



FORMULATION AND EVALUATION OF HERBAL MOSQUITO REPELLENT USING CANANGA ODORATA (LAM) AND MORINGA OLEIFERA (LAM)

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ABSTRACT

Mosquitoes are among the most disturbing blood-sucking insects afflicting human beings. Several mosquito species from the genera *Anopheles*, *Culex*, and *Aedes* serve as vectors for pathogens responsible for various diseases, including dengue fever, malaria, yellow fever, Japanese encephalitis, and several other infections. Mosquitoes alone transmit diseases to more than 700 million people, and over 1 million deaths are reported annually across the globe. Therefore, controlling mosquitoes is a significant global public health concern. As most of the mosquito repellent products and devices available in the market are reported to have harmful effects on human beings. The increasing resistance of mosquitoes to synthetic insecticides has led to a growing interest in natural alternatives. This study aims to formulate and evaluate herbal mosquito repellent gel and emulsion using *Cananga odorata* (Lam.) and *Moringa oleifera* (Lam.). The essential oils were incorporated into two different

formulations: a gel and an emulsion. The gel was prepared using a gelling agent and a suitable solvent, while the emulsion was created using emulsifiers to stabilise the oil-water mixture. Various concentrations of essential oils were tested to determine the optimal concentration for effective mosquito repellent activity.^[10,11] The formulations were evaluated for their physicochemical properties, including pH, spreadability, stability, and sensory characteristics. The mosquito repellent efficacy was assessed using a standard repellence test,

and the duration of protection was also measured. The results demonstrated that both the gel and emulsion exhibited significant mosquito repellent activity, with the emulsion formulation showing a longer duration of protection. The findings demonstrate that *Cananga odorata* (Lam.) and *Moringa oleifera* (Lam.) essential oils are effective natural substitutes for mosquito repellent formulations, offering an eco-friendly and safe approach for mosquito control.

KEYWORDS: Natural mosquito repellent; Mosquito borne diseases; Ylang-ylang oil; Moringa oil; Gel formulation; Emulsion formulation.

1. INTRODUCTION

Mosquitoes, particularly from the *Anopheles*, *Culex*, and *Aedes* genera, are significant vectors of diseases affecting public health globally. They transmit pathogens that lead to serious illnesses such as dengue fever, malaria, yellow fever, and Japanese encephalitis^[1], impacting over 700 million people and resulting in more than 1 million deaths each year. Consequently, effective mosquito control is essential for public health. Preventative measures, including personal protection against bites, are crucial, with mosquito repellents available in various forms such as lotions, gels, coils, and liquidators being commonly employed. Additionally, mosquito bites can induce allergic reactions, which may manifest as local skin responses or systemic issues like urticarial.^[1]

A mosquito repellent is a substance used to deter mosquitoes from landing on skin, clothing, or other surfaces by making them unpleasant to the insects, thus reducing human-mosquito contact. Unlike insecticides or pesticides, repellents do not kill mosquitoes; they contain active ingredients that block mosquitoes' olfactory senses responsible for detecting carbon dioxide and lactic acid released during human perspiration.^[2]

Historically, Dichloro Diphenyl Trichloroethane (DDT) was widely used to eliminate mosquitoes, but the rapid development of resistance among mosquito populations created ongoing challenges. As a result, there has been a shift towards purchasing DEET-based mosquito repellents, which are currently prevalent in the market. However, DEET, while effective, has adverse effects, including disturbances in sensory, motor, memory, and learning functions.^[3,5] Consequently, there is a growing preference for natural plant-based insect repellents, which utilise essential oils extracted from various plant parts, as safer alternatives to synthetic repellents to mitigate the side effects associated with chemical compounds.^[1,6,7]

2. MATERIALS AND METHODS

2.1 FORMULATION PROCEDURE FOR SAMPLE OF GEL- F1 F2, F3 and F4

Weighed accurately 2.08g of Carbopol 934, placed in a beaker, added 20ml of purified water and kept aside for 30 minutes, labelled as (1). Placed about 5ml of purified water into another beaker, labelled as (2), added 1.6 ml of ethanol and 8 ml propylene glycol to it. Mixed thoroughly and then added 0.48g of methyl paraben to the mixture, measured 2.4ml of tween 80, added to the mixture and stirred well and labelled as F1. Similarly prepared samples of F2, F3, and F4. To the F1 added measured 0.2 ml of triethanolamine and added to the Carbopol purified water mixture, labelled as (1) in F1 (Control). Added 4.6ml of ylang- ylang oil and stirred gently.

Measured 0.2 ml of triethanolamine and added to the Carbopol purified water mixture, labelled as (1) in F2. Added 4.6ml of Moringa oil and stirred gently. Measured 0.2 ml of triethanolamine and added to the Carbopol purified water mixture, labelled as (1) in F3. Added 4.6ml of ylang- ylang oil and 4.6ml of Moringa oil, stirred gently. Measured 0.2 ml of triethanolamine and added to the Carbopol purified water mixture, labelled as (1) in F4. Finally, the content of beaker (1) was added to beaker (2) slowly with constant trituration till a homogenous transparent gel is obtained. Finally packed, corked in a light resistant container and labelled.

2.2 FORMULATION OF EMULSION PROCEDURE FOR SAMPLE-F1 (Control)

Weighed 3.6g of soft soap, triturated with portion of purified water in a mortar and continued until a thick creamy emulsion is formed. Then remaining quantity of purified water was added to produce the required volume (40 ml). Finally packed, corked in a light resistant container and labelled.

2.3 PROCEDURE FOR SAMPLE-F2 (Emulsion of Ylang-ylang and Moringa oil)

Weighed 3.6g of soft soap, triturated with portion of purified water in a mortar. Measured 4.6ml of Ylang-ylang and 4.6ml of Moringa essential oil separately in a measuring cylinder, transferred to a beaker and mixed together. The mixture was added drop wise to the soft soap mixture with constant trituration until a smooth creamy emulsion is obtained. Finally remaining quantity of purified water was added to produce the required volume (40 ml).

2.4 GEL

2.4.1. Physical Evaluation

The prepared products F1, F2, F3 and F4 were inspected visually for colour, odor and texture.

2.4.2 pH

About 1g each of the product was mixed with small quantity of purified water. The pH of the products was determined by using pH paper.

2.4.3. Spreadability

Spreadability of products was performed by using glass slide method. Centre of glass slide was marked with 1 cm diameter circle and placed about 1g each of the sample. Another glass slide was placed over the slide forming a sandwich arrangement. The glass slide was slid over another at 45° angles.

2.4.4. Washability

The washability of each of the formulation was tested by applying 1g of the gel on a glass slide and washed with tap water for 30-60 seconds.

2.4.5. Stability test

The products were packed in light resistant containers, stored at room temperature away from light for a period of 2 months and observed the instability problems like phase separation, colour change, odor, and texture.

2.5. EMULSION

2.5.1. Organoleptic property

The organoleptic parameters of the emulsion were performed by observing colour, odor, and texture of the preparation.

2.5.2. Dilution test

To 5ml of the sample, added few drops of distilled water and observed the phase separation.

2.5.3. Dye solubility test

To 1ml of the sample, added a pinch of amaranth dye solution and observed under the microscope.

2.5.4. Cobalt chloride paper test

Cobalt chloride paper (blue in colour) was dipped in emulsion sample and observed the colour change from blue to pink.

2.5.5. Stability

The emulsion was tested for instability problems like creaming, cracking and phase inversion by using standard procedures given in the monograph.

2.6 EVALUATION OF MOSQUITO REPELLENCY

2.6.1 STUDY DESIGN

Based on the functioning of mosquito repellents commercially available in the market and also the same experiencing in our daily life at home.

2.6.2 GEL

Selected and marked a suitable place for the study. The most appropriate one was our study area, where mosquitoes' outbreaks have been experiencing daily mostly at 6:30 pm every evening under the LED rays. A square cabin was made with cardboard sheet in such a way that the top of the same shall be below the height of our shoulder and at a distance of 30cm from us, while a person sitting on a chair inside the cabin. The samples were designed to place on a stand and arranged at any one corner outside of the cabin with a distance of 5cm. The duration of examination time was fixed to 2 hours. The study was designed to observe the approaching flow of mosquitoes inside the cabin. At the same time, at 30 minutes interval, position of the sample was changed through diagonals. Before starting the study, mosquito crowd around us were observed at the site for a period of 3 days. Samples were taken and spread on a glass slide leaving a thin film, placed on a stand and observed the mosquito repellency as per the table given below.

3. RESULT AND DISCUSSION

3.1 EVALUATION OF GEL

3.1.1 PHYSICAL EVALUATION

Table 1: Physical examination.

Colour	Pale-yellow, transparent	White, translucent	Yellow, translucent	Creamy Yellow, translucent
Odor	Odourless	Pleasant	Pleasant	Pleasant
Texture	Jelly like texture	Smooth	Smooth	Smooth

Table 2: Physical evaluation.

sample	pH	Spreadability	Washability	Stability
F1	6-7	Very good	Water washable	No phase separation
F2	6-7	Very good	Water washable	No phase separation
F3	6-7	Very good	Water washable	No phase separation
F4	6-7	Very good	Water washable	No phase separation



Fig. 1: pH determination.

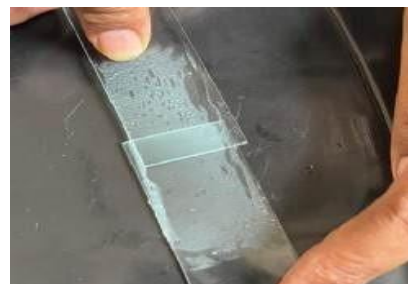


Fig. 2: Spreadability.



Fig 3: Washability.

3.1.2 EVALUATION OF EMULSION

3.1.2.1 Organoleptic Property

Table 2: Organoleptic property.

Organoleptic parameter	F1	F2
Colour	Yellowish brown	White creamy
Odor	Odourless	Pleasant
Texture	Smooth	Smooth



Fig 4: Dilution.

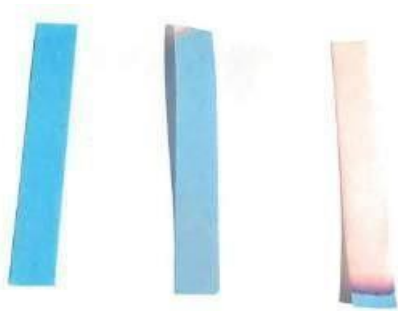


Fig 5: Cobalt chloride test paper.



Fig 6: Dye solubility test.

Table 4: Organoleptic properties of emulsion.

Test	Water Dilution test	Cobalt chloride test		Stability Test
F1 (sample)	Stable	Colour change		No phase separation
F2(Sample)	Stable	Colour change		No phase separation
Emulsion sample	Dye	Observation		Interpretation
		Internal Phase	External Phase	
F1	Amaranth	-	Red coloured background	-
F2	Amaranth	No coloured globules	Red coloured background	O/w emulsion

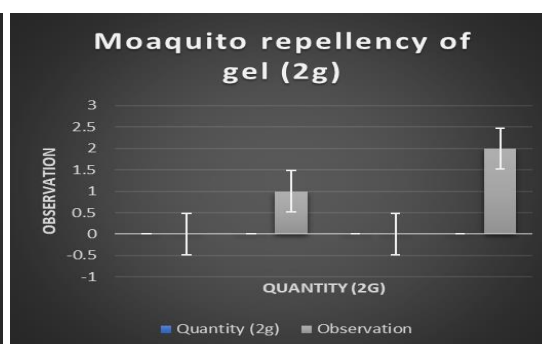
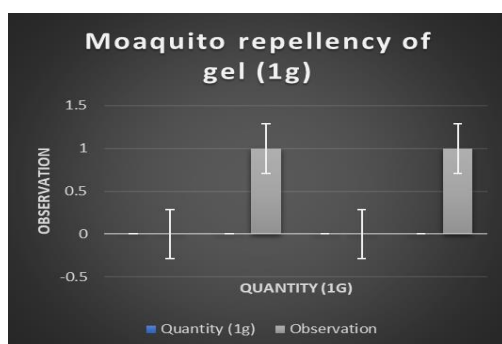
3.1.2 EVALUATION OF MOSQUITO REPELLENCY

3.1.2.1 GEL

Table 5: Mosquito repellent activity study (gel).

Sample	1g		2g		3g		4g		5g	
F1	N	-	N	-	N	-	N	-	N	-
F2	F	+	F	+	G	++	G	++	VG	+++
F3	N	-	N	-	F	+	F	+	F	+
F4	F	+	G	++	VG	+++	EX	++++	EX	++++

N (-): - NO RESULT (0), F (+): - FAIR (1), G (++) : - GOOD (2), VG (+++): - VERY GOOD (3), EX (++++): - EXCELLENT (4)



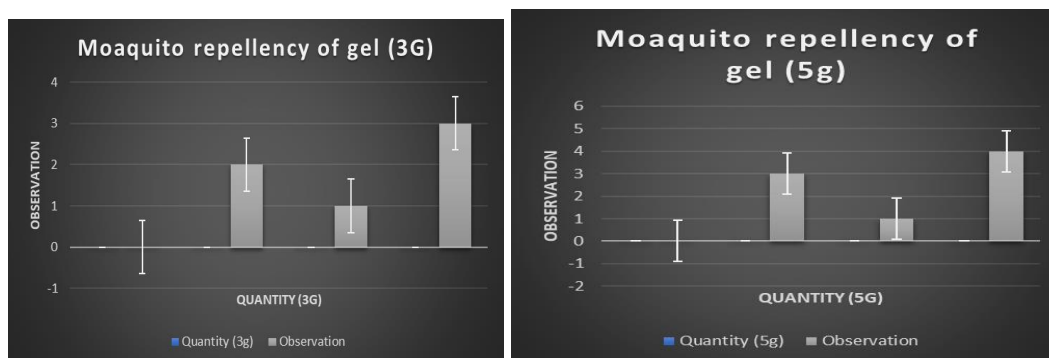


Fig 7-11 Mosquito repellence of gel in various concentrations.

3.1.3 O/W EMULSION

Table 6: Mosquito repellent activity study (Emulsion).

Sample	1/10	2/10	3/10	4/10	5/10	10/10
Blank (F1)	N (-)	N (-)	N (-)	N (-)	N (-)	N(-)
Combination(F2)	N (-)	F (+)	G (++)	VG (+++)	EX (++++)	EX (++++)

N (-): - NO RESULT (0), F (+): - FAIR (1), G (++): - GOOD (2), VG (+++): - VERY GOOD (3), EX (++++): - EXCELLENT (4)



Fig: 12 Mosquito repellence of emulsion(F2).

4. DISCUSSION

This study aims to determine the mosquito repellent activity of gel and emulsion prepared using two herbal oils, namely Ylang-ylang and Moringa. We have developed four formulations: F1, a gel composed solely of Carbopol; F2, a gel incorporating Ylang-ylang mosquito repellent oil; F3, a gel containing Moringa oil; and F4, a gel combining both Ylang-ylang and Moringa oils. For the evaluation study of all preparations, they were assessed for physical appearance, and the pH, spreadability, washability and stability were determined. The products displayed good features such as smooth textures, decent spreadability, and pleasant scents (except for F1, which was odourless). The pH of all formulations was within a range of 6-7, hence safe for applying on skin and washable with water.^[4,8] Confirming the stability of formulations, no trace of phase separation was observed.

The mosquito repellent activity study was carried out for all preparations as per the procedure in table 6, and the results are tabulated in table 15. There is no activity shown in F1 (blank), even though a maximum sample of up to 5g was used, and this is denoted as 'N'. Which means the presence of a mosquito crowd is observed around the site of application. At the same time, activity was observed in F2, a maximum of sample 2g; it is fair, denoted as 'F', which means a small decrease in the crowd. But when the sample quantity was increased to a maximum of 4 g, the result was a sharp decrease in the crowd, which means good (G) repellent activity. It is also noticed that there is very good (VG) repellent activity when the sample quantity was increased to a maximum of 5 g. In addition, it is observed in F3 that up to a sample of 2 g there is observed the presence of a mosquito crowd; however, while increasing the quantity up to 5 g, a small decrease in the crowd around the site is the result. In the case of preparation F4, a small decrease in mosquito crowd is noticed with 1 g of sample, while 2 g showed a sharp decrease in crowd, and 3 g provides very good (VG) repellent activity, meaning there are no more mosquitoes present at the site. Also, with 4 and 5 g of F4, excellent mosquito repellent activity is found, and we have experienced a very good smell of the active ingredients.^[9,12]

To study the mosquito repellent activity of herbal oil, Ylang-ylang and moringa, we have also prepared two O/W types of emulsions as F1 and F2. F1 is the blank, and F2 is an emulsion with both the herbal oils (Ylang-ylang and Moringa) as per table 5. The preparations were evaluated for their organoleptic properties (colour, odour, and texture). F1 is yellowish-brown and odourless, while F2 is white, creamy, and has a pleasant odour. Both emulsions are the oil-in-water type. There was no phase separation. The Cobalt Chloride and dye solubility tests were conducted, and the results also indicated that both emulsions are the oil-in-water type.

A mosquito repellent activity study was also performed as per the procedure in table 7; in the case of the blank, the result is negative. However, in F2 the dilution 2/10 showed a slight decrease in the crowd, and for 3/10 the result is good; likewise, for 4/10 it is very good, and for 5/10 it is noticed that there are no more mosquitoes present around the site of application. The same with 10/10 (no dilution); it also has experienced a very good smell of active ingredients.

5. SUMMARY

Herbal formulations are more acceptable in the belief that they are safe with better efficacy and lower side effects than the synthetic ones. Mosquitoes are among the most disturbing

blood-sucking insects afflicting human beings. Several mosquito species belonging to the genera *Anopheles*, *Culex*, and *Aedes* are vectors for the pathogens of various diseases like dengue fever, malaria, yellow fever, Japanese encephalitis and several other infections. Mosquitoes alone transmit diseases to more than 700 million people, and over 1 million deaths are reported annually across the globe; hence, control of the mosquitoes among the crowd is inevitable.

Therefore, we have selected one interesting and valuable topic for managing the bite of mosquitoes in a safe manner. The study conducted mainly in four formulations (F1, F2, F3 and F4, for gel and two formulations, (F1 and F2, for emulsion) for evaluating the effectiveness of mosquito repellency. The F4 gel and F2 emulsion show the best mosquito repellent activity. The project explored the feasibility of creating eco-friendly, non-toxic alternative against traditional synthetic mosquito repellents.

The formulations underwent a series of evaluations to assess their physical and chemical properties and their ability to repel mosquitoes in controlled settings for each formulation. The combination formulations demonstrate a promising and sustainable approach to mosquito control.

The formulation of mosquito repellent gels and emulsions using *Ylang-ylang* and *Moringa* oil showed promising results. The gels showed excellent mosquito repellent activity, particularly in formulation F4, while the emulsions, especially F2, displayed effective repellent properties and stability. The use of *Ylang-ylang* and *Moringa oil*, not only provided natural insect protection but also offered skin benefits.

6. CONCLUSION

This project explores the formulation and evaluation of mosquito repellent gel and emulsion using *Ylang-ylang* and *Moringa oils*, recognized for their mosquito repellent properties and skin benefits. The results indicate that these natural oils present a viable, eco-friendly alternative to chemical repellents, combining effectiveness with skin safety. The synergistic effects of *Ylang-ylang* and *Moringa* oils enhance repellent efficacy, emphasizing the significance of natural product research in tackling public health issues while promoting sustainability. The study suggests that further refinement of these herbal-based repellents could position them as a leading alternative in the natural mosquito repellent market. Future efforts will focus on optimizing ingredient concentrations for prolonged effectiveness,

ensuring safety for consumers, including children and those with sensitive skin, and testing stability under different environmental conditions to ascertain product reliability in practical applications.

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