

Toxicity of essential oils against termite

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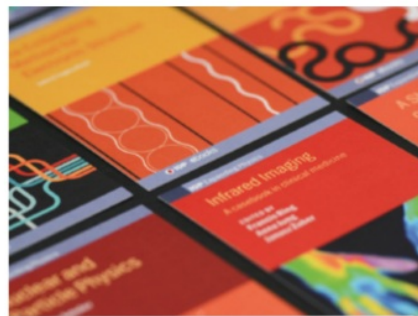
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Toxicity of essential oils against termite *Macrotermes gilvus* Hagen (Blattodea: Termitidae)

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Abstract. Termites are widely known by the public as a pest building. The level of attacks is increasing from year to year. Nowadays, termite control using synthetic pesticides, their use is becoming increasingly uncontrollable that it is very dangerous to human safety. Therefore, the innovative research needed to produce a natural pesticide that is safe for the environment. Research on the use of natural materials as a natural biopesticide control technology innovation that is needed today. Natural materials such as *Syzygium aromaticum*, *Myristica fragran*, *Cinnamomum osmophleum*, *Areca catechu* has a compound that can be used as a termite control *Macrotermes gilvus* Hagen. The statistical test data used was a two-way ANOVA test to Determine the effect of essential oils on termite mortality, while to Determine the essential oil that had a significant effect on termite mortality, the Tukey HSD test was used. The purpose of this study was to analyze the active compounds of *Syzygium aromaticum*, *Myristica fragran*, *Cinnamomum osmophleum*, *Areca catechu* to control subterranean termites *gilvus* M. Hagen. The conclusions of this study are compounds *Syzygium aromaticum*, *Myristica fragran*, *Cinnamomum osmophleum*, and *Areca catechu* with a concentration of 10% has the potential to control subterranean termites *M. gilvus* Hagen.

1. Introduction

Termites are insects that widely known by the public as a pest that causes a lot of damage to buildings and their contents. Termites can eat cellulose derivatives such as furniture, furnishings, fabrics, paper, and all items that contain cellulose [1]. Factors that may affect investment termites in buildings include building components and furniture made of wood, the area around the building with high humidity, wood building components in direct contact with the ground, a pile of wood and cellulose-containing materials. The intensity of termite attack and the amount of resulting damage can lead to high economic losses and tends to increase from year to year, economic losses due to termite attack on a residential building in Indonesia is estimated to reach Rp. 8,7 trillion in 2015 [2].

Macrotermes gilvus Hagen is one of the species of subterranean termites which serves as the primary biodegradator in natural forests. In its natural habitat, this species of termites eating litter and rotten wood as a food ingredient [3]. Termites *M. gilvus* Hagen has no cellulose in its body. These enzymes are produced by microorganisms in the gut of termites to help the digestive process. Compounds produced by microorganisms in *M. gilvus* Hagen, among others dodecamethylcyclohexasiloxane, tetradecamethyl cyclohexasiloxane, hexadecamethyl cyclooctasiloxane, and octasiloxane, 1,1,3,3,5,5,7,7,9,9,11,11,13,13, 15,15-hexadecamethyl and phytosterol β -sitosterol [4].

Currently, termite control system using synthetic termiticide. Using chemical termiticide is still the main method to inhibit termite infestation in wood architecture and agricultural yields. The use of pesticides is not limited to produce pest resistance, safety risks to humans, because of his persistence that long in the land, and the inclusion of chemicals toxic residue in the food chain, conjoined with bioaccumulation and biomagnification, contamination of groundwater and the decline of biodiversity [5].

The increasing human awareness of the health hazards, destructive side issues and environmental pollution because of the usage of synthetic pesticides, constantly changes the core on biological options for controlling termite. Innovation is needed are new in the biological control of subterranean termites [6]. Termite control soil using natural materials is an alternative that can be developed. Biopesticides are a safe alternative in the termite control system. Biopesticides are biodegradable and leave no residue. These natural ingredients are harmless compared to synthetic pesticides, in accordance with the target pest insects and their close relatives. Chemical pesticides are often not well-targeted to the target animal, so they can kill non-target insects,

Research on biopesticide active ingredients from natural materials, the level of application and the environmental impact of pesticide plant is one alternative for pest control [7]. The content of essential oils from aromatic and medicinal plants has a broad range of commixtures of natural organic compositions that are the main defense line plant [8]. The molecular weight of the aromatic compound this natural ingredient is low, volatile, and has a low persistence in the environment [9].

From the problems above problems, it is necessary to do a termite control system with toxic compounds that are not carcinogenic, environmentally friendly, and well-targeted at the target insect. This study aims to analyze some of the active compounds of *Syzygium aromaticum*, *Myristica fragran*, *Cinnamomum osmophleum*, *Areca catechu* to control subterranean termites *M. gilvus Hagen*.

2. Methods

2.1. Preparation Subterranean Termites *Macrotermes gilvus Hagen*

Termites *M. gilvus Hagen*, which have been collected and kept in the laboratory Termite Biology, Faculty UNNES. Termites *M. gilvus Hagen* has been maintained in the laboratory at a temperature of 27-29 ° C, with humidity of 85-90%. Termites taken is caste of workers and soldiers. Each petri dish is filled by 43 worker termites and 7 soldiers.

2.2. Plant material

The samples of *Syzygium aromaticum*, *Myristica fragran*, *Cinnamomum osmophleum*, and *Areca catechu* diluted with ethanol up to 10%. Only the aerial part of the plant was used; the leaves and the apical parts were preserved in the shelter for eight days at 25°C.

2.3. Microwave-assisted hydrodistillation

the microwave-assisted hydro distillation was conducted employing an assembly with a domestic microwave oven, then connected to a Clevenger-type extractor and a cooling system to continuously coagulate the distillate. The excessive condensed water was refluxed to the extraction ask to bring back the water to the plant material. Microwave-assisted hydrodistillation was conducted under the optimum conditions of the extracting time, microwave power, and proportion of plant material/water. 100 gr of *Syzygium aromaticum*, *Myristica fragran*, *Cinnamomum osmophleum*, and *Areca catechu* samples were settled in a 2 liter ask which contain distilled water (200 ml), heated inside the microwave oven cavity, and the mixture was heated at a constant power of 600 W until all essential oils are extracted. The essential oils as the results from various extractions are dried under anhydrous sodium sulfate and stocked in the dark for the use of analysis.

2.4. Hydrodistillation by clevenger

For the extraction of essential oils from *Syzygium aromaticum*, *Myristica fragran*, *Cinnamomum osmophleum*, and *Areca catechu* by hydrodistillation under maximum operating status, a quantity of

100 g of *Syzygium aromaticum*, *Myristica fragran*, *Cinnamomum osmophleum*, and *Areca catechu* was added to 800 ml of distilled water in a 2 liter ask. A set was set in a balloon heater which is hooked up to a cooler to make sure condensation of essential oils last for three hours. At the end of the distillation, two states were examined, an aqueous state (aromatic water) and an organic state (essential oil), less dense than water. The essential oil was taken, dried under anhydrous sodium sulfate, and stored in sealed vials in the dark, at 4°C, until it is used.

2.5. Bioassay

The method used to evaluate the activity of essential oils *Syzygium aromaticum*, *Myristica fragran*, *Cinnamomum osmophleum*, and *Areca catechu* against termites *M. gilvus* Hagen. The essential oil is dissolved into ethanol to a concentration of 10%. 1 milliliter of essential oils *Syzygium aromaticum*, *Myristica fragran*, *Cinnamomum osmophleum*, and *Areca catechu* Whatman filter paper dropped to 110 mm diameter. One Whatman drip with ethanol as a control. After the solution was dried on Whatman paper, 50 termites (43 workers and 7 soldiers) were placed on the filter paper in a petri dish and mortality was observed for 3 hours.

2.6. Data analysis

Termite mortality data *M. gilvus* Hagen analyzed using a 2-way ANOVA test to determine the effect of essential oils *Syzygium aromaticum*, *Myristica fragran*, *Cinnamomum osmophleum*, and *Areca catechu* against termite mortality, followed by Tukey test to determine the essential oils that significantly influence the termite mortality *M. gilvus* Hagen.

3. Results and Discussion

Figure 1 shows that treatment with the use of essential oils *Syzygium aromaticum* termite mortality *M. gilvus* Hagen 100% occurred at 45 minutes after treatment. There are five major factors of the GC-MS analysis of essential oils including eugenol *Syzygium aromaticum* 77.81%, 21.3% Eugenylacetate, β -caryophyllene 8.44%, α -humulene 1.04%, and 0.8% methyl eugenol [10].

Treatment with the use of essential oils *Cinnamomum osmophleum* termite mortality *M. gilvus* Hagen 20% occurred at 105 minutes after treatment. The results of GC-MS analysis, there are five main components of the essential oil of *Cinnamomum osmophleum* among others cinnamaldehyde 76%, 3.88% geranyl acetate, benzaldehyde 3.2%, 2.96% geraniol and eugenol 1.05% [11].

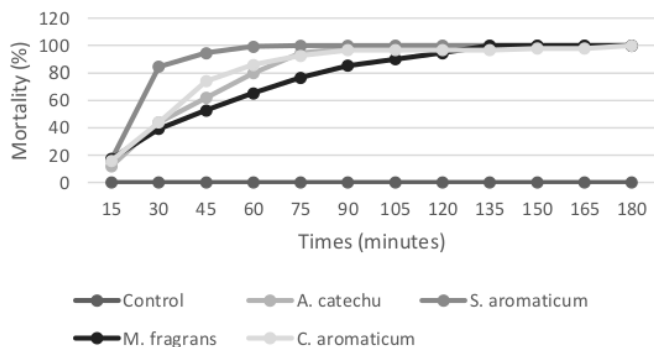


Figure 1. Mortality of termites *Macrotermes gilvus* Hagen after 3 hours of treatment with four oil essential oil containing 10% of *Syzygium aromaticum*, *Myristica fragran*, *Cinnamomum osmophleum*, and *Areca catechu*.

Meanwhile, essential oil treatment *Myristica fragran* that caused *M. gilvus* Hagen 100% mortality occurred at 135 minutes after treatment. The results of GC-MS analysis of essential oil of *Myristica fragran* has five main components, among others Myristicin, safrole, myrcene, β -pinene, and α -pinene [12].

GCMS analysis can be seen active compounds which dominates in the *Syzygium aromaticum* main thing is eugenol (77.81%), in *Myristica fragran* is Myristicin; safrole; Myrcene, on osmophleum *Cinnamomum* (cinnamon) is Cinnamaldehyde (76%), and the *Areca catechu* (betel nut) is a saponin; phenolic; Flavonoids, Triterpenoid.

Eugenol obtained from *Syzygium aromaticum* can be reduced to some compounds, such as methyl eugenol which has been known as a natural attractant [13]. Eugenol known as compounds that can affect animal behavior of insects, such as food-seeking behavior, laying eggs, sexual intercourse and others. Eugenol chemical constituents are slow to action, the compound eugenol clove leaf essential oil extract has potential as termite control because it can be toxic to termites, but the content of eugenol contained in plant extracts can also be towing for termites depends on the concentration and type of crop [14]. Eugenol compound can play a very effective as a termiticide to control termites *Coptotermes formosanus* [15].

The subterranean termites *M. gilvus* Hagen cellulase does not have enzymes in the body. In the digestive system of the termite *M. gilvus* Hagen are mutually beneficial microbial symbionts with bacteria and fungi in the gut. Microorganisms in the termite gut that help termites *M. gilvus* Hagen produce enzymes cellulose [1].

The mechanism is happening inside termite *M. gilvus* Hagen after being given some toxic compounds of natural ingredients are eugenol compounds into the cell membrane by changing membrane permeability. Lipofik nature of eugenol will increase the permeability of the bacterial cell membrane so that the bacterial membrane becomes damaged then the macromolecules and ions out of the cell bacteria easily lead to bacterial cells damaged and die. Disrupted cell membrane permeability causes the protein synthesis of bacteria to be blocked so that the protein structure is changed and the protein can not function anymore. Proteins that do not work cause the denaturation of proteins, then going on coagulation proteins and the disruption of bacterial metabolism [16]. Termite mortality occurred because of no microorganisms in the body of termites in helping the digestive process. This is because the microbes in the gut of termites have died because of the toxic compounds present in the essential oil extracts [4].

4. Conclusion

Conclusions from this research are the essential oil from extracts *Syzygium aromaticum*, *Myristica fragran*, *Cinnamomum osmophleum*, and *Areca catechu* at a concentration of 10% has the potential to control subterranean termites *M. gilvus* Hagen. *Syzygium compound* aromaticum highest activity with the main content of eugenol, as compared to the others. Termite control *M. gilvus* Hagen natural ingredient compounds have good prospects for development in the control system of subterranean termites.

5. Acknowledgements

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