International Journal of Medical and Pharmaceutical Sciences
Open access peer-reviewed Journal
Volume 2, Issue 4, Page 12-21.
https://doi.org/10.5281/zenodo.19394137

Research Article

Development and Characterization of Herbal Mosquito Repellent Cream Containing Plant-Based Actives

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Mosquito-borne diseases remain a major public health concern, especially in tropical and subtropical regions. The present study focuses on the formulation and evaluation of a herbal mosquito repellent cream using plant-based ingredients known for their natural repellent activity. Herbal extracts such as neem, citronella, eucalyptus, and tulsi were selected due to their safety, eco-friendliness, and effectiveness against mosquitoes. The cream was formulated using suitable emulsifying agents, stabilizers, and base materials to ensure desirable consistency and stability. The prepared formulations were evaluated for various physicochemical parameters including appearance, pH, spreadability, viscosity, homogeneity, and stability under different storage conditions. In addition, the mosquito repellent activity was assessed using standard bioassay methods to determine the protection time and effectiveness of the formulation. The results indicated that the herbal cream exhibited satisfactory physicochemical properties and significant mosquito repellent activity without causing skin irritation. The study concludes that herbal mosquito repellent cream can serve as a safe, effective, and economical alternative to synthetic chemical-based repellents, thereby reducing the risk of adverse effects associated with synthetic agents.

Keywords: Herbal cream, Mosquito repellent, Neem extract, Citronella oil, Eucalyptus oil, Tulsi, Natural formulation, Physicochemical evaluation, Bioassay, Skin safety.

INTRODUCTION

In order to provide specific nutritional or cosmetic benefits for the diagnosis, treatment, or mitigation of human or animal sickness, herbal formulations are dosage forms that comprise one or more raw or processed herbs in preset proportions. Since herbal preparations are manufactured by extracting the active chemicals from the biological sources of herbal plants, they are claimed to be more effective and to have less side effects than any other synthetic chemical treatments. In our country, several diseases transmitted by mosquitoes have been reported. These arthropod vectors are mostly responsible for the millions of individuals who suffer from mosquito-borne diseases every year. Because they are known to transmit a number of viruses, bacteria, and protozoa that can cause fatal diseases including dengue, chikungunya, malaria, yellow fever, and Japanese encephalitis, Aedes, Culex, and Anopheles mosquitoes represent a serious danger to public health. Every day, more individuals use insect repellents due to the increasing prevalence of mosquito-borne diseases. Repellents such liquid vaporizers, sprays, vaporizing mats, and mosquito coils are often used throughout the country. Many plant extracts have been demonstrated to have mosquitocidal qualities against mosquito vectors and to be very efficient in keeping mosquitoes away. Because neem extract kills Aedes pupae at relatively low dosages, it can efficiently decrease mosquito populations in place of synthetic pesticides. As a result, three distinct plant leaves Tulsi, lemongrass, and neem leaves—have been chosen for use in this study as the best environmentally friendly method of controlling mosquitoes. A chemical that is applied to skin, clothes, or other surfaces to deter mosquitoes from landing there is known as a mosquito repellent.

Their active component serves as the sole means of keeping mosquitoes away by obstructing their ability to detect lactic acid and carbon dioxide, which are generated when a person perspires [1]. Numerous mosquito species are thought to be the carriers of illnesses such malaria, encephalitis, yellow fever, dengue hemorrhagic fever, and epidemic polyarthritis. The World Health Organization (WHO) reports that these illnesses kill over 3 million people per year. Malaria and other infections spread by mosquitoes can be treated in a variety of methods, but prevention is always preferable. As a result, the phrase "mosquito and other repellent" was created. Applying repellent topically or in another way prevents mosquitoes from biting. Repellent for mosquitoes can be made naturally or artificially. However, most synthetic chemical repellents, especially DEET, can be readily absorbed through the skin, causing many accidental poisonings, especially of children. They also can poison wildlife DDT in particular has been shown to be very harmful to the environment, and DEET is suspected to be a carcinogen, teratogen and/or mutagen. Therefore, another, preferably non-toxic, means of repelling insects is desired. Many natural Substances are known to repel insects and mosquitoes [2]. Mosquitoes are among the most disturbing blood sucking insects afflicting human beings. Several mosquito species belonging to 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 one million deaths are reported annually across the globe. Therefore, the control of mosquitoes is an important public health concern around the world [4]. Malaria is caused by the genus Plasmodium, namely P. falciparum, P. vivax, P. ovale, and P. malariae. Vectors for the genus Plasmodium are various mosquito species Anopheles (A. arabiensis, A. gambias, A. funestus, and A. stephensi), Aedes (A. aegypti and A. albopictus), and Culex falciparum. The disease is transmitted through mosquito bites. Both humans and mosquitoes are considered to be parasite's hosts. Anopheles and Culex species are most active during the dawn and dusk and also at night whereas, Aedes species are active during the day time. Breeding sites for Anopheles and Aedes species are fresh water bodies and Culex species are polluted stagnant water bodies [5]. The repellents are designed as topical preparations or combustible products that are able to protect the user or environment from harmful insects, such as mosquitoes, which transmit diseases through their bite [6]. Bio based mosquito repellent are pest management tools that are based on safe, biologically based active ingredients derived from plants. Benefits of bio-products include effective control of mosquito as well as human and environmental safety. These biobased products were designed to play an important role in providing pest management tools in areas where mosquito resistance, niche markets, and environmental concerns limit the use of products. Mosquito repellents from natural sources are not new. Some of these mosquitorepellent are derived from the following--Basil (Ocimum basilicum), oils of Castor, Cedar, Clove, Fennel, Citronella Eucalyptus, Neem, Rosemary and Catnip oil of Nepeta species having nepetalactone, Celery extract (Apium graveolens) as well as Solanum villosum berry juice. These natural resources are good for the environment and also have added benefit of smelling good [7]. Indonesia is a tropical country rich in various types of insects that provide benefits, but some are detrimental. One of the insect groups that harm humans is mosquitoes which are vectors of various diseases, including malaria, dengue hemorrhagic fever (DHF), and chikungunya. To prevent mosquito bites, some efforts are applied such as by using mosquito repellent sprays (spray), mosquito coils (coil), and repellent preparations are generally used [8]. Malaria is the most prevalent mosquito-borne illness caused by the Plasmodium parasite, which spreads through the bite of female Anopheles. On the other hand, chikungunya and dengue are mosquito mediated viral infections caused by the same mosquito species, i.e. Aedes aegypti and Aedes albopictus. Another common mosquito-borne disease is lymphatic filariasis, commonly known as elephantiasis, caused by infection with filial worms which enter the human body through the bite of the Culex quinquefasciatus mosquito. Another most common mosquito-borne infectious disease, West Nile, is caused by the arbovirus transmitted to humans through the bite of the Cx. pipiens mosquito. As mosquitoes and diseases from them are spreading globally and affecting different regions, mosquito control and personal protection from mosquito bites is the most meaningful measure for controlling several

life-threatening diseases transmitted by bites of blood-seeking mosquitoes. Properly selecting and applying mosquito repellents are essential to reduce mosquito-borne disease. Mosquito repellents are volatile chemicals which repel the mosquito in the opposite direction from its source. An ideal insect repellent must be effective, safe,non- toxic, and not produce any adverse effect when used in houses or applied to children, adults and women during pregnancy [9].

OBJECTIVE:

The primary objective of this project is to formulate and evaluate a herbal mosquito repellent cream that offers safe, effective, and long-lasting protection against mosquito bites using naturally derived ingredients. The study aims to explore plant-based alternatives to synthetic repellents such as DEET, focusing on the efficacy of essential oils like Tulsi, Neem, Clove, and Lemongrass.

Specific objectives include:

1. To identify and select suitable herbal ingredients with known mosquito repellent properties.
2. To formulate a stable cream using these herbal extracts and essential oils.
3. To assess the repellent efficacy of the cream under controlled conditions.
4. To evaluate the safety, skin compatibility, and user acceptability of the formulation.
5. To identify and select suitable herbal ingredients with known mosquito repellent properties.
6. To formulate a stable cream using these herbal extracts and essential oils.
7. To assess the repellent efficacy of the cream under controlled conditions.
8. To evaluate the safety, skin compatibility, and user acceptability of the formulation.
9. To promote the use of natural, sustainable alternatives to chemical-based repellents in public health.

METHODOLOGY:

Plant profile

1. Neem:

History of neem: the legendary medicinal tree of India has grown with the human settlement all over the country and has been an integral part of the Indian way of life for centuries. The history of the Neem tree is inextricably linked to the history of the Indian civilization. The Neem tree has for a very long time been a friend and protector of the Indian villagers. For ages Indians have trusted this tree to fortify their health and remedy scores of diseases. In addition, it has been used for protecting food and stored grains and as a fertilizer and natural pesticide for the fields. It has been used for a far wider array of uses than any other tree! For Indians, the Neem tree had many fascinating aspects. For the children this evergreen, attractive tree was a haven from sun and rain – they spent hours in its cooling shade, plucked the sweet ripe fruit for a snack and built tree houses, which they shared with butterflies, birds and bees. This tree was the chosen one because its shade is known to be cooler than any other trees, and also, no bugs or insects are to be found under it because of its repellant action [27].

Synonyms: Margosa

Biological Source: Neem consists of the fresh or dried leaves and other aerial parts of Azadirachta indica.

Family: Meliaceae.

Chemical constituent: The chief constituents of Neem are azadirachtin, nimbin, nimbidin, nimbidol.

Fig.No.1: Neem

Uses:

1] antibacterial&antiviral
2] antifungal
3] anti-inflammatory
4] antimalarial

5] insect repellent [1].

2. Lemon Grass Oil

Synonyms: East Indian lemon grass oil

Biological source: It is obtained from the fresh aerial part of Cymbopogon citratus.

Family: Graminae

Chemical Constituents: Lemongrass oil is the principal source of Citral. The oil also contains linolol, citronellal, citronellol, methyl heptanone

Fig. No 2: Lemmon grass Oil

Use:

1] Antibacterial
2] Aromathera33] Skin care
4] Hair care [3].

3. Tulsi

Synonyms: Holy basin

Biological Name: Tulsi consists of fresh and dried leaves of Ocimum sanctum.

Family: Labiatae.

Chemical Constituents: It contains Eugenol, Carvacrol and eugenol-methyl-ether.

Fig No. 3: Tulsi

Uses:

1] anti-inflammatory& antioxidant
2] antioxidant
3] immunity buster
4] antibacterial & antifungal [1].

4. Clove:

Synonyms: lavang

Biological Source: Clove consists of the dried flower buds of Eugenia caryophyllus

Family: Myrtaceae.

Chemical Constituents: Clove contains 14 – 21% of volatile oil. The other constituents present are eugenol, acetyl eugenol, gallotannic acid and two crystalline principles; - and β- caryophyllenes, methyl furfural, gum, resin and fibre.

Uses:

1] Antibacterial &antimicrobial
2] Anti inflammatory
3] Antioxidant
4] Antifungal
5] Analgesic & Anaesthetics [3].

Fig No. 4: Clove Oil

Formulation Consideration Of Cream

Preparation of Herbal Mosquito Repellent Cream

- Beeswax (2.8g), liquid paraffin and all other oil phase ingredients like coconut oil were added into chinadish and melted in water bath at temperature of about 70oC.
- Simultaneously, borax was added to water phase such as glycerin, rose water and were heated in the same temperature at 70 oC .
- Finally, 0.5g Neem extract and essential oils like Clove oil, Lemongrass oil, Tulsi oil were added to oil phase just before mixing two phases.
- Water phase is then added to oil phase with rapid stirring.
- The mixtures were stirred properly to ensure that the sample is uniformly mixed.
- And when the temperature dropped to 30 oC, the cream so obtained was transferred into a suitable container.

Table No. 1: Preparation of Herbal mosquito repellent cream

Ingredient NTS	Quantity(25g) F1	Quantity(25g) F2	Quantity(25g) F3
Beeswax	3.8g	2.9g	3.7g
Liquid paraffin	12ml	9ml	9ml
Clove oil	1ml	1ml	1ml
Tulsi oil	0.5ml	1ml	1ml
Lemmon grass oil	0.5ml	1ml	1ml
Glycerine	2ml	3ml	-
Coconut oil	2ml	2.5ml	4ml
Borax	0.2g	0.5g	0.6g
Neem extract	0.5g	0.5g	0.1g
Rose water	2.5ml	3.6ml	4.6ml

Evaluation

- **Physicals appearance:** The formulated natural mosquito repellent cream was visually evaluated for colour, appearance, and transparency. The smoothness of the cream was estimated by rubbing the formulation between the fingers to observe the smoothness, clumps, roughness, and homogeneity where examined [36].
- **pH Determination:** The pH meter was calibrated. The pH measurement of the cream was carried out by dissolving 0.5g of cream in 50ml of distilled water and the measurement was done using a d pH paper [37].
- **Homogeneity:** Homogeneity was analysed by visual inspection for the appearance and existent of any clog [3].
- **Dilution Test:** A small amount of cream was taken in two test tubes one of the test tubes is diluted with water and other with oily medium. Both of these test tubes were shaken for few minutes and then observed to determine the type of emulsion.
- Determination of presence of foreign particles: A little amount of herbal cream is taken and spread on a glass slide and which is then observed against light.
- **Spreadability:** A small sample of cream was taken in a glass slide and it was compressed between two glass slides to uniform thickness. The time in which the upper glass slide moved over the lower slide is calculated as measure of spreadability.

$S = d2 \times \pi/4$

Where, S = spreading area depending on mass (mm2)
d = spreading area diameter

- **Irritancy Test:** The cream was applied to the specific area on the dorsal surface of the left hand and the time was noted. Irritancy, edema, erythema is tested at regular interval for 24 hours.
- **Phase separation:** The cream to be tested was placed in a closed container away from sunlight and the phase separation was observed every 24 hours for 30 days [38].

- **Cage method:** A cage with cardboard was made by cutting its upper part and inside those two slips of paper is kept which is named as A and B. On slip „A‟ the mosquito repellent herbal cream is applied and slip „B‟ is kept as is it is (without any cream). The upper part of the cage is covered with transparent flexible sheet and sealed it properly. Through the side of the cage the mosquitoes are passed into the cage and monitored [39].
- **Stability Study:** A stability study for a cream assesses how the cream quality and effectiveness change over time and under different environmental conditions. It helps determine the shelf life and recommended storage condition. Stability studies typically involve assessing physical, chemical, and microbiological aspects of the cream. Commonly studied aspects include appearance, colour, odour, spreadability, and stability of active ingredients. This study helps determine the self-life, proper storage conditions, and potential degradation pathways of cream. The formulated cream was kept in room temperature at 400C and 35% Humidity for time period of 30 Days. No changes in colour, odour, pH were seen after 30 days observation [1].

RESULT & DISCUSSION

Physical Appearance: Physical appearance we’re evaluated by its colour, odour & Texture. The result is tabulated below

Table No. 2: Physical Appearance

Sr. no	Formulation	Colour	Odour	Texture
1	F1	Olive green	Characteristic odour	Smooth
2	F2	Olive green	Characteristic odour	Smooth
3	F3	Olive green	Characteristic odour	Smooth

2] pH Determination: The pH of the formulated of cream was found to be 6.8

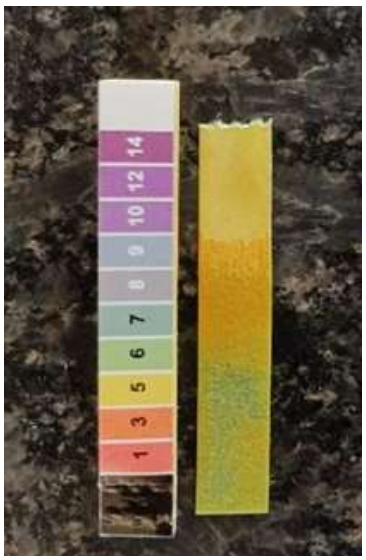

Fig No.5: pH Determination

3] Homogeneity: Homogeneity of formulated herbal cream to was evaluated by visual appearance and a touch. The visual appearance and touch were good.

4] Dilution Test: The test was performed to determine the type of emulsion and were found to be w/o emulsion.

Fig No. 6: Dilution Test

5] Determination of foreign particle: All the prepared formulations are spread on glass slide and which is tested against light and no foreign particles was observed.

Fig No. 7: Foreign particle

6] Spreadability: The prepared herbal crem formulation was tested for spreadability and the area covered by the fixed amount of cream was found to be 9.52 mm2

Fig No. 8: Spreadability

7] Phase separation analysis

Table no. 3: Phase separation analysis

Sr. no	Formulation	Observation
1	F1	No phase separation
2	F2	No Phase separation
3	F3	No Phase separation

From these it was concluded that F3 shows no phase separation hence, F3 is used for the further studies.

8] Cage method: The formulated cream was evaluated form mosquito repellent activities using the cage test and from the observation we can conclude

that the cream shows repellent action against mosquito by not biting the forearm.

9] Irritancy test

Table no. 4: Irritancy test

Sr. no	Formulation	Observation
1	F3	No irritancy

10] Stability Study: The formulated cream was kept in room temperature at 400C and 35% Humidity for time period of 30 Days. No changes in colour, odour, pH were seen after 30 days observation

Table No.5: Stability

Sr. No.	Parameter	Observation
1	colour	No Change
2	Odour	No Change
3	pH	6.8

CONCLUSION:

Recent research on the efficacy of herbal insect repellents has shown positive findings. In particular, it has been shown that two types of herbal insect repellent work well to keep mosquitoes away. Furthermore, it has been demonstrated that using these natural repellents significantly improves human health; no adverse consequences have been documented. Because of this, utilizing natural repellents instead of artificial ones is becoming more popular. Herbal repellents are a viable alternative to dangerous chemicals for those seeking to protect themselves against mosquito-borne illnesses because of their efficacy and beneficial effects on human health. The formulation with the greatest repelling efficacy was F3. The spreadability, stability, pH, and irritancy of the prepared cream were assessed. The cream has a creamy texture and a nice look. An irritancy test was performed, and the results showed no signs of redness or itching, indicating that the cream was safe to apply topically. According to the current study, neem leaves and the oils of lemongrass, tulsi, and clove have strong anti-mosquito properties.

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Cite: Ravindra Kalbande*, Sanket Sonawane, Bhagyashri Latare, Ritesh Bathe, Trupti Dumore, Development and Characterization of Herbal Mosquito Repellent Cream Containing Plant-Based Actives, Int. J. Med. Pharm. Sci., 2026, 2 (4), 12-21. https://doi.org/10.5281/zenodo.19394137