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Effect of Urea Formaldehyde to the Mechanical Properties of Particleboard fromNeolamarckiaCadamba and Endospermum Diadenum

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ABSTRACT. The demand and trend uses wood panel such as particleboard is increasing. It cause faced problem in shortage of raw material sources.This research was carried out to investigate the mechanical properties of particleboard (PB) by using two different wood waste ofneolamarckiacadamba (NC) and endospermumdiadenum (ED). NC and ED are fast growing species available in Peninsular Malaysia. A Single layer particleboard was fabricated with 0.8 mm particle size with density 650 kg/m^3 and bonded with urea formaldehyde (UF) as binder. NC and ED species based of oven-dry weight and amount of adhesive which are 8%, 10% and 12%. The mechanical properties in bending strength modulus of rupture (MOR) and modulus of elasticity (MOE) and internal bond (IB) were determined. The morphological observation on PB was conducted using light microscopy and field emission scanning electron microscopy. The results of morphological properties of ED species shows were less adhesion between fiber and UF in the structure. The resultsof mechanical properties shows MOR testing of NC wood species at 12% had the highest values which are 25.20N/mm^{2}compared to ED species of24.07 N/mm^2. However, the results of MOE and IB testing shows the samples of ED had the highest values which is 3303.32 and 1.29 N/mm^2 compared to NC wood species has 3226.07 and 1.12 N/mm^2. Thus, NC and ED particles can be used as a raw materials to wood-based PB for general purpose application.

Keywords: *Particle board, Urea formaldehyde, Neolamarckiacadamba, Endospermumdiadenum;*

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1. INTRODUCTION

The alternative of natural woody species have been declining, causing the search for new lignocellulosic materials that may efficiently meet the demand. Due to the rise in wood consumption, this issue makes the researcher identify regarding a new products and better utilization of the new raw material available. The main materials use nowadays to produce furniture is using engineered wood as known as wood composite. The production of wood composite is widely commercial around the world due to its applications, advantages, cost and multifunction [1-3]. Furthermore, by used wood waste materials in producing wood composite might profitable and might reduce the wood waste through reuse to maintain the ecosystem in the future.

Recently, many different lignocellulosic woods were used in particleboard production; such as coconut chips [4], waste tea leaves [5] and wheat straw [6]. The reason of using those materials because to utilize the waste become new materials in PB production. Particleboard is a wood based composite come up with any shapes and sizes of wood particles of lignocelluloses materials which is bonded together with an adhesive and associated under heat and pressure [7].

Utilization of wood chips can be one of the factor in varying more types of composite panel products. Wood chips can be utilized to produces any types of wood composite as main materials in wood composite manufacturing. Furthermore, the wood composite can be engineered to various specifications and applications.

NC is fast-growing tree species which is being advanced for its physical and mechanical properties in order to assess its potential for future utilization [8]. NC species can be commercialized as raw material for PB industry [7]. Thus, NC and ED have many benefits and can be modified for wood chips, veneer and wood composites. ED is one of the good alternative timber for furniture industry [9]. This species also can be considerable portion of the supply for raw materials. In this work, the morphology of NC and ED in wood composite for particleboard application was carried out by FESEM.

2. MATERIALS AND METHODS

The main materials to produce particleboard is from wood waste of NC and ED Wood waste is obtained from Forest Research Institute Malaysia (FRIM). The wood excessive in the form of wood end cut, wood chips and sawn timber. A single layer particleboard was fabricated with 0.8 mm particle size with density 650 kg/m^3 and bonded with UF as binder. NC and ED species based of oven-dry weight and amount of adhesive which are 8%, 10% and 12% was applied, respectively. The board were evaluated to determine its mechanical properties which is MOR, MOE and IB based on British European Standard (BS EN 310,319-1993). The sample proceeded to examine the surface of sample by using light microscopy model JenoptikProgRes Capture Pro 21001 magnification applied were 20x each sample.The morphologies analysis of PB composites was conducted using (FESEM) Zeiss Supra 40-VP used to identify clearer image on the surface morphology of the board composite samples.

3. RESULTS AND DISCUSSION

3.1 Bending Strength. Bending strength test was carried out to determine the MOR and MOE of single layer particleboard composite. MOR applied to determine the suitability of materials for structural application and specifies the ability of a sample to bear a transverse (bending) force perpendicular to its longitudinal axis [10]. Table 1 shows the MOR and MOE of single layer particleboard composite with different resin content which is 8%, 10%, 12% at same density of 650 kg/m^3 with two different wood species. From the results obtained, NC species showsimprovement compare to ED species. Whereas the MOR values increased from 20.73 N/mm^2 to 25.20 N/mm^2 as shown in Table 1. Besides that, ED species also has improvement MOR values which is increased from 20.60 N/mm^2 to 24.07 N/mm^2. The MOR values increase with the increasing amount of resin content of each panel.According to the British European Standard the MOR requirement is 14 N/mm^2 EN310-1993. Most of the values is passed.

Table 1 shows the results of MOE for both species. Overall, ED species has better strength compared to NC species in terms of MOE testing. The MOE values of ED has increased from 2591.37 N/mm^2 to 3303.32 N/mm^2. As well, MOE values for NC species also has increased from 2985.55 to 3226.08 N/mm^2. It proved that the increasing of resin addition increasing the MOR values was obtain. Similar results had been observed by [11, 12] who reported that the urea UF could effectively be useful as binder for the manufacturing of

particleboard. Previous study [13] who stated that different wood species used in producing particleboard would effect to the properties of particleboard because it related to the sorption properties and chemical composition of wood itself. Based onthe MOE (EN310-1993) requirement is 11800 N/mm^2, MOE value is met the requirement.

3.2 Internal Bonding Strength. Table 1 showsthe IB values of single layer particleboard composite were produced. This test was used to determine the resistance to tension perpendicular to the plane of the particleboard. From the results obtained, ED species shows the improvement compared to NC species. The IB values increased from 0.65 N/mm^2 to 1.29 N/mm^2. The amount of resin used had effects the internal bond strength of the panel due to the excessive amount of resin would reduce the wettability properties of the particles [14-15]. These indicated that higher amount of resins boosts up strength of interfacial bonding between fibers in the boards panel, thus could extend the ability for the boards to withstand the pulling force crated through the test. According to the BS EN the IB requirement is 0.40 N/mm^2 EN310-1993. Mostly all the IB value is met the requirement.

Table 1 Mechanical testing of particleboard panel bonded with different species ratio and resin content

		Mechanical Testing		
Species Ratio	Resin Content (%)	MOR (N/mm^2)	MOE (N/mm^2)	IB (N/mm^2)
NC	8	20.73	2985.55	0.83
	10	23.03	3048.89	0.93
	12	25.20	3226.08	1.12
ED	8	20.60	2591.37	0.65
	10	23.82	2959.69	1.12
	12	24.07	3303.32	1.29

***3.3 Morphology observation*.** Fig. 1shows the images of ED board panel with different resin content using light microscopy with 20x magnification. It can be seen the surface of panel has glue spot and uneven distribution of glue as marked with red circlesas shown in Fig. 1 (a) and (b). It occurred during the preparation in mixing process of panel board between fiber and UF. The distribution of UF in uneven condition caused glue spot on the surface of board. This is because the panel ED wood species did not give better performance. Thus, can be proven according to the previous test evaluation results which is has lowest values.

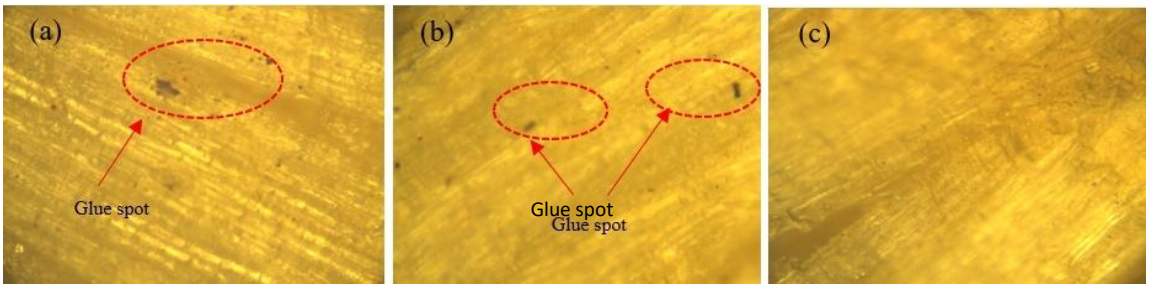

Fig. 1 Surface morphology ED species of 8%, 10%, and 12% UF

Thus, the good spreading of binder will increase the properties of panel board. It might improve the mechanical properties of panel. Therefore, it can be proven according to the previous test evaluation results which is has higher values.

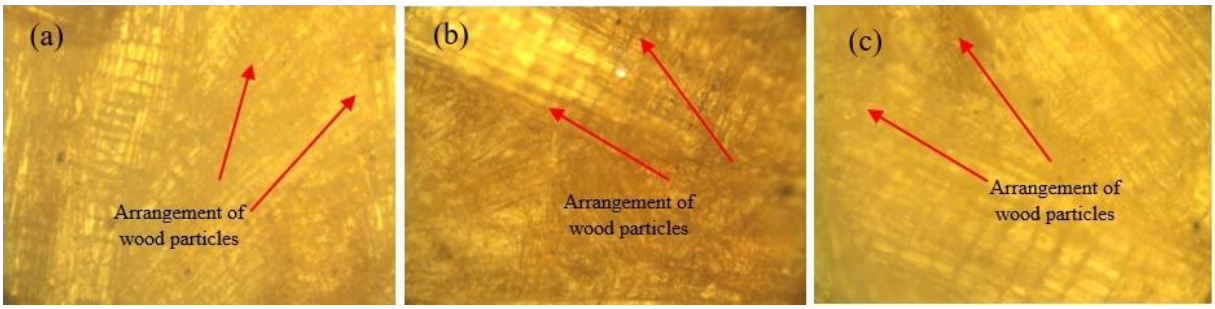

Fig. 2 Surface morphology panel NC species of (a) 8%, (b) 10%, and (c) 12% of UF

Fig. 2 shows the surface morphology of NC board panel with different resin content using light microscopy with 20x magnification. Refer to the Fig. 2 (c) it can be seen clearly the surface of panel board is in good condition without any glue spot on the surface. Besides, the arrangement of wood particles in uniform arrangement as marked with red arrow. The glue with uniform distribution along the wood particles made the binder easy to penetrate between UF and NC fiber. As more glue penetrate into the wood fiber might improve the strength properties.

The effect of different species and UF resin as a binder in manufactured particleboard panel was observed by FESEM analysis. The FESEM micrograph of the particle board are shown in Fig. 3. From the Fig. 3 (a) it can be observed that, the particle of the NC species shows better structure between fiber and UF in the structure due to the different species of the particleboard panels as mark with red arrow compared to Fig. 3 (b) shows a poor properties. The macrostructural of ED species revealed uneven distribution of UF on the surface as mark with red arrow. The condition of ED species cause the panel has lower properties in terms of MOR, MOE and IB.

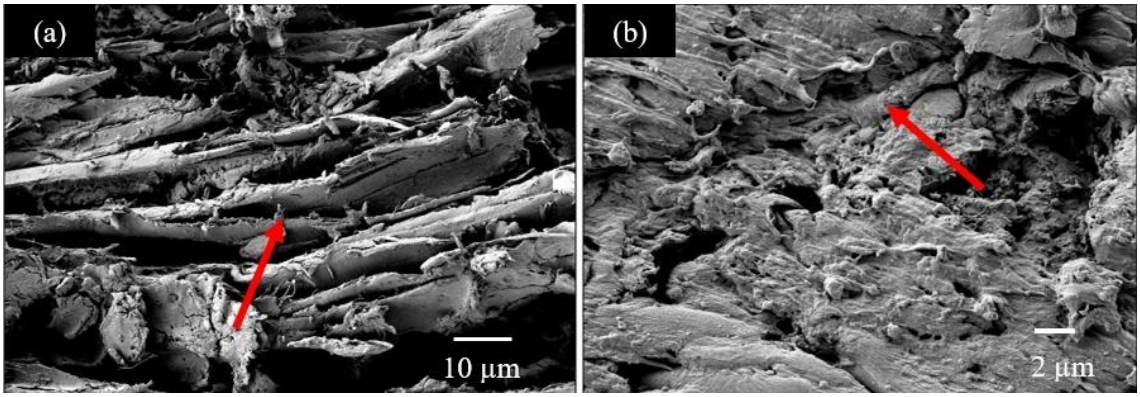

Fig. 3 FESEM imageof panel (a) NC and (b) ED wood species at 8% UF

This can see more clearly on the panel produced with NC and ED wood species. Therefore, the mechanical strength of the panels also improve especially for panel manufactured using NC species. UF resin at 8% did not give better bonding between wood particles and binder. The microstructure shows as 8% of UF contribute poorest bonding particles was obtained as shown in Fig. 3a. In addition, used of more resin content increased the bonding hence improved the interfacial bonding between fiber in boards as shown in Table 1.

This can be proven through mechanical properties testing whereas the NC species showed the highest strength properties of particleboard panel compared to ED species as shown in Table 1.

4. SUMMARY

The objective of this study was to investigate the mechanical properties of particle board by using two different wood waste of NC and ED. The panel made of NC shows highest values of MOR which are 25.20 N/mm^2 compared to ED which is 24.07N/mm^2. IB board made of ED showed high value compared to NC which is 1.29N/mm^2. Different wood species and different amount of resin content are affects the strength properties of particleboard. Hence, NC and ED particles can be used as a raw materials to wood composite particleboard for product applications in order to sustain the resource for wood-based industry in the future.

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