



Test The Effectiveness of the Combination of Essential Oils of Fragrant Lemongrass Leaves (*Cymbopogon nardus*) and Musk Orange Peel (*Citrus Microcarpa*) in Oil-Based Aromatherapy Candle Preparations Used Cooking Oil as a Repellent of *Aedes sp.* mosquitoes

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ABSTRACT

Aedes sp. mosquitoes are the main vector of Dengue Hemorrhagic Fever (DHF) which is a public health problem. Chemical-based mosquito control efforts tend to cause resistance and environmental impacts, so safer natural alternatives are needed. This study aims to test the effectiveness of the combination of essential oils of sweet lemongrass leaves and musk orange peel in the preparation of used cooking oil-based aromatherapy candles as a repellent of *Aedes sp.* mosquitoes. This type of pure experimental research (true experiment) using a complete random design (RAL). The population in this study was *Aedes sp.* mosquitoes and a sample of 300 mosquitoes using one control and three treatments with a concentration of 10% fragrant lemongrass leaves, 10% musk orange peel, and 10% combination of both with 3 repeats for 3 hours of observation. The data was analyzed using the Anova One-Way test with an error rate (α) of 5%. The results of the study showed that aromatherapy wax preparations from essential oils of fragrant lemongrass leaves, musk orange peel and a combination of both with a concentration of 10% can kill mosquitoes 56%, 32% and 92% respectively. There is a significant difference with (p -value = $0.000 < 0.05$). Further development of this aromatherapy wax formulation with variations in concentration is recommended to optimize its effectiveness as a repellent.

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INTRODUCTION

Dengue Hemorrhagic Fever (DHF) is an infectious disease caused by the dengue virus and transmitted through mosquitoes *Aedes aegypti* and *Aedes albopictus* (Dewi & Luciana, 2020). Dengue disease is transmitted through bites *Aedes aegypti* Females who contain dengue virus in their bodies (Maksum et al., 2023). According to (WHO, 2023) In 2023, dengue hemorrhagic fever cases globally reached record highs with more than 6.5 million cases and 6,800 deaths. According to (WHO, 2024) As of April 30, 2024, there are as many 7.6 million cases reported to the WHO in 2024.

In Indonesia, dengue is a serious health problem because its prevalence is quite high and often causes extraordinary events (KLB). Cumulatively, in 2023 there were reported 114,720 cases with 894 deaths. In the 43rd week of 2024, 210,644 cases were reported with 1,239 deaths due to dengue that occurred in 259 districts/cities in 32 provinces (Ministry of Health, 2024).

Based on data from the Gorontalo Provincial Health Office, in 2021 there were 519 known cases with a total of 16 deaths, then in 2022 it increased to 580 cases with a total of 11 deaths. In 2023, it will rise again

to 716 cases with 7 deaths. In 2024, the number of dengue cases from January to October has reached 2161 cases with 21 deaths, with the highest number of cases in February being 390 cases.

The continuous use of chemical insecticides will cause a resistance effect on mosquitoes and have a bad impact on health and the environment because they contain chemicals that are difficult to decompose in nature so that the residue will pollute the environment to reduce the quality of the environment (Maksum & Irwan, 2024). To reduce the adverse impact of the use of chemical insecticides, it is necessary to increase the optimization of the use of plants that have the ability as natural insecticides, especially for mosquitoes (Anindya et al., 2023).

distilling its leaves, this oil contains the compounds citronelal, geraniol and citronelol. The content of citronelol and geraniol is an active ingredient that mosquitoes do not like and is highly avoided. The content of citronella in lemongrass oil is a substance that has the properties of One of the natural insecticides that are widely used is the lemongrass plant. Fragrant lemongrass is a type of essential oil plant that is classified as already developed. Lemongrass essential oil is obtained from the result of poison which can cause death in mosquitoes (Ginting et al., 2024).

The musk orange plant is also a natural insecticide that produces essential oils. The repulsion ability of musk oranges is due to the content of essential oils found in the skin of musk oranges can affect the nerves of mosquitoes, one of which is linalool. Linalool is one of the compounds found in essential oils contained in the skin of musk citrus fruits that can cause mosquitoes to limp or cause death (Soenjono et al., 2022).

One of the efforts made to overcome the vector of the spread of dengue disease is the use of anti-mosquito wax preparations. Aromatherapy candles from natural ingredients can provide health benefits such as reducing stress, increasing relaxation, and improving mood, in addition to which aromatherapy candles can be used to repel insects (Vani et al., 2024). The aromatherapy candles in this study were made with a new innovation, namely by utilizing used cooking oil.

Used cooking oil is oil from leftover frying products that are usually produced from cooking activities in the household. Used cooking oil that is used repeatedly up to 4 times can increase the potential for cancer and narrowing of blood vessels that can trigger hypertension, stroke, and coronary heart disease. Careless disposal of used cooking oil waste can result in soil and water pollution (Bachtier et al., 2022).

Based on the results of the study (Yusmitaria, 2020) Tests conducted on aromatherapy candles showed that the four best formulations of lemongrass essential oil were the formulation of wax preparations with 15% active substances with 10 mosquito deaths. Based on the results of the study (Soenjono et al., 2022) Tests conducted on lotions showed that musk orange essential oil with a concentration of 7.5% and 15% has the ability to resist or repellent 100% for 6 hours against mosquitoes.

Based on the results of a 3-hour pre-laboratory test with concentrations of 5%, 10% and 15%. At a concentration of 5% it causes mosquito mortality *Aedes* sp as many as 7 (28%) of the tails. At a concentration of 10% causes mosquito mortality *Aedes* sp as many as 11 (44%) of the heads. At a concentration of 15% it causes mosquito mortality *Aedes* sp as many as 15 (60%) of the tails. According to (WHO, 2016) that a repellent Mosquitoes are said to be effective if the number of mosquito deaths is 80% - 90% of the total mosquitoes tested. This can prove that the combination of essential oils of lemongrass leaves and musk orange peel has not been effective as a repellent with a concentration of 15%. Therefore, the concentration must be increased.

Based on the background description, it is necessary to conduct research on the 'Effectiveness Test of the Combination of Fragrant Lemongrass Leaf Essential Oil (*Cymbopogon nardus*) and Musk Orange Peel (*Citrus microcarpa*) in the preparation of used cooking oil-based aromatherapy candles as a repellent for *Aedes* sp. mosquitoes.'

RESEARCH METHODS

Research Location and Time

The location of the research conducted is at the Public Health Laboratory of Gorontalo State University, and the research time will be conducted in February-March 2025.

Research Design

The type of research used is a true experiment or pure experiment using a Complete Random Design (RAL), where this study uses 1 control and 3 treatments, namely the administration of citronella leaf essential oil, musk orange essential oil and a combination of both essential oils with 3 repetitions for 3 hours.

Population and Sample

The population in this study is *Aedes* sp mosquitoes and the sample in this study is as many as 300 mosquitoes.

Data Analysis

The data obtained in this study was analyzed using the help of a computer program. The statistical test stage was carried out using the data normality test, then the data homogeneity test, followed by the One-Way Variance Analysis test followed by the Post Hoc test with LSD (Least Significance Difference).

RESULTS

Univariate Analysis Results

Table 1 Death of *Aedes sp* Mosquitoes Using Aromatherapy Wax from Lemongrass Leaf Essential Oil (*Cymbopogon nardus*)

Essential Oils	Number of Deaths of <i>Aedes sp</i> Mosquitoes			Average Mortality of <i>Aedes sp</i> Mosquitoes	
	P1	P2	P3	n	%
Control	0	0	0	0	0
Fragrant Lemongrass Leaves	14	14	15	14	56

Source : Primary Data, 2025

Based on Table 1, it is known that after being given an aromatherapy wax treatment from lemongrass leaf essential oil with a concentration of 10% in an observation time of 3 hours, the most effective as a natural insecticide against the death of *Aedes sp* mosquitoes is in the third repetition with 15 deaths (60%) and the least effective level in the first and second repetitions with 14 mosquito deaths (56%).

Table 2 Death of *Aedes sp* Mosquitoes Using Aromatherapy Wax From Musk Orange Peel Essential Oil (*Citrus microcarpa*)

Essential Oils	Number of Deaths of <i>Aedes sp</i> Mosquitoes			Average Mortality of <i>Aedes sp</i> Mosquitoes	
	P1	P2	P3	n	%
Control	0	0	0	0	0
Musk Orange Peel	7	8	8	8	32

Source : Primary Data, 2025

Based on Table 2, it is known that after being given an aromatherapy wax treatment from musk orange peel essential oil (*Citrus microcarpa*) with a concentration of 10% in an observation time of 3 hours, the most effective as a natural insecticide against the death of *Aedes sp* mosquitoes is in the second and third repetitions with the number of mosquito deaths as many as 8 (32%) and the least effective level in the first repetition with the number of deaths 7 mosquitoes (28%).

Table 3. Death of *Aedes sp* Mosquitoes Using Aromatherapy Candles From the Combination of Essential Oils of the Two

Essential Oils	Number of Deaths of <i>Aedes sp</i> Mosquitoes			Average Mortality of <i>Aedes sp</i> Mosquitoes	
	P1	P2	P3	n	%
Control	0	0	0	0	0
Combination of Fragrant Lemongrass Leaves and Musk Orange Peel	22	23	23	23	92

Source : Primary Data, 2025

Based on Table 3, it is known that after being given an aromatherapy wax treatment from a combination of essential oils of lemongrass leaves (*Cymbopogon nardus*) and musk orange (*Citrus microcarpa*) with a concentration of 10% in an observation time of 3 hours, which is most effective as a natural insecticide against the death of *Aedes sp* mosquitoes was in the second and third repetitions with the number of mosquito deaths as many as 23 (92%) and the least effective rate in the first repetition with the number of mosquito deaths as many as 22 (88%).

Bivariate Analysis Results

Table 4 Results of Data Normality Test Analysis

Variable	<i>p-value</i>
Essential oils of fragrant lemongrass leaves, musk orange peel, and a combination of the two	0,103

Source : Primary Data, 2025

Based on Table 4, the results of the normality test showed that the variable data of essential oils, lemongrass leaves, musk oranges and a combination of the two using the Shapiro-Wilk test obtained a $p\text{-value} = 0.103 > 0.05$, meaning that the data was normally distributed.

Table 5 Data Homogeneity Test Analysis Results

Variable	<i>p-value</i>
Essential oils of fragrant lemongrass leaves, musk orange peel, and a combination of the two	1,000

Source : Primary Data, 2025

Based on Table 5 above, it is known that $p\text{-value} = 1,000 > 0.05$, so it can be concluded that the data has the same variance or homogeneity

Table 6 Anova One-Way Test Results

Variable	<i>p-value</i>
Essential oils of fragrant lemongrass leaves, musk orange peel, and a combination of the two	0,000

Source : Primary Data, 2025

Based on table 6 above, it is known that the results of the One-Way Anova test obtained a $p\text{-value} = 0.000 < 0.05$, so it can be said that there is a difference in the effectiveness of essential oils of lemongrass leaves, musk orange peel and a combination of the two with a concentration of 10% as a repellent of *Aedes sp* mosquitoes.

Table 7 Results of Post Hoc Test Analysis

Variable	<i>p-value</i>
Fragrant lemongrass leaf essential oil	0,000
Musk orange peel essential oil	0,000
Combination of essential oils of the two	0,000

Source : Primary Data, 2025

Based on table 7, it is known that the results of the Post Hoc test using the LSD test show that the treatment of lemongrass leaves is different from the treatment of musk orange peel in killing *Aedes sp* mosquitoes ($p\text{-value} = 0.000 < 0.05$). The treatment of lemongrass leaves is different from the combination treatment of the two in killing *Aedes sp* mosquitoes ($p\text{-value} = 0.000 < 0.05$).

DISCUSSION**Percentage of *Aedes sp* Mosquitoes Killed in Aromatherapy Wax from Lemongrass Leaf Essential Oil (*Cymbopogon nardus*)**

Based on the results of mosquito mortality research *Aedes sp* at a concentration of 10% indicates that aromatherapy candles from lemongrass leaf essential oil are not yet effective as repellent mosquito. According to WHO, (2016) that a repellent Mosquitoes are said to be effective if the number of mosquito deaths is 80% - 90% of the total mosquitoes tested. The results showed that the effectiveness of aromatherapy wax from lemongrass leaf essential oil at a concentration of 10% caused the death of 14 mosquitoes (56%).

Aromatherapy candles from lemongrass leaf essential oil at a concentration of 10% are not effective because the concentration used is too low. The higher the concentration used, the more active compounds are released into the air. Lemongrass leaf essential oil is volatile or volatile which in low concentrations of this compound quickly disappears from the air before interfering with the mosquito's olfactory system (Aryani et al., 2020).

Mosquito mortality *Aedes sp* This is because the essential oils of fragrant lemongrass leaves contain substances such as citronelal and sIttronelol It has contact poison properties. As a contact poison, the essential

oil of lemongrass leaves causes mosquitoes to lose fluid continuously so that their body will lack fluids and eventually die. In addition, aromatic lemongrass leaf essential oil is also contained Geraniol which has the property of gastric poison where this poison can attack the stomach of mosquitoes and cause mosquitoes to die (Darmawan, 2021).

The results of the study are in line with the research Yusmitaria (2020) with the aromatherapy candle method from lemongrass oil for 15 minutes. The results of the study showed that of the 3 concentrations used, namely 5%, 10%, and 15%. The best concentration is 15% with 15% mosquito deaths.

Percentage of Aedes sp Mosquitoes Killed in Aromatherapy Candles From Musk Orange Peel Essential Oil (*Citrus microcarpa*)

Based on the results of mosquito mortality research Aedes sp at a concentration of 10% indicates that aromatherapy wax from musk orange peel essential oil is not yet effective as a repellent mosquito. According to WHO (2016) that a repellent Mosquitoes are said to be effective if the number of mosquito deaths is 80% - 90% of the total mosquitoes tested. The results showed that the effectiveness of aromatherapy wax from musk orange peel essential oil at a concentration of 10% caused the death of 8 mosquitoes (32%).

Aromatherapy candles from musk orange peel essential oil at a concentration of 10% are not yet effective because the concentration used is too low. The higher the concentration used, the more active compounds are released into the air. Musk orange peel essential oil is volatile or volatile which in low concentrations of this compound quickly disappears from the air before interfering with the mosquito's olfactory system (Aryani et al., 2020).

Mosquito mortality Aedes sp This is because musk orange peel essential oil contains bioactive compounds including: D-Limonene which is proven to be contact poison and respiratory poison in insects, especially mosquitoes. Musk orange peel essential oil contains or compounds essential oils can affect the nerves of mosquitoes, one of which is Linalool. Linalool It is also one of the compounds found in essential oils contained in the peel of lime fruits that can cause mosquitoes to limp or cause death (Soenjono et al., 2022).

The composition of compounds contained in the essential oils of the fruit peel of the Citrus genus include Limones, Linalool, Citronelal and Geraniol. The two main compounds are Limonen and Linalool can intoxicate insects (Amalina et al., 2018).

The results of the study are in line with Hasriani & Rasjid (2020) from grapefruit peel in killing mosquitoes. The results of the study showed that of 5 different concentrations, namely 40%, 50%, 60%, 70%, and 80% concentrations with a time interval of 5 hours. In the fifth concentration, no one is able to kill mosquitoes because even at the highest concentration, which is 80%, grapefruit can only kill mosquitoes by (50%).

Percentage of Aedes sp mosquitoes killed on aromatherapy candles from the combination of essential oils of the two

Based on the results of mosquito mortality research Aedes sp At a concentration of 10% indicates that aromatherapy candles from a combination of essential oils of lemongrass leaves and musk orange peel are effective as repellent mosquito. According to WHO (2016) that a repellent Mosquitoes are said to be effective if the number of mosquito deaths is 80% - 90% of the total mosquitoes tested. The results showed that the effectiveness of aromatherapy candles from the combination of citronella leaf essential oil and musk orange peel at a concentration of 10% caused mosquito deaths in 23 (92%).

Mosquito deaths are caused by poisoning by the active compounds found in lemongrass leaves and musk orange peel due to the aroma emitted from the combustion of aromatherapy candles mixed with a combination of essential oils from both plants. The smell was pungent and spread throughout the test box room until the test mosquitoes in the test box were no longer able to survive (Hasriani & Rasjid, 2020).

The combination of essential oils of fragrant lemongrass leaves and musk orange peel can have an effect repellent which is better. This is because both plants contain compounds that can kill mosquitoes. Fragrant lemongrass has the following ingredients: citronelol, geraniol and citronelal. According to (Saputra et al., 2020). that Citronelol, geraniol and citronelol It is toxic at the time of contact with insects and will die due to loss of fluid in the insect's body. Likewise, oranges contain Limonene, Linalool and Geraniol Where the compounds found in oranges are very disliked by mosquitoes and can be deadly to mosquitoes (Firyanto et al., 2021).

Mosquito death is also caused because both plants have the same content, namely Geraniol. Aromatic lemongrass leaf essential oil has ingredients Geraniol as much as 12-18% (Puspita, 2020). While musk orange peel essential oil has Geraniol as much as 1.72% (Elpianasari, 2023). This proves that if the two plants are combined it will increase the effectiveness as a repellent mosquito.

The results of the study are in line with the research Puspita (2020) with the Aedes and Culex mosquito repellent aromatherapy wax method from a combination of lemongrass essential oil and lime peel. The results of the study showed that of the 4 concentrations, namely 5%, 10%, 15% and 25% concentrations.

At a concentration of 25%, it shows the best combination of citronella essential oil and lime peel with mosquito repellent of 25.3%.

The Difference Between Aromatherapy Candles From Lemongrass Leaf Essential Oil, Musk Orange Peel and Combination of Essential Oils Both in Killing *Aedes* sp Mosquitoes

Based on the results of the statistical test using the One-Way Anova test, $p\text{-value} = 0.000 < 0.05$ was obtained, so it can be said that there is a difference in the effectiveness of essential oils of lemongrass leaves, musk orange peel and a combination of the two with a concentration of 10% as a repellent of *Aedes* sp. mosquitoes.

Aromatherapy candles from the combination of citronella leaf essential oil and musk orange peel are more effective compared to single citronella leaf essential oil or single musk orange peel. This can be seen from the average mosquito mortality of 92%. This is in accordance with the explanation (Ramsey et al., 2020) which explains that Combinations of essential oils from different plants are believed to increase the effectiveness of essential oils as insect repellents when compared to individually isolated components.

However, aromatherapy candles from single fragrant lemongrass leaf essential oil already have the potential to be repellent. This can be seen from the average mosquito mortality of 56%. Likewise, the peel of a single musk orange has the potential to be a mosquito repellent. It can be seen from the average mosquito mortality of 32%.

CONCLUSION

The percentage of *Aedes* sp mosquitoes killed in aromatherapy wax from citronella leaf essential oil (*Cymbopogon nardus*) with a concentration of 10% was 14 (56%).

The percentage of *Aedes* sp mosquitoes killed in aromatherapy wax from musk orange peel essential oil (*Citrus microcarpa*) with a concentration of 10% is 8 (32%)

The percentage of *Aedes* sp mosquitoes killed in aromatherapy wax from the combination of essential oils of lemongrass leaves (*Cymbopogon nardus*) and musk orange peel (*Citrus microcarpa*) with a concentration of 10% was 23 (92%)

There is a difference in aromatherapy candles from the essential oil of fragrant lemongrass leaves (*Cymbopogon nardus*), musk orange peel (*Citrus microcarpa*) and the combination of the two in killing *Aedes* sp mosquitoes with ($p\text{-value} = 0.000$)

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