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EFFECTIVENESS TEST OF JACKFRUIT LEAF EXTRACT (*Artocarpus heterophyllus L.) SPRAY FORMULATION AS Aedes aegypti* MOSQUITO REPELLENT

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Abstract

The *Aedes aegypti* mosquito is the primary vector of dengue fever, which remains a major health problem in Indonesia and can affect individuals of all ages, from children to adults, potentially causing death. This study aimed to determine the effectiveness of jackfruit leaf extract spray and to identify the optimal concentration for repelling *Aedes aegypti* mosquitoes. The repellency test was conducted by applying the extract spray and observing mosquito landing rates for 30 seconds up to 6 hours after treatment. The data were analyzed using repeated measures ANOVA. At 30 seconds after application, the 1% extract exhibited an average repellency of 16.25%, the 5% extract 52.53%, and the 9% extract 74.13%. After 6 hours, repellency decreased to 14.52% for the 1% extract, 49.64% for the 5% extract, and 65.23% for the 9% extract. The positive control showed 100% repellency at both 30 seconds and 6 hours, whereas the negative control showed 0% repellency at both time points, indicating no repellent effect. All three formulations of jackfruit leaf extract demonstrated good organoleptic properties, including color, odor, and texture. However, despite their organoleptic quality, none of the three spray formulations were fully effective as repellents for *Aedes aegypti* mosquitoes.

Keywords: Aedes aegypti, Artocarpus heterophyllus L.

INTRODUCTION

Dengue hemorrhagic fever (DHF) is one of the most common infectious diseases transmitted by mosquitoes, with *Aedes albopictus* known as one of the important vectors. On the other hand, dengue virus belongs to the family *Flaviviridae*, genus *Flavivirus*, which is transmitted primarily through the bites of *Aedes polynesiensis* and *Aedes niveus*. DHF can affect both children and adults, causing symptoms such as headache, muscle pain, and thrombocytopenia that may lead to severe complications and even death (Panuluh, 2020).

The primary vector of dengue transmission in Indonesia is *Aedes aegypti*, which can infect people of all ages and may cause fatal outcomes (Mutiarawati, 2017). Transmission occurs when mosquitoes bite humans, starting about two days before the fever subsides until five days after the onset of fever. The virus present in the blood then circulates to the heart and spreads throughout the body. In mosquitoes, the virus undergoes an incubation period of about 8–10 days before it can be transmitted again. Once infected, mosquitoes can carry the virus for life (Siska, 2017).

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One of the preventive measures against mosquito bites is the use of repellents. Repellents are substances applied to the skin, clothing, or other surfaces to prevent mosquitoes from landing or biting. They act by interfering with mosquito receptors, such as lactic acid receptors on the antennae, thereby reducing host-seeking behavior (Adnani, 2020). Plants are widely used as natural alternatives for mosquito repellents due to their bioactive compounds. Jackfruit (*Artocarpus heterophyllus L.*) leaves contain secondary metabolites such as flavonoids, phenols, saponins, tannins, steroids, and terpenoids, which are potential sources of bioactive agents (Wijiastriti, 2017).

Previous studies have shown that jackfruit leaf extract possesses larvicidal activity. Setiawan et al. (2017) reported that the extract demonstrated significant mortality against *Culex sp.* larvae, with death rates of 44%, 52%, 60%, and 72% at concentrations of 0.25%, 0.5%, 0.75%, and 1% within 24 hours, while no mortality was observed in the control group. Based on this background, the present study aims to evaluate the effectiveness of jackfruit leaf (*Artocarpus heterophyllus L.*) extract spray formulation as a repellent against *Aedes aegypti* mosquitoes.

METHOD

Tools

The equipment used in this research included laboratory glassware, database access, sample containers, mixing apparatus, measurement instruments, sampling tools, pipettes, a pH meter, a pycnometer, and spray bottles.

Materials

The materials used were jackfruit (*Artocarpus heterophyllus L.*) leaves, propylene glycol, 96% ethanol, aquadest, and sofel.

RESEARCH PROCEDURE

Sample processing

Jackfruit (*Artocarpus heterophyllus L.*) leaves weighing a total of 680 g were first cleaned with running water and then cut into small pieces. The leaves were air-dried, followed by shade drying for five days under a container covered with black cloth to protect them from direct ultraviolet light. After the drying process, the leaves were ground into a fine powder and subsequently subjected to extraction.

Making of extr racks

The dried jackfruit leaves, weighing 680 g, were placed in a container and mixed with a maximum of 8 L of 96% ethanol. Extraction was carried out using an ultrasonic extractor at 45 °C for 20 minutes. The resulting mixture was then filtered using filter paper. The filtrate was further concentrated by evaporation at 40 °C with a rotation speed of 100 rpm, followed by drying in an oven at 40 °C for 2 days until a dry extract was obtained. This process ensures that the remaining solvent is removed, so the extract is stable and its activity is preserved for subsequent testing.

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Oatmeal

The phytochemical screening of jackfruit leaves (*Artocarpus heterophyllus* L.) revealed the presence of several bioactive compounds, including alkaloids, flavonoids, saponins, tannins, and terpenoids.

Table 1. Formulation of Jackfruit Leaf (*Artocarpus heterophyllus* L.) Extract Spray as Mosquito Repellent

No	Ingredient	Unit	Formulation F1	Formulation F2	Formulation F3	Control (-)	Control (+)	Function
1	Jackfruit Leaf Extract	g	0.6	3	5.4	0	—	Active ingredient
2	Propylene Glycol	mL	12	12	12	12	—	Solvent
3	Ethanol 96%	mL	1	1	1	1	—	Carrier
4	Aqua dest	mL	Ad 60	Ad 60	Ad 60	Ad 60	—	Solvent

Information :

Formulation of Jackfruit Leaf (*Artocarpus heterophyllus* L.) Extract Spray as Mosquito Repellent

Concentrations:

1. F1: 1% jackfruit leaf extract
2. F2: 5% jackfruit leaf extract
3. F3: 9% jackfruit leaf extract
4. Control (-): Formulation without extract
5. Control (+): Commercial mosquito repellent spray

Preparation Procedure:

1. Weigh the jackfruit leaf extract according to the desired concentration: 0.6 g for F1, 3 g for F2, and 5.4 g for F3.
2. Place each extract into a separate container.
3. Add 12 mL of propylene glycol as a co-solvent to aid solubilization.
4. Add 1 mL of 96% ethanol to further dissolve the propylene glycol and extract.
5. Add distilled water (aqua dest) to reach a total volume of 60 mL and mix thoroughly until homogeneous.
6. Prepare the negative control in the same manner but without adding any extract.
7. Use commercial mosquito repellent as the positive control.

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Evaluasi Sediaan Spray

1. Uji Organoleptic
   The organizational test is carried out by observing the form , color change , and smell (Wid Yawa Tidk , 2017) .

2. Measuring the degree of acidity (pH)
   The pH test is performed using a pH meter. The electrode is first calibrated using standard buffers of pH 4 and pH 7. The electrode is then dipped into the sample. The pH value displayed on the screen is recorded; measurements must be performed at room temperature (Priyanka, 2019).

3. Clarity
   Clarity testing is carried out to see whether the preparation is clear or not, the preparation must be perfectly mixed, which is indicated by the absence of particles or coarse grains that can be felt (Kuncoro, 2020).

4. Specific Gravity
   The principle of measuring specific gravity is by comparing the weight of the sample to the weight of water at the same temperature and volume . This measurement is carried out using a 10 mL pycnometer (Priyanka, 2019).

5. Skin Irritation Test
   Irritation testing on volunteers' skin will be conducted by spraying the spray on the wrist and elbow. Observations will be made every 15, 30, 45, and 60 minutes for six hours. A positive irritation reaction is indicated by redness, itching, or swelling on the treated skin (Kuncoro, 2020).

6. Anti-Mosquito Effectiveness Test
   The effectiveness of mosquito repellent will be tested on four volunteers . Volunteers are not allowed to use any fragrances or products for six hours, as proper hand hygiene is essential. The palms of the hands are protected by gloves made of a material that is resistant to mosquito bites. The left hand, from the wrist to the elbow, is sprayed with jackfruit leaf extract, and the right hand with a commercial spray. The arms are then inserted into a cage filled with 50 Aedes aegypti mosquitoes. The arms are placed in the cage for 30 seconds, after which the mosquitoes land on them, with four repetitions each. For subsequent testing, the arms are rested for six hours and must not be exposed to water. After six hours, the test is repeated (WHO, 2009).

RESULTS

Extra

The jackfruit leaf powder, weighing a total of 680 grams, was processed using an ultrasonic extraction method. The extraction was performed by dissolving the powder in 8 liters of solvent for 4 days. After extraction, the resulting solution was prepared into a spray formulation with 39 grams of extract, achieving a yield (rendemen) of 5.73%.

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Phytochemical analysis of the extract indicated the presence of the following bioactive compounds:

- Flavonoids
- Tannins
- Saponins
- Alkaloids
- Terpenoids

These compounds are responsible for the biological activities of the extract, including its potential as a mosquito repellent.

Table 2. Extraction of jackfruit leaves (Artocarpus heterophyllus L.)

Sample	Sample Weight (g)	Solvent (L)	Extract Weight (g)	Yield (%)
Jackfruit Leaves	680	8	39	5,73

Hasil Skreening Fitokimia

Table 3. Chemical Content of Jackfruit Leaf Extract

Sample	Identification	Observation result	Information
Jackfruit Leaves	Flavonoid	Red orange	Positive
	Land	Greenish black	Positive
	Saponin	The presence of foam	Positive
	Alkaloid	White sediment	Positive
	Terpenoid	Blue or purple	Positive

Evalasi sediaan spray

Parameter	K (-)	F I	F II	F III
Color				
Smell				
Flavor				
Form/Preparation				

K (−) : Spray formulation without the use of extract (negative control)
F I : Formulation using 1% jackfruit leaf extract concentration
F II : Formulation using 5% jackfruit leaf extract concentration
F III : Formulation using 9% jackfruit leaf extract concentration

Based on the **organoleptic tests**, the formulations **K (−), F I, F II, and F III** show the following characteristics:

- **K (−)** (negative control) has a clear base without color.
- **F I** exhibits a yellow color.
- **F II** and **F III** display green to dark green colors.

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All formulations have a **pleasant and characteristic smell**, specific to each formulation, and there are **no unpleasant odors** detected. Additionally, the **jackfruit leaf spray formulations** are all in **liquid form**.

Formula	Clarity	pH	Specific Gravity (g/ml)
K (+)	Clear	5,57	0,92143
K (-)	Clear	5,64	0,91971
F I	Light yellow	5,60	0,92487
F II	Blackish green	5,33	0,92745
F III	Blackish green	5,26	0,93004

Information :

Here's a polished and clearer version of your paragraph:

- **K (−)**: Spray formulation without the use of jackfruit leaf extract.
- **F I**: Formulation using 1% jackfruit leaf extract.
- **F II**: Formulation using 5% jackfruit leaf extract.
- **F III**: Formulation using 9% jackfruit leaf extract.

The organoleptic and pH tests were conducted to determine the key characteristics of each formulation. The pH measurement provides information about the nature of the base used in the spray. The quality requirements for the formulations specify a pH range of 4.5–6.5, which is considered suitable for topical applications.

No	Formula	Volunteer	Redness of the Skin	Itchy Skin	Swelling of the Skin
1	F I	I	0	0	0
		II	0	0	0
		III	0	0	0
2	F II	I	0	0	0
		II	0	0	0
		III	0	0	0
3	F III	I	0	0	0
		II	0	0	0
		III	0	0	0

0 : Does n't show any reactions
1 : Redness
2 : Itching - itching
3 : B ank

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4. Effective

Sample	A (%)	B (%)
F I	16,25	14,52
F II	52,53	49,64
F III	74,13	65,23
K (+)	100,00	100,00
K (−)	0,00	0,00

Information :

Here's a clearer and organized version of your data:

1. **K (−)**: Spray formulation without jackfruit leaf extract.
2. **F I**: Formulation using 1% jackfruit leaf extract.
3. **F II**: Formulation using 9% jackfruit leaf extract.

Evaluation Parameters:

1. **A**: Repellent effect measured **30 seconds after application**.
2. **B**: Protective efficacy measured **within 6 hours after application**.

Based on the table above , it can be seen below that the number of averages that have occurred has occurred after 6 hours . There are differences in each component of the system and the number of factors . It can be concluded that Sig > 0 , 0 5 , which means that the data are found in the mother system in a normal way . So it can be carried out further by using the *Rep* Test *eated Measures* ANOVA.

Tabel 8. Uji Repeated Measure Anova

Variables	Say.
Time – Time	0,000
Time – Treatment	0,017

Based on the statistical analysis, it can be seen that for the experimental group, the sig < 0.05, indicating a significant difference between the treatments. Similarly, for the practical group, the sig < 0.05, which also confirms a significant difference in a normal distribution. Because of this, further post-hoc testing can be conducted using the Tukey HSD (Honestly Significant Difference) test to determine which specific groups differ from each other.

Table 9. Tukey HSD Test – Spray Formulation of Jackfruit Leaf Extract (Artocarpus heterophyllus L.)

Treatment Group	Comparison Group	Say.
F1 Treatment	F2 Treatment	0,000
	Perlakuan F3	0,000

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Treatment Group	Comparison Group	Say.
	K+ treatment	0,000
	K-Treatment	0,000
F2 Treatment	Perlakuan F3	0,046
	K+ treatment	0,000
	K-Treatment	0,000
Perlakuan F3	K+ treatment	0,001
	K-Treatment	0,000
K+ treatment	K-Treatment	0,000

B ased on the results of the T u k e y H S D test it can be summed up under the characteristics of each individual implementation system showing < 0.05 so it can be said to be the result There are also differences between 1 % , 5 % , 9 % and 1 % , 5 % , 9 % and negative control .

DISCUSSION

The extract was obtained from 680 grams of jackfruit leaf powder (Artocarpus heterophyllus L.), resulting in a total yield of 39 g (5.73%) when processed in 8 L of solvent. The main purpose of this extraction was to identify and evaluate the secondary metabolites present in the leaves, which are known for their potential repellent activity against Aedes aegypti. A qualitative phytochemical analysis revealed the presence of flavonoids, tannins, saponins, alkaloids, and terpenoids, which are compounds associated with mosquito repellency.

Organoleptic and Physical Properties

- **Color:**
  - F I (1% extract): light yellow
  - F II (5% extract) and F III (9% extract): green to dark green
  - K− (negative control): no color change
- **Odor:** All formulations exhibited characteristic jackfruit leaf aroma without any unpleasant smell.
- **pH:** The pH values for F I, F II, F III, negative control, and positive control ranged from **5.26 to 5.64**, which is within the acceptable range of **4.5–7**, indicating suitability for skin application.
- **Specific Gravity:** All formulations met the standard requirement (**~0.996 g/mL at 25°C**) for spray solutions.
- **Irritation Test:** Application of all formulations did not cause redness, swelling, or discomfort, indicating **non-irritant properties**.

Repellent Effectiveness

The three spray formulations (F I: 1%, F II: 5%, F III: 9%) and controls (K−: negative, K+: commercial) were tested for **repellency against *Aedes aegypti*** at **30 seconds** and **6 hours** post-application:

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Formulation	30 sec Protection	6 hr Protection
F I (1%)	16.25%	14.52%
F II (5%)	52.53%	49.64%
F III (9%)	74.13%	65.23%
K+ (commercial)	100%	100%
K− (negative)	0%	0%

CONCLUSION

Based on the results obtained, it can be concluded that jackfruit leaf extract (*Artocarpus heterophyllus L.*) in the tested concentrations meets the physical and organoleptic requirements (including color, odor, pH, clarity, and specific gravity). However, when applied as a spray in the third formulation, the extract did not achieve optimal repellency against *Aedes aegypti*. The observed protection was below the effective threshold of **80%**, meaning that the formulation's efficacy in preventing mosquito bites did not reach the standard considered as fully effective.

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