Banua: Jurnal Kesehatan Lingkungan
e-ISSN 2797-8184 | p-ISSN 2797-8176
Volume 5 Issue 2, 2025, page 135-141
DOI: 10.33860/bjkl.v5i2.4283
Website:http://jurnal.poltekkespalu.ac.id/index.php/bjkl/
Publisher: Poltekkes Kemenkes Palu

Original Article

Protective Efficacy of Langsat (Lansium domesticum) Peel Extract Lotion Against Aedes Mosquito Bites

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ARTICLE INFO

Article History:
Received: 2025-10-28
Accepted: 2025-11-23
Published: 2025-11-30

Keywords:

Lansium domesticum; protective power; natural repellent; aedes sp mosquitoes

ABSTRACT

Background: Aedes mosquitoes are the primary vectors of dengue fever (DF), which remains a significant public health issue in Indonesia. The continuous use of chemical repellents may pose risks to human health and the environment, creating a need for effective and safer natural alternatives. Langsat peel (Lansium domesticum) contains bioactive compounds with potential repellent properties. This study aimed to evaluate the protective efficacy of langsat peel extract against Aedes sp. mosquitoes.
Method: This experimental study employed a post-test only with a control group design. Langsat peel extract was formulated into lotion preparations at concentrations of 15%, 20%, 25%, and 30%, with five replications each. Repellent efficacy was assessed using a mosquito landing test for 6 hours, with mosquito landings recorded every five minutes. Protective power was calculated using a standard formula. According to the Indonesian Pesticide Commission, a repellent is considered effective if it provides ≥90% protection for up to six hours.
Result: Protective power increased with concentration: 84% at 15% (ineffective), 95% at 20%, and 100% at both 25% and 30%, meeting the effectiveness criteria established by the Pesticide Commission.
Conclusion: Langsat peel extract at concentrations ≥20% is effective as a natural repellent against Aedes sp. mosquitoes and has strong potential for development as an environmentally friendly repellent.

INTRODUCTION

Dengue Fever (DF) or Dengue Hemorrhagic Fever (DHF) remains a serious threat in tropical countries, as it can become an epidemic infectious disease among humans caused by the rapid spread of the virus by Aedes aegypti mosquitoes (Kausar, 2025).

Based on data from the World Health Organization, dengue fever cases have reached more than five million, with over 5,000 deaths in more than 80 countries. In Indonesia, dengue fever remains a serious public health problem, especially in tropical regions such as Central Sulawesi. Data from the Palu City Health Office shows that dengue cases increased from 305 cases in 2021 to 640 cases in 2022, then decreased to 315 cases in 2023, and 441 cases in 2024 (Dinas Kesehatan Provinsi Sulawesi Tengah, 2024)

The most commonly used mosquito control method among the public is fogging with chemical insecticides such as malathion. Although this method provides quick results, continuous use of insecticides can lead to mosquito resistance and have negative impacts on human health

and the environment (Hemingway & Ranson, 2000; World Health Organization, 2020). Therefore, natural alternatives that are safe, effective, and environmentally friendly are needed to replace the role of synthetic chemicals in the long term.

One of the natural ingredients with potential as a repellent is the skin of the langsat fruit (Lansium domesticum). Research by Hiola et al (2018) shows that lotion containing langsat peel extract at a concentration of 25% is able to provide up to 100% protection against Aedes aegypti mosquitoes for two hours of observation. In addition, Greenberg et al (2019)found that langsat peel extract is also effective when used in the form of an electric repellent, while in Malaysia, dried langsat peel is traditionally burned to repel mosquitoes (Abdallah, Mohamed, & Ibrahim, 2022). This indicates that langsat peel contains bioactive compounds such as flavonoids, saponins, and terpenoids, which act as natural mosquito repellents (Lubis, Hasibuan, Syahputra, & Astyka, 2022).

Various studies have proven that langsat fruit peel has great potential to be developed as an economic and environmentally friendly natural repellent base material. However, most previous studies have only tested a few extract concentration variations. Therefore, this study was conducted to determine the effectiveness of langsat peel extract in lotion form against Aedes spp. mosquitoes at various concentrations, so that the most effective concentration level as a natural repellent can be determined.

METHODS

This research is a quantitative experimental study with a post-test only with control group design. The study was conducted at the Entomology Laboratory of the Environmental Health Department, Poltekkes Kemenkes Palu. The test subjects were 3–5-day-old female Aedes sp. mosquitoes obtained from eggs hatched in the laboratory, ensuring they were virus-free and not collected directly from the field. Each test cage contained 25 mosquitoes with five repetitions. Langsat peel extract was obtained through maceration using 96% ethanol as a solvent, then formulated into a lotion with concentration variations of 15%, 20%, 25%, and 30%. Effectiveness testing was carried out using the mosquito landing test method by applying the lotion to the volunteer's arm, then inserting the arm into the mosquito cage for 5 minutes per session, with observation intervals up to a total of 6 hours. An untreated arm was used as the control. Bias control was performed by equalizing the age of the mosquitoes, the number of mosquitoes in each cage, and the laboratory environmental conditions (temperature and humidity). The number of mosquitoes that landed was recorded during each observation session to calculate the protection efficacy (PE) using the formula:

$$DP = \frac{K-R}{K} \times 100\%$$

Note:
K = Number of control landings
R = Number of landings with treatment

According to the Pesticide Commission(1995) The protective effect is considered effective if its protection remains above 90% up to the 6th hour.

RESULTS

The results of the protection capability test conducted by the researchers are presented in the following table:

Table 1. Efficacy of the Protective Power of Langsat Peel Extract against Aedes sp Mosquitoes

Extract Concentration (%)	Replications (U)	Total Mosquitoes Tested	Total Mosquitoes Landed (R)	Total Control (K)	Protection Formula	Protective Efficacy (%)	Protection Category
15%	5	125	3	19	(16/19) × 100%	84	Not Protective
20%	5	125	1	20	(19/20) × 100%	95	Highly Protective
25%	5	125	0	23	(23/23) × 100%	100	Very Highly Protective
30%	5	125	0	23	(23/23) × 100%	100	Very Highly Protective

Table 1 shows the protective efficacy of Lansium domesticum peel extract against Aedes sp. at concentrations of 15%, 20%, 25%, and 30% using five replications and a total of 125 mosquitoes for each concentration. The table includes the total number of mosquitoes landing on the treated skin surface, the number repelled, and the calculated protective efficacy. The results indicate that increasing extract concentration reduces mosquito landings and enhances repellent effectiveness. The 15% concentration produced an efficacy of 84%, categorized as not protective, while concentrations of 20%, 25%, and 30% achieved strong repellent performance with protective efficacy values of 95%, 100%, and 100%, classified as highly protective.

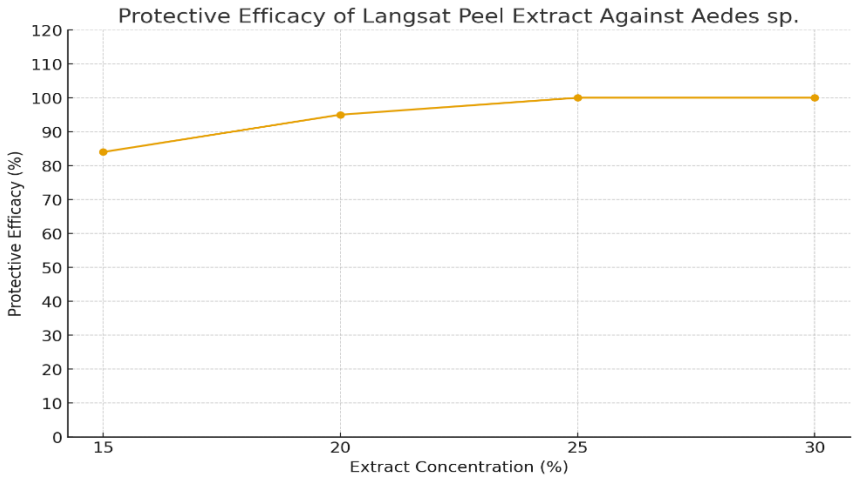

Figure 1. The protective power of langsat skin against Aedes sp mosquitoes

Figure 1 illustrates the trend of protective efficacy of Lansium domesticum peel extract against Aedes sp. across four concentrations (15%, 20%, 25%, and 30%). The line graph demonstrates a clear increase in repellent effectiveness corresponding to higher extract concentrations. At 15%, the protective efficacy reached 84%, while concentrations of 20%, 25%, and 30% achieved 95%, 100%, and 100% efficacy, respectively. The upward trend indicates a strong concentration–response relationship, showing that higher extract concentrations substantially reduce mosquito landings and improve repellent protection.

DISCUSSION

The effectiveness of Lansium domesticum (langsat) peel extract as a mosquito repellent is strongly related to its bioactive compounds, including flavonoids, saponins, tannins, alkaloids, and terpenoids. These compounds exert both neurotoxic and olfactory-modulating effects on

mosquitoes, thereby reducing landing and biting activity. Flavonoids, for instance, inhibit acetylcholinesterase activity in the insect nervous system, disrupting neural transmission and causing behavioral disorientation (Konda, Siampa, Tallei, Kepel, & Fatimawali, 2020; Pavela & Benelli, 2016; Putranta & Wijaya, 2018). Saponins act as natural surfactants that compromise the integrity of insect cell membranes and increase permeability, leading to osmotic imbalance and metabolic stress (Hazzam, Mhada, Bakrim, Taourirte, & Yasri, 2025; Paarvanova, Tacheva, Savova, Karabaliev, & Georgieva, 2023). Terpenoids—volatile and lipophilic compounds—play a primary role in repellency by interfering with the olfactory receptors of mosquitoes and masking host cues such as CO_2 and lactic acid (Mappin & DeGennaro, 2022; Vainer et al., 2023).

Several studies have confirmed the mosquito repellent efficacy of plant-based extracts rich in these bioactive constituents. Adinda et al (2023) reported that lotion containing 25% L. domesticum peel extract provided up to 100% protection against Aedes aegypti during initial exposure. Similarly, Disi et al (2024) demonstrated the effectiveness of electric repellents formulated with langsat peel extract, while Januariana et al (2018) documented the traditional practice in Malaysia of burning dried langsat peels to repel mosquitoes. Comparable findings were reported by Osei-Owusu et al (2023) and Maggi and Benelli (2018), who found that volatile terpenoids from citrus and Ocimum species significantly reduced mosquito landing rates, supporting the hypothesis that aromatic phytochemicals play an important role in mosquito deterrence.

The repellency of L. domesticum peel extract aligns with broader literature on the effectiveness of essential oils and botanical extracts as alternatives to synthetic repellents such as DEET. Studies on citronella (Cymbopogon nardus), lemongrass (Cymbopogon citratus), and clove (Syzygium aromaticum) have shown similar mosquito deterrent effects due to comparable terpenoid and phenolic compositions (Asadollahi, Khoobdel, Zahraei-Ramazani, Azarmi, & Mosawi, 2019; Lopez et al., 2025; Yunus & Rosanty, 2024). These compounds act by masking human kairomones and disturbing olfactory receptor neuron activation in mosquitoes (Afify, Betz, Riabinina, Lahondère, & Potter, 2019; Mappin & DeGennaro, 2022; Pitts, Derryberry, Zhang, & Zwiebel, 2017). Furthermore, at higher concentrations, several phytochemicals demonstrate mild insecticidal activity that alters mosquito feeding behavior and flight orientation (Isman, 2020).

Beyond adult repellency, the larvicidal properties of Lansium domesticum have also been documented. Putranta and Wijaya (2018) observed significant larval mortality in Aedes spp. when exposed to langsat bark infusion at concentrations ≥40%, attributed to flavonoids and terpenoids that penetrate the larval cuticle and disrupt respiratory siphon function. Comparable larvicidal effects have been recorded in other plant-based formulations containing these compounds, such as Azadirachta indica (Marcellia, Septiani, Berawi, Ningtias, & Arindia, 2024) and Ocimum basilicum (Chatterjee, 2023). These findings highlight the multifaceted role of langsat-derived phytochemicals as both repellents and larvicides, offering a sustainable biocontrol approach against mosquito vectors.

From an environmental perspective, botanical repellents present a safer alternative to conventional insecticides like organophosphates and pyrethroids, which have been associated with mosquito resistance, neurotoxicity, and ecological contamination (Hemingway & Ranson, 2000; World Health Organization, 2020). Chemical repellents containing DEET, while effective, may cause skin irritation, mild neurotoxic symptoms, and contamination of aquatic habitats (Chaves et al., 2018). Natural repellents such as L. domesticum, therefore, provide an eco-friendly, biodegradable, and human-safe option (Isman, 2020).

The cumulative evidence from this and prior research indicates that L. domesticum peel extract at concentrations ≥20% demonstrates substantial efficacy as a natural repellent against Aedes mosquitoes. This positions the plant as a promising candidate for the development of plant-based repellents, larvicides, and botanical pesticides that are safe, sustainable, and suitable for long-term vector control. Future studies should focus on isolating and characterizing individual active compounds from langsat peel and evaluating their synergistic effects, stability in formulations, and field performance under diverse environmental conditions.

Study Limitations

This study has several limitations that should be considered when interpreting the findings. First, the repellent efficacy was evaluated under controlled laboratory conditions using the mosquito landing test, which may not fully represent real-world environmental variability such as wind, sweat production, outdoor temperature, and human activity. Second, the observation focused solely on short-term protective performance within a limited exposure period and did not assess long-term stability, residual activity, or skin persistence of the lotion formulation. Third, the study did not include dermatological safety testing or user acceptability assessments, such as skin irritation, odor preference, or comfort during prolonged use. Finally, the analysis did not isolate or quantify individual bioactive compounds in the extract, limiting conclusions regarding the specific constituents responsible for repellency. Future studies should incorporate field trials, extended duration testing, safety evaluations, and phytochemical characterization to strengthen the applicability and generalizability of the results.

CONCLUSION

Based on the research findings, it can be concluded that the protective efficacy of langsat (Lansium domesticum) peel extract formulated as a lotion increases proportionally with concentration. Lower concentrations provide insufficient protection against Aedes mosquitoes, whereas higher concentrations demonstrate strong and consistent protective performance, meeting the criteria for high efficacy.

Author's Contribution Statement: Novarianti: Conceptualization, methodology design, laboratory experiment, data collection, data analysis, preparation of tables and figures, and drafting the manuscript. Saharudin: Supervision, validation of laboratory procedures, refinement of research methodology, critical review of manuscript content, and final approval of the version to be published. Herlina Susanto Sunuh: Literature review, interpretation of results, editing and proofreading of the manuscript, and support in discussion and conclusion writing**.**

Conflicts of Interest: The authors affirm that they have no financial, personal, or professional conflicts of interest that could have influenced the research or the preparation of this manuscript.

Funding Source: This research was independently funded by the research team.

Acknowledgments: We would like to express our sincere gratitude to the Director of the Palu Health Polytechnic and his team for their invaluable assistance in facilitating this research project, particularly in the use of the laboratory. In addition, we would also like to thank the staff who assisted the researchers in the laboratory.

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