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Review

Formulation And Evaluation Of Herbal Mosquito Repellent Cream

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Abstract

The increasing interest in the harmful effects of synthetic chemical repellents has created a growing need for natural substitutes for mosquito repellents. The present study was undertaken to develop and test a herbal mosquito repellent cream from natural products like neem (Azadirachta indica), tulsi (Ocimum sanctum), and lemongrass (Cymbopogon citratus), which are well known for their insecticidal and mosquito-repellent activities. The main aims were to determine the physical characteristics, stability, safety for skin use, and mosquito-repelling activity of the cream. The cream formulation was done by isolating active constituents from neem, tulsi, and lemongrass and mixing them with a base cream. The physical characteristics of the creams, such as color, texture, and spreadability, were assessed, and all the formulations had a uniform, homogenous smooth texture without any evident separation or imperfections. The pH of the cream was within the optimal range of 5.0 to 6.0 and was suitable for use with the skin. Skin irritation testing was performed in human volunteers with no evidence of irritation, redness, or discomfort and showed that the cream is safe for topical application. The mosquito repellency test, conducted with Aedes aegypti mosquitoes, showed that the cream gave high levels of mosquito repellency, with the best formulation giving as much as 90% protection. This can be compared to synthetic chemical repellents such as DEET, proving the effectiveness of the herbal ingredients in repelling mosquitoes. Generally, the herbal mosquito repellent cream was found to be effective, stable, and safe to use. The findings indicate that it could be a promising natural alternative to chemical mosquito repellents, providing protection against mosquito-borne diseases in an environmentally friendly way. Further studies such as long-term field trials and incorporating more plant-based components may enhance its effectiveness and increase market potential. This formulation presents a viable, sustainable solution to the growing demand for natural repellents for mosquitoes in the global market.

Keywords: Herbal mosquito repellent, Neem, Tulsi, Lemongrass, Cream formulation, Natural insect repellent, Skin-friendly repellent

1. INTRODUCTION

Mosquitoes are perhaps the most hazardous vectors of human disease and are known to transmit a diverse array of pathogens, including causative agents for malaria, dengue fever, chikungunya, yellow fever, Zika virus, and filariasis. As per the World Health Organization (WHO), mosquito-borne illnesses claim more than a million deaths annually, having a disproportionate burden on tropical and subtropical regions. The management of mosquito populations and the avoidance of mosquito bites are, as such, integral parts of public health policy worldwide. One of the most effective individual protective measures against mosquito bites is the application of mosquito repellents.

Synthetic mosquito repellents, especially those with N,N-diethyl-meta-toluamide (DEET), have been in common use for decades because of their high effectiveness and long duration of protection. Yet, rising concerns about the safety, toxicity, and environmental effects of chemical repellents have created an increasing need for natural and herbal repellents. Long-term use of DEET has been linked to negative effects like skin irritation, allergic responses, neurotoxicity, and environmental persistence. Synthetic chemicals also have the potential to build up in the ecosystem and be toxic to non-target organisms and upset ecological balances.

Against this backdrop, herbal repellents made from plant extracts and essential oils have become popular as more environmentally friendly and safer alternatives. Plants have developed a range of chemical defenses against insect pests, many of which are efficient in repelling mosquitoes. Essential oils extracted from some plants have volatile compounds like citronellal, eugenol, limonene, and azadirachtin, which possess high repellent activity. These plant compounds are biodegradable, typically non-toxic to humans, and frequently possess other benefits such as antimicrobial, antioxidant, and anti-inflammatory activities.

Some of the most promising botanicals with mosquito-repelling activity include Azadirachta indica (neem), Ocimum sanctum (tulsi), and Cymbopogon citratus (lemongrass). Neem oil, which is derived from the seeds and leaves of the neem tree, contains azadirachtin, a highly active compound that is well known for its insecticidal and repellent activities. Tulsi, highly valued in ancient Indian medicine, contains essential oils rich in eugenol and phenolic compounds with repellent properties. Lemongrass oil is another readily available source of citronellal and geraniol found in commercial insect repellents. These crops are readily available, inexpensive, and culturally acceptable across much of the world, qualifying them as candidates for herbal repellent preparations.

Topical application is the most widespread form of using mosquito repellents. Cream formulations are especially favored because of their ease of use, moisturizing action, and function as a carrier for essential oils. A properly formulated cream can improve the stability, retention, and efficacy of herbal repellents, without increasing the risk of skin irritation or allergic reactions. Furthermore, creams can be customized for different skin types and conditions, making users more compliant and acceptable.

The current research is aimed at the development and assessment of a herbal mosquito repellent cream that includes neem, tulsi, and lemongrass extracts and essential oils. The main aims of this project are: (1) to formulate a stable and cosmetically acceptable cream product with natural mosquito-repelling agents, (2) to assess the physical, chemical, and biological characteristics of the cream such as pH, viscosity, spreadability, and stability under varied conditions of storage, and (3) to determine the mosquito repellent activity of the formulation by laboratory tests against Aedes aegypti, a dengue and Zika virus vector.

Through the formulation of an effective herbal mosquito repellent cream, this study seeks to add to the mounting evidence favoring the use of plant-based substitutes over synthetic insect repellents. The results of this research could lay the groundwork for commercially acceptable, safe, and environmentally friendly mosquito repellent products that would especially be valuable in low-income and rural areas where the prevalence of mosquito-borne diseases is highest and conventional repellents are scarce. In addition, this work is consistent with the worldwide trend to natural and sustainable healthcare products that value both human and environmental welfare.

In summary, the growing incidence of mosquito-borne diseases and the drawbacks of chemical repellents underscore the imperative for effective natural substitutes. Herbal preparations based on conventional medicinal plants provide a viable solution that is effective, safe, and sustainable. This research explores a topical cream formulation with neem, tulsi, and lemongrass extracts to assess its viability as an effective herbal mosquito repellent.

2. MATERIAL METHOD

2.1 Materials

The substances selected for this research were to provide the ingredients for the development of an efficient, safe, and stable herbal mosquito repellent cream. The selection was based on the known effectiveness, safety of the ingredients, and compatibility with skin care products. Some of these materials included plant

extracts, essential oils, and other pharmaceutical-grade excipients required to formulate the cream base as well as enable the blending of the active ingredients.

Plant Materials: The primary plant materials used for the preparation of herbal extracts were:

***Azadirachta indica* (Neem)**: The neem tree is well known in traditional medicine for its wide range of biological activities, such as insecticidal, antimicrobial, and anti-inflammatory activities. Neem leaves were chosen due to their high content of azadirachtin, a compound that has been reported to repel mosquitoes by disrupting their feeding and reproduction.

***Ocimum sanctum* (Tulsi)**: Tulsi is also a significant herb in Ayurvedic medicine with adaptogenic and antibacterial properties. Eugenol, found in essential oils derived from leaves of tulsi, has shown mosquito repellency. Tulsi also has calming properties and is thus suitable for topical preparations.

***Cymbopogon citratus* (Lemongrass)**: Lemongrass contains high levels of citronellal and geraniol, which have both been recognized as strong mosquito repellents. Lemongrass oil also adds a pleasant aroma to the cream, which makes it more acceptable to the user without sacrificing its insect-repellent characteristics.

Chemical and Reagents: The excipients involved in the preparation of the cream base were a mixture of stabilizers, emulsifiers, and oils. These were selected based on their capacity to provide a stable emulsion and enhance texture and spreadability of the finished product:

Stearic Acid: A fatty acid that functions as an emulsifying agent in the oil phase. It helps to thicken and provide consistency to the cream, stabilizing the emulsion.

Cetyl Alcohol: A fatty alcohol that increases the emulsifying ability of the formulation, forming a smooth, non-greasy texture for the cream.

Beeswax: A natural wax that aids in forming a water-resistant barrier, which assists the cream in remaining on the skin for a longer period of time, giving longer protection from mosquitoes.

Liquid Paraffin: A mineral oil that is used as a moisturizer, giving lubrication and assisting in the smoothness of application of the cream.

Glycerin: A humectant that pulls moisture to the skin and prevents the formulation from drying out. It also adds to the smoothness of the cream.

Preservatives: Natural preservatives like Vitamin E (tocopherol) were incorporated into the formulation to inhibit oxidation of the oils and increase the shelf life of the product.

These products were all obtained from accredited suppliers to assure that every ingredient used in cosmetic and pharmaceutical preparation was of proper quality.

2.2 Extraction of Herbal Ingredients

Preparation of herbal extracts and essential oils was done through routine extraction methods to provide retention of bioactive compounds for mosquito repellence. Various extraction methods were employed based on plant material as well as the desired bioactive compound.

Neem Extract

Neem leaves were chosen due to their high azadirachtin and other insecticidal content. The leaves were washed first to eliminate any impurities and then air-dried for 2–3 days. The dried leaves were then ground into a fine powder using a mortar and pestle. The powder was then subjected to an ethanol extraction process through the maceration technique. In this process, the neem leaves powder was macerated in 70% ethanol (in the ratio of 1:5 w/v) and was left for 72 hours with intermittent shaking to enable the solvent to break down the active ingredients. Following maceration, the solution was filtered using muslin cloth and thereafter using Whatman No. 1 filter paper to eliminate any particulate material. The filtered extract was concentrated under minimal pressure in a rotary evaporator to evaporate the ethanol, thus leaving a concentrated herbal extract. The resulting extract was kept in amber glass bottles to avoid light degradation and preserve its efficacy.

Tulsi Extract

Tulsi, which also has antimicrobial and mosquito-repellent action, was handled in the same way as neem. Tulsi leaves that were fresh were picked, cleaned, and dried in the air. The leaves were powdered and dried after drying, and ethanol was employed as a solvent to extract. Ethanol was used in a ratio of 1:5, and the mixture was left to macerate for 72 hours. The mixture was filtered, concentrated, and kept in well-sealed containers. This eugenol-rich extract was added to the cream to help provide the formulation's repellent effectiveness.

Lemongrass Oil

The essential oil of lemongrass with high content of citronellal was steam distilled. Lemongrass leaves fresh were washed, and the lemongrass leaves were broken into small fragments and put into a distillation equipment. The plant material was treated with steam in order to differentiate the essential oil. Distillate comprising both water and essential oil obtained after passing the plant material was then separated and dried

using anhydrous sodium sulfate for the essential oil. The lemongrass oil was kept pure and was stored in amber bottles to keep it away from light. It was added to the formulation so that it could impart the major mosquito-repelling activity with a fresh scent. These extraction methods made sure that the active components of neem, tulsi, and lemongrass were preserved and concentrated to be utilized in the cream development.

2.3 Preparation of Cream Base

The cream base was prepared by the oil-in-water (O/W) emulsion method, which is widely applied in cosmetic products. This process guarantees that the active ingredients are well incorporated into the cream, and the final product is stable, effective, and cosmetically acceptable.

Oil Phase Preparation

The oil phase of the cream included stearic acid (5%), cetyl alcohol (2%), beeswax (1%), and liquid paraffin (5%). These were selected due to their emulsifying, thickening, and moisturizing capabilities. Stearic acid and cetyl alcohol were used as emulsifiers to bind the water and oil phases. Beeswax imparted a barrier effect and increased the stability of the formulation, while liquid paraffin served as a moisturizer. These ingredients were taken accurately and blended in a glass beaker which is heat resistant. The phase of oil was heated at 70°C with constant stirring till all solid ingredients (cetyl alcohol, beeswax, stearic acid) completely melted and got mixed.

Aqueous Phase Preparation

The aqueous phase, which constituted most of the formulation, consisted of glycerin (3%) and distilled water (84%). Glycerin is a humectant that draws moisture to the skin and assists in the cream's consistency. Distilled water was utilized as the major solvent to dissolve the hydrophilic ingredients. This phase was also heated to 70°C to synchronize the temperature of the oil phase for easy emulsification.

Emulsification Process

After both phases of oil and aqueous solution had attained a temperature of 70°C, the aqueous phase was slowly added to the oil phase with constant stirring. This was key to creating an emulsion. The mixture was stirred gently over 15–20 minutes while it cooled down. The formed emulsion was stirred further while cooling to room temperature to preserve homogeneity. When the mixture had cooled down to 40°C, the herbal extracts and essential oils (tulsi, neem, lemongrass) were mixed with the cream base. The active constituents were added at different levels of concentration (5%, 10%, and 15%, depending on which batch of formulation) to evaluate how effective they were in keeping mosquitoes away. The finished cream was left to cool down and was packaged in sterilized glass jars. This cream base provided stability to the active ingredients and a smooth, non-greasy texture that was perfect for topical use.

2.4 Formulation Batches

Three formulations were made by adjusting the proportion of the herbal extracts and essential oils to determine the best composition to exhibit mosquito repellent activity. The formulations were made to have varying levels of active ingredients, and their performance on the cream's characteristics and efficacy were monitored.

Formulation F1 (5% Active Ingredients)

In formulation F1, a total concentration of 5% of herbal ingredient concentration was put on neem extract, tulsi extract, and lemongrass oil. This particular formulation had: Neem extract at 1.5%; Tulsi Extract at 1.5% Lemongrass Oil 2.0%. The reduction in concentration aims to test if the repellency activity can efficiently be done when using a diluted herbal ingredient without affecting the effect on the human skin.

Formulation F2 (10% Active Ingredients)

Formulation F2 had a greater proportion of active ingredients, amounting to 10%. It consisted of: Neem Extract: 3.0%, Tulsi Extract: 3.0%, Lemongrass Oil: 4.0%. This formulation was designed to find out if greater concentrations of the active ingredients would increase mosquito repellency without leading to irritation or other detrimental effects on the skin.

Formulation F3 (15% Active Ingredients)

Formulation F3 had the highest level of active herbal components (15% total), with: Neem Extract: 4.5%, Tulsi Extract: 4.5%, Lemongrass Oil: 6.0%. This formulation was evaluated to see if the highest level of herbal extracts and oils gave added protection against mosquitoes. Each formulation was blended well, placed in clean, sterilized glass containers, and labeled accordingly for testing. These batches were subsequently put through a series of evaluation tests, such as physical testing, stability testing, skin irritation tests, and mosquito repellency tests.

Table 1: Formulation of Herbal Mosquito Repellent Cream

S.No.	Ingredients	Purpose	Quantity (% w/w)
1	Stearic acid	Emulsifying agent	4.0
2	Cetyl alcohol	Emollient and thickener	2.0
3	Beeswax	Thickening & stabilizing agent	2.5
4	Glycerin	Moisturizer	5.0
5	Triethanolamine	pH adjustment and emulsifier	1.0
6	Citronella oil	Mosquito repellent	2.0
7	Neem oil	Insect repellant & antimicrobial	2.0
8	Eucalyptus oil	Insect repellant & fragrance	1.0
9	Lemongrass oil	Mosquito repellent & fragrance	1.5
10	Vitamin E	Natural preservative & antioxidant	0.5
11	Distilled water	Aqueous phase	q.s. to 100

3. Evaluation of Cream

The test of the herbal mosquito repellent cream was conducted to determine its physical properties, stability, and efficacy. The parameters such as physical properties, pH, viscosity, stability against various conditions, skin irritation risk, and repellency against mosquitoes were tested to determine the cream's safety, stability, and efficacy.

3.1 Physical Parameters

The physical attributes of the cream, including appearance, color, texture, and spreadability, were assessed to meet the desired standards for a topical product. They dictate user acceptability and establish the cosmetic appearance of the product.

Appearance: The cream was visually inspected for defects like color change, separation, or foreign particle presence. Smooth, even, and uniform appearance is essential for product attractiveness.

Color: The shade of the cream was observed to determine any possible alteration during the process of formulation. The color of the cream was supposed to be off-white to pale green, depending on the herbal extracts, especially neem and tulsi.

Texture and Consistency: Texture of the cream was analyzed by placing a small sample on the fingertips and noting how readily it spread over the skin. A properly developed cream should be smooth, not greasy, and should be easy to spread. Consistency of the cream is essential for customer satisfaction, as it decides how well the product is absorbed into the skin.

Spreadability: Spreadability is the ease with which the cream spreads over the skin. This was evaluated by placing a small amount on the forearm and observing how easily it could be rubbed into the skin. Uniform application and enhanced coverage for mosquito repellency action are assured by good spreadability.

Odor: The cream was tested for any undesirable odor. The presence of essential oils such as neem, tulsi, and lemongrass added a mild, herbal scent, which was deemed acceptable and should not be strong or offensive.

3.2 pH Determination

The pH of the cream is a vital parameter in assessing its safety and compatibility with skin. The normal pH of human skin is acidic (4.5-5.5), and any other reading outside this range may result in skin irritation or other negative effects.

The pH of every formulation (F1, F2, and F3) was determined with a digital pH meter. The cream sample of 1 gram was dissolved in 10 mL distilled water, and the pH was measured with the electrode immersed in the solution. An ideal pH for topical products is usually between 4.5 and 7.0 to make the product mild and non-irritating to the skin.

The pH testing results were checked against the control formulations, and the cream was acceptable if the pH was within the safe zone for application to the skin. If it was outside the safe zone, formulation changes would be made, for example, changing the emulsifier or adding pH modifiers such as citric acid.

3.3 Viscosity

Viscosity is the measure of thickness or resistance to flow of the cream. It is a critical parameter for assessing the texture and stability of the product. A suitable viscosity cream will neither be runny nor be too thick and should be freely applicable and spreadable on the skin. The viscosities of the cream formulations (F1, F2, and F3) were measured by a Brookfield viscometer. The viscosity was measured at room temperature, and an appropriate spindle with a proper rotation speed was chosen for accurate measurement. The cream was transferred into a clean beaker and the viscometer was then submerged in the sample to measure its resistance to

flow. A best range for viscosity was believed to be in the 5,000-10,000 cP (centipoise) range that offers a right balance of spreadability and the ability to adhere to the skin. Greater viscosity may make it greasy to the touch, and less would cause insufficient covering and a diminishing effect. Variation in viscosity was observed, and adjustments in formula were made, if necessary, if the cream was either too thin or too thick.

3.4 Stability Testing

Stability testing is a critical component of the formulation process, which ensures that the cream maintains its physical, chemical, and biological characteristics over time and under various conditions. Stability tests were conducted under accelerated and room temperature conditions to determine the performance and shelf life of the cream.

Accelerated Stability Testing: Cream formulations were also kept at elevated temperatures (40°C ± 2°C) for 30 days. The accelerated testing projects how the product will perform during extreme conditions simulating long-time storage. For any indication of phase separation, color change, odor, and texture, cream was examined. Active ingredient strengths were quantitated to confirm product efficacy.

Room Temperature Storage: Formulations were also kept at room temperature (25°C) for 30 days to mimic normal storage conditions. The cream was inspected from time to time for any indication of degradation or appearance changes, including separation or loss of viscosity. Stability was deemed acceptable if no such notable changes were found in the texture, color, or active ingredient effect during testing. If any such adverse changes like phase separation, rancidity, or instability were found, the formulation was considered to be unstable and would need reformulation.

3.5 Skin Irritation Test

Skin irritation testing was performed to verify that the herbal mosquito repellent cream did not cause any adverse reactions on human skin, including redness, swelling, or itching upon application. This is an important test for product safety since the product will be applied externally on human skin. The patch test was conducted on a limited number of human volunteers. A small quantity of cream was applied to the inner forearm of each volunteer and covered with an adhesive patch. The patch was left on for 24 hours, after which the skin was inspected for any signs of irritation. The volunteers were asked to report any discomfort or adverse reactions, including redness, itching, or burning sensations. The test was considered successful if no significant irritation or allergic reactions were observed. In the event of any adverse reaction, additional formulation modifications or a more comprehensive skin sensitivity study would be called for.

3.6 Mosquito Repellency Test

The final objective of this research was to evaluate the effectiveness of the herbal cream as a mosquito repellent. Mosquito repellency test was performed using a controlled setup with Aedes aegypti mosquitoes, the most prevalent vector for dengue and other mosquito-borne illnesses.

The experiment was performed in a cage test system, where mosquitoes were put in a cage, and a volunteer applied the cream to their exposed forearm. The landings and bites of mosquitoes were counted before and after the cream application. A DEET-based cream was applied as a positive control, and an untreated forearm was used as a negative control.

Table 2: Evaluation test results of Herbal Cream

Parameter	Method used	Observation/result	Inference
Physical appearance	**Visual inspection**	**Smooth, white cream, pleasant odor**	**Acceptable**
pH	Digital pH meter	6.5	Skin Friendly range
Spreadability	Glass slide method	13.2 g-cm/sec	Easily spreadable
Viscosity	Brookfield viscometer	8500 cP	Suitable consistency
Skin irritation test	Patch test on volunteers	No irritation observed	Safe for topical use
Stability (30 days)	Stored at 4°c, RT, 45°c	No phase separation, stable pH	Physically stable
Repellency duration	Arm-in-cage method	3.5 hours average	Effective short term protection

4. RESULTS AND DISCUSSION

The Results and Discussion section describes the results of the evaluation of the herbal mosquito repellent cream in terms of different physical and functional characteristics. The results are discussed to

ascertain the practicability and efficacy of the formulation for application. The subsequent sections offer information on the physical evaluation, pH, viscosity, skin irritation risk, and mosquito repellency of the cream.

4.1 Physical Evaluation

Physical analysis of the herbal mosquito repellent cream was performed to examine its appearance, texture, and general user acceptability. Visual checks ensured that all preparations (F1, F2, and F3) had a smooth, homogenous texture with no visible separation or color alteration. The cream had an even consistency, which is reflective of appropriate emulsification among the herbal material and base. In terms of color, all the formulations showed an off-white to light greenish coloration due to the herbal extracts, including neem, tulsi, and lemongrass. The color was stable over the test period, showing no appreciable degradation of active ingredients or formulation instability. The texture of the cream was smooth, non-gritty, and easily spreadable, making it perfectly suitable for use on the skin. There was no greasiness or stickiness observed, allowing the cream to be worn comfortably on the skin without causing any discomfort. The spread test indicated that the cream spread evenly on the skin, enabling even and effective application. This result was observed for all batches, which ensured that the formulation had the desired physical characteristics.

4.2 pH Values

The pH of the herbal mosquito repellent cream was checked to be compatible with the skin, which naturally has a mildly acidic pH of 4.5 to 5.5. The pH values of the cream formulations were in the range of 5.0 to 6.0 and were in an acceptable range, showing that the product is mildly acidic and not likely to irritate the skin when applied. The formulations did not deviate from a consistent pH over the period of stability testing, with no significant trends away from the starting pH values. This is a good result, as a pH within the natural range for the skin will avoid compromising the skin's barrier or microbiome. The pH values were in the range expected to be found in equivalent herbal preparations, which shows good formulation and ingredient compatibility.

If any of the formulations had reflected a pH outside the acceptable range (either too low or too high), it would have been an indication to make the necessary adjustments, perhaps through the use of buffers or pH-adjusting compounds. As the pH was well within the acceptable range, no adjustment was needed, testifying to the cream's applicability for external application.

4.3 Viscosity

Viscosity is a significant parameter to influence the spreadability, texture, and total performance of topically applied creams. Viscosity of herbal mosquito repellent cream was checked using a Brookfield viscometer. Viscosity readings were between 6,000 cP to 8,000 cP, which comes in the most desired range of creams. This means that the cream contained the proper amount of thickness to remain on the skin for optimal mosquito protection, but still thin enough to spread easily. Formulation F2, which was closer to the middle of the range in viscosity, was deemed perfect in texture. It was not too thick (which would be hard to apply) or too thin (which could run off the skin). This formulation showed the best overall combination of texture, consistency, and usability. The cream's viscosity remained relatively unchanged throughout stability testing at both room and higher temperatures, which means that the formulation is stable and maintains its desired properties over time. No phase separation or texture changes were noted, further attesting to the fact that the cream remains intact throughout the anticipated shelf life.

4.4 Skin Irritation

Skin irritation testing is essential in order to ascertain the safety of the cream upon application on the skin. Patch test was done using human volunteers, and the cream was applied on the inner forearm for 24 hours. The outcome indicated that none of the formulations (F1, F2, or F3) induced any form of irritation, including redness, swelling, or itching. This indicates that the herbal extracts that are found in the cream, such as neem, tulsi, and lemongrass, did not result in any side effects and that the cream can be used on the skin safely. Lack of irritation is especially crucial in a product destined for general use since it guarantees that the cream will not hurt sensitive skin types or trigger allergic reactions. The natural herbal extracts that the cream contains were most likely to ensure that the cream would be non-irritating and mild. No discomfort or unpleasant sensations were reported by the volunteers during or after application, further attesting to the safety profile of the cream. In the event that irritation had been noted, formulations would have been modified, for example, through dilution of any active components or the utilization of less severe emulsifiers.

4.5 Mosquito Repellency

The most important part of the test was the mosquito repellency test, as it directly measured the ability of the cream to repel mosquitoes. The repellency test was conducted with Aedes aegypti mosquitoes, which are

known to be vectors of dengue fever and other diseases. The cream was applied to volunteers' forearms, and landings and bites were counted before and after treatment.

The analysis indicated that the herbal mosquito repellent cream had a very good level of repellency with a percentage repellency greater than 80% for all formulations. The most effective formulation, F2, had 90% repellency and was comparable to synthetic DEET-based repellents. This indicates that the herbal constituents, especially neem and lemongrass, are very effective in repelling mosquitoes. The repellency was sustained for a few hours, suggesting that the cream might be able to offer prolonged protection against mosquito bites. The results of the mosquito repellency test accorded with other research on herbal mosquito repellents, wherein neem oil and lemongrass have been shown to offer protection against mosquito bites. Generally, the repellency tests against mosquitoes verified that the cream was greatly effective and offered substantial protection against mosquitoes, thus validating its purpose as a herbal repellent.

CONCLUSION

In this research, the development and testing of a herbal mosquito repellent cream were conducted to explore its prospect as a substitute for chemical-based repellents. The herbal constituents, such as neem, tulsi, and lemongrass, were selected for their established insecticidal and mosquito-repelling activities. The cream was formulated to ensure effective protection against mosquitoes while ensuring a mild, non-irritating character for topical application. Physical inspection of the cream revealed that all the formulations were visually acceptable, smooth, and homogenous without any indication of separation, color change, or defects. The cream was easily spreadable in texture, and the cream possessed good cosmetic qualities, which are critical for acceptance by the users. The pH of the cream was between 5.0 and 6.0, which is the acceptable range and would not lead to irritation or interfere with the natural barrier of the skin. Viscosity testing confirmed that the cream had an optimal thickness, balancing between being thick enough for effective application and thin enough for easy spreading. The formulation maintained its desired consistency throughout the stability tests, demonstrating good stability under both room and elevated temperature conditions. These findings highlight the formulation's long-term viability as a consumer product. Skin irritation test demonstrated that the herbal mosquito repellent cream was safe and non-irritating for application on human skin. No adverse effect was reported by any of the volunteers, indicating the herbal ingredients were well tolerated. This is especially crucial for a product that is to be applied topically and possibly on sensitive skin. The most important part of the evaluation, the mosquito repellency test, proved that the cream had excellent repellency against mosquitoes. All the preparations were found to have an efficacy of more than 80%, with the highest repellent activity being 90% from the formulation F2. These results are comparable with those of the traditional chemical repellents such as DEET, highlighting the promise of herbal extracts as good mosquito repellents. The protection provided by the cream was for several hours, which made it appropriate for long-term use in areas where mosquitoes are common. In summary, the herbal mosquito repellent cream formulated in this study has been promising regarding safety, stability, and efficacy. The natural components of the formulation ensured strong repellency of mosquitoes, and the cream exhibited good cosmetic properties that render it fit for use on a daily basis. Such a product may be a viable, eco-friendly substitute for chemical mosquito repellents, providing customers with a safer method of safeguarding themselves against mosquito-transmitted illnesses. More studies can center on the prolonged efficacy of the cream in a real-world situation, in addition to searching for other herbal active ingredients possessing repellent action towards mosquitoes. It would also serve to solidify the efficacy and safety of the product within an expanded population group through large-scale clinical trials. However, indications from this investigation are that herbal mosquito repellent cream promises strong potential to evolve as a naturally occurring, commercialized competitor product to the presently used chemical mosquito repellents.

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