Faculty of Resource Science and Technology

Termite Resistance of Selected Wood Species Treated using Various Chemicals and Treatment Methods Exposed to *Coptotermes curvignathus*

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Termite Resistance of Selected Wood Species treated using Various Chemicals and Treatment Methods Exposed to *Coptotermes curvignathus*

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(Wood Science)

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DECLARATION

I hereby declare that the Masters degree thesis is based on my original work excepts for quotations and citations, which have been duly acknowledged. This thesis has not been accepted for any degree and is not concurrently submitted in candidature for any other degree.

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ABSTRACT

Malaysian forests are blessed with diversity of wood species not only become a source of income to Malaysia in terms of timber trading but also provide its citizens with wood material for various uses. However, all untreated wood exposed to tropical condition is predisposed to high termite and decay hazard and therefore untreated wood needed to be protected using wood protective chemicals. The objectives of this study were to collect and identify termite genus that caused destructive damages to wood and wood products, to provide baseline data on selected basic wood properties and natural durability of selected wood species to termites. Besides that, it was essential to determine the wood protection of selected species using different treatment methods and wood protective chemicals (diesel and dead engine oil, Light organic solvent preservative (LOSP) and agro-insecticides). Treated wood was exposed to the aboveground termite test simulating Hazard Class 2 condition. Information on basic physical properties, extractive contents and natural durability of tested woods had been recorded. The natural durability study found out that a total of 11 out of 69 tested species were regarded as highly susceptible and visually rated 0. Examples of non-durable wood were Aglaia borneensis, Dyera polyphylla, Neolamarckia cadamba, Adinandra borneensis and Hevea brasiliensis. There were 25 out of 69 tested species were found to be moderately resistant to termite and these species were rated 6.5 to 8.9. Examples of these species were Koompassia malaccensis, Canarium apertum, Azadirachta excelsa, Kokoona reflexa and Heritiera aurea. There were 17 wood species considered resistant to termites (rating 9 – 9.4). Examples of these species were Acacia mangium, Anisoptera grossivenia and Palaquium spp. There were 12 out of 69 regarded as highly resistant to termite with rating (≥9.5). Examples of these species were Artocarpus anisophyllus, Upuna borneensis and Eusideroxylon zwageri. This study also confirmed
that the natural durability of *Dipterocarpus* spp. varies depending on the species tested. In experiment 3, *H. brasiliensis*, *A. mangium* and pine ply were dip-treated using diesel revealed that these woods dip-treated using diesel oil achieved good protection to wood (rating: 9.5 – 9.7). In experiment 4, *K. reflexa*, *A. borneensis* and *C. apertum* were dip-treated and vacuum pressure-treated using LOSP. It was found that vacuum pressure-treated wood using LOSP achieved good protection to wood (rating: 9.2 – 10). Dip-treated *H. brasiliensis*, *K. malaccensis* in experiment 5 and also *N. cadamba* in experiment 6 using 6.3 and 12.5% chlorpyrifos, 1.68 and 3.35% cypermethrin as well as 3.38 and 6.75% permethrin were found completely protecting the wood from termites (rating: 10). In experiment 7, *H. brasiliensis* and *N. cadamba* were vacuum pressure-treated to target retentions of different agro-insecticides. Wood vacuum pressure-treated to target retentions of 0.1% m/m cypermethrin were well protected from termites (rating: 9.5 – 10). Good protection (rating: 9.3 – 9.5) had been achieved in wood vacuum pressure-treated to target retentions of 0.0051% m/m deltamethrin. In conclusion, genus *Coptotermes* proven to be prevalent insect pest. Besides that, baseline data of wood physical properties, extractive contents and natural durability of tested wood species had been documented. Diesel and LOSP treatment can be effectively use in wood protection. For dipping treatment, 6.3 and 12.5% chlorpyrifos, 1.68 and 3.35% cypermethrin, 3.38 and 6.75% permethrin were found completely protecting the wood. It was also proven that target retentions used in other countries may not applicable to be used in tropical region.

**Keywords:** Natural durability, termites, LOSP, agro-insecticides, dipping treatment, vacuum pressure treatment
Ketahanan Terhadap Anai-Anai Spesies Kayu Terpilih yang Dirawat dengan Berbagai Bahan Kimia dan Kaedah Pengawetan Didedahkan kepada Coptotermes curvignathus

ABSTRAK


contoh spesies kayu tersebut adalah Artocarpus anisophyllus, Upuna borneensis dan Eusideroxylon zwageri. Kajian ini juga telah mengesahkan bahawa daya ketahanan semula jadi Dipterocarpus spp. terhadap anai-anai adalah berbeza mengikut spesies keruing yang diuji. Dalam eksperimen 3, H. brasiliensis, A. mangium dan papan lapis pine yang dirawat dengan diesel secara rendaman mendapat perlindungan yang baik (kadar visual: 9.5 – 9.7). Dalam eksperimen 4, K. reflexa, A. borneensis dan C. apertum telah diawet dengan LOSP dan didapati menggunakan kaedah tekanan vakum juga memberikan perlindungan yang baik (kadar visual: 9.2 – 10). Kajian ini juga mendapati H. brasiliensis, K. malaccensis dalam eksperimen 5 dan N. cadamba dalam eksperimen 6 diawet dengan 6.3 dan 12.5% chlorpyrifos, 1.68 dan 3.35% cypermethrin, 3.38 dan 6.75% permethrin dengan kaedah rendaman mendapat perlindungan yang sempurna (kadar visual: 10). Dalam eksperimen 7, H. brasiliensis dan N. cadamba yang dirawat secara tekanan vakum sehingga mencecah kadar pengekalan untuk setiap jenis racun serangga perosak. Kayu H. brasiliensis dan N. cadamba yang dirawat mencecah kadar pengekalan 0.1% m/m cypermethrin dan 0.0051% m/m deltamethrin dalam kayu telah mendapat perlindungan yang baik. Kesimpulannya, genus Coptotermes dikenalpasti sebagai serangga perosak yang lazim. Selain itu, maklumat asas untuk spesies kayu yang diuji telah didokumentasikan. Rawatan kayu menggunakan diesel, LOSP dan racun serangga perosak dengan kepekatan yang tinggi juga memberikan perlindungan yang baik kepada kayu. Kayu yang dirawat mencecah kadar pengekalan yang disyorkan untuk negara lain tidak dijamin dapat memberikan perlindungan sepenuhnya kepada kayu.

Kata kunci: Ketahanan semulajadi, anai-anai, LOSP, racun serangga perosak, rawatan rendaman, rawatan tekanan vakum
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CHAPTER 1
INTRODUCTION

Malaysian forests are well-diverse with timber species that continuously provide the citizens with wood to be used as materials for wood products manufacturing which can be used under H2 biological hazard class specified in the Malaysian wood protection Standard (Wong, 2004; 2005). According to Wong (2004), Malaysian hazard class selection guideline would make it easier to select preservative treatment system and specification to protect wood under assigned hazard class. H2 hazard class meant for wood used particularly indoor aboveground not subjected to wetting or leaching. Besides that, some timbers harvested from Malaysian forests also known to have commercial values in timber trading. For instance, Sarawak had exported about 2 million m$^3$ of logs worth approximately RM1.1 billion from January to October 2016 (STA Review, 2016).

Timber species from Malaysian forests have a wide range of natural durability. Natural durability is defined as the ability of timber to withstand attack by wood destroying organisms (Azrieda et al., 2016). Use of naturally high durable or termite resistant wood species often preferred for utilization that their service life is expected to last longer, but over the years these species if without treatment would eventually deteriorate biologically. Although wood is well known for its vast functionality, due to its biological nature, wood is readily degraded by bacteria, fungi and termites (Walker, 1993). In the tropical region, untreated wood is predisposed to high decay and termite hazard (Wong, 2004).

Termite is an important wood bioteriorating insect which feeds mainly on cellulosic materials. For instance, termites feed on papers, wooden buildings and trees. It was reported that there are over 2500 termite species known today while *Reticulitermes* and
Coptotermes are the major destructive pest of America, Europe and Asia (Pearce, 1997). Kirton and Wong (2001), reported that termites as economically important structural pests in tropical countries and their destructive significance to wood products seem more serious than that of tropical decay fungi. Genus Coptotermes causes more widespread and serious damage to mature trees. It was also reported that Coptotermes responsible for more than 90 percent of the total infestations in buildings in West Malaysia. Lee (2004), also reported that in the year of 2003, the cost to control termites in Malaysia amounted USD 10-12 million. So far successful termite control measures in agriculture and wood buildings depend largely on the pest controls and wood preservation industries by applying chemically persistent wood preservatives.

In the past, most woods were treated using chromated copper arsenate (CCA) as it is the most effective wood preservative meant to protect wood from decay fungi and wood attacking insects (Walker, 1993). CCA has been preferably used by the timber industry to treat wood because of its cost effectiveness besides that CCA not only kill insects (due to arsenical compound) but also inhibit fungal attack (due to the presence of copper). CCA treated wood is odourless and paintable (Walker, 1993). CCA previously was widely used throughout the world including Malaysia for both indoor and outdoor use complying with Malaysian Standard MS360:1991 (Wong et al., 1997). In Malaysia, CCA mainly used to treat roof trusses, ceiling joists of residential houses (Wong et al., 2011). However, CCA is not environmental friendly, harmful to workers and the environment. The dangers posed to wood treatment workers by CCA preservative and environmental degradation becoming major concerns from various environmental protection agencies worldwide.
1.1 Problem statements

Many people tend to have the propensity to assume timber quality and durability based on casual observations (Wong & Ling, 2009). It is often assumed that refractory timbers and all dense, dark coloured timbers are durable while all less dense and light coloured timber are non-durable. Besides that, the trade names used in timber trading often confined to multi-species groups that the same trade name may comprises of different species (Wong, 2002). For instance, there are many species under the trade name Keruing. Many local people tend to assume that species with trade name keruing is resistance to termite. However, in actual fact, different species of keruing have different natural durability ranging from moderately durable to non-durable (Wong, 2002; Wong & Ling, 2009). It would be very important to come out with the baseline data in order to provide people with concrete information about the wood instead by assuming the timber quality and durability based on assumption. It can be rather dangerous to assume that termite resistant wood species does not need to be chemically protected.

Every wood species including those naturally resistant to termite need to be protected using chemical preservatives. Since CCA is regarded as harmful wood preservative to the wood treatment workers and the environment. Other part of the world, people use diesel and dead engine oil to preserve the wood (Akutse et al., 2012; Pereira et al., 2015). There are many studies also demonstrate that wood treatment using organophosphate or synthetic pyrethroids including LOSP can provide protection to wood against wood biodeteriogens (Sornnuwat et al., 1994; Messaoudi et al., 2018). Hence, other alternatives of using various chemicals like diesel or dead engine oil, light organic solvent preservatives and agro-insecticides containing organophosphate or synthetic pyrethroids should be considered to protect tropical hardwoods. However, baseline data (especially on aboveground termite test)
of tested wood species are rather limited (Wong, 2005; Kadir & Masseat, 2017). Besides that, the information on the preservation of Malaysian hardwoods using various chemicals such as diesel or dead engine oil, LOSP and synthetic agro-insecticides are very limited.

1.2 Objectives

i. To identify termite genus and species that caused destructive damages to wood and wood products.

ii. To establish baseline data on basic wood properties and natural durability of selected wood species against termites (Coptotermes curvignathus).

iii. To determine termite resistance of selected wood species using oil-based and solvent-based wood preservative.

iv. To compare termite resistance of waterborne preservative-treated wood using dipping and vacuum pressure treatment.
2.1 Tropical timber

Many timbers are used on a large scale for various purposes such as in construction sectors, furniture manufacturing industries, pulp and paper and more. The high demand for tropical timber forces the wood industries to utilize secondary timbers, imported timbers and plantation timbers from indigenous and exotic trees (Remadevi & Muthukrishnan, 2007). In Sarawak, the government had initiated the planting programme of fast-growing timber species to sustain the existing natural forests. Jusoh et al. (2014), stated that although *Acacia mangium* is the main species planted in Sarawak, other tree species such as *Neolamarckia cadamba*, *Paraserianthes falcata*ria and *Eucalyptus* spp. also being planted. According to Remadevi and Muthukrishnan (2007), most of the exotic timber species are fast-growing and yield marketable sized timber in a shorter time. Besides that, exotic trees such as *Eucalyptus* and *Acacia* yield quality timber. Tropical timber logs, sawn timber and plywood are widely commercialized in the international timber trade. In 2016 alone, Sarawak had exported approximately 2 million m³ logs (STA Review, 2016). Examples of timber logs being traded were *Acacia mangium*, kapur, keruing, meranti, resak, selangan batu and other timber species (STA Review, 2016). End-users often prefer wood in terms of good natural durability, strength and appearance of timber for various end-uses (Wong *et al*., 2005).

Malaysian hardwoods are classified according to the timber classification and strength groups. For timber classification, Malaysian Grading Rules (Anonymous, 1984) was used which categorized hardwoods into four broad groups. The four groups are Light hardwood