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The effect of citronella oil as anti-mosquito spray

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Abstract

Background: Jambi Province is one of the endemic province in Indonesia. For the last 13 years (2007-2019) the IR of DHF were fluctuated and the peak was in 2019 (62.4 per 100,000 population) higher than national standard (<49 per 100,000 population). Lemongrass plant produces an essential oil known as citronella oil that can be used as a mosquito repellent. The study objective was to determine the effectiveness of citronella oil as anti-mosquito repellent spray against the death of *Aedes aegypti* mosquito.

Methods: This study was a quasi experimental with posttest only control group design conducted at the Environmental Health Laboratory, Faculty of Public Health, Jambi University. The research sample was 50% citronella oil and adult *Aedes aegypti* mosquitoes breded results from eggs obtained from the Baturaja Health Research and Development Center, South Sumatra Province. The type of data collected in this study was data from the calculation of the number of mosquitoes that died due to the activation of anti-mosquito spray with citronella oil. T-test was employed to determine the mean difference of died mosquitoes in the treatment and control group.

Results: It is resulted that the average of died mosquitoes from 5 replications was 97.32% in the treatment group, meanwhile no mosquitoes died in the control group. The statistical test results showed that the anti-mosquito spray made from citronella oil had a significant difference between the control sprayer to kill *Aedes aegypti* mosquitoes (p value: 0.000, 95%CI: 28.16 – 30.24).

Conclusion: Citronella oil was effective as anti-mosquito repellent spray against *Aedes aegypti* mosquito. It is recommended to be able to use the yard for cultivating lemongrass plants.

Keywords: Anti-mosquito spray, lemongrass, citronella oil

Introduction

Dengue hemorrhagic fever (DHF) is a mosquito-borne disease and one of global public health problems [1-3]. There has been a rapid increase of the disease's cases over the past three decades. It is found in tropical and subtropical areas around the world, especially in urban and semi-urban areas. The disease is caused by a virus from the family of *Flaviviridae* which is spread by the *Aedes* mosquito. There are four serotypes of the virus, which are designated as DENV-1, DENV-2, DENV-3 and DENV-4 [1].

In the last 50 years, the spread of the incidence of the disease has increased 30-fold. It is estimated that 50-100 million cases of infection occur every year and almost half of the world's population resides in endemic countries. Currently, about 75% of the global population at risk of dengue virus exposure resides in the Asia-Pacific region [4].

Indonesia as one of the tropical countries, with high air humidity triggers the breeding of the vectors of DHF, *Aedes aegypti*. This condition makes the DHF easily transmitted in the community. The disease is one of the emerging diseases and remains a major and growing public health problem. It was first reported in Surabaya and Jakarta in 1968. The number of the DHF cases was increasing from year to year. Since 1997, all the provinces in Indonesia reported the DHF cases every year.

Jambi Province is one of the endemic province in Indonesia. The incidence of DHF has spread throughout all the districts. Jambi City still recorded the highest number of cases throughout the year 2007 to 2019, according to the pattern of the disease namely urban disease. This is understandable considering that Jambi City has some health service facilities with supporting laboratories, and mobility of the population from and to dengue endemic areas is a risk factor the high number of dengue cases in the City. For the last 13 years (2007-2019) the IR of DHF were fluctuated.

In the period of 2008-2010 the IR intended to decline, but since 2017 the IR increase and the peak was in 2019 (62.4 per 100,000 population) higher than national standard (<49 per 100,000 population) [5]. The most effective way to prevent transmission of the virus by preventing the bite of the *Aedes aegypti* mosquitoes [1].

In dengue endemic areas, it is estimated that 85% of people use commercial insecticides to prevent *Aedes aegypti* bites. The most widely used type of insecticide is mosquito coil with the most commonly active ingredients are *pyrethroids*. Some studies found that mosquito coils are danger for human health [6-9]. It is because the exposure of its smoke can pose significant acute and chronic health risks. Burning one mosquito coil would release the same amount of PM (2.5) mass as burning 75-137 cigarettes. The emission of formaldehyde from burning one coil can be as high as that released from burning 51 cigarettes [6]. The need for environmental friendly and safe for health insecticides especially *Aedes aegypti* mosquito is an urgent.

Essential oils from plants are generally known as important natural insecticides because they will break down into non-toxic products and have little effect on organisms and the environment [10]. Many studies clearly resulted that clove and citronella oils are the best resources as essential herbal anti-mosquito against *Aedes aegypti* and *Culex* [10-15]. One of the anti-mosquito plants is the lemongrass (*Cymbopogon nardus*) which produces starch or essential oil generally known as citronella oil. The oil contains two important chemical compounds, namely citronellal and geraniol which function as mosquito repellent [16]. Lemongrass plants, especially the stems and leaves contain substances such as *geraniol*, *methyl heptenone*, *terpenes*, *terpenes-alcohol*, *organic acids* and especially *citronellal* which can be used as mosquito repellents [17].

The main content of citronella is essential oil with citronellal, citronellol, and geraniol compounds. Distillation results from citronella can be obtained geraniol and citronellal which can be used to repel mosquitoes. The ash from the leaves and stalks of citronella contains silica which is the cause of dedication (continuous discharge from the insect's body). Citronellal and geraniol are active ingredients that are disliked and highly avoided by insects, including mosquitoes so that the use of these materials is very useful as a mosquito repellent. This is because the CO₂ compounds produced by glands on human skin can be detected by mosquitoes through smell and sight [18].

The combination of the use of essential oils of citronella oil and patchouli as active ingredients in repellent products can provide a protection power of 85.2% for up to 6 hours [19]. There is an effect of using lemongrass extract as an insecticide to replace malathion in fogging with the death rate

of *Aedes aegypti* mosquitoes. The average number of mosquito deaths using lemongrass extract as a poison with the fogging method is 90% [13]. Lemongrass essential oil has activity in killing mosquitoes [20].

Thus, this study aimed to determine the effectiveness of citronella oil as anti-mosquito repellent spray against the death of *Aedes aegypti*.

Methods

This was a quasi experimental with posttest only control group design that conducted at the Environmental Health Laboratory of Public Health Sciences, Jambi University. The samples in this study were divided into two groups, treatment and control group. The sample in the treatment group were adult *Aedes aegypti* mosquitoes and citronella oil with a concentration of 50%. While the control group were adult *Aedes aegypti* mosquitoes and aquadest. We conducted 5 replication and the adult *Aedes aegypti* mosquitoes were obtained by developing from larva to adult mosquito following the natural cycle of mosquito development. Mosquito's egg samples were obtained from the Health Research and Development Center, Baturaja, South Sumatra Province. The sample size for each replication were 30 mosquitoes. While the citronella oil was obtained from the result of the process of distilling lemongrass stems with a distillation system with a concentration of 50%. The treatment application of citronella oil mosquito repellent spray was by spraying with a 2.0 AL aerosol sprayer that sprayed to the mosquitoes in the mosquito cage. Then we calculated the number of dead mosquitoes observed in a period of 10 minutes. Application of negative control (-) is by using Aquadest solution. Previously, we putted 30 mosquitoes in the cages, place the cage in the room and let it rest for 15 minutes so that the mosquitoes are stable and can adjust to the environment then direct the spray towards the cage with a nozzle distance of 1 meter from the cage. Spraying is carried out on each cage.

The study was conducted at 08.00 am until finished, with an interval of 1 hour and repeated the experiment 5 times replication and observed and counted the number of dead mosquitoes every ten minutes. Data analysis using SPSS program, with T Test test.

Results

Our study results showed that the average of died mosquitoes from the first to fifth treatments sprayed by the anti-mosquito spray made from citronella oil with a concentration of 50% showed was 29.2 mosquitoes, and the mortality rate was 97.3%. Meanwhile, for the treatment of anti-mosquito spray with negative control, there were no deaths against mosquitoes (Table 1).

Table 1: Results of anti-mosquito spray made from citronella oil against the death of *Aedes aegypti* mosquitoes

Replication	Treatment	No of died mosquitoes		
		%	Control	%
1	29	96.7	0	0
2	28	93.3	0	0
3	30	100	0	0
4	30	100	0	0
5	29	96.7	0	0
Average	29.2	97.3	0	0

Based on Table 1, it can be seen that in replication 3 and 4 in the treatment group all the mosquitoes were died (100%). Meanwhile, no mosquitoes died in the control group. The statistical test results showed that the anti-mosquito spray

made from citronella oil had a significant difference between the control sprayer to kill *Aedes aegypti* mosquitoes (p value: 0.000, 95%CI: 28.16 – 30.24), the results can be seen in the Table 2.

Table 2: Statistical test results

Variable	Mean	SD	SE	95% CI	P Value
Citronella oil spray	29.20	0.837	0.374	28.16 – 30.24	0.000
Control	0.00	0.000	0.000	-	

Discussion

The results showed that the average number of died mosquitoes against the citronella oil spray was 29.2%. The highest percentage of mosquito mortality was in the third and fourth replication (100%). These results indicated that all the replications in the treatment group resulted died mosquitoes compared with in the control group that used aquadest. The citronella oil from the lemongrass extract is effective as anti-mosquito spray.

The main content of lemongrass is essential oil with citronellal component, citronellol and geraniol. The distillation process of the plant resulted geraniol and citronellal which can be used as mosquitoes repellent. Ash from its' leaves and stem contain silica which is the cause of dedication (exit fluids from the insect's body continuously) [21]. Citronellal and geraniol are ingredients disliked and highly avoided insects, including mosquitoes so that the use of these materials is very useful as a mosquito repellent. These ingredients known to block mosquitoes' carbon dioxide receptor can't be used around people because of unpleasant odors and health safety concerns [9].

The death of mosquitoes after giving the formulation of citronella solution was due to the activity of the essential oil in lemongrass working on the respiratory system. The larvicidal effect of lemongrass powder is thought to be from the content of lemongrass in the stems and leaves of lemongrass. Lemongrass has toxic properties (desiccant), according to the way this poison works like a contact poison that can give death, due to continuous fluid loss so that the body is dehydrated, the mechanism of action of lemongrass inhibits the acetylcholinesterase enzyme by releasing serine phosphorylation of serine at the center of the enzyme concerned [22]. Symptoms of poisoning, due to the accumulation of acetylcholine which causes a special poisoning characterized by central nervous system disorders, convulsions, respiratory paralysis, and death [18, 21].

According to how it works, the chemical compound in the lemongrass extract is like a contact poison that can give death due to continuous fluid loss, so that the mosquito's body lacks fluids [23]. At first, this insecticide enters the insect's body through the surface of the body, especially the thin skin, for example in the areas associated with the segments, indentations formed from body plates, at the base of the hair and the respiratory tract. The poison that has been attached to the insect will directly enter the body and this is where the poisoning begins [22]. The average number of mosquitoes that died was 90%. There is a significant difference in usage Lemongrass extract as a substitute for malathion poison with the mortality rate of *Aedes aegypti* mosquitoes [13]. The formulation of Citronella oil with VCO gives suggestive results to consider that the intensity of the oil can have relevance to the retention time of protection on the skin [11].

The citronella oil as repellent against the bite of *Aedes aegypti*

mosquito is also effective by a minimum concentration of 3%. The higher concentration of citronella oil, the better it is used as a repellent [24]. Citronella oil is one natural product that can be used as a repellent in accordance with the repellent requirements, that is, does not interfere with its use. It is made from natural ingredients that are not sticky, smells good, non-toxic and does not cause irritation to the skin and utilizes the yard environment and is easy to cultivate [10, 11, 20, 21, 25].

Conclusions

The average number of dead mosquitoes by using citronella oil as anti-mosquito spray was 97.32%. The anti-mosquito spray made from citronella oil had a significant difference between the control spray in killing *Aedes aegypti* mosquitoes. The citronella oil is effective as mosquito repellent spray.

Suggestions

It is recommended to use citronella oil as an anti-mosquito spray not only its effectiveness but also environmental friendly. People urge to use the yard for the cultivation of lemongrass plant.

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