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Test the characteristics of essential oils of fragrant Lemongrass stems and clove leaves as an electric mosquito repellent

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Abstracts

Essential oils from the stems of citronella and clove leaves contain chemical compounds, namely citronellal, eugenol, and geraniol, which function as mosquito killers. This study aims to make essential oils from fragrant lemongrass stems and clove leaves using the distillation method. Characteristic tests were carried out in the form of determining color, density, aroma resistance, and mosquito repellency of essential oils. The results of the color determination test showed that the essential oil from clove leaves was more brown in color and the density was greater than the essential oil from the citronella stem oil, while the durability of the aroma in the citronella oil was longer than that of the clove leaf oil. In testing the repulsion of mosquitoes, observations were made for 20 minutes to determine the number of dead mosquitoes, then the value of repulsion (DT) was calculated using probit analysis. The results of the mosquito repellent test showed that the DT value of the essential oil from the citronella stem was 60%-67%, the essential oil from the clove leaf was 54%-60%, while the mixture of the essential oil from the citronella stem and clove leaf was 67%-80 %. This shows that the essential oil from a mixture of citronella stems with clove leaves is able to kill mosquitoes better than only essential oils from citronella stems or clove leaves.

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Keywords: Essential oils, clove leaves, citronella stems, distillation, electric mosquito repellent liquid

1. Introduction

In Indonesia, malaria is a public health problem to date. The mortality rate for this disease is still quite high, especially in the eastern part of Indonesia, where there is a mixture of people coming from areas that are endemic and not endemic for malaria [1]. Dengue Hemorrhagic Fever (DHF) also often occurs in communities with high levels of pollution. DHF is an endemic disease caused by the dengue virus with the *Aedes aegypti* mosquito vector and is still a health problem in Indonesia (Soegijanto, 1997 and Vitaningtyas et al., 2019). This is due to the large number of mosquitoes that breed in various places.

Various ways can be done to stop the breeding of mosquitoes, for example by using mosquito repellent lotion, spray, or burn. However, mosquito repellent circulating in shops poses a dangerous risk, both to human health and the environment. In the journal [3] it is explained that most people are currently afraid to use mosquito repellent products that have been produced by certain factories or industries because they contain chemicals that tend to be dangerous, in his journal [4] describes examples of groups of hazardous chemicals that are often used in medicine. Mosquitoes are carbamates (eg propoxur), pyrethroids (eg permethrin), organophosphates (eg. DDVP or Dichlorovinyl Dimethyl Phosphate, and DEET or diethylmetatoluamide), and organochlorines. The use of this chemical insect repellent can leave residues, lead to resistance, and pollute the environment [5]. According to WHO, one of the triggers for asthma and cancer in the respiratory tract is mosquito repellent [6].

Excessive and repeated use of chemical insect repellent can cause unwanted impacts such as environmental pollution [7]. Research [8] explained that the use of these insecticides can cause vectors to become resistant and have a negative impact on the environment. According to [9] Vegetable insecticides are an environmentally friendly alternative and relatively do not cause resistance. To reduce the side effects of

chemicals, it is necessary to develop insect repellent from natural ingredients that are safer for humans and the environment, and the sources are available in large quantities. These natural ingredients come from medicinal plants.

One of the natural ingredients of medicinal plants that can kill mosquitoes is essential oil or what is known as essential oil. Essential oils contain two important chemical compounds, namely citronellal and geraniol, which function as mosquito killers [10]. The research conducted [11] proved the larvicidal effect of piper betle linn essential oil in vitro against *Aedes aegypti* mosquito larvae.

Essential oils are secondary metabolites of plants that are volatile or volatile, therefore essential oils are also called flying oils [12]. Essential oils are compounds that are generally in the form of liquids, which are obtained from plant parts, roots, bark, stems, leaves, fruit, seeds and flowers by distillation [13].

Essential oils are scented oils that come from plants that are widely cultivated in Indonesia, including vetiver, citronella stems, patchouli, nutmeg, clove leaves, ylang ylang, jasmine and others. One of the essential oils that has potential in Indonesia is citronella oil. Citronella oil can be used in various industrial fields, for example in the flavor and fragrance industry [14].

The content of citronella stems, especially essential oils with components of citronellal 32-45%, geraniol 12-18%, citronellol 11-15%, geraniol acetate 3-8%, citronellyl acetate 2-4%, citral, kavikol, eugenol, elemol, kadinol, kadinen, vanillin, limonene, kamfen. Citronella oil contains 3 main components, namely citronellal and geraniol (Sastrohamidjojo, 2004). From the research conducted [10] explaining the results of the distillation of citronella stems, geraniol and citronellal can be obtained which can be used to repel mosquitoes. In addition, according to [7] citronella oil can also be used as a fragrance for soap, spray, disinfectant, and a polishing agent.

The results of the analysis of research conducted [10] on the effect of repelling

power of citronella (*Cymbopogon nardus*) stems on the bite of *Aedes aegypti* mosquitoes stated that the effective concentration to be used as repellent against mosquitoes, a minimum concentration of 3%. The higher the concentration of lemongrass (*Cymbopogon nardus*) juice, the better it is used as a repellent.

Another natural ingredient that can produce essential oils is clove leaves. Clove oil is widely used in the food industry as a flavor in cakes. In addition, clove oil also has biological activities, such as antibacterial, antifungal, insecticidal, antioxidant, and is used traditionally as a flavoring and antimicrobial agent in food [15]. According to [16], clove oil is traditionally used for toothache medicine. Clove oil contains essential oils in all parts of the plant. According to research [17], the essential oil content in clove leaf flowers reaches 21.3% with eugenol levels between 78-95%, from the stalk or peduncle it reaches 6% with eugenol levels between 89-95%, and from clove leaves it reaches 2-3% with eugenol content between 80-85%. The largest content of clove leaf oil is eugenol, which is useful in the manufacture of vanillin, eugenyl methyl ether, eugenyl acetate, etc.

Various studies on the manufacture of natural insect repellent in the form of lotion, spray, and even aromatherapy candles such as those carried out [18] can prove that the content of essential oils is very effective in killing mosquitoes. In a study conducted [19] citronella stems were used as an anti-mosquito material which was then processed and used as an anti-mosquito lotion, in this case the lotion could last for 6 hours. Research was also carried out by [20] using the active ingredient of patchouli oil as an anti-mosquito spray formulation. However, the range of the anti-mosquito spray formulation is limited and tends to be wasteful.

From this experiment, we used essential oils of citronella stems and clove leaves as a substitute for electric mosquito repellent liquid to test the determination of color, density, aroma resistance, and repellency against mosquitoes.

2. Experiments Procedure

Tools and Materials

The ingredients used in this study included: dry clove leaves, citronella stems, NaCl, ethanol, water, and yeast. The equipment used in this study were: a set of steam distillation equipment, an electric mosquito repellent, a mosquito cage, and a balance.

Essential Oil Manufacturing

The process of making essential oils begins with preparing the materials and tools that will be used. First, the citronella stems are cut into small pieces and weighed 500 grams, then pounded until the smell of the citronella stems is emitted. The results of the collision are put into a steam distillation apparatus, then distillation is carried out to obtain the essential oil extract. The process of making essential oils using the distillation method is shown in Figure 1.



Figure 1. Making essential oils using a distillation apparatus.

The distillation process produces a mixture of water and essential oil, then the essential oil is separated by adding NaCl so that the emulsified essential oil is separated from water as evidenced by the formation of two layers, namely the water phase and the oil phase. This is also done in the manufacture of essential oil from clove leaves.

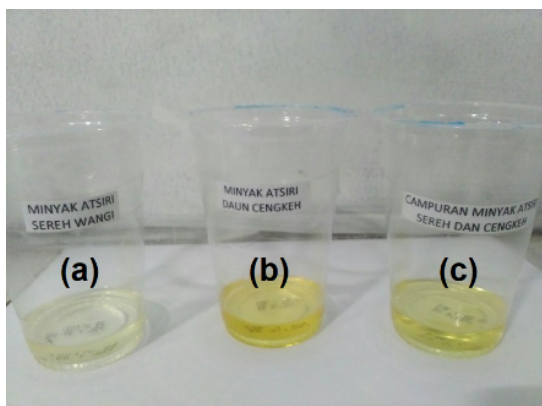


Figure 2. The results of the manufacture of essential oils. a) Citronella essential oil. b) clove leaf essential oil. c) a mixture of essential oils from fragrant citronella stems and clove leaves.

According to [21] the method of selecting steam distillation is carried out because the volatile oil is volatile. So that when exposed to hot steam, the essential oil from the fragrant lemongrass stem and clove leaves will also be carried out and accommodated as an essential oil distillate. The yield of the essential oil is shown in Figure 2.

Test Characteristics of Essential Oils

Color Determination

A total of 10 ml of essential oil is put in a clear container (avoid air bubbles). The test tube is propped up on white paper or cardboard. Color was observed with the distance of observation with the eye of ± 30 cm.

Determination of Density

Density determination is done using a balance.

Determination of Aroma Lasting

This determination is done by placing 6 ml of the essential oil that has been obtained into a small bottle. Then it is installed on an electric mosquito repellent which is connected to 220 V electricity.

Mosquito Repellent Test

The test was carried out by preparing three small bottles filled with essential oils from fragrant citronella stems, clove leaves, and a mixture of citronella stems and clove leaves. Then the bottle is mounted on an electric mosquito repellent and put into a mosquito cage measuring 30 x 22 x 21 cm³. To invite mosquitoes into the cage, a black plastic bag with yeast is used. If there are 15 mosquitoes in the cage, the cage hole is closed, and the electric mosquito repellent is connected to 220 V electricity. The number of mosquitoes that died in each experiment was calculated after evaporation at 5, 10, and 20 minutes. The mosquito repellent test process was shown in Figure 3.

Repelling power is calculated using the following formula:

$$DT = \frac{(K - P)}{K} \times 100\% \quad (1)$$

where DT is Repelling Power, K is Number of mosquitoes that are still alive, P is Number of dead mosquitoes.

3. Results and Discussion

Examination of essential oil characteristics aims to determine the quality of the essential oil produced. Characteristics examinations carried out included: color, density, aroma resistance and mosquito repellency. The test results for color, density, and aroma endurance of essential oils can be shown in Table 1.

Color Determination

Based on the results of color analysis, the essential oil from the stems of fragrant lemongrass is pale yellow, while the essential oil from clove leaves is more brownish yellow. This is due to the color of the basic ingredients of fragrant lemongrass and clove leaves

themselves. The color of the dried clove leaves is brown while the color of the fragrant lemongrass stem is white.



(a)



(b)



(c)

Figure 3. Testing mosquito repelling using essential oils. a) Citronella essential oil. b) clove leaf essential oil. c) a mixture of essential oils from fragrant citronella stems and clove leaves.

Determination of Density

In the results of the density testing of the three essential oils, it was found that the clove leaf essential oil had the highest density compared to other oils, while the lemongrass stem essential oil had the smallest density. This is because the oil content in clove leaves is more than the citronella stems. The density results obtained from this study are still in the

density range listed in the characteristics requirements of the National Standardization Agency (BSN) for essential oils.

Table 1. Test of color, density, and aroma endurance of citronella essential oil, clove leaves, and a mixture of citronella essential oil and clove leaves.

Oil Sample	Colour	Mass Density (g/L)	Aroma Lasting (Minute)
Fragrant lemongrass stalks	Pale yellow	0.897	60
clove leaf	Brownish yellow	1.026	40
A mixture of fragrant lemongrass stems and clove leaves	Yellow	0.971	100

Determination of Aroma Lasting

In the aroma endurance test, a mixture of essential oils of fragrant lemongrass stems and clove leaves produces a more fragrant, less pungent, and long-lasting aroma. This is in accordance with research conducted [14], that the aroma of citronella stems produced from its constituent components, namely geraniol, citronellal, and citronellol, can synergize with eugenol compounds from clove leaf oil.

Mosquito Repellent Test

The results of testing the mosquito repellent power of essential oils from citronella stems, clove leaves, and a mixture of citronella stems and clove leaves can be shown in Table 2.

Based on Table 2 and Figure 4, it is shown that the mixture of essential oils of citronella stems and cloves is far superior to only essential oils from citronella stems or clove leaves. This is because the constituent components of citronella, namely geraniol, citronellal, and citronellol, can synergize with eugenol from clove leaf oil. The mixture of these compounds produces a more fragrant

aroma and can damage the mosquito's nervous system more quickly.

Table 2. Test of repulsion of citronella essential oil stems, clove leaves, and a mixture of citronella stems and clove leaves on the number of mosquito deaths

Essential Oil Test Sample	test	The number of mosquitoes that died in the minute			
		1	5	10	20
Fragrant lemongrass stalks	1	0	3	7	10
	2	0	2	7	10
	3	0	2	6	9
Clove leaf	1	0	2	5	8
	2	0	1	3	9
	3	0	2	4	8
A mixture of fragrant lemongrass stems and clove leaves	1	0	2	8	11
	2	0	3	8	10
	3	0	2	9	12

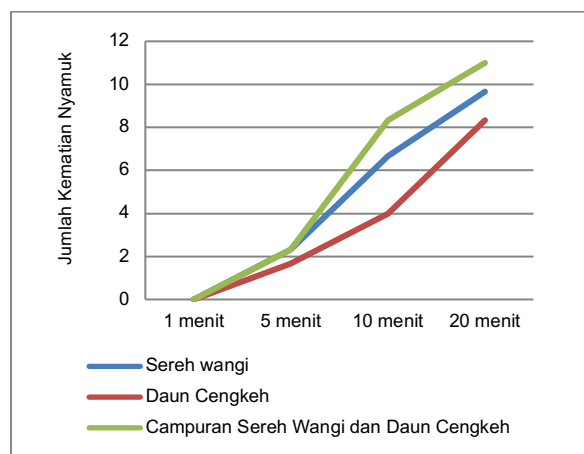


Figure 4. Graph of comparison of the average number of mosquito deaths using essential oils from citronella stems, clove leaves, and a mixture of citronella stems with clove leaves

Table 3 shows the insecticidal potential of essential oils and the time interval shows that the peak effectiveness in killing mosquitoes is in the interval of 5-20 minutes. The results of statistical analysis obtained three DT values, namely DT values from samples of citronella stems, clove leaves and

mixtures. The value of DT on fragrant lemongrass stems is 60%-67%, clove leaves is 54%-60% while the mixture of fragrant lemongrass stems and clove leaves is 67%-80% which shows that there is a difference at 5 minutes, 10 minutes, and 20 minutes. minutes in killing mosquitoes.

Table 3. Rejection Value of the number of Mosquito deaths

Essential Oil Test Sample	test	Rejection value (%) at minute			
		1	5	10	20
Fragrant lemongrass stalks	1	0	20	57	67
	2	0	14	57	67
	3	0	14	40	60
Clove leaf	1	0	14	44	54
	2	0	7	20	60
	3	0	14	37	54
A mixture of fragrant lemongrass stems and clove leaves	1	0	14	54	74
	2	0	20	54	67
	3	0	14	60	80

4. Conclusion

The conclusion that can be drawn from this study is that the characteristics of citronella essential oil are paler in color, for clove leaf essential oil the color is more brown, in density testing, citronella essential oil has a smaller density compared to clove leaf essential oil. In the aroma endurance test, a mixture of citronella stem essential oil and clove leaves produced a more fragrant, less pungent, and long-lasting aroma compared to citronella stem essential oil or clove leaf essential oil alone.

Essential oils of citronella stem and clove leaves have activity in killing mosquitoes in a span of 5-20 minutes. The mixture of citronella oil and clove leaves can kill more mosquitoes.

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