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COMPARISON OF THE ADDITION OF EM4 ACTIVATOR AND ORGANIC LEACHATE WATER IN COMPOSTING EMPTY BUNCHES PALM OIL

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ABSTRACT

Palm oil processing resulting empty fruit bunch waste that has a high organic content. Empty fruit bunches produce up to 6 million tons of waste per year and this waste has not been widely utilized so that can become an environmental problem such as pollution in the future. Alternative way to utilize the wastes is by converting them into organic fertilizer or compost. Therefore, this study aims to analyze and compare the results of EM4 activator composting by using leachate activators, the effect of composting time for each activator and the quality of compost referring to SNI 19-7030-2004. In this study, the composting process was carried out for 21 days with three experiments that include without treatment, by adding 1 litre of EM4 activator and by adding of 1 litre leachate water. The parameters measured were physical, temperature, humidity, pH, C, N, P, K and C/N-ratio. The results of this study indicate that composting with EM4 activator resulting composting pH level of 4.4 - 6.2, humidity of 1.5 - 70%, temperature of 29-38 °C, brownish black in colour, rough and hard in textures and soil-like (earthy) smell while composting using leachate water has a pH of 4.6 - 6.5, humidity of 3.9 - 80%, temperature of 29-38 °C and brownish black in colour, rough texture and slightly stink. Compost with EM4 activator was showing a faster composting time than using leachate. In term of quality, the composting by using EM4 activator produced higher quality compost compared to leachate activator composting with compost quality close to SNI 19-730-2004 requirement.

Keywords : Compost, Empty Bunch, Activator, EM4, Leachate..

ABSTRAK

Limbah tandan kosong menjadi salah satu limbah padat yang dihasilkan dari pengolahan kelapa sawit yang memiliki kandungan bahan organik yang tinggi. Limbah tandan kosong menghasilkan limbah hingga 6 juta ton per tahun dan juga limbah ini belum banyak dimanfaatkan sehingga dalam jangka panjang dapat menjadi masalah lingkungan seperti pencemaran. Salah satu cara untuk memanfaatkannya adalah dengan mengubahnya menjadi pupuk organik atau kompos. Penelitian ini bertujuan untuk mengetahui perbandingan hasil pengomposan aktivator EM4 dengan aktivator air lindi, pengaruh waktu pengomposan tiap aktivator dan kualitas kompos terhadap SNI 19-7030-2004. Pada penelitian ini proses pengomposan dilakukan selama 21 hari dengan tiga perlakuan yaitu tanpa perlakuan, penambahan 1 L EM4 serta penambahan 1 L Air Lindi. Parameter yang diukur yaitu fisik, suhu, kelembapan, pH, C, N, P, K dan C/N-rasio. Hasil penelitian ini menunjukkan bahwasannya pengomposan dengan aktivator EM4 memiliki kadar pH 4,4 – 6,2, kelembapan 1,5 – 70%, suhu 29-38 °C dan hasil akhir pengomposan memiliki warna yang hitam kecoklatan, tekstur kasar dan berbau tanah sedangkan pengomposan menggunakan air lindi memiliki pH 4,6 – 6,5, *kelembapan 3,9 – 80%, suhu 29-38 °C dan hasil akhir kompos berwarna hitam kecoklatan, tekstur yang kasar dan sedikit berbau busuk. Kompos dengan aktivator EM4 memiliki waktu pengomposan yang lebih cepat dibandingkan menggunakan air lindi. Kualitas kompos tandan kosong menggunakan aktivator EM4 terbukti lebih sesuai dengan SNI 19-730-2004 dibandingkan dengan aktivator air lindi.*

Kata kunci : *Kompos, Tandan Kosong, Aktivator, EM4, Air Lindi.*

Introduction

Crude Palm Oil (CPO) is produced from palm fruit processing that vastly growing throughout Indonesia except in Java and Bali. In between 2015-2019, CPO production increased by an average of 7.74% per year. Aceh Province has a large area of plantation land and has increased from 370,079 ha in 2016 to 500,118 ha in 2019, spread across 23 districts located in Aceh Province (Firdaus et al., 2020). The palm oil processing process produces waste in form of liquid waste and solid waste.

Liquid waste from the processing of Fresh Fruit Bunches (FFB) into crude palm oil (CPO) can be used as liquid fertilizer. Solid waste from this process includes empty fruit bunches and boiler ash which have a high organic material content. Empty bunches themselves produce quite a large amount of waste, namely 6 million tons per year. However, currently this waste has not been utilized much so that in the long term it can become an environmental problem such as pollution.

The utilization of empty oil palm fruit bunch wastes can reduce environmental pollution problems and provide economic benefits by increasing the value of the waste by converting them to organic fertilizer or compost. In empty bunch compost there is a high enough organic content for soil rehabilitation (Sugiatun, 2017).

To speed up the composting process of empty palm oil bunches can be done by adding activators. Activators can be chemicals or biochemicals that help in the process of decomposing organic materials. Activators can be used to speed up the composting process of empty oil palm fruit bunches so that compost is obtained in a shorter time. By adding an activator, the composting process can take place quickly and efficiently, so it is expected that it can reduce environmental pollution problems and provide benefits from its use as organic fertilizer.

The activator consists of enzymes, humic acid and microorganisms (bacterial culture) that play a role in accelerating the composting process. Some of the activators that available on the market that can be used in composting are Effective Microorganisms-4 (EM4), Dectro Orgadeg, Stardeg, Fix-up plus and Harmoni (Ketaren, 2018). In this study, to speed up the composting process EM4 activator was added. EM4 is a type of solution that contains microbes including Lactobacillus sp (lactic acid bacteria), Photosynthetic bacteria, Streptomyces sp, and Yeast (Sugiatun, 2017).

It is expected that EM4 can help speed up the decomposition process of oil palm empty fruit bunch. EM4 has a combination culture of microorganisms that are beneficial for the development of plants and livestock which can be used as an inoculant to increase the diversity and population of microorganisms. Composting empty bunches is done by crushing empty bunches into fiber, digesting and mixing them with EM4 bioactivator liquid. However, composting process is occurred quite slowly because the palm oil fibre has hard texture.

There are many methods for processing empty fruit palm oil into compost, not only using EM4 (Abdillah et al., 2021), although according to study of Ngapiyatun and Kustiawan (2010) the most effective activator in degrading the empty palm oil bunches into compost is by using EM4. The compost produced from treatment with EM4 has better content compared to using Catechol. Catechol is organic compound used to promote humus that contains several microbes that are effectively degraded organic materials into nutrients for the soil. Based on several comparative studies, the addition of EM4 and organic leachate to composting empty bunches can produced compost that meet standard of quality. Therefore, it is expected that this study will be able to reuse empty bunch waste as organic fertilizer.

Methods

The tools used in conducting composting experiment of palm oil empty fruit bunches with EM4 activator are 3 test containers (20kg used paint buckets), gauze, gloves, scales, 1000 ml or 1 litre measuring cup, electric soldering iron, clear mica plastic, black duct tape, rubber tire cord, soil tester and thermometer. While the materials used were 15 kg palm oil empty bunches, 1 litre EM4 activator and 1 litre organic leachate. The experiment steps are:

a) Prepare the equipment and materials to be used.
b) In the composter, holes are drilled around the bucket. Each hole has 4 cm in diameter. The ventilation holes are made with electric soldering.
c) Then the ventilation holes were covered with gauze and taped so that the gauze can stick to the bucket to prevent flies from entering and carrying bacteria during the composting process.
d) In the next step the compost container is covered with clear mica plastic, the aim is to make it easier to observe the composting process.
e) Empty bunches are chopped into powder and after being chopped they are weighed, 5 kg in each container.
f) Then the activator is given and, after that, the empty bunches are put into each experimental container
g) Each test container is marked as follows:
   - No Treatment : A (Control)
   - Treatment I : B (1 Liter of EM4 activator)
   - Treatment II : C (1 Liter of Leachate)
h) To the treatment container, activator is added in the following volume:
   - Container A: For empty bunches without activator
   - Container B: For empty bunches containing 1 liter of EM4 activator
   - Container C: For empty bunches containing 1 liter of Leachate activator
i) Compost stirring is done every day to evenly decompose the compost material and to reduce the moisture content of the compost material. Temperature, humidity and pH are measured by using a thermometer to measure temperature and Soil Tester to measure humidity and pH.
j) Physical observations (color, texture and smell) are observed every 3 days when empty bunches are turned into compost.
k) After the composting process completed, the compost is dried for 4 days until the moisture content of the compost following the SNI.

l) Then laboratory tests are carried out for macro nutrient parameters, namely C-Organic, Nitrogen (N-total), Phosphorus (P2O5), Potassium (K2O) and C/N-ratio.

Results and Discussion

The results of this study on composting empty bunches with the addition of EM4 activator and organic leachate showed optimal composting results. Parameter data can be seen in Table 1, Table 2, and Table 3. Data on pH, humidity, temperature, color, texture and odor were measured and observed during 21 days of the composting in accordance of compost quality standards.

The data on pH, soil moisture, temperature, color, texture and odor are shown in Table 1 to Table 3.

Table 1. daily data of pH, humidity (%), temperature (˚C) and physical compost in container A (control) during the composting process

Day (23 Dec 2022-12 Jan 2023)	Untreated (Container A)			Physical Observation of Compost (Once Every 3 Days)
	pH	Compos (%)	Temperature (°C)	
1	7	1	38	Brownish yellow,rough, smells like bunches
2	6,8	1	36	
3	7	1	34	
4	6,8	1	29	Brownish yellow, rough, slightly smells of bunches
5	7	1	36	
6	7	1	31	
7	7	1	32	Brownish yellow, rough, slightly smells of bunches
8	6,9	1	33	
9	6,8	1	27	
10	6,8	1	36	Brownish yellow, rough, slightly smells of bunches
11	6,8	2	34	
12	6,7	2	36	
13	6,9	1	33	Brownish yellow, rough, slightly smells of bunches
14	7	1	32	
15	7	1	32	
16	7	1	35	Brownish yellow, rough, slightly smells of dry bunches
17	6,8	1	31	
18	7	1	32	
19	7	1	32	Brownish yellow, rough, slightly smells of dry bunches
20	6,8	1,2	37	
21	7	1	37	

Figure 1. Compost in Container 1 (without threatment)

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Table 1 presented the results of composting of empty palm oil bunches that were fermented for 21 days that produced a compost that had a pH in the range of 6.8-7 with humidity in the range of 1-2% and a temperature in the range of 27-38 °C. Physical observation of the compost results using the empty bunch activator showed that on the 3rd day the compost had a brownish yellow color, had a rough texture and smelled of bunches. On days 4 to 15, the compost has a brownish yellow color, has a rough texture and has a slight smell of bunches. On the 16th to the 21st day, the compost had a brownish black color, rough texture and smelled of dry bunches.

From Table 1 it can be seen that the change in the color of the compost to brownish black began on the 16th day. This color change indicates that the compost is starting to mature. According to Amalia and Widiyaningrum (2016), the characteristics organic material starting to compost to be degraded by microorganisms are the color of the compost material will become blackish brown, the stinky smell of the mixture of organic will disappear and start to smell like soil. Likewise, the texture of the compost material has started to show fine grains like soil. It can be seen from Figure 1 that the empty bunches were not completely decomposed. This is because there are no additional activators to help the composting process properly. The fibers of empty bunches that are still look rough.

The results of composting using an activator in Table 2 that composting empty bunches by using EM4 as an activator.

Table 2. Daily Data on pH (%), Temperature (°C) and Compost Physics in Container B (1 Liter EM4)

Hari Ke (23 Des 2022-12Jan 2023)	EM4 activator treatment (Container B)			Pengamatan Fisik Kompos (3 Hari Sekali)
	pH	Kompos (%)	Suhu (°C)	
1	5,3	7,2	38	Brownish, rough, slightly smells of bunches
2	5,2	50	37	
3	5,4	55	36	
4	5,6	75	33	Brownish, rough, slightly smells of bunches
5	5,4	25	38	
6	6,2	50	31	
7	5,4	70	33	Brownish, rough, slightly smells of bunches
8	5,4	48	34	
9	6,2	38	29	
10	5,2	60	36	Brownish, rough, slightly smells of bunches
11	5,6	68	35	
12	5,4	62	36	
13	6,5	58	34	Brownish, rough, slightly smells of bunches
14	5,8	35	32	
15	5	40	32	
16	5,9	60	36	Brownish, rough, slightly smells of bunches
17	6,2	38	33	
18	5,4	55	36	
19	5	1,5	33	Brownish black, rough, earthy smell
20	5,8	5,9	37	
21	4,4	20	36	

a b

Figure 2. Compost of Container B (EM4 activator), First Day (a), 21st Day (b)

Table 2 shows results of composting of empty bunches by using the EM4 activator that produce a compost that has a pH in the range of 4.4 - 6.2 with humidity in the range of 1.5 - 70% and a temperature in the range of 29 - 38 °C. Physical monitoring of the compost results using the empty bunch activator showed that on the 9th day the compost had a brownish color, had a rough texture and had a slight smell of bunches. On the 10th to 15th day, the compost has a brownish black color, has a rough texture and has a slightly foul smell. On the 16th to the 21st day, the compost has a brownish black color, a rough texture and an earthy smell.

A good compost is compost that has undergone weathering with characteristics of a color that is different from the initial color, odorless, low water content, and has room temperature (Yuniwati, 2012). In Table 2, it can be seen that the difference characteristic with the compost characteristic in Table 1 where the compost color changed more quickly to brownish black on the 10th day, because 1 liter of EM4 activator was used. The empty bunches in container B from day 1 (a) to day 21 (b) decomposed very well.

The addition of 1 liter of EM4 activator is used to speed up the rate of composting due to the increase in the number of decomposer microorganisms originating from the activator compared to material without the addition of the activator. The color of the material with the addition of the activator experiences a quick change to the darker. The final compost product is brownish black in color. In accordance with compost standards according to SNI 19-730-2004, the color of compost is blackish in color and has an earthy smell, while the material without the activator still shows fibers and smells of wood (Sarwono et al, 2021). The combination of EM4 treatment and empty bunches will accelerate the development of the microorganism population in the organic material so that the fermentation time will be faster. The compost smell is observed by using the sense. Compost that is not yet perfect still smells fresh like the original smell of the compost material and when the compost smells more like soil, the compost is approaching maturity. The compost that has an earthy smell is a sign that the compost is ready (Nafis, 2021). In general, compost stabilization is achieved if the compost has characteristics in accordance with SNI 19-7030-2004, namely humus-like, blackish brown in color, smells like earth and has a temperature close to environmental temperature (Wahyudin, 2016).

Table 3 shows the composting data of empty bunches uses an organic activator of leachate water.

Table 3. Daily Data of pH, Humidity (%), Temperature (°C) and Physical Compost in Container C (1 Liter of Organic Leachate)

Day 2 (23 Dec 2022-12 Jan 2023)	Leachate Actovator Treatment (Container C)			Physical Observation of Compost (Once in 3 Days)
	pH	**Compos (%)**	**Temperature (°C)**	
1	5	4,5	38	Brownish, rough, slightly smells of bunches
2	5,3	30	35	
3	6	40	32	
4	6,2	35	34	Brownish, rough, slightly smells of bunches
5	6,4	30	37	
6	5,5	58	31	
7	6	39	32	Brownish, rough, slightly smells of bunches
8	5,4	30	33	
9	6,5	20	29	
10	6,3	40	35	Brownish black, rough, slightly foul smelling
11	6,3	20	34	
12	5,6	40	35	
13	6,2	20	33	Brownish black, rough, slightly foul smelling
14	5,6	58	32	
15	4,8	20	33	
16	6,1	60	35	Brownish black, rough, foul smelling
17	6	68	32	
18	5,6	40	34	
19	5,9	30	34	Brownish black, rough, foul smelling
20	4,6	80	37	
21	6	3,9	35	

a b

Figure 3. Compost of Container C (Leachate activator), First Day (a), 21st Day (b)

Table 3 shows the results the composting of empty fruit bunches by using a leachate activator that produce compost that has a pH in the range of 4.6 – 6.5 with humidity in the range of 3.9 – 80% and a temperature in the range of 29-38 °C. Physical observation of the compost showed that on the 9th day the compost had a brownish color, had a rough texture and had a slight smell of bunches. On the 10th to

15th day, the compost has a brownish black color, has a rough texture and has a slightly foul smell.

Leachate is liquid resulted from the waste degradation and if it is disposed into the environment without being treated, the leachate can cause environmental pollution. Leachate contains elements that needed by plants so it can be used as an organic compost activator. Leachate contains high levels of nutrients and organic matter which can increase the activity of microorganisms (Dewilda and Apris 2016). The compost using leachate is shown in Figure 3. The data of leachate composting in presented in Table 3. The color of the compost changes from brownish to brownish black on the 10th day. This is because it uses an additional activator of 1 liter of leachate. Utilizing leachate as a bioactivator is an alternative for utilizing leachate from piles of rubbish into something useful for processing organic waste into compost. According to Sarwono and Prasetya (2013), the addition of 1 liter of leachate in the composting process of empty palm fruit bunches reduces the content of organic matter, organic carbon, total hemicellulose, cellulose and lignin in the compost produced faster than without adding leachate but reduces the C/N ratio and the increase in nitrogen content is faster without the addition of leachate. Previous research suggests that the activator in the form of leachate has an influence on the speed of decomposition and quality of compost (Mirwan 2018).

Figure 4 shows the effect of varying activator concentration and control of pH in the composting process. pH measurements in the four composting containers were carried out every day for 21 days with the results shown in Figure 4.

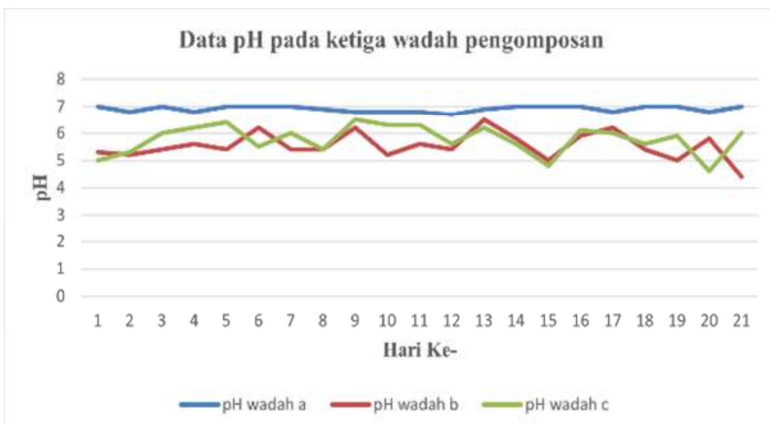

Figure 4. Daily pH comparison data of 3 composting treatments

During the composting process, pH measurements were carried out in the three experimental containers. To see the effect of pH in the composting process. From Figure 4 it can be seen that it fluctuated, allegedly because of the compost material had not decomposed completely that give fluctuated measured pH by using a soil tester.

The results of pH measurements carried out in container A as a control showed that the highest pH was 7 and the lowest pH was 6.8. Container B which had the EM4 activator added had the highest pH of 6.5 and the lowest with a pH of 4.4. In container C which had added the leachate activator, it had the highest pH with a pH of 6.5 and the lowest of 4.6.

The pH of compost in container A (control) of 6.90 meets the pH requirements in accordance with SNI 19-7030-2004, with a minimum value of 6.80 and a maximum of 7.49. Meanwhile, the average pH in container B (with EM4 activator) and container C (with leachate water) are at a value of more or less than the requirements specified by SNI 19-7030-2004 with pH of 5.54 and 5.58. According to Putra et al. (2018) during the compost making process, the organic acids become neutral and the compost matures, usually reaching a pH of between 6-8. Apart from pH, another environmental factor that influences the composting process is humidity.

Humidity plays a very important role in microbial metabolic processes, and indirectly affects oxygen supply (Widarti et al., 2015). Moisture is the percentage of water content of a material which can be expressed on a wet basis or on a dry basis. Humidity measurements in the four composting containers were carried out every day for 21 days with the results shown in Figure 5.

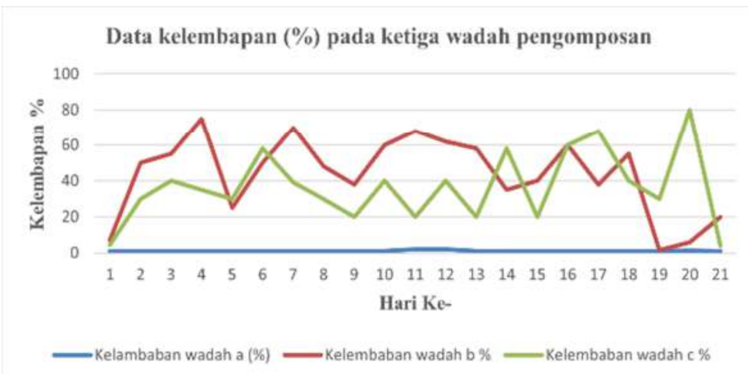

Figure 5. Daily data of humidity (%) for three composting process

The results of humidity measurements carried out in container A as a control had humidity between 1 and 2%. Container B with addition of EM4 activator had humidity between 1.5% and 68 In container C with leachate activator added, it had the highest humidity between 3.9% and 80%.

Figure 5 shows that the highest value of humidity of composting process occurred in container C which is 80%. This is suspected because of empty bunches contain the highest water content. According to Nasrin et al (2008) empty palm oil bunches identified to contain very high water content of around 60%-65%, and contain potassium (K) which reaches 2.4%, besides that they are also known to contain chlorine (Cl). Apart from that, humidity is also influenced by the addition of organic leachate.

The results of observations during the composting process regarding the temperature changes, at high temperatures it is characterized by water vapor on the lid of the composting container which is produced from heat. While at low temperatures the water vapor produced is little or almost non-existent. Temperature measurements in the four composting containers were carried out every day for 21 days with the results shown in Figure 3.

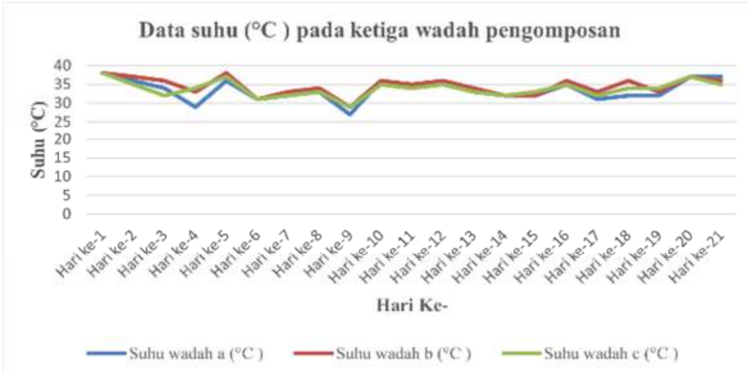

Figure 6. Daily temperature data for the three containers during the composting process

The temperature measurements were carried out on container A as a control had the highest temperature of 37 ºC and the lowest temperature of 27 ºC. Container B with EM4 activator added had the highest temperature of 38 ºC and the lowest temperature of 29 ºC. In container C which had added the leachate activator, the highest temperature was 38 ºC and the lowest temperature was 29 ºC.

Figure 6 shows that, in the composting process carried out, the mesophilic temperature in container A occurred from the first day to the 21st day of composting. According to Widiyaningrum and Lisdiana (2015), compost material undergoes three stages of the composting process, namely the mesophilic stage, thermophilic stage, and compost ripening stage. The composting process begins with the mesophilic stage, namely microorganisms that live at temperatures of 25-40ºC.

The next stage is the thermophilic stage, the microorganisms involved in this stage can live at temperatures of 25-40ºC, and play a role in degrading organic materials quickly, by consuming carbohydrates and proteins. Figure 3 shows that the peak temperature in the containers (A, B, and C) during the composting process occurred on day 5, namely reaching 36ºC, 38ºC, and 37ºC. However, the peak temperature in the three containers only lasted for 1 day, this is because of the compost material used was 5 kg, which made the compost material lose heat more slowly. These results are in accordance with research by Suwatanti and Widiyaningrum (2017) which found that an increase in temperature occurs due to bacterial activity in decomposing organic matter.

The heat generated from microbial activity is associated with an increase in temperature and microbial metabolism in the degradation process. The higher the temperature, the more CO2, water vapor and heat resulting from metabolic decomposition of organic compounds and the faster the decomposition process (Widiyaningrum and Lisdiana, 2015). The microorganisms that live at this stage are thought to be Actinomycetes and thermophilic fungi, some of the Actinomycetes are capable of breaking down cellulose and hemicellulose. Temperatures higher than 60°C will inhibit microbial performance and only thermophilic microbes will survive (Royaeni et al., 2014). When very active decomposition of organic material occurs, the microbes in the compost material will decompose the organic material into CO2, water vapor and heat through a metabolic system with the help of oxygen (Kurnia et al., 2017). The hot steam produced is what causes the temperature to rise and fall during the composting process.

The final result of composting is the result of analysis of C-Organic content, N-Total, P-Total content, K-Total content and C/N ratio

Table 4. Compost Quality Test Results using SNI 19-7030-2004

No	Parameter	SNI Standard 19-7030-2004			Compost Test Research Results		
		Unit	Min	Max	Container A (Control)	Container B (1L) EM4	Container C (1L) Leachate
1	C-Organic	%	9,80	32	31,56	25,11	38,11
2	Nitrogen (N-total)	%	0,40	-	0,43	0,69	0,68
3	Phosphate (P_2O_5)	%	0,10	-	0,06	0,19	0,09
4	C/N – Ratio		10	20	73,39	36,39	56,04
5	Potassium (K_2O)	%	0,20	*	2,17	1,81	3,39

Description: * The value is greater than the maximum or smaller than the minimum

Carbon is an important energy source for cell growth. In aerobic composting, organic material decomposes into CO2 through the metabolic system of microorganisms. Based on Table 4, it shows that analysis of C-organic levels in the control container as well as variations in activator concentration had an influence on the addition of activator. The C-Organic content obtained in container A (control) was 31.56%, container B (1L EM4) 25.11%, and container C (1L leachate) 38.11%. The C-Organic content obtained meets the requirements for mature compost according to SNI 19-7030-2004, namely between 9.8% - 32%.

According to Bachtiar and Ahmad (2019) during the fermentation process, changes in organic compounds occur which are caused by the activity of microorganisms, and are used as an energy source in the formation of microorganism cells, so that a lot of CO2 is released due to the activity of microorganisms which will affect levels C-Organic compost is produced.

Nitrogen is needed by microorganisms as a source of food and nutrition for the formation of body cells, and carbon as a source of energy to reproduce properly and produce energy (Irawan, 2014). Based on Table 4, it shows that analysis of total N levels in the control container and variations in activator concentration did not have an influence on the addition of activator. The total N content obtained in container A (control) was 0.43%, container B (1L EM4) 0.69%, and container C (1L Leachate) 0.68%. The total N levels in the three experimental containers met the compost quality standards according to SNI 19-7030-2004, the minimum required level is 0.40% and there is no maximum limit.

The increase in total N levels is thought to be due to microorganisms contributing a number of single cell proteins obtained during the composting process. After the decomposition process is complete, nitrogen will be released again as one of the components contained in fertilizer. This result is strengthened by the opinion of Sundari et al. (2014) which states that various types of nutrients, especially N as a result of the description, will be bound in the bodies of microorganisms and will later return after the microorganisms die.

In the composting process, the element P is needed by microorganisms to build their cells (Hidayati et al., 2010). In fresh organic material, P nutrients are usually found in complex organic forms which are difficult for plants to use directly for growth. However, after the composting process takes place, the activity of microorganisms will convert these nutrients into the form of PO42- (available P) which is easily absorbed by plants (Syafrudin and Zaman, 2007). The breakdown of organic matter and the process of assimilation of phosphorus occurs due to the presence of phosphatase enzymes produced by some microorganisms. If the number of microorganisms in the compost is less then the process of breaking down the organic material and the process of assimilation of phosphorus by microorganisms is also less so that phosphorus is less utilized, and vice versa if the number of microorganisms in the compost is sufficient then the process of breaking down the organic material runs perfectly (Tantri et al., 2016).

Based on Table 4, it shows that analysis of P-total levels in the control container and variations in activator concentration did not have an influence on the addition of activator. The P-total level obtained in container A (control) was 0.06%, container B (1L EM4) 0.19%, container C (1L Leachate) 0.09%. There were 2 total P levels in the three experimental containers that did not meet the compost quality standards according to SNI 19-7030-2004, the minimum required level was 0.10% and there was no maximum limit. The high and low total P content in compost is thought to be due to the large amount of phosphorus contained in the raw materials used, and the large number of microorganisms involved in composting. This result is strengthened by the opinion of Kurnia et al. (2017) which states that the P content increases with the weathering of composted organic material. At the compost ripening stage, the microorganisms will die and the P levels in the microorganisms will mix into the compost material which will directly increase the P content in the compost.

During composting, potassium is used by microorganisms in the substrate material as a catalyst, the presence of bacteria and their activity will greatly influence the increase in potassium content. Potassium is bound and stored in cells by bacteria and fungi. If the decomposition is complete, potassium will become available again (Hidayati et al., 2010). Basically, organic materials already contain potassium, but the potassium is still in complex organic form so it cannot be absorbed directly by plants. With the decomposition process, the complex organic material will break down into simpler organic material, thus producing the element potassium which can be absorbed by plants.

Based on Table 4, it shows that analysis of K-total levels in the control container as well as variations in activator concentration had an influence on the addition of activator. The total K level obtained in container A (control) was 2.17%, container B (1L EM4) 1.81%, and container C (1L Leachate) 3.39%. The K-total levels in the three experimental containers met the compost quality standards according to SNI 19-7030-2004, the minimum required level is 0.20%. If the initial compost material used has sufficient N content, then usually other nutrients such as P and K will be available in sufficient quantities in the compost, and a high K content in the compost material is thought to also have the effect of high K content at the end of composting.

The C/N ratio of compost is obtained from dividing the organic C value by the total N value of the compost. The C/N-ratio of organic materials is one of the important factors in the rate of composting, and also one of the most important aspects of total nutrient balance is the C/N-ratio. This is because composting depends on the activities of microorganisms which require N in the process of destroying materials containing high C. The C/N ratio is an important factor in composting. This is because composting depends on the activities of microorganisms which require carbon as an energy source and together with nitrogen for cell formation (Gaur, 1983).

Based on Table 4, it shows that the analysis of the C/N-ratio levels in the three experimental containers greatly influenced the addition of activator. The C/N-ratio level obtained in container A (control) was 73.39, container B (1L EM4) 36.39, and container C (1L Leachate Water) 56.04%. The C/N ratio levels in the three experimental containers have exceeded the quality standards for compost quality standards according to SNI 19-7030-2004, the levels required are a minimum of 10 and a maximum of 20. According to Tantri et al. (2016) states that good compost is compost that has a C/N-ratio of 10-12, while Novizan (2005) states that good compost is one that contains a C/N-ratio of 12-15, because according to quality standards SNI 19-7030-2004 good compost maturity contains C/N – the ratio has a value of (10-20): 1.

Conclusion

Based on the research that has been carried out, it can be concluded that:

1. The results of composting using the EM4 activator have a pH range of 4.4 - 6.2, humidity in the range 1.5 - 70%, temperature in the range 29 - 38 °C and the final composting result has a brownish black color, a smooth texture. rough and has an earthy smell, while composting using leachate has a pH in the range of 4.6 - 6.5 with humidity in the range of 3.9 - 80% and a temperature in the range of 29 - 38 °C and has the final result of compost with a brownish black color, a rough texture and has a slightly stinky odor.
2. The results of physical monitoring of composting of empty palm oil bunches using EM4 activator and leachate water on the 9th day, both had a brownish color, had a rough texture and had a slight smell of the bunches. However, on day 16 to day 21, the condition of the compost with the EM4 activator had a brownish black color, rough texture and had an earthy smell, while the condition of the compost with the leachate activator had a brownish black color, had a rough texture and had a slightly stinky smell. So compost with eEM4 activator has a faster composting time than using leachate.
3. The quality of empty bunch compost using EM4 activator was proven to be more in accordance with SNI 19-730-2004, namely blackish in color and had an earthy smell. Meanwhile, composting using leachate is still classified as not meeting SNI 19-730-2004 standards because it does not meet standards in terms of odor.

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