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Effect of Different Concentrations of *Lantana Camara* Linn. Leaf Juice on The Mortality of *Aedes Aegypti* Larvae

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ABSTRACT

Aedes aegypti is the primary vector of several arboviral diseases, including dengue, Zika, and chikungunya. The continuous use of synthetic insecticides has led to insecticide resistance and adverse environmental effects, creating a need for safer and environmentally friendly alternatives such as botanical larvicides. This study aimed to determine the effectiveness of *Lantana camara* Linn. leaf juice at concentrations of 11%, 13%, and 15% on the mortality of *Aedes aegypti* larvae. This study employed a true experimental design using a Completely Randomized Design (CRD). The samples consisted of 240 third-instar *Aedes aegypti* larvae divided into four groups: a control group (0%) and treatment groups containing 11%, 13%, and 15% concentrations of *Lantana camara* leaf juice, with three replications for each group. Larval mortality was observed after 24 hours of exposure, and data were analyzed using the Kruskal–Wallis test. The results showed that the average larval mortality rates at concentrations of 11%, 13%, and 15% were 80%, 90%, and 95%, respectively, while no mortality was observed in the control group. Statistical analysis revealed a significant difference among treatment concentrations ($p = 0.042$; $p < 0.05$). The 15% concentration was the most effective in causing larval mortality. Therefore, *Lantana camara* Linn. leaf juice has the potential to be developed as an environmentally friendly botanical larvicide for controlling *Aedes aegypti* populations.

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INTRODUCTION

Mosquitoes are recognized as the primary vectors of various human diseases that continue to impose a significant global health burden. It is estimated that approximately 700 million people, representing about 20% of the world's population, are at risk of mosquito-borne infections each year (1). *Aedes aegypti* is the principal vector of dengue, Zika, and chikungunya viruses worldwide (1,2,11,3–10). In addition, *Aedes aegypti* serves as a vector for zoonotic diseases such as Rift Valley fever (12). These viruses pose substantial threats to human health and have the potential to spread rapidly in densely populated areas. Consequently, they have become critical public health concerns in many tropical and subtropical regions around the world (13).

Aedes aegypti is widely distributed throughout its native range in Africa as well as in many subtropical regions of the Americas, Australia, and Asia (14). Indonesia, as a tropical country, provides suitable environmental conditions for mosquito breeding and survival. The high mosquito density in Indonesia has contributed to the transmission of numerous mosquito-borne diseases (15).

The control of these pathogens largely depends on reducing mosquito vector populations through the control of both larval and adult mosquito stages. Vector control, which includes the elimination of breeding habitats and the use of insecticides to maintain mosquito populations at acceptable levels, remains the most effective strategy for preventing these diseases (16–18). In this context, the application of insecticides to kill or repel mosquitoes constitutes the cornerstone of most mosquito control programs (19,20). However, the extensive use of insecticides in agriculture and public health has accelerated the development of insecticide resistance, thereby threatening the effectiveness of chemical-based vector control strategies (21–23).

In Indonesia, vector control strategies involve chemical, physical, and biological methods (24). Chemical control is still widely implemented through fogging and the use of Abate (25). Nevertheless, the continuous use of synthetic insecticides may cause adverse effects on the environment and non-target organisms, highlighting the need for safer and more environmentally friendly vector control alternatives. One plant with potential as a botanical larvicide is *Lantana camara* L., commonly known as wild sage or tembelekan. This shrub, native to tropical America, grows extensively in tropical and subtropical regions and is widely cultivated as an ornamental plant because of its colorful flowers (26,27). Besides its ornamental value, *L. camara* has long been used in traditional medicine to treat various ailments, including gastric disorders, wounds, coughs, rheumatism, infections, and asthma (28,29). Leaf extracts have been reported to exhibit stronger biological activity than flower extracts (30). The leaves contain several secondary metabolites, including flavonoids, tannins, saponins, and essential oils, which possess antioxidant, antibacterial, and larvicidal properties (31,32). Flavonoids act as neurotoxic and respiratory toxins in larvae (33), tannins inhibit larval feeding activity (31), saponins function as antifeedants that interfere with nutrient absorption (34), while essential oils can damage the nervous and respiratory systems of larvae, ultimately leading to death (35).

Previous studies have demonstrated that *L. camara* leaves are effective as larvicides against *Aedes aegypti*, achieving an 81% larval mortality rate at a concentration of 9%, indicating their potential as a botanical larvicide (31). Preliminary laboratory tests conducted over a 24-hour exposure period using *L. camara* leaf juice against *Aedes aegypti* larvae at concentrations of 5%, 7%, and 9% showed larvicidal activity. Larval mortality rates were 20% (4 larvae) at 5%, 40% (8 larvae) at 7%, and 50% (10 larvae) at 9%. These findings indicate that increasing the concentration of *L. camara* leaf juice tends to increase the mortality rate of *Aedes aegypti* larvae. Therefore, *L. camara* leaf juice has considerable potential for development as a botanical larvicide. Accordingly, this study aimed to evaluate the effectiveness of *Lantana camara* Linn. leaf juice at concentrations of 11%, 13%, and 15% as a botanical larvicide against the mortality of *Aedes aegypti* larvae.

RESEARCH METHODS

This study employed a true experimental design using a Completely Randomized Design (CRD). The study population consisted of naturally collected *Aedes aegypti* larvae, while third-instar *Aedes aegypti* larvae were selected as the study samples because of their relatively larger size and well-developed body organs (36). Each treatment and control group consisted of 20 larvae with three replications, resulting in a total sample size of 240 larvae.

The experimental groups consisted of a control group (0%) and treatment groups exposed to *Lantana camara* leaf juice at concentrations of 11%, 13%, and 15%. The selected concentrations were based on preliminary tests using concentrations of 5%, 7%, and 9%, which did not produce optimal larval mortality. The treatments were administered for 24 hours with three replications for each concentration.

Data analysis was performed by conducting a normality test using the Shapiro–Wilk test and a homogeneity test using Levene's test. Data were considered normally distributed and homogeneous when the p-value was greater than 0.05. Furthermore, differences in the effectiveness of the various concentrations of *Lantana camara* leaf juice on the mortality of *Aedes aegypti* larvae were analyzed using the Kruskal–Wallis test, as illustrated in Figure 1 (Study Design Diagram).

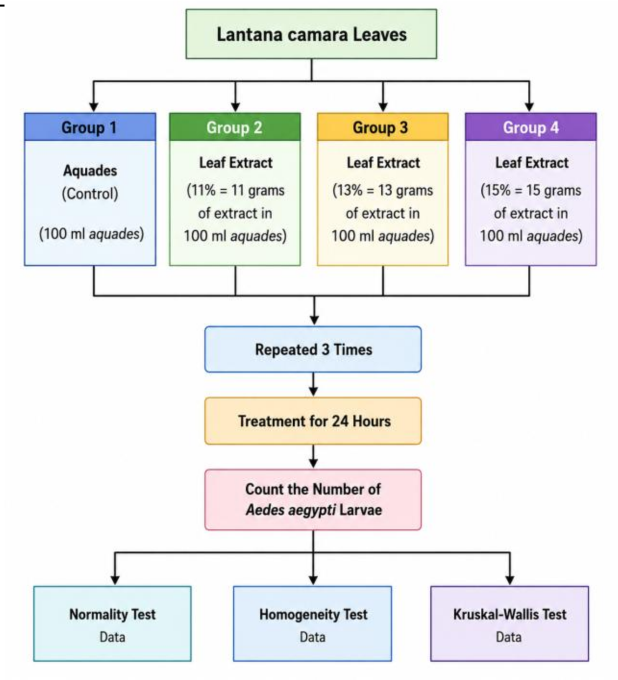

Figure 1. Research Design Diagram.

The research procedure consisted of the preparation of *Lantana camara* leaf juice, the preparation of different treatment concentrations, the exposure of *Aedes aegypti* larvae to the treatments, and the observation of larval mortality after 24 hours. The research procedure is illustrated in Figure 2 below.

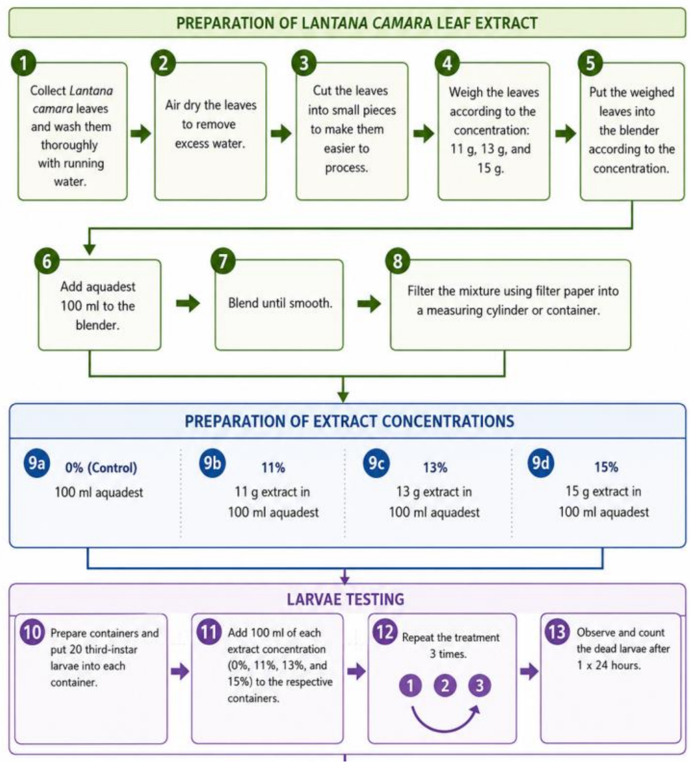

Figure 2. Work Procedure

Figure 2 illustrates the research procedure, which began with the preparation of *Lantana camara* leaf juice, including washing, drying, cutting, weighing, grinding, and filtering the leaves to obtain the extract. The extract was then prepared at different concentrations, namely 0% (control), 11%, 13%, and 15%, and subsequently tested against third-instar *Aedes aegypti* larvae with three replications over a 24-hour period. Observations were conducted to determine the number of larval deaths in each treatment group, thereby enabling the evaluation of the effectiveness of *Lantana camara* leaf juice as a botanical larvicide.

RESULTS AND DISCUSSION

The results of the observations on the mortality of *Aedes aegypti* larvae after exposure to *Lantana camara* Linn. leaf juice at different concentrations for 24 hours are presented in Table 1.

Table 1. Mortality of Mosquito Larvae at Different Extract Concentrations

Extract Concentration (%)	Number of Test Larvae	Number of Mosquito Larvae Deaths in Each Replication (n, %)			Mean Larval Mortality (n, %)
		P1	P2	P3	
0%	20	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
11%	20	14 (70.0)	17 (85.0)	16 (80.0)	16 (80.0)
13%	20	17 (85.0)	18 (90.0)	18 (90.0)	18 (90.0)
15%	20	18 (90.0)	19 (95.0)	20 (100.0)	19 (95.0)

Notes: P1 = First Replication
P2 = Second Replication
P3 = Third Replication

Based on Table 1, *Lantana camara* Linn. leaf juice at concentrations of 11%, 13%, and 15% exhibited larvicidal activity against *Aedes aegypti* larvae. The most effective concentration was 15%, with an average larval mortality of 19 larvae (95%). The lowest effectiveness was observed at the 11% concentration, with an average mortality of 16 larvae (80%), while the 13% concentration resulted in an average mortality of 18 larvae (90%).

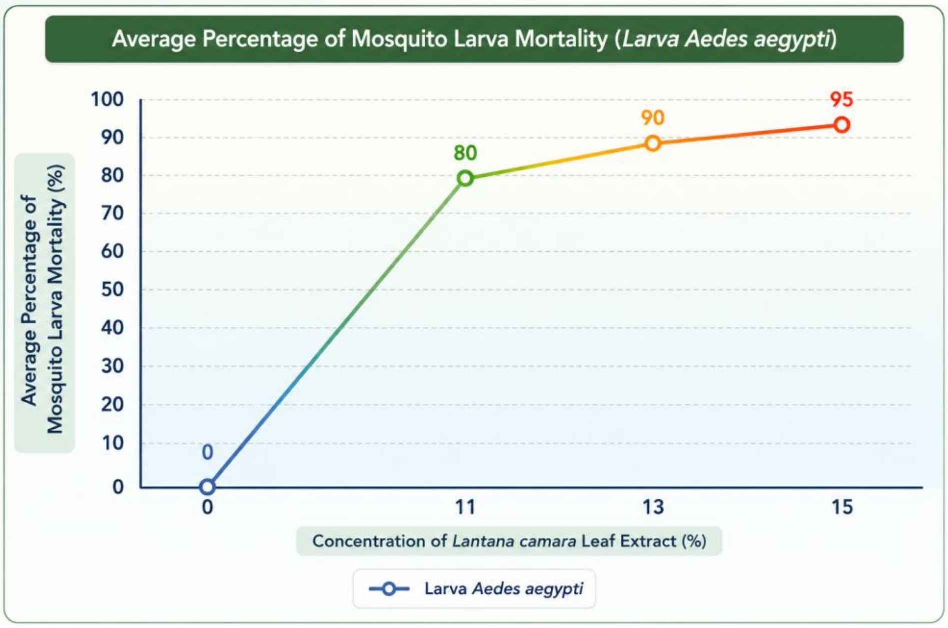

Figure 3. Mortality graph of Aedes aegypti larvae

Figure 3 shows that the mortality of *Aedes aegypti* larvae increased with increasing concentrations of *Lantana camara* leaf juice. In other words, the higher the concentration, the greater the number of *Aedes aegypti* larvae that died. Higher extract concentrations and longer exposure periods result in higher larval mortality rates (37). High extract concentrations can cause morphological damage and inhibit larval development to the pupal stage in mosquito species (30).

Table 2. Kruskal–Wallis Test Results on the Effect of *Lantana camara* Linn Leaf Extract Concentrations on *Aedes aegypti* Larval Mortality

Variable	Statistical Test	p-value	Interpretation
Concentrations of 11%, 13%, and 15% of *Lantana camara* Linn leaf extract on *Aedes aegypti* larval mortality	Kruskal–Wallis	0.042	Significant differences among concentrations ($p < 0.05$)

The results of the statistical analysis using the Kruskal–Wallis test showed a p-value of 0.042 ($p < 0.05$), indicating significant differences among the concentrations of *Lantana camara* Linn. leaf juice in causing the mortality of *Aedes aegypti* larvae. This finding suggests that increasing the concentration of *Lantana camara* leaf juice leads to higher mortality rates of *Aedes aegypti* larvae.

In the control group (0%), no mortality of *Aedes aegypti* larvae was observed after 24 hours of exposure. This was because the control group contained only distilled water, which does not contain toxic chemical substances capable of causing larval mortality. These results indicate that larval mortality was not influenced by environmental factors (38). The findings of this study, with a 24-hour exposure period, are consistent with previous studies reporting that *Lantana camara* leaf extract exhibits significant larvicidal activity against *Anopheles* larvae, as demonstrated by high larval mortality after 24 hours of exposure (39).

Lantana camara is listed among the world's ten most invasive and toxic plant species (40). A larvicide is considered effective if it causes larval mortality within the range of 10–95%; therefore, the results of this study fall within the effective category (41). The effectiveness of *L. camara* is attributed to its active compounds, including flavonoids, tannins, saponins, and essential oils. Flavonoids act as respiratory toxins that interfere with the larval respiratory system, whereas tannins and saponins inhibit digestive processes and damage cell membranes (33,42). Plant secondary metabolites possess complex mechanisms of action and can induce larval mortality through multiple pathways, thereby enhancing their effectiveness as botanical larvicides (43).

CONCLUSION

Lantana camara Linn. leaf juice at concentrations of 11%, 13%, and 15% was effective as a botanical larvicide against *Aedes aegypti* larvae, with average larval mortality rates of 80%, 90%, and 95%, respectively. These findings indicate that higher extract concentrations and longer exposure periods result in increased larval mortality. Statistical analysis showed significant differences in the effectiveness of the various concentrations of *Lantana camara* leaf juice on *Aedes aegypti* larval mortality, as indicated by a p-value of 0.042 ($p < 0.05$).

SUGGESTION

Further studies are recommended to identify the bioactive compounds responsible for the larvicidal activity of *Lantana camara* leaf extract. Toxicity assessments on non-target organisms and environmental safety evaluations should also be conducted to ensure its safe application as a botanical larvicide. In addition, field studies are needed to evaluate the effectiveness of the extract under natural environmental conditions

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