Evaluation on the Physical and Mechanical Properties of Particleboard From Batai (*Paraserianthes falcataria*)

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Abstract

The objective of this study was to investigate the suitability of Batai wood (Paraserianthes falcataria) in manufacture of particleboard. In this study, Urea Formaldehyde (UF) was used as a binder with three different resin content; 8%, 10% and 12% with/without addition 1% of wax. Two different particles size; 1.0 mm and 2.0 mm were used. The target density was 550kg/m^2. The properties include Bending Strength (MOR and MOE), Internal Bond Strength and water absorption were determined based on Japanese International Standard (JIS). From the study, it showed that, MOR and MOE value for panel with size 2.0mm is greater compare with 1.0mm. Conversely, panel manufactured using 1.0mm was better in internal bond strength compare with panel 2.0mm The result also shows that, MOR, MOE and internal bond strength for panel without wax is higher compare with panel with wax. The percentage of resin contain also affected the bending strength of the panel. When the percentage of resin increased, the MOR and MOE value was increased. The water absorption rate for panel with addition of wax using 1.0mm particle was slightly lower compare with panel manufactured without wax. Particles sizes, percentage of resin contain and addition of wax were affected the mechanical properties of particleboard from Batai.

Keyword: particleboard, Paraserianthes falcataria, UF, wax, resin content

INTRODUCTION

Particleboard is a composite panel product consisting of cellulosic particles of various sizes that are bonded together with a synthetic resin or binder under heat and pressure. Particle geometry, resin levels, board density and manufacturing processes may be modified to produce products suitable for specific end uses (Hashim et al., 2010). Today's particleboard gives industrial users the consistent quality and design flexibility needed for fast, efficient production lines and quality consumer products. Particleboard panels are manufactured in a variety of dimensions and physical properties providing maximum design flexibility for specifies and end users.

Wood supply now depends on the forest, at the insistence of the environmental requirements the forest harvesting rates have reduced. When minimized, the problem of raw material supplies facing shortage. Although wood is a renewable resource, but it took a long time to replanting. As we known, lignocelluloses such as oil palm, jute, bamboo, rattan and kenaf was develop to produce a new wood base product, in order to substitute solid wood, however it is not comparable of solid wood. Therefore, one of the fast growing timber species recommended is Batai as alternative source.

Batai (*Paraserianthes falcataria*) also known as sau Maluku or Sengon in Java, is a medium sized tree, has fast growth in the wet forest of Southeast Asia. Batai community forests in Java have been estimated to supply about 22.7% of the total Indonesia timber demand. Batai timber usually is used by community members themselves for various purposes, starting from fuel woods to many products, such as kitchen utensils, packing boxes, furniture, construction, and recently it has become a raw material for the timber industry (chips) in several parts of Java. Batai wood is versatile and promising species for use in forest development programs in the humid tropics because of its fast growth, vigorous regrowth, and good ability to compete with weeds and utility systems agroforestry and silvipastorales (Parrotta, 1990).

Batai was one of the species that can be developed as a new material in wood industry. However, we do not realize that Batai tree have own value to be commercially as a particleboard. Through this research it is to ensure that raw material for wood industry can be obtained continuously and also preserve a clean environment as well as to achieve a zero waste strategy. The physical properties of the board can be engineered to some extent by using different particle sizes in the core or surface (Kelly, 1976). This paper discusses the physical and mechanical properties of batai particleboard.

MATERIALS AND METHODS

Batai logs were obtained from a private company in Kedah, Malaysia. Three batai trees with dbh 26.7cm, 28.4cm and 27cm, approximately 7-10 years old were harvested. The logs were sawn into planks and then chipped to 3-5cm size. The chips were then flaked in the ring flakers to produce particles. After air-drying, the particles were screened into separate particles with size 1.0mm and 2.0mm. The particles were then oven dried at 90±5°C for at least 48 hours until the desire moisture contain. In this study, urea formaldehyde (UF) was used as a binder with three different resin content; 8%, 10% and 12% with addition 1% of wax and without wax. UF was obtained from a private company in Selangor, Malaysia. The UF adhesives pH was 8.41, solid content 65.5% with viscosity 2.03%. The target particleboard density was 550kg/m^3.

For board manufacture a weighted amount of particles was placed in the Particleboard Adhesive Mixer and sprayed with a resin mix containing resin, hardener and wax. The glue mix was sprayed as a fine mist at an air pressure of 0.4 MPa to obtain an even distribution of resin over the oil palm particles. After spraying, the sprayed particles were then manually laid in a wooden mould over a caul plate with a dimension of 340 mm x 340 mm and then pre-pressed with a cold press at 3.5 MPa for 30 seconds. Silicone release agent was sprayed onto the caul plate to prevent the panel from sticking to the plate during hot pressing. The wooden frame was removed and two metal stops of 12 mm were placed near the sides of the consolidated mat before another caul plate was laid on top of it. After that, the mat was then finally pressed with the hot press to the required thickness of 12 mm at

160°C for 6 minutes. For each condition, a total of three boards were produced. The particleboard produce were conditioned at 20°C and RH 65±2%. The panels were then cut into required size based on the testing procedure. 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

Physical Properties

Table 1 shows the density of particleboards from batai according to resin content, particles size and addition of wax.

Table 1: Density of particleboard from batai for different resin content manufactured using different particle size with addition of wax and without wax

Particle Size	Resin Content	Density	
		Wax	Without Wax
1.0mm	8	583.27 (72.57)	586.02 (28.57)
	10	586.08 (35.38)	591.63 (15.97)
	12	591.61 (24.77)	581.24 (26.03)
2.0mm	8	604.33 (58.95)	584.99 (53.20)
	10	541.36 (14.92)	567.69 (3.48)
	12	566.99 (15.45)	590.04 (21.17)

*Value in parenthesis indicate the standard deviation

Bending Properties (MOR and MOE)

Figure 1 and Figure 2 shows the modulus of rupture (MOR) and modulus of elasticity (MOE) value of batai particleboard according to different resin content, particle sizes with/without wax.

From Figure 1, for MOR value, board bonded with 12% resin content was higher compared with board bonded with 8% and 10% resin content for both 1.0mm and 2.0mm particle size. It was also observed that MOR value was slightly higher for boards bonded using resin without wax. With addition of wax, the MOR value decreases due to the resistance offer by wax towards bonding. The different particles size also affects the MOR. The larger particle size increases the number of bonding sites and makes the board stronger (Turner, 1954). A similar situation was also experienced by MOE value (Figure 2). Boards bonded with 12% UF without wax using 2.0mm particles size showed higher MOE values.

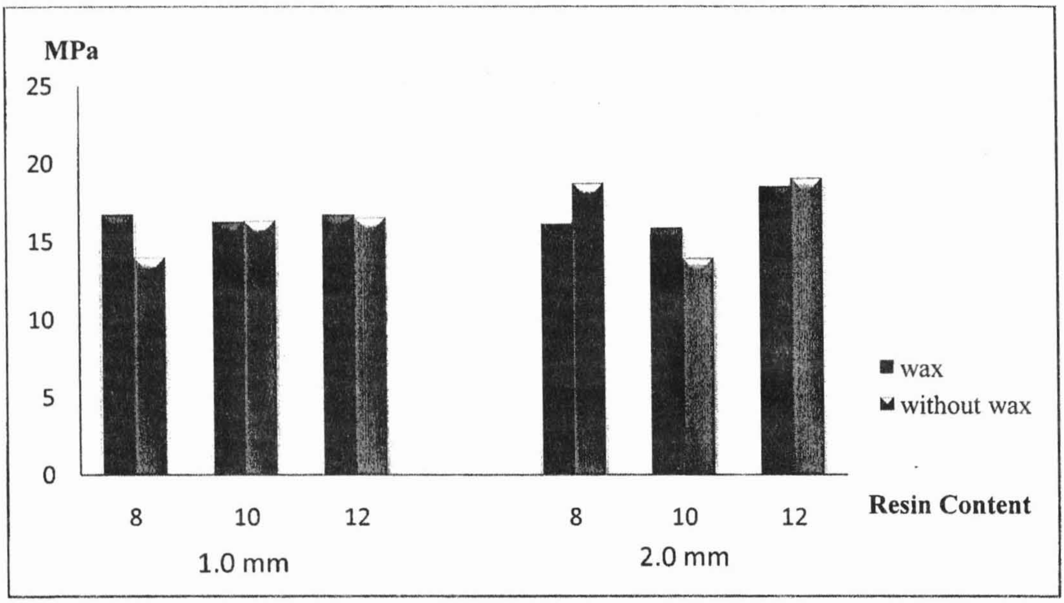

Figure 1: MOR of particleboard from batai wood at different resin content, particle size with/without addition of wax

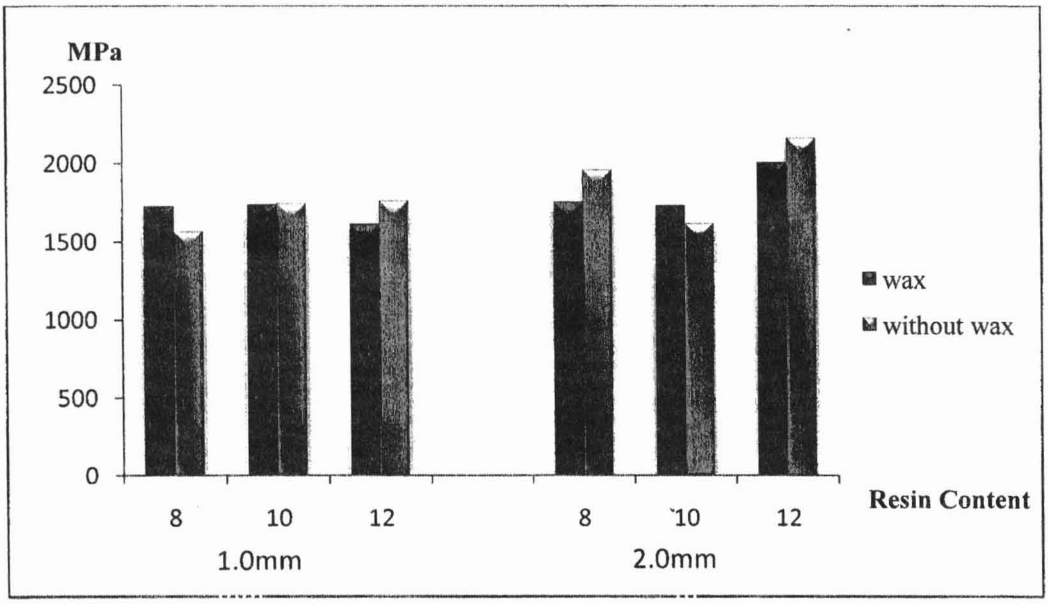

Figure 2: MOE of batai particleboard at different resin content, particle size and with/without wax

Internal Bond Strength

Figure 3 shows the internal bond (IB) strength according to particle size, resin content and addition of wax. Boards made with 12% resin content with 1.0 mm and 2.0 mm particles size showed higher IB values compared with boards made with 10% and 8% resin content. The higher amount of resin available increases the IB strength of the board. The result also shows the IB value also differs for baorads with wax and without wax. The board added without wax made from particles size 1.0 mm and 2.0 mm particles had IB values better than those boards with wax. IB value of board manufactured using 1.0 mm was higher than 2.0 mm particles size.

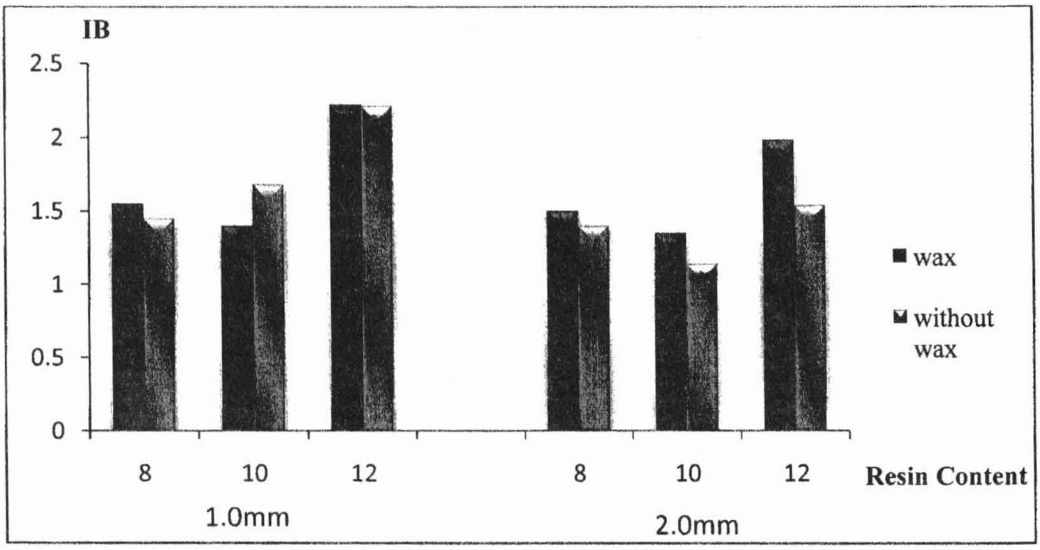

Figure 3: Internal Bonding strength of batai particleboard at different resin content, particle size with/without wax

Thickness Swelling and Water Absorption

Thickness Swelling (TS) and Water Absorption (WA) were evaluated within every two hours until the reading was constant. The TS and WA according to resin content with and without wax manufactured using 1.0 mm and 2.0 mm particle sizes are shown in Figure 4 and 5, respectively.

Figure 4 and 5 shows the effect of resin content with/without addition of wax on TS and WA for boards using 1.0 mm particle size. According to the result percentage of TS and WA of board using 12% of resin content with wax addition was lower compare with the panel using 12% of resin content without wax. A similar situation was experienced by board bonded with 10% and 8% resin content. The additional of wax on the panel reduced the rate of water intake. Increasing the resin content improves the thickness stability of particleboard. This is because the resin increases the bonding resisting the uptake of water. (Hann et al., 1963; Kimoto et al., 1964; Gatchell et al., 1966; Lehmann and Hefty, 1973).

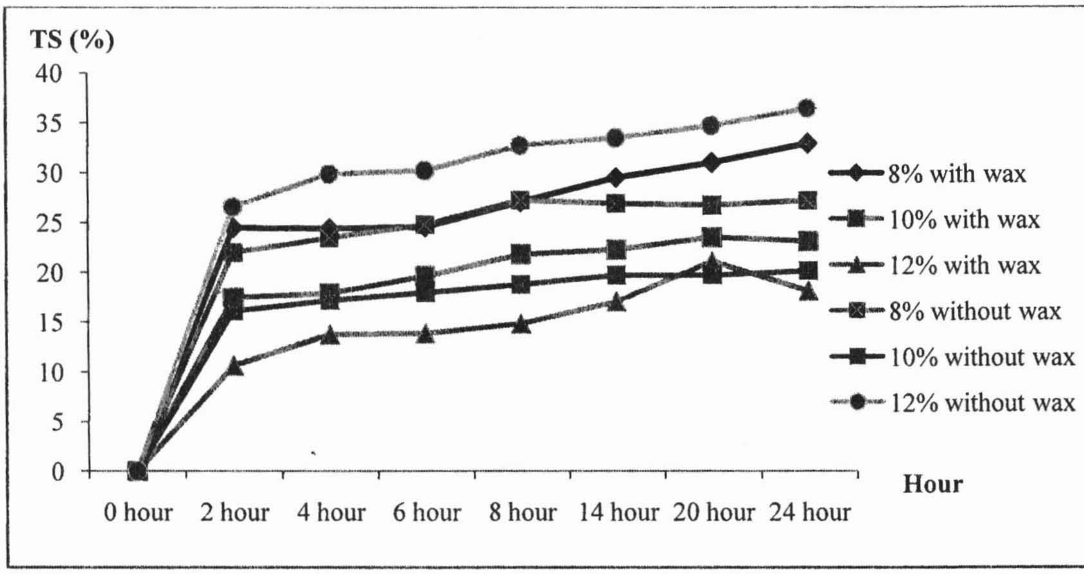

Figure 4: Thickness Swelling rate of batai particleboard according to different resin content with1.0mm particle size with/without addition of wax

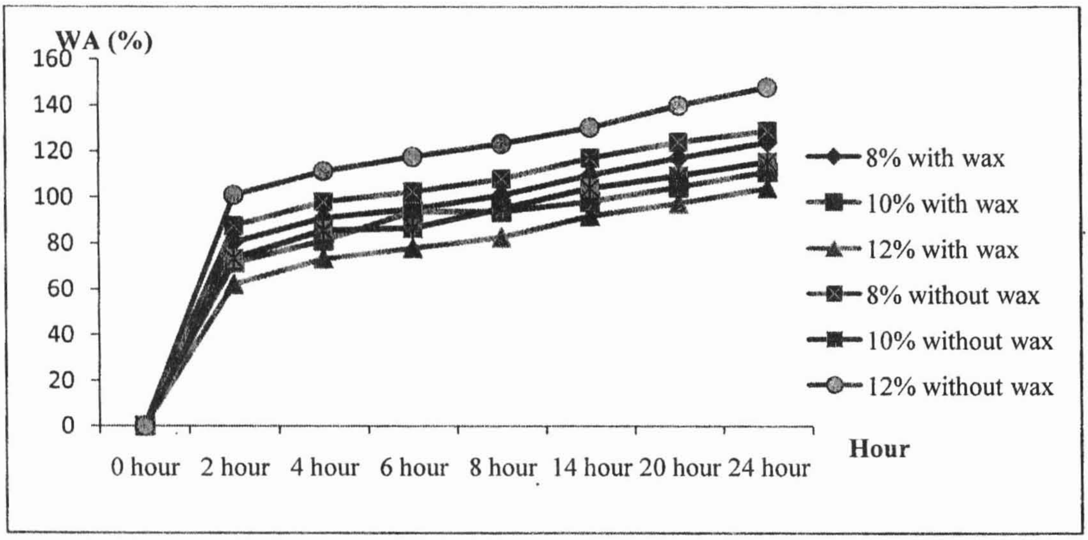

Figure 5: Water Absorption rate of batai particleboard according to resin content using 1.0mm particle size with/without wax addition

Figure 6 and 7 shows the effect of resin content with/without addition of wax on TS and WA for boards made from 2.0 mm particle size. From Figure 6, the board consisting of 12% of resin content and 1% wax is better on TS and WA than the board that consist 12% of resin content without wax. The additional of wax on the panel make the panel less absorbance towards water. Increasing resin content improves the TS and WA. This is due to the better bonding between the particles creating less void preventing water uptake.

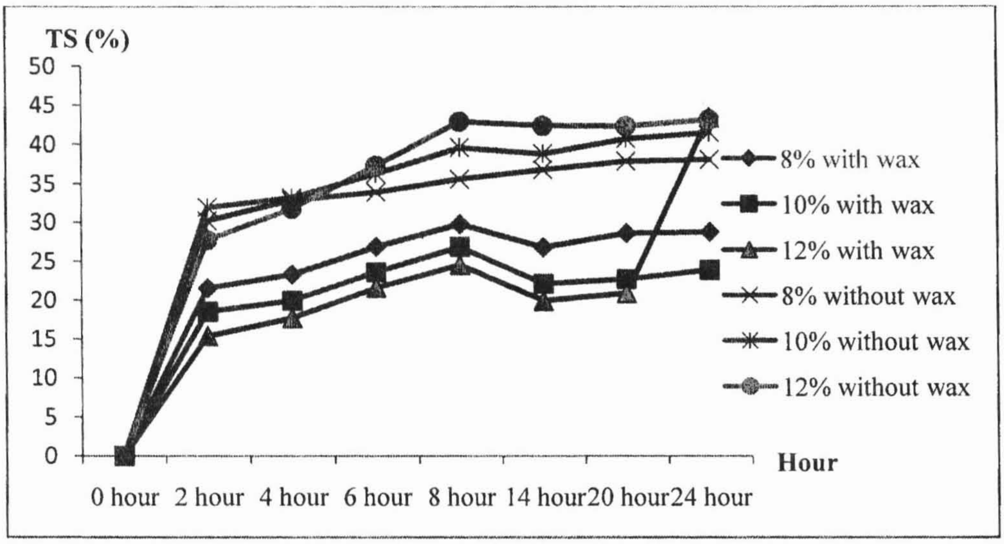

Figure 6: Thickness Swelling rate of particleboard from batai according to resin content using 2.0mm particle size with/without wax

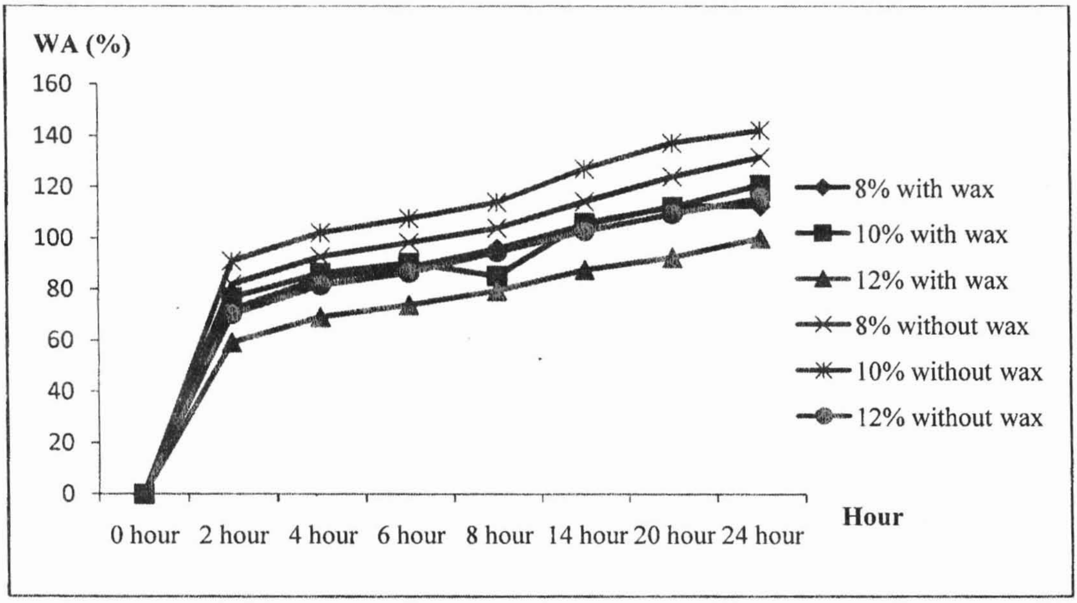

Figure 7: Water Absorption rate of particleboard from batai for different resin content using 2.0mm particle size with/without wax

Boards manufactured using 2.0 mm tends to absorb more water compared with panel manufactured using 1.0 mm. Wood is hygroscopic material that tends to absorb water. In this study, it shows that, when the particles size was increased, the TS and WA also increased.

CONCLUSIONS

Boards made from 1.0 and 2.0 mm bonded with 12% UF show better MOR, MOE and IB strength. However, with addition of wax, mechanical properties was reduced except for TS and WA. It can be said that Batai is a suitable resources to manufacture particleboard. However, further research need to be undertaken in order to improved the physical and mechanical properties.

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