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Performance of Particleboard with Varying Jabon Wood and Andong Bamboo Composition Against Subterranean Termite Attack

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Performance of Particleboard with Varying Jabon Wood and Andong Bamboo Composition Against Subterranean Termite Attack

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Abstract. This study investigated the effect of mixed material composition of jabon (*Anthocephalus cadamba* Miq.) and andong (*Gigantochloa pseudoarundinaceae* Steud.) particleboards on their resistance to subterranean termite (*Coptotermes curvignatus* Holmgren). Six types of 35cm × 35cm × 1.2 cm particleboards were produced and glued with phenol formaldehyde in the proportion of 100:0, 70:0, 60:40, 50:50, 40:60 and 30:70 for jabon and andong. Those panels were tested according to SNI 727-2014. The results showed that material composition of jabon and andong was significantly influenced weight loss and termite mortality. Particleboard with 30:70 jabon-andong proportions had the lowest weight loss (4.28%) and classified as resistant class. Termite mortality rate escalated as jabon composition in the panel decreased.

1. Introduction

It was reported that forest industries yield a significant amount of waste [1]. This waste could be recycled [1] and offers alternative materials for wood substitution [2]. Wood wastes and other lignocellulosic fibers can be altered into particles and manufactured as composite products [3, 4].

Recent advanced technology on adhesive and manufacturing processes contributed to the increasing demand of composite products for structural and furniture purposes as opposed to solid wood [5]. Further, the advancement technology made it possible to have superior physical and mechanical properties compared to solid wood [5]. Composite products were composite materials which are manufactured by binding lignocellulosic fibers with adhesive [6]. The panel can be manufactured from fibers, particles, strand, veneer, lamina and board of wood [6]. However, those lignocellulosic fibers should met physical, mechanical and biological properties of wood-based products [7]. Particleboards were one of composite products that have been widely utilized ranging from structural wood composites and furniture purposes [8].

Wood-based particleboard commonly had low resistance against wood destroying organisms (9). Extensive studies on treatment for increasing wood and composite products resistance against termite infestation were recorded [10, 11, 12, 13, 7 5]. Nevertheless, research on the resistance of jabon and andong particleboards against subterranean termite attack is lacking. This study was aiming for determining the influence of the proportion of jabon (*Anthocephalus cadamba* Miq.) and andong bamboo (*Gigantochloa pseudoarundinaceae* Steud.) particles on the resistance to subterranean termite *Coptotermes curvignatus* Holmgren attack.



2. Materials and Method

2.1. Materials

Jabon and andong bamboo were collected from community plantation in West Java. Particles of jabon and andong were collected from wood working activity and bamboo stripping process. Particles were screened through 5 mm and 2 mm screens. Particles which passed through a 5 mm screen and retained on a 2 mm screen were used. Those particles were then air-dried and oven-dried for 48 hours at 80°C to reach moisture content of 4%. Afterwards, it stored in an air-tight container to keep the moisture content. Liquid phenol formaldehyde (PF) was used as adhesive.

Materials used for laboratory termite resistance test in this study were subterranean termite *Coptotermes curvignathus* Holmgren, sterile sand and distilled water.

2.2. Particleboard manufacturing and sample test preparation

Six variations of particleboard were made with a dimension of 35 cm x 35 cm x 1.2 cm and targeted density of 0.6 g cm⁻³. The panels were manufactured with the following jabon-andong proportions: 100:0, 70:30, 60:40, 50:50, 40:60 and 30:70.

Jabon and andong particles were weighed and mixed in accordance to the assigned proportions. The amount of liquid phenol formaldehyde (PF) adhesive used was 10% (resin solid) on the basis of dry-weight particles. The hardener para formaldehyde was 0.5% of the PF weight and wax emulsion 0.5% of the particles weight was added to PF. A specified quantity of particles was sprayed with certain amount of glue mixture in a blender. The mixture was then hand-formed into a loose mat in a wooden deckle box (30 x 30 cm internal dimensions). The mat then loaded in a hot press set at temperature of 150°C and specific pressure of 25 kg cm⁻² for 10 minutes. Afterwards, it stored in room temperature for 7 days prior to laboratory test.

2.3. Laboratory termite resistance test

The resistance test was performed in accordance to SNI 7207-2014 [14]. Testing specimens of the particleboards were 2.5 cm × 2.5 cm × 1.2 cm. Five replications were made for each types of particle proportions. The specimens were oven-dried (100±2)°C until a constant weight is obtained and weighed (W₁). The specimens were buried in a cylindrical glass tube where 200 g sterile sands which have moisture content below water holding capacity (7%) were placed. About 200 healthy and active workers of subterranean termite were introduced in the cylindrical glass tube and kept in a dark room for four weeks (Figure 1).



Figure 1. Subterranean termite test specimen.

After four weeks, the specimens were oven-dried until a constant weight is obtained and weighed. Weight losses and mortality percentage were calculated using Equation 1 and 2.

$$WL = \frac{W_1 - W_2}{W_1} \times 100 \quad (1)$$

where: WL= weight loss (%), W_1 = initial oven-dried weight (g), W_2 = final oven-dried weight (g)

$$M = \frac{R_n - R_h}{R_n} \times 100 \quad (2)$$

where: M = mortality (%), R_n = number of termite at the initial treatment (subterranean termite = 200 termites), R_h = number of termite after the treatment .

The resistance class of particleboards against termite attack referring to SNI 7207-2014 are presented in Table 1. [14]

Table 1. Classification of particleboards against subterranean termites attack (*Coptotermes curvignathus* Holmgren).

Class	Weight loss interval (%)	Resistance criteria
I	< 3.5	Very resistant
II	3.5 – 7.4	Resistant
III	7.5 – 10.8	Moderately resistant
IV	10.9 – 18.9	Non-resistant
V	> 18.9	Susceptible

2.4. Data analysis

Completely Randomized Design was applied to analyze laboratory test results by using SPSS Ver.23. The effect of proportions of jabon and andong particles to the particleboard resistance against subterranean termite attack were tested, with the following proportions: 100:0 (JA1), 70:30 (JA2), 60:40 (JA3), 50:50 (JA4), 40:60 (JA5) dan 30:70 (JA6). If the proportions of jabon and andong particles significantly affected the resistance of particleboards against termite attack, it then followed by Duncan Test [15].

3. Result and Discussion

Analysis of variance revealed that the varying jabon and bamboo particle compositions in the panel have significant effect to weight loss ($F_{calc} = 8.233$) and mortality rate ($F_{calc} = 179.499$). The average of particleboard weight loss and termite mortality rate are presented in Figures 2 and 3.

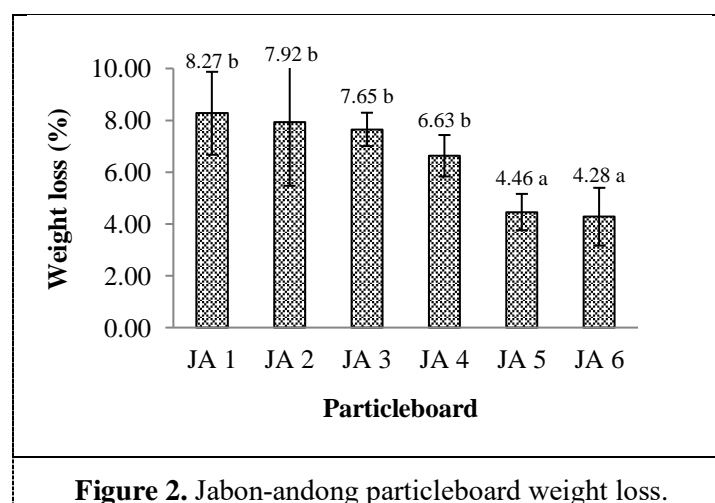


Figure 2. Jabon-andong particleboard weight loss.

According to the SNI 7207-2014 on wood testing against wood destroying organism, JA1, JA2 and JA3 were categorized in Class III (moderately resistant), while JA4, JA5 and JA6 were in Class II (resistant) [14]. Figure 2 presents the tendency on increasing weight loss with the addition of bamboo

particle. The composition of 70% jabon and 30% andong (JA6) had the lowest weight loss at 4.28%. The highest weight loss was in 100% jabon particleboard (JA1). Hermawan et al. [11] explained that Particleboard composed from high density wood have greater resistance against subterranean termite (*Coptotermes curvignathus* Holmgren) compared to that of low density wood. Wood density of jabon and andong bamboo was 0.34 g cm^{-3} and 0.68 g cm^{-3} , consecutively. Particleboard made of more andong particle was more resist to termite infestation than panel with less andong particle. This is in line with previous study which exposed the resistance of mindi wood (*Melia azedarach*) against subterranean and dry-wood termites in comparison to sengon wood (*Paraserianthes falcataria*) due to its distinct density. Wood density was proved has an important role in escalating *Shorea leprosula* particleboard resistance to termite attack [13].

Differences in chemical composition of andong and jabon also affect the resistance of the particleboard. The silica content of andong (1.2%) is higher than jabon (0.1%) [16, 17]. In addition, the extractive content of andong is higher than jabon, this can be seen from the value of solubility in hot water for andong 10.7% while jabon 3.1% [16, 17]. The natural resistance of jabon solid wood was classified as Class V (susceptible) (16), while andong was listed in Class IV (non-resistant) [18]. However, the resistance of a mix jabon and andong particleboard with a certain proportion (30:70) was significantly rose compared to their natural resistance in the solid form. Apart from density factor and its chemical composition, the application of phenol formaldehyde in the panel could augment the resistance class of particleboard against termite attack and reached Class II (resistant). Phenol formaldehyde influenced the resistance of wood-based composite to termite infestation [19, 20 21]. Furthermore, Silva et al. [22] concluded that the chemical content of phenol formaldehyde in *Pinus caribaea* particleboard affected the intensity of termite (*Coptotermes gestroi* Wasmann) infestation.

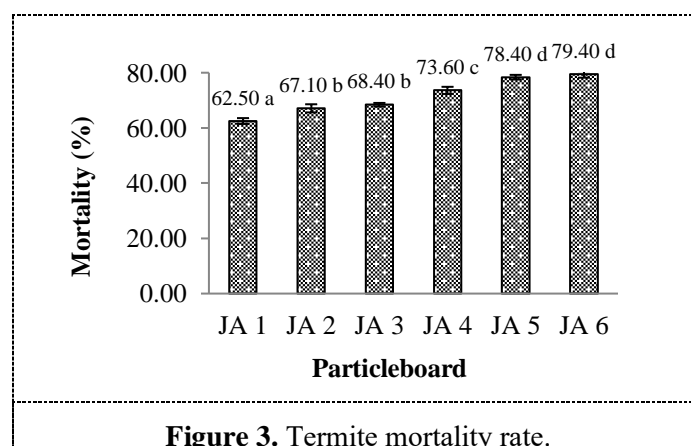


Figure 3 depicts that termite mortality rate increased with the addition of andong particle. The highest mortality rate (79.4%) was in JA6 with 30% jabon and 70% andong proportion, while the lowest mortality rate (62.50%) was in 100% jabon particle (JA1). Hadikusumo [23] argued that mortality rate over 70% demonstrates wood resistance against termite attack [23]. Furthermore, it was explained that phenol formaldehyde plays an important role in binding less-resistant-wood and bamboo strands. Phenol formaldehyde adhered the strands and its phenol component was harmful to termite [24]. The resin has a distinct odor and strong antiseptic characteristic. Besides poisonous to termite, these characteristics may affect enzyme activities in termite [25]. This may cause the alteration of the feeding activity in termite. The limited available feed resource forced them to kill non-productive termite in the colony [26]. Thus, increases termite mortality.

4. Conclusions

Particleboard with 30% jabon and 70% andong yielded the lowest weight loss and the highest termite mortality rate. Thus, this jabon and andong particles proportion was more resistant against subterranean termite attack compared to other particle proportions. This finding suggested that the recycling of jabon and bamboo wastes were potential alternative construction materials due to the growing scarcity of wood

supply. The application of renewable resource-based adhesive should also be considered in the further study to produce resistant particleboard.

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