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Studies of Locally Effective Microorganisms (EM) to Enhance the Degradation of Empty Fruit Bunches, Pome and Cake During Composting Process

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Malaysia's palm oil industry is the fourth largest contributor to the national economy and currently accounts for RM53 billion. Wastes from oil palm industries are generated daily and every year becoming a great concern consequently, an urgent development of bio-composting process has been researched. Bio composting is an environmentally way where its product could be utilized as plant growth enhancement. The study was concerning about simple composting process using substrate that has been selected in this experiment which are EFB, POME and CAKE whereas the co-substrate is sawdust. *Phanerochaetechrysosporium*was inoculated in compost trays and the growth can be seen clearly in day 15. It is a white fungus that was serves to degrade the lignin of the substrate. At day 15 *TricordermaViride* was inoculated while *Aspergillus Niger* was inoculated at day 30. *Pennicillium* was inoculated at day 45 to destroy the toxicity of the compost. The maturity of the composting could be reflected by the best C/N ratio obtained was run 6 which are 16.51, pH, and germination index result of 154%. This simple technology urge to enhance the productivity and sustainability of the Malaysian palm oil milling industry by improving the local isolated fungal strains and increasing composting utilization.

Key words: Effective Microorganisms, EFB, Compost, Parameters.

Oil palm production is a major agricultural industry in Malaysia. Currently, there are more than three million hectares of oil palm plantations[1]. The empty fruit bunches (EFB) represent about 9% [1] of this total. They are the residue left after the fruit bunches are pressed at oil mills, and the oil extracted. The oil mills are located near or in the plantation itself[2,3]. EFB is a suitable raw material for recycling because it is produced in large quantities in localized areas. In the past, it was often used as fuel to generate steam at the mills[2]. More than 500 kg (around 0.5 m^3) of liquid wastes, mainly in the form of palm oil mill effluent (POME), are discharged during the processing of 1.0 mt of fresh fruit bunches. Thus, we would expect to get more than 20 mt of EFB and more than 50 m^3 of POME from a mill after processing 100 mt of fresh fruit bunches. EFB is a common raw material used in composting. Other materials are often added, particularly chicken manure and POME. However, POME has a high nutrient content[4], and large oil palm plantations prefer to use it directly as fertilizer. The POME is first treated to reduce the organic load[2]. The sediments left after treatment, which have a higher nutrient value than the slurry[4].

The improper disposal of large quantities of agro based industrial waste causes energy,

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economic, and environmental problems. Therefore the amount of waste produced can be reused in the fermentation process rather than just throw it away. Besides, due to the economical concern, the method used which is solid state fermentation process gives advantages on lower energy requirements, might be easier to meet aeration requirements and resembles the natural habitat of some fungi and bacteria[5]. Thirdly, composting is attractive since it can reduce the volume/weight of sludge. In the composting process, aerobic microorganisms use organic matter as a substrate. The microorganisms decompose the substrate, breaking it down from complex to intermediate and then to simpler products[6,7,8].

Composting is a natural biological process, carried out under controlled aerobic conditions (requires oxygen). In this process, various microorganisms, including bacteria and fungi, break down organic matter into simpler substances. The effectiveness of the composting process is dependent upon the environmental conditions present within the composting system i.e. oxygen, temperature, moisture, material disturbance, organic matter and the size and activity of microbial populations. During composting, compounds are transformed to more stable organic matter.Therefore, this study is to aim at utilizing the wastes of palm oil that are hazardous to the environment converting them into beneficial and useful product.

MATERIALS AND METHODS

The analytical analysis for composting process start by collecting the samples of EFB, POME and cake are used as a substrate in this experiment while sawdust as a co-substrate[9,10]. The microorganism chosen are *Trichodermaveride*, *PhanerochaeteChrysosporium* and *Penicillium*.PhanerochaeteChrysosporium, TricodermaHarzianum and Penicillum are chosen in this experiment. Penicillum is used to destroy toxicity, while PhanerochaeteChrysosporium, TricodermaHarzianum are used to degrade lignin, cellulose and hemicelluloses. The composting process is done for 60 days using a tray bioreactor. The co-substrate used is sawdust. Different parameters will be varied which are inoculum size, pH and particle size. Others will be fixed as Moisture content: 50%, ambient temperature and C/N Ratio.

The sample of empty fruit bunch (EFB), POME and CAKE are collected from Sime Darby at Carey Island, Banting Selangor. While the co-substrate used, sawdust is collected from IIUM workshop at Kulliyyah of Engineering.

The experiment was done in a tray filled with substrates and co-substrate which undergo composting period of 60 days. In addition, the inoculations of selected fungi were one of the factors which could affect the results of the compost. It was treated similar as the tray bioreactor where it was spread out in the container and incubated in an ambient temperature. In this experiment, there were 17 runs in which they were varied in different pH, inoculums doses and particle size of empty fruit bunch. There are several analyses done every 15 days to evaluate the compost which can be divided under physical, chemical and biological analyses such as protein assay, optical density (OD), organic matter (OM), C/N Ratio, temperature, pH, electrical conductivity (EC), germination Index (GI) and moisture content of the compost.

RESULTS AND DISCUSSION

The characteristics of the compost of run determine which run is the best and produce good compost. From the experiment, out of 17 runs, run number 6 has been chosen based on temperature, germination index, pH, C/N ratio, electrical conductivity, optical density and temperature. The C/N ratio and GI were 16.51 and 197.1% respectively. Organic matter was calculated in order to determine the total carbon and then C/N ratio can be obtained. According to the graph plotted the percentage of organic matter is slightly decreased from day 30 to day 45 as the biodegradation time increases.

Physical analyses

The temperature profile has been compared with control samples. There were no much difference between the control and experimental since the both were conducted at room temperature in the laboratory. The temperature involve around 27 to 29 ºC. The reading was read using thermometer by putting the probe deep into the compost. Readings were taken at several

locations including various depths and the average readings of temperature were taken. The best compost produced was evaluated based on the temperature plotted. The highest temperature of compost or the compost that can maintain the hot temperatures for the longest period of time is good compost.

As shown in Figure 1, all 17 runs were increasing from day 0 to day 15 while from day 15 to 30 all runs were increasing except for run 1, 8, 10, 12, 14 and 15. The OD of run 6 was increasing as time increasing until day 60 with the final reading 2.57. The color of water extract was changing to be darker as the composting period increased. The color changed according to the growth of fungal cells and spores. In composting process, different polymers are metabolized into simpler products[11]. Thus, [12] stated that the water extract of compost may have those organic constituents along with microbial cells and spores.

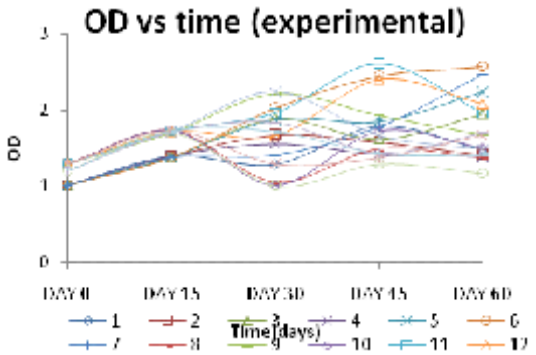

Fig. 1. Changes in optical density/color intensity as time increase for experimental

The degradation of OM was related to the growth of microorganisms. [13] said that composting process causes the organics substrate were degraded into more stable product and as time increased, the weight of the substrate also reduced. Figure 2 below show the profile of OM for experimental and control values.

Chemical analyses

The starting pH for run 1, 6, 10, 12 and 13 were pH 5, run 2, 7, 8, 9, 11,14 and 17 were 6.5 while for run 3, 4, 5, 15 and 16 were pH 8. From day 0 to day 15, the pH increased and slightly decreases from day 15 to 30. The increased in pH during the first period of composting is expected because of the acids form during metabolism of readily available carbohydrates and sawdust. The pH

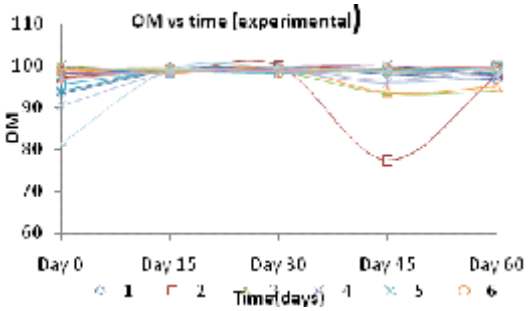

Fig. 2. Changes in organic matter (OM) as time increase for experimental

reading of the control samples were slightly same with the experimental in which during the first period of composting process, the pH of all runs were increased except for control number 15.

Electrical conductivity (EC) was measured during the composting since it reflects the salinity of composting products and its suitability of plant growth [14]. The reading were taken by using Extech 407510 Dissolved Oxygen Meter and graphs plotted in Figure 4.7 and Figure 4.8 shows the profile of EC from day 0 to day 60. Electrical conductivity decreased in day 0 to day 15 for both control and experimental due to utilization of soluble salts by the microorganism. It increased after day 15 to day 45 because the salts released from the compost.

The carbon-nitrogen ratio (C/N ratio) was analyzed for evaluation of compost maturity. The experimental data shows that the C/N ratio in final compost is 24.93, 19.52, 17.11, 18.92, 17.25, 16.51, 37.43, 18.91, 51.01, 49.98, 47.01, 25.91, 42.56, 45.01, 18.03, 20.86 and 23.19. The best C/N ratio obtained was run 6 which are 16.51. It has been stated that if the C/N ratio of the compost was less than 20, the

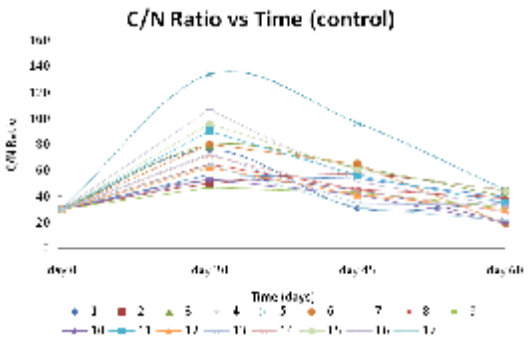

Fig. 3. Figure 4.10: Changes in pH as time increase for control samples

compost is mature and can be used without any restriction[15].

Biological analyses

The protein absorbance in run 8 was highly increased until day 45. This can be said that the fungus grows very well and had enough nutrient and food.

Organic matter was calculated in order to determine the total carbon and then C/N ratio can be obtained. According to the graph plotted the percentage of organic matter is slightly decreased from day 30 to day 45 as the biodegradation time increases. The degradation of OM was related to the growth of microorganisms.

Germination index at day 0 is low for all the runs. At day 45, *Penicillium* was inoculated and %GI in increasing in the run 6, run 10, run 4, run 11, run 5 and run 15. A GI value of 50% has been used as indication of phytotoxic free compost and GI of more than 80% is considered mature compost [16] as shown in Figure 4.

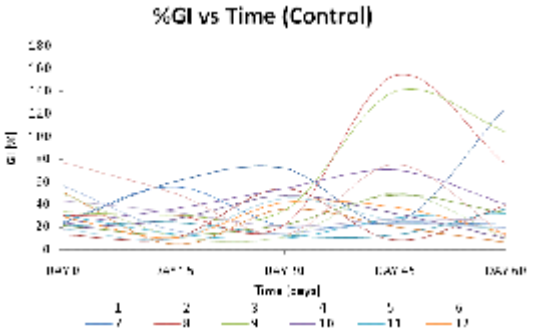

Fig. 4. Changes in Germination Index (GI) as time increase for day 0 to day 60

The figure above shows that control 8 and 9 were increased at day 30 and dropped at day 45 to lower value. The profile of GI for controls were slightly different from the experimental since starting day 0 to 30 their GI were lower compared to the experimental value. The reason the GI was lower is because of the compost was not matured yet and still contained a pathogen that can block the composting process from occur.

CONCLUSION

In this study, the characteristics of the compost of run determine which run is the best and produce good compost. From the experiment, out of 17 runs, run number 6 has been chosen based on germination index, pH, C/N ratio, electrical conductivity, optical density and temperature. The C/N ratio and GI were 16.51 and 197.1% respectively. The color intensity shows as the compost period increase, the color of the compost turn darker. The electrical conductivity of the compost is 1.56 which is below than 4 shows that the compost is good compost and safe. The ability of the compost to stand at high temperature for a long time also indicates that the compost is better than other runs. As studied, the achieved characteristics of the compost stated that run number 6 was the best as the compost was mature and can be considered as bio-fertilizer. Therefore, the objectives of the project have been achieved.

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