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Insecticidal Effectiveness Test of Mahogany Fruit Peel (Swietenia Mahagoni (L.)) Extract on Mosquito Aedes Aegypti for Increasing Economy

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Abstract

Mahogany rind which is underutilized in the environment contains secondary metabolites that have the potential as insecticides such as alkaloids, flavonoids, tannins, and saponins. The purpose of this study was to determine the mahogany rind extract was effective as an insecticide in controlling the mosquito vector Aedes aegypti and to determine the concentration of the mahogany rind extract which was most effective as an insecticide for the Aedes aegypti mosquito. Mahogany rind extraction method with percolation method using ethanol as solvent. The extraction result of mahogany rind was 21 grams with a yield of 5.428%. Mahogany rind extract has effectiveness as an insecticide against Aedes aegypti mosquitoes. The results showed that the higher the concentration of mahogany skin extract, the more the number of Aedes aegypti mosquitoes dead. The lowest killing power to the one that effectively kills mosquitoes is 0.5%, 1%, 2%, and 4% with a mortality of 14.28%, respectively; 21.42%; 45.53% and 57.14%. In the probit analysis LC_{50} of mahogany fruit peel extract is at a concentration 3.796% and including the poisonous category.

Keywords
dengue hemorrhagic fever; mahogany fruit peel; insecticide

I. Introduction

Dengue Hemorrhagic Fever (DHF) is still a public health problem in Indonesia. According to data from the World Health Organization (WHO), Indonesia is reported as the 2nd country with the largest dengue cases among 30 countries in endemic areas (WHO, 2009). The Ministry of Health stated that the number of dengue cases in Indonesia until July 2020 reached 71,633. There are 10 provinces that have the most cases of DHF. Lampung occupies the 5th position as the province with the most dengue cases in 2020 (Ministry of Health, 2020).

The main cause of this disease is the Aedes aegypti mosquito, more precisely transmitted by the female Aedes aegypti mosquito which contains the Dengue virus in its body (Amelia et al., 2017). Several efforts have been made in controlling the Aedes aegypti mosquito, starting from environmental control, biological control and chemical control using chemical insecticides which are widely used by the community because they can provide effective and optimal results (Adril, 2019).

The use of chemical insecticides is basically more practical, effective and has optimal results, but repeated use can cause residues that pollute the environment. The use of chemical insecticides should be limited to prevent the occurrence of resistance to mosquitoes. So, the solution to control the Aedes aegypti mosquito that can be done is to use natural insecticides. Natural insecticides made from plants can be an option because they are environmentally friendly. There are diverse species of mosquitoes that exist in

but around 30 - 40 species were reported to be carriers of the plasmodium parasite (Ghosh in Bawo et al, 2020).

Swietenia mahagoni (L.) or better known as mahogany is an example of a plant that has insecticide effectiveness. according to Durai et al., (2016) Mahogany contains flavonoids, saponins, tannins, and alkaloids.

Mahogany rind extract was obtained from the percolation method. The principle of the percolation method of extraction is that the simplicia is placed in a vessel with a porous bulkhead at the bottom. The solvent liquid is flowed from top to bottom through the material (smplicia). The solvent used is 96% ethanol solvent, because ethanol solvent can bind polar compounds.

Based on the description above, a research will be conducted on the effectiveness test of mahogany fruit peel extract insecticide against the Aedes aegypti mosquito.

II. Research Methods

2.1 Simple Processing

The mahogany rind was previously determined first. Mahogany rind taken in good and fresh condition. Then it is washed and dried in a dry way without direct sunlight. Then the dry skin is mashed using a blender and then extracted.

2.2 Extract Manufacture

A total of 500 grams of mahogany rind simplicia was immersed in a closed vessel using 96% ethanol solvent for at least 60 minutes. The extraction process is continued in the percolator using 96% ethanol solvent gradually, the total solvent used is 7 liters until the liquid dripping from the percolator is clear. Then the liquid extract was obtained. The liquid extract was then concentrated with a rotary evaporator at a temperature of 35oC to obtain a thick extract which was then oven-baked at a temperature of 35oC until the extract was obtained in the form of a paste.

2.3 Phytochemical Test

a. Alkaloids

1 mL of the extract was added with 1 mL of 1% HCl and 1 mL of Mayer's reagent a pink color appeared, a white precipitate was formed indicating the presence of alkaloids.

b. Flavonoids

1 mL of extract was added with Mg powder and 1 mL of concentrated HCl then shaken to form red, yellow or orange colors, positive for flavonoids.

c. Saponins

1 mL of the extract after added hydrochloric acid, then shaken to produce a stable foam for 5 minutes indicates the presence of saponins.

d. Tannins

1 mL of the extract after adding 1 mL of 10% iron (III) showed a dark blue or greenish black color change indicating that it contained tannin positively.

e. Polyphenol

1 mL of the extract was added 10 drops of methanol and filtered then added 3 drops of 1% FeCl3 there was a green color change indicating the presence of phenol.

2.4 Insecticide Effectiveness Test

In this study, the sample size used was 28 Aedes aegypti mosquitoes for each group with 4 repetitions. The treatment group was divided into 6 groups, including 2 groups as

control and 4 groups as experimental groups with various treatment concentrations which in this study used extract concentrations of 0.5%, 1%, 2% and 4%. Negative control using distilled water, positive control using commercial insecticides. The test was carried out by means of 28 adult Aedes aegypti mosquitoes in each test cage, then sprayed with various concentrations of mahogany skin extract, negative control and positive control. Each concentration of mahogany rind extract, negative control and positive control were sprayed into the test cage as much as 3 mL. Then calculated the number of dead mosquitoes with the mortality formula, as follows:

$$\%Mortalitas = \frac{jumlah\ nyamuk\ mati}{jumlah\ banyak\ nyamuk}\ x\ 100\%$$

Table 1. Details of mahogany peel extract testing on Aedes aegypti larvae (WHO, 2005)

Treatment	Number of larvae x repetition	Total
K (-) Aquadest	28 mosquitoes x 4	112
K (+) Commercial Insecticide	28 mosquitoes x 4	112
$Extract_1$	28 mosquitoes x 4	112
$Extract_2$	28 mosquitoes x 4	112
$Extract_3$	28 mosquitoes x 4	112
$Extract_4$	28 mosquitoes x 4	112
AMOUNT		**672**

2.5 Data Analysis

Data from the results of testing the effectiveness of mahogany skin extract (Swietenia mahagoni L.), were analyzed using the Analysis of Variance (ANOVA) statistical test with a 95% confidence level. Then followed by Post-Hoc Least Significant Difference (LSD).

III. Results and Discussion

3.1 Results

a. Extraction and Yield

Mahogany rind extract obtained from the percolation extraction process is an extract in the form of a paste. After obtaining the extract in the form of a paste, calculations were carried out to obtain the extract yield. The mahogany rind extract obtained was the extract in the form of a paste. After obtaining the paste extract, the extract yield was calculated.

Table 2. Results of Mahogany Peel Extrac

Extract Type	Powder Weight (g)	Extract Weight (g)	Percent Yield (%)
Paste Extract	500	21	5,428

Based on the calculation results, the % yield obtained in this study was 5.428%.

b. Phytochemical Test

Phytochemical tests were conducted to determine the content of secondary metabolites contained in mahogany skin extract, the tests carried out included tests for alkaloids, flavonoids, saponins, tannins, phenols, steroids and terpenoids.

Table 3. Phytochemical test results of mahogany skin extract (Swietenia mahagoni)

Test	Observation	Results
Alkaloids	Formation of pink color, and the presence of a white precipitate	(+)
Flavonoids	Yellow color	(+)
Saponins	Embossed stable foam for 5 minutes	(+)
Tannins	Greenish black color	(+)
Phenol	Green color	(+)
Steroids and Terpenoids	Purple color	(+)

c. Larvicide Effectiveness Test of Mahogany Peel Extract

Tests on larvae were carried out on 28 Aedes aegypti mosquitoes using mahogany skin extract with concentrations of 0,5%, 1%, 2%, and 4%. The negative control used was distilled water and the positive control was Temephos by 1%. The results of the death effectiveness test can be seen in table 4.

Table 4. Results of Insecticide Test Results of Mahogany Peel Extract Against Aedes Aegypti Mosquitoes

Concentration	Mosquito Death Observations			P.Value
	Average mortality (%)	LC_{50} (%)	LT_{50} (minutes)	
0,5%	14,28	3,796	235,220	0,000
1%	21,42		107,301	0,000
2%	45,53		43,867	0,000
4%	57,14		13,299	0,000
Control (+)	100		0,321	0,000
Control (-)	0		18586,041	0,000

d. LSD Post Hoc Test Results

The LSD test was carried out to see the smallest significant difference in each treatment and to determine the concentration that was not significantly different from the positive control.

Table 5. LSD Post Hoc Test on Mahogany Fruit Peel Extract

Concentration	0,5%	1%	2%	4%	Control (+)	Control (-)
0,5%		0,001	0,000	0,000	0,000	0,000
1%	0,001		0,000	0,000	0,000	0,000
2%	0,000	0,000		0,000	0,000	0,000
4%	0,000	0,000	0,000		0,000	0.000
Control (+)	0.000	0.000	0,000	0,000		0,000
Control (-)	0,000	0,000	0,000	0,000	0,000	

From table 5 LSD (Least Significant Differences) test resultsmahogany rind extract showed a significant difference because the significant value obtained was ($P<0.05$) so that each concentration had different effectiveness as an insecticide from the positive control.

3.2 Discussion

This study tested the effectiveness of mahogany skin extract (Swietenia mahagoni (L.)) against Aedes aegypti mosquitoes with various test concentrations. The initial stage of the study was carried out by determining the sample, namely mahogany skin. The determination was carried out at the Chemistry Laboratory of the Faculty of Mathematics and Natural Sciences, University of Lampung with the results showing that the mahogany skin sample used was the true mahogany skin of the species Swietenia mahagoni (L).

The mahogany skin simplicia obtained was extracted by the percolation method. The use of this method is because percolation is an extraction method with simpler steps. In addition, the sample used will be continuously flowed by the solvent so that the substances contained in the sample can be attracted optimally. The solvent used in the extraction was 96% ethanol. This 96% ethanol can attract the active substances contained in simplicia that are polar or non-polar polar. The active substance contained in the simplicia of mahogany rind which is thought to function as an insecticide is polar and non-polar, so the use of 96% ethanol is very suitable in this study.

The mahogany rind extract that had been obtained was concentrated using a rotary evaporator. Rotary evaporator is used to remove the solvent content of 96% ethanol used in the extraction process. Rotary evaporator works by separating the extract and its liquid by heating accelerated by rotation so that a thick filtrate is obtained. The extract obtained with a rotary evaporator was then placed in an oven at a temperature of $35^{o}C$ to remove the remaining ethanol solvent contained in the extract so that the extract was obtained in the form of a paste. Furthermore, calculations are carried out to obtain the extract yield. Yield is the ratio between the extracts obtained and simplicia, the higher the yield value, the more extracts obtained. The yield obtained in this study was 5.428%. Mahogany rind is included in a hard plant, so that during the process of refining the mahogany skin it is difficult to grind and causes the solvent to not perfectly absorb the simplicia, so that the resulting extract is not too much and the yield obtained is small (Afifah, 2017). The mahogany rind extract that has been obtained is then carried out phytochemical screening to determine the secondary metabolite compounds contained in it. so that the resulting extract is not too much and the yield obtained is small (Afifah, 2017). The mahogany rind extract that has been obtained is then carried out phytochemical screening to determine the secondary metabolite compounds contained in it. so that the resulting extract is not too much and the yield obtained is small (Afifah, 2017). The mahogany rind extract that has been obtained is then carried out phytochemical screening to determine the secondary metabolite compounds contained in it.

Phytochemical screening carried out in this study included tests for alkaloids, flavonoids, saponins, tannins, phenols, steroids and triterpenoids. Testing for alkaloids was carried out using Mayer's reagent where a positive result was obtained, namely a white precipitate. The extract is taken as much as 1 mL and then 1% HCl is added, where the function of this solution is to increase the solubility of the alkaloids, because the alkaloid compounds will react with HCl and will form salts that are easily soluble in water. After that, the extract was tested by adding a specific reagent for alkaloids, namely Mayer's reagent. The results obtained in this test were positive extracts containing alkaloids with the formation of a white precipitate. It is thought that the precipitate is a potassium-alkaloid complex. In the manufacture of Mayer's reagent, a solution of mercury (II)

chloride plus potassium iodide will form a red precipitate of mercury(II) iodide. If too much potassium iodide is added, potassium tetraiodomercurate (II) is formed. Alkaloids contain nitrogen atoms that have lone pairs of electrons so that they can be used to form coordinate covalent bonds with metal ions. In the alkaloid test with Mayer's reagent, it is estimated that the nitrogen in the alkaloid will react with the metal ion K^+ from potassium tetraiodomercurate (II) to form a precipitated potassium-alkaloid complex. Flavonoid testing was carried out by taking 1 mL of extract and then adding it with Mg powder and 1 mL of concentrated HCl. The results obtained are the formation of a yellow color which indicates a positive flavonoid. The purpose of adding Mg and HCl is to reduce the benzopyron core contained in the flavonoid structure so that red or orange flavylium salts are formed. Flavonoids are compounds that contain two aromatic rings with more than one hydroxyl group. Phenolic compounds with more hydroxyl groups have greater solubility in water or are polar, so they can be extracted in polar solvents (Ergina et al., 2014). Saponin testing was carried out by adding HCl and then shaking. The results showed the formation of a stable foam which means it was positive for saponins. Saponins have physical properties that are easily soluble in water and will cause foam when shaken (Mailuhu M. et al., 2017). Tannin testing was carried out by taking 1 mL of extract and then adding a few drops of 1% FeCl3 solution. The result obtained is a black green black color is formed which indicates the formation of complex compounds between tannins and $Fe3^+$. Formation of a green-black color in the extract after the addition of 1% $FeCl_3$ because tannins will form complex compounds with Fe^3 ions. Phenol testing was carried out by adding 10 drops of methanol in 1 mL of extract, filtered and then adding three drops of 1% $FeCl_3$. The result obtained is the formation of a green color which indicates a positive phenol. The color change of phenol is caused by the Fe^{3+} ion reacting with the keto group on phenol which acts as a metal chelating agent (Mailihulu M. et al., 2017). Testing of steroids and triterpenoids was carried out by adding 1 mL of CH_3COOH and 1 mL of concentrated H_2SO_4 in 1 mL of extract. The purpose of adding CH_3COOH solution is to break the steroid-terpenoid group with other groups, while the purpose of adding H_2SO_4 is to break the sugar bonds in the compound. If the sugar bond is released, the presence of free steroids in the sample will be indicated by the presence of a red ring (Puspa E.O. et al., 2017). The result obtained is a change in color to purple with a red ring which indicates positive for steroids and triterpenoids. After knowing the secondary metabolites contained in the mahogany skin extract, an insecticide test can be carried out on the Aedes aegypti mosquito.

The test animals used in this study were 28 adult Aedes aegypti mosquitoes per treatment that were 2 days old. Mosquito age is a very influential factor on mosquito resistance to exposure to chemical compounds. Selection of mosquito age is an important activity in research. The age range of 2-5 days is the best age range for mosquitoes. The age of the mosquito is under 2 days, its physical condition is still weak so that it will facilitate the death of the mosquito, besides that the mosquito that has just changed from the pupa phase can not immediately suck blood because it is repairing its body structure. Meanwhile, at the age of more than 5 days, the mosquito's body resistance has decreased which will result in an increased risk of death (Wibawa, 2012). After the mosquitoes were 2 days old, the testing process was carried out using the spray method.

The distance between the tip of the sprayer and the target mosquito at the time of spraying can affect the results of the study. The spraying in the effectiveness test of mahogany rind extract was carried out horizontally and there were no Aedes aegypti mosquitoes in a straight line in the direction of spraying. The length of contact time between the Aedes aegypti mosquito and the mahogany rind extract affects the exposure

effect of the mahogany rind extract to the Aedes aegypti mosquito. Effective application exposure time is less than one hour. Because if more than that time, the insecticide will be carried away by the wind. The length of time that is too short will also cause a reduction in the length of interaction between chemical compounds and the target mosquito which will result in a decrease in the number of dead mosquitoes (Wibawa, 2012).

The results of the study in Table 4 can be seen that the average percentage of the number of mosquito deaths after 1 hour of treatment was 14.28% in the 0.5% extract concentration group; 21.42% in the 1% extract concentration group; 45.53% in the 2% extract concentration group; 57.14% in the 4% extract concentration group; 100% in the positive control group and 0% in the negative control group. Based on these results, it shows that mahogany skin extract has a different insecticidal effect at each concentration, where the higher the concentration, the more the number of dead mosquitoes.

When there is exposure between mahogany skin extract (Swietenia mahagoni (L.)) and Aedes aegypti mosquitoes with the spray method, the compounds contained therein, namely flavonoids, will enter the mosquito's mouth through the respiratory system in the form of spiracles on the surface of the mosquito's body, which will cause the mosquito to breathe. cause damage to the spiracles and nerves resulting in respiratory problems and eventually the mosquito dies (Adril, 2019). Alkaloids as anticholinesterases have a mechanism of action almost the same as organophosphates, namely anticholinesterases make cholinesterase inactive as a result of which acetylcholine accumulates, resulting in impaired transmission of nerve impulses, resulting in respiratory problems (Wibawa, 2012). Saponins can cause digestive tract wall corrosion due to the ability of saponins to damage the membrane, besides that saponins can also interfere with the lipoid layer on the epicuticle and the protein layer on the endocuticle making it easier for toxic substances to enter the insect's body. Tannins are inhibitors of the work of food digestive enzymes such as amylase and protease, causing protein to be disturbed and resulting in the death of insects due to impaired nutrient absorption and decreased growth rate in insects (Rahmawati, 2018). From the working mechanism of the active ingredients above, the effectiveness of mahogany skin extract (Swietenia mahagoni (L.)) can be used as an insecticide for Aedes aegypti mosquitoes.

Based on the One Way ANOVA data, it shows that the significant value obtained is 0.000 ($P<0.05$), which means that the mahogany skin extract (Swietenia mahagoni) is effective in killing the Aedes aegypti mosquito and shows a significant difference ($P<0.05$) in the number of Aedes aegypti mosquitoes. mortality of Aedes esgypti mosquitoes in each treatment. ANOVA was followed by the LSD (Least Significance Different) test as a follow-up test or post hoc testaim to see the effect of the ratio of extract concentration mahogany skin (Swietenia mahagoni) to positive control and negative control. The LSD test results showed that the mahogany rind extract had a significant difference at each concentration because the significant value obtained was ($P<0.05$) so that each concentration had different effectiveness as an insecticide and was not as strong as the positive control.

The next test is the probit analysis test which is carried out to determine the Lethal Concentration 50 (LC_{50}) and Lethal Time 50 (LT_{50}). The LC_{50} value obtained is 3.796%. This shows at that concentrationMahogany fruit peel extract can kill 50% of Aedes aegypti mosquitoes and it can be said that mahogany fruit peel extract has toxic properties in killing Aedes aegypti larvae. According to Ismatullah (2014), the toxicity is said to be very toxic in the <1% range, 1-10% toxic, moderately toxic 10-50%, slightly toxic 50-99%, and non-toxic in the >100% range. While the results of the LT_{50} value at a concentration of 0.5% is 235.226 minutes; concentration 1% 107.301 minutes; concentration of 2% 43,867

minutes and 4% concentration 13,299 minutes. From these results, it can be concluded that the higher the concentration of mahogany rind extract used, the faster the LT_{50} value, so that the best concentration and best time of mahogany rind extract (Swietenia mahagoni (L.)) was at a concentration of 4% at 13,299 minutes.

V. Conclusion

From the research results of the effectiveness test of mahogany skin extract (Swietenia mahagoni) against Aedes aegypti mosquitoes, it can be concluded that mahogany skin extract (Swietenia mahagoni L.) is effective as an insecticide against Aedes aegypti mosquitoes with an LC_{50} value of 3.796%. The most effective concentration of mahogany skin extract (Swietenia mahagoni L.) was at a concentration of 4% which had a mortality value of 57.14% with an LT_{50} value of 13,299 minutes. The higher the concentration of mahogany skin extract (Swietenia mahagoni L.) the higher the mortality of larvae.

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