Effect of Resin Content and Species on the Properties of Particleboard from Leuceana spp and Rubberwood

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Abstract

This study focus on alternative species to produce particleboard with the targeted density of 700kg/m^3.Leuceana was mix with rubberwood in order to counter depleting supply of rubberwood. The main objective of this study was to determine properties with different ratio of species and resin content to determine the strength and durability of board. The particleboard ratio between the species (Leucaena:Rubberwood) were 30:70, 50:50, and 70:30 with 8% and 12% of urea formaldehyde resin. The modulus of elasticity, modulus of rapture, internal bond and thickness swelling of particleboards were determined according to British Standards Institution (BS EN Standard). Generally, the strength properties increase with increasing of resin content.

Keywords: resin content, particleboard properties, leuceana spp, rubberwood

INTRODUCTION

Most composite material development so far has been fabricated in order to improve its mechanical properties such as strength, stiffness, toughness and high temperature performance. They are currently being used in building material such as doors, windows, walls and floorings, reusable packaging and other products. The best known wood composites are particleboard and fiberboard (John *et.al*, 1982). According to Malaysian Timber Council, Malaysia particleboard industry increased gradually from year 2000 till 2007. The export of the particleboard is increasing for 83 % from 2003 to 2007. It shows that, Malaysian particleboard industry was speedy expanded year by year. The particleboard usually exported to USA, Taiwan, Japan, Korea and Singapore. In Malaysia, *Leuceana* is not commercially available at this moment and still in research. Thus, mixing rubberwood and *Leuceana* to produce particleboard can give us new particleboards panel that can be commercialize. It's would create a new evolution to the rubberwood particleboard industry. Due to the wood density of two species, it's almost similar. It gives a good combination between this two species. According to the previous research, wood properties influence the composite performance especially MOE and MOR (Maloney, 1977). In order to produce good qualities of particleboard, suitable species ratio of mixing and resin percentages is need to determine the strength properties of particleboard made from *Leuceana* with rubberwood and make sure the board qualities is achieve the standard.

MATERIALS AND METHODS

This study performed single layer particleboard from *Leuceana* mix with *Hevea brasiliensis*. The material of *Leuceana leucocephala* were taken behind Pasar Jerantut, Pahang while *Hevea brasiliensis* were taken at Rubberwood Plantation at UiTM Jengka, Pahang. The rubberwood trunk bark was remove using heard rig and then cut into smaller blocks and

flaked using a disc flakers to produce strand-like particle and then passed through a dust extractor to reduce them into particle. Urea Formaldehyde (UF) resin with solid content (60.5%) was used as the adhesive for making particleboard, UF was obtained from Malayan Adhesive Company at Shah Alam, Selangor. Particleboards were fabricated at the density 700 kgm^{-3} and the thickness is 12mm. Urea Formaldehyde resin was used at 8% and 12% and the particles size is random. Board size is 340 cm x 340cm. After debarking process, the materials are chipped to get a small chip of wood before fine flakes of the desired thickness and length. This contributes to the optimum strength and smooth finish on the surfaces of the boards. After that, we screen it use Gildson Screener. The purpose of this process is to remove the dust and also the over size of the particles that can affect the strength properties of the board. Particles fed over a vibrating flat screen or series of screens. The screens may be wire cloth, plates with holes or slots, or plats set on edge. Then, the particle we dried to get less than 5% moisture content in an oven dry. The dried particles were proceeding to the blender where we are mixed with resin. The amounts of resin based on the board requirement were continuously calculated before mixed in the mixer machine. After that we begin mixing process, we were using particleboard mixer machine that can combine the resin, hardener and particle to be mixed sufficiently. After completing the mixing process, we are weighed and divide into 3 boards for each density. The mould particleboard is 340 mm x 340 mm. This process was done manually because the mat forming machine is not available at workshop. Before forming, silicon realeve is used to spray tray because to avoid the particle stick on the tray and mould. The mats were placed in the cold press accommodating 3 minutes per board at room temperature. It is important to initiate bonding between particles. After cold pres section, the particle was bought to the hot press section. In hot pressing machine, the mats were placed in the press accommodating one sheet at each time. Each mats sit between a pair of heated platens. This machine that was used known as Taihei Hot press. The temperature for the hot process is 180^0c. For the first step it takes 180 second and the pressure is 1800 psi. While for Second step it remains for 120 second and its pressure is 1200 psi, and for the last step it was take about 180 seconds where the pressure are 1800 psi. In this process the particle must compress again with the high temperature and high pressure. The purpose of the three stages is to give a smooth and clear hot press process and indirectly avoid it from straight pressure. After all process particleboard making were finished. The board is separated from metal plate after several minutes. Then, let to the environment temperature about 4 to 6 minutes to air conditioning to be cold before trimming process. The properties of particleboard produce were evaluated based on Analyze of Variance for effect of species ratio and Independent Sample T-Test for effect of percentages of resin content to determine significant or not.

RESULTS AND DISCUSSIONS

Table 1 and 2 show the results of mechanical and physical properties of *Leuceana* with rubberwood. The results were compared to meet the minimum requirement for strength properties of particleboard panels for general uses and furniture manufacturing were evaluated based on BS EN standard.

Effect of resin content

Basically, the resin content had big influences that affect board properties. Based on previous research, high resin content gave higher strength properties of board.

Table 1: Effect of Resin on Mechanical and Physical Properties

Density (Kg/m^3)	Resin (%)	MOR MPa	MOE MPa	IB MPa	TS (%)
700	8(a)	18.38(a)	2631(a)	3.89(a)	24.25(a)
	12(b)	20.51(a)	2819(a)	4.21(a)	18.77(a)
	BS EN	>14.00	>1900	>0.5	<12

Note: Different letters down the column indicate significant at $p<0.05$

Bending Properties

Based on the result, MOR and MOE for bending test is achieve the standard. Table 1 shows the effect of varying resin content on the mechanical properties. According to Europe standard, all the samples for MOR testing meet the minimum requirement of standard. With increasing resin content, the MOR values increased (Rahim *et.al*, 1992). The Modulus of Elasticity (MOE) exhibited a similar trend as the MOR. This indicates that the addition of more resin into the board improved the MOE value through the better bonding of the particles.

Internal Bonding Properties

Based on the result, internal bond is determining as the inner strength of the boards which basically focused on properties of the particle bonded. It is well understood that the adhesion of porous materials involves mechanical interlocking, physical attraction and chemical bonding (Wellons, 1980). With higher resin content, more resin are available for particle bonding and increases the mechanical properties.

Thickness Swelling Properties

There are four major parameters that affect particleboard dimensional properties. They are board density, particle geometry, resin and wax and pressing condition (Razali, 1985). According to the standards, the thickness swelling was not able to meet the standard. Higher resin loading decreased the thickness swelling value. This indicates that the board with greater resin coverage on the particle had less thickness swell. Furthermore, increase in resin content, increase in contact areas and this turn contribute to better adhesion between particles (Rahim *et.al*, 1992).

Effect of Species Ratios

Bending Properties

The effect of ratio on strength properties are shown in Table 2 and were found to be not significant. Although the ratio of 30% Leucaena:70% R/W had the highest MOR and MOE compare to the other ratio. The result indicated that ratio does not influenced the mechanical

properties of the board. It's because *Leucaena* with rubberwood has almost same density. According to Lim *et.al*, (2003) the density of rubberwood ranges from 480 to 650 kg/m^3 depending on their age and possibly due to their clonal variation and the density of *Leucaena* 500-600 kg/m^3 according to Jones *et.al*,,(1997). Wood properties was shown to influence the composite performance especially MOE and MOR (Maloney, 1977 and Haygreen *et.al*, 1996).

Table 2: Effect of Species Ratios on Mechanical and Physical Properties

Density Kg/m^3	Ratio (%)	MOR MPa	MOE MPa	IB MPa	TS (%)
700	70(L):30(R.W)	20.20(a)	2747(a)	4.12(a)	21.56(a)
	50(L):50(R.W)	18.63(a)	2679(a)	3.93(a)	21.68(a)
	30(L):70(R.W)	19.50(a)	2748(a)	4.11(a)	21.29(a)
		BS EN	>14.00	>1900	>0.5

Note: -: Leucaena; R.W – Rubberwood. Different letters down the column indicate significant at $p<0.05$

Internal Bonding Properties

The result of ratio on IB properties was not significant. Although the ratio 30L:70R.W is the highest value compare to the others but it almost the same like others ratio .According to Loh *et.al*, (2010) lighter density particles have tendency to flow on top of the mixing tank and hence absorb more resin than the heavy particles .But the result almost the same. It shows that *Leuceana* and rubberwood can be merged at any ratio to produce particleboard. So that, we can indicate that different ratio did not influence the internal bonding properties of the board. It's because *Leuceana* with rubberwood has almost same properties. The internal bonding (IB) testing for the particle board is achieving the standard

Thickness Swelling Properties

The results of physical properties of thickness swelling for every ratio level of treatments were not significantly difference. According to Yaguang Zhou (2002), great internal bond strength of the boards should lead to small value of thickness swelling. The result shows that thickness swelling value almost the same. That's mean, each type of ratio can be use for particleboard making. Usually higher density species will be more stable in thickness swelling and less stable than lower density. Based on this result, *Leuceana* with rubberwood has almost same properties.

CONCLUSIONS

Based on the results, the ratio between the species does not influence the strength properties of the boards from *Leuceana* mix with rubberwood particles while the percentages of resin

content greatly influenced the MOR board properties. *Leuceana* and rubberwood are suitable to mix for particleboard making because the boards achieved the minimum requirement standard for MOR, MOE and IB. Although physical properties fail to achieve the standard, this limitation could be improved by adding water repellant agent such as wax emulsion. Thus, it recommended that *Leuceana* be considered as an alternative wood material to supplement rubberwood in particleboard manufacture for furniture making.

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