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The Effectiveness of Three Preservatives and the Relative Resistance of Ten Malaysian Hardwoods against the Subterranean Termite, *Coptotermes curvignathus* (Holm.).

AHMAD SAID SAJAP, ROSLI MOHAMAD and ABD. RAHIM ABU SAMAH
Department of Forest Management, Faculty of Forestry, Universiti Pertanian Malaysia, Serdang, Selangor, Malaysia.

Key words: **Copper-chrome-arsenic; sodium pentachlorophenol; sodium tribomophenol; subterranean termite** *(Coptotermes curvignathus* **(Holm.)***).*

RINGKASAN

Kesan tiga bahan pengawet kayu dan kerentanan sepuluh spesies kayu keras telah diuji ke atas anai-anai tanah, Coptotermes curvignathus *(Holm.) di makmal. Kesemua bahan pengawet dapat melindungi kayu dari serangan anai-anai dengan berkesan. Copper-chrome-arsenic (CCA) didapati lebih berkesan dari sodium pentachlorophenol (Na PCP) atau sodium tribomophenol (Na TBP). Ujian menunjukkan kayu keras Chengal dan Resak kurang dirosaki oleh anai-anai dan mengalami kehilangan berat kurang daripada satu peratus. Meranti merah muda, Jelutong dan Damar minyak dari kayu keras rengan adalah sangat dirosaki dan mengalami kehilangan berat lebih daripada sepuluh peratus.*

SUMMARY

Effectiveness of three preservatives and relative resistance of ten species of hardwoods were tested against the subterranean termite, Coptotermes curvignathus *(Holm.), in laboratory bioassay. All three preservatives evaluated significantly increased wood resistance to attack. Copper-chrome-arsenic (CCA) was more effective than either sodium pentachlorophenol (Na PCP) or sodium tribromophenol (Na TBP). The bioassay indicated that the heavy hardwoods, Chengal and Resak were the least susceptible woods with a wood mass loss less than one per cent. The light hardwoods, Light red meranti, Jelutong andDamar minyak, were the most susceptible wood with a wood mass loss exceeding ten per cent.*

INTRODUCTION

Termites are responsible for much degradation of wood and other cellulosic materials. In Peninsular Malaysia 25 genera have been recorded and of these, *Cryptotermes, Coptotermes* and *Microcerotermes* are of significance to forests and forest products (Dhanarajan 1969).

A number of studies on evaluation of the relative resistance of tropical woods and the effectiveness of preservatives against termites have been carried out (Beal *et al.* 1974; Sen-Sarma 1975; Usher and Ocloo 1975); In Peninsular Malaysia, the studies have been only conducted in the field where the woods were buried and exposed to wood destroying organisms for more than two decades (Foxworthy 1930; Jackson 1957).

In recent years, laboratory bioassays for determining the relative resistance of wood samples and the effectiveness of wood preservatives against termites have been developed (Gay *et. al.* 1955; Becker 1969; Behr *et al.* 1972; Fougerousse 1973; and Howick and Creffield 1975). These tests have certain advantages over the field tests in that they are economical in cost and time, and are free of climatic influences. In this study the wood block laboratory bioassay was employed (Beal *et. al.* 1974) to evaluate (i) the relative resistance of ten commercial timbers of Peninsular Malaysia and (ii) the effectiveness of three commercial preservatives against the subterranean termite *Coptotermes curvignathus* (Holm.). This species was selected because it has been reported to cause considerable damage to forest plantations, electric poles, fences, stakes and structural timber (Harris 1961; Dhanarajan 1969; and Tho 1974).

Key to authors' names: Ahmad Said, M. Rosli and A.S. Rahim.

MATERIALS AND METHODS

Termites

A colony of the termite, *C. curvignathus* (Holm.) was collected from an infested *Agathis borneensis* tree at Forest Institute, Kepong, Selangor. The colony was maintained in segments of the colonized logs in the laboratory.

Preservative-treated wood test

In this test, a known non-durable wood, Jelutong *(Dyera costulata)* was used and blocks of 19 mm X 19 mm X 19 mm, was treated by vacuum pressure impregnation to refusal with copper-chrome-arsenic (CCA), sodium pentachlorophenol (Na PCP) and sodium tribromophenol (Na TBP) at 0.5%, 1.0%, 2.0%, 3.0% and 5.0% concentrations. After impregnation, the blocks were air dried for three days and weighed. Untreated blocks served as controls.

Glass jars 80 mm in diameter and 90 mm in height were packed with sterile sand and moistened with distilled water to maintain the relative humidity near saturation. Each treated block was inserted into a jar and 200 worker termites were introduced. Ten replicates were carried out for each treatment.

Natural resistance test

The ten species selected represented three ranges of wood density as shown in Table 1. Test blocks (19 mm X 19 mm X 19 mm) were cut from the heartwood. One weighed test block was placed in a glass jar, as in the preservative efficacy test, and 400 worker termites were introduced. Five replicates were carried for each wood species.

All jars for both tests were placed in a dark room at 28° C ± 2° C. Daily observations were made during the test period and when a 100% mortality was recorded in each jar, the test block was removed, washed, dried and reweighed to obtain an estimate of the amount of wood eaten.

Analysis of data

The data from the study were analysed by analysis of variance and Duncan's multiple range test was used to compare the treatment means. Percentage weight-loss was used as an index of the susceptibility of wood to termites in the natural resistance test, as the density of wood varied markedly between the species.

RESULTS AND DISCUSSION

Preservative-treated wood test

The preservatives tested significantly increased the wood resistance to attack. The resistance effect increased progressively with concentration, but for CCA no significant increase (2% to 5%) was observed (Figure 1).

The results on the effectiveness of the three preservatives tested against *C. curvignathus* (Holm.) are shown in Table 2. In general, CCA gave the best protection and Na TBP gave the least protection. At 0.5% and 5% concentrations, the CCA treated blocks experienced average weight loss ranging from 91.95 mg to 28.62 mg respectively

TABLE 1
Wood samples used in the natural resistance test

Density Group	Species	Common name	Family
Heavy hardwood	*Neobalanocarpus heimii*	Chengal	Dipterocarpaceae
	Vatica sp.	Resak	Dipterocarpaceae
	Tetramerista glabra	Punah	Ochnaceae
Medium hardwood	*Koompassia malaccensis*	Kempas	Leguminosae
	Dipterocarpus sp.	Keruing	Dipterocarpaceae
	Shorea curtisii	Seraya (Dark red meranti)	Dipterocarpaceae
	Shorea ovalis	Meranti kepong (Light red meranti)	Dipterocarpaceae
Light hardwood	*Dyera costulata*	Jelutong	Apocynaceae
	Agathis borneensis	Damar minyak	Coniferae
	Hevea brasiliensis	Rubber	Euphorbiaceae

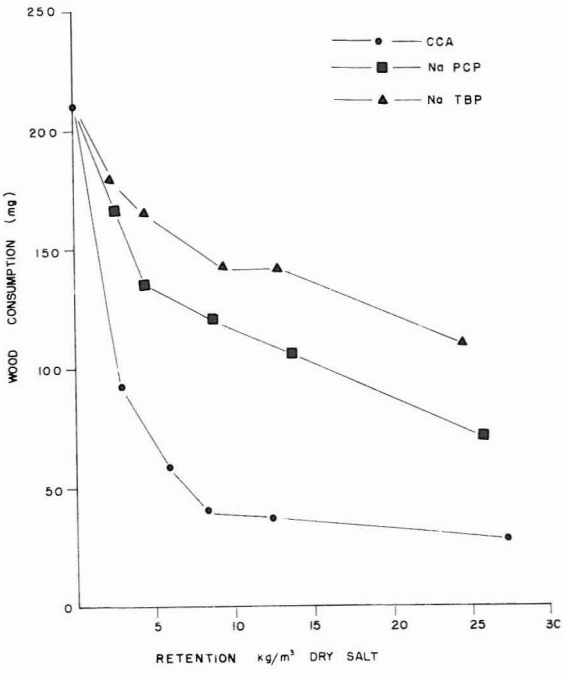

Fig. 1. Relationship between preservative retention levels and the amount of wood eaten by termites.

in contrast with Na PCP, (167 mg to 72 mg) and Na TBP, (179 mg to 110 mg). Even very low corresponding retention to CCA at 2.78 kg/m³ gave equivalent protection as Na PCP and Na TBP did at the levels of retention of more than 13.7 kg/m³ and 24.49 kg/m³ respectively.

The effectiveness of CCA in the test was not surprising as CCA has been shown to be effective against *Pseudacanthotermes militaris* (Usher and Ocloo, 1975), *Reticulitermes santonensis* (Fougerousse, 1973) and *Mastotermes darwiniensis* (Howick and Creffield, 1975). Na PCP and Na TBP could still be used for termite control if applied at higher concentrations as they are also excellent fungicides. Should these preservatives be required for timber treatment, it has been suggested that compatible insecticides could be added to enhance their effectiveness and reduce the cost of treatment (Nicholas and Ryke, 1972).

Natural resistance test

The amount of wood eaten by the termites in this forced-feeding bioassay varied significantly with wood species (Table 3). Light red meranti, Jelutong and Damar minyak were more susceptible woods. The least susceptible woods were Resak and Chengal where the weight of wood consumed

TABLE 2

Wood consumption of preservative-treated blocks by *Coptotermes curvignathus* (Holm.)[1]

Preservative	% Concentration	Retention (kg/m³)	Wood eaten[2] mg	Wood eaten[2] %
CCA	0.5	2.78	92 c	3.45
	1.0	5.98	59 b	2.19
	2.0	8.19	40 a	1.45
	3.0	12.42	38 a	1.41
	5.0	27.46	27 a	0.95
Na PCP	0.5	2.63	167 a	6.03
	1.0	4.65	135 ef	5.00
	2.0	8.80	121 de	4.46
	3.0	13.70	106 cd	3.74
	5.0	25.75	72 b	2.51
Na TBP	0.5	2.33	179 g	6.49
	1.0	4.38	165 g	5.55
	2.0	9.43	140 f	5.05
	3.0	12.72	140 f	4.72
	5.0	24.49	110 d	3.67
CONTROL	–	–	211 h	10.18

1. Figures are averages of 10 replications.
2. Means followed by the same letter are not significantly different at the 0.05 level of probability.

TABLE 3
Feeding and survival of *Coptotermes curvignathus* (Holm.) exposed to ten wood species[1]

Wood Species	Density	Wood eaten[3]		Termite[2] Survival (days)
		mg	%	
Light red meranti	0.54	498	16.72 a	28 ab
Jelutong	0.46	440	14.60 a	22 c
Damar minyak	0.46	344	11.49 ab	21 c
Rubber	0.55	375	8.50 bc	22 c
Kempas	0.88	354	6.44 cd	30 a
Keruing	0.88	274	5.54 d	24 d
Dark red meranti	0.71	180	4.81 d	23 c
Punah	0.72	53	1.05 e	23 c
Resak	0.95	41	0.76 e	21 c
Chengal	0.94	35	0.74 e	19 c

1. Figures are averages of 5 replications.
2. Termite survival as number of days before death of all termites in group.
3. Percentage values in the same column followed by the same letter are not significantly different at the 0.05 level of probability.

was less than one per cent. The remaining wood species fell into an intermediate and overlapping group and the weight of wood consumed ranged from 4.8% to 8.5%. The present results appear to be agreement with those obtained by Jackson (1957) who had classified the durabilities of Malayan timbers according to their average servicable life in the field. This relation suggests that the present woods tested with weight-loss of $< 10\%$, $5\%–10\%$ and $> 3\%$ correspond to the not durable, moderately durable and durable as given by Jackson (1957) respectively.

The termites survived best on Kempas, Keruing and Light red meranti. The lowest survival was found on Chengal (Table 2).

The natural resistance of wood to termite attack could be due to several factors. Wood density influences the resistance of wood to termite (Behr *et al.* 1972) and similarly, a significant linear correlation ($r = -0.83$) was obtained in this study between the mean percentage weight loss and wood density. Furthermore, it has been found that certain chemicals in the wood prevent attack of timber by termites (Wolcott 1957, Rudman and Gay 1967). Thus, it may be inferred that the relatively high resistance as found for Resak and Chengal could be due to their density complemented with certain antagonistic compounds which might be present in these woods.

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