THE ABILITY OF TRICHODERMA SP AND PLEUROTUS SP FOR THE DECOMPOSITION OF OIL PALM EMPTY BUNCHES

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ABSTRACT

The empty bunches of palm can-not directly decompose into compost because it is still in the form of complex elements, so it must be degraded first, and the process of degradation naturally takes a very long time, for which the fungus used to accelerate the process of degradation. The fungus has a ligninolytic ability, namely the ability to dissipate enzymes that can degrade lignin. Materials used in this study include empty fruit bunches (EFB), bran, and dolomite lime. The ingredients were evenly mixed and then inoculated with the fungus in four treatments, which were without mushroom fungus, Pleurotus sp, Tramella sp, and Trichoderma sp. This study shows several attributes related to the quality of compost such as temperature, pH, macronutrient and C: N ratio. The treatment of Trichoderma sponge inoculation gives the best quality compared to others. The C / N ratio after 8 weeks of decomposition is 22.09. It can be concluded that the Trichoderma spray inoculation treatment can be a potential biodestructor for EFB.

Keywords: EFB, fungus, Pleurotus sp, Trichoderma sp, Tramella sp.

INTRODUCTION

It has been widely acknowledged that in palm oil processing industry, the main wastes are empty fruit bunches (EFB). In the processing, for every one ton of fresh fruit bunches as much as 0.21 ton 21% of crude palm oil (CPO) and 0.05 ton 5% of palm kernel oil (PKO) were produced, as well as the remaining waste 23% of the EFB, 13.5% of fiber, and 5.5% of seed shells, (Kavitha et al., 2013). EFB contains various macro and micro nutrients that are respectively very important for plant growth, among others: 0.8% N; 0.22% P₂O₅; 2.9% K₂O; 42.8% C; 0.30% MgO, 23 ppm Cu, and 51 ppm Zn (Singh et al., 1989).

Indonesia’s palm oil production in 2010 amounted to 13,468,966 tons of 4,391,624 ha of land. This number increased 29.67% compared to the year 2014 which amounted to 17,464,905 tons for the same land area. Today, the increase of the oil palm plantation area reached 27.31% and every year the area and the production are also increasing (BPS 2016). Thus, EFB waste is also increasing. The waste if not processed will cause serious problems for the environment. Currently, there have been several introduced solutions for utilization of EFB such as: materials for steam generator at the plant (Ma et al., 1993), EFB compost (Shafawati and Siddiquee, 2013), and mulches in plantations (Mohammad, 2012). However, these solutions are considered ineffective and costly.

One problem of composting the EFB in traditional method is that it takes too long (months or years). This is due to the high C:N ratio and existence of polymers such as cellulose and lignin which act as natural barrier that hamper the natural biodegradation. However, according to Gaind and Nain (2007), addition of specific microorganisms can cut the composting time of EFB. Goyal et al., (2005) stated that the fungus helps in organic matter decomposition by actively decomposing cellulose, hemicellulose, and lignin. Due to the ability in producing enzymes for decreasing cellulose, hemicellulose and lignin (Shafawati et al., 2014; Gaind et al., 2006), inoculation of cellulolytic fungi such as Aspergillus, Pleurotus and Trichoderma can accelerate composting process by one month (Biswas and Narayanasamy, 2002; Amira et al., 2012). Trichoderma species have been shown to effectively degrade organic materials, as biological control agents, and produce toxins against phytopathogenic fungi that can increase plant growth (Zainuddin and Faridah, 2008; Pandya and Saraf, 2010).

Other researches confirmed the role of Trichoderma for the issue in hand. The Trichoderma reesei was capable in improving soil biochemical properties (Gaind and Nain, 2007), whereas. Pandya and Saraf (2010) reported this Trichoderma genus are important biocontrol agent against some phytopathogenic fungi. More specifically, Amira et al., (2012) added Trichoderma virens to the
composting of empty bunches and palm oil mill waste which because of the higher levels of enzymatic activity, this application resulted in the reduction of composting period. The EFB in this study was composted with addition of three potential fungal plane strains, with the aim to examine physio-chemical changes (temperature, pH, and macro nutrient content) during the process of the composting that had been inoculated by the three types of fungus.

MATERIALS AND METHODS
Materials: Materials used in this study include EFB, bran, and dolomite lime with a composition of 5: 1: 0.05. EFB is derived from Luwu Unit 1 Palm Oil Plant, Lagego Village, Bura District, East Luwu Regency, Indonesia. The bile was collected from a rice mill in Pattimang Village, Malangke. Lime dolomite bought from a farm shop. EFB was chopped into small pieces of about 5-10 cm in size to accelerate decomposition.

Implementation of the study: The material was mixed evenly and then inoculated with the moldy fungus in four treatments. Treatment 1 (K0): No Fungus (Control), Treatment 2 (K1): Tramella sp Fungus, Treatment 3 (K2): Pleurotus sp Fungus, and Treatment 4 (K3): Trichoderma sp. The fungus is selected from the collection of Puslitbag Agricultural Biotechnology, Hasanuddin University. Composting is done on a 200 x 100 x 80 cm tub with aeration and water discharge holes which located on the sides and bottom of the tub. Compost is covered with tarpaulins and reversed every 2 weeks and placed in the shade for up to 8 weeks to speed up decomposition.

Observation Temperature and pH: Temperature of composting was observed every day and the humidity was set to always around 60%, then left until composting was complete. Water content, carbon, nitrogen, phosphorus, potassium, calcium, and magnesium in the compost were measured and in order to determine the C: N ratio. Weekly temperature measurement was performed during the composting process as in Erwan et al. (2012). Three different places were taken for this temperature measurement i.e. the top, middle and bottom of the compost heap where the thermometer was inserted and left for five minutes prior for each reading. Compost pH was measured every week during the composting period by reading the pH of solution which were obtained by the procedure, about 10 g of compost was dissolved into a 500 mL glass of water then added with 50 mL of sterile water, this solution were then shaken for about 30 minutes with a shaker (Jeong and Kim, 2001).

Measurement of NPK and C: N: Each 15 g sample was taken and put into the furnace for 5 hours. The first one-hour temperature was 300 °C and the next 4 hours was 500 °C. Then the sample was rested overnight before the ashes were weighed. Erwan et al. (2012) suggested the formula for calculating the percentage of carbon content formulas follows:

\[
\% \text{ of Carbon} = \frac{(\text{Sample of dry weight}) - \text{Weight of ash}}{\text{Sample dry weight}} \times 100\%
\]

As for the Nitrogen content determination, the digestive method was employed with the following procedures. At a temperature of 60 °C, each sample was dried for 72 hours, it was then filtered using 20 mm mesh. As much as 0.25 g of the sample is mixed with 5 ml of concentrated sulfuric acid (H₂SO₄) into the gut flask and for 30 minutes were digested at 200 °C. The temperature was then raised to 360°C for 1 hour after which 10 mL of hydrogen peroxide (H₂O₂) is added until the reaction is complete. The final solution is produced by adding 100 mL of distilled water. Nitrogen is determined by using Auto-analyser (System 4, Chemlab). The formula for calculating percentage of nitrogen content was suggested by Erwan et al. (2012):

\[
\% \text{ Nitrogen} = \frac{(\text{ppm} \times 400 \times \text{dilution})}{10^6} \times 100
\]

sample and heated for 30 min at 80 °C. Distilled water is used for cooling down the sample and maintaining it at 20 mL volume. After cooling, and ensuring the distilled water is added to the final volume of 20 mL, the solution was then taken for analysis by using an Atomic Absorption Spectrophotometer to determine the macro nutrient values of P and K. The C: N ratio on the other hand is calculated with the following formula (Erwan et al., 2012):
RESULT AND DISCUSSION

Changes in pH and Temperature: Figure 1 illustrates different temperatures recorded during composting process. All treatments had a range of starting temperature from 25 to 36 °C, while the ambient temperature was 30 °C. Compost temperature increased sharply during the first three weeks, then gradually decreased until the final stages of composting. The highest recorded temperatures were 50 °C of K0 (Without Fungus) treatment, 55 °C of K1 treatment (Pleurotus sp), 53 °C of K2 treatment (Tramella sp), and 59 °C of K3 treatment (Trichoderma sp). The pH value of the compost is also presented in Figure 1. The pH values range from 5.4 to 7.8 at the beginning of composting. All treatments had fluctuating pH values and tend to be more acidic. At the end of the composting process, the pH values of each treatment are K0 (5.3), K1 (6.1), K2 (6.4) and K3 (6.9).

Figure 1: Changes in temperature and pH of EFB compost in treatment without fungus (K0), Pleurotus sp (K1), Tramella sp (K2) and Trichoderma sp (K3).

One important parameter in assessing composting process is temperature. The temperature rises and fall during the process which could be the result of organisms’ dynamic related to their type, metabolism and growth rates in the compost (Tiquia and Tam, 2002). The results showed that the temperature values were in the thermophilic range from 40 to 65 °C (Bernal et al., 2009). In this study, all treatments except K0 (without fungus inoculation) reached the 55 °C, this temperature is required to kill pathogenic microorganisms (Kala et al., 2009). The temperature rise was due to metabolic heat from the activity of the high decomposition and high cellulose (EFB) compost. In general, the temperature at all treatments varies. After three weeks, the temperature started fluctuating, though still above the ambient temperature. This fluctuation was achieved in the first 21 days of composting due to EFB biodegradation by the fungus. After eight weeks, the compost temperature approaches ambient temperature; maybe the EFB biodegradation is almost complete and the process is stabilizing. This occurs because environmental conditions support the occurrence of biodegradation by the molding fungus.

Changes in pH due to acid formation during the EFB decomposition process by the fungus. In the first week, all fungal inoculation treatments showed a small decrease in pH. Thereafter, the pH of all fungal inoculation treatments increased during the second week. This increase was the result of decomposition of organic matter, the degradation of acidic compounds, such as carboxylic and phenol, and mineralization of other organic compounds such as proteins, amino acids, ammonia and peptides (Ishak et al., 2014; Rana and Dahot, 2017). Compost pH at the end of composting is more acidic than early composting. This is due to the nitrification that decreases the pH of the compost. The pH decrease was significant when the compost was mixed with T. Reesei (Gaind and Nain, 2007). Optimum pH for compost is 6.5-8 (Said-Pullicino et al., 2007). During composting process, microorganisms digest organic matter which result in decrease in pH value in the first week. Thereafter, the pH value significantly incre-
ased at the decomposition stage. The increase is due to increased ammonia (Gajalakshmi and Abbasi, 2008; Petric et al., 2009).

**Ingredients of macronutrient elements:** Intrabulated EFB composite *Trichoderma* sp had the highest value for the three main macro nutrients (Nitrogen), phosphorus and potassium. The N, P, K, values respectively were 1.22; 2.61; 8.12 observed at week 8, and these are better compared to the inoculated compound of *Pleurotus* sp, *Tramella* sp, and control (Figures 2a, 2b, and 3a). The amount of macronutrients found increased from week 4 to week 8. Erwan et al. (2012) suggested that C and N influence the content of macronutrient in the compost. Chabbey (1993) stated that the high macronutrient value is a result of decomposition of organic content during the composting process. The high nitrogen content of the compost inoculated by the fungus was compared with the controls due to the increased decomposition of organic materials by *Trichoderma* sp (Pramanik et al., 2007). This is in line with the Gaind and Nain (2007) study on the effect of inoculant fungal mixtures, it was found that nitrogen content increased significantly in the mixed fungal inoculants compared to that with single inoculation. Moreover, Wong and Saddler (1992) added that the high nitrogen content of compost was also determined by the initial nitrogen content of the used raw materials.

High phosphorus content in the three composts inoculated by the fungus (Fig. 2). This is because the phosphorus was not lost during the composting process due to evaporation or lixiviation. Instead, the concentration of phosphorus increased as a result of composting (Wong and Saddler (1992). Gaind and Nain (2007) suggested that the inclusion of fungi may enhance phosphatase activity. Correspondingly, the potassium content of the three composts was higher than that without inoculation. The release of PO$_4$ ions from the colloidal humor into the system become the cause of this (Pramanik et al., 2007). Overall, Amira et al., (2012) therefore suggested that the presence of fungal strains plays an important role in increasing phosphorus and potassium content during the composting process.

![Figure 2: Nitrogen (a) and phosphorus (b) analysis during field trial](image)

**Ratio of C: N:** The change in C:N ratio of EFB composts of all treatments is shown in Figure 3b. The highest C: N ratio was obtained in the 36.58 fungus control compound; followed by compost treatment of *Tramella* sp 26.68; compost treatment *Pleurotus* sp 24.38 and compost treatment *Trichoderma* sp 22.09. The C: N ratio describes the portion of C per N unit required by microorganisms. The C: N ratio is a significant parameter when compost is about to be applied as fertilizer on the soil. With high C: N ratio, it can inhibit the decomposition and availability of nitrogen in the soil. During composting process, the C: N ratio decreased due to the conversion of organic C to CO$_2$, and the loss of nitrogen in the form of NH$_3$ (Ishak et al., 2014).

This study identified C: N ratio decrease for all treatments during the composting process (Figure 3b). As above, the C: N ratio decreased due to the mineralization of organic materials by microorganisms (Kala et al., 2009). According to Shilev et al., (2007), mature compost has a C: N ratio of less than or equal to 25. Nagasaki et al., (1992) suggested that the ratio of C: N to compost should be in the range of 16 to 25. The results showed that the inoculation treatment of *Pleurotus* sp and *Trichoderma* sp fungi was in the range of C: N optimum ratio (≤25) and ready for use as organic fertilizer.
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CONCLUSION
Inoculation of the fungus accelerates the composting process, improves the physical and chemical properties as well as contributes to the nutrient contents of the compost. This study identified the quality of compost under different parameters such as temperature, pH, macro nutrient and C: N ratio. The treatment with fungal inoculation of Trichoderma sp and Pleurotus sp provides better quality compost than other treatments with C: N ratios of 22.09 and 24.38 respectively, indicating that they are ready for use as organic fertilizer.

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REFERENCES


