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INFLUENCE OF BOARD DENSITY AND PARTICLE SIZES ON THE HOMOGENOUS PARTICLEBOARD PROPERTIES FROM KELEMPAYAN (*Neolamarckia cadamba*)

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Abstract- Three Kelempayan trees were harvested from UiTM Pahang Forest Reserve and chipped and flaked into small particles. The particles were then screened into two different sizes; 1.0mm and 2.0 mm. Urea formaldehyde (UF) resin was used in the board manufacture. The hot press temperature was set for 165 C for 6 minutes. The board was cut in accordance to Japanese Industrial Standards: Particleboards for General Purpose (2003). Results showed that increased board density, the increasing the strength properties of the particleboard particle sizes non-significant effects on all the board properties except IB. Higher board density increases MOR, MOE, TS and WA while decreases IB. Particle sizes show the significantly effect MOR, IB, WA, TS except MOE .Particle sizes of 2.0 mm increases the MOR, MOE and TS significantly while 1.0 mm particles affected IB and WA only. All Kelempayan particleboards tested surpassed the minimum requirements of the JIS. This shows that Kelempayan trees can be used as raw material for particleboard manufacture.

Keywords: Kelempayan, Homogenous particleboard, Flexural properties, Physical properties, UF, Japanese Industrial Standards (JIS)

I. INTRODUCTION

Wood composite is a wood panel product that combines of various geometry particle sizes and binder with synthetic adhesives such as urea formaldehyde, phenol formaldehyde, melamine formaldehyde at specific pressure or temperature. Composites can uses for structural like furniture with any design and non-structural or support of many application of building. Particleboard is define wood is changing into particles, bonded with resin together, forming the particles, and with pressure and heat into panel product [1]. Part of that, particleboard or other name 'chipboard' is more choosing because a suitable, durability and have consistency of quality for making furniture, flooring, cabinet, wall and kitchen. Nowadays, in Malaysia the demand and trend of uses wood panel product such as particleboard is increasing in market. Therefore, the manufacturing of furniture have faced problem in shortage of raw material. As a result, such as uses of waste machine (sanding, planer, and band saw) and forest plantations can be replacement. Kelempayan (*Neolamarckia cadamba*) is one of species forest plantations and can be considerable portion of the supply of raw material. This tree has many benefits and can be modified for sawn timber, veneer, chips, pulp and wood composites [2,8,9]. In Malaysia, as supplies the main of raw material was shortage and there views the plan of future of this species can substitute the rubber wood. [7].The timber is white with a light yellow tinge and becoming creamy yellow on exposure. The sapwood is differentiated from the heartwood but not clearly. The wood have density 290-560 kg/cum at 15% moisture content. The bole has a fine to medium texture; straight grain; low luster and has no characteristic odor or taste[4].In this study, the objective was to investigate the properties of the particleboard from Kelempayan (*Neolamarckia cadamba*).These studies also aims to evaluate the effect of board density and particle size on the homogenous particleboard properties (MOR-Modulus of Rupture, MOE-Modulus of Elasticity, IB-Internal Bonding, WA-Water Absorption and TS- Thickness Swelling)of using urea formaldehyde.

II. MATERIALS AND METHODS

Preparation of Kelempayan Materials

Three Kelempayan were harvested with diameter at breast height (DBH) ranging from 35cm to 44cm at Forest Reserve UiTM Jengka, Pahang. The heights of tree were harvested at 10m to 16m. The trees were cut using bandsaw, and then proceed to chipped machine. The chips were sent into knife ring flake to produce particles. After flake, particles were air drying in one week and continue with screening process.
The particles were screened to get desirable size 1.0 and 2.0mm and remove the unwanted objects. The particles size 1.0 mm and 2.0mm were oven dried for 48 hours, 80ºC was set for temperature. The moisture content (MC) was reach below 5%.

Board Manufacturing

In the manufacture of homogenous particleboard, urea formaldehyde was used. The resin was made from Malaysian Adhesive, Shah Alam Selangor.

TABLE 1 RESIN SPECIFICATION

Properties	**Urea formaldehyde**
Viscosity	2.30 p
SG/30ºC	1.266
Solid Content	62.5*
Gel Time/100ºC	65*
Free Form	0.33

For homogenous particleboard, two different were used respectively 1.0 and 2.0mm. The three types of board density 500, 600, 700 kg/cm3 were used for this study. The percent resin 11% is similar for three types of board density. The hardener (ammonium chloride) solution 20% solid content, were used with urea formaldehyde for faster curing. The amount of hardener was calculated 3% based on resin used. The particles (below 5%) were mixing with UF and hardener and forming into the mould sizes were used 35mmx35mm x 12mm. The mats were pre-pressed in 2 min for consolidating the mat. The mats were sent into hot press, two metals with 12mm for thickness were placed at both sides the mats. The mats were pressed in 6 min and 165ºC for temperature.

Evaluation of Sample and Testing

The board were cut follow the JIS standards. The test of pieces particleboard were be left under conditioning room or which reach the constant weight at the temperature 20±2ºC and the relative humidity 65±5ºC.All the samples were shall be take the measurement as specific of the standard. The mechanical and physical of samples were evaluated based on Japanese Industrial Standard: JIS A 5908:2003. The mechanical (MOR/MOE), (IB) were tested using INSTRON machine.

III. RESULTS AND DISCUSSIONS

3.1 Flexural Strength and Physical Properties of Kelempayan Composites.

TABLE 3 FLEXURAL STRENGTH AND PHYSICAL PROPERTIES OF KELEMPAYAN COMPOSITES

Density (kg/m^{-3})	P.size (mm)	MOR (Mpa)	MOE (Mpa)	I.B (Mpa)	W.A (%)	T.S (%)
500	1mm	17.613	5632.232	0.620	131.915	30.680
	2mm	17.503	5309.223	0.553	128.643	32.147
600	1mm	24.323	7778.693	0.747	119.343	34.765
	2mm	27.315	8751.843	0.603	114.345	41.080
700	1mm	33.500	10678.628	0.813	117.985	46.777
	2mm	35.845	10967.920	0.567	112.652	53.615
JIS:2003		13.0-min	2500 -min	0.2min		12-max

The mechanical strength and physical properties was carried out according to target board density and particle size. All board was produced meet the JIS standard. Based on table 3,board with target density 700 kg/m^{-3} with particles 2.0mm shows the highest value of MOR (35.845 MPa), MOE(10967.92 MPa),TS(53.615%) but lower in WA(112.65%) for all board made from 500 kg/m^{-3} showed particle sizes 2.0mm higher MOR (27.315 MPa), MOE (8751.84 MPa), TS (41.080 %) but had lower in IB (0.603 MPa). For homogenous particleboard made from target density500 kg/m3, had the highest value MOR (17.613 MPa), MOE (5632.232 MPa), IB (0.620MPa) WA (131.915%) but lower in TS (30.680%).

The result of particle shows particle sizes1.0mm and 2.0mm is increase with trend. Internal bonding shows that particle sizes 1.0mm high value better than 2.0mm. All the result showed when an increase board density 500 kg/m-3 to 700 kg/m-3 increases the mechanical and physical properties. The result homogenous of particleboard showed density 500 kg/m-3 to 700 kg/m-3 are able to meet the requirement Japanese Industrial Standard (JIS).

3.2 Statistical Significance

Table 4 shows the summaries of the Analysis of variance (ANOVA) on the influence of board density and particle size on the particleboard properties. Target board density shows the significant influence on MOR, MOE, WA, TS and IB while non-significant on all the homogenous particleboard properties. All the homogenous particleboard made from particle sizes 1.0mm and 2.0mm shows significant influence on MOR, IB, WA , TS and MOE . The relation between density and particle sizes showed that only significant influence on MOE and MOR, IB, WA, TS shows non-significant on the all particleboard.

TABLE 4 SUMMARIES OF THE ANALYSIS OF VARIANCE (ANOVA) ON THE INFLUENCE OF BOARD DENSITY AND PARTICLE SIZE

SOV	df	MOR	MOE	IB	WA	TS
Density	2	135.075*	190.253*	2.187 ns	19.227*	74.225*
Particle Size	1	4.198*	1.953 ns	12.189*	4.374*	14.534*
Density * Particle Size	2	1.234ns	2.790*	1.431ns	0.086 ns	1.789 ns

*Note: SOV Source of variance, *p<0.05, **high significant, p<0.01,ns-not significant, df-degree of freedom,

3.3 Effect on board density.

Density is one of the parameter that shows the better mechanical properties of particleboard. Previous research, shows the significantly influence board density on the flexural strength properties when increasing density can cause the higher compaction ratio in the board[5].Figure 1 shows the influence of board density on the flexural strength. Based on graph shows the increasing the target board density 500, 600 and 700 kg/m-3, flexural strength properties of MOR, MOE and IB also increases. According Siti Noorbaini Sarmin *et al.* 2013, as similar reported that when board of particleboard increased, the value flexural strength MOR, MOE and IB also increased [6].

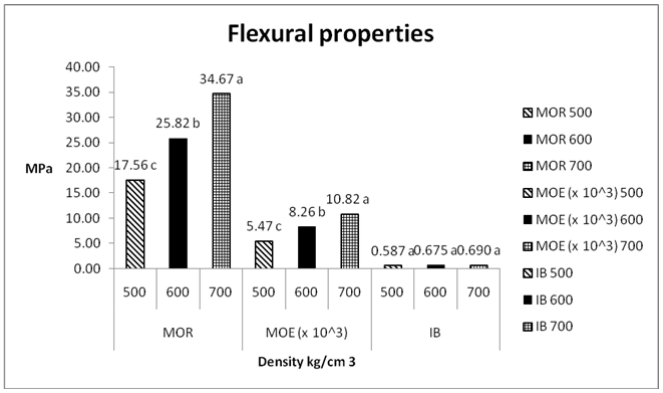

Fig 1 Duncan Multiple Range Test (DMRT) on the effect of board density on the flexural strength properties of Kelempayan *(Neolamarckia cadamba)* particleboard.

Figure 2shows on the effect of board density on the physical properties of Kelempayan *(Neolamarckia cadamba)* particleboard. The result of physical properties also shows the increment value from /500 kg/m-3 to 700 kg/m-3. Stegmann and Kratz (1997) also state thickness swelling and water absorption was increased 500kg/m-3 to 700 kg/m-3, when board density was increasing [7]. According Niemz and Steinmetzler (1992) was familiar with impact on board density and thickness swelling on swelling stress. They obtained that swelling stress increased, when thicknesses swelling increasing which more prove with boards with higher density [8].

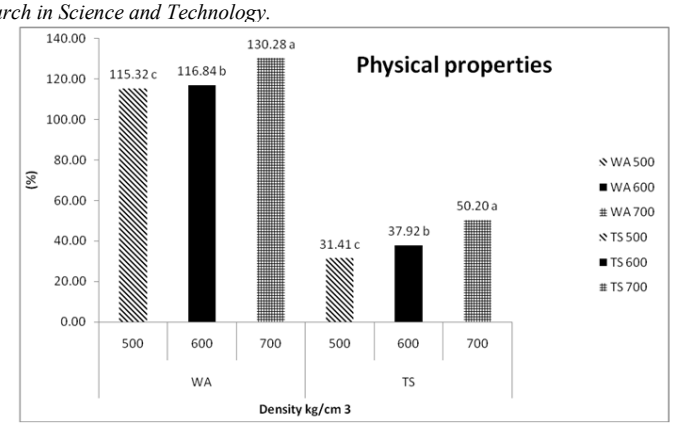

Fig 2 Duncan Multiple Range Test (DMRT) on the effect of board density on the physical properties of Kelempayan *(Neolamarckia cadamba)* particleboard.

3.4 Effect on particle sizes.

Figure 3, shows graph the effect of particle sizes on the flexural strength properties of Kelempayan *(Neolamarckia cadamba)* particleboard. The particle sizes 2.0mm shows the higher than particle sizes 1.0mm.Bigger surface areas of particle give better stress distribution than small sizes. The higher value of bigger particles size can obtained when more amount resin contain per unit area [6] has. Another finding from Rokiah Hashim *et al.* (2010), increase the larger surface area, increasing the strength properties because in a better glue line respectively [9]. Internal bonding obviously decreased with increased particle sizes. There is small different value on the Modulus of Elasticity.

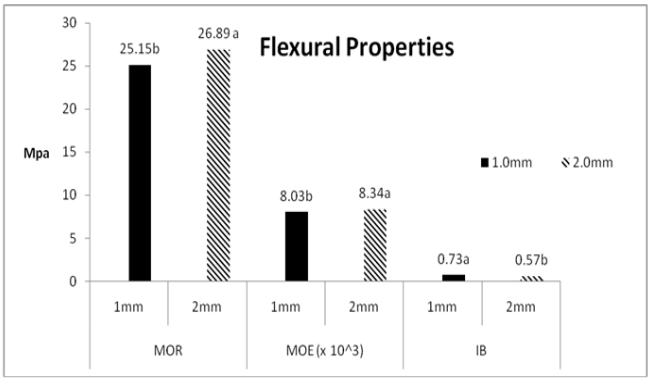

Fig 3 Duncan Multiple Range Test (DMRT) on the effect of particle sizes on the flexural strength properties of Kelempayan *(Neolamarckia cadamba.)* particleboard.

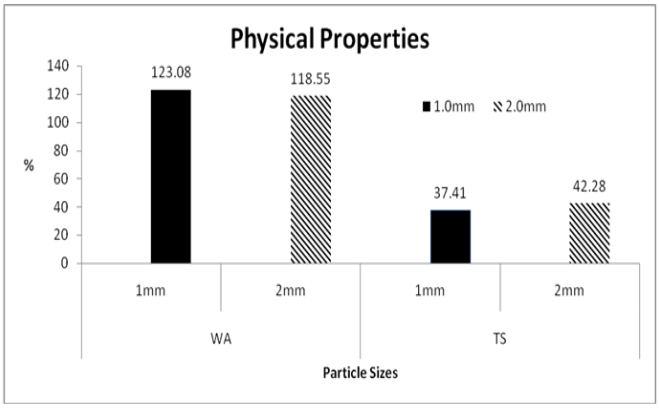

Fig 4 Duncan Multiple Range Test (DMRT) on the effect of particle sizes on the physical properties of Kelempayan *(Neolamarckia cadamba)* particleboard.

Figure 4 shows the effect of particle sizes on the physical properties of Kelempayan *(Neolamarckia cadamba)* particleboard. Particles size is an important part for determined reaction of board to water absorb and thickness swell. The increases values of particle size 1.0mm differ than 2.0mm probably because the compaction during hot pressing. Tarkov and Turner (1958) find that the swelling pressure increases, when increasing the densification of the wood. The result shows increases thickness swelling particle size 2.0mm compare than 1.0mm.

Another factor, less amount of resin were used to covered all the surface of particle According Jamaludin Kasim (2006), bigger particle sizes increase because can produce a larger surface area and inability to closely compare than smaller particle sizes.

IV. CONCLUSION

For this study, it can be obtained that the influence of board density and particle sizes produce better mechanical and physical properties. All the board with target density 500 kg/m-3,600 kg/m-3 and 700 kg/m-3 meet the requirement Japanese Industrial Standard (JIS). Increasing the target board density from 500 kg/m-3,600 kg/m-3 and 700 kg/m-3 significantly influence the mechanical and physical properties except WA. A particle size 2.0mm shows the better result for mechanical properties and physical properties on the homogenous particleboard. In conclusion, Kelempayan trees (*Neolamarckia cadamba*) can be commercialized as raw material for particleboard industry in future.

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REFERENCES

[1] J.A.Youngquist, Wood based composites and panel products in wood handbook: wood as an engineered material, Gen. Tech.Rept.FPL-GRT-113.,USDA Forest Serv.,Forest Prod, Madison, WI,1999, pp.1-31.

[2] Logan, A. F., V. Balodis, YK. Tan &F.H. Phillips. 1986. Pulping properties of regrowth Anthocephaluschinens is and MacarangahoseifromSarawakForests.Trop.Sci. 26: 45-58.

[3] Niemz and Steinmetzler, 1992.

[4] Orwa C, MutuaA ,Kindt R , Jamnadass R, Simons A. 2009. AgroforestreeDatabase:a tree reference and selection guideversion 4.0 (http://www.worldagroforestry.org/af/treedb/).

[5] Jamaludin,K, Zalifah , M, Nurrohana, A, Siti Nor Ain, T, Nor Suziana, S, Nor Ashikin, R, Properties of Phenol Formaldehyde Particleboard from Oil Palm Trunk, XXII IUFRO Conference in Seoul, South Korea 23th-28th 2010.

[6] JamaludinKasim, Properties of particleboard and thermoplastic board from bulohsemanatan(*GigantochlaScortechini*),2006, University publication Centre (UPENA), UniversitiTeknologi MARA.

[7] Panshin, A. J. &C. De Zeeuw, Textbook of wood technology, 1980, Ed. 4. McGraw-Hill, New York .

[8] Peh, T.B., Preseut status of pulping and paper-making research with special reference to the possible utilization of tropical hardwoods, 1970 Mal. For. 33: 324-327.

[9] Phillips,F.R.. A.F.Logan&V.Balodis, Suitability of tropical forests for pulpwood. Mixed hardwoods, residues,and reforestation species, 1979, Tappi 62:77-8l.

[10] Rokiah, H, Norhafizah, S, Othman, S, Tomoko, S, Salim, H, Masatoshi, S, Ryohei, T, Effect of particle geometry on the properties of binderless particleboard manufactured fromoil palm trunk. Materials and Design 31, 2010, 4251-4257.

[11] Stegmann and Kratz, 1997.

[12] Siti Noorbaini, S, Shaikh Abdul Karim Yamani, Z, Jamaludin, K, Mechanical Properties of Homogenous and Heterogeneous Three Layered Particleboard Composite in Relation on Different Resin Content, Advanced Materials Research Vol.699, 2013,pp 637-640.

[13] Tarkov,H;Turner, HD, The swelling pressure of wood. Forest Product Journal, 1958, 8970:25-27.