Effects of Resin Content, Wax Addition and Particle Sizes on the Properties of Eight Year-Old Petai Belalang (*Leuceana Leucocephala*) Particleboard

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ABSTRACT

Petai belalang was successfully used in the manufacture of urea formaldehyde particleboard at a target density of 700 kg/m^3, resin content (8, 10 and 12%), 1% wax and with particle sizes of 1 and 2 mm and, with a board thickness of 12 mm. Increasing resin content increases the MOR, MOE, IB and improves the TS significantly. Wax also showed significant effects on MOR, IB and TS. Particle size does not influence the board properties.

Keywords: *particleboard, resin content, wax, particle size*

Introduction

Malaysian particleboard industry, since the 1980's, has been depending on rubberwood as their main source of raw material. However, this source is also sought for by the other wood-based industries especially the furniture industries. At present, *Acacia mangium* and mixed hardwood species are now used to supplement raw material to meet the demand of the industry.

Petai Belalang (*Leuceana leucocephala*) is planted as shade trees for cocoa and their leaves are also being use as supplemental feed materials for cows and sheep. It is a multipurpose tree growing rapidly and vigorously, drought tolerant and can grow in a wide range of soils (Gupta and Atreja, 1999). *L. leucocephala* in the 1970's and 1980's was promoted as a miracle tree for its multiple uses (Gutteridge and Shelton, 1998). It has also been described as a weed of open (often coastal or riverine) habitats, semi-natural, disturbed, degraded habitats and other ruderal sites. Since they are fast growing, their potentials as a raw material for the manufacture of particleboard are further evaluated. The objective of this paper is to discuss the properties of urea formaldehyde (UF) particleboard from petai belalang. The effects of resin content, wax content and particle sizes are also reported.

Materials and Methods

Sample Preparation

Ten Petai Belalang trees of about 8 years old were felled from the MARDI Research Station in Bachok, Kelantan. The average diameter at breast height was 30.0 cm with an average height of 20 feet. The logs were first cut into three feet billets and then sawn lengthwise into 2" × 2" × 3' and fed into a Taihei wood chipper to produce chips. The chips were further processed in a Pallman Knife-ring flaker set at 0.3 mm to produce wood particles. The particles produced were then airdried and sieved into 2.0 mm and 1.0 mm particle sizes. The particles were then dried at 60°C in an oven until it reaches the average moisture content of about 5%. Particle size analysis was also carried out on the dried particles.

Board Preparation

Single-layered urea formaldehyde particleboard of 12 mm thickness at varying resin content (RC) of 8, 10 and 12%, particle sizes (2.0 and 1.0 mm) and a 1% wax were produced. Resin used was supplied by a local resin manufacturer in Shah Alam. A measured quantity of particles was sprayed in Drais mixer with a resin mix containing urea formaldehyde, hardener and wax. The sprayed particles were then laid in a wooden mould and pre-pressed at 3.5 kg/cm^2. The consolidated mat was finally pressed in Taihei hot-press at 165°C for 6 minutes. The cooled board was then conditioned in a condition room at 20°C and 65% relative humidity. The board was then cut into the desired sizes according to the British Standards for strength and dimensional stability tests (BS: 5669. 1989).

Results and Discussion

Statistical Significance

Table 1 indicates that resin content showed significant effect on all the board properties. Wax also showed significant effects on all board properties except on MOE, while PS had no significant effects on all board properties. However, their interaction showed significant effects only on MOE and IB.

Table 1: Summary of the Analysis of Variance (ANOVA) on the Board Properties

SOV	df	MOR	MOE	IB	TS'
Resin Content (RC)	2	32.93*	81.85*	43.28*	25.32*
WAX (W)	1	5.19*	1.69ns	33.53*	37.16*
Particle size (PS)	1	0.20ns	4.23ns	3.58ns	2.03ns
RC X W	2	0.10ns	1.07ns	7.24*	3.79*
RC X PS	2	6.16*	2.46ns	2.92ns	3.25*
PS X W	1	0.10ns	0.26ns	21.57*	36.08*
RC X PS X W	2	1.03ns	7.57*	7.15*	0.15ns

Note: ns- F-value are not significant at $p < 0.05$, *significant at $p < 0.05$

Effects of Resin Content

Variation in resin content significantly affected the mechanical and TS properties as shown in Figure 1. The MOR, MOE and IB values indicate an increasing trend similar to Moslemi (1974) findings. TS improve with higher resin content. The correlation analysis in Table 2 further revealed that increasing RC shows a positive relationship with MOR (r = 0.67*), MOE (r = 0.83*), IB (r = 0.56*) and a decreasing relationship with TS (r = -0.53*).The higher mechanical properties and better TS values are due to the more resin available for bonding the wood particles together. Similar observations on the strength properties-resin contents relationship were also reported by other works on wood (Kelly, 1976), bamboo (Jamaludin et al., 2001) and oil palm fruit bunches (Shaikh et al., 1997).

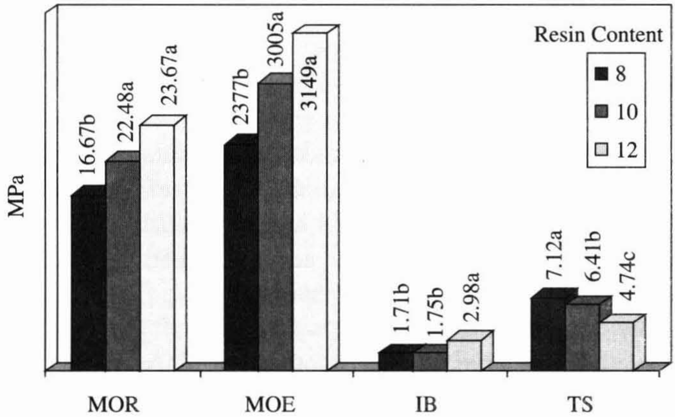

Figure 1: Effects of Resin Content on MOR, MOE, IB and TS

Table 3: Summary of the Correlations Effects of Resin Content, Wax Content and Particle Sizes on Board Properties

Source	MOR	MOE	IB	TS
RC	0.67*	0.83*	0.56*	-0.53*
Wax	0.20ns	0.13ns	- 0.39*	-0.50*
PS	-0.10ns	-0.13ns	-0.13ns	0.21ns

Notes: RC - Resin content, MOR - modulus of rupture, MOE - modulus of elasticity, IB - internal bond, TS - thickness swelling

Effects of Wax Content

Figure 2 shows the effects of wax addition on the MOR, MOE, IB and TS. Wax is usually was added to improve the board resistance towards water absorbent. Wax addition was shown to have a significant effect on MOR and TS. Correlation analysis shows that with wax, there was a non significant increment in MOR (r = 0.20ns), MOE (r = 0.13ns), and a negative correlation in IB (r = -0.39*) and TS (r = -0.50*). The increase in MOE (by 6.5%) was however, not significant. Stegman and Durst (1964) and Jamaludin et al. (1997) reported that the wax content increases dimensional stability but decreases the strength properties values. The decrease in strength values is due to the presence of wax, which prevents maximum bonding between the particles.

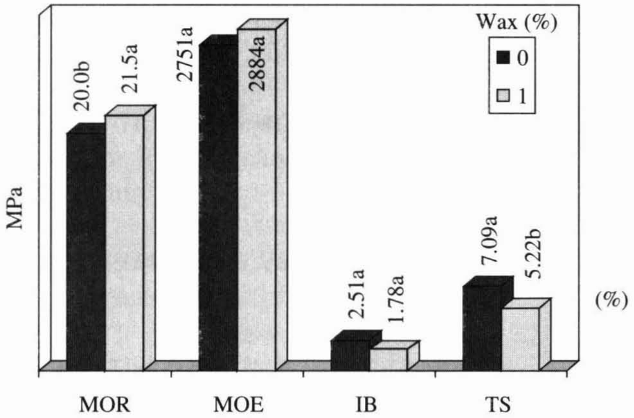

Figure 2: Effect of Wax Addition on MOR, MOE, IB and TS

Effects of Particle Sizes

Figure 3 shows the effects of PS on the board properties. Increment of particle size from 1.0 mm to 2.0 mm does not show any significant effect on the board properties. Table 2 indicates that with bigger particles (2.0 mm), a negative non-significant correlation is exhibited for MOR, MOE and IB, while with TS, a non-significant increment of TS values was shown. The higher MOR, MOE and IB values of smaller particles could be due to the more uniform distribution of stress and reduction of voids present (Shaikh 1991). From the correlation analysis (Table 3), the MOR ($r = -0.10$), MOE ($r = -0.13$) and IB ($r = -0.13$), decreased insignificantly with bigger particles. After 1 hour soaking, increases in TS were found to be insignificantly higher with 1.0 mm particles. This is further strengthened by the correlation analysis where TS ($r = -0.21$) increased insignificantly with bigger particle size.

Conclusion

From the study, the effects of varying resin content on all board properties were shown to be significant. Wax content was found to affect MOR, IB and TS, while PS had no significant effects on board properties. Particleboard can be made using both 1.0 mm or 2.0 mm particles producing acceptable board properties.

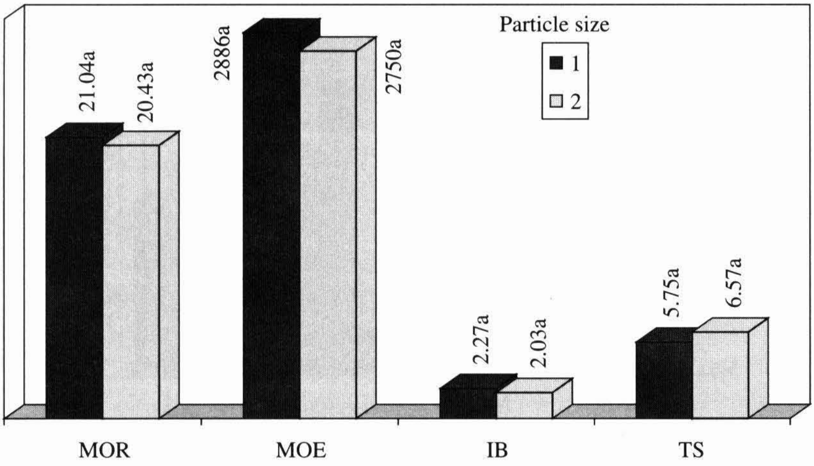

Figure 3: Effects of Partice Sizes on MOR, MOE, IB and TS

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