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Research Article

Emulgel A Novel Approach for The Formulation and Development of Mosquito Repellent: *Duranta Erecta*

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ABSTRACT

This research aims to examine the effectiveness, safety, and potency of Duranta plants as mosquito repellent as well as to evaluate formulations. The Duranta erecta leaf crude is extracted in chloroform using soxhlet extractors. Duranta erecta, belonging to the Verbenaceae family and is a tiny to moderately-sized plant. It is also known as angels Whisper, Brazilian sky flower, Duranta, golden dewdrop, golden tears, and pigeon berry. It has been proven that the plant component has antimalarial, antibacterial, antioxidant, and cytotoxic properties including leaves, fruit, stems, and flowers. Its effective therapeutic qualities are said to be derived from phytoconstituents such 'alkaloids, flavonoids, glycosides, phenolics, saponins, steroids, tannins, and terpenoids'. The two emulgel preparations are formulated using crude petroleum ether extracted Duranta leaf extract. The 3% xanthan gum and 3% HPMC were used as gelling agents in formulation 1 and formulation 2 respectively. The comparative evaluation results of the two formulations show that the xanthan gum and HPMC at 3% respectively show very stable and optimized efficacy of the drug as a mosquito repellent by increasing the retention time of the formulation.

INTRODUCTION

Of all the biting, bloodsucking, tortured insects, mosquitoes are usually the most well-known. They may also be the subject of most research among arthropods with significant commercial value. 'The West Nile virus, yellow fever virus and dengue fever virus are ring viruses' that are among the most significant parasites transmitted by mosquitoes. Programs to battle and lessen the spread of these diseases have received attention because of the insect's features of rapid proliferation and huge egg production, which have led to an epidemic and a widespread spread of these diseases globally (1).There are 255 species of mosquitoes in India, categorized into 16 genera. Because the species that make up these genera are

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the carriers of numerous diseases, anopheles, aedes, and Culex are the three most significant genera in terms of medicine. There have only been reports of 57 species of culex, 111 species of Aedes, and 58 families of anopheles from India (2). These three genera constituent species either act as major or secondary carriers of fatal "illnesses" such as chikungunya, hemorrhagic fever, yellow fever, dengue fever, filariasis, Japanese encephalitis, and malaria (3). Malaria ranks among the most prevalent and deadly insect-borne infections in many Asian, African, and Latin American nations. Anopheles species, of which there are roughly 70 species, are capable of spreading malaria. The four primary malaria parasite species "plasmodium vivax, P. Malariae, P. Falciparum, and P. Oval" are spread by mosquitoes and are responsible for human malaria. Malarial parasites are exclusively transmitted to humans via mosquitoes. As per a who report, 300 - 500 million individuals suffer from malaria annually, resulting in 1.5 to 2.7 million fatalities. Shockingly, every 12th-second witnesses the loss of a child to this disease (5,12). Currently, over 2.1 billion people are at risk of malaria across 103 countries, and a considerable portion of them inhabit regions where adequate measures for mosquito control are unavailable (4). Additionally, the utilization of chemical-based mosquito repellents is associated with issues like skin irritation, erythema, desquamation, and the formation of bullae on individuals' skin (2). DEET, the prevailing chemical mosquito repellent, is acknowledged for inducing harmful effects such as encephalopathy in children, anaphylaxis, urticaria syndrome, along with a decrease in heart rate and hypotension (1). Due to apprehensions about health hazards, vector resistance, and environmental pollution resulting from chemical insecticides, ongoing evaluations are being conducted for safe, plant-based alternatives. Phytochemicals derived from plants, known for their mosquito control potential, can act as substitutes for synthetic insecticides. They can be deployed either independently of chemical insecticides or in conjunction with them within an integrated vector control program (4). Furthermore, phytochemicals sourced from an extensive variety of plant species are both safe and biodegradable. They can be subjected to assessments for their insecticidal and mosquito-repellent activities, while also undergoing scrutiny for potential mammalian toxicity (3).

Figure 1 Aedes Mosquito

Herbal formulation

According to the world health organization (who), herbs are described as botanical constituents, whether fresh or dried, fragmented or powdered, employed in compositions to formulate final products. Plant-derived materials and products having medicinal action and additional health advantages are known as herbal products. (6). The active components found in herbal formulations are derived from different biological origins within herbal plantae. Because of the notion that herbal preparations are believed to be more efficacious and cause less or no side effects than synthetic chemical alternatives, there is a growing global demand for herbal preparations. (7,23).

Figure 2 Mosquito Biting

There is a wide range of herbal products offered in the pharmaceutical market to address different health conditions and promote public health. including:

i. Herbal hair oils
ii. Herbal creams
iii. Herbal gels and Emulgel
iv. Herbal aerosol preparations and more. (7).

Herbal mosquito repellent formulations

Mosquito repellents are substances that render surfaces undesirable to insects. They can be administered to the skin or other surfaces to dissuade mosquitoes from settling and to avert bites. Typically, active compounds in these formulations are herbal or polyherbal preparations that repel mosquitoes, along with auxiliary substances that facilitate distribution. While these repellents are available in various forms such as oils, lotions, and creams, aerosol formulations are the most prevalent (6). According to the 'World Health Organization (WHO) report around 80% of the world's population depends on herbal traditional medicine' in certain parts of prime health care (2). Many different diseases and ailments are treated with various herbs. One of these is linn's Duranta recta. Belongs to the Verbenaceae family and is a tiny to moderately-sized plant. It is also known by the names Angels Whisper, Brazilian sky flower, Duranta, golden dewdrop, golden tears, and pigeon berry (8,9). It has been observed that plant components with antimalarial, antibacterial, antioxidant, and cytotoxic properties include leaves, fruit, stems, and flowers (10). Its' effective therapeutic qualities are said to be derived from 'phytoconstituents such as alkaloids, flavonoids, glycosides, phenolics, saponins, steroids, tannins, and terpenoids'(11) The other significant ingredients that support the restorative qualities include scutellarein, repennoside, pectolinaringenin, durantol, and repenins (12).

MATERIAL AND METHODOLOGY

1. Procurement of Plant Specimens

Based on the extensive literature survey, the following plants have been selected for the formulation of mosquito-repellent emulgel (13,14). The plant of Duranta erecta linn (Verbenaceae) leaves was collected from the herbal garden of 'Dev Bhoomi Uttarakhand University, Chakrata road, Manduwala, Naugaon, state Uttarakhand, 248007' during February and March 2024. The leaves underwent washing with tap water, then were rinsed using distilled water. Then they were parched in the shade and stored in a sealed container for later use.

Figure 3. Duranta leaf was procured from the herbal garden of Dev Bhppmi Uttarakhand University, Dehradun

Figure 4. Cleaning Crude Leaf Of Duranta

2. Extraction:

The procured plant materials were carefully washed in water, chopped, and then dried in the shade for two weeks at room temperature ±37°C. Afterward, the shaded dried parts of the plant were coarsely grounded into powder using a mortar and pestle. For extraction, the 100 grams of powdered dry plant material was subjected to extraction with 250 milliliters of chloroform for 10 hours using the Soxhlet apparatus. The resulting extracts were then filtered and concentrated using a vacuum apparatus for 30 minutes. Finally, the concentrated extracts were stored at 4°C (15,18,20).

Fig 5. Extraction Of Crude Drug With Soxhlet Apparatus

Figure 6. Crude Extract

3. The Phytochemical Analysis

Phytochemical analysis was conducted following standard protocols: (16, 17,19)

a Assessment for terpenoids content (Salkowski's test):

"The 0.5 g of the plant extract was taken in a test tube, and 2 ml of chloroform was added in it. The 3ml of Concentrated H2SO4 was added carefully to form a layered structure. A reddish-brown color at the interface indicates the presence of terpenoids".

b Assessment for alkaloids content (Dragendorff's test):

'The 5ml of plant extract was taken in a glass tube, and he chloroform layer underwent extraction using 10 milliliters of CH3COOH. Added Dragendorff's reagents (potassium-bismuth-iodide solution) which give a reddish-brown precipitate'.

c Assessment for flavonoids content:

"The 5ml of the extract was heated with 10 ml of C4H8O2(ethyl acetate) over a steam bath for 3 min. The mixture was filtered and 4 ml of the filtrate was shaken with 1 ml of dilute ammonia solution. A yellow coloration indicates the presence of flavonoids."

4. Formulation development of emulgel

Emulgel was formulated following the protocol mentioned by Kumar et al., 2022 (30), and followed the flow chart of the same is indicated in Fig 12. The formulated gel contains a total of 10% v/v of active ingredients.

Preparation of Emulgel

Table .1 Preparation of emulsion:

Sr. No	Ingredients	Quantity
1.	Duranta erecta extract	10% v/v
2.	Coconut oil	20gm
3.	Clove oil	3.0ml
4.	Neem oil	5.0ml
5.	Cetyl alcohol	5.0gm
6.	Tween 80	0.5gm
7.	Span 20	0.5gm
8.	Glycerin	5.0ml
9	Distilled water (gm2)	Qs

Procedure

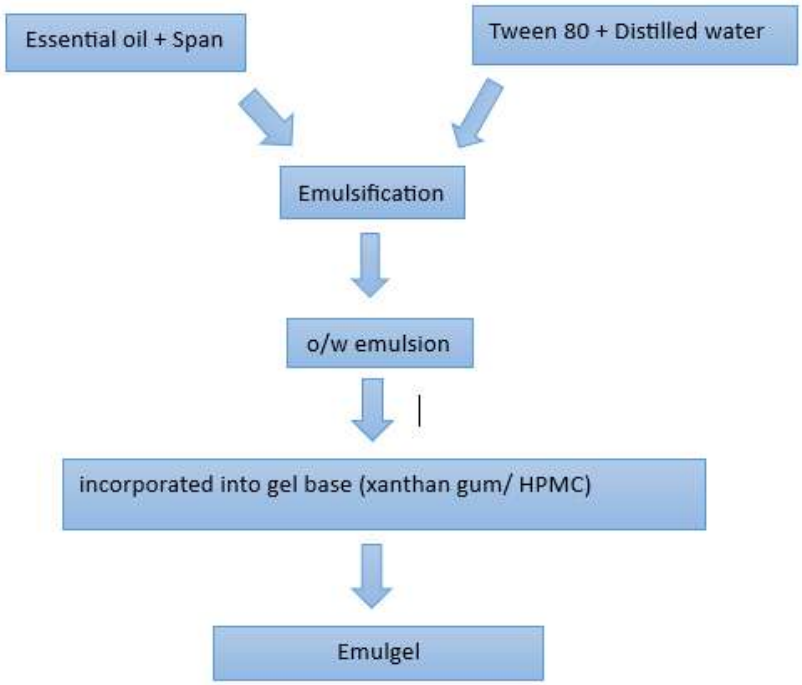

Fig 7: Schematic Representation For The Procedure Of Emulgel

A. Preparation of gel base:

Formulation of two gel base with xanthan gum (formulation 1) and hydroxy propyl methylcellulose (formulation 2) for the development of mosquito-repellent emulgel (21).

The gel base was prepared for the emulgel preparation by dissolving 3.0 gm of xanthan gum in warm water with continuous starring using a magnetic stirrer and pH was regulated to 5-7 using triethanolamine.

Table 2: Preparation of gel base I

Sr. No.	Ingredients	Quantity
1.	Xanthan gum	3gm
2.	Distilled water	42ml
3.	Triethanolamine	1-2 (drops)

Table 3: Preparation of gel base II

The gel base was prepared for the emulgel preparation by dissolving 3.0 gm of hydroxy propyl methylcellulose (HPMC) in warm water with continuous starring using a magnetic stirrer (at moderate speed), and pH was regulated to 5-7 using triethanolamine.

Sr No.	Ingredients	Quantity
1.	Hydroxypropyl methylcellulose (HPMC)	3gm
2.	Distilled water	42ml
3.	Triethanolamine	1-2 (drops)

C. Preparation of mosquito repellent Emulgel

Preparation of mosquito repellent gel with the help of gel base and emulsion.

Table 4: Preparation of mosquito repellent Emulgel:

"Add the prepared emulsion into the gel base dropwise with continuous stirring using a homogenizer to get emulgel."

Sr No.	Ingredients	Quantity
1.	Emulsion	50
2.	Gel base	45
3.	Distilled water	Qs

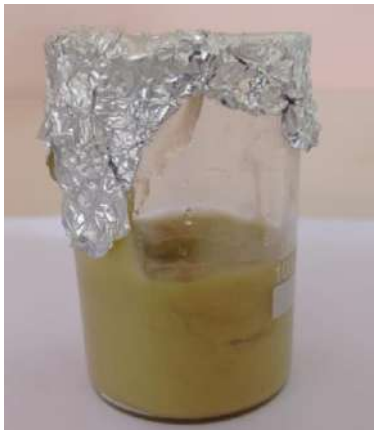

Figure 8. Xanthan Gum (Gelling Agent 3%) Emulgel Formulation (F1)

Figure 9. HPMC (gelling agent 3%) emulgel formulation (F2)

5. Evaluation of Emulgel

Physical evaluation:

The gel formulation underwent visual assessment for color and transparency. The texture of the gel was assessed by gently rubbing the formulation between fingers to gauge its smoothness, presence of clumps, roughness, and overall homogeneity. (24,25)

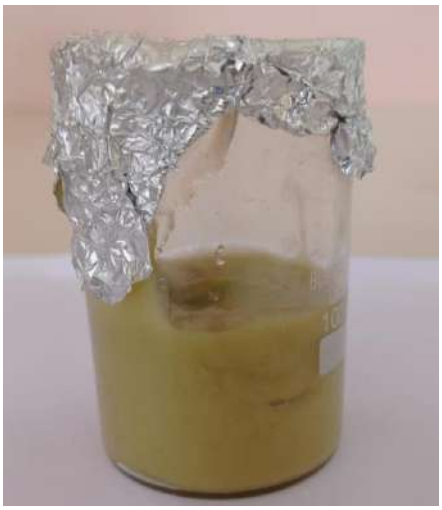

Figure 10. Emulgel(F1)

Figure 11. Emulgel (F2)

pH:

The pH meter was assessed to measure the pH. A quantity of 1 gram of the formulated gel was dissolved in 25 milliliters of distilled water. pH measurements were conducted in triplicate, and the average value was calculated. (26, 27)

Figure 12. Universal Ph Indicator

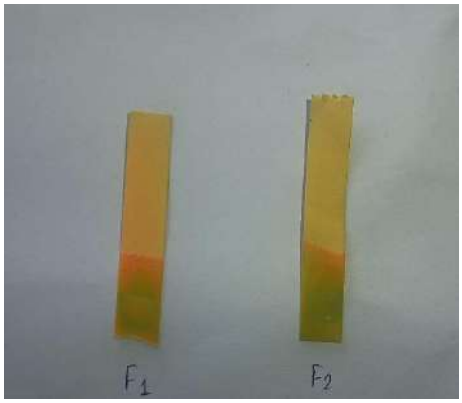

Figure 13. Result Of Ph OF F1 & F2

Spreadability:

Two grams of the prepared gel were placed between two identical glass slides. A weight of 200 grams was applied to compress the slides, removing any trapped air and creating a uniform film between them. The upper slide was then moved, and the time required to separate the glass slides was measured using the formula:

Spreadability (s)= m X l / t

Where m represents the weight applied on the upper slide (200 grams), l denotes the length of a glass slide (6 centimeters), and t signifies the time taken in seconds to separate the glass slides (26, 28)

Figure 14. Spreadibility testing

Viscosity:

'The viscosity of the formulated gel was determined using the digital Brookfield viscometer using spindle no. 62 at 1 rpm and temperature of 25±1°c. The corresponding dial reading was noted' (29)

Figure 15. Evaluation Of Viscosity Of Emulgel With Brookfield Viscometer

Skin-irritation test:

A skin irritation assessment was conducted by applying the formulated preparation to the skin of the hand, followed by observations at 15-minute and 30-minute intervals to detect any adverse reactions (30).

Figure 16. Skin Irritation Test

Figure 17. Skin Irritation Results After 15 Min Of Application

Figure 18. Skin Irritation Results After 30 Min Of Application

Washability:

The ease of washing off the gel with water was assessed visually post application. The 1gm prepared emulgel was applied on the surface of the hand and arms and tried washing with tap water without using any detergents or soap (24,31)**RESULTS AND DISCUSSION**

The extraction of Duranta erecta was carried out using a soxhlet apparatus with chloroform as solvent and evaluated for phytochemical screening i.e. terpenoids, alkaloids, and flavonoids. The evaluation results prove that the above-mentioned phytochemicals are present in the Duranta erecta leaves (table: 7) The two preparations of mosquito repellent emulgel were formulated of 10% v/v chloroform extract each using the above-

mentioned table (table 1, 2, 3, 4) and evaluated for color, transparency, homogeneity pH, Spreadability, viscosity, skin irritation, and washability (table 8, 9, 10). The result proved that the formulation with xanthan gum and HPMC as a gelling agent at 3% optimized the stability, consistency, and retention properties of the formulation as a mosquito repellent.

Table:7 Results Of The Phytochemical Assessment Of Crude Chloroform Extracts Of Duranta Erecta.

Tests	Inferences	Results	Tests
Assessment for terpenoids content (Salkowski's test)	'A reddish-brown color of the interface indicates the presence of terpenoids'	Positive	Assessment for terpenoids content (Salkowski's test)
Assessment for alkaloid content (Dragendorff's test)	'A reddish-brown precipitate indicates the presence of alkaloids'	Positive	Assessment for alkaloid content (Dragendorff's test)
Assessment for flavonoids content	'A yellow coloration indicates the presence of flavonoids'	Positive	Assessment for flavonoids content

Table 8: Results for color, transparency, and homogeneity evaluation.

Formulation	Color	Transparency	Homogeneity
F1	Olive green	Non-transparent	Good
F2	Pale yellow	Non-transparent	Good

Table 9: Results for pH, Spreadability evaluation

For**mulation**	**pH**	**Spreadability**
F1	**5.5**	**23.50**
F2	**6.0**	**25.37**

Table 10: Results for viscosity, skin irritation, and washability evaluation.

Formulation	Viscosity	Skin irritation
F1	26630 cp	Negative
F2	22320 cp	Negative

*cp= centipoise

CONCLUSION

Based on the findings of the investigational study, the emulgel preparation of Duranta erecta with essential oil has mosquito-repellent activity and showed good results as formulation. The primary objective of the present study is to optimize the efficacy of the drug as a mosquito repellent. One of the effective ways to optimize the mosquito repellent drug's effectiveness is by increasing the retention time of the drug. One of the main factors, which is directly proportional to the retention time of the drug is viscosity. The present study shows that the formulation with the gelling agent xanthan gum and HPMC has very effective results and both are very suitable for the emulgel formulation for the mosquito repellent. Further, an in-vivo screening test of the drug has to be conducted.

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