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Development and Evaluation of Mosquito repellent herbal Emulgel from some essential oils

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Abstract
The basis of Indian medical systems is Ayurveda. The potential of natural bioactive components is of significant interest to the researchers. The creation of efficient, secure, and long-lasting repellents is necessary since mosquito-borne illnesses present serious threats to world health. To battle mosquitoes, a variety of repellents have been introduced to the market. Conversely, the mosquitoes became resistant to them. Additionally, a range of known and undiscovered adverse side effects are being reported by consumers. In order to counteract the negative effects of other commercially available mosquito repellents, the researcher was required to create and assess Emulgel that contained various essential oils. This study focuses on the formulation and evaluation of an emulgel-based mosquito repellent incorporating Lavender essential oil, Lemongrass essential oil, Cedarwood essential oil, Clove oil, Citronella oil. A promising topical drug delivery method for both hydrophilic and hydrophobic medications is emulgels. They improve the drug's effect and increase its absorption.

Keywords: Mosquito repellent, emulgel

Introduction

Thoroughly researched organisms on the world the Mosquitoes are among the most, and their role in disease transmission and nuisance biting justifies that focus. There are about 3,500 mosquito species on the planet, and they may be found everywhere except Antarctica. Despite this tremendous diversity, only a limited number of species may carry the viruses that cause human disease, and these species have been examined the most completely. This considerable corpus of research in public health has aided our understanding of mosquito-borne disease transmission and guided the development of mosquito and disease control measures. [1]

Traditional Indian medicine is among the world's oldest medical sciences. Ayurveda, the most extensively utilized system of traditional Indian medicine, stresses holistic care, which considers the body, mind, and spirit as a unit. It is founded on the idea that humans attain physical, mental, and emotional health by coexisting peacefully with environment. [2]

Mosquito-borne diseases continue to be a major public health concern around the world, particularly in tropical and subtropical regions. Malaria, dengue fever, chikungunya, Zika virus, and filariasis of the lymph nodes are mostly transmitted by mosquitos like *Aedes aegypti* and *Culex quinquefasciatus*. The World Health Organization (WHO) estimates that mosquito-borne infections cause over 700,000 deaths per year, with malaria alone accounting for 619,000 deaths in 2021. These numbers underline the critical need for effective mosquito control techniques to limit the spread and impact of these diseases (WHO, 2022). [3]

Highly invasive species have spread ecologically as a result of increased worldwide trade, changing climates, and human migration. These invasive creatures, including arthropods, inflict lethal diseases, resulting in epidemics or pandemics. Mosquitoes (Diptera: Culicidae) are particularly significant in this regard since they serve as vectors for a wide range of dangerous infections and parasites. Anopheles, Aedes, and Culex are the most dangerous vectors of major illnesses, causing diseases like malaria, Dengue, yellow fever, filariasis, Japanese encephalitis, and Zika.

Numerous behavioral, pharmacological, biological, and mechanical techniques are employed in the management of diseases spread by mosquitoes. A lack of effective vaccinations and delays in the development of antiviral medications for the majority of arboviruses have limited the success levels that have been attained. The increasing insecticide resistance in the mosquito vectors, hampering the development of new drugs and vaccines, curtails these efforts. The failing vector control strategies, the proliferation of invasive mosquitoes as well as increased contact between humans and these vectors have led to the constant re-emergence of arboviruses. Mosquito control programs are therefore faced with significant and rapidly changing challenges that necessitate the development of new approaches in the detection and control of diseases as a new requirement in public health. [4]

The genus Plasmodium, which includes P. falciparum, P. vivax, P. ovale, and P. malariae, is responsible for malaria. Many mosquito species, including *Anopheles* (*A. arabiensis, A. gambias, A. funestus, and A. stephensi*), *Aedes* (*A. aegypti and A. albopictus*), and *Culex falciparum*, are vectors for the genus Plasmodium. Mosquito bites are how the disease spreads. Humans and mosquitoes are regarded as the hosts of parasites. While Aedes species are active throughout the day, Anopheles and Culex species are most active during dawn, dusk, and night. Freshwater waters serve as breeding grounds for Anopheles and Aedes species, while contaminated stagnant water bodies serve as breeding grounds for Culex species. [5]

Children, the elderly, and pregnant women should not use commercially available mosquito repellents for an extended period of time since they contain dangerous synthetic chemicals that can cause skin/eye irritation, coughing, and asthma.[6] Several plants and essential oils were mentioned in the literature study, including lavender essential oil, mint, rosemary, basil, lemongrass essential oil, cedar, eucalyptus, cedarwood essential oil, geranium, chamomile, peppermint,

neem, Clove oil, Citronella oil, pyrethrum to possess mosquito-repellent activity.[7] Herbal formulations have been effectively invented by researchers, and many of them are currently on the market for daily usage. The goal of the current study was to create a gel-like herbal formulation and assess it.

Material and Method

Materials

Essential oils of *Lavandula angustifolia* (Lavender), *Cymbopogon citratus* (Lemongrass), *Juniperus barbadensis* (cedarwood), *Eugenia caryophyllata* (Clove oil) and *Cymbopogon nardus* (Citronella) were procured from Sahyadri Scientific Suppliers, Satara. India. Span 20, tween 80, Carbopol 934, triethanolamine, and ethanol were purchased from Thermosil Fine Chem Industries, Pune, India. Every chemical and solvent utilized was of analytical quality.

Methods

Preparation of Emulgel [5, 8]

Table 1: Composition of emulgels

Sr. No	Name of Ingredients	F1 (%)	F2 (%)
01	Lemongrass essential oil	10	10
02	Lavender essential oil	7.5	7.5
03	Cedarwood essential oil	7.5	7.5
04	Clove oil	5	-
05	Citronella oil	-	5
06	Span 20	0.5	0.5
07	Tween 80	0.5	0.5
08	Carbopol 934	0.5	0.5
09	Triethanolamine (drops)	3	3
10	Distilled water (gm^2)	50	50

a. Emulsion Preparation

1. Firstly, take a 100 ml beaker and add 10 ml of lemon grass oil, 7.5 ml Lavender oil, 7.5 ml Cedarwood oil, 5 ml Clove oil, 5 ml Citronella oil.
2. Then add 0.5 ml of span 20 in beaker and shake for few minutes.
3. Next, take a second beaker (II), fill it with 0.5 ml of Tween 80, add 3 ml of distilled water, and shake for a few minutes.
4. The material from beaker (II) is then added dropwise to beaker (I) and shaken until no clear, transparent emulsion is produced.

b. Gel Base Formulation

1. First, fill a 250 ml beaker with 500 mg of Carbopol 934 and 10 ml of purified water.
2. The mixture was now stirred mechanically for one hour.
3. After adding two to three drops of triethanolamine, a clear, translucent gel was created.

c. Preparation of Mosquito Repellent Gel

First, place 35 grams of the prepared gel in a 500 ml beaker, add 10 ml of the prepared emulsion, add 50 grams of distilled water to make up the volume, and mix for a few minutes until the gel is clear and apparent. Was formed. Finally, the gel was placed into a plastic container, allowing for testing (Flow chart 1). [5, 8]

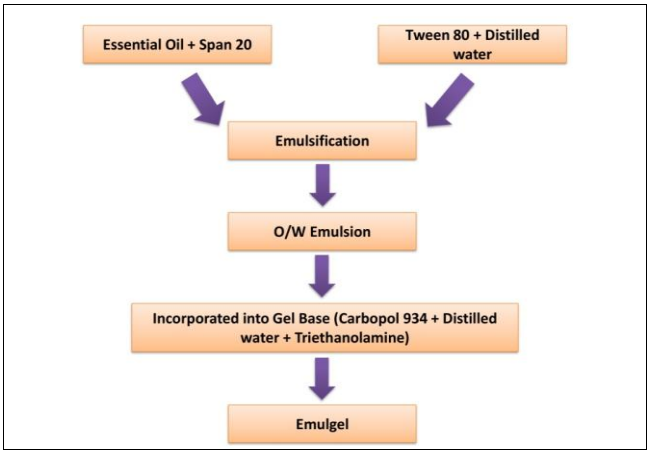

Fig 1: Formulation of Emulgel

Emulgel Formulation Evaluation

Physical evaluation

The color and transparency of the formed gel were evaluated visually. To assess the gel's smoothness, the formulation was simply rubbed between fingertips to check for homogeneity, clumped smoothness, and roughness. [5, 9]

Washability

By putting the gel on the skin, assessing how easy and thorough it was to wash it with distilled water, and manually examining the results, the washability of formulations was investigated. [5, 9]

pH

The digitally calibrated pH meter was used to assess the gel's pH. 25 ml of distilled water were used to dissolve 1 gm of the prepared gel. The pH was measured three times, and the average result was computed. [5,9]

Spreadability

Two identical glass slides were placed between two grams of the prepared gel. To release the trapped air and provide a consistent film between the slides, a 200-gm weight was added to the slides. The formula was used to calculate how long it took to separate the glass slides once the top slide was pulled. [5, 9]

Spreadability (S) = ML\T

Where M = weight placed on the upper slide (200 g); L = length of a glass

slide (6 cm); T = time taken (sec) to separate the glass slides from one another.

Skin irritation test

After applying 0.5 g of the prepared gel to a 6 cm2 area of normal hairless skin, the area was wrapped with a semi-occlusive bandage for one hour. After the application period, the bandage was taken off, the gel was carefully scraped off, and any rashes or other signs were visually examined. The test was conducted over a seven-day period. Grades were used to express the outcomes. [5, 9]

Viscosity

Using a digital Brookfield viscometer with spindle number 64 at 10 rpm and a temperature of 25±1°C, the viscosity of

the prepared gel was measured. Note was the matching dial reading. [5, 9]

Table 2: Physical assessment of the gel compositions

Formulation	Color	Transparency	Smoothness	Washability	Irritability
F1	Light Yellow	Nontransparent	Smooth	Good	No Irritation
F2	Light Yellow	Nontransparent	Smooth	Good	No Irritation

Table 3: Evaluation parameters of Emulgel

Formulation	pH	Spreadability (g.cm/s)	Viscosity (cp)
F1	7.6	21.26	4316
F2	7.2	18.23	4293

Results and Discussion

The produced F1 and F2 gel formulations were both light yellow in color, nontransparent, smooth-textured, and free of solid particles or grit when touched between the fingers. The amount of carbopol 940 included in the gel formulations has a significant impact on the translucency. No skin irritation, edema, rashes, erythema, dermatological reaction, or particular inflammation occurred after applying the gel formulations for seven days. Furthermore, a brilliant washability attribute has been observed for all the developed formulations (Table 2).

The gel compositions' pH was determined to be between 7.2-7.6, which is within the skin's typical pH range. Viscosity is a crucial component that affects pharmacological characteristics like spreadability from the container, among other things. The formulas' viscosity F1 shows 4316 cp and F2 shows 4293 cp. This demonstrated that a little shear may distribute the gel formulation with ease. (Table 3).

Conclusion

The research was undertaken with the aim to design emulgel formulation for topical application of Lavender essential oil, Lemongrass essential oil, Cedarwood essential oil, Clove oil, Citronella oil. Based on the findings of the investigational study, the emulgel preparation with essential oil has mosquito-repellent activity and showed good results as formulation.

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