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Preeti Mishra
Faculty of Pharmacy, Raja Balwant Singh Engineering Technical Campus Bichpuri, Agra, Uttar Pradesh, India

Nitin Agrawal
Faculty of Pharmacy, Raja Balwant Singh Engineering Technical Campus Bichpuri, Agra, Uttar Pradesh, India

Namrata Gupta
Faculty of Engineering, Raja Balwant Singh Engineering Technical Campus Bichpuri, Agra, Uttar Pradesh, India

Sudhakar Yadav
B.Pharma Scholar, Raja Balwant Singh Engineering Technical Campus Bichpuri, Agra, Uttar Pradesh, India

Priya
B.Pharma Scholar, Raja Balwant Singh Engineering Technical Campus Bichpuri, Agra, Uttar Pradesh, India

Nisha Singh
B.Pharma Scholar, Raja Balwant Singh Engineering Technical Campus Bichpuri, Agra, Uttar Pradesh, India

Parvesz Ali
B.Pharma Scholar, Raja Balwant Singh Engineering Technical Campus Bichpuri, Agra, Uttar Pradesh, India

Nicy
B.Pharma Scholar, Raja Balwant Singh Engineering Technical Campus Bichpuri, Agra, Uttar Pradesh, India

Love Agrawal
B.Pharma Scholar, Raja Balwant Singh Engineering Technical Campus Bichpuri, Agra, Uttar Pradesh, India

Shlok Pandey
B.Pharma Scholar, Raja Balwant Singh Engineering Technical Campus Bichpuri, Agra, Uttar Pradesh, India

Corresponding Author:
Preeti Mishra
Faculty of Pharmacy, Raja Balwant Singh Engineering Technical Campus Bichpuri, Agra, Uttar Pradesh, India

Formulation and evaluation of safe herbal mosquito repellent roll-on

Preeti Mishra, Nitin Agrawal, Namrata Gupta, Sudhakar Yadav, Priya, Nisha Singh, Parvesz Ali, Nicy, Love Agrawal and Shlok Pandey

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Abstract
Mosquitoes are pretty much everywhere, and most of us know how easily they spread diseases like dengue, malaria, and yellow fever. Since we still don't have proper vaccines for many of these mosquito-borne infections, finding safe and effective ways to keep them away has become really important. A lot of the repellents we use today are chemical-based. They work, but they can also irritate the skin, harm the environment, and cause other issues if used too much. That's why people have started looking back at traditional plants that were always known to repel insects. These natural options are usually cheap, easy to find, and much safer compared to synthetic chemicals. In this study, we tried making a mosquito repellent using natural ingredients. We chose oils from neem, bergamot, lavender, and eucalyptus-plants that are already known for keeping mosquitoes away. Using these, we prepared two different mixtures. We also made a simple roll-on repellent using the same essential oils and checked how it smelled and whether it caused any kind of skin irritation.

Keywords: Natural mosquito repellent, essential oils, herbal ingredients, traditional plants, mosquito-borne diseases

Introduction
Mosquitoes are easily some of the most troublesome blood-feeding insects that affect people [1, 2]. Different species from groups like Anopheles, Culex, and Aedes are known for spreading a wide range of illnesses, including dengue, malaria, yellow fever, Japanese encephalitis, and several other infections [3]. Every year, mosquitoes are responsible for infecting more than 700 million people worldwide, and over a million deaths are linked to mosquito-borne diseases [4, 5]. Malaria alone continues to be a major health concern, with an estimated two to three million new cases reported yearly. In India, it remains one of the biggest contributors to the death rate among infants, children, and adults [6]. Dengue cases have also risen sharply, increasing nearly thirty times on a global scale in recent years Over the last few decades, dengue has increased at an alarming rate, becoming the fastest-spreading mosquito-borne viral infection [7]. Since these illnesses spread only through mosquito bites and we still don't have reliable vaccines to stop them, preventing mosquito contact remains one of the most effective ways to reduce their impact. Even though treatments exist for malaria and a few other mosquito-linked diseases, prevention is always the safer and smarter approach [8]. At present, there are no specific drugs or solid vaccines that can fully block the transmission of these viruses, which makes mosquito control absolutely essential, especially for many neglected tropical diseases. A lot of work has gone into developing mosquito repellents and larvicides to reduce mosquito populations. Repellents are basically substances that make surfaces or skin unattractive to mosquitoes, stopping them from landing or biting [9]. Mosquito control using scents or chemicals generally works through three main methods: repellents that push mosquitoes away, masking agents that make humans less detectable, and attractants that pull mosquitoes toward traps kept at a distance from people [10]. Using these strategies effectively can significantly cut down mosquito-human interaction and help slow the spread of infections. Most repellents sold today rely on synthetic chemicals like DEET, allethrin, N, N-diethyl mandelic acid amide, and dimethyl phthalate. However, these chemical-based options aren't always safe.

Reports have linked them to allergic reactions, skin irritation, and even neurological or cardiovascular effects when overused or applied incorrectly. Heavy dependence on such chemicals has also harmed the environment and disturbed natural ecosystems. This makes it necessary to explore safer, biodegradable, low-cost alternatives that communities can use without health risks [11]. Natural repellents fit well into this need. Herbal ingredients and essential oils have shown various medicinal properties, including the ability to repel mosquitoes. People are turning toward plant-based solutions because they're generally considered safer and have fewer side effects compared to synthetic products [12]. Natural sources have long been used to develop bioactive compounds, and they continue to play a major role in discovering new medicines. Traditional plant-based repellents have been part of local practices for generations and offer a simple, affordable method of personal protection against mosquitoes-especially species of Anopheles [13]. Using this traditional knowledge to create new natural repellents provides a valuable alternative to chemical pesticides. Strengthening mosquito-control research is crucial not only to stop the spread of mosquito-borne diseases but also to reduce our dependence on harmful chemical insecticides and protect the environment [14].

Essential oils and insect repellents

A repellent is basically any substance that keeps insects or other arthropods from landing on your skin or biting you. Female mosquitoes are mainly drawn to the lactic acid and carbon dioxide we give off through sweat-signals they easily pick up using the chemical sensors on their antennae. Essential oils are made up of natural, volatile compounds produced by plants, and many of them have been proven to work as insect repellents. Their components-like monoterpenoids, sesquiterpenes, and certain plant-based alcohols-play a big role in why mosquitoes dislike them. Oils containing ingredients such as citronellol, citronellal, α-pinene, and limonene have shown strong ability to keep mosquitoes away. Recent research has also found that compounds like linalool (a terpene alcohol found in many flowers and spices) and eucalyptol can activate specific odor-detecting neurons in a mosquito's antenna. This has helped scientists create a new method of testing repellents based on how they affect a mosquito's sense of smell, allowing the development of repellents with new and more effective modes of action [15]. In simple terms, a repellent works by interfering with the insect's ability to detect the moisture and chemical signals that normally help it find humans. By blocking these sensory cues, the chemicals in repellents make it harder for mosquitoes to recognize or locate people.

Herbal mosquito repellent roll-on

Essential oils are typically extracted through distillation, often using steam. Other techniques include cold pressing, resin tapping, wax embedding, solvent extraction, absolute oil extraction, expression, and wax extraction. Essential oils (EOs) are defined as volatile oils that have strong aromatic components and give a distinctive odor, flavor, or scent to an aromatic plant. Many natural EOs with mosquito repellent properties have been discovered and utilized [16]. They have various biological effects, such as antiseptic, antibacterial, antiviral, and fungicidal properties. Additionally, their larvicidal activity, repellent effects, and insecticidal properties have been confirmed [17]. Roller bottles, which can be used to create customized blends, are a helpful tool for utilizing essential oils. The roller ball on top makes it easy to apply the precise amount to the desired area, as it delivers a portion of the mixture upon contact. Due to their size, they don't take up much space in your handbag or backpack.

How to use a essential oil roller?

The use of essential oils in roller bottles will save money because they last longer, and the dilution process doesn't harm the essential oils in any way; rather, it aids in getting the oils. As roller bottles are convenient to apply where they are needed and then massage them more thoroughly [18]

Fig 1: Illustrate Roll-on

Essential oil used in preparation

Table 1: Formulation with quantity

Sr. No.	Ingredient	Quantity
1	Almond Oil	7.75ml
2	Eucalyptus Oil	1ml
3	Clove oil	0.5ml
4	Lavander	0.5ml
5	Bergamot	0.25ml
		Total - 10ml

Procedure

- Select a 10 ml roller bottle.
- Add the required amount of Almond oil [7.75 ml] into the bottle.
- Add ml of eucalyptus oil and 0.5 ml of Clove oil to the carrier oil.
- Add 0.5 ml of Lavender oil and 0.25 Bergamot oil to the bottle, respectively.
- Blend the oils well

Study aimed to develop and evaluate herbal mosquito repellents, including roll on to address the issue of mosquito-borne diseases. The use of plant essential oils has shown promise in providing mosquito repellent activity. The formulations were found to be safe, nontoxic, and cost-effective, making them a viable alternative to chemical-based mosquito.

Fig 2: Preparation of a 10 mL herbal mosquito-repellent roll-on formulated with almond oil, eucalyptus oil, clove oil, lavender oil, and bergamot oil

Result

Evaluation of Rollon

The evaluation of the roll-on produced the following results.

Physical analysis

- **Colour:** Pale yellow
- **Odor:** Pleasant

Skin irritation test

The roll-on was tested on the skin and checked every hour for any signs of irritation. It absorbed quickly and caused no discomfort. There was no redness, itching, or irritation throughout the observation period.

Fig 3: Rollon evaluation strips

Fragrance testing strips

The fragrance testing strips were used to evaluate the aroma of both the essential oils and the final formulation. Unmarked strips were dipped into the oils for a few seconds before being removed. The strips were then held 3-5 inches away from the nose and a quick smell was taken. It was found that the oils were fragrant and non-toxic. Mouilettes are strips or squares of plain absorbent paper used for testing scent formulations and specific fragrance components. They can either be dipped into your perfume or have perfume blend dropped or sprayed onto the strip. Drop individual oils onto the squares to see how the blend will smell before using it as a blending blotter [19]. Tester blotter strips, or Tester Blotters are small fragments of pH- neutral absorbent board that are used to test various scents and odors [20].

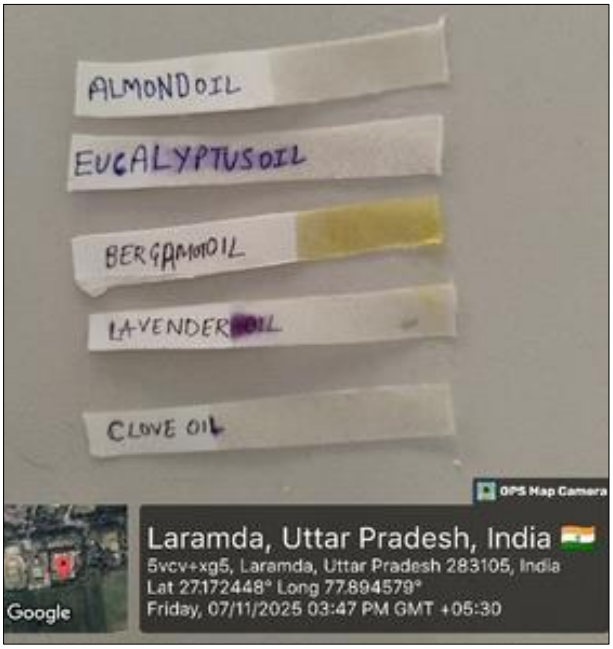

Fig 4: Strips essential oil

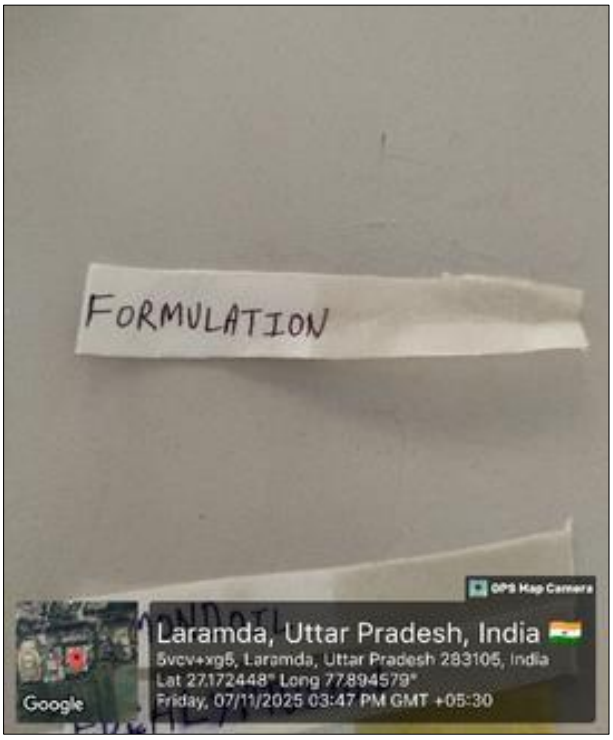

Fig 5: Of strips formulation

Conclusion

After applying the roll-on and observing the skin at regular intervals, the formulation proved to be fully safe for use. It absorbed rapidly and showed zero indicators of irritation-no

redness, no itching, and no discomfort of any kind. These results strongly suggest that the roll-on is skin-friendly, non-irritating, and suitable for regular application.

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