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Mat Electric Repellent as an Alternative for Dengue Fever's Prevention using *Ocimum basilicum* Essential Oil

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Abstract

Indonesia is one of the tropical countries, located in the equatorial region where mosquitoes can grow well. Dengue fever is a disease caused by a virus carried by a mosquito vector. The main vector of this disease is the Aedes aegypti mosquito. The prevalence of dengue fever in Indonesia at the beginning of 2018 until the early week of 2019 have a increase in the number of people affected by dengue, with the highest number of patients in East Java with a total of 700 people. In 2017, 22.55% of 100,000 populations infected by dengue fever, with cases of 444 deaths and the highest incidence occurred in Bali. Prevention of this disease can be done by eradicating vectors using chemicals (fogging), but some chemicals contained in fogging are dangerous to humans. Therefore, another alternative that is safe, good and easy to use is needed, one of which is by using the basil (Ocimum bacilicum) plant. Ocimum bacilicum is a plant that grows a lot in Indonesia. Essential oils from this plant are known to have activity as larvacides, especially for Aedes aegypti mosquito. Essential oils from Ocimum basilicum plants are made into electric mosquito repellents in matt form with certain formulations. The process of making this product begins with the extraction of basil leaves by distillation. Then the separation between the oil and water phase is carried out using a separating funnel. Electric insect repellent media is made using cork containing 0.01 g/l d-allethrin which has been sterilized using 70% alcohol. The cork is then soaked in basil essential oil for 3 minutes (until perfectly submerged). The test activities obtained LC50 at 16.925% concentration which shows effective results to provide larvicidal activity. It can be concluded that this preparation can be used as an alternative for prevention of dengue fever.

Keywords

Aedes aegypti, dengue fever, mat electric repellent, Ocimum basilicum

1. Introduction

DENGUE is a mosquito-borne viral disease that has rapidly spread in recent years. Dengue virus is transmitted by female mosquitoes mainly of the species *Aedes aegypti* and, to a lesser extent, *Ae. albopictus*. Dengue is found in tropical and sub-tropical climates worldwide, mostly in urban and semi-urban areas and widespread throughout the tropics. Severe dengue (also known as Dengue Haemorrhagic Fever or Dengue Fever) was first recognized in the 1950s during dengue epidemics in the Philippines and Thailand. Today, severe dengue affects most Asian and Latin American countries and has become a leading cause of hospitalization and death among children and adults in these regions [1].

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The global incidence of dengue has grown dramatically in recent decades, about half of the world's population is now at risk. The number of cases reported worldwide increased from 2.2 million in 2010 to 3.2 million in 2015 [1]. In Indonesia, cases of dengue fever occurred during 2017 were 59,047 cases with an incidence rate 22.55% per 100,000 population and the number of cases died was 444 cases [2]. As of February 3, 2019, nationally there were 16,692 cases with 169 people died. The most cases are in East Java, Central Java, NTT, and Kupang [3].

Among the plants known for medicinal value, the plants of genus Ocimum are rich in phenolic compounds and very useful for many therapeutic activities [4]. Moreover, among more than 150 species of the genus Ocimum, Basil is the major essential oil crop which is commercially used in many countries [5]. Basil, binomial name *Ocimum basilicum*, is well-known as a plant of folk medicinal value and as such is accepted officially in a number of countries. The leaves of the Basil are used in folk medicine as a tonic and anthelminthic drug [6]. Traditionally, basil is used to treat the diseases of heart and blood, biliousness *kapha* and *Vata*, leucoderma etc. The juice relieves joints pain, gives luster to eyes, is good for toothache, earache and cures epistaxis when used with camphor [7]. This plant also have some pharmacological effect from its part. The flowers of this plant are stimulant, diuretic and demulcent in action [8]. The juice of the plant shows carminative, stimulant and antibacterial actions [9][10]. Basil essential oil possesses antibacterial, antifungal and insecticidal effects [11].

Eradication of dengue hemorrhagic fever is done by eradicating the *Aedes aegypti* mosquito as a vector of dengue virus. There are several methods to control the number of mosquitoes, such as controlling the environment (3M programs), biological control (use of mosquito repellent animals and plants), and chemical controls (sprinkling abate powder and fogging) [2]. Recently, the government has been promoting a fogging program to control the number of mosquitoes, but this has a worse impact on health. Fogging can cause poisoning because the chemicals to kill mosquitoes contaminating the body through the respiratory tract [12]. Gas-shaped pesticides that enter the lungs more than 50 microns may not reach the lungs, but can cause interference with the mucous membranes of the nose and esophagus [13]. Because of its toxicity, it needs another action to control mosquito’s number. There are some forms of repellent, one of them is mat-form.

Based on the statement above, it can be concluded that we need an innovation to prevent the dengue fever. Prevention activity can be another alternative than curative (fogging). Using repellent plant, it can be made through mat-repellent form to prevent dengue’s virus.

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2. Method

The method used in this study is qualitative analysis based on the study of literature at various sources. Sources are obtained through the Google Scholar index using the keywords *Ocimum basilicum*, basil leaves, dengue fever, larvicidal activity, mosquito repellent and mat electric repellent. The analysis starts from identifying the problem based on existing data, analyzing the root of the problem and finding the best solution from the analysis that has been done.

Materials

The materials used in this research are *Ocimum basilicum* leaves, aquades, acetone, dog biscuits for mosquito's food, *Aedes aegypti* larvae, dechlorinated water, sodium sulfate anhydrous and alcohol.

Extraction of essential oil

Fresh leaves *O. basilicium* sorted then obtained with water until clean and weighed 7 kg to extract. Extraction of essential oil using hydro-distillation method with Clavenger Apparatus for 8 hours. The oil phase then removed from the water phase using a

separating funnel. The essential oil obtained is dried with sodium sulfate anhydrous. Every 1 ml of essential oil is completely dissolved with 100 ml of acetone considered 1% concentration, and prepare a concentration of 2%, 4%, 6%, 8%, 10%. [14]

Larvicidal activity

Aedes aegypti larvae and pupae are fed with dog biscuits and yeast at a ratio of 3: 1, maintained at a temperature of 28 ± 2^{o}C with 70-85% relative humidity (RH) over a 12 hour period. After that, twenty-five instar I, II, III, IV larvae from *Aedes aegypti* were stored in a 500 ml glass containing 249 ml of dechlorination water and 1.0 ml of *O. Basilicum* essential oil. Perform 3 replications for each calculation. The control used was added with 1.0 ml of acetone in 249 ml of dechlorinated water. Calculation of LC_{50}, LC_{90}, regression equation and 95% confidence level of the lower confidence limit (LCL) and the upper limit of Wence Limit (UCL) are calculated using probit analysis [15].

Manufacturing of mat electric repellent

Essential oils as much as 25 ml were taken using a pipette volume then diluted in 70% alcohol until 100 ml in a measuring flask. The concentration of essential oil produced is 25% v / v [14]. Cork is used as a medium in manufacturing of mat electric repellent. Cork is sterilized by soaking 70% alcohol for 48 hours, and immersed in distilled water. Cork dried in a sterile incubator for 30 minutes until no distilled water left. After that, the cork is soaked in *O. basilicum* essential oil for 20 minutes. [16]

3. Result and Discussion

The methods used as mosquito control are chemical, physical or biological controls. Space spraying of insecticides (fogging) is one of the chemical controls that are often used during emergency situations when outbreaks of dengue fever are already in progress [17]. Unfotunately, fogging is considered ineffective because it can increase the incidence of DHF in the same period in the South-East Asia region for 25 years [1].

The purpose of mosquito control in endemic areas, especially dengue fever, is to prevent the transmission and spread of the virus as quickly as possible. N, N-Diethyl-m-Toluamide (DEET), picaridin and permethrin are several chemical compounds that are widely used as a repellent in preventing dengue fever because they can interact with the mosquito's nervous system. The dosage forms that are marketed are pump spray, aerosols, lotions, gels, sticks and mat [1]. Larvicidal chemical compounds have limitations because they can cause resistance to mosquito vectors and cause negative impacts on the environment because they cannot be destroyed or eliminated [18].

In this study, we used hydro-distillation method to extract essential oils from *O. basilicum* leaves. We choose this method because the temperature in the extraction process is lower than 100°C. This is the suitable temperature to keep the essential oils stable and not degraded in process. Hydro-distillation is cheaper and more efficient. When compared with other extraction methods, the distillation method still classified as traditional method, but the previous studies found that extraction of essential oils from basil leaves by hydro-distillation method can give good results. The percentage of yield from hydro-distilation is greater (81.76%) compared to steam distillation method (65.44%) [19].

Essential oils produced from *O. basilicum* leaves extraction are 6.8 ml/kg leaves. The results of this extraction were used to test larvicidal activity against the *Aedes aegypti* mosquito. Based on research larvicidal and repellent potential of *Ocimum basilicum* Linn against dengue vector, *Aedes aegypti*, can provide larvicidal activity with LC_{50} 5,449% [15]. Another study states that with a concentration of 50 ppm after 24 hour can provide larvicidal activity with percent of death 86,7% [20]. *Ocimum basilicum* is also effective as larvicidal with a concentration of 100 ppm can provide larvicidal activity with an LC_{50} of 42,57% [21]

Table I. Larvicidal activity of *O. Basilicum* on different of instar larvae and pupa of *Aedes aegypti* [15]

Plants species	Larva instar	Log LC_{50} (Log LC_{90})	LC_{50} (LC_{90}(%))	Regression equation	95% Confidence limit		Chi-square value
					LCL [LC_{50} LC_{90} (%)]	UCL [LC_{50} LC_{90} (%)]	
O. Basilicum essential oil	I	0,572 (0,877)	3,734 (7,528)	Y= -1.261+0,338X	1,490 (6,057)	5,039 (11.386)	11,967
	II	0,618 (0,919)	4,154 (8,292)	Y= -1,286+0,310X	2,088 (6,745)	5,464 (5,464)	10,987
	III	0,669 (0,942)	4,664 (8,746)	Y= -1,465+0,314X	2,641 (7,087)	6,087 (13,271)	12,841
	IV	0,710 (0,981)	5,124 (9,767)	Y= -1,415+0,276X	3,356 (8,000)	6,058 (14,359)	9,983
	Pupa	0,736 (1,192)	5,449 (15,474)	Y= -0,697+0,128X	4,451 (13,052)	6,339 (20,027)	1,124

Table II. Larvicidal activity of *O. Basilicum* of *Aedes aegypti* [20]

Plant species	Time	Concentration (ppm)	%mortality±SE	LC_{50} (LCL-UCL)	LC_{90} (LCL - UCL)
O.Basilicum essential oil	24 hour	25	28,51 ± 0,67	42,47	119,63
		50	53,66 ± 0,58	42,57	119,63
		75	70,84 ± 0,66	42,57	119,63
		100	91,07 ± 0,57	42,57	119,63

The selection of mat electric dosage forms is based on the ease of essential oils to evaporate when heated in the appropriate temperature. Electrical energy will be converted into heat energy which will cause essential oils from *O. basilicum* leaves to evaporate and spread throughout the room. This method is more effective because it has been proven to have potent activities, does not cause toxicity, easier to use, and cheap.

Compared to mat electric repellent, liquid vaporizers also have been widely used for plant essential oils as a repellent. However, in terms of storage, the liquid form is not easy to carry and easy to spill, and requires an appropriate formulation so that essential oils remain stable. Therefore, the mat electric repellent can be used as a good and sustainable alternative to the eradicate *Aedes aegypti* larvae.

4. Conclusion

Based on the study, O. *Basilicum* essential oil has larvicidal activity, shown with LC_{50} 5.447%. This concentration is effectively used to eradicate *Aedes aegypti* mosquitoes. Alternative media used as preventive is mat electric because the media is safe, easy to use and does not produce residue. For the next experiment, optimization is necessary to determine the effectiveness of the mat electric from O. *Basilicum* essential oil as a mosquito repellent.

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