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Preference of subterranean termites *Macrotermes gilvus Hagen* (Blattodea: Termitidae) control using smoke wood and borax

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ABSTRACT

Termites are widely known as building pests. Gunungpati, Semarang is a suitable area for the termites *Macrotermes gilvus Hagen*. Feeding preference of subterranean termites *Macrotermes gilvus Hagen* (Blattodea: Termitidae) was investigated. Nowadays, termite control used synthetic chemical compounds. Therefore, it is necessary to control termites by using organic compounds that are environmentally friendly. The aims of this study is to analyse food consumption and the durability of *M. gilvus Hagen* termites after liquid smoke treatment using *sengon* wood waste and borax. The method that used in this study was the preference test for *M. gilvus termites* with liquid smoke treatment using *sengon* and borax waste, mortality test and GCMS analysis of *sengon* wood. The results showed that liquid smoke from *sengon* wood at a concentration of 0.5% was effective for controlling *M. gilvus Hagen* termites for 40 hours, meanwhile borax could control *M. gilvus Hagen* termites with a concentration of 0.5% for 16 hours. This research can serve as a reference for termite control companies in Indonesia.

***Key words** : Subterranean termites, Macrotermes gilvus Hagen, Smoke wood, borax*

Introduction

The subterranean termite *Macrotermes gilvus Hagen* (*M. gilvus Hagen*) is widely known as an insect pest that disrupt housing, school buildings and buildings (Subekti, 2019). Its attack on residential buildings has become a major problem because the value of losses increasingly over time. Termite identification in Semarang show that it is dominated by subterranean termites including *M. gilvus Hagen* (Subekti and Saniaturrohmah, 2020). Building damage due to termite attacks in Semarang has reached more than 85% (Subekti *et al.*, 2018). Meanwhile, economic losses due to termite attacks in Indonesia reach 8.7 billion rupiah per year (Nandika, 2016).

Nowadays, controlling *M gilvus Hagen* subterranean termites use synthetic pesticides and it has some weakness: it pollutes the environment, does not target insects, can cause cancer if exposed to the skin (Malik *et al.*, 2011). Moreover, the prices of synthetic pesticides and borax are also expensive. Based on these problems, it is necessary to control termite using organic materials that are environmentally friendly and right on the target insects. Biological control is one solution.

Various studies on termite control using natural materials have been carried out, including: making biopesticides from agarwood leaves (Subekti *et al.*, 2019) and mangrove leaves (Sahidah and Subekti, 2019). However, the manufacture of biopesticides from these materials still has a weakness, namely the limited raw materials in nature.

Therefore, liquid smoke from *sengon* wood waste is an alternative effort to control subterranean termites that are natural, safe for the environment, and do not cause cancer if touched by humans. In addition, the advantage of this liquid smoke is that it is easily available in the environment. Several compounds from liquid smoke can be used as natural ingredients for wood preservation. The purpose of this study was to analyse and compare the effectiveness of liquid smoke from *sengon* and borax wood waste for *controlling M. gilvus Hagen* subterranean termites.

Materials and Methods

Preference test for *M. gilvus Hagen*

The research was conducted at the Laboratory of Biology, Faculty of Mathematics and Natural Sciences, Universitas Negeri Semarang. The test was carried out using the modified cellulose pads (Syafii, 2000) method. Cellulose paper with a diameter of 50 mm will be preserved with 1 ml of liquid smoke and borax at various concentration levels: 0%, 0.5%, 1%, 1.5% and 2%. This Cellulose paper is placed in the test glass, then left until it reaches a relative humidity. For control, cellulose paper which was treated without the addition of liquid smoke was used. For feeding to the ground termite *M. gilvus Hagen*, the treated cellulose paper is put in a glass container. Each test sample was given 25 *M. gilvus Hagen* termites with details of the 16-worker caste and 4 healthy and conditioned soldier castes. To maintain moisture, the sand in the test glass is dripped with distilled water. The test glass is covered with gauze and kept in a dark place for 1 week. There are two parameters used in this test, namely the mortality of the ground termite *M. gilvus Hagen*.

Bioassay Anti Termite *M. gilvus Hagen*

The determination of the mortality value was carried out after completing the test using the formula of Sornnuwat *et al.* (1995), as follows:

$$M (\%) = \underline{N_1 - N_2} \times 100\% \ N_1$$

Where :
M = Mortality of termites in percent (%)
N1 = Number of initial termites (tails)
N2 = Number of live termites after feeding (tail)

Making *Sengon* Wood Liquid Smoke (*Paraserianthes falcataria*)

The dried *sengon* wood (*Paraserianthes falcataria*) is put into the gasifier, then turn on the fire for the combustion process. After the fire has started and some of wood has burned, add the *sengon* wood pieces again until they are full and close the gasifier. Turn on the blower to make air circulation to help the gasification process. The combustion temperature in the reactor is 250 °C and the gas exit temperature (10) is 54 °C. Then the product gas will come out through the output. To obtain tar, condensation is required using fresh water where the pipe from the gasifier output is passed through a condensation basin filled with water. Then the tar will be condensed and collected down in the tar shelter (Abnisa *et al.*, 2013).

Gas Chromatography Mass Spectrometry (GC-MS) Analysis

The extracted solution was analysed by Gas Chromatography Mass Spectrometry (GC-MS) at the Center for Forensic Laboratory of Polri Headquarters based on modification of the method undertaken by Lu *et al.* (2011). This solution was analysed using GC / MS Aglient 5977B in spitless mode with helium as carrier gas and electron impact (EI) of 70 eV. The oven injector was set at 250 ° C and the transfer point toward MS was set at 250 ° C. The oven temperature was adjusted at 40 ° C for 0.5 min, then increased at a rate of 10 ° C / min to 200 ° C and held for 1 min, then increased again at 20 ° C / min to a temperature of 240 ° C and held for 1 minute. MS was set in the SIM (Selected Ion Monitoring) mode on 41, 83, 97, 111, 125 and 141 ions. The GC-MS results were then analysed using the W10N14.L

Results and Discussion

The results showed that the mortality of subterranean termites after being tested using smoke treatment as shown in Table 1 below:

From Table 1 above shows that the control of *M. gilvus Hagen* subterranean termites in the first 5 hours of treatment using liquid smoke concentrations of 2%, 1.5%, 1% and 0.5% respectively, there were deaths of 12%, 8%, 5, 33% and 4%. Table 1 above shows that liquid smoke at a concentration of 0.5% can kill the ground termite *M. gilvus Hagen*

100% within 40 hours. The greater the concentration, the faster the time needed to kill the ground termite *M. gilvus Hagen*. The greater the concentration, the greater the active substance that works to kill termites. Chemical compounds that enter the body of termites will affect the number and activity of microorganisms in the termites' intestines. While termites really need microorganisms in their bodies to degrade cellulose. If the number of these microorganisms is reduced, it will accelerate the death of termites (Subekti *et al.*, 2017). Research conducted by Oramahi *et al.* (2014) stated that the group of alcohol, phenol, acid and ketone compounds contained in bio–oil can increase mortality in insect testing. This was confirmed by Fang *et al.* (2002) who stated that some of the compounds produced in the charcoal process are carcinogenic and cause permanent damage to living organisms.

The results showed that the death of termites after being tested with borax was shown in Table 2 below:

From Table 2 above shows that the control of *M. gilvus Hagen* subterranean termites in the first 5 hours of treatment using liquid smoke concentrations of 2%, 1.5%, 1% and 0.5% respectively, there were deaths of 12%, 8%, 5, 33% and 4%. Table 2 above shows that borax at a concentration of 0.5% can kill the 100% ground termite *M. gilvus Hagen* within 16 hours. The greater the borax concentration, the faster it will take to kill the ground termite *M. gilvus Hagen.* The higher the borax concentration, the higher the chemical compounds contained to kill termites. The main content of borax is sodium tetraborate decahydrate. If sodium tetraborate decahydrate is present in large quantities in an organism's body, it will damage the organism's central nerve (Lushchak *et al.*, 2018). The compound sodium tetraborate decahydrate penetrates the cuticles, cell membranes and nerve sheaths of termites. So that in large quantities, will cause acute toxins in the body of termites.

Table 3 shows the main components of Heptanoic Acid *sengon* wood liquid smoke whose main content is acid. These compounds can cause acute poisoning in the attack, especially termites. Heptanoic Acid (CAS) heptoic acid when in contact with termite skin, can be carcinogenic (Chang *et al.* 2020). Termites are small, so that the body surface area is relatively larger compared to mammals. The cuticles in termite skin are dihophobic and lipophilic, which are similar to membranes. If a lot of Heptanoic Acid (CAS) heptoic acid compounds come into contact with the skin, then acute poisoning will occur in termites (Bagchi *et al.,* 2016). Similar research was conducted by Subekti and Yoshimura (2020) for termite control *Coptotermes formosanus* and *Reticulitermes speratus* using bamboo liquid smoke. The results showed that bamboo pyrolysis temperature of 450 ^{o}C with a concentration of 10% was very effective for termite control. This was also done by Oramahi *et al.* (2018) which states that the acid content contained in liquid smoke further increases mortality in *laban* wood testing from subterranean termite attacks.

Conclusion

The conclusion of this research is the concentration

Table 1. Mortality of subterranean termites after being tested using smoke treatment

Time (hour)	5	10	15	20	25	30	35	40	
Mortality (%)	0%	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	1.33±2.31	1.33±2.31
	0.5%	4.00±4.00	22.67±2.31	45.33±4.62	60.00±4.00	68.00±4.00	73.33±2.31	89.33±6.11	100.00±0.00
	1%	5.33±2.31	29.33±6.11	46.67±2.31	69.33±2.31	77.33±2.31	82.67±2.31	100.00±0.00	100.00±0.00
	1.5%	8.00±4.00	33.33±2.31	49.33±2.31	69.33±2.31	78.67±2.31	85.33±2.31	100.00±0.00	100.00±0.00
	2%	12.00±4.00	37.33±2.31	60.00±4.00	74.67±2.31	82.67±2.31	100.00±0.00	100.00±0.00	100.00±0.00

Tabel 2. Mortality subterranean termites *M. gilvus Hagen* after borax treatment

Time (hour)	1	4	7	10	13	16	
Borax (%)	0%	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
	0.5%	5.33±2.31	34.67±2.31	54.67±2.31	62.67±2.31	80.00±4.00	100.00±0.00
	1%	9.33±2.31	50.67±8.33	82.67±6.11	88.00±4.00	100.00±0.00	100.00±0.00
	1.5%	6.67±2.31	57.33±12.22	84.00±4.00	96.00±4.00	100.00±0.00	100.00±0.00
	2%	6.67±2.31	64.00±4.00	90.67±2.31	100.00±0.00	100.00±0.00	100.00±0.00

Table 3. Contents of 5 main compounds of liquid smoke from *sengon* wood waste *Paraserianthes falcataria*

Smoke of sengon wood *Paraserianthes falcataria*	Compound content	Percentage (%)
Heptanoic Acid (CAS) heptoic acid	37.50	
Pentanal (CAS) n-Pentanal	10.17%	
Acetic acid, pentyl ester (CAS) n-Amyl acetate	7.47%	
Acetic acid (CAS) Ethylic acid	6.38	
Heptanal (CAS) n-Heptanal	5.91%	

of 0.5% *sengon* wood waste liquid smoke can cause 100% mortality of termites within 40 hours. Meanwhile, borax with a concentration of 0.5% can cause 100% mortality of termite within 16 hours for the controlling *M. gilvus Hagen* subterranean termites. This can be used as a recommendation for environmentally friendly termite control in Indonesia.

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