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Lansium domesticum: A natural dual-action defense against dengue mosquitoes

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Abstract: Preventing dengue virus transmission, which leads to Dengue Hemorrhagic Fever (DHF), can be effectively achieved using plant-based insecticides. This study investigates the potential of *Lansium domesticum* extract as both a repellent and a larvicide against *Aedes aegypti*, the primary vector of dengue fever. Five concentrations of *Lansium domesticum* extract (10%, 20%, 30%, 40%, and 50%) were tested for their repellent properties, while larvicidal efficacy was evaluated at concentrations of 20%, 40%, 60%, 80%, and 100%. The evaluation of larval mortality obtained an average larval mortality of 5%-20%, then a statistical analysis was carried out using the Anova test. Furthermore, probit analysis was carried out to determine the LC50. Results showed that all concentrations had a repellency rate greater than 50%. The larvicidal tests indicated that the 100% concentration was the most effective in killing larvae. These findings highlight *Lansium domesticum* as an effective natural repellent and larvicide against *Aedes aegypti*, offering a promising plant-based solution for dengue fever prevention.

Keywords: *Lansium domesticum*; reppelant; larvicidal

INTRODUCTION

Dengue hemorrhagic fever (DHF) is caused by the dengue virus, transmitted by the anthropophilic Aedes mosquito. These mosquitoes often live close to humans and are commonly found indoors. Asia ranks first globally in dengue cases, with a significant number of sufferers each year.[1] Current vector control methods primarily involve chemical means, such as fogging, which has been reported to be less effective in killing targets and increasing vector resistance to insecticides. [2,3,4,5]

The eradication of dengue vector mosquito larvae has traditionally involved using Temephos. However, Temephos usage raises significant environmental pollution concerns. Similarly, the widespread use of DEET (N, N-Diethyl-meta-toluamide) as an insect repellent presents several issues, including skin toxicity and potential impacts on the central nervous system if not used properly.[6] The chemicals used in synthesizing repellents often contain halogenated hydrocarbons, which have a long half-life and are known for their toxic properties.[7,8] These insecticides also leave toxic residues in food, water, air, and soil, leading to the resurgence and resistance of insect pests and negatively affecting non-target organisms. Over 645 species of insects and mites have developed resistance to insecticides, with 542 species of arthropods resistant to at least one compound. Approximately 7,470 cases of resistance have been reported in insects against specific insecticides, with 16 arthropod species accounting for 43% of these cases.[9]

Dengue virus transmission can be prevented using plant-derived insecticides, which can target adult mosquitoes, larvae, and serve as protection against mosquito bites (repellents). Larvicides are substances designed to kill larvae, while repellents work locally or at a distance to prevent mosquitoes from flying, landing, or biting the skin of humans and animals. Using repellents can significantly reduce exposure to mosquito bites that may carry the dengue virus.[10]

Considering the negative effects of chemical larvicides and synthetic repellents, it is essential to study and find natural alternatives. The *Lansium domesticum* shows potential as a natural insecticide.[11] This is based on empirical evidence that rural communities in Southeast Sulawesi have long used langsat skin to repel mosquitoes. Studies have also reported that langsat skin can be used as an electric mosquito repellent.[12,13] *Lansium domesticum,* commonly referred to as langsat, is a medicinal plant extensively cultivated in Southeast Asia.[14] Capable of reaching heights of up to 30 meters, this plant has yielded several bioactive compounds,[11,15,16,17,18] some of which exhibit potential as antimalarial,[19] antibacterial,[20] antifeedant,[14] antimutagenic,[21] and insecticidal agents.[22] Previous research has identified alkaloids, flavonoids, saponins, triterpenoids, and tannins in the bark of *Lansium domesticum* stems, demonstrating larvicidal properties. In addition, studies conducted in Indonesia have shown the potential of plants that contain several bioactive compounds such as flavanoids, saponins, alkaloids found in *Citrus lemon* and *Pogostemon cablin* that show larvicidal and repellent activity.[23,24] Given the variability in secondary metabolite levels among different langsat plant varieties, it is imperative to investigate the specific variety found in Southeast Sulawesi. The analysis of secondary metabolites will provide valuable insights into its efficacy as a repellent and larvicide, offering a natural and sustainable alternative to chemical insecticides.

MATERIAL AND METHOD

This study is experimental study with post-test only control group design. The research procedure starts with collecting samples of the bark and stems of *Lansium domesticum* from Konawe Regency, Southeast Sulawesi. The bark and stems are then washed, dried, and ground into powder, followed by phytochemical screening preparations.

The bark and steams of *Lansium domesticum* are washed with running water, drained, and chopped. Samples are dried in the open air, protected from sun exposure. The dried samples are then ground into a powder and placed in a beaker with ethanol solvent at a 1:4 ratio. The samples are soaked for 5 days, occasionally stirred for homogenization. The liquid extract is filtered using filter paper, and the filtrate is collected. The sample is then macerated for 2 days with fresh ethanol solvent. The macerated sample is filtered, and the filtrate is combined with the previously collected filtrate. The combined filtrate is concentrated using a rotary vacuum evaporator to remove the solvent. This procedure is also used for the bark extraction of *Lansium domesticum*.

Procedure for Making Repellent Lotion

The lotion uses *Lansium domesticum* peel extract and involves weighing all ingredients and preparing a mortar. Ingredients include cetyl alcohol, stearic acid, methyl paraben, Adeps lanae TEA, glycerin, olive oil, and aquadest. The water phase (methyl paraben, warm water, TEA, glycerin) and oil phase (stearic acid, cetyl alcohol, lanolin, propyl paraben, patchouli extract) are heated separately at 70°C until homogeneous, then combined and stirred to form a lotion. Lotions are made at concentrations of 10%, 20%, 30%, 40%, and 50%.

Repellent Testing Against *Aedes aegypti*

The method using Arm-in-Cage Test. This method is commonly used to evaluate the effectiveness of mosquito repellents. In this procedure, a human volunteer (probandus) places an arm treated with repellent and an untreated arm into a container with mosquitoes to observe and compare the number of landings or bites on each arm. The process of testing *repellant* against *Aedes aegypti* follows: (1) Mosquitoes are included in the test container. Each container put 25 female mosquitoes; (2) *Repellent* lotion preparation is applied to the left arm and the right hand is not smeared. This presentation was carried out for 5 minutes; (3) Furthermore, the number of mosquitoes that landed during the exposure was calculated, both on the test arm and the control arm; (4) The test is carried out for 6 series, where each test series is carried out for 35 minutes and exposure is 5 minutes.[26] During the *repellent*, probandus was unable to wipe or wash hands. The protection or repulsion power can be known how the level of effectiveness after calculated based on the formula of Schreck et al, namely: % (repellency) = $[(Ta - Tb)/Ta] \times 100$, where, Ta is the number of mosquitoes in the control and Tb is the number of mosquitoes on the test treatment.[27]

Larvicide Test

The larvicidal test uses *Lansium domesticum* stem extract. Twenty-five *A. aegypti* instar III larvae are placed in a test bottle containing the extract, Temephos (positive control), or aquadest (negative control). Larvicidal activity is observed for 24 hours. The mortality rate of the test larvae due to the larvicidal extract is recorded.

Data Analysis

The average larval mortality rate is statistically analyzed using ANOVA. Probit analysis is then conducted to determine the LC50 value.[16]

RESULTS AND DISCUSSION

The results of phytochemical screening of Lansium domesticum peel and stem compound can be seen in table 1.

Table 1. Test results of secondary metabolites content of Lansium domesticum

No	Parameters	Lansium domesticum peel	Lansium domesticum stem	Standar indicator
1	Alkaloid	+	-	An orange or red precipitate or a white precipitate is formed
2	Flavonoid	-	+	Changes color from green to orange or yellow
3	Saponin	-	+	Stable foam is formed
4	Triterpenoid	+	+	Formed red or there is a brownish ring
5	Steroid	-	-	A blue-green color is formed
6	Tannin	+	-	Blackish brown and precipitate formed
7	Fenol	+	-	Changing green to black

Note:
(+) = Positive contains compound
(-) = Negative contains compound

The results of the phytochemical screening of *Lansium domesticum* show that the bark extract of *Lansium domesticum* contains Alkaloids, Triterpenoids, Tannins and Phenols. While the stem extract of *Lansium domesticum* contains flavonoids, saponins, and triterpenoids. The results of phytochemical screening were carried out to determine the chemical components of *Lansium domesticum* which were identified qualitatively.

The composition of the lotion based on Lansium domesticum peel extract and the results of the physical stability test can be seen in table 2 and table 3.

Table 2. Composition lotion of *Lansium domesticum*

No	ingredient	Function	concentration				
			10 %	20%)	30%	40%	50%
1	Extract of Lansium domesticum	Active substance	10 %	20 %	30 %	40 %	50%
2	Cetyl alkohol	moisturizer	3 %	3 %	3 %	3 %	3 %
3	Asam stearat	emulsifier	10 %	10 %	10%	10%	10%
4	Metyl parabean	Preservative	0,15%	0,15%	0,15%	0,15 %	0,15 %
5	Adeps lanae	Addition substance	2 %	2 %	2%	2%	2%
6	TEA	Humektan	2 %	2%	2%	2%	2%
7	Gliserin	Humektan	10 %	10%	10%	10%	10%
8	Olive oil	solvent	10 %	10%	10%	10%	10%
9	Aquadest	solvent	100 %	100%	100%	100%	100%

Table 2 shows the chemical composition for each concentration of Lansium domesticum skin is the same, namely Cetyl alcohol 3%, stearic acid 10%, Methyl parabean 0.15%, adeps lanae 2%, TEA 2%, glycerin 10%, Olive oil 10% and aquadest 100%.

Table 3. Results of homogenity test and organoleptic lotion *Lansium domesticum*

Concentration reppelant	Homogenity test	Organoleptis test
10 %	Viscous form, light brown color and aromatic characteristic odor	Homogeneous, without air bubbles
20 %	Homogeneous, without air bubbles	Homogeneous, without air bubbles
30 %	Homogeneous, without air bubbles	Homogeneous, without air bubbles
40 %	Homogeneous, without air bubbles	Homogeneous, without air bubbles
50 %	Homogeneous, without air bubbles	Homogeneous, without air bubbles

Table 3 shows that all concentrations of Lansium domesticum skin reppelant lotion showed the results of the homogeneity test which were thick, light brown in color and characteristically aromatic. The organoleptic test results showed a homogeneous lotion consistency and no air bubbles.

Table 2. Test of Reppelant Lotion *Lansium domesticum* against *Aedes aegypti*

Note: C (+) = control positive
C (-) = control negative

No	Formulation concentration of Lansium domesticum	Total of masquitoes	Protective power (%)						
			0	1	2	3	4	5	6
1	10 %	25	91%	89%	90 %	89%	88%	87%	85%
2	20 %	25	92%	91%	90%	90%	87%	85%	85%
3	30 %	25	92%	89%	88%	89%	88%	87%	85%
4	40 %	25	92%	91%	88%	87%	87%	85%	85%
5	50 %	25	92%	89%	85%	82%	79%	76%	75%
6	C(+)	25	100%	100%	100%	98%	95%	94%	94%
7	C(-)	25	0	0	0	0	0	0	0

Table 3 shows that the protective power of Lansium domesticum peel extract for all concentrations is quite effective because it has a repulsion power above 50%. The effectiveness of langsat fruit peel extract in producing a repulsion of more than 50% against Aedes aegypti is due to the active substance content of the langsat fruit peel. Research has shown that the higher the concentration of *repellent*, the higher the repellency of mosquitoes.[24] Furthermore, in another study, it was also stated that plants that had the highest repellent potential wereplants from the family *Asteraceae, Cladophoraceae, Labiatae, Meliaceae, Oocystaceae,* and *Rutaceae.*[28] plant *Lansium domesticum* from the Meliaceae family. The main volatile oil components of plants with *repellent* are *monoterpenoids* such as *geraniol, citronellol, linalool, terpineol*, *thymol, q-cymene, -bulnesene, patchouli alcohol, -pinene, -patchoulene*and *carvone.*[26,29,30,31]

From the Reppelency test, it can be seen that in the first hour the percentage of repulsion increases and then continues to decrease until the 6th hour. sixth. This is in accordance with the research of Pebrianti, et al.[32]

Larvicide test of Lansium domesticum on the mortality of Aedes aegypti

The results of the larvacide test of Lansium domesticum stem extract can be seen in Figure 1 below.

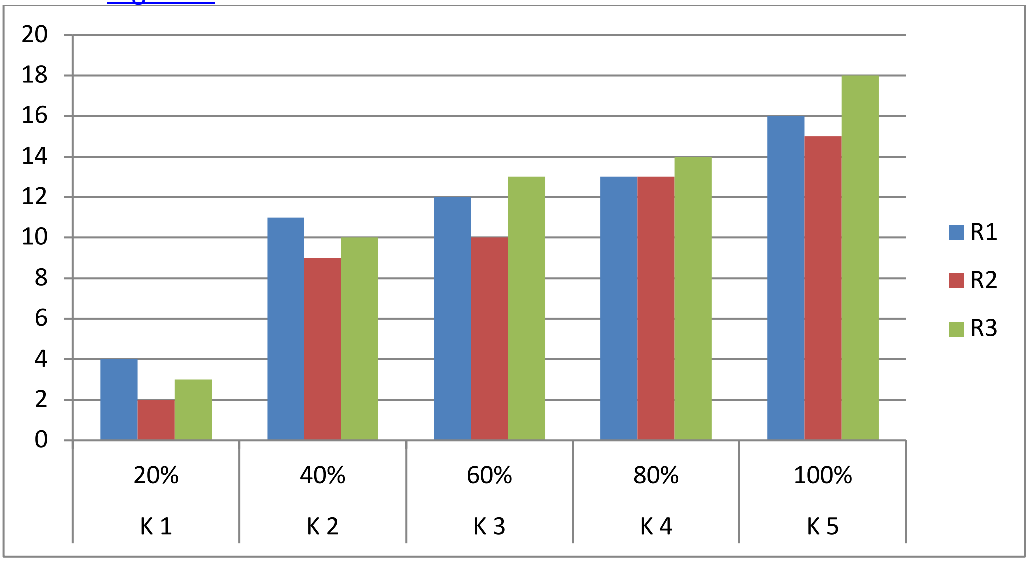

Figure 1. Larvicide test results of langsat bark on Aedes aegypti mortality

These results indicate that the highest percentage of *Aedes aegypti* was found in Lansium domesticum stem extract with a concentration of 100%, while the smallest larval mortality percentage was found in langsat stem extract at 20%.

Analysis of ANOVA test and Probit test

Data analysis to determine mortality mortality of Aedes aegypti larvae is using ANOVA test, which can be seen in table 4 below.

Table 4. Results of statistical tests using the Anova

	Sum of Squares	df	Mean Square	F	Sig
Between Groups	900,952	6	150,159	150,159	,000
Within Groups	14,000	14	1,000		
Total	914,952	20			

The table of Anova test results shows the calculated F value of 150,159 which is greater than the good F table at the 1% significance level of 2.85 and at the 5% significance level of 4.46. This means that there is a difference in the average mortality of mosquito larvae at each concentration of langsat skin infusion. The significance value shows 0.000 is smaller than 0.05 which means that each concentration of langsat skin infusion has an effect on the mortality of *Aedes aegypti*.

In the study, the 50% Probit analysis test was carried out which can be seen in the following table.

Table 5. Probit analysis of larvicidal power (LC 50)

Larvicidal Power (LC)	24-hour time (%)	Range limit	
		Below	Upper
LC50	47.571	10,001	85.286

Based on the table above, it shows that the LC50 value is 47.51, which means that the concentration required for the death of Aedes aegypti larvae by 50% is 47.571%. The bark of langsat used in this study is the bark of old langsat which is still fresh, characterized by the bark of the stem being greenish brown or grayish, cracked and white. Observations of larval mortality showed that the percentage of larval mortality always increased with the high concentration used, this is in line with the theory that the higher the concentration of a larvicide, the higher the number of larval deaths, and the longer the exposure time, the higher the mortality of larvae. Alkaloids, terpenoids and flavonoids are plant defense compounds that can inhibit the eating process of insects and are also tox.

Flavonoids and saponins themselves function as respiratory tract inhibitors. Flavonoids function as respiratory inhibitors, where flavonoids function to disrupt energy metabolism in the mitochondria by inhibiting the electron transport system so that obstacles in the electron transport system will block ATP production and cause a decrease in oxygen use by mitochondria and cause larvae to have difficulty breathing. [33]

Triterphenoid compounds are one of the secondary metabolites that are found in large quantities and various molecular frameworks. Terpenoids are plant components that have an odor and can be isolated from plants by distillation called essential oils.[34] This compound is a repellent (Reppelant) because it has an odor that insects do not like. These compounds will enter through the respiratory tract through the food eaten by insects and these substances are absorbed by the digestive tract.

The difference in the mortality of mosquito larvae at each concentration is due to the difference in the sensitivity of each larva to the concentration of langsat bark, where the higher the concentration used, the higher the level of viscosity and concentration of the langsat stem extract, so that the movement space of the larvae is not as limited as that of the larvae. being in the natural environment or in the outside environment, causing the larvae to have difficulty breathing and taking air on the surface of the water which results in insufficient oxygen for the larvae to grow, causing the death of the larvae.[35] The results of the probit analysis showed results that were in line with Handito's [36] study which reported that the greater the concentration, the greater the toxicity of a solution to Aedes larvae, so that the number of mosquito larvae mortality also increased. This happens because the more toxic compounds that enter the larva’s digestive tract, they will bind to the receptors on the digestive cell membrane, cause damage to the cell membrane that leads mortality of larvae.

CONCLUSION

Lansium domesticum from the Meliaceae family that has the potential as a repellant and larvacide against *Aedes aegypti → perbaiki lagi, tambhkan implikasi dari hasil penelitian ini apa.*

AUTHORS’ CONTRIBUTIONS

Reni Yunus: Corresponding authors, prepared the samples, designed the protocols, executed the protocols, wrote the manuscript, submit and revision and review the manuscript. Anita Rosanty: collection. data analytic and visualization statistically. All authors have read and approved the final manuscript

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DATA AVAILABILITY STATEMENT

The utilized data to contribute in this research are available from the corresponding author on reasonable request.

DISCLOSURE STATEMENT

The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of any affiliated agency of the authors. The data is the result of the author's research and has never been published in other journals.

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