NATURAL WEAPON AGAINST DENGUE: LARVICIDAL EFFICACY OF PAPAYA (*Carica Papaya* L.) FRUIT PEEL ETHANOL EXTRACT ON *Aedes albopictus*

Nidha Luthfiana Fawziah[1], Andi Zsazsa RM[1], Nur Mahdi[2], Deni Setiawan[2]*

[1]D-III Pharmacy Program, Darul Azhar Health College, Batulicin
[2]Pharmacy Program, Faculty of Mathematics and Natural Sciences, Universitas of Lambung Mangkurat

*Email : nidhalutfiana@gmail.com

ABSTRACT

Dengue or, as it is commonly known, dengue fever, has become a public health problem in the world, not only in Indonesia. Until now, dengue disease is still not well controlled. Dengue fever is caused by Aedes argypi and Aedes albopictus mosquitoes. The purpose of this study was to determine the effectiveness of papaya peel extract (Carica papaya L) against Aedes albopictus mosquito larvae. This study is an experimental study of post test only control group design using 600 Aedes albopictus larvae. This study used papaya peel extract with 6 concentration treatment groups of 0.4 mg/ml, 0.8 mg/ml, 0.12 mg/ml, 0.16 mg/ml, positive control group and negative control group. Observations were made 24 hours after treatment and larval mortality was calculated every 1 hour. The results showed that the average larval mortality at a concentration of 0.4 mg/ml was 6.25%, concentration of 0.8 mg/ml was 8.25%, concentration of 0.12 mg/ml was 10.75%, at a concentration of 0.16 mg/ml was 14.5%, for the positive control was 100%, and for the negative control was 0%. The results of probit analysis of LC90 of papaya peel extract amounted to 48.501 and LT50 at the fastest killing concentration of 0.16 mg/ml was 59.017 hours. Based on the results of the study, it can be concluded that papaya peel extract (Carica papaya L.) can kill Aedes albopictus mosquito larvae.

***Keywords** : Aedes albopictus, Biolarvicide, Extract papaya peel, Dengue*

INTRODUCTION

Dengue Hemorrhagic Fever (DHF), also known as Dengue Haemorrhagic Fever (DHF), is a viral disease that is very significant to public health in Indonesia. This disease is caused by the dengue virus (DENV), which is transmitted through the bite of vector mosquitoes, especially *Aedes aegypti* and *Aedes albopictus*. These mosquitoes are commonly found in urban areas in tropical and subtropical regions. The role of mosquitoes as vectors is very important because they can spread various diseases, including DHF, which is one of the main diseases of concern in Indonesia (Kesumawati Hadi et al., 2012).

Dengue fever transmission involves three main components in the arthropod-borne disease cycle, namely viruses as pathogens, mosquitoes as disease vectors, and vertebrates as hosts. Environmental factors also play an important role in

supporting this transmission cycle, because suitable environmental conditions can facilitate interactions between the three components, thereby increasing the risk of disease spread (Kesumawati et al., 2015). Therefore, environmental control is one of the important strategies in the prevention and control of dengue fever.

According to the World Health Organization (WHO), for more than five decades, dengue has become a global public health problem, not only in Indonesia. Although various efforts have been made, dengue disease is still not well controlled, as seen from the significant increase in incidence worldwide. In Indonesia, dengue outbreaks occur every year, causing ongoing concern among the public.

Control of *Aedes aegypti* and *Aedes albopictus* mosquito vectors, which are the main cause of Dengue Hemorrhagic Fever (DHF), remains a priority given the high number of dengue virus infections each year, especially in tropical and subtropical areas. In 2015, Indonesia recorded a DHF morbidity rate of 50.57 per 100,000 population with a mortality rate of 0.83%. Central Java Province reported 255 DHF cases with an Incident Rate (IR) of 48.55 per 100,000 population and a Case Fatality Rate (CFR) of 1.56%. In addition to dengue, the *Aedes albopictus* mosquito also spreads chikungunya, with 2,285 cases reported in 8 provinces in 2015, an increase from the previous year (Kemenkes, 2022).

The main risk factors for contracting dengue fever include living in or traveling to tropical areas such as Southeast Asia, Latin America, and Africa. The risk increases if someone has been previously infected with the dengue virus, as the disease can cause more severe symptoms if reinfected. In addition, children under the age of 15 are also at higher risk of contracting dengue fever (Kemenkes, 2022).

Dengue cases are spread across almost all cities and districts in Indonesia, with the highest incidence in densely populated urban areas. By the end of 2022, the number of dengue cases in Indonesia reached 143,000, with the provinces of West Java, East Java, and Central Java recording the highest incidence rates. Strengthening the management of dengue control programs is urgently needed, including the use of larvicides to control *Aedes albopictus* mosquitoes. However, the use of chemical larvicides such as Abate (temephos), which has been used since 1980, is now facing challenges in the form of resistance and potential toxic effects on humans, animals, and the environment. Because the use of chemical larvicides has negative effects, alternatives to control the *Aedes albopictus* mosquito

population need to be developed. One such alternative is to use papaya skin extract, which contains saponins and flavonoids that are thought to have larvicidal properties. This approach aims to minimize the negative impacts caused by chemical larvicides.

Previously, research has shown that papaya (*Carica papaya* L.) latex extract can kill all *Aedes albopictus* mosquito larvae with a mortality rate of 100% at concentrations of 8 ppm, 12 ppm, 18 ppm, and 27 ppm (Wulandari et al., 2012). The results indicate a significant potential for using natural materials as larvae.

Based on these findings, further research is proposed to explore the potential of other parts of the papaya plant, especially papaya peel, as a natural larvicidal agent. This study aims to find a safer and more effective method of controlling Aedes albopictus mosquitoes while reducing the risk of side effects associated with the use of chemical larvicides. Based on the background description above, the purpose of this study was to determine the effectiveness of papaya peel in controlling the death of *Aedes albopictus* mosquito larvae.

METHODE

This study was an experiment with a post-test-only control group design, which aimed to compare the effectiveness of antemephos and natural larvicide from papaya peel extract in killing *Aedes albopictus* larvae. The study population was *Aedes albopictus* larvae, while the sample consisted of 1 kg of papaya peel obtained from Batulicin District, South Kalimantan. The independent variable in this study was papaya peel extract, while the dependent variable was the number of dead larvae.

This study involved the preparation of papaya peel extract with various concentrations and testing of larvicide on *Aedes albopictus* larvae for 24 hours. The data obtained were presented in the form of tables, graphs, and narratives and analyzed through editing, coding, and tabulation processes. The results of the study are expected to show the effectiveness of papaya peel extract as a natural larvicide in controlling the population of *Aedes albopictus* mosquitoes.

After the data on the number of living and dead larvae were obtained, a series of statistical tests were carried out for analysis. The normality test using *Shapiro-Wilk* was used to determine the data distribution, with a probability value >0.05 indicating a normal distribution. Furthermore, the homogeneity test of variance used the *Levene test* to evaluate the similarity of data variances, where results > 0.05 indicated homogeneous

variances. The ANOVA test was then conducted to determine significant differences in larval mortality at various concentrations of papaya extract, and if the requirements were not met, the *Kruskal-Wallis* test was used. Finally, the probit test was used to calculate the LC_{90} and LT_{50} values, which measure the toxicity of larvicides based on the concentration and time required to kill 50% and 90% of larvae.

RESULT AND DISCUSSION

Rendement

The yield is calculated to compare the weight of the simplex with the extract obtained. The yield of papaya fruit skin extract (*Carica papaya* L.) is 11.76%. Table 1 displays the results of the phytochemical screening of papaya fruit skin (*Carica papaya* L.).

Table 1. Phytochemical Screening

Compound	Result	Indicator
Flavonoids	+	A yellow solution is formed
Saponins	+	There is foam that lasts for 30 minutes.
Alkaloids	-	No orange precipitate is formed (Dragendorff's reagent). No yellow precipitate is formed (Mayer's reagent).
Steroids	-	No blue precipitate is formed

Biolarvicide Test

Table 2. Total time of death of Aedes albapictus larvae in 4 replications every 1 hour, 3 hours, 6 hours, 12 hours, and 24 hours.

Concentration (%)	Number of Larval Deaths (n=100)					
	1	3	6	12	24	Total
Control (+)	0	0	0	0	0	0
Control (-)	1	8	15	58	18	100
0,4 mg	0	1	3	9	12	25
0,8 mg	0	2	3	12	16	33
0,12 mg	0	2	3	20	17	43
0,16 mg	2	2	6	26	22	58

This study aims to test the larvicidal effectiveness of papaya (*Carica papaya* L.) peel extract against *Aedes albopictus* larvae. In this study, six different test groups were used to measure the effectiveness of the extract. Papaya peel extract was obtained through the maceration method, which is one of the most common extraction methods used in laboratory research. The maceration method used in this study involved the use of 70% ethanol as a solvent. Ethanol was chosen because it has low toxicity properties, making it a safe choice for use in extraction. In addition, ethanol is semipolar, which means it can attract both polar and nonpolar compounds, thus maximizing the amount of compounds extracted from papaya peel. The maceration method is considered effective in separating compounds that have different solubilities in certain solvents. In

this study, using ethanol as a solvent helps to effectively extract active compounds from papaya peel, which is expected to significantly kill Aedes albopictus larvae.

The herbal medicine, or dried raw material from papaya fruit peel (*Carica papaya* L.), is put into a tight glass jar and then soaked (macerated) with 70% alcohol for three days. During this maceration process, the mixture is stirred occasionally to ensure that all compounds in the herbal medicine can dissolve well in the solvent. We obtained 35.3 grams of thick extract from 300 grams of papaya fruit peel herbal medicine, resulting in a yield of 11.75 percent. In this study, we used a simple water bath method to carry out the extract evaporation process. This method was chosen because of its ease and simplicity in evaporating the solvent, namely 70% alcohol, so that only the extract that is rich in active compounds remains. Although simple, this method is quite effective in producing thick extracts from papaya fruit peels in herbal medicine. The results of phytochemical screening of the extract from papaya fruit peel showed the presence of several important chemical compounds. Among them are alkaloids, flavonoids, and saponins, all of which are known to have various pharmacological benefits. The presence of these compounds shows the potential of papaya skin extract as an efficacious ingredient, including in this study as a larvicide.

We obtained the Aedes albopictus larvae for this study from the Tanah Bumbu Public Health Laboratory (LABKESMAS) and hatched them in the Entomology Laboratory. This study aimed to see how well papaya (*Carica papaya* L.) peel extract kills *Aedes albopictus* larvae within 24 hours. The number of larvae used in each test cup was 25, in accordance with the standards set by the World Health Organization. This number of larvae is important because if it exceeds 25 in 100 ml of water, larval death can occur due to the larvicide effect and high media density. To determine the concentration of papaya peel extract used, a preliminary test was carried out based on previous research, which showed that a concentration of 120 mg/100 ml of papaya leaf extract was effective in killing Aedes aegypti larvae (Maulana et al., 2022). In this study, six groups were created with different amounts of extract: 0.4 mg/ml, 0.8 mg/ml, 0.12 mg/ml, and 0.16 mg/ml, along with two control groups—one with just distilled water and another with 10 mg of temephos. The negative control only contained 100 ml distilled water without papaya extract, and no larval mortality was observed for 24 hours, indicating that distilled water itself did not have a larvicidal effect. The positive control in this study used temephos, which is a

standard chemical larvicidal agent, to compare its effectiveness with papaya peel extract. The results of this comparison are important to see how well papaya peel extract works at killing *Aedes albopictus* larvae compared to regular larvicides. In this way, this study provides a more profound understanding of the potential of papaya peel extract as a natural alternative in mosquito control.

The results indicated that the concentration of papaya skin extract had a significant effect on the number of deaths of *Aedes albopictus* larvae. At an extract concentration of 0.4 mg/ml, 25 larvae died, while at a concentration of 0.8 mg/ml, the number of deaths increased to 33 larvae. When the extract concentration was increased to 0.12 mg/ml, the number of larvae that died reached 43, and at the highest concentration of 0.16 mg/ml, the number of larvae that died reached 58. These data indicate a direct relationship between the concentration of the extract and the level of larval mortality, where the higher the concentration, the more larvae died. Temephos, which was used as a positive control in this study, is an organic phosphate compound that works as a larvicide. This compound contains a phosphorothionate group that has an anticholinesterase effect. Anticholinesterase works by inhibiting the activity of the cholinesterase enzyme, which functions to break down the neurotransmitter acetylcholine at the nerve endings. As a result, acetylcholine accumulates along the nerve pathway, causing nerve dysfunction that leads to larval death (Refai et al., 2013).

Thus, temephos has proven its effectiveness in killing Aedes albopictus larvae through this mechanism of action. Comparison of these results with papaya peel extract can help assess the potential of the extract as a natural alternative for mosquito larval control. The increase in the number of dead larvae at higher extract concentrations indicates that papaya peel extract may also work with a similar mechanism, although further research is needed to fully understand its effectiveness and mechanism of action (Mahdi et al., 2022).

A study on administering papaya peel extract to *Aedes albopictus* larvae showed that larval mortality increased as extract concentration increased. Researchers found that more larvae died at extract concentrations of 0.4 mg/ml, 0.8 mg/ml, 0.12 mg/ml, and 0.16 mg/ml. This study also involved a probit test to determine the concentration needed to kill 90% of larvae, or LC_{90}. The results of the probit test indicated that a concentration of 38.595 mg/ml of papaya peel extract was effective in killing 90% of *Aedes albopictus* larvae within 24 hours. As a comparison, a similar study using Citrus nobilis peel obtained an LC_{90} value of 2335 (Santoso et al., 2020). Based on the results of the LC_{90} probit test,

papaya peel proved to be more potent at killing larvae compared to Citrus nobilis peel, which had a much higher LC_{90} value. This evidence shows that papaya peel extract is more effective in controlling *Aedes albopictus* larvae at lower concentrations compared to Citrus nobilis peel. In other words, papaya peel extract requires a lower concentration to achieve the same level of larval mortality. However, the results of the LT_{50} probit test indicated that papaya peel extract took longer to achieve 50% mortality of *Aedes albopictus* larvae compared to red ginger (*Zingiber officinale* var. rubrum) extract. At a concentration of 0.16 mg/ml, the LT_{50} value of papaya peel extract was 59.017 hours to achieve 50% larval mortality in 24 hours. In contrast, the LT_{50} value for red ginger extract was 2.196 hours (Qatrinida et al., 2021), indicating that red ginger was faster in killing 50% of larvae compared to papaya peel extract. This result indicates that although papaya peel is more potent in terms of the concentration required, it is less effective in terms of speed of action compared to red ginger.

The active compounds in papaya peel extract, namely flavonoids and saponins, are thought to cause the death of *Aedes albopictus* larvae at various concentrations. Previous studies have indicated that Belimbing Wuluh (*Averrhoa bilimbi* L.) extract, which also contains flavonoids and saponins, has a significant larvicidal effect on *Aedes albopictus* larvae (Mahfiroh et al., 2023). Symptoms of larval death observed in this study included the inability to move when touched and the stiffness of the larval body, which are indications that the larvae have died due to the influence of these active compounds. Flavonoid compounds in papaya peel extract function as respiratory toxins. Flavonoids enter the larval body through the surface siphon, which then causes nerve atrophy and damage to the siphon(Setiawan et al., 2025). As a result, the larvae cannot breathe, this mechanism by confirming that flavonoids directly affect the respiratory system of mosquito larvae. In addition to flavonoids, saponin compounds also contribute to larval death through different mechanisms. Saponin functions as a poison that interferes with the larvae's ability to eat by attacking the digestive tract. Saponin enters the larva's body and acts as a stomach poison that reduces the activity of digestive enzymes and prevents food absorption. Saponin lowers the surface tension of the mucus lining in the larva's digestive system, making the walls of the digestive system harmful and eventually leading to damage (Fuadzy & Marina, 2012). This mechanism causes damage to the larva's digestive system and contributes to its death.

CONCLUSION

The research's findings lead us to the following conclusion:

1. Papaya fruit peel extract (Carica papaya L.) has the potential as a biolarvicidal agent on Aedes albopictus larvae.
2. Papaya fruit peel extract (Carica papaya L.) has a biolarvicidal effect on LC90, which is 38,595 mg/ml, while at LT50 at a concentration of 0.16 mg/ml, it is 59,017 hours.

Suggestions for this research include developing trials on other mosquito larval species, exploring the use of solvents other than ethanol in the extraction process, and continuing research to the histopathology stage to gain a deeper understanding of the effects of extract from papaya fruit.

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