



Potential of zodia (*Evodia suaveolens*) as natural repellents for *Culex* sp

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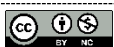
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Abstract

Background: Adult *Culex* sp mosquitoes as disease vector also cause discomfort around humans. Various efforts have been made to prevent the transmission of diseases carried by mosquitoes, including the use of mosquito nets and the use of chemical insecticides in the larval and adult stages. **Objectives:** This Reserach aim to investigates the potential of Zodia (*Evodia suaveolens*) as natural repellents. **Materials and Methods:** An experimental study was conducted to test the effectiveness of Zodia extract at concentrations of 1%, 2%, and 3% against *Culex* sp. mosquitoes. The tests were conducted under controlled conditions in the Laboratory of Parasitology, University of Binawan. The effectiveness was measured by the percentage of mosquitoes repelled after exposure. **Results:** The effectiveness of Zodia repellent increased with concentration, showing 76.4% effectiveness at 1%, 81.3% at 2%, and 91.05% at 3%. These results indicate a concentration-dependent increase in repellency, with the highest concentration approaching typical efficacy rates of synthetic repellents. **Conclusions:** The Zodia repellent (*Evodia suaveolens*) with a concentration of 1%, 2% and 3% has been demonstrated to be effective as a natural repellent against *Culex* sp. mosquitoes.

Keywords

Culex sp., Chemical repellents, *Evodia suaveolens*, Natural repellents, *Zodia*.



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1. Introduction

The global COVID-19 pandemic that began in 2019 diverted public health attention and resources away from other pressing concerns, including mosquito-borne diseases like filariasis and Japanese encephalitis (Nitattattana et al., 2005; Blackburn et al., 2023). Filariasis is caused by *Wuchereria bancrofti*, *Wuchereria timori* and *Wuchereria malayi*.

Culex sp adult mosquitoes as disease vector and also cause discomfort around humans. Various efforts have been made to prevent the transmission of diseases carried by mosquitoes, including the use of mosquito nets and the use of chemical insecticides in the

larval and adult stages. Chemical insecticides application by use of chemical repellents on human skin. The repeated use of chemical repellents creates resistance in insects (Hamdan et al., 2005). With increasing concerns over the long-term safety and environmental impact of chemical insecticides, the search for effective natural repellents has gained importance. Natural repellents provide a safer alternative with fewer side effects, making them a valuable tool in disease prevention.

The use of chemicals on the skin can leave residues, irritate the skin and be harmful, so a natural repellent with minimal side effects is needed. Several studies have attempted to find effective alternative natural insecticides such as papaya (*Carica papaya*) and lenca (*Solanum nigrum*) seed extracts to kill *Culex* sp. and *Aedes* sp. larvae (Pramitaningrum & Sari, 2020). Zodia leaf (*Evodia suaveolens*) is an ornamental plant native to Papua which has been widely cultivated in various regions in Indonesia. Residents use the zodia plant as a mosquito repellent by rubbing it on the skin. This study aims to evaluate the effectiveness of Zodia (*Evodia suaveolens*) leaves as a natural alternative to chemical repellents in preventing *Culex* sp. bites, by testing different concentrations of Zodia extract in controlled laboratory condition.

2. Materials and Methods

2.1. Research design

This experimental study aimed to assess the effectiveness of Zodia (*Evodia suaveolens*) extract as a natural repellent against *Culex* sp. mosquitoes. The study was conducted at the Laboratory of Parasitology, University of Binawan, and used a randomized, controlled design to compare different concentrations of Zodia repellent with an untreated control group.

2.2. Zodia Leaf Extract

Approximately 1000 grams of fresh zodia leaves were collected from Bogor, subsequently dried, and extracted at the Bogor Spice and Medicinal Plants Center (Balitro). The leaves underwent soxhlet extraction at 47°C using hexane for 3 days according to previous method (Ahdiyah & Purwani, 2015). The extraction resulted in yield of 126.3 grams of Zodia extract.

2.3. Rearing larvae of *Culex* sp.

Culex sp. larvae were collected from stagnant waters around Cililitan and reared under controlled laboratory conditions. These larvae were kept at room temperature (approximately 25-28°C) and 70-80% humidity. The process of rearing them until they reach maturity took 7-8 days, during which time they were fed with a standard larval diet such as yeast or powdered dog food (Siwiendrayanti et al., 2021).

2.4. Natural repellents from zodia leaf extract

The Zodia-based repellent was formulated as a semi-lotion using Zodia extract, stearic acid, cetyl alcohol, triethanolamine (TEA), glycerol, and distilled water, following the method described by Rahayu & Naimah (2010). Three different concentrations of the repellent (1%, 2%, and 3%) were prepared by diluting the Zodia extract in the lotion base. All ingredients were mixed at a controlled temperature (e.g., 60°C) until a homogeneous mixture was achieved. The final volume of each formulation was adjusted to ensure consistent application during the experiments.

2.5. Zodia repellent application on *Culex* sp.

Prior to the application, participants thoroughly washed their hands to remove any contaminants. Zodia repellent was then applied to the wrists at a consistent dosage across all tests. The treated hands were placed into a cage containing 50 *Culex* sp. mosquitoes for a period of 2 minutes. During this time, the number of mosquitoes that perched on or bit the skin was recorded manually. A one-hour interval was maintained between applications of different repellent concentrations to prevent mosquitoes from becoming engorged. Each concentration (1%, 2%, and 3%) was tested in triplicate, and control trials were performed with untreated hands. The experiments were conducted during the active biting period of *Culex* sp. mosquitoes, from afternoon to evening (Nitapattana et al., 2005). Skin reactions to the repellent were also monitored for any signs of irritation.

3. Results and Discussion

3.1. Result

The descriptive results show the difference between hands smeared with Zodia repellent and controls exposed to *Culex* sp. The formula for calculating effectiveness is:

Effectiveness=(average of mosquitoes that perch or bite for 2 minutes÷50 *Culex sp*×100%)

In the control group, there was 18% of mosquitoes neither land nor bite. Conversely, at a 1% concentration of zodia repellent showed 76.4% effectiveness, at 2% zodia repellent showed 81.3% effectiveness and at a 3% zodia repellent showed 91.05% effectiveness.

Table 1. Results of application of zodia repellent on *Culex sp*.

Mosquito	Number of mosquitoes that land or bite in 2 minutes			
	Repellent 1 %	Repellent 2 %	Repellent 3 %	control
<i>Culex sp</i>	10	7	4	41
	10	8	4	
	9	8	3	



Figure 1. Zodia repellent (*Zodia suaveolens*) semi lotion with concentrations of 1%; 2% and 3% respectively.

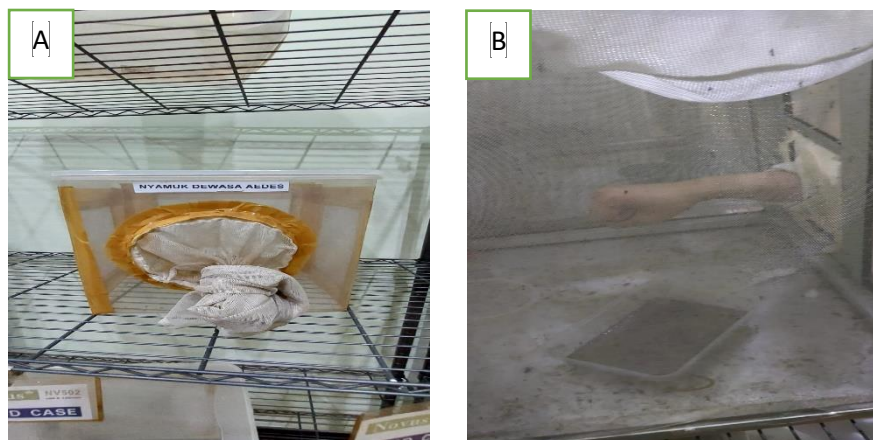


Figure 2. (A) Mosquito storage area (B) Application of Zodia repellent to *Culex sp* Mosquitoes.

3.2. Discussion

The efficacy of *Zodia* (*Evodia suaveolens*) as a natural mosquito repellent can be attributed to the presence of alkaloids, flavonoids, and tannins. Alkaloids, known for their bitter taste and toxicity, likely deter *Culex* sp. mosquitoes by disrupting their digestive processes, making the insects avoid contact. Flavonoids interfere with the respiratory system of mosquitoes, weakening their respiratory nerves, while tannins bind to proteins and other essential nutrients, further disrupting the insect's growth and metabolism (Fitriyatun & Putriningtyas, 2021; Won et al., 2021). These combined effects are likely responsible for the increased repellent effectiveness observed with higher concentrations of *Zodia* in this study. Previous studies have predominantly focused on the larvicidal potential of *Zodia* extract, particularly against *Aedes* sp., a known vector for Dengue Hemorrhagic Fever (DHF) (Amalia et al., 2022). However, the present study extends this application by exploring the repellent properties of *Zodia* against *Culex* sp., a vector for filariasis and Japanese encephalitis. While other natural extracts like mahogany seeds (Hidayati & Suprihatini, 2020) and pineapple skin (Juariah & Irawan, 2017) have shown efficacy against mosquito larvae, this study highlights *Zodia*'s potential as a repellent in its adult stage.

In this study, the repellent made in a semi lotion formula was considered more durable and did not dry out quickly compared to the liquid form. The addition of TEA and glycerol makes the formula moister on the skin. It is also adapted because its use is on human skin.

It is known that the average total cholesterol level in fresh serum samples is 190.71 mg/dL and the average 6-day delayed serum at 4°C is 188.06 mg/dL. Serum decreased after being delayed for 6 days at 4°C, this decrease was not too large, the average decrease was 1.05%.

There is a slight decrease in this serum sample because there are enzymes, one of which is the lipase enzyme. Lipase enzyme is a hydrolase enzyme that breaks the ester and lipid bonds formed between glycerol and long chain fatty acids. Lipase enzymes can only process fats that encounter the water surface. This lack of water in the serum severely limits the ability of the lipase enzyme to break down fat (Won et al., 2021) This is supported by a similar study by Amelda & Asrori (2020) which concluded that there was no significant difference in fresh serum and delayed serum and also experienced a decrease in levels that was not too large or significant (Amelda & Asrori, 2020) And this is

also supported by another study which explained that there was a decrease in samples in fresh serum and serum stored for 24 hours at a temperature of 2-8°C, at average of 3.06% (Afrilika, 2019).

4. Conclusions

The study demonstrates that Zodia (*Evodia suaveolens*) repellent, in concentrations of 1%, 2%, and 3%, is potentially effective as a natural repellent against *Culex* sp. mosquitoes. The findings show that the repellent's effectiveness increases with concentration, with the 3% formulation achieving the highest level of protection at 91.05%. This suggests that Zodia extract offers a promising, plant-based alternative to chemical insecticides, which may help reduce the risk of mosquito-borne diseases while minimizing adverse effects on human health and the environment.

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Author Contributions: Intan Kurniawati Pramitaningrum: Conceptualization, Formal analysis, Investigation, Resources, Writing -Original Draft, Writing -Editing, Software, Project administration, Funding acquisition
Waras Budiman: Validation, Supervision, Review
Muhammad Rizki Kurniawan: Methodology, Data Curation, Visualization.

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