Physical and Mechanical Properties of Three Layer Particleboard from Oil Palm Frond

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Abstract

This study was undertaken to determine the properties of three layered particleboard from oil palm frond (OPF) with different ratio resin content and particle sizes. Four different ratio of resin content; 12:10:12, 12:8:12, 10:10:10 and 10:8:10 were used with particle size for core; 2mm and face/back; 1mm. Urea Formaldehyde (UF) was used as a binder with/without wax addition. The target density was 500kg/m³. The properties of bending strength, internal bonding (IB), thickness swelling (TS) and water absorption (WA) were evaluated base on JIS standard. From the result, it shown that MOR and MOE value were perform better with particleboard using ratio 12:8:12 bonded with UF without wax. The IB strength was parallel with bending strength except for board using 12:10:12 ratio bonded using UF with addition of wax. TS and WA rate showed lower in particleboard using resin contain with ratio 12:8:12. In conclusion, the ratio of resin contain within the layered affected the properties of particleboard manufactured from OPF.

Keyword: *particleboard, oil palm frond, UF, Wax, resin content*

INTRODUCTION

Wood-based industry comprises of sawn timber veneer and panel products which include plywood and other reconstituted panel product such as OSB, particleboard, chipboard, fiberboard, moldings and builders joinery and carpentry (BJC). In view of the need to maximize the utilization of wood resources, the industry has diversified into the production of high value-added reconstituted panel products such as OSB and particleboard. The wood-based industry, over the years has successfully exported its products particularly for use in the furniture industry (John, 1982).

Particleboard is define as panel material manufactured under pressure and heat from particles of wood and or other lignocelluloses material in the particle form with the addition of an adhesive. In the United States, particleboard is a generic term for a material manufactured from wood particles or other lignocelluloses material and a suitable binder under heat and pressure. It is also known as particle panel product which is described as any wood-based panel product made from pieces of wood smaller than veneer sheets but larger than wood fibers (Kollmann et all., 1975).

Recently, the main raw material for the manufacture of particleboard from tropical wood is decreasing year by year. Alternative material was developing using lignocelluloses such as oil palm biomass to reduce the use of solid wood as a main material. Due to shortage of wood supply as raw material for producing furniture, many researches were carried out to find out the new material. The uses of oil palm frond are greatly beneficial in terms at replacing the wood as raw material for furniture making with the development of oil palm frond particleboard which it will be one of the new material sources. This was related with the oil palm industry to

generate hundred tones at oil palm frond waste that can be fully utilized by making particleboard (Basiron, 2007). This paper discusses the physical and mechanical properties of three-layered particleboard made from oil palm fronds particles.

MATERIALS AND METHODS

Oil Palm Frond (OPF) was harvest from DPIM plantation at UiTM Jengka, Pahang. The OPF attached to oil palm trees approximately 10-15 years old. Leaflets were removed from the fronds. The fronds will be chipped to 3-5cm size. Next, the chips will put into the ring flakers to produce particles. The size is usually less than 5.0mm. After air-dried, the particles will be screened to get the desire size of particles; core; 2mm and face/back; 1mm. The particles will be than undergo for oven dried at 90±5°C until the desire moisture contain.

Urea Formaldehyde (UF) used as a binder. UF was supply from private company at Klang, Selangor. UF was used with addition of wax and without addition of wax. Three layered particleboard from oil palm frond (OPF) will be fabricated with different ratio resin contain and particle sizes within face/back and core. Four different ratio of resin contain; 12:10:12, 12:8:12, 10:10:10 and 10:8:10 will be used with particle size for core; 2mm and face/back; 1mm. The target density is 500kg/m³. The dried particle will then put in the mixer. The amount of resin based on the board requirement is calculated before mixed in the mixer. The mould used was 340mm X 340mm. The mat was pre-pressed at 150psi for 2 minutes. The mats were placed in a hot press, a process in which accommodating one sheet at a time. Each mat sit between a pair of heated plated. The temperature used was 165°C for 6 minutes. Next, exposed the panels to the environment temperature about 4 to 6 minutes before shifted into conditioning room. The properties of bending strength, internal bonding (IB), thickness swelling (TS) and water absorption (WA) were evaluated base on Japanese Industrial Standard; JIS A 5908:2003 Particleboard (2003).

RESULTS AND DISCUSSIONS

Modulus of rupture (MOR) and Modulus of elasticity (MOE)

Figure 1 and Figure 2 show the bending strength (Modulus of Rupture; MOR and Modulus of Elasticity; MOE) of particleboard from OPF at different ratio resin content. From the result, it showed that, MOR value for panels bonded using 12:8:12 with addition of wax was highest compare with panels bonded using others ratios. The value of MOR also showed slightly higher for panels bonded using UF without addition of wax. The same behavior also experienced on MOE values. The addition of wax affected the properties of the panels which was reduced the value of MOR and MOE. This might due to the chemical substance in wax that reacts with UF which cause weaker adhesion between the OPF particles. As can be seen from the

Figure 1 and 2, the value of MOR and MOE for panels bonded using 12:10:1, 10:10:10 and 10:8:10 were in range, however panels bonded using 12:8:12 was slightly higher.

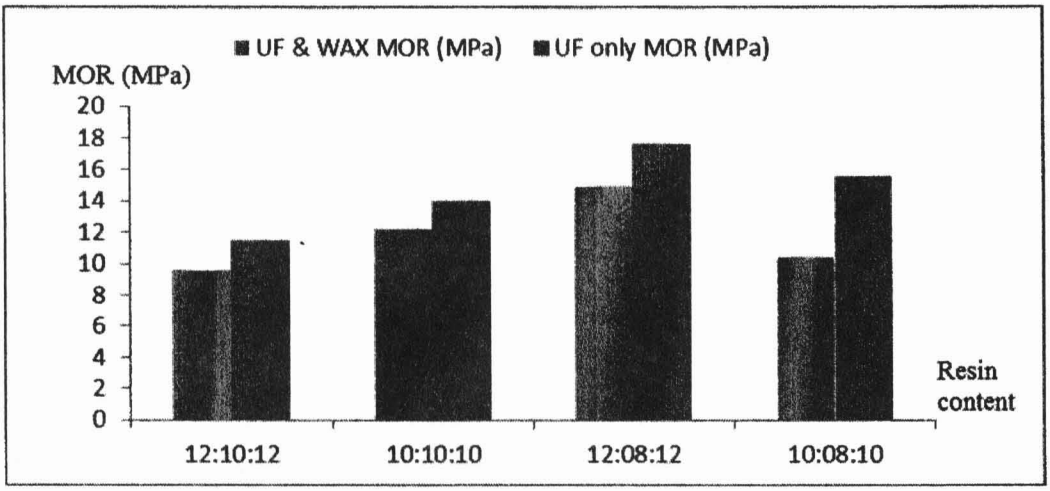

Figure1: Modulus of rupture (MOR) of three-layer particleboard from oil palm frond at different resin content and with/without wax

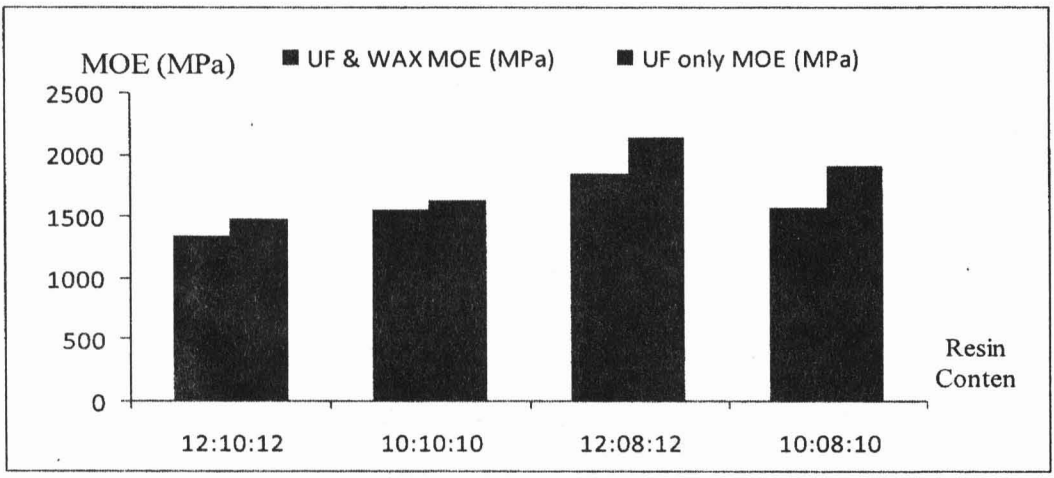

Figure 2: Modulus of elasticity (MOE) of three-layer particleboard from oil palm frond for different resin content ratio

Internal Bonding Strength (IB)

Figure 3 shows the internal bonding (IB) strength of particleboard from OPF at different ratio resin content. From the result obtained, it can be seen that panel manufactured without addition of wax was higher in all ratios except for 12:10:12.

With addition of wax, the IB strength was slightly decreased. IB value for panel bonded using12:8:12 without addition of wax was better compared with others three ratio resin content.

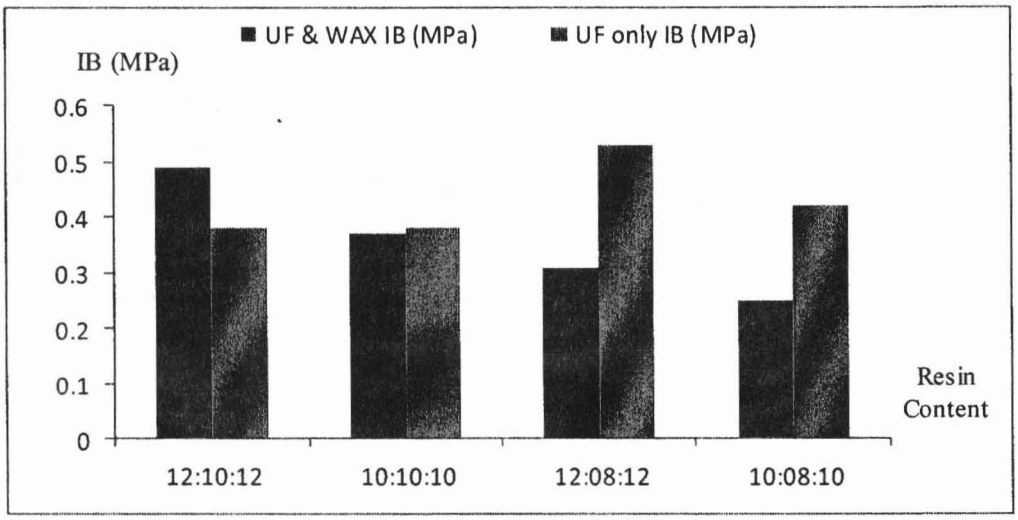

Figure 3: Internal Bonding strength of three-layer particleboard from oil palm frond at different resin content and with/without wax

Water Absorption

Figure 4 showed the water absorption rate for panel bonded using addition of wax, while Figure 5 showed panel bonded using without addition of wax. From the result, it can be seen that, panel bonded without addition of wax was slightly higher absorb water compared with panel bonded with addition of wax. Within the ratio of resin contain, the water absorption rate for panel bonded at 12:8:12 was lower compared with others three ratios. The additional of wax on the panel reduced the rate of water intake. Increasing the resin content improves the thickness stability of particleboard.

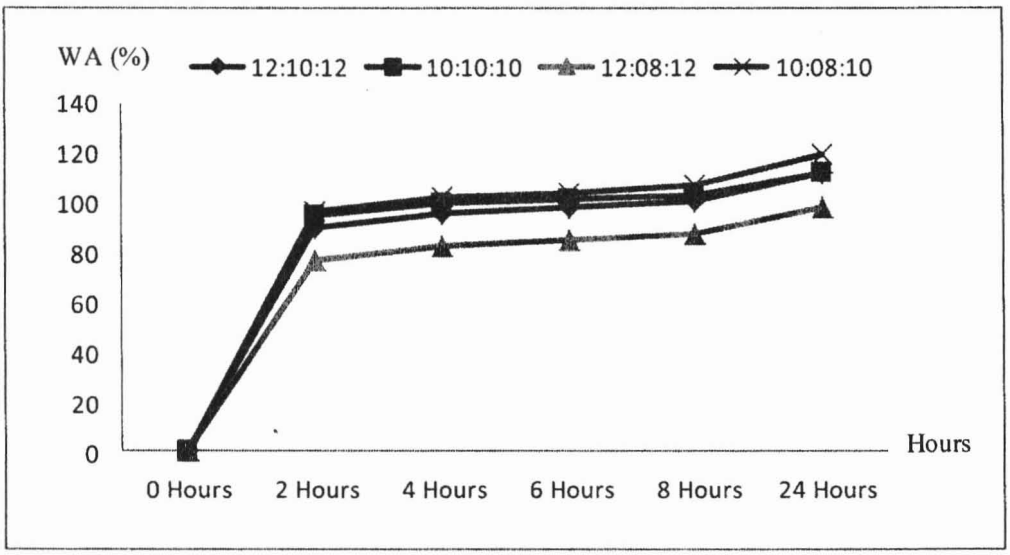

Figure 4: Water Absorption of three-layer particleboard from oil palm frond for different resin content ratio with addition of wax

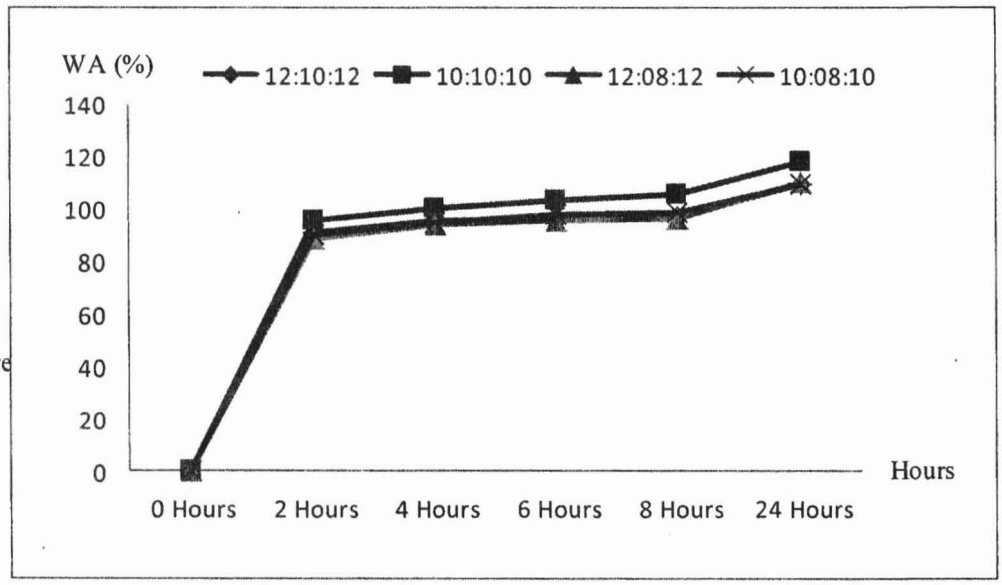

Figure 5: Water Absorption of three-layer particleboard from oil palm frond for different resin content ratio without addition of wax

Thickness Swelling

Figure 6 showed thickness swelling rate for panel bonded using addition of wax, while Figure 7 showed panel bonded using without addition of wax. Similar situation with water absorption, panel bonded using addition of wax was lower at thickness swelling rate compared with panel bonded using without addition of wax.

However, within the ratio resin contain, panel bonded at 12:10:12 showed the lowest thickness swelling rate compared with others three ratio.

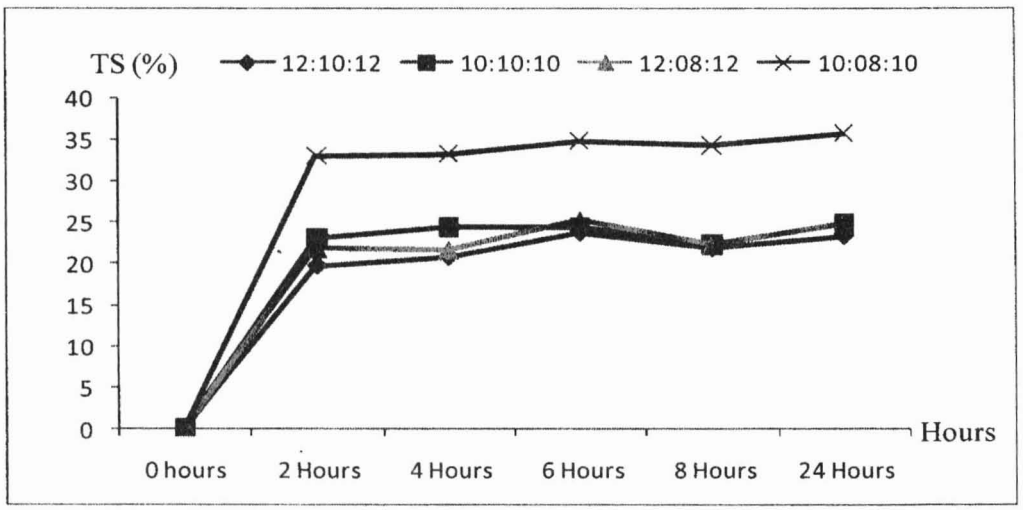

Figure 6: Thickness swelling of three-layer particleboard from oil palm frond at different resin content with addition of wax

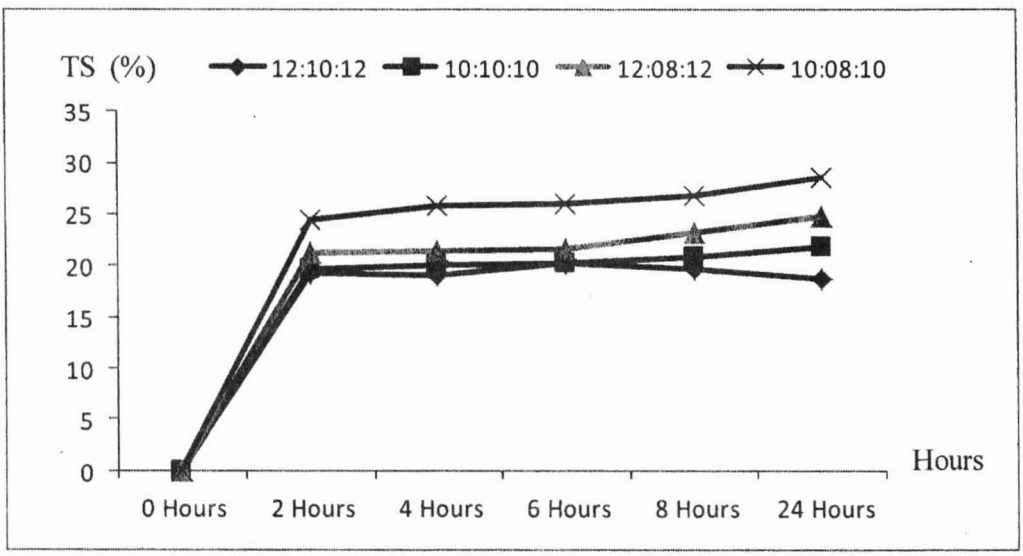

Figure 7: Thickness swelling of three-layer particleboard from oil palm frond at different resin content ratio without addition of wax

CONCLUSIONS

From the investigation, ratio of resin contains within the layered will affected the physical and mechanical properties of particleboard manufactured using OPF. It may be concluded that, OPF is suitable materials to produced particleboard with a

slight resistance effect on the absorption of water into the board with addition of wax. Resin content had significant effect on the MOR, MOE and IB strength, whereas higher ratio of resin content will increased the mechanical properties. As a result, the three layered board made from 12:8:12 satisfied fully the minimum requirement set by JIS A 5908:2003 Particleboard (2003) standard for general uses. However, the application of OPF for particleboard manufacture requires further investigation where to minimize the negative effect of the properties.

References

Haygreen, J.G. & Bowyer, J.L., 2019. Forest products and wood science, third ed. Iowa State University Press, USA, ISBN 0-81382-256-4.

Jamaludin Kasim. 1999. Properties of particleboard and thermoplastic composite from bamboo (*Gigantochloa scortechinii*). PhD Thesis. Universiti Putra Malaysia.

Howard A. Miller, 1977. Particleboard Manufacture, Noyes data Corporation, New Jersey.

Zaidon A., Junaidi B., Faridan M.T., & Nor Yuziah M.Y., 2001. Properties and Durability of MUF-Bonded Particleboard Treated with Boron Compound, *Sains Malaysiana* 30 (2001): 177-186.

Pizzi 1994, Advance wood adhesive technology. Marcel Dekker, inc. New York, Basel and Hong Kong, Pp.67

Pizzi 1983. Wood Adhesive, Chemistry and Technology. Marcel Dekkel, Inc. New York.

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