



## Potensi Zodia (*Evodia suaveolens*) sebagai Insektisida Nabati terhadap *Aedes aegypti*

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### Abstrak

**Latar Belakang:** Upaya pengendalian yang sering dilakukan masyarakat adalah pengendalian kimiawi. Penggunaan insektisida kimiawi dapat berdampak negatif bagi manusia dan lingkungan serta menimbulkan resistensi terhadap nyamuk.

**Metode:** Penelitian ini merupakan penelitian deskriptif kuantitatif dengan pendekatan studi komparatif. Populasi dalam penelitian ini adalah seluruh jurnal dari empat kata kunci pencarian yaitu, larva *Aedes aegypti*, *Evodia suaveolens*, ekstrak daun zodia, dan insektisida nabati, dari artikel jurnal ilmiah terpublikasi yang diperoleh melalui ResearchGate dengan sampel sebanyak 10 jurnal penelitian yang difokuskan pada potensi penggunaan zodia (*Evodia suaveolens*) terhadap *Aedes aegypti*. Analisis data menggunakan reduksi data, display data, dan verifikasi.

**Hasil:** 70% artikel jurnal meneliti ekstrak daun zodia sebagai repelan, dengan penggunaan hewan uji berkisar antara 30-600 hewan uji. Pengadaan bahan uji 30% menggunakan metode distilasi dengan 40% pengadaan hewan uji merupakan hasil rearing. Senyawa kimia yang ditemukan dalam zodia yaitu, flavonoid, tanin, alkaloid, evodiamine, linalool,  $\alpha$ -pinene, dan terpenoid.

**Kesimpulan:** zodia berpotensi sebagai insektisida nabati, terutama sebagai repelan nyamuk *Ae. aegypti*.

### Abstract

**Background:** Control efforts that are often used by the community are chemical controls. The use of chemical insecticides can have a negative impact on humans and the environment and cause resistance to mosquitoes.

**Methods:** This research is a quantitative descriptive with a comparative study approach. The population in this study were all journals from four search keywords namely, *Aedes aegypti* larvae, *Evodia suaveolens*, zodia leaf extract, and plant-based insecticide from published research journal articles obtained through ResearchGate with a sample of 10 research journals focused on the potential of the use of zodia (*Evodia suaveolens*) against *Aedes aegypti*. Data analysis was used data reduction, data display, and verification.

**Results:** 70% of journal articles examined zodia leaf extract as a repellent, with the use of test animals ranging from 30-600 test animals. Procurement of 30% test material using the distillation method with 40% of the procurement of test animals is the result of rearing. The chemical compounds found in zodia are flavonoids, tannins, alkaloids, evodiamine, linalool,  $\alpha$ -pinene, and terpenoids.

**Conclusion:** zodia have the potential as a botanical insecticide, especially as a repellent for the *Ae. aegypti* mosquito.

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## Introduction

*Aedes aegypti* is a vector that carries the dengue virus, the cause of Dengue Hemorrhagic Fever (DHF), and has the potential to be a vector for several diseases such as filariasis, chikungunya, yellow fever, Japanese encephalitis, and Zika virus. *Ae. aegypti* is an active mosquito that bites in the morning until noon, and transmission of the disease is usually carried out by female mosquitoes. In contrast to female mosquitoes that suck blood to obtain protein intake, male mosquitoes obtain the energy needed from flower nectar and plants. *Ae. aegypti* on average can fly as far as 40 meters and a maximum of 100 meters, but sometimes can fly further away if the wind. The *Ae. aegypti* mosquito is well adapted to an urban environment and is a highly competitive vector due to its anthropophilic nature (Tuiskunen Bäck & Lundkvist, 2013). Humans are the primary host of the virus and can be infected through the bites of infected *Ae. aegypti*.

In Indonesia, dengue fever is still one of the health problems that exist with the number of sufferers increasing every year. According to WHO, Asia Pacific bore 75 percent of the burden of dengue in the world between 2004 and 2010, while Indonesia became the second country with the largest DHF cases among 30 endemic regions (Indrayani & Wahyudi, 2018). DHF cases in 2018 in Indonesia numbered 65,602 cases, with a total of 467 deaths. In Central Java Province, the DHF Incidence Rate (IR) in 2018 was 10.2 per 100,000 population, decreased compared to 2017 which was 21.68 per 100,000 population with the DHF Case Fatality Rate (CFR) in Central Java in 2018 of 1.05 percent, decreased when compared to the 2017 CFR which was 1.24 percent. This figure is still higher than the national target (<1%), but lower than the strategic plan target (<2%) (Dinkes Jateng, 2019).

It is extremely difficult to control *Ae. aegypti* because they adapt well to the environment with high resilience or with the ability to rapidly bounce back to initial numbers after disturbances resulting from natural phenomena or human interventions (CDC, 2011). As an effort to prevent mosquitoes from breeding, people are still accustomed to chemical control such as the

use of anti-mosquito spray, fuel or lotion, the use of abate powder, to do fogging. Although chemical insecticides are considered to be faster and more effective, but if used excessively they will have a negative impact on humans and the environment and cause resistance to mosquitoes. Therefore, insecticides that come from nature and do not damage the environment are needed. Plant-based insecticides have some benefits compared to chemical insecticides, such as rapid degradation or decomposition by sunlight, air, moisture, and other natural components thereby reducing the risk of soil and water contamination, and generally has low toxicity thereby safe for humans (Cahyati et al., 2017). The materials used in the manufacture of plant-based insecticides can be in the form of several parts of the plant, such as roots, leaves, stems, or tubers which are then processed in various ways. In killing insects, plant-based insecticides have three ways of working, namely by entering through the pores of the skin, digestive tract, or respiratory tract. At present, there have been many studies related to plants that have the potential as plant-based insecticides, one of which is the zodia plant.

Zodia plants (*Evodia suaveolens*) are native plants of Indonesia originating from Irian (Papua) including Hamadi, Sentani, Kertosari, Sabron, Nimbokrang, Maribu, etc. and are believed to be able to repel mosquitoes and insects. Papuans used to use it before entering the forest by rubbing zodia leaves on their skin so that the leaves would produce essential oils that are not favored by mosquitoes (Simaremare et al., 2017). Apart from being considered to have the potential as a plant-based insecticide, from an economic perspective zodia is also considered to be cheaper and easier to obtain so that it can be applied by the wider community. The potential of Zodia as a plant-based insecticide has been proven by several existing studies. Based on the results of zodia leaf extracts analyzed using FTIR (Fourier Transform Infra Red), it shows that there are phytochemical groups contained in zodia leaves, such as tannins, flavonoids, and alkaloids (Basundari et al., 2018). According to the results of research conducted by Kardinan (2003) at Balai Penelitian Tanaman Rempah dan Obat (Balitro) with gas chromatography,

oil distilled from the leaves of zodia plants contains linalool (46%) and  $\alpha$ -pinene (13.26%), so plants zodia can repel mosquitoes for 6 hours with power away (power protection) (Mirawati et al., 2018).

Those active ingredients contained in zodia plants are known to increase mortality in *Ae. aegypti* because it will block the sensory function in mosquitoes so that it disrupts the ability of mosquitoes to recognize attractant material from humans. Thus it will protect nearby humans from mosquito bites (Hasibuan et al., 2017). Tannin compounds have a bitter taste, and may interfere with insect digestion by binding to proteins in the digestive tracts that required by insects for growth, causing abnormal digestion (Cahyati et al., 2017). Flavonoids are chemical compounds that attack several vital nerve organs in insects work by causing wilt in the nerves and become an inhibitor for the breathing of mosquito larvae (Setya & Dewangga, 2017). While, Alkaloid substances are active compounds that are toxic and can cause antifeedant, stomach poisoning, and can interfere with the nervous system of *Ae. aegypti* larvae. Alkaloid makes this enzyme failed to transmit stimulus to the larval digestive tract (midgut), causing gut movement could not to be controlled. Simaremare et al. (2017) explain that linalool is a contact poison that increases sensory nerve activity in insects, can further cause motor nerve stimulation, causing spasms and paralysis in several types of insects. Evodiamine compounds are alkaloids that can inhibit the work of the nervous system and damage cell membranes and can cause the death of larvae.

There have been many studies on zodia leaf extracts as larvicides, insecticides, and repellants with various types of preparations and dosages, so researchers are interested in summarizing and making the results of these studies to be re-examined. A literature review is a survey of scholarly articles, books, and other sources relevant to a particular issue, area of research, or theory, and by so doing, providing a description, summary, and critical evaluation of these works (Ramdhani et al., 2014). One of the goals of conducting a literature study is to avoid unnecessary repetition of research by searching for research topics that have been

previously studied so that new research can be planned (Nurkamto, 2020). What distinguishes this study from previous research is no research has been found that summarizes the potential of zodia extract as a plant-based insecticide in killing *Ae. aegypti*, and whether zodia are more effective in using *Ae. aegypti* in the larval or adult stage to the correct dosage and dosage form in using zodia as a plant-based insecticide. So the goal of conduct a literature review is to find conclusions from previous research in order to facilitate further research that wants to apply it to the community. This study aims to analyze the potential of zodia (*Evodia suaveolens*) as a plant-based insecticide against *Ae. aegypti*.

## Method

This research is a quantitative descriptive with a comparative study approach. The population in this study were all journals from four search keywords namely, *Aedes aegypti* larvae, *Evodia suaveolens*, zodia leaf extract, and plant-based insecticide from published research journal articles obtained through ResearchGate with a sample of 10 research journals focused on the potential of the use of zodia (*Evodia suaveolens*) against *Aedes aegypti*. Journal articles sought were selected using inclusion criteria, namely: zodia leaf extract used for mosquitoes, zodia leaf extract as an insecticide, and secondary metabolite content in zodia leaf extract. As for the exclusion criteria, journals were published under 2010. Data analysis was used data reduction, data display, and verification.

## Results and Discussion

From the search results on ResearchGate by entering five keywords in the form of *Aedes aegypti*, *Evodia suaveolens*, zodia leaf extract, and plant-based insecticide, 41 journal articles were found which were then obtained 10 journal articles that could be used after entering the study inclusion criteria. The 10 articles are, 1) Pengaruh Kandungan Ekstrak Daun Zodia (*Evodia suaveolens*) Terhadap Mortalitas Larva Nyamuk *Aedes aegypti* by Basundari, 2018 from Bioma. 2) Formulation Study of Topical Lotion from Zodia Leaf Extract (*Evodia suaveolens*) Against *Aedes aegypti* by Sutaryono (2020) from Journal of Physics:

Conference Series. 3) Lotion Ekstrak Daun Zodia (*Evodia suaveolens*) sebagai Repellent Nyamuk *Aedes sp.* by Werdiningsih (2018) from Jurnal Vektor Penyakit. 4) Sabun Zodia sebagai Repellent terhadap Nyamuk *Aedes aegypti* by Simaremare (2017) from Pharmaceutical Journal of Indonesia. 5) Potensi Umbi Gadung (*Dioscorea hispida*) dan Daun Zodia (*Euodia suaveolens*) sebagai Insektisida Nabati by Priyanto (2017) from Media Litbangkes. 6) Efektivitas Repelan Losion Minyak Atsiri Daun Zodia (*Evodia suaveolens*) terhadap Nyamuk *Aedes aegypti* Linnaeus by Yanti Eff (2020) from Majalah Farmasetika. 7) Uji Potensi Minyak Atsiri Daun Zodia (*Evodia suaveolens* Scheff) sebagai Insektisida Nyamuk *Aedes aegypti* L. dengan Metode Elektrik by Lestari (2017) from PHARMACY: Jurnal Farmasi Indonesia. 8) Uji Efektivitas Repellent Sediaan Lotion Kombinasi Minyak Atsiri Daun Zodia (*Evodia suaveolens* Scheff) dan Minyak Atsiri Batang Serai (*Cymbopogon citratus*) terhadap Nyamuk *Aedes aegypti* L. by Mirawati (2018) from PHARMACY: Jurnal Farmasi Indonesia. 9) The Effectiveness of Fixative Addition on Zodia (*Evodia suaveolens* S.) and Rosemary (*Rosmarinus officinalis* L.) Gel against *Aedes aegypti* by Widawati (2013) from Health Science Indones. 10) *Evodia suaveolens*'s Repellent Action against *Aedes aegypti* from Entering a Room by Sulianti (2018) from IOP Conference Series: Materials Science and Engineering.

From 10 studies that were collected, 10% studied the effect of zodia leaf extract on the mortality of *Ae. aegypti* larvae (1 study), 70% studied zodia leaf extract as a repellent (7 studies), and 20% studied the potential of zodia leaf extract as a plant-based insecticide (2 studies).

The type of research used by these 10 studies was experimental research and the number of tested animals used in each study varied, ranging from 30-600 tested animals. This is in accordance with WHO provisions, which used of the sample was *Ae. aegypti* instar III as many as 25 individuals in each group. Larvae instar III-IV were chosen for use in testing because they are morphologically and physiologically more perfect than larvae instar I-II so they have a better defense system (Kuncoro, 2013). Meanwhile, in preparing

articles using bibliography, it is known that 26.667% used national journal articles (52 articles), 30.256% used international journal articles (59 articles), 18.462% used national books (36 books), 7.692% used international books (15 books), and 16.923% used other sources such as theses, final projects, websites, research reports, proceedings and, tabloids (33 other sources) with the publication year between 1950 and 2018. So it can be concluded that the highest percentage in literature utilization namely used international journal articles.

For procurement for test materials, 20% used the maceration method (2 studies), 10% used the fusion method (1 study), 40% used the distillation method (4 studies), 10% used *E. suaveolens* in pots (1 study), 10% used essential oils from zodia leaves into a lotion formulation (1 study), and 10% used Carbopol Ultrez 10<sup>®</sup> mixed by water and TEA (1 study). So, it can be concluded that the distillation method were more frequently used as methods for processing zodia leaves as preparations which is 40%. Distillation is the process of separating the components between two or more types of substances that have different characteristics in a mixture, meanwhile steam distillation is a method of isolating organic substances that are insoluble in water by flowing water vapor with the principle of reducing the boiling point of the mixture, and is generally used to separate a mixture of compounds that have a boiling point of 200°C or more (Asfiyah & Supaya, 2020). In Simaremare et al.'s (2017) research states that the zodia essential oil used in the study was obtained through a steam distillation process for approximately 8 hours. Meanwhile, Lestari & Simaremare (2017) explains that the steam distillation method is carried out because essential oils are volatile so that when they are exposed to hot steam, water will also be carried out and stored as zodia essential oil distillates. Zodia leaf oil and lemongrass stems in Mirawati et al.'s (2018) research were also obtained by steam distillation for 8 hours.

In procurement of animal use, 10% used *Ae. aegypti* larvae taken from the field (1 study), 40% used *Ae. aegypti* results from rearing (4 studies), 30% used *Ae. aegypti* taken from the campus forest (3 studies), 10% used *Ae. aegypti*

larvae and mosquitoes susceptible strain (1 study), and 10% did not use test animals (1 study). In Yanti Eff et al.'s (2020) study, *Ae. aegypti* strain Liverpool put in a plastic tray measuring 30x20x5 cm<sup>3</sup> which has been filled with clean water. After that, the newly hatched mosquitoes were given sugar water in a ratio of 1:10. For testing, researchers used female mosquitoes aged 3-5 days who were left starving (not fed sugar or blood). Whereas Widawati & Santi (2013) research used adult female mosquitoes aged 3-4 days who had been left starving. Mosquitoes were taken randomly from rearing cages measuring 50x35x40 cm, which was kept in a well-ventilated room with a temperature of 26-30°C and a humidity of 60-80%.

Mosquitoes are purposefully reared for both research and intervention. Research

can be conducted to determine the anatomy of mosquitoes, diseases transmitted by mosquitoes, or the spread of insecticide resistance to wild mosquitoes. Mosquito rearing can also aim at interventions such as releasing modified mosquitoes in the laboratory to control vector-borne diseases or controlling mosquito populations by releasing sterile male mosquitoes.

Mosquito rearing protocols are highly species-dependent and require a climate-controlled rearing room where temperature, relative humidity, and the light: dark cycle can be controlled (Parker, 2020). Balestrino et al. (2014) stated that larval rearing conducted at water temperatures of 25.5°C and 26.5°C resulted in a higher number of pupae produced probably due to the increased larval development time at these two temperatures.

Table 1. Procurement of test materials and test animals

No.	Researchers	Procurement of Test Materials	Procurement of Test Animals
1.	Basundari, 2018	Zodia leaf essential oil extraction was carried out by the maceration method, and the extract was thick green and in the form of a paste.	<i>Ae. aegypti</i> larvae instar III obtained from five villages in Tembalang District, namely Tandang, Tembalang, Sendangguwo, Sendangmulyo, and Meteseh villages
2.	Sutaryono, 2020	Zodia leaf lotion is formulated using the fusion method	Do not use test animals
3.	Werdiningsih, 2018	Zodia leaf extract is made using a distillation method, then mixed with a lotion consisting of beeswax, coconut oil, and olive oil which is made without additional ingredients	<i>Ae. aegypti</i> obtained from rearing results from ovitrap installation in Banguntapan District
4.	Simaremare, 2017	Zodia essential oil is obtained through a steam distillation process and then made in the form of solid soap	Mosquito collection was carried out by several volunteers in the campus forest at 09.00 - 11.00 WIT and 16.00 - 17.00 WIT
5.	Priyanto, 2017	Zodia leaf extract was made by the maceration method for five days using 70% ethanol solvent	For larvicide test: larvae instar II to III susceptible strain  For the test of repellency: <i>Ae. aegypti</i> mosquito aged 3-5 days with full sugar conditions, susceptible strain insectarium colony B2P2VRP Salatiga
6.	Yanti Eff, 2020	Mixing essential oils isolated from zodia leaves at a concentration of 1%, 1.5%, and 2% into a lotion formulation consisting of stearic acid, cetyl alcohol, liquid paraffin, dimethicone, yellow vaseline, triethanolamine, and citric acid	<i>Ae. aegypti</i> female mosquitoes were hatched from mosquito eggs taken from the Faculty of Veterinary Medicine, IPB

7.	Lestari, 2017	Zodia leaf essential oil is obtained from the steam distillation process and then processed by the electric method in the form of a mat	Mosquito collection was carried out by several volunteers in the campus forest at 09.00 - 11.00 WIT and 16.00 - 17.00 WIT
8.	Mirawati, 2018	Zodia leaf essential oil is made by steam distillation and then put on top of the lotion preparation	Mosquito collection was carried out by several volunteers wearing black clothes in the campus forest at 08.00 - 10.00 WIT and 14.00 - 16.00 WIT
9.	Widawati, 2013	The repellent gel from the essential oil of Zodia leaves with concentrations of 0.1%, 0.5%, 1%, 2%, 4% made by Carbopol Ultrez 10 <sup>®</sup> mixed with water and TEA	<i>Ae. aegypti</i> mosquitoes were obtained from rearing results in the insectarium research workshop P2B2 Ciamis Research and Development Workshop.
10	Sulianti, 2018	<i>E. suaveolens</i> plants aged 6-8 weeks planted in pots	<i>Ae. aegypti</i> adults aged 5-7 days were bred from larvae <i>Ae. aegypti</i> in Bandung

The mechanism of insecticides entering the body can be done in three ways, namely through the skin pores, digestive tract, and respiratory tract. Based on the research results, it can be concluded that the zodia leaf extract found 7 chemical compounds from various dosage forms, such as flavonoid (5.882% were found in 1 study), tannin (5.882% were found in 1 study), alkaloid (5.882% were found in 1 study), evodiamine (17.647% were found in 3 studies), linalool (23.529% were found in 4 studies),  $\alpha$ -pinene (17.647% were found in 3 studies), terpenoid (5.882% were found in 1 study), and 17.647% not mention chemical compounds zodia in their articles (in 3 studies). This is in line with research by Ngibad & Lestari (2020) which states that the results of phytochemical screening of zodia leaf extracts show that zodia leaves contain alkaloid, flavonoid, tannin, and saponin compounds. These compounds that cause zodia are potential as plant-based insecticides because they are toxic to insects.

Basundari et al. (2018) states that there are phytochemical compounds contained in zodia leaf extract after being analyzed using FTIR (Fourier Transform Infra Red), one of which is flavonoids. Flavonoid compounds are chemical compounds that have insecticidal properties and attack several nerve organs in several vital insect organs, causing weakening of nerves such as in the respiratory organs and can cause death. This is in line with Lumowa & Nova (2015) which states that flavonoids are respiratory toxins that work by entering the

insect's body through the respiratory system which then causes withering of the nerves so that the insects cannot breathe and eventually die. Gautam et al. (2013) stated that flavonoids can be used to develop environmentally friendly insecticides as an alternative to synthetic insecticides because flavonoids have larvicidal activity against mosquitoes.

In a study conducted by Basundari et al. (2018), it was stated that tannin compounds cannot be digested by the stomach and have a binding capacity with protein, carbohydrates, vitamins, and minerals so that they interfere with insects in digesting food. This is in line with research conducted by Yasi & Harsanti (2018) dan Kaihena et al. (2012) stated that the bitter taste of tannins can reduce the intensity of eating in insects, causing hunger and eventually death. It can be concluded that the higher the extract containing tannins, the more it causes insect mortality.

Basundari et al. (2018) states that alkaloids are active components that work on nerves and can cause digestive disorders and can act as toxins through the mouth of larvae. This is in line with the research of Adrianto et al. (2018) who explained that alkaloids have potential as stomach poisons because they can damage the digestive tract by damaging midgut and gastric caecum epithelial cells so that insects will die. Jemi et al. (2019) also explained that alkaloid compounds can inhibit insect growth, especially in the three main hormones, namely brain hormone, edikson hormone, and growth hormone (juvenile hormone) so that

insects will fail to metamorphose.

Evodiamine is included in the alkaloid group, especially quinazolines derivatives (Basundari et al., 2018). According to Priyanto (2017), the content of evodiamine in zodia has high potential as a plant-based insecticide. This is supported by research by Boesri et al. (2015) which stated that with the dominant active ingredient evodiamine, zodia leaves with a minimum concentration of 1.56% were able to kill 100% larvae. This is in line with research by Lestari & Rauf (2017) which states that *E. suaveolens* contains the active ingredient evodiamine so that the plant is insecticidal for aphids, borer, fly larvae, and mosquito larvae.

In the research of Sutaryono et al. (2020) stated that linalool is a contact poison that increases sensory activity in insects, and with greater concentrations can cause motor nerve stimulation which can cause seizures and paralysis in several types of insects. Whereas Werdiningsih (2018) explain that linalool is an alcohol terpenoid that is intended as pest control that can affect the nervous system of insects and is a type of respiratory poison. According to Lestari & Simaremare (2017) linalool works on the sensory nerves of insects and stimulates their motor nerves, causing mosquitoes to experience paralysis.

$\alpha$ -pinene is the most common terpenoid in nature. In plants,  $\alpha$ -pinene exhibits fungicidal activity and is used to produce flavors and fragrances, including its use as a natural insecticide (Cristina et al., 2012). This is in line with Russo & Marcu (2017) which states that  $\alpha$ -pinene shows larvicidal activity against *Anopheles subpictus*, *Ae. albopictus*, and *Culex tritaeniorhynchus*.

In research conducted by Yanti Eff et al. (2020), terpenoids are the main component in essential oils which are usually found in essential

fractions that are distilled by money and cause a distinctive fragrance, fragrance, or odor on zodia leaves. This is in line with (Kuntorini et al. (2020) which states that terpenoids cause a distinctive aroma in various plants.

The results showed that zodia, 10% said zodia leaf extract was very effective as a larvicide for *Ae. aegypti* mosquitoes (1 study), 80% said zodia plants (both still in the form of plants and those that have been processed into lotions or solid soaps) are very effective as repellants (8 studies), and 10% said zodia leaf essential oil in the form of mats has the potential to be a natural insecticide (1 study). So, both in the form of plants and those that have been processed into lotions or solid soaps, were more effective as repellants for *Ae. aegypti*. Priyanto (2017) states that zodia leaf extract is more potential as a repellant than as a larvicide. Aseptianova et al. (2017) stated that the zodia extract as an electric insecticide can kill mosquitoes within 30 minutes. Yanti Eff et al. (2019) also states that the compound content in zodia leaves functions as a mosquito repellent, so that the higher the repellant concentration, the better the tendency for protection against mosquito bites. This is supported by Kuncoro (2013) who states that zodia plants can be plant-based insecticides because they contain chemical compounds that function as mosquito repellents. So it can be concluded that zodia have the potential as a plant-based insecticide, especially as a repellant for the *Ae. aegypti* mosquito.

According to WHO (2005), an insecticide is considered effective if it can cause 10%-95% of the test mosquitoes to die in 24 hours. Meanwhile, in Lestari & Simaremare's (2017) research states that the essential oil of zodia leaves has the activity of killing *Ae. aegypti* 100% within 20-30 minutes.

Table 2. Zodia potential as a plant-based insecticide

No.	Researcher	Zodia Potential as a Plant-Based Insecticide
1.	Basundari, 2018	Zodia leaf extract is very effective in killing <i>Ae. aegypti</i> larvae at low concentrations (LC <sub>50</sub> : 34,67-58,25%)
2.	Sutaryono, 2020	At a concentration of 25%, zodia leaf extract has a strong repulsion against the <i>Ae. aegypti</i> mosquitoes
3.	Werdiningsih, 2018	There is an effect of using lotions from zodia leaf extract in various concentrations (with a concentration of 60% until the 6th hour, namely 16%)
4.	Simaremare, 2017	The addition of zodia essential oil concentration will increase the protective power as a repellent (addition of 1.5 ml of essential oil has 81% protection against <i>Ae. aegypti</i> mosquitoes)
5.	Priyanto, 2017	Zodia leaf extract has the potential as a larvicide and has greater potential as a repellent
6.	Yanti Eff, 2020	Zodia leaf essential oil lotion at a concentration of 1.5% and 2% has activity and was effective as a repellent for <i>Ae. aegypti Linnaeus</i>
7.	Lestari, 2017	Zodia leaf essential oil can be used as a natural insecticide in the form of mats with an electric method and has the activity of killing <i>Ae. aegypti</i> mosquitoes 100% within 20-30 minutes
8.	Mirawati, 2018	The best comparison for a combination lotion preparation of zodia leaf essential oil and lemongrass essential oil as a repellent for <i>Ae. aegypti</i> mosquitoes, namely 7: 3, with the highest effectiveness of repelling mosquitoes, namely at 0 hours with 100% deterrent power
9.	Widawati, 2013	The addition of rosemary and zodia gel fixatives was proven effective in increasing the repellent protection power against <i>Ae. aegypti</i> mosquitoes

## Conclusion

From the research results it can be concluded that zodia are potential as botanical insecticides because they contain 7 chemical compounds (flavonoids, tannins, alkaloids, evodiamine, linalool,  $\alpha$ -pinene, and terpenoids) that cause death in *Ae. aegypti*.

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