Study on Drying of Oil Palm Trunk with Ethanol

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ABSTRACT

Wood-based industry in Malaysia is dependent on the natural forest resources and forest plantations. The highly demand of this resource makes it more scarce and expensive. Currently the industries are searching for other resources to overcome the over dependence on local timber. The waste biomass from the oil palm industries can be turned into value-added products providing an alternative raw material for the wood industry, but OPTs (Oil Palm Trunk) are reported to be difficult to dry, not only because of its extremely high green moisture content, but also its drying defects. The objectives of this study are to characterize of drying defects in the OPT at different height (bottom to top) and layer of the trunk (bark to pith). To have different layer of trunk, the OPTs are sawn with sawing around pattern. Seventy two samples sized 25 mm thick x 100 mm wide x 200 mm long obtained from three palm trunks were soaked with 75% concentration of ethanol liquids and dried using the Terazawa's Quick Drying Test (QDT) Likert Method scale is used to rate the defect level of the sample between the of scale of 1 (free from a defect) to 5 (severe defect). Chi-squared independent test is conducted to determine the significant effect. The result showed a gradual increase in drying defect along the trunk height and depth, but no significant relationship between trunk portion and Layers. It is concluded that the OPT mixed with Ethanol can be dried with oven dry method a minimum time consumption produced minimum drying defect.

Key Words: *Oil Palm trunk (OPT), Ethanol, Quick Drying Test (QDT)*

Introduction

The oil palm is a monocot plant that produces edible oil used in food manufacturing, Oleo Chemical and other sources of palm based product. The oil palm plants are perennial crop and when planted it will produce fruit economically until the age of 25 to 30 years.

In Malaysia, the oil palm planted area in 2011 achieved 5 million hectares growth of 3.0% against 4.85 million hectares recorded the previous year. This is mainly due to the increase in the planted area in Sarawak, which recorded an increase of 11.0 % or 102,169 hectares. Sabah is still the largest oil palm planted state with 1.43 million hectares or 28.6% of total oil palm planted area, followed by Sarawak with 1.02 million hectares with 20.4%. Obviously, in 2011, Malaysia has generated revenue of nearly RM 80.4 billion and RM60 billion for 2010. In volume, 2011 registered export of 24.27 million metric tonnes as compared to 23.06 million metric tonnes of palm products in 2010(Anon, 2011).

This unutilized biomass must be developed into new products. It can further reduce the environmental impact of the unutilized biomasses and also to extract the potential material for the alternative of the traditional timber species that are fast depleting (Ghana, 2006). To explore the oil palm contribution, various efforts have been made to encourage, enhance and commercialize the usage of the unvalued material including the stem, which is the primary and largest waste (Ahmad et al., 2011). However, only 20% of the oil palm trunk is useable in the production of plywood and low grade lumber (Abdul Khalil et al., 2010).

There are technologies on hand to convert oil palm biomass to various types of value-added products such as Medium Density Fiberboard (Laemsak & Okuma, 2000), particleboard (Ahmad et al., 2011; Chew, 1987), fiber plastic composite (Shinoj et al., 2011), fiber-reinforced cement board (Abraham et al., 1998; Rahim et al., 1995), plywood (Anis et al., 2011), Laminated veneer lumber (Wahab et al., 2008) and compress lumber (Salim et al., 2012).

To any kind of products utilizing the oil palm biomass, the material must be dried first. However, variation of moisture content and density of the trunk inhibit its full utilization (Choo et al., 2011). This makes processing of these biomass resources has a considerable challenge, mainly from the trunk, which can have a green moisture content of up to 300% to 500% (Bakar et al., 2008) and density of 200 to 700 kg/m^3 (Anis et al., 2007).

Oil palm trunk offers the best properties of wood as compared to that of other types of oil palm biomass viz-a-viz empty fruit bunch and oil palm frond (Bakar et al., 2008). The outer part of the trunk is higher in density, and 1/3 of the most outer part can be used as solid wood. Due to its very high green moisture content and soft structure, especially in the central part, oil palm lumber (OPL) is difficult and takes a long time to dry. OPL is highly recommended using a special drying schedule and the drying method compared to other timbers (Mohamad et al., 1989)

So far, there is no single company that has successfully developed an optimal drying method for OPL. On the other hand, no comprehensive study to develop proper drying for OPL has yet been reported. At the current scenario; the company dries oil palm lumber using their own trial and error drying schedule. Some companies take 30 to 40 days' time of drying, while others use slightly shorter times, but produce excessive defects in the lumber(Ho, 2012; Ramli, 2012). This approach leads to be uneconomic drying process that contributes to waste of time, energy and material.

The study on chemical drying of OPL helps determine the most effective drying method for the material that is shorter in drying time with minimal defects. This study conducted to identify the characteristics of drying defects in the OPL at different height (bottom to top) and layer of the trunk (bark to pith). This would inspire in determining suitable drying method of the material and identifying ways of avoiding the drying defect. Similar studies have been done by Bakar et al., (2000); Lim & Gan, (2005), Anis et al., (2007) and Fauzi et al. (2012), however, the impact of drying defect on OPL with Ethanol has not been proven yet, and the relationship of tree height and layer in the formation of a defects has not been discussed.

Materials and Methods

The material for the experiment obtained from 30-years-old *Elaeis guineensis Jacq* from Felda Jengka 19 Maran, located at 3°41'20.3"N, 102°25'9.4" E, at 63m altitude in Pahang state. Three trunks with diameter ranges over 43 - 55 cm were divided into 3 m long portions: bottom, middle, and top. The 6" band-head rig was used to saw the trunk to lumber size using sawing around method and a 4" band-resaw was used for further process that determines the final size of 25 mm thick x 100 mm wide x 200 mm long.

For drying, this research adopts a Terazawa's Quick Drying Test (QDT) Method (Terazawa & Tsutsumoto (1976). The principle of QDT states that as small samples of wood exposed to severe drying condition, the drying defects is proportionate to the expected result that was studied to predict the occurrence of collapse in *Eucalyptus* wood by Ilic and Hillis (1986).

Using the QDT method, the OPL samples were placed in the oven and the drying process took at least 24 hours at 40-70°C until the sample archived moisture content at -+ 10%. The outcome of the samples on the end checks/splits, honeycomb, and deformation after the drying process were recorded and analyzed. Likert scale is used to rate the defect level from the scale 1 for samples free from a defect to scale 5 for severe defect samples. As for the type of defect, the samples are crossed, and labeled as D1 for end checks/splits, D2 for honeycomb and D3 for deformation. Each parameter needs ten samples, thus a total of 90 samples were gathered for the analysis.

The number of defects on each trunk portion is obtained through the multiplication of the defect severity level, as weightage and the number of defects occurrences at each defect type.

Results and discussion

From the study it was found that the number of defect shows a gradual increase along the trunk height (Figure 1) and across the depth of the trunk (Figure 2).

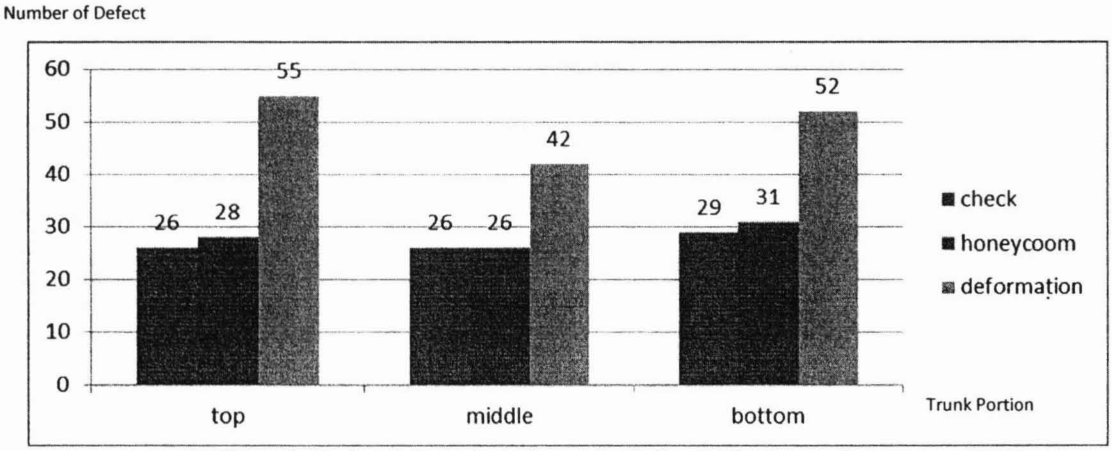

Figure 1: Drying defects along the trunk of oil palm from top to bottom

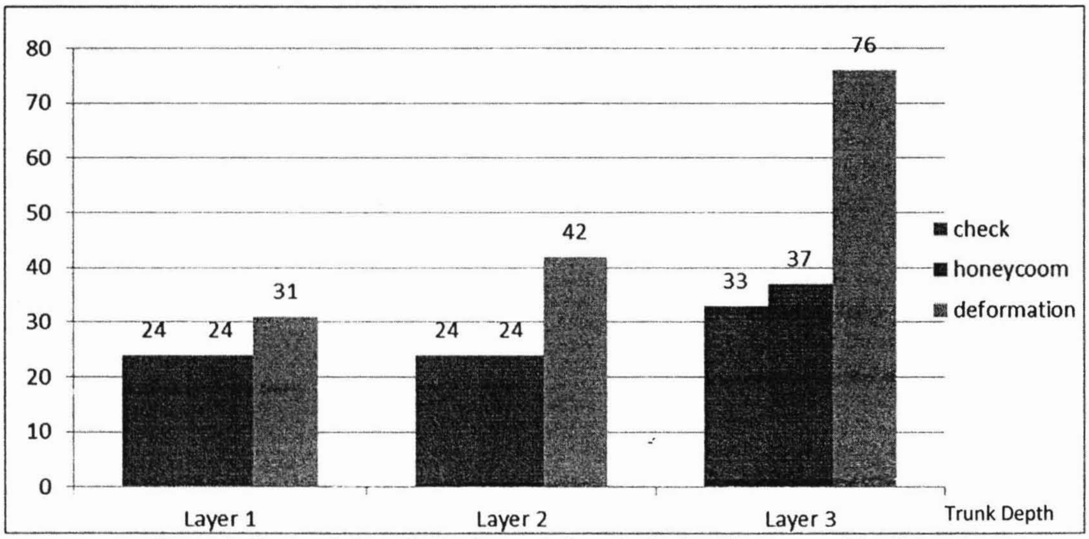

Figure 2: Drying defect of oil palm trunk from the bark to the center of the pith

The statistical test using the chi-square independent test between the trunk portion and Layers on the type of defect produced a p-value of 0.95 and 0.5, indicated that no significant association between the parameters. These findings were in tandem with Fauzi et al. (2012); (Loh et al., 2010) that no association between the trunk portion and defect type due to homogeneity of density. While Jusoh et al.(1991) discover that the rate of shrinkage between radial and tangential are about similar that produces less drying defect and no significant effect on the longitudinal direction.

On the other hand, there is an increase in the number of defect in accordance to the layers. This is expected to be related to the different amount of parenchyma cell and vascular bundle between the layer, where the peripheral zone (outer layer) is composed of a small amount of parenchyma cells and a large amount of vascular bundles which give more stability in the mechanical properties of the palm trunk (Lim & Gan, 2005). The result has also improved compared to the previous study by Fauzi et al. (2012) shows higher defect on the samples.

Conversely, the soft central region (pith) has a small amount of vascular bundles embedded within a large amount of parenchyma tissue that might be resulted from sorption properties during drying process (Zaihan et al., 2011). The distinctive moisture level in different layers of the oil palm trunk is expected to have been different drying properties (Bakar et al., 1999.,1998; Choo et al., 2011). The peripheral region contains the lowest moisture content and increases progressively from the peripheral region to the pith or central region(Paridah & Anis, 2007).The differences are also affected by variation of size, location, and distribution of vascular bundles along tree height and depth (Balfas, 2006; Lim & Khoo, 1986).

From the SEM image analysis in Figure 1 and 2, ethanol liquid at 75% concentration can stabilize the vessel and fibre structure and this might hinder the collapse, and deformation occurs after soaking process, compared to normal oven dry without ethanol (figure 1). From the observation, most of the penetration occurred through the parenchyma cells. According to Tomimura (1992), parenchyma in OPT is soft and less strength compared to vascular bundles. Besides, parenchyma is attached with the centre core which easily allows the penetration of the chemical. Conversely, the structure vascular bundles of OPT is hard and the density area with rich in vascular bundles; like the central region which is slightly rich of parenchyma and very soft. This suggests that the structure can easily collapse and deform to abnormal shape.

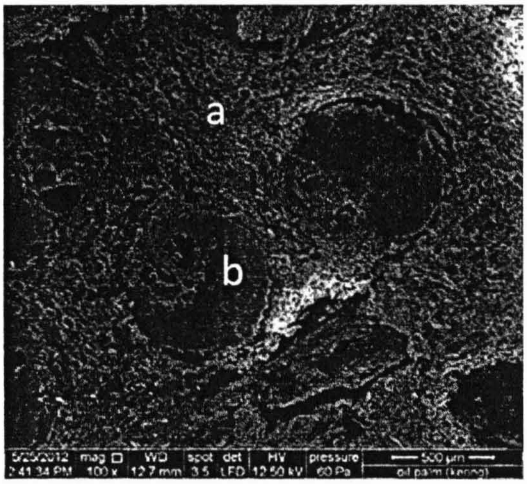

Figure (1) Untreated OPT

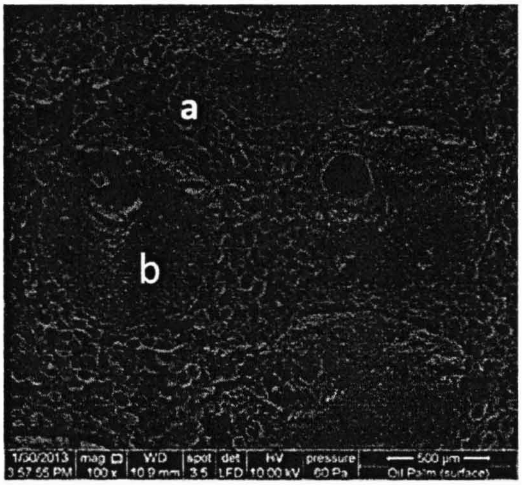

Figure (2). Treated OPT

a: parenchyma b: vascular bundles

From the microscopic inspection (Figure 2), it is evident that the ethanol spread well over the surfaces and cell wall. It is possible that ethanol links, react with hydroxyl groups in the OPT make the structure more harden and also would reduce the lignin content and crystallinity of cellulose and increase surface area(Alam, Muhammad, & Mahmat, 2005).

Furthermore Mohamad (1989) and Killmann (1983) suggested the core of oil palm trunk cannot be used because of its poor drying properties, and because of that he proposed the necessity of OPL segregation according to the potential uses. Similarly, Fauzi et al. (2012) also recommended segregating lumber made from oil palm trunk by densities prior to lumber manufacturing.

Conclusions

It was observed that the drying defect was significantly increased toward the inner zone. The most occurred defect was "Deformation", followed by "Honeycomb", and "Check". Because of that, it is highly recommended to use the oil palm trunk separately based on its transverse section. It also evident that the outer and middle region of the trunk is possible to dry with ethanol with less defect as compared to the center region, producing a lumber with simple drying method with min drying time and low drying defect.

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