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AEROBIC-ANAEROBIC COMPOSTING IN OIL PALM FACTORY WITH BUNKER SYSTEM

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Abstract

Oil palm biomass, which includes fronds of oil palm leaves, oil palm fiber and palm kernel shells, empty fruit bunches, liquid waste from oil palm, and other mill wastes, can pose significant environmental hazards. Solid waste and liquid waste have the highest potential for composting. As a result, the goal of this study is to determine the composting features of aerobic-anaerobic systems in palm oil mill bunkers. The research was conducted at PT Eastern Sumatra Indonesia, Bukit Maraja POM, Simalungun Regency, with samples evaluated at Medan's Socfindo Laboratory and Bogor's Center for Research and Development of Biotechnology and Agricultural Genetic Resources. The data acquired in Farm Manager's PLC (Process Logic Control) system was evaluated visually, as were the results of compost qualities from the aerobic-anaerobic system in bunker. Compost made from empty fruit bunches (EFB) via aerobic and anaerobic processes has varied characteristics. The nutrients for N=1.9%, P=0.39%, K=2.48%, Ca=0.31%, Mg=0.4% and pH =8.59% of anaerobic compost are greater than those produced by aerobic compost in bunker.

Composting in an aerobic system may suppress the generation of Methane (CH_4) gas until it is undetected, however composting in an anaerobic system can detect a high level of Methane (CH_4) gas formation.

Keywords*: nutrient, organic fertilizer, methane, empty bunch, effluent*

Introduction

Composting is a viable option since oil palm mill waste is organic and contains a high organic content. Because of its high organic content, this waste has the potential to cause environmental problems in the long run. Inadequate disposal in open regions might result in groundwater leakage or runoff polluting nearby waterways. Improper waste disposal can also result in cosmetic concerns as well as airborne infections, which may be the source of various vector-borne illnesses. As a result, in environmental management, garbage reduction or recycling should be prioritized. Composting is an effective organic waste management method (Embrandiri et al., 2013).

Palm oil industry biomass, which includes oil palm leaves, fibers, palm kernel husks, empty fruit bunches, and liquid waste from palm oil mill effluent, among other things, can cause serious environmental problems. The amount of rubbish generated by the palm oil industry grows year after year as the industry expands (Vakili et al., 2015)

Palm oil mills have the most difficulty dealing with solid and liquid waste. The effluent from Crude Palm Oil (CPO) plant sewage treatment facilities in Indonesia (the ultimate product discharged to nature) is still frequently noncompliant, with Biochemical Oxygen Demand (BOD) still exceeding 100 ppm (Rahardjo, 2010).

Because liquid waste from palm oil mills (POM) has extremely high levels of BOD and COD (chemical oxygen demand) before entering the plantation, BOD and COD from liquid waste must be reduced (Febijanto, 2010). Apart from liquid waste, POM does not handle solid waste to the best of its ability. The most frequent solid wastes created by the palm oil industry during processing in POM are empty fruit bunches (EFB), nut husks, fibers, sludge or sludge and nuts. There is also solid waste from sewage treatment facilities in the form of activated sludge, as well as incineration ash from EFB combustion in incinerators, where EFB produces 0.5 % ash. The most common sort of solid garbage is empty fruit bunches (EFBs), which are frequently disposed of on oil palm plantation vacant lots or burned in incinerators (Syahwan, 2012).

Empty fruit bunches are the most prevalent sort of rubbish produced by the palm oil manufacturing business (EFB). One ton of fresh fruit bunches (FFB) processed yields 0.21 ton (21%) crude palm oil and 0.05 ton (5% palm kernel oil), with the remainder being waste in the form of empty fruit bunches, fiber, and kernel shells, which account for 23%, 13.5%, and 5.5% of fresh fruit bunches, respectively (Schuchardt et al., 2002). Empty bunches have not been used as fuel for power generation in Indonesian palm oil mills since it requires particular equipment, but there are several CDM (Clean Development Mechanism) projects in Malaysia that have used empty bunches as fuel for power plants. The empty bunches are not only used as fuel for electricity generation, but there are currently efforts underway to use them as raw material for fertilizers.

In a perfect world, both solid and liquid waste would be compostable. Composting, as defined by Potgieter (2012), is the degradation of biologically complicated organic waste into a simple, relatively stable substance that resembles humus under controlled aerobic circumstances. Composting, or the conversion of agricultural waste into compost, is one of the most popular, cost-effective, and straightforward techniques of digesting and stabilizing waste and producing organic fertilizer (Vakili et al,.2015). Composting is one approach for boosting the nutritional value and minimizing the amount of lost oil palm fruit bunches, according to Syukri et al (2019). The use of empty oil palm fruit bunches as compost material would solve the problems caused by the accumulation of empty oil palm fruit bunches in the factory, as well as generate additional benefits from compost sales and lower the cost of utilizing inorganic fertilizers. As a result, the goal of this research is to find out the characteristics of compost from the aerobic-anaerobic system in the palm oil plant to be used as organic fertilizer.

Materials and Methods

Research Materials

1. Oil Palm Factory liquid waste (73%)
2. Solid waste (empty fruit bunches) (27% with C/N =57.6)
3. Air

Research Tools

1. Bunker where empty bunches are stored with liquid waste
2. Wheel Loader for compost transfer
3. Temperature sensor (temperature probe)
4. Oxygen gas sensor
5. Methane gas sensor
6. Hose
7. Liquid Waste Pump
8. Air Pump (Exhaust Fan)
9. Conveyor

10. Fiberized (shredder) machine for chopping Empty Fruit Bunches
11. Bunch Press (Single Barrel)
12. Bunker Filling Machine
13. Telescopic Handler (JCB) for cleaning spraying pipes

Research Methods

The research was conducted at PT Eastern Sumatra Indonesia's Bukit Maraja POM in Simalungun Rule, with testing conducted at Socfindo Research Facility in Medan and the Center for Investigate and Improvement of Biotechnology and Agrarian Hereditary Resources' Research Facility in Bogor.

1. Filling Bunker of Empty Fruit Bunches Fiber and liquid waste
    a. 90 ton empty natural product bunches from the Palm Oil Process are chopped into 10-15 cm pieces on the Fibrelizer machine every day, at that point the fiber is squeezed on the Bunch Press to expel the remaining palm oil, which is around 1.5 % and includes a dampness substance of around 53 %.
    b. The fluid squander is streamed to the bunker for watering purge bunch filaments whereas the result of chopping strands of purge bunches through a transport is exchanged to the bunker slowly. When fluid squander soaked the filaments, which were obvious on the heap of purge bunch filaments, it was essential to halt watering.
    c. It takes approximately 5 days for the purge bunch fiber to fill the 500-ton bunker, after which it is carried to the maturation bunker

d. The surrounding temperature A test sensor is utilized to puncture a heap of purge bunch strands whereas concurrently observing oxygen and methane levels with a sensor hose. The oxygen consuming prepare is carried out within the bunker by ventilation the record of purge bunch fiber with a temperature of 60-70 °C, an oxygen gas substance of 16-20%, and a methane gas level of 0%. Temperature sensors, oxygen gas, and methane gas can be recorded from the influence of composting exercises within the bunker utilizing an anaerobic handle with no discuss presentation on heaps of purge bunch fiber.

e. There are two filling bunkers, which are then again utilized to fill purge bunches and fluid squander from the Palm Oil Process.

2. Fermentation Bunker

a. Once the bunker is full, a wheel loader is utilized to exchange the blend of purge bunches and fluid squander to the aging bunker, where the wheel loader is utilized to put purge bunches into bunker #3 with the assistance of the Bunker Filling Machine device so that the purge bunch fiber that will be fermented to compost within the bunker is dispersed more equitably. When the filling bunker is purge, a adaptive handler must be utilized to clean the pipe stream.

b. After the purge bunch fiber is exchanged to bunker #3, the air circulation handle is begun by blowing discuss into the heap of purge bunch fiber within the bunker with a temperature of 60 °C-70 °C, an oxygen gas substance of 16 % - 20%, and a methane gas substance of 0%.

c. Each bunker's maturation strategy includes watering fluid squander for 2 minutes at a time, with a 60-minute delay between watering fluid waste

d. Each bunker's maturation prepare takes 6 days, in this manner the purge bunch fiber is moved to the another bunker in arrangement each 6 days until bunker #8, employing a to begin with in, to begin with out (FIFO) approach.

e. For purge bunches and fluid squander, there are six aging bunkers, which are utilized in arrange. As a result, the compost delivered in bunker #8 takes the specified time for aging, which is 30 days, some time recently being put within the stacking region and prepared for utilize within the field.

3. Observations made on the aerobic-anaerobic composting process (data obtained) are:
   a. Temperature at each bunker
   b. Oxygen gas rate at each bunker
   c. Methane gas rate at each bunker
4. Readily applied samples of compost from aerobic processing were taken in the loading area for observation in the laboratory with observation parameters:
   a. pH
   b. C contents
   c. N contents
   d. C/N ratio
   e. Nutrient content of N, P, K, Ca dan Mg

Data Analysis

The findings of the aerobic-anaerobic framework's compost features were examined using the Graphical Strategy, and the obtained data were assessed in the form of a chart recorded on the PLC (Process Logic Control) framework inside the Cultivate Supervisor.

Results and Discussion

pH Compost with Aerobic and Anaerobic Process

The pH values of all observed aggressively handled compost periods were all neutral (6.15-6.91), but the pH of anaerobically handled compost was all acidic (8.47-8.59) (Figure 1). Due to the discussion circulation through the nine holes within the cap of each compost holder, unbiased pH conditions are maintained. These circumstances aid in the discharge of carbon dioxide gas trapped between the compost chambers, allowing acidic conditions and drastic pH reductions to be avoided. Antacid conditions are thought to be beneficial for composting because they help to inhibit the growth of pathogens.

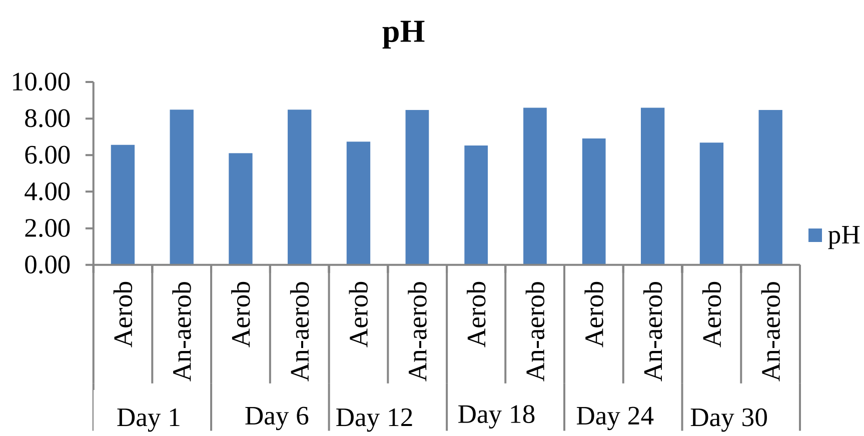

Figure 1. Fluctuation of Compost pH with Aerobic and Anaerobic Process

pH variations in the oxygen-consuming composting prepare are caused by microbial activities during the composting process. According to the results of phylogenetic research, Ensifer adhaerens, Aspergillus flavus, Aspergillus fumigatus, Trichoderma asperellum, and Rhizopus microspores are among the tiny organisms that play a role in composting. Ammonification, or the conversion of nitrogen into NH_3 or NH_4^+, is characterized by fluctuations in pH levels that tend to climb during the composting process (Zakarya et al., 2018). The pH of the compost fabric has decreased from day 24 to day 30 of composting due to ammonium dissipation and hydrogen particle discharge via a process known as nitrification (Gao et al., 2010). The pH esteem of each compost changes, but it remains within the antacid range, which is regarded good, and the co-composting strategy is unaffected.

According to Saraswati et al. (2017), the optimal pH level is 8 (2017). If the compost fabric has a pH more than 8, alkali gas is produced and released into the environment. The act of discharging corrosive generates a temporary or localized reduction in pH. (fermentation). Other microorganisms will then utilise natural acids as food and produce smelling salts from nitrogen-containing molecules, leading the pH to climb in the early stages of composting before reverting to normal in develop compost. In anaerobic composting, the higher the pH, the faster the compost grows (Irvan et al., 2014). This contrasts to the C/N value obtained by the anaerobic approach (Figure 2).

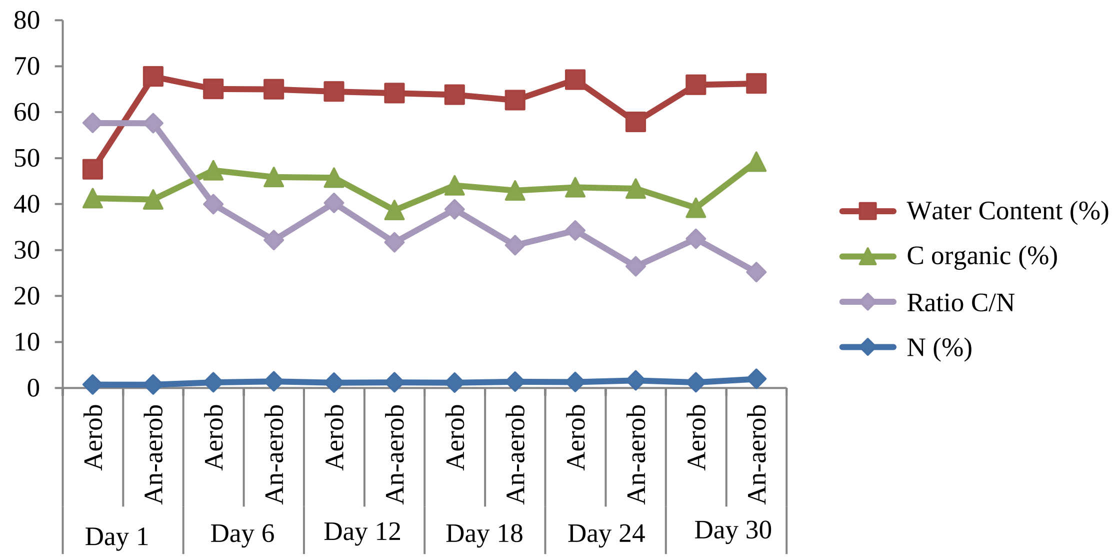

Figure 2. Characteristics of Compost With Aerobic and Anaerobic Systems

C/N Compost with Aerobic and Anaerobic Process

The carbon-to-nitrogen (C/N) proportion may be a key metric for deciding compost development and soundness. Agreeing to Figure 2, the C/N proportion steadily dropped amid the composting handle at all stages. On the primary day of composting, the C/N proportion was 57.63 for high-impact composting and 57.58 for anaerobic composting, which was respected tall due to the tall carbon and cellulose substance in palm oil squander. Anaerobic treatment of palm oil squander compost decreases the C/N proportion speedier than high-impact treatment, coming about in a more satisfactory C/N proportion. On the 6th day of composting, the C/N proportion for each sort of composting strategy, to be specific 39.96 for oxygen consuming and 32.12 for anaerobic, diminished. On the 12th day, the C/N proportion within the anaerobic compost diminished to 31.67, though the C/N ratio within the high-impact compost climbed to 40.42. On day 18, the C/N proportion within the oxygen consuming and anaerobic forms declined once more, with values of 38.81 and 31.05. The least C/N proportion in anaerobic compost was 26.45 on day 24, whereas the C/N proportion in high-impact compost fell marginally to 34.27 on day 24. At that point, on day 30, the anaerobic compost C/N proportion dropped to 25.19, whereas the high-impact compost C/N proportion rose to 32.42. In spite of the drop in nitrogen, dynamic biodegradation with the assistance of lots of actinomycetes within the compost come about in a huge diminish in carbon substance. As a result, the C/N proportion can still appear a moderate drop. The C/N proportion gotten from this oxygen consuming composting method is comparable to that of Baron et al., (2019) of 30%, but requires a longer composting period of 60 days.

Compost Water Content with Aerobic and Anaerobic Process

The sum of water in natural compound is measured by its water substance. Mugginess features a critical affect on microbial metabolic forms and, as a result, on oxygen conveyance.

Figure 4.7 appears that after 6–30 days, the dampness level of the compost fabric remained or maybe steady, extending from 63.7–65.9% in oxygen consuming frameworks to 62.1–66.25 % in anaerobic composting. On the off chance that a natural substance is solvent in water, microorganisms can take advantage of it. Rahmadi et al., (2014) states that the ideal dampness or mugginess content is 40-60 %, with 50 % being the leading (Saraswati et al., 2017). This run must be kept up in arrange to get the greatest number of microorganisms conceivable, because the bigger the populace, the speedier the fabric will break down. The nearness of water within the composting handle helps the decay handle by permitting microorganisms to flourish. Microorganisms can advantage from natural substances that are dissolvable in water, agreeing to Warsito et al. (2016).

Compost Carbon Content with Aerobic and Anaerobic Process

Amid the perception period, the carbon substance of each composting strategy appeared comparative varieties, expanding and diminishing amid the composting period (Figure 2). The C substance of the compost fabric with high-impact and anaerobic frameworks was 41.3 and 41 % at the begin of composting, separately, whereas by the completion of composting (30th day), it was 39.22 % within the oxygen consuming process and 49.24 % within the anaerobic prepare. The drop in carbon content suggests that microorganisms are respiring, coming about within the arrangement of CO_2.

The C-Organic substance gotten in this consider meets the SNI compost 19-7030-2004 criteria. The diminish in C-organic concentration may be a sign that decay is happening. There's a move in add up to C-organic substance amid the composting of natural matter. The misfortune of carbon as carbon dioxide causes the C-organic move. The microbial action that plays a portion in composting decides the corruption of carbon particles. In composting, the carbon dioxide discharged by oxidation means an increment in microbial movement.

When natural matter is presented, microorganism action increments, as does the method of breaking down natural matter, which makes carbon (Yunindanova et al., 2013). The discoveries of this ponder authenticate those of Wibowo et al., (2017), who found that the compost of purge natural product bunches created by palm oil plants can be a source of supplements. The tall carbon substance of purge natural product bunch compost acts as a soil conditioner.

N Rate of Compost with Aerobic and Anaerobic Processes

Made strides brooding time expanded N rate in all composting forms inspected (Figure 2). The greatest rise within the high-impact approach happened 24 days after hatching, coming about in N of 1.27 %, while the greatest increment within the anaerobic compost strategy happened on the 30th day, coming about in N of 1.96 %. These discoveries point to the probability of tall sufficient microbial action, especially among lignolytic microbes, coming about in a rise in populace, movement, and protein levels. According to Riniarti et al. (2012), component N contains a work within the arrangement of photosynthetic proteins, and the chlorophyll substance of takes off underpins this speculation. The in general nitrogen substance of compost made from purge natural product bunches met the criteria for being utilized as an natural fertilizer. It meets the SNI 19-7030-2004 criteria for compost quality from natural squander, which is at slightest 0.4 %.

The composting strategy and the crude materials utilized have a enormous affect on the nitrogen concentration of the compost. Since there's sufficient O_2 for organisms to change over proteins into ammonium and nitrate when composting takes put beneath perfect conditions, the nitrogen substance of the compost will be tall. Moreover, in the event that the nitrogen concentration of the compost crude fabric is high and there's adequate carbon, the microbes will deliver a large amount of ammonium. A diminish within the weight of compost fabric moreover contributes to the rise in nitrogen substance. It is since of the dissipation of CO_2 and H_2O and the discharge of a number of supplements through the mineralization prepare which comes about in expanded nitrogen concentration within the compost.

Macro Nutrient Content of Compost with Aerobic and Anaerobic Systems

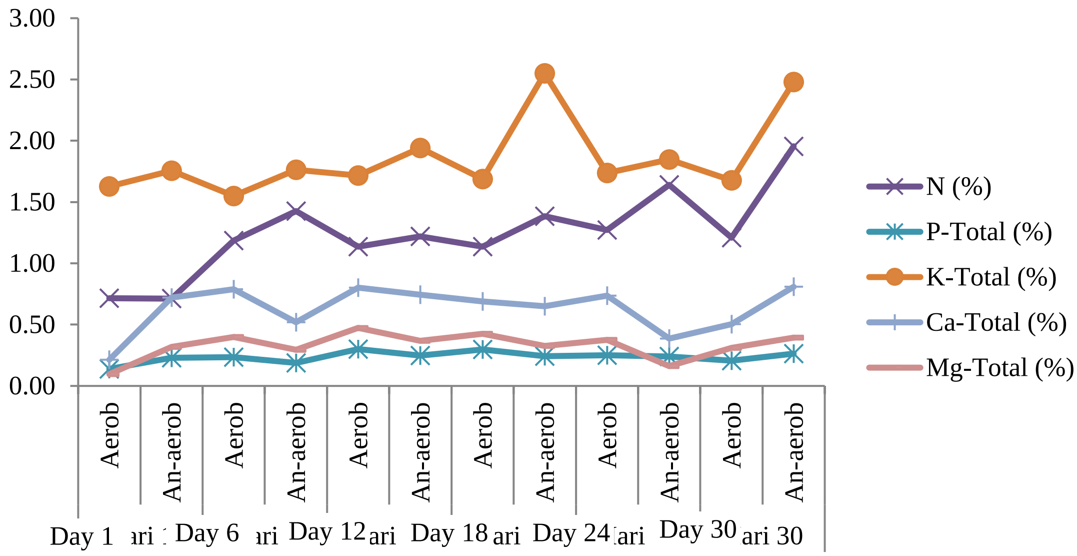

Figure. 3. Macro Nutrient Content of Compost with Aerobic and Anaerobic System

The high-impact composting approach created lower levels of P, K, Ca, and Mg than the anaerobic composting strategy. The C/N proportion of the fabric created in each stage of observation/process is related to the higher substance of these components within the anaerobic framework. This wonders is steady with Widarti (2015) discoveries, which appear that the C/N proportion of compost source materials impacts the generation of compost with the next P substance. This should do with bacteria' inclusion in changing over existing natural substances to natural phosphorus. Natural P compounds are changed and neutralized back into natural compounds, and they play a basic part in soil ripeness by retaining supplements from natural matter.

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Not only is empty fruit bunch ash high in metals like calcium and potassium, but it also contains additional readily available elements like chromium, zinc, salt, and magnesium. Overall, high concentrations of potassium can justify their usage as organic fertilizers in the presence of significant quantities of anions such as nitrate and phosphate. This also demonstrates that OPEFB can be employed to boost hydrocarbon potential and prevent hydrocarbon degradation. It is because it contains high levels of nitrate, phosphate, and potassium (Udoetok, 2012). Add up to N

(1.91 %), K (1.51 %), Ca (0.83 %), P (0.54 %), Mg (0.09 %), C-organic (51.23 %), C/N proportion 26.82 %, and pH 7.13 are among the supplements found in oil palm purge natural product bunch compost, agreeing to Hayat & Andayani (2014). OPEFB natural fertilizer encompasses a double reason: it includes supplements to the soil while also expanding the sum of natural matter within the soil, which is basic for upgrading the soil's physical qualities. The soil structure will be more steady and the capacity to hold water will be made strides by expanding soil natural matter. Plant root improvement and supplement take-up are helped by changes in soil physical characteristics (Rozy et al., 2013).

CH_4 Production (%) In Anaerobic Composting Process

Figure 4. CH_4 Production (%) In Anaerobic Composting Process

In terms of methane gas (CH_4) era, the anaerobic composting prepare yields 0.5–0.8 % CH_4 at each step of perception over the 30 day composting period. The creation of CH_4 gas in anaerobic composting started on day 6 with an normal gas generation of 0.65 %, expanding to 0.77 % on day 12 and 0.82 % on day 22. Composting on days 26 and 30, on the other hand, come about in a 0.5 % diminish within the sum of CH_4 gas produced. At that point, when mugginess and oxygen concentrations diminished, no CH_4 outflow was found from any of the medications. This study's CH_4 outflow generation cycle is comparable to prior investigate (Sánchez-Monedero et al., 2010; Jiang et al., 2011; Jiang et al., 2015). Seriously breakdown amid the primary four weeks of anaerobic composting diminishes O_2 levels essentially and is mindful for the considerable beginning CH_4 emanations. Methanogens can as it were create CH_4 in anaerobic circumstances. This is often clarified by the gigantic amount of enormous particles within the palm oil squander utilized in this test, through which oxygen cannot penetrate, coming about in anaerobic conditions.

CH_4 Production (%) In Aerobic Composting Process

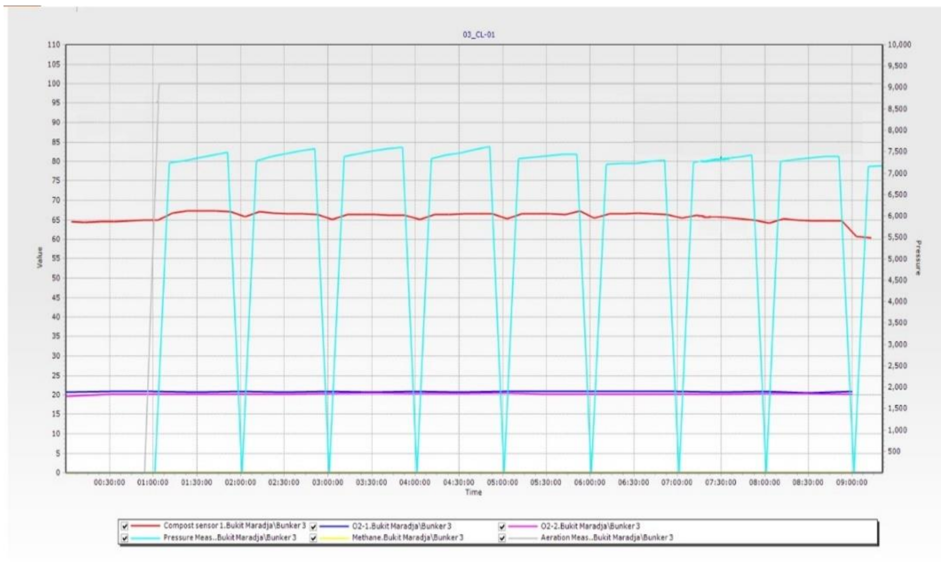

Figure 5. CH_4 Production (%) In Aerobic Composting Process

Concurring to the discoveries of this examination, no methane (CH_4) was discharged amid the high-impact composting handle. The nearness of tall oxygen (17.5–21.9 %) causes delays within the discharge of CH_4 amid the oxygen consuming composting prepare. When compared to the concentration esteem of CH_4 gas created by anaerobic composting, this aerobic composting produces a really small sum (nearly imperceptible). The discoveries of this consider are steady with those of Faundry et al. (2015), who found that oxygen consuming composting of family rubbish produces 1.29 mg/minute of CH_4 and dry leaf squander produces 9.5 mg/minute of CH_4. Basically, anaerobic circumstances result within the arrangement of CH_4 gas. The consideration of compost piles in this composting strategy comes about in anaerobic conditions in oxygen consuming composting. Since there's a particular stature within the compost heap amid handling, the composting handle cannot elude this anaerobic zone. Suprihatin et al. (2008) bolster this perspective by expressing that composting natural squander can moreover minimize methane emanations from landfills since natural matter in waste is vigorously processed into a steady shape (compost) and carbon dioxide, with no methane made. The rate of decrease in methane emanations is related to the sum of natural squander arranged of in landfills or composted junk.

Air Temperature Conditions (ºC) in the Aerobic and Anaerobic Composting Process

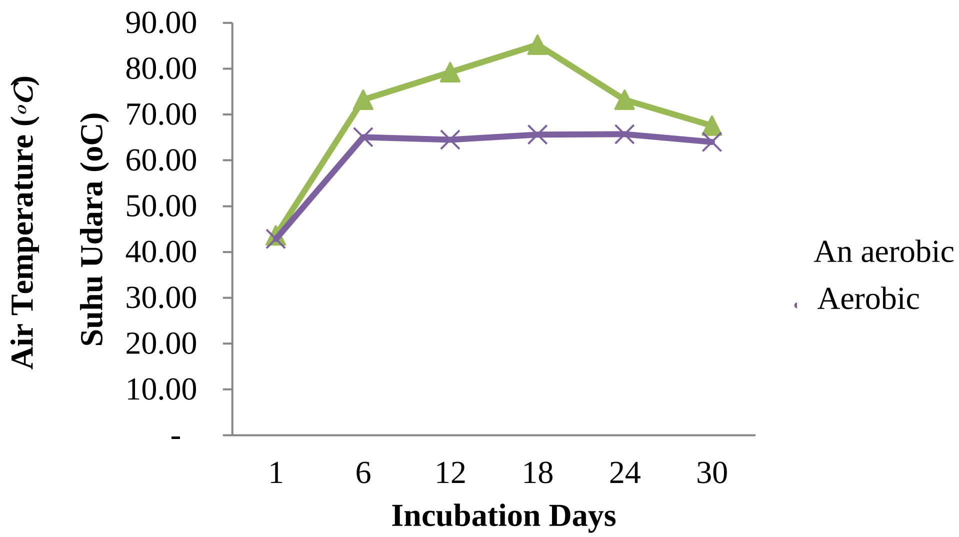

Figure 6. Air Temperature Conditions (ºC) in the Aerobic and Anaerobic Composting Process

Agreeing to Figure 6, the normal composting temperature within the anaerobic method increments from day 6 (73.25 ºC to day 18 (85.25 ºC), at that point diminishes until it approaches the beginning temperature rise condition on day 30, in spite of the fact that the temperature remains over 67.55 ºC. In the interim, in oxygen consuming composting, the discuss temperature of the fabric expanded starting on day 6, but the temperature extend remained reliable at 65.03 ºC on day 6 and 64.03 ºC on day 30.

Based on this, the composting temperature made is still higher than the perfect composting temperature given by Shafawati and Siddiquee (2013) of 54-60 ºC. Since the composting prepare is carried out in a closed bunker with no oxygen input, the warm radiated by natural matter is protected within the bunker. In the interim, the ideal temperature created by oxygen consuming treatment is about indistinguishable to the perfect composting temperature and is lower than that produced by anaerobic composting. Typically due to the truth that high-impact composting is worn out an open environment, in this manner the warm made on the surface of the compost is additionally misused with the discuss.

The temperature changes within the compost are caused by the deterioration movement of cellulose and hemicellulose atoms, especially those found in purge natural product bunch and rice straw squander, which are annihilated by enzymatic hydrolysis with cellulase proteins as a catalyst. Cellulase may be a cellulose-degrading protein that discharges diminishing sugars. Diminishing sugars are glucose or carbohydrates, both of which are monosaccharides with an aldehyde and a ketone bunch. Monosaccharides will be broken down into CH_4, CO_2, and vitality gasses. The warm energy produced is mostly released into the climate and somewhat put away within the compost pile.

The movement of microorganisms will increment as the composting temperature rises (Aprilya et al., 2021). Dynamic microorganisms can develop and prosper amid the composting prepare. Agreeing to the figure, microorganisms from the thermophilic bunch of microbes play a imperative part beneath ideal temperature conditions of anaerobic treatment. Since these organisms can develop and prosper at temperatures over 45 ºC. In the mean time, since the temperature was 45 ºC, the microorganisms that play a big role during the composting process with oxygen are only mesophilic microorganisms. The higher the action of microorganisms, the more heat made by microorganism digestion system is discharged within the compost, and thus the composting temperature rises.

Conclusion

Composting purge natural product bunches (EFB) in bunkers with high-impact and anaerobic frameworks comes about in compost with changing properties. The essential supplements (N, P, K, Ca, Mg) produced by anaerobic composting are higher than those created by oxygen consuming composting, as is the pH of the compost delivered in bunker. On the one hand, composting in an oxygen consuming framework was able to stifle the advancement of methane (CH_4) until it was not recognized, but composting in an anaerobic framework brought about in a noteworthy level of methane gas (CH_4) in bunker. Methane gas (CH_4) in anaerobic composting happened by 0.53 % on day 6, at that point developed to 0.77 % and 0.82 % on days 12 and 18 in bunker. On brooding days 24 and 30, it fell once more and remained consistent by 0.5 % in bunker.

Reference

Aprilya, C. A. K., Afriani, M., Maulana, A., & Gusmawartati. (2021). Studi Literatur: Uji Kemampuan Konsorsium Isolat Bakteri Selulolitik dalam Mempercepat Dekomposisi Tandan Kosong Kelapa Sawit. *Jurnal Ilmu Tanah Dan Lingkungan*, *23*(1), 28–32. https://doi.org/10.29244/jitl.23.1.28-32

Baron, V., Supriatna, J., Marechal, C., Sadasiban, R., & Bonneau, X. (2019). Waste reduction and nutrient recovery during the co-composting of empty fruit bunches and palm oil mill effluent. *E-Journal Menara Perkebunan*, *87*(2), 77–86. https://doi.org/10.22302/iribb.jur.mp.v87i2.338

Embrandiri, A., Ibrahim, M. H., & Singh, R. P. (2013). Palm oil mill wastes utilization ; sustainability in the Malaysian context. *International Journal of Scientific and Research Publications*, *3*(3), 1–7.

Faundry, Y. S., Setyo, H., & Siwi, D. (2015). Analisis Timbulan Gas Rumah Kaca (CO_2, CH_4 dan N_2O) Dari Proses Komposting Aerobik Sumber Pengolahan Sampah Terpadu. *Jurnal Teknik Lingkungan*, *4*(2), 1–10. https://doi.org/10.15036/arerugi.45.811_1

Gao, M., Liang, F., Yu, A., Li, B., & Yang, L. (2010). Evaluation of stability and maturity during forced-aeration composting of chicken manure and sawdust at different C/N ratios. *Chemosphere*, *78*(5), 614–619. https://doi.org/10.1016/j.chemosphere.2009.10.056

Hayat, E., & Andayani, S. (2014). Pengelolaan Limbah Tandan Kosong Kelapa Sawit Dan Aplikasi Biomassa Chromolaena Odorata Terhadap Pertumbuhan Dan Hasil Tanaman Padi Serta Sifat Tanah Sulfaquent. *Jurnal Teknologi Pengelolaan Limbah*, *17*(2), 44–51.

Irvan, Permata Mhardela, & Bambang Trisakti. (2014). Pengaruh Penambahan Berbagai Aktivator Dalam Proses Pengomposan Sekam Padi (Oryza sativa). *Jurnal Teknik Kimia USU*, *3*(2), 5–9. https://doi.org/10.32734/jtk.v3i2.1501

Jiang, T., Li, G., Tang, Q., Ma, X., Wang, G., & Schuchardt, F. (2015). Effects of aeration method and aeration rate on greenhouse gas emissions during composting of pig feces in pilot scale. *Journal of Environmental Sciences (China)*, *31*(Guoxue Li), 124–132. https://doi.org/10.1016/j.jes.2014.12.005

Jiang, T., Schuchardt, F., Li, G., Guo, R., & Zhao, Y. (2011). Effect of C/N ratio, aeration rate and moisture content on ammonia and greenhouse gas emission during the composting. *Journal of Environmental Sciences*, *23*(10), 1754–1760. https://doi.org/10.1016/S1001-0742(10)60591-8

Potgieter, J. J. C. (2012). *Compostability of municipal and industrial wastewater sludge : physical , chemical and biochemical transformations and end-product characteristics by Johannes Jacobus Christiaan Potgieter Submitted in partial fulfilment of the requirements for the degree*. University of Pretoria.

Rahardjo, P. N. (2009). Studi Banding Teknologi Pengolahan. *Jurnal Teknik Lingkungan*, *10*(1), 9–18.

Rahmadi, R., Awaluddin, A., & Itnawita. (2014). Pemanfaatan Limbah Padat Tandan Kosong Kelapa Sawit dan Tanaman Pakis-Pakisan Untuk Produksi Kompos Menggunakan Aktivator EM-4. *JOM FMIPA*, *1*(2), 245–253.

Riniarti, D., Kusumastuty, A., & Utoyo, B. (2012). Pengaruh Bahan Organik , Pupuk P , dan Bakteri Pelarut Phosfat Terhadap Keragaan Tanaman Kelapa Sawit pada Ultisol The Effect of Kind Organic Matter , Phospat Fertilizer , and Posphat Solubilizing Bacteri on Vigour of Oil Palm at Ultisol. *Jurnal Penelitian Pertanian Terapan*, *12*(3), 187–195.

Rozy, F., Rosmawaty, T., & Fathurrahman, F. (2013). Pemberian Pupuk NPK Mutiara 16: 16: 16 dan Kompos Tandan Kosong Kelapa Sawit pada Tanaman Terung (Solanum melongena. L). *Jurnal Relevansi*, *Akurasi Dan Tepat Waktu (RAT)*, *2*(1), 228–239

Sánchez-Monedero, M. A., Serramiá, N., Civantos, C. G. O., Fernández-Hernández, A., & Roig, A. (2010). Greenhouse gas emissions during composting of two-phase olive mill wastes with different agroindustrial by-products. *Chemosphere*, *81*(1), 18–25. https://doi.org/10.1016/j.chemosphere.2010.07.022

Saraswati, R., Heru, R., Tentara, J., No, P., & Barat, J. (2017). Percepatan Proses Pengomposan Aerobik Menggunakan Biodekomposer / Acceleration of Aerobic Composting Process Using Biodecomposer. *Perspektif*, *16*(1), 44–57. https://doi.org/10.21082/psp.v16n1.2017.44-57

Schuchardt, F., Darnoko, D., & Guritno, P. (2002). Composting of empety oil palm fruit bunch (EFB) with simultaneous evaporation of oil mill waste water. *International Oil Palm Conference*, *CTE-15*, 1–9.

Shafawati, S. N., & Siddiquee, S. (2013). Composting of oil palm fibres and Trichoderma spp. As the biological control agent: A review. *International Biodeterioration and Biodegradation*, *85*, 243–253. https://doi.org/10.1016/j.ibiod.2013.08.005

Suprihatin, Indrasti, N. S., & Romli, M. (2008). Potensi Penurunan Emisi Gas Rumah Kaca Melalui Pengomposan Sampah. *Jurnal Teknologi Industri Pertanian*, *18*(1), 53–59

Syahwan, F. L. (2012). *Potensi Limbah Dan Karakteristik Proses Ditambahkan Sludge Limbah Pabrik*. *11*(3), 323–330.

Syukri, A., Nelvia, N., & Adiwirman, A. (2019). Aplikasi Kompos Tandan Kosong Kelapa Sawit dan Pupuk NPKMg Terhadap Sifat Kimia Tanah Ultisol Dan Kadar Hara Daun Kelapa Sawit (Elaeis guineensis Jacq). *Jurnal Solum*, *16*(2), 49. https://doi.org/10.25077/jsolum.16.2.49-59.2019

Udoetok, I. A. (2012). Characterization of ash made from oil palm empty fruit bunches (oefb). *International Journal Od Environmental Science*, *3*(1), 518–524. https://doi.org/10.6088/ijes.2012030131033

Vakili, M., Rafatullah, M., Ibrahim, M. H., Salamatinia, B., Gholami, Z., & Zwain, H. M. (2015). A review on composting of oil palm biomass. *Environment, Development and Sustainability*, *17*(4), 691–709. https://doi.org/10.1007/s10668-014-9581-2

Warsito, J., Sabang, S. M., & Mustapa, K. (2016). Fabrication of Organic Fertilizer from Waste of Oil Palm Bunches. *Jurnal Akademika Kimia*, *5*(February), 8–15.

Wibowo, B. S., Hanum, H., & Fauzi. (2017). Aplikasi kompos TKKS dan berbagai dosis pupuk majemuk untuk meningkatkan hara N,P, dan K serta pertumbuhan bibit kelapa sawit (Elaeis Guineensis Jacq.) pada pembibitan utama di Tanah Ultisol. *Jurnal Agroteknologi*, *5*(3), 500–507.

Widarti, B. N. (2015). Pengaruh Rasio C/N Bahan Baku Pada Pembuatan Kompos Dari Kubis dan Kulit Pisang. *Jurnal Integrasi Proses*, *5*(2), 75–80.

Yunindanova, M. B., Agusta, H., & Amono, D. (2013). Pengaruh tingkat kematangan kompos tandan kosong sawit mulsa limbah padat kelapa sawit terhdap produksi tanaman tomat (Lycopersicon esculentum Mill,) pada tanaman ultisol. *Jurnal Ilmu Tanag Dan Agroklimatologi*, *10*(2), 91–100.

Zakarya, I. A., Khalib, S. N. B., & Mohd Ramzi, N. (2018). Effect of pH, temperature and moisture content during composting of rice straw burning at different temperature with food waste and effective microorganisms. *E3S Web of Conferences*, *34*, 4–11. https://doi.org/10.1051/e3sconf/20183402019