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Effectiveness Of Papaya (*Carica papaya L.*) Peel Extract On Instar III *Aedes aegypti* Larvae

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ABSTRACT

Dengue Hemorrhagic Fever (DHF) is a disease transmitted by the Aedes aegypti and Aedes albopictus mosquitoes. Repeated use of chemical larvicides can lead to vector resistance, environmental pollution, and the death of non-target organisms. To determine the effectiveness of papaya (Carica papaya L.) peel extract as a natural larvicide against instar III Aedes aegypti larvae. The research used a True Experimental design with a purposive random sampling method. The probit analysis results showed LC_{50} values of 7.046% (3 hours), 4.976% (6 hours), and 3.196% (9 hours), while LT_{50} values were 12.950 hours (1%), 9.386 hours (3%), and 6.073 hours (5%). Papaya peel extract has been proven to be effective as a natural larvicide against instar III Aedes aegypti larvae.

Keywords: *Aedes aegypti third instar larvae, Larvicide, Papaya peel (Carica papaya L.)*

INTRODUCTION

Dengue Hemorrhagic Fever (DHF), remains a persistent health problem in various countries, particularly in tropical Asia. Dengue fever can occur year-round and infect all age groups. Its occurrence can be linked to environmental factors and societal behavioral patterns. Dengue Hemorrhagic Fever (DHF) is classified as an arbovirus disease spread by two species of mosquito vectors: *Aedes aegypti* and *Aedes albopictus* (Ismah et al., 2021).

Indonesia is one of the countries where climate significantly influences vector development. At the end of 2022, 143,000 new cases of dengue fever were recorded, with the highest incidence occurring in Central Java, East Java, and West Java (Surya, 2023). East Java Province experienced an increase in dengue fever cases in 2022, with a total of 13,236 recorded cases, with an incidence rate (IR) of 33 per 100,000 population and a case fatality rate (CFR) of 154 (1.2%). Meanwhile, in 2023, dengue fever incidents in East Java decreased, with a total of 7,235 documented incidents, with an incidence rate (IR) of 17.96 per 100,000 population and a case fatality rate (CFR) of 65

(0.9%) (DINKES JATIM, 2023). Despite experiencing a decline in the dengue fever phenomenon in East Java Province, authorities continue to emphasize the importance of vigilance.

According to (Suparyanti, 2020), the most effective way to stop dengue fever is to inhibit the development of *Aedes aegypti* mosquito larvae and limit direct contact with them. This is because there is no preventative vaccine or drug to eradicate the dengue virus. To date, chemical control is the most effective method used by the public because it is considered to have the best reaction. The active ingredients in manufactured larval medicines are chemicals that are very dangerous if not monitored, including temephos or abate. Repeated use of temephos has the potential to cause the death of non-target organisms, vector resistance, and environmental pollution (Lukiyono et al., 2021).

Based on the description above, to minimize the effects of applying chemical anti-larvae, natural larvicides (natural lava substances) are applied. As larvicides derived from nature, natural larvicides are easily decomposed because their residues are easily oxidized by air. The use of natural larvicides is expected to have minimal impact on the environment and human health and not contribute to the development of vector resistance (Saputri et al., 2021). One of the plants that has the potential as a natural larvicide is papaya skin (*Carica papaya L.*). Research (Liling et al., 2020) demonstrated that the active ingredients in papaya peel include additional metabolites, including alkaloids, tannins, flavonoids, and saponins. According to available literature, one of these four compounds is suspected of inhibiting the evolution of mosquito larvae, including *Aedes aegypti*.

A research study conducted by (Ramayanti & Febriani, 2016) evaluated the larvicidal effectiveness of papaya (*Carica papaya L.*) leaf extract on third-instar *Aedes aegypti* larvae, using varying concentrations of 0.25%, 0.5%, 0.75%, 1%, 1.25%, and 4%, and was performed four times. The analysis showed that the Lethal Concentration$_{50}$ (LC_{50}) was detected at a concentration of 3.73%. The novelty of this research compared to previous studies lies in the type of extract used: papaya peel extract at varying concentrations of 1%, 3%, and 5%. Furthermore, this study also assessed the Lethal Concentration$_{50}$ (LC_{50}) and determined the Lethal Time$_{50}$ (LT_{50}).

Based on the description above, the aim of this study is to evaluate the extent to which compounds from papaya (*Carica papaya L.*) peel are able to influence the development of *Aedes aegypti* mosquito larvae in the 3rd instar growth phase.

MATERIAL AND METHODS

The study used a True Experimental Design with a Post-test Only Control Group Design. The extraction procedure was carried out by macerating dried papaya peels in 96% ethanol. The maceration process was performed at room temperature for 72 hours with occasional stirring to maximize the extraction of active compounds. The ratio of sample to solvent was maintained at 1:4 (w/v). After maceration, the mixture was filtered using filter paper to separate the filtrate from the residue. The obtained filtrate was then evaporated using a rotary vacuum evaporator at 40–45 °C until a thick extract was produced. The resulting extract was stored in a tightly closed dark glass container at 4 °C to prevent degradation and maintain stability until further use. Researchers prepared various concentrations of papaya peel extract of 1%, 3%, and 5%. Application 25 larvae were added to each treatment and control solution. Observations were conducted at 3, 6, and 9 hours post-treatment to assess larval mortality. The study adhered to ethical principles such as honesty, accuracy, openness and lab safety.

Mortality percentage was calculated from the number of dead larvae. LC_{50} (Lethal Concentration 50%) and LT_{50} (Lethal Time 50%) values were computed using Probit analysis via SPSS version 21. Data handling included editing, coding, entry, and verification before statistical analysis.

RESULTS AND DISCUSSION

This study aimed to determine the effectiveness of papaya peel extract (*Carica papaya L.*) against third instar larvae of Aedes aegypti. Observations were made at three exposure times: 3 hours, 6 hours, and 9 hours, with extract concentrations of 1%, 3%, and 5%, along with positive control (Abate 1%) and negative control (Aquadest).

Table 1. Mortality Percentage of *Aedes aegypti* Larvae (Instar III) After 3 Hours of Exposure

Treatment	Total Larvae	Total Death					Average Larval Mortality	Mortality Percentage
		Replication						
		1	2	3	4	5		
Positive Control (+) Abate 1%	25	14	15	17	16	16	15,6	62,4%
Negative Control (-) *Aquadest*	25	1	0	2	0	1	0,8	3,2%
Extract Concentration 1%	25	2	2	2	4	1	2,2	8,8%
Extract Concentration 3%	25	6	4	6	5	5	5,2	20,8%
Extract Concentration 5%	25	7	7	9	8	9	8	32%

Table 2. Mortality Percentage of *Aedes aegypti* Larvae (Instar III) After 6 Hours of Exposure

Treatment	Total Larvae	Total Death					Average Larval Mortality	Mortality Percentage
		Replication						
		1	2	3	4	5		
Positive Control (+) Abate 1%	25	20	21	19	22	23	21	84%

Negative Control (-) *Aquadest*	25	1	0	2	0	1	0,8	3,2%
Extract Concentration 1%	25	4	5	5	3	4	4,2	16,8%
Extract Concentration 3%	25	8	6	9	7	9	7,8	31,2%
Extract Concentration 5%	25	12	11	14	13	13	12,6	50,4%

Table 3. Mortality Percentage of *Aedes aegypti* Larvae (Instar III) After 9 Hours of Exposure

Treatment	Total Larvae	Total Death					Average Larval Mortality	Mortality Percentage
		Replication						
		1	2	3	4	5		
Positive Control (+) Abate 1%	25	22	23	24	23	24	23,2	92,8%
Negative Control (-) *Aquadest*	25	1	0	2	0	1	0,8	3,2%
Extract Concentration 1%	25	7	8	7	9	6	7,4	29,6%
Extract Concentration 3%	25	10	11	12	14	14	12,2	48,8%
Extract Concentration 5%	25	15	17	16	18	17	16,6	66,4%

Table 4. LC_{50} – 3 Hours Contact Time

Mortality (%)	Concentration (%)	Confidence Level (%)	Lower Limit (%)	Upper Limit (%)
50	7,046	95,0	5,792	10,009

Table 5. LC_{50} – 6 Hours Contact Time

Mortality (%)	Concentration (%)	Confidence Level (%)	Lower Limit (%)	Upper Limit (%)
50	4,976	95,0	4,304	6,134

Table 6. LC_{50} – 9 Hours Contact Time

Mortality (%)	Concentration (%)	Confidence Level (%)	Lower Limit (%)	Upper Limit (%)
50	3,196	95,0	2,637	3,800

Table 7. LT_{50} – 1% Concentration

Mortality (%)	Time (Hours)	Confidence Level (%)	Lower Limit (%)	Upper Limit (%)
50	12,950	95,0	10,722	18,722

Table 8. LT_{50} – 3% Concentration

Mortality (%)	Time (Hours)	Confidence Level (%)	Lower Limit (%)	Upper Limit (%)
50	9,386	95,0	8,105	12,013

Table 9. LT_{50} – 5% Concentration

Mortality (%)	Time (Hours)	Confidence Level (%)	Lower Limit (%)	Upper Limit (%)
50	6,073	95,0	5,144	7,022

Based on Table 1, after 3 hours of treatment with various concentrations of papaya peel extract, the highest mortality rate of *Aedes aegypti* larvae (third instar) was observed at a concentration of 5%, with a mortality percentage of 32%. In contrast, the lowest mortality occurred at the 1% concentration, with a mortality rate of 8.8%. In the positive control group using Abate 1%, the larval mortality rate reached 62.4%, whereas in the negative control group using distilled water (Aquadest), larval mortality was only 3.2%.

From Table 2, after 6 hours of treatment, the highest larval mortality was again observed at the 5% concentration, with a percentage of 50.4%. Conversely, the lowest mortality was found at the 1% concentration, at 16.8%. In the positive control group (Abate 1%), the larval mortality rate was 84%, while the negative control group (Aquadest) showed a mortality rate of 3.2%.

According to Table 3, after 9 hours of treatment, the highest mortality of Aedes aegypti larvae (instar III) occurred at the 5% concentration, with a mortality rate of 66.4%. Meanwhile, the lowest mortality rate was recorded at 1%, which was 29.6%. The positive control group (Abate 1%) had a larva mortality rate of 92.8%, while the negative control (Aquadest) showed a mortality rate of only 4%.

According to larvicide effectiveness criteria by WHO (2005), a larvicide is considered effective if it is capable of causing larval mortality within the range of 10–95% (Sasmilati et al., 2017). The results of this study confirm that the concentration of the extract is directly proportional to the increased mortality of *Aedes aegypti* larvae. After exposure for 3, 6, and 9 hours at concentrations of 1%, 3%, and 5%, the papaya peel extract showed larvicidal effects. At a 5% concentration, the highest larval mortality occurred. Therefore, papaya peel extract is considered effective as a larvicide. Furthermore, the data obtained were analyzed using probit regression analysis to determine the Lethal Concentration 50% (LC_{50}) and Lethal Time 50% (LT_{50}). A previous study by (Ramayanti & Febriani, 2016) investigated the larvicidal efficacy of papaya leaf extract on

Aedes aegypti third instar larvae using concentrations of 0.25%, 0.5%, 0.75%, 1%, 1.25%, and 4%, repeated four times. The LC_{50} value in that study was identified at a concentration of 3.73%.

Based on Table 4, probit analysis of the mortality data for *Aedes aegypti* third instar larvae shows that the LC_{50} value at 3 hours was 7.046%, with a confidence interval ranging from 5.792% to 10.009%. This indicates that a 7.046% concentration of papaya peel extract can cause 50% mortality of test larvae within a 3-hour period.

According to Table 5, probit analysis at 6 hours indicated that the LC_{50} value was 4.976%, with a confidence interval between 4.304% and 6.134%. This suggests that a 4.976% concentration of papaya peel extract could cause 50% mortality of the larvae within 6 hours.

Based on Table 6, the LC_{50} value at 9 hours was found to be 3.196%, with a confidence range of 2.637% to 3.800%. This demonstrates that a 3.196% concentration of the extract can cause 50% larval mortality within 9 hours.

According to Table 7, the LT_{50} value for papaya peel extract at 1% concentration was 12.950 hours, with a confidence interval between 10.722 and 18.722 hours. This indicates that applying a 1% concentration of the extract for approximately 12.950 hours can kill 50% of the test larvae.

As shown in Table 8, the LT_{50} value for the 3% concentration was 9.386 hours, with a confidence interval ranging from 8.105 to 12.013 hours. This means that 50% of larvae died after approximately 9.386 hours of exposure to the extract at 3% concentration.

Based on Table 9, the LT_{50} value for the 5% concentration was 6.073 hours, with a confidence interval of 5.144 to 7.022 hours. This demonstrates that a 5% concentration of papaya peel extract was able to cause 50% larval mortality within 6.073 hours.

The findings of this study demonstrate that papaya peel extract (Carica papaya L.) exhibits larvicidal activity against Aedes aegypti third instar larvae, with effectiveness increasing along with higher concentrations and longer exposure times. The highest mortality was observed at 5% concentration after 9 hours, with LC_{50} and LT_{50} values of 3.196% and 6.073 hours, respectively. These results are consistent with previous studies reporting that secondary metabolites in papaya peel, such as alkaloids, flavonoids, tannins, and saponins, have insecticidal properties (Liling et al., 2020; Ramayanti & Febriani, 2016).

Mechanistically, flavonoids and saponins can disrupt larval respiration by reducing water surface tension, making it difficult for larvae to obtain oxygen. Alkaloids interfere with the nervous system, while tannins bind proteins and inhibit digestive enzymes, ultimately leading to larval death. These biological actions explain the observed dose-dependent increase in larval mortality.

CONCLUSION AND SUGGESTION

This study demonstrates that papaya peel extract (*Carica papaya L.*) has larvicidal effects against *Aedes aegypti* larvae (instar III), with effectiveness increasing in line with higher concentrations and longer exposure times. The highest larval mortality occurred at a 5%

concentration after 9 hours of exposure, with a mortality rate of 66.4%. The LC_{50} values decreased over time, from 7.046% at 3 hours to 3.196% at 9 hours, indicating greater effectiveness with prolonged exposure. Similarly, LT_{50} values decreased as concentration increased, from 12.950 hours at 1% to 6.073 hours at 5%. These findings suggest that papaya peel extract has the potential to be developed as a natural and eco-friendly alternative to synthetic larvicides for controlling *Aedes aegypti* populations, especially in dengue-endemic areas. However, further research is recommended to isolate and identify the active compounds involved, to evaluate long-term effectiveness in field conditions, and to explore potential impacts on non-target organisms and the environment.

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CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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