

PROTECTIVE EFFECT OF LEMONGRASS AND CINNAMON ESSENTIAL OIL LOTION AGAINST *Aedes aegypti*

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ABSTRACT

Protective Effect of Lemongrass and Cinnamon Essential Oil Lotion Against *Aedes aegypti*. Dengue hemorrhagic fever (DHF) is still a health problem and threat in several regions of Indonesia. Using mosquito repellent can prevent the incidence of dengue fever. In the industrial world, products such as mosquito repellent lotion are released. Lotions circulating in the community contain DEET. Bug sprays with chemicals can be replaced with natural bug sprays made from things like the essential oils *Cymbopogon nardus* (C.n.) and *Cinnamomum burmannii* (C.b.), which contain chemicals that kill mosquitoes. This study employs an experimental laboratory approach, utilizing a post-test-only group design. The goal of this study was to find out how well mosquito repellent lotion made with *Cymbopogon nardus* (C.n) essential oil and *Cinnamomum burmannii* (C.b) essential oil worked at keeping people safe. *Aedes aegypti* mosquito samples totaled 1200 mosquitoes. Each treatment was repeated six times (50 mosquitoes). B2P2VRP Salatiga research location. A repellent test is used to collect data. Data processing is carried out with the Anova statistical test. The Anova statistical test was used to process the data. On average, lotions at 400 ppm C.N. provided the most protection at the 1st hour (82.16%) and the 6th hour (50.12%). The conclusion of this study was that, although it did not reach the effective value (<90%), with the addition of concentration, it is possible to increase repulsiveness. So, more research can be done on the effectiveness of *Cymbopogon nardus* essential oil and *Cinnamomum burmannii* essential oil by mixing them in lotions in different ways.

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INTRODUCTION

Mosquitoes are small insects that are active and multiply in hot and humid conditions. Mosquitoes are spread all over the world, can bite and cause allergic reactions and disorders ⁽¹⁾. Mosquito distribution is typically found in tropical countries such as Indonesia. Mosquitoes that can be vectors of disease are only female mosquitoes with the genera *Aedes*, *Culex*, *Anopheles*, *Mansonia* and *Armigeres* ⁽²⁾. Mosquito *Aedes aegypti* is a vector dengue disease. Almost half of the world's population, or about 4 billion people, lives in areas prone to dengue ⁽³⁾. Dengue cases increase in the rainy season. The number of cases of dengue in Indonesia in the 22nd week of 2022 reached 45,387 incidents, while the number of deaths due to dengue reached 432 incidents. There are 10 provinces that have the potential to be endemic to dengue fever incidence in Indonesia ⁽⁴⁾.

The incidence of dengue fever can be prevented by using mosquito repellents. The industrial world manufactures lotion mosquito repellent. However, the emergence of mosquito repellents from industry has caused many problems, ranging from the waste produced to the disruption of human health ⁽⁵⁾. Repellents circulating in the community mostly contain diethyltoluamide, or DEET, which has a negative impact ⁽⁶⁾, which can be minimized by shifting to using natural mosquito repellents. Natural mosquito repellent can be obtained from plants that contain chitranolol, granial, flavonoid, chaponic, and phenolic compounds, such as citronella plants (*Cymbopogon nardus*) and cinnamon (*Cinnamomum burmannii*) ⁽⁵⁾. Essential oil Citronella contains the compounds sitronellal and geraniol, which function as mosquito repellents, but it is not yet known at what concentration citronella is effective at repelling mosquito bites. Compound citronellal Acting as a material insecticide who works as athantifeedant and repellent (insect repellent and inhibitor) ⁽⁷⁾. The contents of the essential oil cinnamon, i.e., flavonoid, onin and geraniol, can be used as mosquito repellents or repellents against mosquitoes *Aedes aegypti* ⁽⁸⁾.

Previous research has explained that Essential Oil Chair Bank (*Cymbopogon nardus*) at a concentration of 97.91 percent has a repulsive power (repellent) for 2 hours ⁽⁹⁾. Previous research has also explained that cinnamon ethanol extract (*Cinnamomum burmanii*) with concentrations of 5%, 10% and 20% can be used as a repellent against the mosquito *Aedes aegypti*. The concentration of cinnamon ethanol extract (*Cinnamomum burmanii*) that is most effective as a repellent (rejection) is at a concentration of 20% ⁽¹⁰⁾. Mosquito control can be done by using repellent lotion made from natural materials to reduce the impact repellent chemicals that are negative for the human body. Therefore, it is necessary to have a safer, more effective, efficient and environmentally friendly alternative, namely the natural repellent ⁽¹¹⁾.

This study was carried out to determine the effective formulation of a lotion mosquito repellent consisting of a combination of essential oil Chair Bank (*Cymbopogon nardus*) with essential oil cinnamon (*Cinnamomum burmannii*), because the citronella plant (*Cymbopogon nardus*) contains chemical compounds, namely sitronellal and geraniol, which function as mosquito repellents. The citronella plant has a strong and distinctive aroma so it can be a mosquito repellent because of its smell, which mosquitoes do not like. ⁽¹²⁾. While cinnamon plants have chemical compounds, namely flavonoids, Saponin and geraniol, which function as mosquito repellents, Therefore, the two plants are used as natural repellents, especially for mosquitoes ⁽¹³⁾. Based on this explanation, a study on protective power was carried out on Repellent Lotion Essential Oil Serai Wangi *Cymbopogon nardus* C.N. combined with Essential Oil Cinnamon *Cinnamomum burmannii* C.B. against Mosquitoes *Aedes aegypti*.

MATERIALS AND RESEARCH METHODS

This study is a laboratory experiment using a posttest only group design which aims to determine the protective power of *Cymbopogon nardus* (C.n) essential oil in combination with *Cinnamomum burmannii* (C.b) essential oil formulated into mosquito repellent lotion. The sample of *Aedes aegypti* mosquitoes was 1,200 mosquitoes per treatment and repeated 6 times (1 repetition = 50 mosquitoes). The location of the research is in B2P2VRP Salatiga. Data collection was carried out by repellent test. Data processing was carried out by Anova statistical test.

The manufacture of lotion in this study was by preparing tools such as mortar, tamper, porcelain cup, water bath, measuring cup spatula, measuring tube, pipette, and analytical scale. The ingredients in making lotions are EO C.n, EO C.b, paraffin, stearic acid, cetyl alcohol, triatenolamine, propylene glycol, and aquades. The method of making lotion begins by preparing the tool and weighing the ingredients EO C.n (0.2 ml, 0.3 ml, 0.4 ml), EO C.b (0.1 ml), paraffin (2.5 ml), stearic acid (3 gr), cetyl alcohol (2 gr), triatenolamin (2 gr), propylene glycol (1 ml), and aquades (ad 100 ml). The two phases of the oil, consisting of paraffin, stearic acid, cetyl alcohol, propylene glycol, are put into a porcelain cup and then heated in a

water tank until all the ingredients are dissolved and then put into the mortar and homogenized. Next, the water phase of triatenolamin is heated and then mixed with the oil phase and homogenized, plus aquades little by little until it becomes the desired concentration, and finally add EO C.n and EO C.b and homogenized until mixed, after that put it into the lotion container.

Repellent testing is carried out by comparing the control arm with the experimental arm. The experimental arm is an arm that is given a special treatment, namely applied Eo C.n lotion in combination with Eo C.b with concentrations of 200 ppm C.n and 100 ppm C.b, 300 ppm C.n and 100 ppm C.b, 400 ppm C.n and 100 ppm C.b and 2 ml of negative control is inserted into the repellent test tank for 5 minutes every hour in a span of 6 hours. Meanwhile, the control arm did not receive any special treatment and was put into the repellent test chamber for 5 minutes every hour in a span of 6 hours. Each treatment was counted for mosquitoes that landed on the hands of probands, to determine the protective power of the repellent EO C.n combination of EO C.b.

RESEARCH RESULTS AND DISCUSSION

Results of Lotion Manufacturing

Cymbopogon nardus (C.n) essential oil lotion combined with Cinnamomum burmannii (C.b) essential oil is made with 3 concentrations, namely Cymbopogon nardus (C.n) essential oil 200 ppm, 300 ppm, and 400 ppm added cinnamon essential oil Cinnamomum burmannii (C.b) 100 ppm each. The comparison of the 3 concentrations of essential oil lotions is control negative lotion which is a lotion without the mixture of essential oil C.n and essential oil C.b. The weight of the lotion produced is 100 ml. The characteristics of the lotion include the color, texture, aroma, and viscosity of the lotion. There are 4 lotion formulations. Formulation 1 consists of 0 ppm C.n and 0 ppm C.b called control negative. Formulation 2 consists of 200 ppm C.n and 100 ppm C.b called 200 ppm C.n. Formulation 3 consists of 300 ppm C.n and 100 ppm C.b called 300 ppm C.n. Formulation 4 consists of 400 ppm C.n and 100 ppm C.b called 400 ppm C.n. Testing the characteristics of this lotion is carried out to determine the characteristics of the four lotion formulations. The results of the characteristic test are as follows:

Table 2. Characteristics of *Lotion Formulation*

Parameter	Formulation			
	<i>Control negative</i>	200 ppm C.n	300 ppm C.n	400 ppm C.n
Color	White	White	White	White
Texture	Soft and Smooth	Soft and Smooth	Soft and Smooth	Soft and Smooth
Aroma	Odorless C.n	Somewhat smelly C.n	Smells of C.n	Very smelly C.n
Consistency	Semipadat	Semipadat	Semipadat	Semipadat

Lotion formulations 1-4 are white, have a smooth texture, and are soft when applied to the skin. The 400 ppm C.N. lotion formulation smells the most C.N. compared to other concentrators because it has the highest C.N. content in the lotion, while the control negative lotion formulation does not smell C.N. because it is not mixed with C.N. essential oil in the lotion. The four semi-dense lotion formulations maintain consistency and are simple to apply on the skin.

Repellent Test Results

The protective power of the four lotion formulations can be seen in tables 3 to 6.

Table 3. *Negative Control Lotion Protection*

Replication	1st Hour	2nd Hour	3rd Hour	4th Hour	5th Hour	6th Hour
	DP(%)	DP(%)	DP(%)	DP(%)	DP(%)	DP(%)
1	27,05	30,53	32,60	27,25	30,53	29,14
2	50,85	25,67	24	30,40	28,77	26,15
3	47,71	27,52	33,21	29,98	27,71	28,57
4	11,71	36,04	31,88	31,76	32,46	27,29
5	23,06	31,04	27,57	27,30	28,69	29,02
6	21,81	32,21	29,66	30,73	28,70	30,86
Rerata DP (%)	30,49	30,50	29,84	29,60	29,47	28,50

The protection of the 6 probandus decreased from the 1st to the 6th hour. The average protection power of the 1st hour is 30.49%, while the average of the 6th hour is 28.50%. The protection of *negative control lotion* tends to decrease every hour.

Table 4. *Lotion Protection Power 200 ppm C.n*

Replication	1st Hour	2nd Hour	3rd Hour	4th Hour	5th Hour	6th Hour
	DP(%)	DP(%)	DP(%)	DP(%)	DP(%)	DP(%)
1	44,66	45,59	37,95	35,47	48,19	60,52
2	53,83	47,93	52,39	45,57	29,71	39,33
3	61,26	57,95	41,83	57,65	65,61	45,99
4	76,08	57,81	47,54	46,63	41,54	40,59
5	62,98	46,00	42,10	41,56	41,77	39,67
6	64,38	51,11	42,22	46,84	43,84	44,13
Rerata DP (%)	60,54	51,07	44,01	45,59	45,11	45,04

Probandus number 1's protection has increased from the 1st hour to the 6th hour. The average result of the protection power of the 6 probandus decreased from the 1st to the 6th hour. The average protection power of the first hour is 60.54%, while the average of the sixth hour is 45.04%. The protective power of 200 ppm C essential oil lotion tends to decrease every hour.

Table 5. *Lotion Protection Power 300 ppm C.n*

Replication	1st Hour	2nd Hour	3rd Hour	4th Hour	5th Hour	6th Hour
	DP(%)	DP(%)	DP(%)	DP(%)	DP(%)	DP(%)
1	65,60	50,87	38,36	42,39	40	41,18
2	53,44	61,76	39,67	40,68	55,80	65,87
3	70,27	58,16	57,78	48,18	69,59	53,69
4	74,76	71,28	62,33	63,13	50,62	43,73
5	58,76	61,76	59,85	50,96	51,36	49,15
6	65,84	66,35	50	51,19	51,5	42,30
Rerata DP (%)	64,79	61,70	51,37	49,42	53,81	49,29

Probandus protection number 2 is fructuous, going up and down from the first hour to the sixth hour. The average result of the protection power of the 6 probandus decreased from the 1st to the 6th hour. The average protection power of the first hour is 64.79%, while the average of the sixth hour is 49.29%. Each hour, the protective power of 300 ppm C essential oil lotion tends to decrease.

Table 6. *Lotion Protection Power 400 ppm C.n*

Replication	1st Hour	2nd Hour	3rd Hour	4th Hour	5th Hour	6th Hour
	DP(%)	DP(%)	DP(%)	DP(%)	DP(%)	DP(%)
1	79,44	44,77	47,17	55,75	48,47	47,86
2	79,74	73,65	44,16	30,16	48,30	60,71
3	82,39	62,15	50	53,62	53,20	45,74
4	88,77	60,07	41,76	55,82	64,59	33,28
5	74,56	70,29	72,05	68,82	58,96	56,59
6	88,04	78	74,18	66,74	51,45	56,69
Rerata DP (%)	82,16	65,13	54,89	53,94	54,18	50,12

Probandus number 2's protection has increased from the 1st to the 6th hour. The average result of the protection power of the 6 probandus decreased from the 1st to the 6th hour. The average protection power of the first hour is 82.16%, while the average of the sixth hour is 50.12%. Each hour, the protective power of an essential oil lotion at 400 ppm C.N. tends to decrease.

The protection results show that lotion control is negative, which is smaller than lotion essential oil. This indicates that the materials used, either lotion or base lotion, have no effect on increasing protection against mosquitoes *Aedes aegypti*. More essential oil added to lotion will increase the average protection lotion from the 1st hour to the 6th hour. Research by Werdiningsih and Amalia (2018) supports the idea that a lower concentration of extracts results in a less significant impact on insects. On the other hand, a higher concentration of extracts results in a greater influence, as the action of a compound is heavily influenced by its concentration.

Lotion essential oil C.N., C.B., and lotion control tend to experience a decrease in protection from the 1st to the 6th hour. Decrease in protection power in lotion demonstrates the durability of essential oil. It is not long enough. Essential oils are less durable. This could be attributed to factors such as the high rate of evaporation during the test, skin and sweat absorption, human factors like temperature, and the activity of the probandus during the test⁽¹⁵⁾.

Based on the research that has been carried out, the results show that lotion control at 200 ppm C.N., 300 ppm C.N., and 400 ppm C.N. are less effective because they have less than 90% protection. According to the Pesticide Commission Department's government regulation (1995), repellent protection should reach an average of 90% by the 6th hour. The standards in Indonesia are not in line with the standards used in Canada, which say that a repellent can be registered if the substance provides more than 95% protection for at least 30 minutes⁽¹⁶⁾. The 400 ppm C.N. lotion in Table 4 shows the highest average protection compared to other concentrations, namely 82.26% at the 1st hour and 50.12% at the 6th hour. This study's protection is less effective because it is less than 90%. Essential oils *Serai Wangi Cymbopogon nardus* (C.n) and cinnamon *Cinnamomum burmannii* (C.b.) have been proven to be effective in repelling mosquitoes. According to Halim and Fitri's (2020) research, lotions with citronella oil content (397,000 ppm), citronellol (120,000 ppm), and geraniol (176,000 ppm) have an average protection of 98.3% in the first hour. According to Devitria (2021), cinnamon ethanol extract (*Cinnamomum burmanii*) with concentrations of 50,000 ppm, 100,000 ppm and 200,000 ppm can be used as a repellent against *Aedes aegypti* mosquitoes. The most effective concentration of cinnamon ethanol extract (*Cinnamomum burmanii*) for repelling mosquitoes is 200,000 ppm. The addition of essential oil to lotion alters the protection provided.

This study found that the essential oils *Serai Wangi Cymbopogon nardus* (C.n) and cinnamon *Cinnamomum burmannii* (C.b) provide less protection than commercial DEET. *Serai Wangi Cymbopogon nardus* (C.n) and essential oil *Cinnamomum burmannii* (C.b) have lower protection compared to commercial DEET. This can be observed from the average repellent power of the positive control, which uses Lotion 100% commercially branded Soffel (18). The active ingredient in Lotion Soffelll is 13% DEET. Protection lotion Soft fell in protecting the body from mosquito bites, which reached 8 hours after application, while in this study, 400 ppm C.N. lotion only had an average protection of 82.26% in the first hour.

Difference in the Protection Power of Essential Oil Lotion

Bivariate analysis using the Anova test was carried out to determine the difference in protective power between the concentration of *Cymbopogon nardus* (C.n) lemongrass essential oil in combination with *Cinnamomum burmannii* (C.b) cinnamon essential oil in repelling mosquitoes. The results of the anova test are as follows:

Table 7. Anova test results on an hourly basis

Treatment	Protection (%) per hour					
	1st Hour	2nd Hour	3rd Hour	4th Hour	5th Hour	6th Hour
<i>Control negative</i>	30,49	30,50	29,84	29,60	29,47	28,50
200 ppm C.n	60,54	51,07	44,01	45,59	45,11	45,04
300 ppm C.n	64,79	61,70	51,37	53,81	53,81	49,29
400 ppm C.n	82,16	65,13	54,89	54,18	54,18	50,12
Significance	0,000	0,000	0,000	0,000	0,000	0,000

he results of the anova test showed that the significance value of all hourly lotion protection concentrations was $0.000 \leq 0.05$, so there was a difference in the protection power of the negative control lotion at 200 ppm C.N., 300 ppm C.N., and 400 ppm C.N. in repelling mosquitoes. The lotion with the highest concentration has a protective power of 400 ppm C.N.

Research Halim & Fitri (2020) This research is supported by testing the anti-mosquito activity of citronella oil. The test results statistic shows a p-value of 0.000 or $< \alpha$ (5%), so it can be concluded that there is a significant difference between the use of citronella oil and the VCO formulation on the protection against mosquitoes, *Ae. aegypti*. Lukman et al. (2012) are researching the formulation of cinnamon bark oil gel as a mosquito repellent preparation. Based on the results of the one-way anova calculation, the F value is calculated to be greater than the F table at the 1% level, indicating a difference between the preparation's appearance, specifically its smell, and the concentration of cinnamon bark oil added. The higher the concentration of cinnamon bark oil added, the stronger the smell and the more repellent.

This study found that the lotion control formulations with a concentration of 200 ppm C.N., 300 ppm C.N., and 400 ppm C.N. had an ineffective protection power of approximately 90%. Although lotion control is negative, 200 ppm C.N., 300 ppm C.N., and 400 ppm C.N. are not effective. However, this study proves that EO *Cymbopogon nardus* and EO *Cinnamomum burmannii* can repel mosquitoes. Protection lotion can be improved by adding more EO to the lotion ⁽²⁰⁾.

Lotion C.n. and C.b. have higher protection than control negative. The Citronella plant, *Cymbopogon nardus* (C.n.), is known as Citronella Oil. Citronella oil has an odor that mosquitoes do not like and contains two important chemical compounds, namely sitronellal and geraniol, which function as mosquito repellents ⁽¹⁷⁾. Sitronellal and geraniol possess the capacity to act as contact toxins, enhancing sensory nerve activity in insects and stimulating motor nerves, leading to seizures and paralysis in certain insects ⁽¹⁷⁾. Geraniol It also possesses the potential to act as a stomach poison, which, when ingested by insects, can lead to poisoning and even death ⁽²¹⁾. Chair Bank (*Cymbopogon nardus*) has a distinctive and strong aroma. This aroma is derived from citronellal compounds. The smell is not liked and is highly avoided by insects, including mosquitoes and cockroaches ⁽²²⁾. Based on ethanol extract testing, *Cinnamomum burmannii* (C. b.) is effective as a repellent for mosquitoes, specifically *Aedes aegypti*. For mosquitoes that move away, the results are different for each concentration. Mosquitoes can stay away due to the chemical compounds contained in cinnamon ethanol extract, namely flavonoids, saponins and phenolics ⁽²³⁾.

Fadlilah & Widya Hary Cahyati (2017) said that the active substances in papaya leaves, such as flavonoids, saponins and phenolics, are effectively used as repellent So it can affect the average number of mosquitoes that land on the arm because the substance functions as a natural insecticide, repellent, and insect poison. The compounds that possess the potential to act as a repellent include flavonoids. Flavonoids are one of the compounds that give plants

their flavor. The flavonoid flavor can act as a mosquito repellent. Saponins have a bitter and sharp taste, so they can help prevent mosquitoes from biting humans. The phenolic compound contained in cinnamon ethanol extract is in the form of cyanaldehyde. This content acts as an aroma-giver to natural repellent ingredients. The mosquito's brain interprets this smell as something to avoid, subsequently altering its behavior to prevent perching ⁽²⁵⁾.

Researchers have found that a mix of Serai Wangi (*Cymbopogon nardus*) essential oil and cinnamon (*Cinnamomum burmannii*) essential oil could be used instead of repellents that contain harmful ingredients. According to Utami et al. (2023), plant-based insecticides are no less effective than synthetic insecticides. As for the potential of vegetable insecticides to compete with synthetic insecticides, the concentration of plant extracts used must be higher than the concentration of synthetic insecticides. The higher the concentration of essential oil added to the lotion, the greater its protection power. hers can then develop the essential oils Serai Wangi *Cymbopogon nardus* (C.n) and cinnamon *Cinnamomum burmannii* (C.b) to make lotion that has a protection of >90% and a comfortable scent so that it can be used by the wider community.

CONCLUSIONS AND RECOMMENDATIONS

The conclusion in this study is that there is a difference in the protective power of the lotion concentration of *Cymbopogon nardus* essential oil *Cymbopogon nardus* (C.n) in combination with cinnamon essential oil *Cinnamomum burmannii* (C.b) compared to negative control formulations. At the first hour, the average protection power of negative control lotion was 30.49%, and at the sixth hour, it was 28.50%. At the first hour, the average protection power of the 200 ppm C.N. formulation was 60.54%, and at the sixth hour, it was 45.04%. At the first hour, the average protection power of the 300 ppm C.N. formulation was 64.79%, and at the sixth hour, it was 49.29. At the first hour, the average protection power of the 400 ppm C.N. formulation was 82.16%, and at the sixth hour, it was 50.12%. Compared to other formulas, the 400 ppm C.N. formulation has the highest average protection power, even though it does not reach an effective value of <90%. The addition of concentration allows for increased repulsion. Which means that the benefits of EO *Cymbopogon nardus* and EO *Cinnamomum burmannii* can be researched further by mixing them in lotions in different ways or by adding more of each.

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