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学位論文全文に代わる要約
Extended Summary in Lieu of Dissertation

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学位論文題目：
Title of Dissertation

Antitermite and Antifungal Activities of Indonesian Wood Biomass Against a Subterranean Termite *Coptotermes formosanus* and Wood Rotting Fungi
(インドネシアの木質バイオマスの　地下シロアリ*Coptotermes formosanus* に対する抗蟻活性および木材腐朽菌に対する抗真菌活性)

学位論文要約：
Dissertation Summary

Chapter I.　Introduction

Termites are the greatest importance in recycling woody and other plant material. On the other hand, termites become economic pests when they start destroying wood and wooden products and other commercial products (Meyer, 2005). Biodegradation of wood caused by termites is recognized as one of the most serious problem for wood utilization.

Fungi play various important roles in the forest ecosystem because they were contribute significantly to carbon recycling (Wu *et al*., 2012; Singh and Singh, 2014). Wood-decaying fungi lead to great economic losses of lignocellulosic materials. Several types of fungal wood decay are recognized including white-rot, brown-rot, soft-rot, staining fungi, and molds. Among the fungi that can infect and colonize wood, the white, the brown and the soft rot fungi have been extensively studied because of their ability to degrade wood cell walls, which can lead to extensive damage and failure of wooden products in service (Blanchette *et al*., 1990). White-rot fungi are the microorganisms known to efficiently degrade all the components of wood, including lignin (Bakar *et al*., 2013). Brown-rot fungi selectively decay structural polysaccharide with limited lignin degradation, resulting in this component becoming elevated in brown-rotted wood (Pandey and Pitman, 2003).

From the aspect of forest resource utilization efficiency, these attacking organisms are very harmful because they can shorten the service life of wood and wood products. Therefore, efforts to extend the service life of the wood such as the introduction of chemicals into the wood structure are very important. Natural products are a promising source of compounds exhibiting pesticidal and fungicidal activities. Nature has produced a large variety of plants with an array of survival and defensive chemical strategies including insecticidal and antifeeding components. Many plant extracts and essential oils may be the alternative sources of termite and fungi control agents because they constitute rich sources of bioactive chemicals.

The aim of this study were to examined the antitermite and antifungal activities of Indonesian wood biomass, namely gofasa (*Vitex cofassus*), kecapi (*Sandoricum koetjape*) and sengon (*Albizzia falcataria*) that potentially developed as sources of the green preservatives that environmentally friendly against termites and wood-rotting fungi.

Chapter II. General methods

The heartwood of the samples were milled and extracted according to the procedure described by Wu *et al.* (2005) with slight modification. The scheme of the extraction and fractionation of the heartwood mill shown in the Figure 2.1 below.

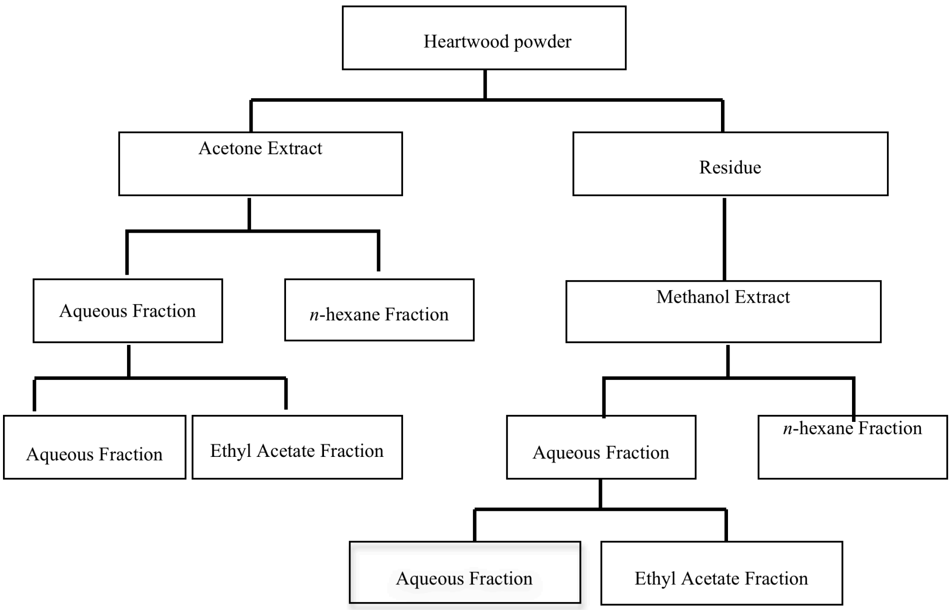

Figure 2.1 Schematic of the extraction and fractionation of heartwood mill

No-choice and two-choice tests were employed to assess the termiticidal activity of wood extract according to the procedure reported by Ohmura *et al.* (2000). Paper discs (Whatman International, diameter 13 mm) were permeated with 60μl of the MeOH solutions (10.000 ppm) containing each extract and its fractions. The weight loss of the paper discs were used to determine termiticidal properties of extract that was obtained by the following equation: in the no-choice bioassay, the absolute coefficient of antifeedancy (A) = [(KK – EE)/(KK + EE)] x 100(%), while in the two-choice bioassay, the relative coefficient of antifeedancy (R) = [(K – E)/(K + E)] x 100(%); where KK (K) and EE (E) are the weight losses of the control and treated paper discs, respectively. The total coefficient of antifeedancy (T) is equal to A plus R. All extracts tested were classified into the following classes according to their T values; feeding preference (T < 0), class I (0 ≤ T < 50), class II (50 ≤ T < 100), class III (100 ≤ T < 150), class IV (150 ≤ T < 200) and 200 for complete antifeedant.

The termite *Coptotermes formosanus* Shiraki used those was collected in black pine forest on the coast of Kochi Prefecture, Japan and also those bred in Forestry and Forest Products Research Institute, Tsukuba, Japan.

Moreover, fungal bioassay was conducted according to procedure explained by Wang *et al*. (2005) using the Potato dextrose agar (PDA) medium containing 50 and 100 ppm of samples (the extracts and the fractions) in a Petri dish. PDA plates containing methanol without the samples were used as a control. When the mycelium of fungi on the control medium reached the edge of the Petri dish, the antifungal index (%) was calculated as follows: antifungal index (%) = (1－Da/Db) x 100, where Da: diameter of mycelium colony growth with the samples (cm), Db: diameter of mycelium colony growth in the control (cm). Based on the antifungal activity (AFA) value, the activity of each fraction was then classified into activity category level according to Mori *et al*. (1997): AFA ≥ 75% (very strong), 75% ≤ AFA < 50% (strong), 50% ≤ AFA < 25% (moderate), 25% ≤ AFA < 0 (weak) and 0 (not active).

The fungal strains used were a white rot fungus (*Trametes versicolor*, NBRC 4937) and a brown rot fungus (*Fomitopsis palustris*, NBRC 30339) that were purchased from Biological Resource Center, National Institute of Technology and Evaluation, Tokyo, Japan.

The wood species that used in this study were obtained from various areas in Indonesia, while the waste wood of *A. falcataria* given by Nankai Plywood Co., Ltd. Japan. *V. cofassus* and *S. koetjape* were obtained from South Sulawesi Province, while *A. falcataria* bark was from Bogor, West Java Province. Those of the areas shown in the Figure 2.2 below.

Figure 2.2 Map of wood sample origin in Indonesia

Chapter III. Gofasa (*Vitex cofassus*)

Gofasa (*Vitex cofassus* Reinw.) is one of the wood species that potential to explore it's bioactive compounds, since this wood species showed high resistance to wood deteriorating organisms without any chemical preservatives. Gofasa usually used as the main raw material for building, the woodworking, boat construction and domestic utensils (Martawijaya *et. al*., 1981; Furusawa *et. al*., 2014). This wood species also is well known as *bitti* wood, especially for people in South Sulawesi and it is usually used as the main raw material for the construction of traditional boats called *Phinisi,* is a famous traditional boat from South Sulawesi.

The genus *Vitex* contains about 270 species distributed around the world. These species contain a variety of potentially bioactive molecules, such as iridoids, flavonoids, diterpenoids, derivatives, and phytosteroids. Most of these species possess analgesic, anti-inflammatory, antimicrobial, antioxidant, hepatoprotective, antihistamine, and antiasthmatic properties (Meena *et al*., 2011).

Extract yield

Extraction and fractionation of *V. cofassus* heartwood afforded the methanol extract (10.4%) had higher percentage than the acetone extract (2.7%), and the successive fractionation of acetone extract gave the *n*-hexane (13%), ethyl acetate (19%) and aqueous fractions (65%), respectively. Moreover, the methanol extracts afforded *n*-hexane (1%), ethyl acetate (7.5%) and aqueous fractions (71%), respectively. This data indicated that the extracts of *V. cofassus* wood tend to be polar.

The relationship between extractives and natural durability of wood was first reported by Hawley *et al* (1924) in (Nascimento *et al.*, 2013). The natural durability of wood is often related with its toxic extractive components. Several studies have shown that after removal of extractives, durable wood loses its natural resistance and makes them more susceptible to decay (Oliveira *et al.*, 2010).

Mortality of termite

The mortality rate of *C. formosanus* suggested that there are significant differences on protection of these extracts against termite, where the *n*-hexane fraction of methanol extract from both of no-choice (51.3%) and two-choice (92%) bioassays generated the highest mortality rate compare to the other fractions. According to mortality rate classification described by Lee *et al*. (2013), mortality rate of termites caused by *n*-hexane fraction belonging into the moderate-heavy. This data suggested that the substances that contain in these extracts had less toxic against the termites.

Table 3.1 shows antifeedant activity of *V. cofassus* heartwood extracts and their fractions. The methanol extract had higher antifeedant activity than the acetone extract. The ethyl acetate fraction of the methanol extract had highest activity, followed by the *n*-hexane fraction. The activity of the acetone extract might be enriched in the ethyl acetate fraction. Those extracts and fractions were classified into class III of antifeedancy classification.

Table 3.1 Antifeedant activity of *V. cofassus* extracts and its fractions

Extract	Total coefficient of antifeedancy	Antifeedant Classes
Acetone extract	4.9 ± 6^{d}	I
n-hexane fraction	59.9 ± 8^{c}	II
Ethyl acetate fraction	110.8 ± 7^{bc}	III
Aqueous fraction	-60.2 ± 4^{e}	Feeding Preference
MeOH extract	125.3 ± 4^{ab}	III
n-hexane fraction	115.9 ± 4^{b}	III
Ethyl acetate fraction	145.2 ± 5^{a}	III
Aqueous fraction	66.9 ± 9^{c}	II

(The letters after the numbers indicates the significant differences of the antifeedant activity at the level of $P < 0.05$ according to the Scheffe test).

On the contrary, the aqueous fraction of the acetone extract revealed feeding preference activity. Feeding preference activity means that the Formosan termites preferred to consume the filter paper containing those extracts. A study by Gite *et al*. (2010) indicated that water-soluble extract could contain sugar. Kartal *et al*. (2004) stated that residue fraction in his study could contain substances, such as vanillin and something else that are digestible and preferable by termite.

Separation of active fractions

From the antitermite test, we obtained that the active fractions were ethyl acetate fractions of acetone and methanol extracts. The active fractions were further fractionated and purified by Thin Layer Chromatography to obtained the active compounds that responsible to antitermite activity. The fractions were applied to the bottom of the PLC plate and was developed with *n*-hexane : ethyl acetate (1 : 3, v/v). The spots then were visualized by an ultraviolet lamp with 254 nm wave length. The locations of the compounds on the PLC plate were defined by R_f value, which is defined as the distance of the spot center from the starting point divided by the distance of the solvent front from the starting point.

The ethyl acetate fraction of acetone extract sub-fractions

Separation of the ethyl acetate fraction of acetone extract sub-fractions through Preparative Layer Chromatography gave 9 sub-fractions. These sub-fractions namely ethyl acetate fraction of acetone extract sub-fractions (EAAC) expressed their different retention factor value (R_f), i.e the distance that a compound travels on the TLC plate, which is the ratio of the distances from the starting line to the compound and to the solvent front. Sub-fractions with their Rf values were EAAC-0 (0), EAAC-1 (0.03), EAAC-2 (0.08), EAAC-3 (0.16), EAAC-4 (0.35), EAAC-5 (0.49), EAAC-6 (0.59), EAAC-7 (0.81) and EAAC-8 (0.92).

Mortality rate of termite of the ethyl acetate fraction of acetone extract sub-fractions

All the ethyl acetate fraction of acetone extract sub-fractions provided the significantly mortality rate of termites. However, the mortality rate of termites only classified into the slight mortality according to Lee *et al*. (2013). This data indicated that all the ethyl acetate fraction of acetone extract sub-fractions might be had non-toxic against the termites.

Antifeedant activity of the ethyl acetate fraction of acetone extract sub-fractions

No-choice bioassay test showed that all the sub-fractions had antifeedant activity as well as the sub-fractions 1-6 from two-choice bioassay. This might be due to bioactive compounds that contain in this sub-fractions do not suitable for termites diet. Chang and Cheng (2002) explained that compounds with an aldehyde group, such as cinnamaldehyde, have the best antitermitic activity.

Based on the antifeedant activity from no-choice and two-choice bioassays, the total coefficient of antifeedancy then was obtained as shown in the Figure 3.1. It can be seen that almost the sub-fractions had antifeedant activity, and classified into the class I – III of antifeedancy classification, except the sub-fractions 0 and 8 that showed the feeding preference properties. Among these sub-fractions, the sub-fractions 1 and 5 gave the higher antifeedancy classification, thus we focused to purificated more these sub-fractions.

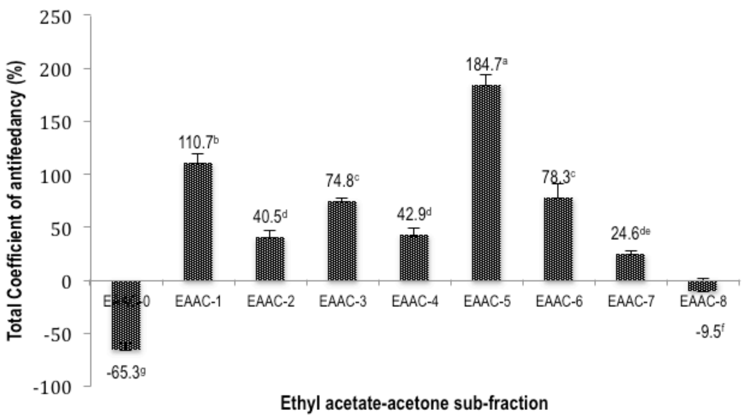

Figure 3.1 Total coefficient of antifeedancy of the ethyl acetate fraction of acetone extract sub-fractions
(Different letters at the top of the bars indicate the significant difference of the total coefficient of antifeedancy at the level of $P < 0.05$ according to the Scheffe test).

The ethyl acetate fraction of methanol extract sub-fractions

Separation of the ethyl acetate fraction of methanol extract sub-fractions through Preparative Layer Chromatography gave 8 sub-fractions. The sub-fractions namely the ethyl acetate fraction of methanol extract (EAME) with their retention factor values were EAME-0 (0), EAME-1 (0.03), EAME-2 (0.14), EAME-3 (0.19), EAME-4 (0.35), EAME-5 (0.59), EAME-6 (0.81) and EAME-7 (0.89).

Mortality rate of termite of the ethyl acetate fraction of methanol extract sub-fractions

The mortality rate of termites after subjected into paper discs that treated by the ethyl acetate fraction of methanol extract sub-fractions showed that the sub-fraction 6 revealed the highest mortality rate in no-choice bioassay (8%) compared to the other sub-fractions, while from two-choice bioassay the highest mortality rate was sub-fraction 5 (5.3%). Eventhough all the sub-fractions can delivered the significant mortality rate, but all the mortality class only classified into the slight mortality according to mortality classification described by Lee *et al*. (2013). This data indicated that the compounds contain in these sub-fractions had non-toxic properties against termites.

Antifeedant activity

The total coefficient of antifeedancy was obtained as shown in Figure 3.2. It clearly seen that almost the sub-fractions performed the positive antifeedancy and were classified into the class I – III of the antifeedancy classification as was described by Ohmura *et al*. (2000). The sub-fractions 0 and 5 revealed the negative antifeedancy that suggested that these sub-fractions had feeding preference properties.

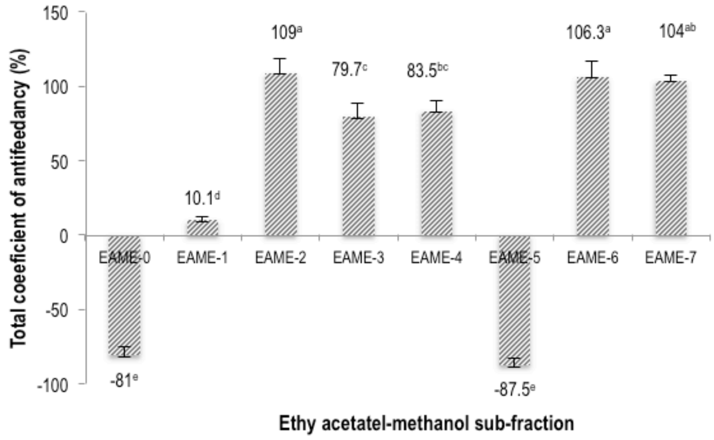

Figure 3.2 Total coefficient of antifeedancy of the ethyl acetate fraction of methanol extract sub-fractions

(Different letters at the top of the bars indicate the significant difference of the total coefficient of antifeedancy at the level of $P < 0.05$ according to the Scheffe test).

Antifungal activity

Table 3.2 shows that the aqueous fraction of acetone extract of *V. cofassus* heartwood possessed strong antifungal activity towards *T. versicolor*, and all the other fractions belong to moderate activity. On the other hand, the ethyl acetate fraction of the methanol extract revealed high activity against *F. palustris*, and all the other fractions belong to moderate or low activity.

Table 3.2 Antifungal index of the extracts and their fractions against wood-rotting fungi

Extract	Antifungal Index (%)	
	Trametes versicolor	*Fomitopsis palustris*
Acetone extract	40.6 ± 7^{ab}	22.7 ± 5^{ab}
n-hexane fraction	26.3 ± 4^{b}	5.6 ± 5^{c}
Ethyl acetate fraction	30.3 ± 7^{b}	11.1 ± 5^{bc}
Aqueous fraction	54.4 ± 3^{a}	27.2 ± 4^{ab}
Methanol extract	46.6 ± 5^{ab}	11.1 ± 5^{bc}
n-hexane fraction	31.9 ± 6^{b}	17.4 ± 4^{abc}
Ethyl acetate fraction	36.1 ± 8^{ab}	30.3 ± 4^{a}
Aqueous fraction	32.8 ± 8^{ab}	11.1 ± 5^{bc}

(The letters after the numbers indicates the significant differences of the antifungal activity at the level of $P < 0.05$ according to the Scheffe test).

Chapter IV. Kecapi (*Sandoricum koetjape*)

Introduction

S. koetjape wood, also known as wild mangosteen, is one kind of trees that produced fruit. This wood species widely used as building materials, boats, carts and crates (Badan Revitalisasi Industri Kehutanan, 2007). Various parts of the tree have medicinal properties. *S. koetjape* bark containing sandoricum acid and tradionally used for cure skin disease called *Tinea corporis* or ringworm. Fresh leaves applied to treat diarrhea, decoction or infusion of leaves used for baths to reduce fever. Bark poultice used for ringworm. Roots used as tonic and in Malayan medicine as preventive after childbirth and as a general tonic. Moreover, aqueous extract of the bark is consumed as a tonic after childbirth. In Indonesia, bark decoction used to treat leucorrhea and colic (Nassar *et al*., 2010).

Extract yield

Extraction and fractionation of *S. koetjape* heartwood results showed that the acetone extract had higher percentage (76.5%) compare to the methanol extract (2.3%). The *n*-hexane fraction of acetone extract had highest percentage (45.9%) compare to the other fractions, namely ethyl acetate (28.7%) and aqueous fractions (2.9%). Moreover, the ethyl acetate fraction of methanol extract had highest percentage (34.8%) compare to the *n*-hexane (24.1%) and aqueous fractions (25.3%). This finding data indicated that extract of *S. koetjape* wood tend to be non polar.

Mortality of termite

The mortality rate of *C. formosanus* suggested that there are no significant differences on protection of these extracts and fractions against the termite at no-choice bioassay and all these extracts and fractions classified into the slight mortality according to the mortality classes that described by Lee *et al*. (2013). On the contrary, the *n*-hexane fraction of methanol extract from two-choice bioassay generated the highest mortality rate (93.7%) compare to the other fractions. According to mortality rate classification described by Lee *et al*. (2013), mortality rate of termites caused by *n*-hexane fraction belonging to the heavy mortality.

Antifeedant activity

The total coefficient of antifeedancy (T) of *S. koetjape* extracts and its fractions displayed in Figure 4.1 below.

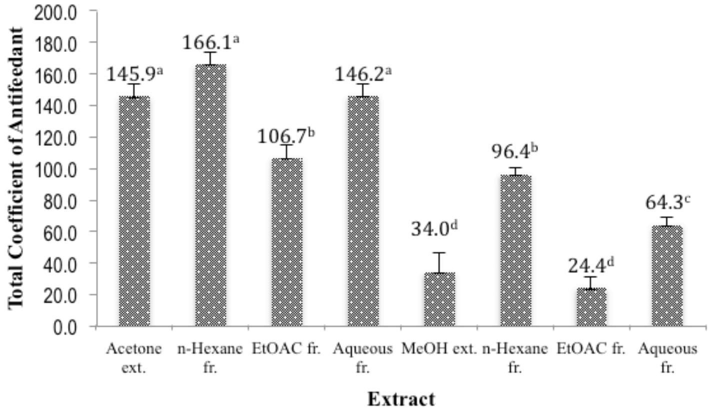

Figure 4.1 Total coefficient of antifeedancy of *S. koetjape* extracts and their fractions
(Different letters at the top of the bars indicate the significant difference of the total coefficient of antifeedancy at the level of $P < 0.05$ according to the Scheffe test).

Figure 4.1 shown that the acetone extract and its fractions demonstrated the high antifeedancy that including to class III-IV of antifeedancy classification as described by Ohmura *et al*. (2000). On the other hand, the methanol extract and its fractions showed the lower antifeedancy that were classified into class I-II of antifeedancy classification. This finding indicated that *S. koetjape* extracts and its fractions had high activity against termites.

Antifungal activity

Antifungal test showed that *n*-hexane fractions from both of acetone and methanol extracts of *S. koetjape* at 50 and 100 ppm indicated the highest antifungal activity against *T. versicolor,* while the ethyl acetate fraction of acetone extract at 50 ppm and MeOH extract at 100 ppm showed the lowest antifungal activity. On the other hand, the *n*-hexane fraction of methanol extract at 50 ppm and the aqueous fraction of acetone extract at 100 ppm showed the highest antifungal activity against *F. palustris*. Moreover, the acetone extract at 50 ppm and the ethyl acetate fraction of methanol extract revealed the lowest antifungal activity against *F. palustris*.

According to antifungal classification described by Mori *et al.* (1997), antifungal activity of *n*-hexane fractions of methanol extract against *T. versicolor* classified into strong activity, while the aqueous fraction of acetone extract classified into weak activity against *F. palustris*. Generally, all the extracts and fractions showed the moderate activity against *T. versicolor* at 100 ppm. In contrast, all the extracts and fractions indicated the weak activity against *F. palustris*.

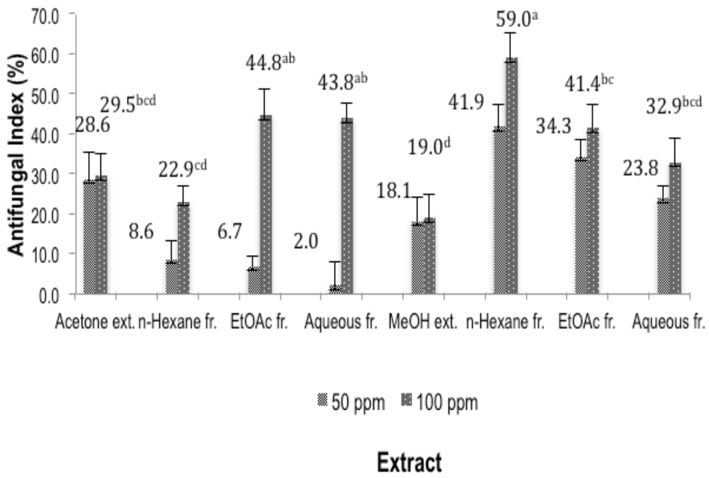

Figure 4.2 Antifungal Index of *S. koetjape* extracts and fractions against wood rotting fungi *Trametes versicolor* (Different letters at the top of the bars indicate the significant difference of the antifungal index at the level of $P < 0.05$ according to the Scheffe test).

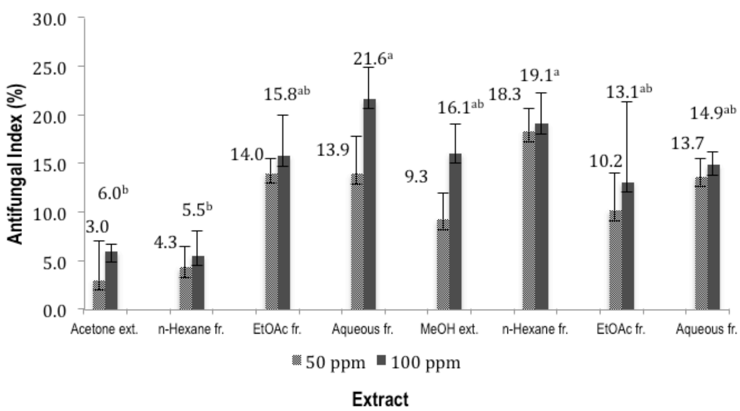

Figure 4.3 Antifungal Index of *S. koetjape* extracts and fractions against wood rotting fungi *Fomitopsis palustris* (Different letters at the top of the bars indicate the significant difference of the antifungal index at the level of $P < 0.05$ according to the Scheffe test).

Chapter V. Sengon (*Albizzia falcataria*) bark and waste wood

Introduction

Albizzia falcataria one of the member of Family Fabaceae, is most widely developed and utilized tree species for forestry development program in Indonesia. *A. falcataria* is one of the tree species preferred for industrial forest plantations in Indonesia because of its very fast growth, ability to grow on a variety of soils, favourable silvicultural characteristics and acceptable quality of wood for the panel and plywood industries. This wood species plays an important role in both commercial and traditional farming systems in several sites in Indonesia. This species, like other fast-growing tree species, is expected to become increasingly important for wood industries as supplies for plywood from natural forests decrease (Krisnawati *et al*., 2011).

Extract yield

Extraction and fractionation of samples showed that the methanol extract of *A. falcataria* wood and *A. falcataria* bark had higher percentage than the acetone extract, and the successive fractionation resulted the aqueous fractions of both of acetone and methanol extracts had higher percentage compare to the other fractions, except for ethyl acetate fraction of acetone extract of *A. falcataria* waste wood. This data indicated that the extracts of *A. falcataria* bark and *A. falcataria* waste wood tend to be polar.

Extractives content of *A. falcataria* bark higher than *A. falcataria* waste wood. It is might be due to the age and the *A. falcataria* wood is a fast growing species, where low extractives levels may easily be attributed to a rate of growth effect (Wilkes, 1984). According to Yang and Pirjo (2011), generally, content of extractives is higher in bark, leaves and roots, than that in stem wood.

Mortality of termite

The mortality rate of *C. formosanus* from no-choice and two-choice bioassays indicated that all the extracts and fractions significantly delivered mortality rate of termites. However, according to mortality rate of termite classification that was described by Lee *et al*. (2013), all the extracts and fractions only generated the slight mortality rate of termites, except the methanol extract of *A. falcataria* bark in no-choice bioassay (58%) that was classified into moderate mortality. This data indicated that extractives that contain in these extracts and fractions from both of waste wood and bark might be possess non-toxic properties.

Antifeedant activity

Based on the antifeedant activity value that derived from no-choice and two-choice bioassays that mention above, the total coefficient of antifeedancy (T Value) then was obtained as shown in Table 5.1 below.

According to their T value, the antitermite activity of these extracts and fractions then was classified into the antifeedancy classification as described by Ohmura *et al.* (2000).

Table 5.1 Total coefficient of antifeedancy (T Value) of *A. falcataria* waste wood and *A. falcataria* bark

Extract	T value		Antifeedancy Classification	
	A. falcataria waste wood	*A. falcataria* bark	*A. falcataria* waste wood	*A. falcataria* bark
Acetone extract	60.6 ± 6[bc]	86.1 ± 3[bcd]	II	II
n-Hexane fraction	56.4 ± 6[bc]	111.4 ± 7[ab]	II	III
Ethyl acetate fraction	70.7 ± 12[ab]	87.6 ± 14[bc]	II	II
Aqueous fraction	66.3 ± 6[b]	67.6 ± 10[cd]	II	II
Methanol extract	96.3 ± 3[a]	128.6 ± 1[a]	II	III
n-Hexane fraction	78.5 ± 9[ab]	94.5 ± 7[d]	II	II
Ethyl acetate fraction	40.5 ± 6[c]	113.2 ± 6[ab]	I	III
Aqueous fraction	61.3 ± 3[bc]	59.2 ± 8[d]	II	II

(The letters after the numbers indicates the significant differences of the total coefficient of antifeedancy at the level of $P < 0.05$ according to the Scheffe test).

Antifungal activity

From *A. falcataria* waste wood, the *n*-hexane fraction of acetone extract demonstrated the highest antifungal activity against *T. versicolor* and therefore possess moderate activity class, while *n*-hexane fraction of methanol extract showed the lowest activity that including to weak activity. Moreover the aqueous fraction of methanol extract exhibited the highest antifungal activity against *F. palustris* compared to the other fractions. However, the activity of these fraction classified into weak activity as well as the methanol extract itself and *n*-hexane fraction of methanol extract. Moreover, another fractions exhibited negative antifungal activity against *F. palustris*.

Futhermore, the acetone extract of *A. falcataria* bark demonstrated the strongest actvity against *T. versicolor* compared to the other fractions. Thus the acetone extract and the *n*-hexane fraction of methanol extract than were classified into moderate class of antifungal activity class. On the other hand, the ethyl acetate fraction of acetone extract showed the highest antifungal activity compared to the other fractions against *F. palustris*. However, all the extracts and fractions only classified into the weak antifungal activity.

General Conclusions

Three species of Indonesian wood namely *Vitex cofassus*, *Sandoricum koetjape* and *Albizzia falcataria* were examined their antitermite and antifungal activity against a subterranean termite *Coptotermes formosanus*

Shiraki and wood rotting fungi, a white rot fungi (*Trametes versicolor*) and a brown rot fungi (*Fomitopsis palustris*).

Extraction and fractionation process resulted the different yield of each wood species samples and bark. The extract of *V. cofassus* heartwood tend to be polar and this finding similar with the *A. falcataria* waste wood and *A. falcataria* bark. On the contrary, the *S. koetjape* heartwood results showed that the extract tend to be non polar.

The antitermite test of *V. cofassus* revealed that the methanol extract itself, the ethyl acetate fraction and the *n*-hexane fraction from the methanol extract, and the ethyl acetate fraction from the acetone extract had high antifeedant activity against *C. formosanus* and their activity almost classified into class II – III of antifeedancy classification, except the aqueous fraction of acetone extract that showed the feeding preference activity. On the other hand, the acetone extract of *S. koetjape* and its fractions exhibited the significantly antifeedant activity and all of them classified into class III-IV of antifeedancy classification. Antitermite test revealed that *Albizzia falcataria* bark classified into class II – III, while the *Albizzia falcataria* waste wood had revealed the antitermite activity that classified into class I – II of the antifeedancy classification. This data suggested that all the wood biomass tested had antitermite acitivity.

Furthermore, all the extracts and fractions of *V. cofassus* had strong-moderate activity against the wood rotting fungi *T. versicolor*, while all these extracts and fractions had moderate-weak activity against *F. palustris*. In addition, the antifungal test of *S. koetjape* resulted the extracts and another fractions almost belonging to moderate-weak activity against *T. versicolor*. Conversely, all the extracts and fractions showed weak antifungal activity against *F. palustris*.

From the antifungal test results confirmed that the extract of *A. falcataria* waste wood were classified into moderate-weak class of antifungal activity class against *T. versicolor.* On the contrary, all these extracts and fractions only classified into the weak-not active antifungal activity against *F. palustris*. Furthermore, the extracts and fractions of *A. falcataria* bark demonstrated the moderate-weak antifungal activity against *T. Versicolor*. However, all these extracts and fractions revealed classified into weak-not active antifungal classification against *F. palustris*.

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