EFFECT OF BORIC ACID TREATMENT ON TERMITE RESISTANCE OF PARTICLEBOARD COMPOSED OF DIFFERENT RATIO OF OIL PALM AND ACACIA FIBER

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ABSTRACT

One way to overcome the shortage in wood supply is by substituting the commercial wood utilization with other wood materials that has great potential but still limited in its utilization such as oil palm (*Elaeis guineensis* Jacq.) and acacia (*Acacia mangium* Wild.) fibers. The possibility of using acacia and oil palm wood as raw material in particleboard production as well as medium density fiberboard has previously reported. Meanwhile, decay and insect attack which may limit the performance of the particleboard is one of the major concerns. A study has been conducted to evaluate the effect of boric acid treatment on termite resistance of particleboard composed of different ratio of oil palm and acacia fiber (0%:100%, 25%:75%, 50%:50%, 75%:25% and 100%: 0%, respectively). Termite resistance of the particleboard were evaluated according to a modified wood block test (MWBT) standard. It was observed that termite resistance of the untreated particleboard was relatively low. However, the boric acid treatment has significantly improved the termite resistance of the particleboard.

Keywords : oil palm, acacia fiber, boric acid, termite resistance, particleboard, *C. curvignathus*

An increasing of Indonesian population by 2.5% per year leads to the increasing demand of wood material for housing construction purposes as well as for furniture. At the end of of *Pelita VI* (The five-year Development Plan VI), the demand for wood was about 40 million m^3 per annum while in the year 2000 the demand is estimated to increase up to 80 million m^3 per annum. The supply of logs in 1995 was only about 48.54 million m^3, while by the year 2000 the supply is estimated to be 49.01 million m^3 (Kartodihardjo, 1995). One way to overcome the shortage in wood supply is by substituting the commercial wood utilization with other wood materials that has great potential but still limited in its utilization such as oil palm (*Elaeis guineensis* Jacq.) and acacia (*Acacia mangium* Wild.) fiber.

At present, oil palm plantation has reached 2.2 million hectares and scattered all over 16 provinces throughout the country. It is expected that by the year 2005, Indonesia will become the leading country in oil palm industry. In line with the growth of oil palm products, biomass waste also increases every year. Part of the biomass waste that has not been utilized is the oil palm stem, which contribute the major part of the oil palm trees (Said, 1996). Under the provision of a sustained yield plantation management, future supplies of oil palm timber in Indonesia will amount to 1.1 million m^3 per annum. However, the proportion of oil palm wood that can be optimally utilized is relatively low since the inner part of the stem consists of very low density wood (Prayitno, 1991). Therefore, oil palm fiber-based products should be considered as one of the promising wood based panel for housing construction and furniture in Indonesia. This is obviously true for Indonesia since its agricultural and forest products has significantly contributed to the national development.

In the future, Indonesia's primary interest is to ensure that the role of plantation forests will continually be recognized. The Forestry Principles established at the Rio Earth Summit of 1992 stated that the role of planted forests and permanent agricultural crops as sustainable and environmentally sound sources for renewable energy and industrial raw material need to be recognized, enhanced, and promoted. Their contribution to the maintenance of ecological processes, offsetting pressure on primary growth forest and to providing regional employment and development with adequate involvement of local inhabitants should be recognized and enhanced." In this context, acacia (*A. mangium* Willd.) is one of the most important species in Indonesian plantation forest areas. At present, there is more than one million ha of *A. mangium* plantation found through the country.

The possibility of using acacia and oil palm wood as raw material in particleboard production (Nandika, Hadi and Gunawan, 1998) as well as medium density fiberboard (Thole, 1998) has previously reported. Meanwhile, decay and insect attack which may limit the performance of the particleboard is one of the major concerns. Several researchers reported that boron compounds are particularly suitable as preservative system for wood composites (Hashim *et al.*, 1992; Laks & Manning, 1994, 1995; Laks, *et al.*, 1994; Yalinkilic, 1996).

This paper discus the effect of boric acid treatment on termite resistance of particleboard composed of different ratio of oil palm and acacia fiber.

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MATERIALS AND METHODS

Particleboard Production

Oil palm log with an air-dry density of 0.34 g per cm^3 and acacia log with an air dry density of 0.49 g per cm^3 were used as raw materials. Wafers were prepared with a disc-flaker, and then hammermilled into particles. The particles (20-40 mesh) were dried with a vacuum dryer until the moisture content reached about 5%.

Urea formaldehide (UF) adhesive was used as a resin binder. The resin content of the boards, based on the oven-dry weight of the particles, was 6.5%. Water was added to the adhesive at 50% resin-concentration to achieve a suitable viscosity for spraying. The composition ratio of oil palm fiber and acacia fiber used for fiberboard construction were 0% : 100%, 25% : 75%, 50% : 50%, 75% : 25% and 100% : 0%, respectively. The resin was sprayed on the particles in a drum-type rotary blender using an airless gun. Hand-formed particle-mats were pressed at 140°C with a target board density of 0.7 g per cm^3 and 10 mm thickness under air-dried conditions. An initial pressure of 30 kg per cm^3 was applied for 5 minutes, and then reduced to 10 kg per cm^3 for additional 5 minutes. Specimens were cut from the boards, and tested after conditioning for 2 weeks as 20°C and 65% relative humidity (RH).

Boric Acid Treatment

Boric acid liquid (water solution, DESOWAG-Germany) was used as preservative for the particleboards using glue mixing method. The concentration of boric acid used was 2% w/w BAE (boric acid equivalent) with expected retention of 12 kg/m^3.

Termite Resistance Test

Each type of boards with the size of 20 x 20 x 10 mm (board-thickness) was subjected to attack by subterranean termite *Coptotermes curvignathus* Holmgren, according to Modified Wood Block Test (MWBT) Standard. Each type of board was served to 250 workers and 25 soldiers of subterranean termite *C. curvignathus* in a glass bottle. Thirty grams of sand sieved through 20 meshes were filled into the bottle and moistened with 6 ml of distilled water. Each of board was then buried into the sand of glass bottle. Each bottle was plugged with cotton wool and kept in the darkroom under ambient room condition for 21 days (Figure 1). After 21 days, those boards were taken out from the containers, cleaned, and oven-dried, and re-weights to determine the percentage of weight loss.

After three weeks of test period, the termite mortality and weight loss of the boards caused by termite attack was calculated. The weight loss data (in percentage) of each type of board was used to classified the level of termite resistance of the particleboard following the method of Sornnuwat *et al.* (1995) (Table 1).

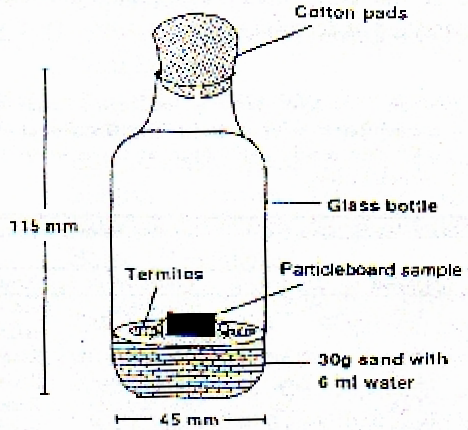

Figure 1. An glass bottle container for modified wood block test (MWBT-test)

Table 1. Classification of termite resistance level of wood products based on their weight loss in modified wood block test (modified from Sornnuwat *et al.*, 1995)

Weight loss (%)	Level of resistance
0	Highly resistant
1 – 3	Resistant
4 – 8	Moderately resistant
9 – 15	Non-resistant
> 15	Susceptible

RESULTS AND DISCUSSION

Mean weight loss of untreated and treated particleboard composed of different ratio of oil palm and acacia fiber after 21 days exposure to *C. curvignathus* is shown in Table 2. On the untreated particleboard, the weight loss of particleboard containing the lower percentage of oil palm fiber was smaller than those of particleboard containing the higher percentage of oil palm fiber. Data analysis indicated that weight loss of particleboard composed of 50% as well as 25% oil palm fiber are smaller than of particleboard composed of 100% as well as 75% of oil palm fiber. Meanwhile, the lowest weight loss was exhibited by particleboard containing 25% as well as 0% oil palm fiber. In general, untreated particleboard has low termite resistance (classified as susceptible and non resistant)

On the other hand, boric acid treatment has improved the termite resistance of the particleboard. Weight loss of boric acid containing particleboard was significantly smaller than those of untreated particleboard; it ranged from 2.4% to 6.2%. As such, almost all of the boric acid containing particleboard could be classified as **termite resistant**.

Table 2. Mean weight loss of untreated and treated particleboard composed of different ration of oil palm (OP) and acacia (AC) fiber in three weeks termite resistance test

Ratio OP/AC	Mean Weight Loss (%)[1]		Level of Termite Resistance	
	Untreated	Treated	Untreated	Treated
100/0	18.2a	6.2a	Susceptible	Moderately resistant
75/75	17.8a	3.0a	Susceptible	Resistant
50/50	14.4b	2.8a	Non-resistant	Resistant
25/75	13.6b	2.5a	Non-resistant	Resistant
0/100	11.9b	2.4a	Non-resistant	Resistant

[1] from five replications

However it was observed that boric acid treatment could not completely protect the particleboard from termite attack. This finding is consistent with previous knowledge on boron compounds as they are slow acting toxicants which kill termite when they ingest treated wood rather than contact. So, it is unrealistic to assume that boric acid treated wood would always be intacted by termite attack before, at least, limited feeding damage occurred on wood within its structures, because feeding must occur to kill termites (William *et al.*, 1990).

It was also found in this study that boric acid treatment influenced termite mortality. Treated particleboard showed a significantly higher termite mortality than those of untreated particleboard. Which is due to the termiticide effect of boric acid compound. The termite mortality in treated particleboard almost reach 100% (Table 3).

Table 3. Termite mortality of untreated and treated particleboard composed of different ratio of oil palm (OP) and acacia (AC) fiber in three weeks termite resistance test

Ratio OP/AC	Termite mortality (%)[1]	
	Untreated	Treated
100/0	15.6a	98.0a
75/75	16.2a	100a
50/50	18.6b	100a
25/75	20.2b	100a
0/100	20.5b	100a

[1] from five replications

Manning and Flaks (1996) reported that zinc borate is an effective preservative for aspen flake composites when used in appropriate exposure conditions. These finding are consistent with previous research result reported by Yalinkilic *et al.*, (1996) which indicated that boric acid without leaching by running water performed good efficacy against subterranean termite *Coptotermes formosanus* Shiraki on treated sugi wood. Almost 100% termite mortality was observed by even 0.25% concentration of BAE.

Hashim *et al.*, (1992) reported that vapour boron treatment did not have any significant effect on most of the mechanical properties of the particleboards. The exception is due to a reduction in impact strength, especially, at the higher retention level.

CONCLUSIONS

In general, untreated particleboard composed of different ratio of oil palm and acacia fiber has relatively low termite resistance. It is classified as **susceptible** and **non resistant** to termite attack. However, the ratio of oil palm fiber and acacia fiber affected the termite resistance of the particleboard. The lower the percentage of oil palm fiber, the higher the termite resistance of the particleboard.

Boric acid treatment has improved the termite resistance of the particleboard. Almost all of the boric acid containing particleboards could be classified as **termite resistant**. It was also found that the boric acid treatment influenced termite mortality. Treated particleboard showed a significantly higher termite mortality than those of untreated particleboard.

It is suggested to investigated the effect of boric acid treatment on the physical as well as mechanical properties of the particleboard.

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