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Evaluation of the chemical quality of coffee grounds composted by various types of decomposers using a scoring system

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ABSTRACT

In recent years, the amount of coffee consumption by the Indonesian people has increased. As a result, there is an increase in coffee waste in the form of coffee grounds so it has the potential to have a negative impact on the environment. Proper management is needed so that coffee grounds are not wasted and pollute the environment. Composting is one way to convert coffee grounds into organic fertilizer. The provision of decomposers is useful for accelerating the composting process of coffee grounds so that it affects the quality of the compost produced. This study aims to determine the chemical quality of coffee grounds compost using different decomposers based on the Indonesian National Standard (SNI) 19-7030-2004. This research was carried out in the Compost House Department of Agroecotechnology and Soil Laboratory Department of Soil Faculty of Agriculture, Lambung Mangkurat University, Banjarbaru for three months, from June to August 2021. This research uses quantitative methods (laboratory analysis) to determine the chemical quality of coffee grounds compost. The treatments were decomposers, d1 = EM4, d2 = M21, d3 = Beka, and d4 = Petro Gladiator. The results showed that the use of EM4, M21, BeKa, and Petro Gladiator decomposers produced organic C, total N, P_2O_5, K_2O, Ca, Mg, and C/N ratio of coffee grounds compost in accordance with SNI 19-7030-2004, but the pH value of coffee grounds compost treated with EM4, M21, BeKa, and Petro Gladiator decomposers did not meet SNI 19-7030-2004.

Keywords: Coffee Waste, Composting, Eco-Friendly, Organic Fertilizer, Zero Waste Agriculture.

1. Introduction

Coffee is a plantation commodity that has a high economic value among other plantation crops and plays an important role as a source of foreign exchange for the country. Coffee not only plays an important role as a source of foreign exchange but also as a source of income for no less than half a million coffee farmers in Indonesia (Rahardjo, 2012). Caffeine needs the body to increase enthusiasm for activities. The habits that drive coffee production every day continue to increase.

People's habit of consuming coffee makes coffee shop business opportunities, ranging from simple small shops to luxury shops, especially in big cities. According to data from the South Kalimantan Province Cooperative Service (2019), data on the development of micro-scale MSMEs in Banjarbaru reached 9,201, and coffee shops or coffee shops were one of the data contributors. The number of coffee shops in Banjarbaru has reached more than 100 stalls, and the progress of these stalls certainly cannot be separated from the amount of waste generated by these businesses. Coffee grounds waste that can be produced by one shop per day can reach 2 kg - 5 kg, and most of the coffee grounds waste are just thrown away.

Coffee grounds waste can be used as a raw material in the composting process (Jumar et al., 2022). According to Kasongo et al. (2011), coffee waste in the form of coffee grounds contain organic C by 44.87%, N by 1.2%, P_2O_5 by 0.02%, and K_2O by 0.35%. Each nutrient element contained certainly has an important role in plant growth. According to Cruz et al. (2012), nitrogen can increase photosynthesis in plants, especially when growing or vegetatively. Phosphorus can affect and improve cell metabolism processes in plants. Potassium is useful in enzyme activation, photosynthesis, sugar transportation, and protein formation. Coffee grounds also have the potential as organic anions to increase soil pH. Micronutrients found in coffee grounds include magnesium, sulfur, and calcium (Arifiati et al., 2017).

Coffee grounds waste can be processed into compost which can help reduce coffee grounds waste that is just wasted. The composting process can help minimize odors from organic waste and reduce environmental pollution. In addition, the composting process can help reduce the need for the use of inorganic fertilizers used in crop cultivation (Ho et al., 2022).

Composting is a biological process in the activity of microorganisms in decomposing organic matter into humus-like materials (Jumar & Saputra, 2018). Compost can be used as nursery growing media, potted plants, garden plants, or flower and lawn containers. The addition of organic matter is also important to do to improve soil quality and help the process of absorption of nutrients in plants. Organic materials added to plants can help absorb nutrients and increase land productivity (Barus, 2011).

The decomposition process is an important requirement in composting. Help from microorganisms is needed, especially in the decomposition process, so that the compost that has been produced is expected to be easily absorbed by plants (Ho et al., 2022). This statement is reinforced by Widarti et al. (2015) the use of a decomposer will help speed up the composting process and can improve the quality of the compost. The addition of decomposers is important, therefore it is necessary to do research related to the chemical quality of coffee grounds compost produced from composting using several types of decomposers in this study.

The explanation above is the background of this research using several different decomposers in the composting process, including EM4, M21, BeKa, and Petro Gladiator. Different decomposers are given to determine the quality of coffee grounds chemical compost (pH, organic C, N, P, K, Ca, Mg, and C/N ratio) compared to compost specifications according to the Indonesian National Standard (SNI) 19-7030-2004. This study aims to determine the chemical quality of coffee grounds compost using different decomposers based on the Indonesian National Standard (SNI) 19-7030-2004.

2. Materials and Methods

This research was conducted at the Compost House, Department of Agroecotechnology, and the Soil Laboratory Department of Soil Faculty of Agriculture, Lambung Mangkurat University (ULM), Banjarbaru, starting from June to August 2021.

This research uses quantitative methods (analysis in the laboratory) to determine the chemical quality of coffee grounds compost. The treatment given was in the form of decomposers (D), namely:

d1= 20 kg coffee grounds + 1 kg cow manure + 1 kg chicken manure + 1 kg guano + 0.3 kg bran + 1 kg dolomite lime + 20 mL molasses + 20 mL **EM4 decomposer**

d2= 20 kg coffee grounds + 1 kg cow manure + 1 kg chicken manure + 1 kg guano + 0.3 kg bran + 1 kg dolomite lime + 20 mL molasses + 20 mL **M21 decomposer**

d3= 20 kg coffee grounds + 1 kg cow manure + 1 kg chicken manure + 1 kg guano + 0.3 kg bran + 1 kg dolomite lime + 20 mL molasses + 20 mL **BeKa decomposer**

d4= 20 kg coffee grounds + 1 kg cow manure + 1 kg chicken manure + 1 kg guano + 0.3 kg bran + 1 kg dolomite lime + 20 mL molasses + 20 mL **Petro Gladiator decomposer**

Formulation ingredient making compost referring to the research of Jumar et al. (2022).

Coffee grounds are collected and taken from coffee shops in the Banjarbaru area, South Kalimantan. As much as 80 kg of coffee grounds is used as the main ingredient for making fermented organic fertilizer. Guano taken from a cave in Batu Hapu Village, Hatungun District, Tapin Regency, South Kalimantan required is 4 kg for all treatments. Cow manure and broiler chicken manure were obtained from Bentok Darat Village, Bati-Bati District, Tanah Laut Regency, South Kalimantan. The amount of cow manure and chicken manure required is 4 kg for all treatments.

The composting of coffee grounds with four types of decomposers is carried out with the following steps (Jumar & Saputra, 2018):

a. Materials in the form of coffee grounds, cow manure, chicken manure, bat droppings (guano), bran, and dolomite lime according to the measurements are put into a composting box measuring 50 x 50 x 50 cm;
b. The ingredients are then stirred until evenly mixed;
c. Furthermore, the EM4 decomposer solution that has been prepared (mixed with molasses/molasses and added water) is put into the gembor, poured over the pile of material to be composted and stirred using a shovel until well blended;
d. Likewise, the treatment of other decomposers, namely the M21 decomposer, the BeKa decomposer, and the Petro Gladiator decomposer were treated the same;
e. After that, each composting box is covered with burlap sack on top (on the surface of the composting box).

Sampling of coffee grounds compost for nutrient analysis was carried out using a purposive sampling technique. The amount of compost samples for each treatment needed to test the chemical properties of compost in the laboratory is 100 g. Observations made in this study include compost pH of the electrode pH method (Neves et al., 2021), organic C content of the Walkley & Black method (Shamsuddin et al., 1994), total N of the Micro-Kjeldahl method (Horneck & Miller, 2019), P_2O_5 of Ascorbic Acid method (Raun et al., 1987), K_2O of the Flame Photometry method (Juo, 1978), Ca and Mg of the Flame Photometry method (Eviati & Sulaeman, 2009), and C/N ratio. The quantitative data obtained was then scored for each compost parameter, then compared with SNI 19-7030-2004. This scoring system gives value to each treatment (Table 1). Scoring is done based on ranking, then the maximum score is given to the treatment that has the best score and the minimum score is given to the treatment that is not good (Raharjo et al., 2016).

Table 1. Criteria to evaluate the chemical quality of coffee grounds compost

Parameter	SNI*	Scale	Scoring
pH	Min. 6.80; Max. 7.49	According to SNI	2
		Not according to SNI	1
Organic C (%)	Min. 9.80; Max. 32	25 to 32	1
		17 to 24	2
		9.2 to 16	3
Total N (%)	Min. 0.40	<0.4	1
		>0.4 to 0.9	2
		1 to >2	3
P_2O_5 (%)	Min. 0.10	<0.1	1
		=0.1	2
		>0.1	3
K_2O (%)	Min. 0.20	0.2 to 1	1
		1 to 1.5	2
		>1.5	3
Ca (%)	Max.	>2.50	1
		=2.50	2
		<2.50	3
Mg (%)	Max.	>0.60	1
		=0.60	2
		<0.60	3
C/N ratio	Min. 10; Max. 20	>20	1
		10-20	2
		10	3

* Source: Indonesian National Standard (2004)

3. Results and Discussion

Chemical Quality of Coffee Ground Compost

Coffee grounds waste with EM4 decomposer contains organic C 22.73%, total N 2.25%, P_2O_5 1.71%, K_2O 0.40%, Ca 6.98%, Mg 0.19%, and C/N ratio 10.10. M21 decomposers had 28.65% organic C, 2.64% total N, 1.96% P_2O_5, 0.23 K_2O, 9.76% Ca, 0.39% Mg, and C/N ratio of 10.87. BeKa decomposers had 22.82% organic C, 2.24% total N, 1.62% P_2O_5, 0.22 K_2O, 6.80% Ca, 0.19%, and C/N ratio of 10.19. Petro Gladiator decomposers has 22.92% organic C, 2.24% total N, 1.87% P_2O_5, 0.40% K_2O, 6.41% Ca, 0.19% Mg, and C/N ratio of 10.21 (Table 2).

Table 2. The result of chemical quality analysis of coffee grounds compost with different decomposers

Decomposer	pH (H_2O)	Organic C	Total N	P_2O_5	K_2O	Ca	Mg	C/N ratio
		---------- % ----------						
EM4	8,00	22,73	2,25	1,71	0,40	6,98	0,19	10,10
M21	9,22	28,65	2,64	1,96	0,23	9,76	0,39	10,87
BeKa	8,84	22,82	2,24	2,24	0,22	6,80	0,19	10,19
Petro Gladiator	8,45	22,92	2,24	1,87	0,40	6,41	0,19	10,21

The degree of acidity (pH) in coffee grounds compost with the treatment of several decomposers has a high pH, namely: 8.00 (EM4), 9.22 (M21), 8.84 (BeKa), and 8.45 (Petro Gladiator). Based on the Indonesian National Standard 19-7030-2004, the pH standard for mature compost is 6.80-7.49. This high degree of acidity or pH is thought to be due to the addition of dolomite lime as an additive in the composting process of coffee grounds with different decomposers. According to Rumahorbo (2016), giving dolomite can increase pH, decrease exchangeable Al, and increase exchangeable Ca, exchangeable Mg, and exchangeable Na. In addition to lime, the addition of guano to the coffee grounds composting process also affects the high pH of the coffee grounds compost. According to Charlos et al. (2021), guano contains several polymeric compounds that can react with aluminum cations to form Al chelate compounds as a contributor to H^+ ions that cause acidity.

The highest total N content was found in coffee grounds compost with M21 decomposer treatment (2.64%). In addition to the highest total N, the compost in the M21 decomposer treatment also produced high P_2O_5 (1.96%), Ca (9.76%) and Mg (0.39%) content. The high total N and P_2O_5 were due to the bacteria content in the M21 decomposer rapidly breaking down organic matter and also converting organic matter into nutrients. This is also stated by Candrasari et al. (2019), the microorganisms that work in the M21 decomposer help decompose organic matter into simpler ones. M21 decomposers, including *Actinomycetes, Pseudomonas, Lactobacillus, Trichoderma, Azotobacter,* and *Rhizobium* can accelerate and increase the fermentation process. M21 decomposer also has zymogenic microorganisms that help in the decomposition process so that it can add content to the compost (Astuti, 2005). The high potassium value occurs due to the decomposer containing the contents not working fully so some decomposers still have values that are not by SNI 19-7030-2004, this was conveyed by Yusbaini et al. (2020), fungi in the decomposer can affect the calcium content in the compost. The magnesium content in compost was also stated and magnesium content can be influenced by the compost material used.

The highest K_2O content is with the addition of EM4 decomposer and Petro Gladiator. The high content of K_2O in coffee grounds compost causes the quality of coffee grounds compost to be better because K_2O is an essential macronutrient needed by plants. Potassium is useful as an enzyme activator, helps the absorption of water and nutrients from the soil by plants, and helps transport assimilated products from leaves to plant tissues (Agricultural Research and Development Agency, 2015). The content of K_2O is quite high in some decomposers because it contains potassium nutrients in it. The potassium present in the decomposer is used by microorganisms in the substrate material as a catalyst because the increase in potassium content in the compost is influenced by the activity of microorganisms. This was also stated by Wirosoedarmo et al. (2019), that the K element in organic matter is still complex and unavailable to plants, but microbes in decomposers use K for activities and decomposition processes that were initially complex into simpler organic matter, resulting in K elements being available to plants.

Organic C content is inversely proportional to other content because low organic C indicates that microorganisms carry out the decomposition process well (Putri et al., 2022, Saputra et al., 2020). During the composting process, the organic C content present in the organic material will decrease because, in the process of decomposition of organic matter, organic C is used as an energy source by microorganisms, then during the digestion process a combustion reaction occurs between the elements carbon and oxygen into calories and carbon dioxide (CO_2) by microorganisms (Ho et al., 2022; Agricultural Research and Development Agency, 2011). Organic C content in coffee grounds compost in all treatments was by SNI 19-7030-2004. Judging from its content, the lowest organic C was found in the EM4 decomposer treatment (22.73%), while the highest was in the M21 decomposer treatment (28.65%). This is influenced by the content of microorganisms found in compost and decomposer materials. Amnah & Friska (2019) stated that the high organic C content was due to the low microbial content and when the compost matured the organic C remained high, and vice versa.

C/N ratio is the same as organic C, which is inversely proportional to the other contents, because if the C/N ratio is high, then the decomposition process takes a long time. Therefore, C/N ratio must be low (10-20) so that the decomposition process can work optimally so that the compost matures well. The function of composting aims to reduce the C/N of organic matter to the same as C/N ratio of the soil (<20) (Siboro et al., 2013). A too-high C/N ratio will cause microbes to lack N for protein synthesis so that decomposition is slow (Jumar et al., 2020), and C is used as a source for the formation of microbial body cells during the composting process (Amnah & Friska, 2019). C/N ratio of coffee grounds compost with different decomposer treatments in this study met the compost quality requirements based on SNI 19-7030-2004.

Scoring The Chemical Quality of Coffee Ground Compost

Assessment of the quality of coffee grounds compost is carried out by scoring, namely giving a value to each compost with different decomposer treatments. The scoring is based on the ranking of each compost (Raharjo et al., 2016), the maximum score is given to coffee grounds compost which has the best chemical quality, and the minimum score is given to coffee grounds compost whose chemical quality is not bad (Table 3).

Table 3. Results of scoring the chemical quality of coffee grounds compost with different decomposers

Parameter	EM4	M21	BeKa	Petro Gladiator
pH	1	1	1	1
Organic C	2	1	2	2
Total N	3	3	3	3
P_2O_5	3	3	3	3
K_2O	1	1	1	1
Ca	1	1	1	1
Mg	3	3	3	3
C/N ratio	2	2	2	2
Total	**16**	**15**	**16**	**16**

The results of scoring pH, organic C, total N, P_2O_5, K_2O, and C/N ratio, the coffee grounds compost with different decomposer treatments have met the Indonesian National Standard 19-7030-2004. This means that the compost is worthy of being called quality compost. The highest score with a total score of 16 was found in the treatment of EM4, BeKa, and Petro Gladiator decomposers, while the lowest score with a total score of 15 was found in the M21 decomposer treatment.

4. Conclusions

The use of EM4, M21, BeKa, and Petro Gladiator decomposers produced organic C, total N, P_2O_5, K_2O, and C/N ratio of coffee grounds compost by the Indonesian National Standard (SNI) 19-7030-2004. The pH value of coffee grounds compost treated with EM4, M21, BeKa, and Petro Gladiator decomposers exceeded the Indonesian National Standard (SNI) 19-7030-2004.

It is recommended to apply the coffee grounds compost as the result of this research on land that has a high acidity level. It is hoped that the high pH of the compost can reduce the acidity of the soil on the land.

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