variation and dose of cow dung against temperature of the compost from coffee exocarp wastes, however, no interaction was found at 15 and 30 DAI. The dose treatment of cow dung has significant effect on temperature of the compost at 1, 15, and 30 DAI, while the treatment of bioactivator variation has no effect on temperature of the compost at 1, 15, and 30 DAI. Effects of bioactivator variation and dose of cow dung on temperature of compost made of coffee exocarp wastes are presented in Table 2.

Based on Table 2, the highest temperature at 1 DAI is shown by the treatment of D_2S_3 at temperature 34.67°C, and the lowest is shown by the treatment of D_1S_1 at temperature 31.33°C. The highest temperatures at 1, 15, and 30 DAI are shown by treatment S_3 (6 kg dose of cow dung) and the values are 34.17; 29.29; and 27.60 °C, respectively, while the lowest temperatures are shown by treatment S_1 (2 kg dose of cow dung) and the values are 33.08; 28.86 and 27.13 °C. On the other side, at 7 DAI, any interaction is caused by the application of bioactivator, which has worked on the cow dung, so that temperature of the compost will increase.

Table 2. Effects of bioactivator variation and dose of cow dung on temperature compost made of coffee exocarp wastes

Time (DAII)	D	S			$\bar{x}$ Temperature (°C)
		S_1	S_2	S_3	
1	D_1	31,33 a	34,33 c	34,00 c	33,22 a
	D_2	32,67 b	34,33 c	34,67 c	33,89 a
	D_3	34,00 c	34,00 c	33,67 bc	33,89 a
	D_4	34,33 c	33,67 bc	34,33 c	34,11 a
$\bar{x}$Suhu (°C)		33,08 a	34,08 b	34,17 b	
15	D_1	29,03 a	29,10 a	29,40 a	29,18 a
	D_2	29,00 a	29,13 a	29,37 a	29,17 a
	D_3	28,73 a	28,73 a	29,37 a	28,94 a
	D_4	28,67 a	29,37 a	29,03 a	29,02 a
$\bar{x}$Suhu (°C)		28,86 a	29,08 ab	29,29 b	
30	D_1	27,17 a	27,23 a	27,73 a	27,38 a
	D_2	27,03 a	27,27 a	27,37 a	27,22 a
	D_3	27,03 a	27,00 a	27,97 a	27,33 a
	D_4	27,27 a	27,90 a	27,33 a	27,50 a
$\bar{x}$Suhu (°C)		27,13 a	27,35 ab	27,60 b	

Notes:
D: Bioaktivator, D_1: Bioaktivator EM_4, D_2: Bioaktivator Moebillin, D_3: Bioaktivator Petrofast, D_4:

BioaktivatorDecoprima, S: Kotoran Sapi, S_1: 2 kg Kotoran Sapi, S_2: 4 kg Kotoran Sapi, S_3: 6 kg Kotoran Sapi, $\overline{x}$: rata-rata.
The alphabet followed by the same letter in the same column are not significantly different from the DMRT at the 5%

b) Acidity Level (pH)

Acidity level (pH) is a factor, which determines ripeness of the compost, besides temperature. pH values change during the composting process. Based on the result over the analysis of variance at 7, 14, 21, 28, and 35 DAI, no interaction was found between bioactivator variation and cow dung against pH of the compost. Dose of cow dung shows significant effect on pH of compost made of coffee exocarp wastes at 14, 21, 28, and 35 DAI, while bioactivator shows significant effect on pH of the compost made of coffee exocarp wastes at 35 DAI. Effects of bioactivator variation and dose of cow dung on pH of compost made of coffee exocarp wastes are presented in Table 3.

Initially, the coffee exocarp wastes were in acidity condition by pH 5.8. pH of the coffee exocarp wastes were increased at 7 DAI, but it did not have significant effect. On the other side, dose of cow dung has significant effect on pH at 7, 14, 21, 28, and 35 DAI. It was shown by higher pH by increasing dose of cow dung. At 14, 21, 28, and 35 DAI, the highest pH was shown by treatment S3 along with each value for about 6.25; 6.15; 6.17; and 6.06, while the lowest pH was shown by treatment S1 along with each value for about 5.97; 5.94; 5.94; 5.73. These conform to the research by Putri et al. (2014), the application of cow dung 20% in leaf wastes showed higher pH than the control, so that it could increase pH of the compost. As described by Hanafiah (2013) and Widarti et al. (2015), the increase pH was caused by decomposition of protein into ammonia (NH_3), and then ammonia reacts to water (H_2O) will produce NH_4 and OH^- ¬, so that pH value will increase.

Table 3. Effects of bioactivator variation and dose of cow dung on pH of compost made of coffee exocarp wastes

Time (DAII)	D	S			$\overline{x}$ Temperature (°C)
		S_1	S_2	S_3	
1	D_1	31,33 a	34,33 c	34,00 c	33,22 a
	D_2	32,67 b	34,33 c	34,67 c	33,89 a
	D_3	34,00 c	34,00 c	33,67 bc	33,89 a
	D_4	34,33 c	33,67 bc	34,33 c	34,11 a
$\overline{x}$Suhu (°C)		33,08 a	34,08 b	34,17 b	
15	D_1	29,03 a	29,10 a	29,40 a	29,18 a
	D_2	29,00 a	29,13 a	29,37 a	29,17 a
	D_3	28,73 a	28,73 a	29,37 a	28,94 a
	D_4	28,67 a	29,37 a	29,03 a	29,02 a
$\overline{x}$Suhu (°C)		28,86 a	29,08 ab	29,29 b	
30	D_1	27,17 a	27,23 a	27,73 a	27,38 a
	D_2	27,03 a	27,27 a	27,37 a	27,22 a
	D_3	27,03 a	27,00 a	27,97 a	27,33 a
	D_4	27,27 a	27,90 a	27,33 a	27,50 a
$\overline{x}$Suhu (°C)		27,13 a	27,35 ab	27,60 b	

Notes:
D: Bioactivator, D_1: Bioactivator EM_4, D_2: Bioactivator Moebillin, D_3: Bioactivator Petrofast, D_4: Bioactivator Decoprima, S: Cow dung, S_1: 2 kg Cow dung, S_2: 4 kg Cow dung, S_3: 6 kg Cow dung, $\overline{x}$: average.
The alphabet followed by the same letter in the same column show no significant difference at LSD test 5% (p = 0.05)

c) N-Total

Nitrogen is highly required in composting process to increase growth of the microorganism. Based on result of the analysis of variance at 7, 14, 21, 28, and 35 DAI, no interaction occurred between bioactivator variation and dose of cow dung against N-total of the compost. The results conformed to the research by Sunjoto et al.(2014), which suggested that the results had no significant difference with the treatment of bacterial isolates and addition of phosphate rock to N-total of compost made of coffee exocarp wastes. At 3 DAI, however, significant effect was shown on each treatment, such as in bioactivator variation and dose of cow dung, while at 28 DAI, the significant effect was only shown by dose of cow dung. Effects of bioactivator variation and dose of cow dung on N-total of compost made of coffee exocarp wastes are presented in Table 4.

Based on Table 4, treatment of bioactivator showed significant effect on N-total of compost at 3 weeks after incubation (WAI). The application of bioactivator D4 (Decoprima) showed significant difference with treatment D3 (Petrofast), while treatment D1 (EM4) and D2 (Moebillin) did not show any significant difference with the treatments D3 and D4. The highest N-total at 3 WAI was shown by D3 for about 2.50% and the lowest N-total was shown by D4 for about 2.13%. Organism, for instance, Trichoderma spp. and Pseudomonas sp. decrease C/N ratio of coffee exocarp wastes on the decomposition of organic matter and increase N (Sunjoto et al., 2014).

Table 4. Effects of bioactivator variation and dose of cow dung on N-total of compost made of coffee exocarp wastes

Time (DAI)	D	S			$\bar{x}$ N-total (%)
		S1	S2	S3	
7	D1	2,16 a	2,28 a	2,29 a	2,24 a
	D2	2,41 a	2,29 a	2,34 a	2,35 a
	D3	2,24 a	2,41 a	2,80 a	2,48 a
	D4	2,12 a	2,03 a	2,16 a	2,10 a
$\bar{x}$N-total (%)		2,24 a	2,25 a	2,40 a	
14	D1	1,96 a	2,30 a	2,08 a	2,11 a
	D2	2,01 a	2,00 a	2,12 a	2,04 a
	D3	2,37 a	2,31 a	1,99 a	2,22 a
	D4	1,59 a	2,14 a	1,89 a	1,87 a
$\bar{x}$N-total (%)		1,98 a	2,19 a	2,02 a	
21	D1	2,45 a	2,36 a	2,14 a	2,32 ab
	D2	2,51 a	2,15 a	2,45 a	2,37 ab
	D3	2,82 a	2,64 a	2,04 a	2,50 b
	D4	2,31 a	2,15 a	1,94 a	2,13 a
$\bar{x}$N-total (%)		2,52 b	2,33 ab	2,14 a	
28	D1	2,35 a	2,58 a	2,13 a	2,35 a
	D2	2,58 a	2,53 a	2,18 a	2,43 a
	D3	2,68 a	2,31 a	2,00 a	2,33 a
	D4	2,55 a	2,56 a	2,20 a	2,43 a
$\bar{x}$N-total (%)		2,54 b	2,49 b	2,13 a	
35	D1	2,43 a	2,60 a	2,53 a	2,52 a
	D2	2,34 a	2,15 a	2,23 a	2,24 a
	D3	2,54 a	2,47 a	2,20 a	2,41 a
	D4	2,42 a	2,26 a	2,52 a	2,40 a
$\bar{x}$N-total (%)		2,43 a	2,37 a	2,37 a	

Notes:

D: Bioactivator, D_1: Bioactivator EM_4, D_2: Bioactivator Moebillin, D_3: Bioactivator Petrofast, D_4: Bioactivator Decoprima, S: Cow dung, S_1: 2 kg Cow dung, S_2: 4 kg Cow dung, S_3: 6 kg Cow dung, $\bar{x}$: average.

The alphabet followed by the same letter in the same column show no significant difference at LSD test 5% ($p = 0.05$).

d) C-Organic

C-organic is the essential element in composting process. Effects of bioactivator variation and dose of cow dung on C-organic of compost made of coffee exocarp wastes are presented in Table 5.

In accordance with result on analysis of variance at 7, 14, 21, 28, and 35 DAI, no interaction was found between treatments and no significant effect was found on each treatment against C-organic of the compost. C-organic in compost at 7, 14, 21, 28, and 35 DAI, range 14.66%-23.36%; 13.12%-20.07%; 25.20%-27.65%; 23.59%-25.06%, and 21.40%-24.91%, respectively. At 14 DAI, C-organic in compost decreases from C-organic at 7 DAI. C-organic was back to increase at 21 DAI. And then, C-organic decreased at 28 and 25 DAI, but the values were still higher than at 7 and 14 DAI.

Table 5. Effects of bioactivator variation and dose of cow dung on C-organic of compost made of coffee exocarp wastes

Time (DAI)	D	S			$\overline{x}$ C-organik (%)
		S_1	S_2	S_3	
14	D_1	20,98 a	19,86 a	22,66 a	21,17 a
	D_2	20,75 a	22,33 a	21,48 a	21,52 a
	D_3	18,28 a	23,36 a	18,07 a	19,90 a
	D_4	14,66 a	22,50 a	19,51 a	18,89 a
$\overline{x}$C-organik (%)		18,67 a	22,01 a	20,43 a	
14	D_1	17,11 a	15,08 a	15,09 a	15,76 a
	D_2	16,65 a	20,07 a	16,88 a	17,87 a
	D_3	17,52 a	17,15 a	17,08 a	17,25 a
	D_4	17,58 a	17,41 a	13,12 a	16,03 a
$\overline{x}$C-organik (%)		17,22 a	17,43 a	15,54 a	
21	D_1	26,86 a	25,44 a	25,42 a	25,91 a
	D_2	27,65 a	26,50 a	25,92 a	26,69 a
	D_3	25,20 a	25,49 a	26,86 a	25,85 a
	D_4	25,99 a	27,29 a	25,32 a	26,20 a
$\overline{x}$C-organik (%)		26,43 a	26,18 a	25,88 a	
28	D_1	24,59 a	24,18 a	24,21 a	24,33 a
	D_2	24,22 a	24,55 a	25,06 a	24,61 a
	D_3	25,00 a	24,09 a	24,25 a	24,45 a
	D_4	24,54 a	24,74 a	23,59 a	24,29 a
$\overline{x}$C-organik (%)		24,59 a	24,39 a	24,28 a	
35	D_1	24,72 a	22,58 a	21,40 a	22,90 a
	D_2	24,91 a	21,79 a	21,63 a	22,78 a
	D_3	22,81 a	23,71 a	24,41 a	23,65 a
	D_4	22,93 a	24,64 a	23,03 a	23,54 a
$\overline{x}$C-organik (%)		23,85 a	23,18 a	22,62 a	

Notes:
D: Bioactivator, D_1: Bioactivator EM_4, D_2: Bioactivator Moebillin, D_3: Bioactivator Petrofast, D_4: Bioactivator Decoprima, S: Cow dung, S_1: 2 kg Cow dung, S_2: 4 kg Cow dung, S_3: 6 kg Cow dung, $\overline{x}$: average.
The alphabet followed by the same letter in the same column show no significant difference at LSD test 5% (p = 0.05)

e) C/N Ratio

C/N ratio depends on result of C-organic and N-total in compost. C/N ratio becomes the important indicator in determining ripeness of the compost. Moreover, C/N ratio is the important requirement in decomposting process. Based on result against the analysis of variance, no interaction occurred between the application of bioactivator and dose of cow dung at 7, 14, 21, 28, and 35 DAI. Effects of bioactivator variation and dose of cow dung on C/N ratio of compost made of coffee exocarp wastes are presented in Table 6.

Based on Table 6, dose of cow dung showed significant effect on C/N ratio at 28 DAI, but the treatment of bioactivator had no significant effect at 7, 14, 21, 28, and 35 DAI. Treatment of S1 (2 kg) showed significant difference with treatment S3 (6 kg), but treatment S2 (4 kg) did not show significant difference with treatment S1 and S2. The highest C/N ratio was shown by treatment S3 for about 11.45 and the lowest C/N ratio was shown by S1 for about 9.78. C/N ratio is highly affected by C-organic and N-total in compost. Significant effect was shown at 4 DAI by dose of cow dung on C/N ratio of compost made of coffee exocarp wastes caused by significant effect of cow dung dose on N-total. According to Pandebesie and Rayuanti (2013), fluctuative C/N ratios were caused by fluctuative level of N-total during the composting process. Low C/N ratio in compost indicates high N level, while high C/N ratio indicates high C-organic in compost materials (Putri et al., 2014).

Table 6. Effects of bioactivator variation and dose of cow dung on C/N ratio of compost made of coffee exocarp wastes

Time (DAI)	D	S			$\bar{x}$C/N rasio
		S_1	S_2	S_3	
1	D_1	9,75 a	8,64 a	9,95 a	9,45 a
	D_2	9,03 a	9,82 a	9,17 a	9,34 a
	D_3	8,15 a	9,72 a	7,40 a	8,43 a
	D_4	7,02 a	11,11 a	9,04 a	9,06 a
$\bar{x}$C/N rasio		8,49 a	9,82 a	8,89 a	
2	D_1	8,11 a	6,26 a	7,03 a	7,13 a
	D_2	8,16 a	9,96 a	8,32 a	8,81 a
	D_3	7,73 a	8,35 a	8,47 a	7,96 a
	D_4	12,29 a	9,00 a	6,51 a	9,27 a
$\bar{x}$C/N rasio		9,07 a	8,39 a	7,58 a	
3	D_1	10,96 a	10,82 a	11,91 a	11,23 a
	D_2	11,07 a	12,35 a	10,60 a	11,34 a
	D_3	9,20 a	9,70 a	13,48 a	10,79 a
	D_4	11,54 a	12,79 a	13,19 a	12,51 a
$\bar{x}$C/N rasio		10,69	11,42 a	12,30 a	
4	D_1	10,46 a	9,39 a	11,38 a	10,41 a
	D_2	9,51 a	9,70 a	11,49 a	10,24 a
	D_3	9,48 a	10,49 a	12,13 a	10,70 a
	D_4	9,65 a	9,67 a	10,80 a	10,04 a
$\bar{x}$C/N rasio		9,78 a	9,81 ab	11,45 b	
5	D_1	10,29 a	8,81 a	8,59 a	9,23 a
	D_2	10,77 a	10,19 a	9,72 a	10,23 a
	D_3	9,04 a	9,72 a	11,15 a	9,97 a
	D_4	9,53 a	10,92 a	9,44 a	9,96 a
$\bar{x}$C/N rasio		9,91 a	9,91 a	9,73 a	9,85 a

Notes:
D: Bioactivator, D_1: Bioactivator EM_4, D_2: Bioactivator Moebillin, D_3: Bioactivator Petrofast, D_4: Bioactivator Decoprima, S: Cow dung, S_1: 2 kg Cow dung, S_2: 4 kg Cow dung, S_3: 6 kg Cow dung, $\bar{x}$: average.
The alphabet followed by the same letter in the same column show no significant difference at LSD test 5% (p = 0.05)

Based on result of the research, it showed the fluctuative C/N ratio. It was due to the effect of microorganism activities in compost. According to Sunjoto *et al.* (2014), declining C/N ratio in composting showed the occurrence of decomposition process. Stable yield was indicated by the declining C/N ratio continuously, which showed that the compost is well-processed and ready to be used.

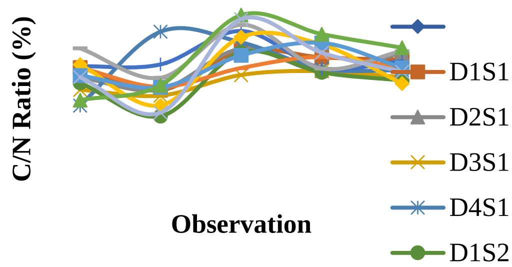

Figure 1. Content C/N ratio Compost

f) Color

The change in color of compost shows the decomposition result against compost materials due to well-processed compost will turn its color to blackish brown (Hastuti *et al.*, 2017). Results of organoleptic on color change of compost are presented in Table 7.

During observation at 10 DAI, color of the compost was still dominantly brown to dark brown (Table 7). The color was still the same as the origin color of coffee exocarp waste before it was mixed with cow dung and bioactivator. However, during decomposition at 10 DAI, the treatment of D_4S_3 showed the change in color that turned to blackish brown. It indicated decomposition by the treatment of D_4S_3 was faster than other treatments. After 20 DAI, the compost color turned into dark brown and blackish brown. The change in color was parallel with research by Sunjoto *et al.* (2014), which changed color of the coffee exocarp compost into dark brown to blackish brown. At 30 DAI, results of the research showed that the color turned into dark brown to blackish brown on all treatments, except D_1S_2 (light brown) (Table 7).

Table 7. The change in color of compost made of coffee exocarp wastes

Treatment	Color of Fertilizer (DAI)		
	10	20	30
D_1S_1	Light Brown	Light Brown	Blackish Brown
D_2S_1	Dark Brown	Dark Brown	Blackish Brown
D_3S_1	Dark Brown	Blackish Brown	Blackish Brown
D_4S_1	Dark Brown	Blackish Brown	Blackish Brown
D_1S_2	Light Brown	Light Brown	Light Brown
D_2S_2	Brown	Dark Brown	Dark Brown
D_3S_2	Light Brown	Blackish Brown	Dark Brown
D_4S_2	Light Brown	Blackish Brown	Dark Brown
D_1S_3	Dark Brown	Dark Brown	Blackish Brown
D_2S_3	Light Brown	Blackish Brown	Blackish Brown
D_3S_3	Dark Brown	Dark Brown	Dark Brown
D_4S_3	Blackish Brown	Blackish Brown	Dark Brown

g) Reduction

Decomposition process of the compost by microorganism will reduce the available compost material. Based on result of the analysis of variance, no interaction occurred between bioactivator variation and dose of cow dung against the reduced weight of compost made of coffee exocarp wastes. The treatment of cow dung dose showed significant effect on reduction of compost made of coffee exocarp wastes at 35 DAI. Meanwhile, bioactivator variation did not show any significant effect on weight reduction of compost made of coffee exocarp wastes. Results of weight reduction of compost made of coffee exocarp wastes are presented in Table 8.

Table 8. Reduction of Compost Weight Made of Coffee Exocarp Waste

Time (DAI)	D	S			$\bar{x}$Reduction (%)
		S_1	S_2	S_3	
35	D_1	37,14	33,70	25,76	32,20
	D_2	37,62	29,26	26,36	31,08
	D_3	36,19	35,19	26,36	32,58
	D_4	27,62	30,74	24,24	27,53
$\bar{x}$Reduction (%)		34,64 b	32,22 ab	25,68 a	

Notes:
D: Bioactivator, D_1: Bioactivator EM_4, D_2: Bioactivator Moebillin, D_3: Bioactivator Petrofast, D_4: Bioactivator Decoprima, S: Cow dung, S_1: 2 kg Cow dung, S_2: 4 kg Cow dung, S_3: 6 kg Cow dung, $\bar{x}$: average.
The alphabet followed by the same letter in the same column show no significant difference at LSD test 5% (p = 0.05)

h) Quality of Compost from Coffee Exocarp Waste

Quality test on organic fertilizer was conducted against compost made of coffee exocarp wastes by applying bioactivator variation and dose of cow dung. Results of analysis on compost made of coffee exocarp wastes at 35 DAI are presented in Table 9.

Based on Table 9, quality of the resulted compost from coffee exocarp wastes has met the standard of quality for compost as stated by Regulation from Minister of Agriculture Number 70/Permentan/SR.140/10/2011 and National Standard of Indonesia SNI 19-7030-2004. Parameters, which have met standard of quality for compost as stated by Permentan and SNI on all treatments, include pH (5.6-6.09), C-organic (21.40%-24.91%), N-total (2.15%-2.60%) and aroma (earthy odor).

Table 9. Result of Analysis on Compost of Coffee Exocarp Waste at 35 DAI

Treatment	pH	Water Content	C-Organic	N-Total	C/N ratio	Depreciation (%)	Aroma	Color
		%						
D_1S_1	5.62	56.81	24.72	2.43	10.29	37.14	Earthy Odor	Blackish Brown
D_2S_1	5.70	53.54	24.91	2.34	10.77	37.62	Earthy Odor	Blackish Brown
D_3S_1	5.74	52.55	22.81	2.54	9.04	36.19	Earthy Odor	Blackish Brown
D_1S_2	5.81	51.66	22.58	2.60	8.81	33.70	Earthy Odor	Light Brown
D_2S_3	6.05	56.80	21.63	2.23	9.72	26.36	Earthy Odor	Blackish Brown
D_3S_3	6.03	54.85	24.41	2.20	11.15	26.36	Earthy Odor	Dark Brown
Permentan	4 -9	8-20%	min 15	-	15-25	-	-	-
SNI	6.9-7.49	Max. 50%	9.80-32	min 0.4%	10-20	-	Earthy Odor	Blackish

4. DISCUSSION

a) Temperature of Compost from Coffee Exocarp Wastes

According to Putri et al. (2014), the dose application of cow dung may affect on temperature of composting as a result of cow dung that contains microorganism, so that it affects on composting activity, which accelerate the achievement of maximum temperature. The fastest degradated compounds, such as sugar, fatty acid, and amino acid, may increase microorganism metabolism, will increase the temperature (Santos et al., 2016).

Condition of the compost in 30 days occurred under mesophilic temperature. It was shown from the temperature, which was not more than 40°C on all treatments (Table 2). According to Djaja (2008) in Masnun (2013), temperatures that range 10-40°C showed the composting process occurred under mesophilic temperature, while temperature > 40°C showed that the composting process occurred thermophilically. Such mesophilic that occurred during the composting process was caused by the heat inside the compost could not stand longer. It was due to the compost pile was not too high. The compost pile, which is not more than 1-2 meter height will easily lose the heat and, of course, high temperature of the compost could not be achieved (Widarti et al., 2015). The available microorganism under mesophilic temperature will utilize O2 and release CO2 during the decomposition process to produce heat and reach the maximum temperature. Stable temperature, which conforms to temperature of the soil, indicates that the composting process has been completed and ready to be used. Decreasing temperature in the composting process is due to the available O2 has decreased. As a result, microorganism activities have reduced, as well as the temperature back to normal in accordance with temperature of the soil (Widawati, 2005; Hastuti et al., 2017).

b) Acidity Level (pH)

According to Degefe et al. (2016), treatment of coffee exocarp wastes + cow dung has the highest pH than treatment of vegetable wastes, enset wastes, and khat wastes after having vermicompost. At 35 DAI, bioactivator treatment has also significant effect on pH of compost. The highest pH was shown by treatment D4 along with the value for about 6.01, but did not show significant difference with treatment D3. The lowest pH was shown by treatment D1 for about 5.83, which did not show significant difference with treatments D2 and D3. Significant effect of bioactivator variation (35 DAI) was caused by different content of microorganism in bioactivator. According to Saraswati et al. (2006), decomposition of organic material during composting will be determined by amount and types. Activator such as fungi (Aspergillus niger, Trichoderma viridae and Chaetomium sp.) functions as organic decomposer and produces material, which is identical with organic matter (humous) in the soil (Widawati, 2005).

Fluctuative values of pH in compost increase at 7 DAI, but decrease at 14 and 21 DAI, and increase again at 28 DAI, which is due to protein decomposition has changed into ammonia (NH3) by microorganism that also utilize organic acid, so that pH increase. Microorganism acivities in mineralization process of organic matter will release cations, so that pH values will be optimal (Kassa et al., 2011). The active microorganisms in compost cause the carbon source in compost will be reduced (Setiyo, 2007).

Final result of the research paralleled with Pandebesie and Rayuanti (2013), which showed results of pH during composting process were about pH 5.5 and showed qualified characteristics due to have pH, which was rather acid that was beneficial in maintaining N in the compost (Degefe *et al*., 2012). It indicated that the decomposition process during the composting of coffee exocarp wastes has run well.

c) N-Total

The application of cow dung dose on coffee exocarp wastes showed significant effect on N-total of compost at 21 and 28 DAI. At 21 DAI of composting, the treatment S_1 (2 kg) showed significant difference with treatment S_3 (6 kg), while at 28 DAI, treatment S_3 showed significant difference with treatments S_1 and S_2. The highest N-total at 21 and 28 DAI and 28 DAI were shown by treatment S_1 and the values were 2.52% and 2.54%, respectively, while the lowest N-total was shown by treatment S_3 and the values were 2.14% and 2.13%, respectively. N-total at 21 and 28 DAI has conformed to Regulation from Minister of Agriculture Number 70/Permentan/SR.140/10/2011, in which N + P_2O_5 + K_2O was, at least, 4% due to N-total in this research range 2.1-2.5%. It was due to cow dung contains N, so that the given treatment has significant effect on N-total in compost made of coffee exocarp wastes.

According to Krismawati and Hardini (2014), the addition of manure in composting process may decrease C/N ratio due to N contained in manure will decrease C/N ratio in compost. According to Krismawati and Hardini (2014), the addition of manure in composting process may decrease C/N ratio due to N contained in manure will decrease C/N ratio in compost.

N is unstable. Such condition is caused by microorganism, which used N as source of food to grow during the decomposition process and uneven air circulation during the composting process. Pandebesie and Rayuanti (2013) suggested that microorganism requires N as source to construct body cells. N-total increased at 3 WAI as a result of nitrification process in compost. It conformed to Pandebesie and Rayuanti (2013) who suggested that at the third day of composting, N-total increased as a result of nitrification process. N-total increased due to the microorganism decompose the compost materials and change ammonia into nitrite, so that N-total in compost shows the available N, which include N-mineral, protein, amino acid, and amina (Sunjoto *et al.,* 2014). N in compost is highly important for mineralization process of organic matter, and to count concentration of N-total, as well as its correlation with N-transfer cumulatively in plant (Hernandez *et al*., 2010).

d) C-Organic

Results of the research by Sunjoto et al. (2014) showed the decrease C-organic during the composting, in which at the final composting process, C-organic ranges 24%-30% at 28 DAI. Fluctuative C-organic along with longer period of composting may be caused by C source of the composting materials.

The available organic matter in compost will be utilized by microorganism during the decomposition process. Such organic matter will be used as source of energy by microorganism that will decrease C-organic of the compost (Hastuti et al., 2017). The decrease C-organic is caused by microorganism activities in the compost, which use the organic matters to be decomposed into CO2, H2O, and new cells of the microorganism (Pandebesie and Rayuanti, 2013).

e) C/N Ratio

According to Widarti et al. (2015) and Hastuti et al. (2017) microorganism will decompose the organic matter in compost by utilizing C-organic as source of energy for microorganism and utilizing N as cell composer for microorganism. It causes fluctuative values in C-organic and N-total contained in compost and affect C/N ratio in compost. In general, C/N values will keep declining in accordance with the decreasing C-organic in compost.

f) Color

According to Putri *et al.* (2014), the color change of compost from brown to blackish brown showed activity of microorganism that decomposed the compost material. Treatment of D_1S_2 showed the same color with the origin color of compost. According to Sunjoto *et al.* (2014), similar color with the material of the compost means that the compost has not well-done or it is not ready to be used.

g) Reduction

Moreover, most of carbohydrate will be lost and evaporated, while nitrogen compound will increase and the composting process, which produce heat that cause evaporation of water and CO2. Results of the research conformed to Sriharti and Salim (2008), which showed that depreciation on treatment of Rotary 1 was 35.83% and Rotary 2 was 39.42%.

At 35 DAI, the treatment of cow dung dose showed significant effect on decreasing compost. Dose of cow dung S3 (6 kg) showed significant difference on S1 (2 kg), while S2 (4 kg) showed no significant difference on S1 and S3. The highest decreasing weight was shown by treatment S1 ¬for about 34.64% and the lowest was shown by treatment S3 for about 25.68% (Table 9). It was due to different C/N ratio of compost material. According to Yurmiati and Hidayati (2008), different C/N ratios affect on decreasing weight of compost. Such change caused final weight of compost decreased. According to Yurmiati and Hidayati (2008), weight of compost decreased for about 40%-60% from initial weight. Such desrease was due to the nutrient release from organic compound and turned into inorganic compound (Sriharti and Salim, 2008).

h) Quality of Compost from Coffee Exocarp Waste

According to Regulation from Minister of Agriculture Number 70/Permentan/SR.140/10/2011, Article 1 Number 15 and 16, definition for Letter of Quality Identification is a written notification given by institution for quality test as recommendation that the product has met the given standard of quality. Standard of quality is parameter that is issued by the National Body in the form of SNI (National Standard of Indonesia), or issued by Minister of Agriculture in the form of Minimum Technical Requirements. Standard of quality for fertilizer is also presented on Regulation of National Standard of Indonesia SNI 19-7030-2004. According to Indriani (2007), the principle of composting is reducing C/N ratio of compost materials parallel with C/N ratio of soil (< 20). Physical structure of compost can be recognized from the color and aroma. Both parameters are very essential in determining ripeness of the compost. For chemical property, compost is said to be well processed if C/N ratio < 25 and parallel with C/N ratio of the soil tanah.

Parameter C/N ratio, water content, and color have shown the results, which have not conformed to standard of quality for compost as determined by Permentan and SNI on some treatments. C/N ratio values of the compost range 8.81-11.15 at 35 DAI. D_3S_3 treatment is the closest criteria that conforms to Permentan Number 70 by value 11.15 and followed by treatments D_1S_1, D_2S_1, D_2S_2, D_4S_2, which have C/N ratio >10 in accordance with SNI 2004. Results of the research by Degefe *et al.* (2016) showed the result of C/N ratio less than 10, which is still under condition that can be accepted by agriculture. Water content of the compost has not conformed to standard of quality for compost as determined by Permentan and SNI due to on all treatments of compost have water content > 50% (35 DAP). Based on physical properties of color, some treatments of coffee exocarp wastes (D_1S_1, D_2S_1, D_3S_1, D_4S_1, D_1S_3, D_2S_3) belong to category, which conform to quality standard of compost from SNI.

5. CONCLUSION

1. The application of Decoprima (D4) bioactivator and 6 kg dose of cow dung (S3) may increase and show the highest value on pH compost 6.01 (D4) and 6.06 (S3). 2 kg dose of cow dung (S1) show the highest depreciation value of the compost (34.64%) in comparison with 4 kg dose of cow dung (S2) (32.22%) and 6 kg (S3) (25.68%). On the other side, the application of bioactivator variation and dose of cow dung have no significant effect on compost quality, such as water content (51.66%-57.67%), N-total (2.15%-2.60%), C-organic (21.40%-24.91%) and C/N ratio (8.81-11.15). Physical properties of each compost color show earthy odor and dark brown-blackish brown.
2. The best treatment was shown by the application of Petrofast (D3) bioactivator and 6 kg dose of cow dung (S3) by C/N ratio 11.15. The value is still below the provision of Permentan. It is suggested for the next research to consider additional organic materials in order to make C/N ratio value of the compost could fulfill the predetermined standard. Then on 3 WAI (week after incubation) the composting process can be stopped due to C/N ratio (9.20-13.48), pH (5.84-6.21) have conformed to standard of quality from Minister of Agriculture Number 70/Permentan/SR.140/10/2011 and National Standard of Indonesia SNI 19-7030-2004..

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