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Organic Liquid Fertilizer from Palm Oil Mill Effluent (Pome) Enriched by Indigenous Bacteria Activator

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Abstract

An experiment to produce organic liquid fertilizer from POME (Palm Oil Mill Effluent) which is enriched by indigenous bacteria activator had been carried out from October up to December 2011 and has taken place in Chemical Engineering Laboratory, Sriwijaya University, Palembang, Indonesia. This experiment was aimed to determine the contents of Nitrogen, Phosphorous and Potassium useful for liquid fertilizer in palm oil plantation. POME (Palm Oil Mill Effluent) used were from anaerobic waste pond No 3 at pH 7, temperature 30 ^{o}C, time range 5, 10, 15, 20, 25 days, and volume of indigenous bacteria media concentrate of 10%, 15%, 20%, and 25%. The result found that the best result was obtained from fermentation time of 20 days and volume concentrate 25%, and Nitrogen contents 0.444%, Phosphorous 0.207%, and Potassium 0.337%. It was concluded that the fermentation time and bacteria density played an important role in the liquid fertilizer's production.

Key words: Liquid fertilizer,POME, nutrient contents, indigenous bacteria, fermented time

1. Introduction

1.1. Background

Palm Oil Mill Effluent can be used as fertilizer on farm land throught *land application* of POME at certain conditions and contains nutrients that can be used for crops. According to the Decree of the Minister of Environment Republic Indonesian No 29 Year 2003 on the Use of Palm Oil Technical Guidelines, BOD of 3000-5000 mg / L was recommended in order to prevent environment pollution but still valuable enough for the plants. Nutrient content in 1 m^3 of POME BOD5 has approximately 5000 mg / L that equivalent to 1.5 kg urea, 0.3 kg SP-36, 3.0 kg and 1.2 kg MOP fertilizer kieserit. Palm Oil Mill Effluent with a capacity of 30 tons / hour will produce around 480 m^3 of liquid waste / day, so the area can be applied to the waste is 100-120 hectares (www.primatama.litbang.deptan. Go.id). Palm oil mill effluent contains macro nutrients such as N, P, and K required by palm tree. Therefore, the application of POME to palm oil farm land (*land application*) can save the cost fertilizer. The farmers preferred to use inorganic fertilizer because the nutrient content of inorganic fertilizers is relatively higher. Lately, the prices of in organic fertilizers have increase and pose additional land maintenance cost to the farmers. Addition of inorganic fertilizers can lead to dependence and may bring adverse effects, such as

land so damaged by overuse and continuously will cause the soil to be loud, polluted water, and the balance of the soil is disturbed (Indriani, 2004). To address these research needs that can turn waste into something useful. One of them in particular harnessing waste organic waste to liquid fertilizer raw materials so as to reduce the accumulation of waste and can assist farmers in providing fertilizer. During this compost produced from organic waste in solid form is plentiful. But rarely is a liquid, in more practical terms effluent used as fertilizer because the manufacturing process is relatively inexpensive, and manufacturing costs incurred is not too large (Hadisuwito, 2007). Raw materials are very good organic fertilizer from organic waste that is wet organic materials or organic materials that have a high water content such as waste oil. In addition to easily composed, this material is also rich in nutrients that plants need. The greater content of cellulose and organic matter (C / N ratio), the process of decomposition by bacteria takes longer (Purwendro and Nurhidayat, 2006). Based on this, researchers are interested to know the utilization of Palm Oil Plantation. Liquid fertilizer can be treated by several variables palm oil mill effluent with nutrient N, P, and K from a variety of BOD which is expected later to know one of the values of the above parameters, it can be predicted value of wastewater BOD or otherwise concerned with knowing BOD values can be predicted value of N, P, and K and palm oil mill effluent.

1.2. Objectives of Research

Knowing the quality of POME in the pond cross-section. see Palm Oil Plantation Optimum conditions NPK nutrients and MLSS with indigenous bacterial activator that can produce the best fertilizer. Getting a liquid fertilizer that meets the requirements of SNI. Determine the effect of POME / liquid fertilizers on the growth of oil palm plantations.

1.3. Benefits of Research

The benefit of this research is to provide POME treatment solutions Palm Oil Plantation into liquid organic fertilizer, tackle environmental pollution by way of reduce, recycle, recovery and reuse (R4), can reduce the cost of waste treatment Palm Oil Plantation, and to produce a draft wastewater treatment process effectively and efficiently, resulting in a design process of conversion by regulating POME variable operating conditions, and can be applied to the solid waste.

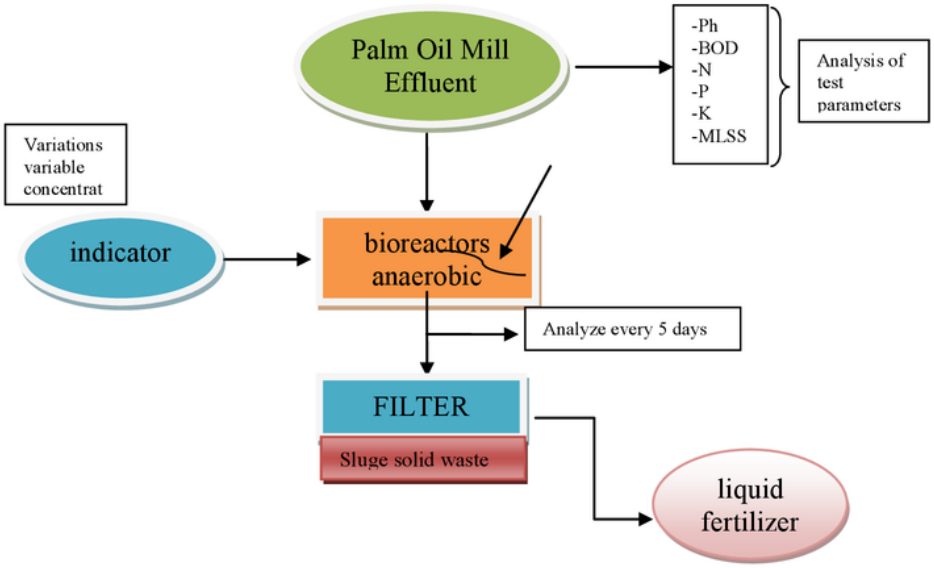
2. Materials and Methods

2.1. Materials and Methods

Chamber Anaerobic which size 35 x 20 x30 cm Chamber Anaerobic glass 5 inch hose clamp hose: the incoming feed faucet to take a sample thermometer, a pH indicator, Pasteur pipette, burette, stative, clamps, measuring flask, Erlenmeyer, stirrer, glass beaker and a measuring cup. Materials used primary anaerobic POME pond 2, which have been analyzed BOD, COD, pH, MLSS, N, P, K. Bacteria Indegenous with various concentrations for standard liquid fertilizer, but it is also used additives such as molasses and others.

2.2. Step Experiment

Figure 1: Process of Organic Liquid Fertilizer



3. Results and Discussion

3.1. Physical Properties of Organic Fertilizer

The results Palm Oil Mill Effluent Plantations are being subjected to a liquid organic fertilizer made physical changes. Physical changes have anything to do with the incubation period (Table 1). and the activator concentration variations.

In Table 1 it can be seen that the incubation period of 25 days of any change of liquid fertilizer Physical at Organic liquid fertilizer from POME anaerobic pond 3, a change color. color origin of anaerobic pond 3 is processed into fertilizer that is yellow to brownish, smelly and foamy after a few days of observation day 5 to day 25 undergoing rapid change which becomes darker, this resulting from process POME were Activators. From the observation of physical changes, POME from various concentrations of activators, namely 10%, 15%, 20% and 25%. According to Widowati (2005), the color change occurs as a result of the process of decomposition by microbes, which causes the materials used in the manufacture of organic fertilizer liquid dye loss. In liquid organic fertilizer fermentation process occurs which is characterized by a change in physical properties such as color, odor, and foam. The smell of liquid organic fertilizer that occurred on the day of incubation to day 10, the smell of froth/ beer and frothy. The foam is caused by the fermentation process that describes organic compounds into inorganic with the help of microorganisms that exist in the activator. Variables such properties also occur at an incubation time of 15 days at each concentration activator (10%, 15%, 20%, 25%). At the time of incubation of 15 days the color changes from brown to dark brown, at each concentration of activators of bad beer smell the liquid fertilizer.

Table 1. Changes in Physical Properties of Liquid Organic Fertilizer Palm Oil Mill Effluent Plantation

Variations concentration	character physical	Incubation time				
		5	10	15	20	25
Pond 3 Without treatment	Color odor foam	• *** xx	• *** Xx	• *** xx	• *** xx	• *** xx
10%	Color odor foam	• *** xx	• *** Xx	•• ** x	• ** x	•• ** xx
15%	Color odor foam	• *** xx	• *** Xx	•• *** xx	•• ** x	••• ** xx
20%	Color odor foam	• *** x	• *** X	•• * x	••• ** xx	••• * xx
25%	Color odor foam	• *** xx	• *** xx	•• *** xx	••• *** xx	••• *** xx

*Note : • = yellowish brown, •• = brown, ••• = brown, * = somewhat smelly, ** = smelly, *** = very smelly, x = a little frothy, xx = foamy*

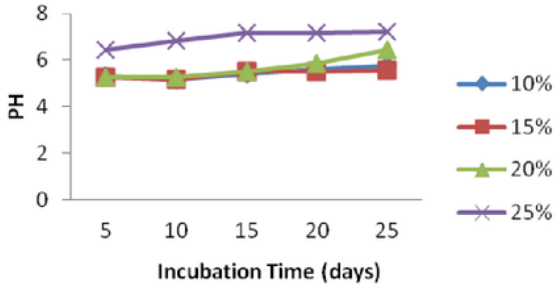
According Isroi (2008) odors that occur in the process of making liquid fertilizer caused anaerobic process where the process will result in compounds odors such as organic acids (acetic acid, sulfuric acid, valerate putrecine), ammonia from H_2S. At the time of incubation of 20 days the smell of froth is some what reduced from the liquid fertilizer and is still a bit smelly on the kind of concentration of 20%. On day 25 of incubation, variation activators of various concentrations (10%, 15%, 20%, 25%) is still a little smell wafted tape but froth / foam does not happen again and liquid organic fertilizer produced dark brown. This occurred in 20% while the activator concentration in consentration activator (10%, 15%, 25%), the organic fertilizer produced with still very smelly and there froth / foam, while the yellowish brown color compared to the concentration of 20%. In liquid organic fertilizer maturity level is determined by 3 aspecf the Physical, Chemical, and Biological (Murbandono, 1995). Based on the observation of liquid organic fertilizer 25 days is known that during the process of liquid organic fertilizer there is a change to the physical properties of liquid organic fertilizer that is the smell, the froth / foam, and color. Yunilas (2009) suggested that due to the changing nature of the proficiency level in the decomposition of biological materials for liquid organic fertilizer.

3.2. Effect of Activator Concentration Variations Against pH

Incubation time which give influence pH of the liquid organic fertilizer in Figure 2 can be seen all variations of the concentration of the activator, at the beginning of the decomposition process of organic matter decline in the value of pH neutral (7) and then an increase in the value of pH. At the end of the decomposition of organic matter on the type concentration 10%, 15%, 20%, 25% pH value decreased on day 5 where its pH value was 5.29, 5.28, 5.27 and 6.43. pH values

fell at the beginning of the decomposition process of organic matter due to the activity of bacteria such as lactic acid, acetic acid, pirenat acid, organic acid is derived from the decomposition of carbohydrates, protein and fat (Suriawiria 2003). In concentration activator of 20%, pH value is not decreased but the pH value is always increasing. According Djuarnani et al (2005) this is due to the existence of other types of microorganisms that convert organic acids are formed.

Figure 2. Changes in pH.



After a few days it will increase value pH, pH value which are due to be re-increased activity of micro-organisms in the breakdown of organic nitrogen into ammonia (Jenie and Rasayu 1998) determination of the value of pH due to other microorganisms By the advent of the materials described as methane bacteria capable of breaking down acetic acid to methane, so the pH will increase, micro-organisms will utilize organic acids produced. So the pH material will go back up after a few days (Mulyadi, 1994). Based on laboratory analyzes pH Organic liquid fertilizer produced in the range of acidic to slightly acidic. In each concentration activator of 10% pH 5.73, cocentration of 15% pH 5.54, concentration of 20% pH 6.42, and concentration of 25% pH 7.23. pH liquid organic fertilizer which is acidic allegedly ripping process is not perfect.

3.3. Effect of Activator Concentration Variations Of Nitrogen Content.

The LSD is known that the incubation time to give effect to the value of N-total liquid organic fertilizer. LSD test result shows that the interaction of the activator concentration variation with time of incubation of the value of N-total for each type of activator can be seen in Table 2

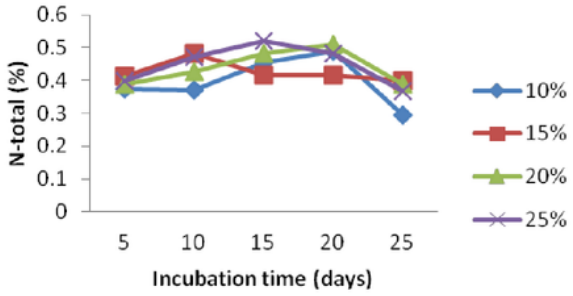
Table 2. The influence of activator concentration and incubation time on the content of nitrogen.

% Concentrate activators	Incubation time (days)				
	5	10	15	20	25
10%	0,376 a	0,370 a	0,454 b	0,491 b	0,295 a
15%	0,412	0,482 c	0,416 a	0,416 a	0,400 b
20%	0,388 a	0,426 b	0,482 b	0,510 b	0,388 b
25%	0,398 a	0,472 c	0,519 c	0,482 b	0,368 b

Note : The number followed the same letter in the same pool showed no real difference in the level of 5% LSD test

In Table 2 it can be seen that during the 5-day incubation period, the effect of% concentration of activators provide no significant effect on N-total, highest value contained in the activator concentration of 15% by 0.412% At 10 days of incubation concentration of 15% gives a different effect very real activator concentration of 10% and 20%. And unreal with activator concentration of 25%. At the time of incubation of 15 days, showed that the concentration of 10% and 15% gave no real effect and influence are significantly different from the concentration of 20% and a highly significant 25% activator concentration. At the time of incubation of 20 days give no real effect on N-total% activator concentration of 25%. Activator concentration of 20% and 10% still give effect different % concentration with 15% whilst the 25-day incubation at 15% activator concentration gave the effect is not noticeable to the activator concentration of 20% and 25% by value respectively 0.400%, 0.388%, and 0.368%. But all three types of activator concentration variation of 15%, 20%, and 25% this gives a significantly different effect on the activator concentration of 10% of the N-total liquid organic fertilizer with a value of 0.295%. Levels of nitrogen from organic liquid fertilizer that is analyzed Kjedahl Total Nitrogen (NTK), obtained results-total N content ranged from 0.409 to 0.463% as shown in figure 3.

Figure 3. Relationship incubation time with N-total



In figure 3 it can be seen for all types of activator concentration at the start of a process liquid organic fertilizer increased the value of N-total by Indriani (2004) this is because the process of making liquid organic fertilizer decomposition occurs (change) that increases the amount of carbohydrate will be lost / dropped and soluble N compounds (ammonia) increases. N-total value will decrease with increasing incubation time. In the activator concentration of 10%, 20% and 25% are impaired N-total on day 25 with respective values are 0.426%, 0.435% and 0.444% for a 15% concentration of activators N-total values have decreased on day to 15 at 0.416%. N-total decline in value because of a substantial overhaul of nitrogen by microorganism activity, but it also uses nitrogen to microorganisms metabolic activity of life (Notohadiprawiro 1999). Thus at the end of the liquid organic fertilizer derived N-total content is lower.

3.4. Effect of Activator Concentration Against The content of Phosphate (P)

The LSD value phosphate on the interaction with the activator concentration type indicates the effect of incubation time were varied. Interaction with the activator concentration incubation time are presented in Table 3

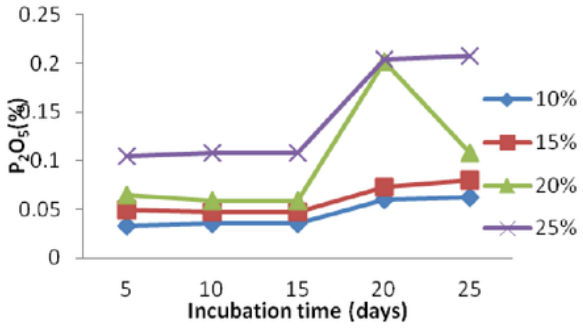
Table 3.The effect of multiple concentrations of activator and incubation time on P_2O_5 content - Total (%).

Type of activator concentration	Incubation time (days)				
	5	10	15	20	25
10%	0,033	0,036 a	0,036 a	0,060 a	0,062 a
15%	0,049 b	0,047 b	0,047 b	0,073 b	0,080 b
20%	0,065	0,059 c	0,059 c	0,202 c	0,108 c
25%	0,105 d	0,108 d	0,108 d	0,204 c	0,207 c

Note : The number followed the same letter in the same colum showed no significant difference in the level of 5% LSD

From table 3 it can be seen that the incubation time 10, 15, and 20 days differ very real influence each other. Highest value on day P_2O_5, the 10 and the 15 are the activator concentration of 25% to the value of each day is 0.105%, 0.108% and 0.108%. At the time of incubation of 20 and 25 days, it appears that the concentration of activators 25% had no real influence with the activator concentration of 20% and differed significantly with activator concentration of 15% and 10%. Results highes present in a concentration of 25% at 0.204% at day 20 and 0.207% at the time of incubation to 25.

Figure 4. Incubation Time Relationships with P_2O_5



Based on Figure 4 can be seen that the activator concentration of 10%, 20% and 25% have increased nutrient incubation begins with P values respectively 0.36%, 0.59%, 0.108% this is not the activator concentration of 15% by value 0.047%. And further phosphorus content in liquid organic fertilizer has increased by day 25 but not for 20% activator concentration.

3.5. Effect of Activator Concentration Against The content of potassium (K)

Under the influence of LSD known activator concentration versus time of incubation with the content of potassium in liquid organic fertilizer. Interaction are presented in Table 4

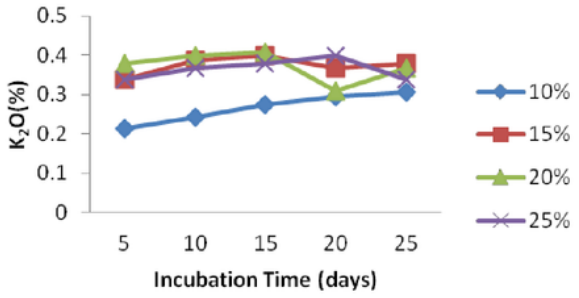
Table 4 The impact of activator concentration and incubation time on the content of K_2O - total (%)

Type Activator Concentration	Incubation time (days)				
	5	10	15	20	25
10%	0,213 a	0,244 a	0,275 a	0,295 a	0,307 a
15%	0,337 b	0,388 b	0,400 b	0,368 b	0,378 c
20%	0,378	0,400 b	0,409 b	0,308 b	0,368 bc
25%	0,337 d	0,368 b	0,378 b	0,400 b	0,337 ab

Note : The number followed the same letter in the same colum showed no significant difference in the level of 5% LSD

The LSD showed that the 5-day incubation period showed diverse relationships on any kind activator. At the time of incubation of 10, 15 and 20 days is known that the concentration of activators 15%, 20% and 25%. Gives a significantly different effect on potassium liquid organic fertilizer when compared with the activator concentration of 10%. At an incubation time of 25 days is seen that 25% activator concentration did not differ significantly with the concentration of activator, activator concentration of 20% and 10% and differed significantly with 15% activator concentration. Higher potassium values obtained at the concentration of 15% is 0.378% and the lowest at 0.307% concentration of the activator. Based on the laboratory analysis of the value of K flamefotometer method during incubation is known that the incubation time has a relationship with the content of potassium in liquid organic fertilizer. Relationships with Potassium incubation time can be seen in Figure 5

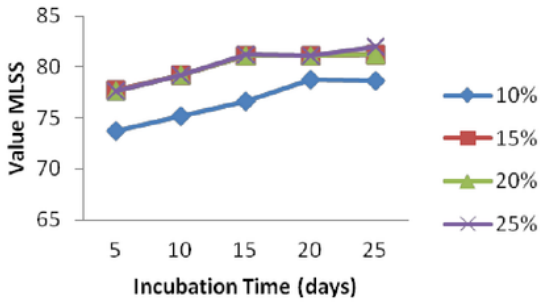
Figure 5. Relationship with K_2O-incubation time in total.



Based on the pictures it can be seen that 5 of incubation at 5, 10, 15, 20, and 25 days worth Potassium on any type of activator concentration increased. At the 25-day incubation period decreased potassium values for each concentration of activators Potassium impairment for activator concentration is 0.378% of 15%, 20% concentration of the activator is an activator concentration of 0.368% and 0.337% of 25% Declining value of Potassium on organic liquid fertilizer is caused by the decomposition of organic matter. According Notohadiprawiro (1999) it is thought to be caused by the activity of microorganisms. Microorganisms in addition to over hauling Potassium, Potassium also used for metabolic activity of life.

3.6 Effect of Activator Concentration Variations Of Mixed Liquor Suspended Solids (MLSS)
Effect of variation in the concentration of activators to the allowance Mixed Liquor Suspended Solids (MLSS) within the whole system can be seen in figure 6

Figure 6. Relationship incubation time with the MLSS



Allowance MLSS in the tubs anaerobic activator concentration of 10%, 15%, 20% and 25%. The results of the calculation of the allowance MLSS concentration of activators to 10% in the overall system (figure a) shows that the variation of the concentration to 5 percent decrease 73.78%, day 10 amounted to 75.21%, 76.65% at day 15 to day 20 of 78.75% today to 25 by 78.64%. Similar results were also obtained in 15% activator concentration where the separation MLSS percent on day 5, 10, 15, 20, and 25 on average respectively 77.67%, 79.15% 81.15% 81.15% 81.25 results in anaerobic basin to variations in the concentration of 20% in the whole system obtained MLSS per cent allowance for days 5, 10, 15, 20 and 25 respectively, 77.67%, 79.15% 81.15% 81.15% 81.24%. while for activator concentration variation of 25% on day 5, 10, 15, 20, and 25 at 77.67%, 79.15%, 81.15% 81.15% 82.03% was an increase of MLSS in the tubs anaerob at a concentration of 25%. In general, removal efficiency shows that are not significantly different MLSS. This shows that the process of separation of solids in the POME is hardly affected when fluid retention. Filtration is a separation process that was suspended in the fluid based on the physical characteristics of solids include the size and shape of the particles (Montgomery 1975: Foust 1980)

3.7. Nutrient Content of Liquid Organic Fertilizer

Liquid organic fertilizer contains nutrients needed by plants, especially of N, P, and K. Resulting from nutrient liquid fertilizer using different activators concentration 10%, 15%, 20% and 25% contains N, P, and K are different. In detail can be seen in table 5.

Table 5 the effects of activators for PH, N-total and K-total.

Type activator concentration	N-total (%)	P_2O_5 (%)	K_2O (%)
10%	0,426	0,062	0,306
15%	0,417	0,080	0,382
20%	0,444	0,108	0,386
25%	0,444	0,207	0,337

From Table 5 shows the overall nutrient content of organic liquid fertilizer that given the increased variety activator concentration greater equivalent liquid organic fertilizer that is not given activator concentration that is 10% smaller and this is because the greater the concentration of activators of the more contain microorganisms that affect decomposition Palm Oil Mill Effluent (POME). Microorganisms contained in any work % effective concentration of activators can add nutrients when organic material in a state of pretty. The organic matter is a source of food and energy. As a source of food microorganisms then given a liquid organic fertilizer added sugars. In Table 5 it is known that each type of activator has a total value of N-total P_2O_5 and K_2O total is total. N-total and the highest P_2O_5 contained in the activator type and concentration of the activator concentration of 25% by value of the 0.444% and 0.207%. The high value of N-total activator concentration 25% are caused by microbes that grow and develop more quickly because of the percent concentration of activators, obtained non-symbiotic bacteria Nitrogen fixation is Lactobacillus sp streptomyces sp and Azotobacter which serves to bind the nitrogen in the manure increased. At the table 5 this also shows that the highest potassium content product of organic liquid fertilizer contained in the activator concentration of 20% with a value of 0.386%. Potassium content of the activator concentration of 20% is not much different from the content of potassium in concentrations of 15% with a value of 0.382%. It is thought activator concentration of 20% and 15% are not much different from the growth of Lactobacillus Sp Microorganisms, streptomyces sp and Azotobacter. Overall the nutrient content of organic liquid fertilizer were added% larger compared activator concentration liquid organic fertilizer which is low given the% concentration of the activator concentration of 10%, this is because% concentration affect microorganism growth will affect the processing of Palm Oil Wastewater (POME) Microorganisms contained in any concentration of activators can work effectively for additional nutrients when organic materials in an organic material is enough food and energy source. Microorganisms as food sources so the liquid organic fertilizer given the addition of sugar.

4. Conclusion

The research concluded that percent variations of activator's concentration affect the physical changes of liquid organic fertilizer such as odor, color, foam. The pH of the organic fertilizer from POME at various concentrations of Activators at 10% is 5.73, at 15% is 5.54, at 20% is 6.42, and 25% is 7.23. The nutrients (N) content of organic Fertilizer produced from POME also varies according to the concentration of activators. At activator's concentration of 10% the N content are N is 0.426%, P_2O_5 is 0.062%, and K_2O is 0.306%. Activator concentration 15% had N content of 0.417%, P_2O_5 is 0.080% and K_2O is 0.382%. Activator concentration 20% had N content of 0.444% P_2O_5 is 0.108% and K_2O is 0.386%. Activator concentration 25% had N content of 0.444%, P_2O_5 is 0.207% and K_2O is 0.337%. The study found the best activator concentration was at 25% with the increase of each nutrient if the liquid organic fertilizer harvest on the day 20 and declined on day 25.

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