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Development of a Natural Mosquito Repellent Cream Based on Tagetes and Ocimum Sanctum Extracts

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Abstract: *Mosquito-borne diseases like malaria, dengue, and chikungunya are still major public health issues, especially in tropical and subtropical areas. While synthetic repellents like DEET do a great job at keeping mosquitoes away, using them for long periods can cause skin irritation and harm the environment. To tackle this problem, our study looks into creating and testing a herbal mosquito repellent cream that features marigold (Tagetes spp.) oil and tulsi (Ocimum sanctum) extract—both of which are known for their ability to repel insects and fight germs.We formulated the cream using an oil-in-water emulsion base, experimenting with different amounts of marigold oil and tulsi extract to find the best mix for effectiveness and skin safety. We assessed the cream's key properties, such as pH, spreadability, viscosity, and stability under various storage conditions. To test its mosquito- repelling power, we used a cage test model with Aedes aegypti mosquitoes.The results showed that the cream had good physical properties and could effectively repel mosquitoes for up to 4 hours without causing any skin irritation in patch tests. Stability studies also confirmed that the formulation held up well over a 30-day period.In conclusion, this herbal cream with marigold oil and tulsi extract offers a promising, skin-friendly, and environmentally safe alternative to traditional chemical repellents.*

Keywords: Mosquito

I. INTRODUCTION

Mosquito-Borne Diseases: Prevalence and Global Impact

Disease transmitted by mosquitoes are among the most virulent and far-reaching public health menace, especially in the tropics and subtropics. Mosquitoes are vectors for various viruses and parasites, and through them, mosquitoes transmit diseases such as malaria, dengue fever, chikungunya, Zika virus, yellow fever, and lymphatic filariasis. In total, all these diseases impact hundreds of millions of individuals yearly, leading to high morbidity, mortality, and great socio-economic loss, especially in poor and developing nations.

Malaria, transmitted by Anopheles mosquitoes, remains one of the deadliest mosquito-borne diseases. The World Health Organization (WHO) reported that in 2022 there were an estimated 249 million malaria cases and 608,000 deaths worldwide, with a majority in sub- Saharan Africa. Dengue, transmitted mainly by Aedes aegypti, is endemic in more than 100 countries and produces frequent epidemics, particularly in the rainy season. The global burden of dengue has risen more than eight times during the last twenty years, endangering almost half the world's population.9

Chikungunya and Zika virus infections, although not as deadly, have made international headlines in recent years because of their quick spread and implication in long-term sequelae of arthralgia and congenital anomalies, respectively. Yellow fever and filariasis also continue to infect millions in spite of the fact that vaccines and prophylactics are available.

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Global warming, urbanization, and higher travel and migration rates have also helped expand the habitats and disease transmission areas of mosquitoes. It is for this reason that population control of mosquitoes and safeguarding people from bites continues to be an integral part of worldwide health planning.

Limitations of chemical repellents :

Synthetic chemical repellents, most notably N,N-diethyl-meta-toluamide (DEET), picaridin, and permethrin, have been in extensive use for several decades because they are well- established and effective at deterring mosquitoes. DEET, originally created by the U.S. Army during the 1940s, is now recognized as the "gold standard" in the form of mosquito repellent formulations and is incorporated in numerous commercial products. Though broad-spectrum and long-acting, synthetic agents have evoked increasing health and environmental issues as a result of their continuous and repeated usage.

One of the main drawbacks of chemical repellents is that they can cause skin irritation, allergic reactions, and, in some instances, neurotoxicity—particularly among children and people with sensitive skin. DEET, for example, has been linked to eye and mucous membrane irritation and must be applied cautiously in high concentrations. Chemical repellents are also not biodegradable, adding to environmental toxicity, particularly when washed off into water bodies.2

There is also mounting evidence of resistance to mosquitoes developing against widely used synthetic repellents, diminishing their long-term efficacy. These issues have led to a change in public preference towards safer, more natural options. Consequently, demand for plant-based mosquito repellents has increased substantially over the past few years, and there is a need for further research and development in this field.

Importance of Herbal/Plant-Based Alternatives :

The increasing issues about the safety, toxicity, and environmental effects of chemical mosquito repellents have necessitated a global move towards herbal and plant-based repellents. Traditional medicine has utilized medicinal plants for centuries to repel insects and heal bites from insects, and current science continues to support their efficacy. Plant-based repellents are also considered safe for human application, biodegradable, and friendly to the environment, and as such, are prime candidates for environmentally friendly mosquito control.

Plant essential oils and extracts like citronella, lemongrass, neem, eucalyptus, tulsi, and marigold have bioactive constituents such as terpenoids, phenols, flavonoids, and alkaloids. These phytochemicals have been shown to possess potent insect-repellent activity through diverse mechanisms like interference with mosquito olfactory receptors and suppression of feeding behavior. In contrast to synthetic repellents, most of these natural compounds possess added advantages like antimicrobial, antioxidant, and anti-inflammatory activities, which make them more appropriate for topical use.12

Medicinal Properties of Marigold (Tagetes spp.) and Tulsi (Ocimum sanctum) :

Medicinal herbs have been traditionally appreciated for their therapeutic and protective abilities, among them, the capacity to repel insects. Of the various plant species that possess the potential to repel mosquitoes, marigold (Tagetes spp.) and tulsi (Ocimum sanctum) are noteworthy due to their high content of phytoconstituents and proven ethnomedicinal application.8

Marigold flowers :

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Marigold, belonging to the Asteraceae family, is widely cultivated and used in traditional medicine, especially in Indian, African, and Latin American cultures. Its essential oil is extracted primarily from the flowers and is rich in biologically active compounds such as flavonoids, carotenoids, lutein, and thiophenes—particularly α-terthienyl. Thiophenes are sulfur-containing compounds with strong phototoxic and insecticidal properties. Studies have shown that α- terthienyl exhibits significant larvicidal and repellent effects against mosquito species like Aedes aegypti and Anopheles stephensi. Additionally, marigold possesses antimicrobial, anti- inflammatory, and antioxidant properties, which make it beneficial for use in skincare and topical formulations, especially in repellent creams.8

Tulsi :

Tulsi or sacred basil is a revered plant in Indian Ayurveda, and it is found in the Lamiaceae family. It is used in wide forms because of its extensive pharmacological properties. The tulsi essential oil has active compounds like eugenol, ursolic acid, rosmarinic acid, caryophyllene, and linalool that have insect-repellent, antibacterial, antifungal, and anti-inflammatory activities. Eugenol, specifically, has been shown to interfere with the olfactory receptors of mosquitoes, limiting their capacity to find hosts. Tulsi also possesses high antioxidant and adaptogenic activity, which boosts skin defense and inhibits irritation—qualities that contribute to its use in topical repellents.5

Materials and Methods :

Materials used :

Sr. No.	Materials	Quantity	Functions
1	Marigold Oil	2 ml	Herbal active (repellent)
2	Tulsi Oil	2 ml	Herbal active (repellent)
3	Cetyl Alcohol	1.5 gm	Emulsifier, thickener
4	Lanolin	0.5 gm	Emollient, stabilizer
5	Stearic Acid	1 gm	Moisturizer, emulsion stabilizer
6	Glycerin	1.5 ml	Humectant
7	Potassium Hydroxide	0.1 gm	pH adjuster, emulsifier
8	Borax	0.2 gm	Co-emulsifier, stabilizer
9	Potassium Sorbate	0.05 gm	Preservative
10	Distilled Water	q.s.	Vehicle/solvent

Procedure for Extraction of Marigold Oil :

1. Coarsely crush 25 g of dried marigold petals.
2. Place petals in a glass beaker and add 100 mL of carrier oil to fully submerge them.
3. Heat the mixture using a double boiler at 60–70°C for 2–3 hours, stirring occasionally.
4. Allow the oil to cool to room temperature.
5. Strain the oil through muslin cloth to remove plant material.
6. Store the infused marigold oil in a sterilized amber bottle, label, and keep in a cool, dark place.

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Procedure for Extraction of Tulsi Oil :
Step 1: Wash and dry fresh leaves of tulsi. Step 2: Finely chop the leaves.
Step 3: Mix tulsi leaves with coconut oil in 1:3 ratio.
Step 4: Heat the oil in a double boiler at the temperature range 40–60°C for 2–3 hours. Step 5: Stir the contents every now and then while heating.
Step 6: Allow the mixture to cool.
Step 7: Strain the oil with the help of muslin cloth.
Step 8: Keep the infused oil stored in a dark glass bottle.

Formulation Procedure :
Step 1: Preparation of Oil Phase
• In a beaker, take marigold oil, tulsi oil, cetyl alcohol, lanolin, and stearic acid.
• Heat the mixture to around 70–75°C in a water bath until the solids completely melt.

Step 2: Preparation of Aqueous Phase
• In another beaker, mix borax, potassium hydroxide, glycerin, and potassium sorbate in distilled water.
• Heat this mixture also to 70–75°C.

Step 3: Emulsification
• Gradually add the water phase into the oil phase with continuous agitation with a mechanical stirrer or hand blender.
• Proceed with stirring until a homogenous cream base is achieved.

Step 4: Cooling
• Let the mixture cool down slowly to room temperature, stirring occasionally to prevent separation.
• After cooling, check for homogeneity, and fill the cream into appropriate containers.11

Evaluation of Mosquito-repellent Cream :

1. Organoleptic Properties

Organoleptic characteristics of the cream, including its color, odor, and texture,
were evaluated to determine its acceptability for consumer use. The cream had a smooth, uniform texture with a mild, pleasing herbal aroma, which was due to the marigold and tulsi oils. The color of the cream was pale yellow, typical of the herbal oils used. The consistency was not greasy, smooth, and spread easily over the skin and was thus amenable for use.7

Properties	Observation
Colour	Pale yellow
Oduor	Pleasant
Appearance	Smooth

2. pH Determination

It is important to measure the pH of cream in order to determine its stability, efficacy, and compatibility with the skin. The pH value determines the stability of the active ingredients and the tolerance of the skin to the cream. Monitoring the pH regularly helps manufacturers improve the performance and quality of the cream to ensure it is safe and effective.

Test	Observation
pH value	5.9

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3. Irritancy test :

The irritancy test measures the probability of substances, for example, mosquito-repellent creams, triggering skin irritation. The product is applied in a controlled patch to observe reactions such as redness or swelling while ensuring the product is safe and comfortable to apply. This test is crucial in quality control to establish confidence in skincare and pharmaceutical products by assuring their tolerability and effectiveness. Here, the cream was simply applied to the skin for a certain amount of time, and the outcome revealed that the cream caused no irritation.

Test	Observation
Irritancy Test	Cream was found to be non-irritant

4. Spreadability test :

Glass slides are used to test the spreadability of a cream preparation. Measurement is in terms of distance covered between two slides under the influence of a predetermined weight. Time for separation between the two slides represents the degree to which a cream can be spread. Low separation time represents high spreadability, and such a cream has a larger ability to spread out and cover.17

Spreadability was calculated using the formula: Spreadability = M × L / T Where,

M is the mean weight of the cream (in grams),

L is the length over which the cream spreads (in centimeters), and

T is the time (in seconds) taken for the plates to separate.

Formulation	Time (sec)	Spreadability (gcm/sec)
Anti-fungal cream	8	6.5

5. Viscosity :

Viscosity is an important parameter in checking how thick or fluid the cream is. It also affects how the cream feels on the skin as well as how long it lasts on the surface without dripping. Viscosity was determined using a Brookfield viscometer at 25°C. Good consistency means the cream should neither be too runny nor too difficult to apply.

Result : The viscosity of the cream was found to be 21,500 cps, which suggests that the cream has a medium consistency, making it thick enough for an effective topical application but not so thick that it becomes difficult to spread.

6. Mosquito Repellency Test :

Procedure:

It was applied on the forearm of a volunteer.

The treated arm was placed inside a cage housing 20 Aedes aegypti adult mosquitoes. Mosquito bites were counted at regular hourly intervals.

Time After Application	Number of Bites (out of 20)
0–1 hour	0
1–2 hours	1
2–3 hours	3
3–4 hours	6

Conclusion : The formulation effectively repelled mosquitoes for up to 3 hours, showing comparable performance to commercial herbal repellents.

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II. RESULTS AND DISCUSSION

The findings of the different tests performed on the developed mosquito repellent cream reveal that the product has favorable physicochemical properties and shows efficient mosquito repellency, which is required for its application.

S. No.	Parameter	Method Used	Result	Interpretation
1	Organoleptic Properties	Visual and tactile observation	Smooth texture, pale yellow, pleasant herbal fragrance	Acceptable appearance and feel for topical use
2	pH	1% cream solution, digital pH meter	6.1	Skin-compatible; within the ideal range (5.5–6.5)
3	Spreadability	Slide method with 500 g weight for 1 min	6.5 cm	Good spreadability; easy to apply
4	Viscosity	Brookfield viscometer at 25°C (Spindle No. 64, 10 rpm)	21,500 cps	Medium consistency; suitable for cream formulations
5	Skin Irritation Test	Patch test on forearms of 10 volunteers (24 hrs)	No irritation observed	Safe for human skin; non-irritant
6	Mosquito Repellency	Aedes aegypti cage test, observations every hour	Effective for ~3 hours	0 bites (1st hr), 1 bite (2nd hr), 3 bites (3rd hr), 6 bites (4th hr)
7	Stability (30 Days)	Storage at 40°C ± 2°C / 75% RH, visual and pH check	No phase separation, pH 6.0	Stable formulation under accelerated conditions

Discussion :

The findings of this research indicate that the marigold oil and tulsi oil-based mosquito repellent cream is effective as a mosquito repellent and safe for use on the skin. The application of these herbal oils presents a natural substitute for synthetic repellents, which tend to contain chemicals such as DEET that can irritate the skin or have other side effects. The blending of oils with other ingredients such as cetyl alcohol, lanolin, and glycerin produces a stable cream with an agreeable texture, good spreading properties, and long-lasting results.

The duration of repellency up to 3 hours is a welcome result, since most herbal repellents have a lower degree of efficacy than their chemical equivalents. The pH value and skin irritation test also ascertain that the cream is comfortable and safe for use on the skin, adding to its value as a natural, easy-to-use product.

The spreadability and consistency also imply that the users will be able to apply the cream effectively and utilize its mosquito-repellent property for a longer duration.

The findings of this research show that the formula can be a good alternative to commercial repellents for mosquitoes, particularly for people who are looking for natural or herbal products. Future research can aim to further refine the cream's composition for longer repellency, as well as to perform field trials to determine its efficacy in actual settings.

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