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Analysis of The Physical Quality of Coffee Husk Compost with The Addition of EM4 Bioactivator

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Abstract. Coffee production potential is matched by waste from grinding coffee cherries. However, the coffee cherry peel (husk) is rich in essential nutrients for plant growth, including potassium, phosphorus, and nitrogen. Therefore, the purpose of this research was conducted to determine the physical quality of coffee husk compost given the addition of EM4 bioactivator. This study consisted of 2 treatments and 4 replications, namely control (coffee husk + sawdust + goat manure) and EM4 (coffee husk + sawdust + goat manure + EM4). Observations were made every 3 days until the compost was ripe with the parameters of temperature, humidity, color, smell, and texture. The results showed that the entire coffee husk compost had matured within 36 days and exhibited physical characteristics according to SNI 19-7030-2004. According to the matured compost speed, treatment with mixing compost materials using EM4 shows a faster time than without EM4. In addition, the addition of EM4 gives better results in terms of texture, color, and smell compared to compost without EM4.

Keyword: Bioactivator, Coffee Husk, Compost, Fertilizer, Organic Matter, Soil.

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1 Introduction

Based on data from the Business Competition Supervisory Commission, there are five largest coffee producers of provinces in Indonesia, namely South Sumatra, Lampung, Aceh, North Sumatra, and East Java [1]. South Sumatra, Lampung, and North Sumatra supply more than 50% of coffee needs in Indonesia. As one of the coffee producers, Lampung Province has many coffee plants managed by farmers, especially forest farmers. Forest farmers in Lampung manage forest stands using an agroforestry pattern that mixes forest plants with crops, plantations, and livestock. The land extension utilized by farmers means coffee production is also produced in

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the area around the forest. Approximately 80% of coffee farming in Lampung Province is located around the forests [2].

However, the large potential of the coffee produced was accompanied by the large amount of waste generated from grinding the coffee cherries. Coffee fruit waste is usually in the form of fruit flesh, which physically makes up 48%, consisting of 42% fruit skin and 6% seed skin [3]. Coffee pod skin waste (coffee husk), which is quite large and abundant, is a problem for coffee-producing areas such as Lampung Province, because the waste has not been managed properly. The more coffee cherries are harvested, the more coffee husk is produced. Lampung Province coffee production in 2019 reached 117,111 tons, 117,311 tons in 2020, and 116,281 tons in 2021 [4]-[5] . It is estimated that the output of coffee husk in 2019 will reach 56,213 tons, in 2020 it will reach 56,309 tons, and in 2021 it will be 55,815 tons. This waste has not been utilized optimally. So far, it is only for fertilizers that are applied directly. coffee husk is sown directly in the planting area [6]. It is less effective because the coffee husk will take a long time to decompose [7].

Coffee husk contains elements needed by plants. Coffee husk contains 45.3% organic C, 2.26% potassium, 0.18% phosphorus, and 2.98% nitrogen [8]. Therefore, a breakthrough is needed to process coffee husk properly. Then it can be utilized and not wasted. The content of coffee husk is rich in nutrients. It is very appropriate to process coffee husk into beneficial products for plants. Compost is an alternative to produce. Compost can be used as fertilizer, but compost can also be used as an adjunct and combined with planting media [9]. Making compost from organic waste has been widely studied, but not much research has been done on compost from coffee husk using simple technology composter. Compost quality data from coffee husk waste can be used as a reference in processing unused waste to become useful and increase its economic value.

Making compost simply or naturally without any additions will take a long time until the compost is mature. Its process can take up to three months [10], while some take 6-12 months [11]. To resolve this, one thing that can be given is to mix compost materials with activators such as EM4. EM4 can accelerate the decomposition of organic matter and increase the availability of nutrients for plants [12]. Several studies on composting using EM4 have been carried out where it can shorten the composting time to 32 days [13], and some are ripe within 30 days [14]. However, previous studies did not use coffee fruit peels as the main ingredient for making compost. Therefore it is necessary to research the physical quality of coffee pod compost given the addition of an EM4 bioactivator.

2 Research Method

This research conducted from July to September 2022 in Talang Baru Hamlet, Talang Mulya Village, Teluk Pandan District, Pesawaran Regency, Lampung Province. The ingredients for making compost are coffee husk as the main ingredient of compost, sawdust as a mixing material that is rich in carbon (C) content [15], goat manure helps increase decomposing microorganisms in the composting process [16], and EM4 bio activator which contains bacteria photosynthesis, lactic acid bacteria, yeast, actinomycetes, and fermenting fungi which function to increase the acceleration of the breakdown of organic matter [14]. A simple composter made from outworn drums was used to make this compost. The composter design is in Figure 1.

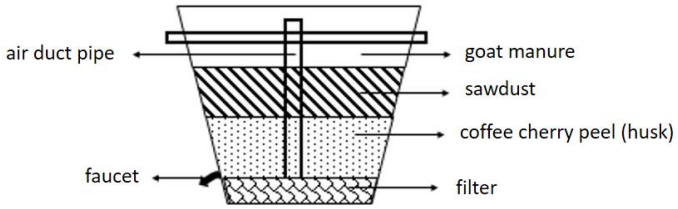

Figure 1 The design of composter.

The study was conducted using two treatments, namely the control treatment (four replicates) and the EM4 treatment (four replicates). The control treatment consisted of a mixture of coffee husk, sawdust, goat manure, and water to increase the humidity of the compost material. The EM4 treatment consists of a mixture of coffee husk, sawdust, goat manure, and an EM4 bioactivator. Both used a ratio of 2:1:1 for coffee husk, sawdust, and goat manure. The EM4 liquid used is 50 ml.

Compost materials such as coffee husk, animal dung, sawdust, and liquid bioactivator are added to the composter in layers. After all, the ingredients enter the composter, then mix well. Furthermore, the composter is tightly closed. The periodic stirring was conducted for three days. Moreover, the physical properties of the compost were also checked, such as temperature, humidity, color, texture, and odor. Then stored compost for 36 days or matured (in this study the compost matured within 36 days or five weeks).

Temperature measurements were carried out using a digital thermometer by sticking it in the compost. Moisture measurement using a digital soil moisture meter by sticking it in the compost. Compost color testing using the Munsell Soil Color Chartbook. Compost texture is determined based on other research [17]. In that study, three criteria for compost particle size were used. While in this study they were adjusted to five criteria, namely size > 30 mm = very coarse; 30-20 mm = coarse; 20-10 mm = slightly fine or medium; 5-10 mm = fine, and < 5 mm = very fine.

3 Result and Discussion

The maturity of the compost can be seen from the measurement of the physical properties at each stage of the composting process. The physical test of the compost consists of observing temperature, smell, color, and texture [14].

3.1 T-Test

The T-test was conducted to see whether there was an effect of the treatment on the compost. The results of the T-test with a significance level of 95% are presented in Table 1.

Table 1 The compost's physical qualities T test results

Parameter	N	df	Mean	Std. Error Mean	Sig.
Temperature	8	7	25,3625	,10166	,000**
Humidity	8	7	41,6250	,49776	,000**
Texture	8	7	4,0000	,37796	,000**
Color	8	7	3,0000	,37796	,000**
Smell	8	7	3,5000	,18898	,000**

Note: **sig < 0,05

This T-test is used to see whether there is an influence from the treatment given to a research object. Based on the results of the T-test showed that the two treatments have a very significant difference. The composting treatment using EM4 will show significantly different results from the composting treatment with EM4 signs or the control.

3.2 Temperature

In the process of composting organic matter, chemical reactions occurred. One of the influencing factors in this process is the temperature of the compost material. Temperature is one of the factors that can affect the speed of chemical reaction rates [18]. In this study, the compost temperature was measured to see temperature fluctuations from the start of the composting to the end of this process. It is done what was conveyed by [19] to check out the progress of the organic matter composting measurements are carried out every day. The occurrence of temperature fluctuations or changes in the level of heat and cold in compost is caused by the activity of microorganisms in the composting material [14]. Graphs of changes in compost material temperature are in Figure 2 and 3.

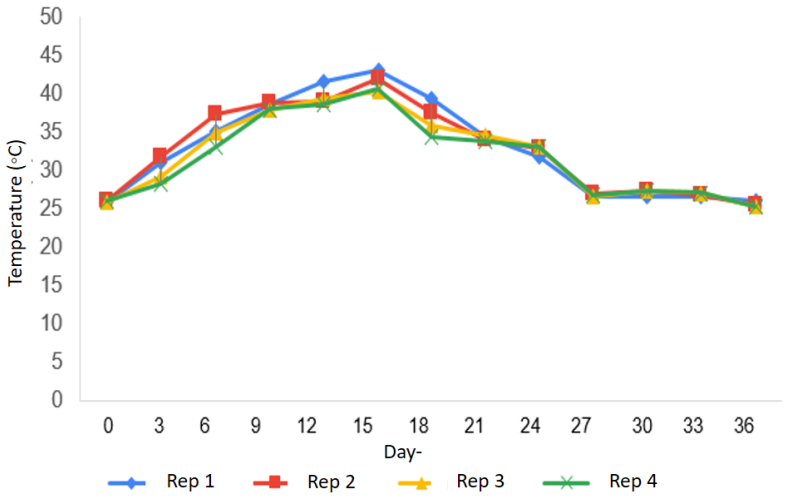

Figure 2 Composting temperature dynamics in the control treatment.

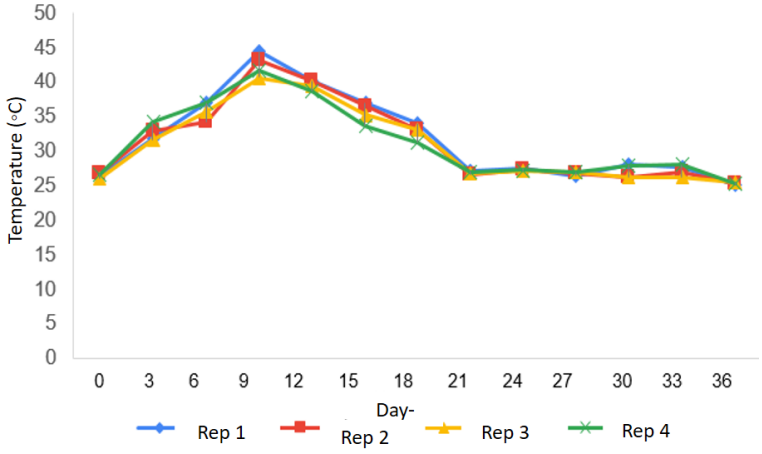

Figure 3 Composting temperature dynamics in EM4 treatment.

Figures 2 and 3 show that the dynamics of temperature changes occur during the composting process. There has been an increase in temperature at the beginning of composting. Then after reaching the peak temperature point, the temperature slowly decreases towards a temperature that tends to be more stable or has dynamics that are not too different at the end of composting. At the beginning of composting, the average temperature of the control compost material was 25.9^{o} C and the temperature increased to the highest temperature on the 15th day. The average temperature on the 15th day was 41.5^{o} C which then decreased the following day until the compost reached maturity on the 36th day of observation with an average temperature of 25.5^{o}C. Slightly different from the compost material given the addition of EM4. At the beginning of composting, the average of initial temperature was 26.4^{o}C. Then there was an increase in temperature. It was at the peak temperature on day 9th with an average temperature of around 42.5^{o} C. The temperature decreased slowly until the last observation day, which was equal to 25.3^{o} C

In both treatments, it appears that a rate of a chemical reaction can be observed by increasing the temperature. The peak temperature rise occurred in both treatments. However, this happened on a different observation day where the EM4 treatment was reached first, namely on the 9th observation day (42.5^{o} C). On the contrary, the control occurred on the 15th observation day (41.5^{o} C). The similarity of these two treatments is that the composting process does not reach the phase of developing thermophilic microorganisms (temperature 45-60^{o} C) [20]. However, this opinion is different from [21] stated the presence of mesophilic microorganisms occurred at a temperature of 20-40^{o} C, then the active thermophilic microorganism stage was at a temperature >40^{o} C. So both composts had reached the thermophilic phase with temperatures of 42.5^{o} C and 41.5^{o} C.

Both treatments did not have very high peak temperatures (below 45^{o} C). It is because during the composting process, stirring is carried out periodically (once every three days). The period of stirring or turning the compost material affects the temperature [22]. The organic matter was reversed or stirred in 4, 7, and 10-day treatments. The peak temperature values started from the lowest, namely once every four days (41.4^{o} C), every seven days (42.6^{o} C), and every ten days (46,6^{o} C). It was influenced by the release of heat when the composter opened and reversed or stirred. Therefore, the more the compost is stirred frequently, the peak temperature will not reach the top heat.

3.3. Humidity

Another parameter that is measured to see the physical properties of the compost is the humidity of the compost every day. In the process of making compost, several things can affect the maturity level of fertilizer, including temperature and humidity factors. The recommended temperature to proceed with the decomposition process is 38^{o} C while the humidity is 60%. At this set point the activity of microorganisms that help the decomposition process can work optimally [23]. Figures 4 and 5 showed the humidity conditions in the composting process.

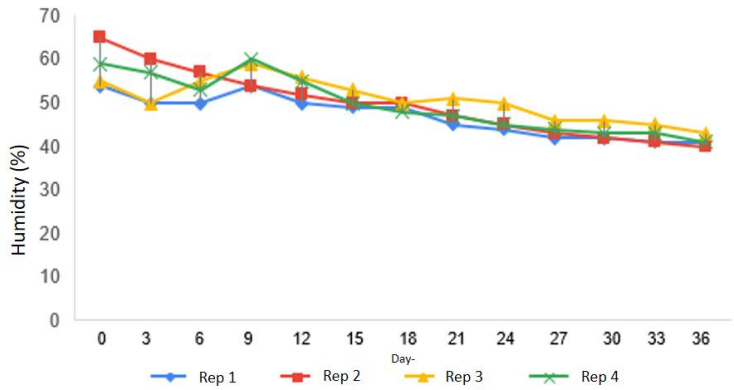

Figure 4 Humidity dynamics in the composting process in control treatment.

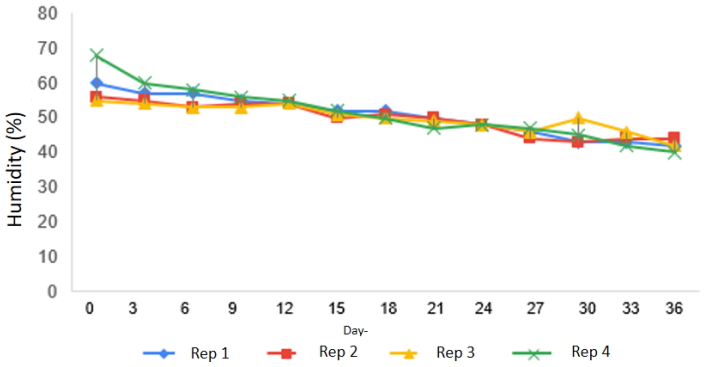

Figure 5 Humidity dynamics in the composting process in EM4 treatment.

The results showed a change in humidity from the start of composting until the compost was ready for use. At the beginning of composting, the average moisture content of the compost material was 58.25% (control) and 59.75% (treated with EM4). Even though there are ups and downs of humidity fluctuations in the compost material, the graph shows the tendency of the compost material to experience a decrease in humidity. Fluctuations in humidity values occur due to differences in unstable environmental conditions that affect values in humidity measurements [24].

Figure 4 and 5 show graphs that tend to decrease and arrive at the moisture value when the compost has matured. Both treatments showed that the moisture content of the compost at maturity was in the range of 41.25% (control) and 42% (treated with EM4). This phenomenon is by research conducted by [23] stated the composting process fluctuations in humidity values occur. The humidity of the compost material in the early weeks of the decomposition process shows a high value. Then on the following days, the humidity value gradually decreased. In addition, the humidity value, which ranges from 40–60%, is the optimum range for microbial metabolism [25] then the decomposition process is successful.

3.3 Colour

The results of observations on the color of the compost material from the beginning to the end showed that the colors were changing. The color conditions of the compost material are in Table 2.

Table 2 Color change in coffee-husk compost

Treatment	Replication	Observation day-												
		0	3	6	9	12	15	18	21	24	27	30	33	36
Control	1	1	1	1	1	1	1	1	1	1	2	2	2	2
	2	1	1	1	1	1	1	1	1	1	2	2	2	2
	3	1	1	1	1	1	1	1	1	1	2	2	2	2
	4	1	1	1	1	1	1	1	1	1	2	2	2	2

Treatment	Replication	Observation day-												
		0	3	6	9	12	15	18	21	24	27	30	33	36
EM4	1	1	1	1	1	1	2	2	2	2	3	3	4	4
	2	1	1	1	1	1	2	2	2	3	3	3	4	4
	3	1	1	1	1	1	2	2	2	3	3	3	3	4
	4	1	1	1	1	1	2	2	2	2	3	3	4	4

Note: 1 = brown; 2 = slightly black; 3= black; 4 = dark black

The results of the two treatments showed that the compost had matured on the 36th day of observation. It was indicated by the color of the compost mostly black according to the quality standard of SNI 19-7030-2004. The change in color in the composting process is due to the decomposition process by microorganisms that convert organic matter with complex C chains into simple C forms. This process causes the composted material to lose its color pigment and then turn black [26].

Compost with EM4 treatment showed a darker black color than the control. It is in line with the study of Zuhrufah et al. [27] showed that compost using EM4 had a blacker color than treatment without EM4. The results of composting using EM4 showed a black discoloration in the 4th week. It is also in line with research by Hastuti et al. [13] stated the treatment using a bioactivator began to turn black on the 32nd day of observation or the 4th week.

3.4 Texture

Based on the results of texture observations on coffee husk compost (control and EM4 treatment), all of them experienced changes in texture. It changes from coarse to finer. Changes in compost texture are in Table 3.

Table 3 Texture change in coffee-husk compost

Treatment	Replication	Observation day-												
		0	3	6	9	12	15	18	21	24	27	30	33	36
Control	1	1	1	1	1	1	1	1	2	2	2	3	3	3
	2	1	1	1	1	1	1	1	2	2	2	3	3	3
	3	1	1	1	1	1	1	1	2	2	2	3	3	3
	4	1	1	1	1	1	1	1	2	2	2	3	3	3
EM4	1	1	1	1	2	2	2	2	3	3	4	4	4	5
	2	1	1	1	2	2	2	2	3	3	4	4	4	5
	3	1	1	1	2	2	2	2	3	3	4	4	4	5
	4	1	1	1	2	2	2	2	3	3	4	4	4	5

Note: size > 30 mm = very coarse; 30-20 mm = coarse; 20-10 mm = slightly fine or medium; 5-10 mm = fine, and < 5 mm = very fine.

The results showed that at the beginning of the observation, the texture of the compost was still like the texture of the original material in the form of coffee husks and very coarse sawdust.

Changes in the texture of the compost to become finer indicates that there is degradation activity by microbes in the compost. Compost gradually becomes more crushed and refined [13],[26]. In this study, the texture of the compost was also influenced by compost materials such as coffee husks and small sawdust. So that the process of decomposition by microbes is faster. Meanwhile, if the particle size of the compost material is larger, the decomposition process will be slower. The particle size of the material has a role in determining the size of the space between the materials. To speed up the process of materials decomposition, it can be done by reducing the particle size of the material by chopping or cutting it [14].

3.5 Odor/smell

The last observed physical characteristic of compost is odor/smell. The smell in the composting process also changes. The results of observing the smell in the coffee husk composting process are in Table 4.

Table 4 Odor/smell change in coffee-husk compost

Treatment	Replication	Observation day-												
		0	3	6	9	12	15	18	21	24	27	30	33	36
Control	1	1	1	1	1	1	1	1	2	2	2	2	2	3
	2	1	1	1	1	1	1	1	2	2	2	2	3	3
	3	1	1	1	1	1	1	1	2	2	2	2	2	3
	4	1	1	1	1	1	1	1	2	2	2	2	2	3
EM 4	1	1	1	1	1	1	2	2	2	3	3	3	4	4
	2	1	1	1	1	1	2	2	2	3	3	3	4	4
	3	1	1	1	1	1	2	2	2	3	3	3	4	4
	4	1	1	1	1	1	2	2	2	2	3	3	4	4

Note: 1= coffee-like scent; 2= lacks any discernible fragrance; 3=enough aroma of soil; 4= very strong scent of soil.

Initially, all the compost ingredients smelled like the basic or the main ingredient for making this compost, namely coffee husks. Along with the decomposition process and the performance of microorganisms in the composting process, the aroma of the compost material changes. In the control sample, mature compost has an earthy odor. Meanwhile, with the addition of EM4, the earthy smell was already smelled on the 24th day of observation, and on the 33rd day, it was very earthy. Judging from the result, the two composts are by the criteria of SNI 19-7030-2004. Thus, mature compost has an earthy odor.

4 Conclusion

The entire coffee husk waste compost has matured within 36 days and shows the physical characteristics according to SNI 19-7030-2004. However, the rate at which compost maturement and treatment by mixing compost materials using EM4 show a faster time than

without EM4. The addition of EM4 to compost gives better results in terms of texture, color, and smell than without EM4.

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