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Research

Formulation and Evaluation of herbal mosquito Repellent cream using *Tagetes erecta L.* & *Mentha piperita L.*

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Abstract:

Mosquito-borne diseases are a significant public health concern worldwide. The use of synthetic insecticides for mosquito control has led to various drawbacks, including the development of resistance, environmental pollution, and adverse effects on human health. Therefore, there is a growing interest in developing natural and eco-friendly alternatives, such as plant-based mosquito repellents. Tagetes erecta L. (marigold) and Mentha piperita L. (peppermint) are two promising plants with potential mosquito repellent properties. The objective of this study is to formulate and evaluate a herbal mosquito repellent cream using the essential oils of T. erecta and M. piperita. The cream formulation is expected to provide a convenient and effective way to deliver the repellent activity of these plants, while ensuring good stability and sensory properties.

Keyword: *Mosquito, Mentha Piperita, Insecticidal, Repellency, Dermatological, Essential oil*

1. Introduction

Against the backdrop of a world increasingly grappling with the pervasive threat of mosquito-borne diseases and a parallel concern for the potential health implications associated with synthetic insect repellents, the scientific community has been propelled into a quest for herbal alternatives. Mosquito-borne diseases are a significant public health concern worldwide. The use of synthetic insecticides for mosquito control has led to various drawbacks, including the development of resistance, environmental pollution, and adverse effects on human health [1]. This study stands at the forefront of this scientific endeavor, undertaking the intricate task of formulating and rigorously evaluating a herbal mosquito repellent cream that harnesses the innate properties of two botanical powerhouses - Tagetes erecta L. (marigold) and Mentha piperita L. (peppermint). Peppermint oil, derived from the peppermint plant (Mentha piperita), is not just a source of the refreshing aroma we all are familiar with, but it also boasts of having components like menthol, menthone, and pulegone which endow it with potent insecticidal, acaricidal, and repellent properties against various pests including mosquitoes[1].This revelation comes at a time when the quest for effective natural mosquito repellents is more pressing than ever, especially as malaria, dengue fever, chikungunya, and other mosquito-borne diseases continue to pose significant health risks globally[1] [2].A comprehensive review of recent studies has highlighted a significant increase in the exploration of essential oils, including peppermint oil as viable mosquito repellent options, reflecting a growing scholarly interest in leveraging nature's arsenal to combat these vectors[2]

Therefore, there is a growing interest in developing natural and eco-friendly alternatives, such as plant-based mosquito repellents. Tagetes erecta L. (marigold) and Mentha piperita L. (peppermint) are two promising plants with potential mosquito repellent properties. [7], [8].

As we delve deeper into examining peppermint oil and its role in repelling mosquitoes, our focus will be on understanding the science behind its efficacy and exploring the formulation and evaluation processes involved in creating a potent mosquito repellent. In doing so, we will also compare its advantages over synthetic repellents, illuminating peppermint oil's positioning as a key player in the fight against malaria, dengue fever, and chikungunya. The evidence amassed from various studies provides us new avenues to potentially limit the spread of these diseases, further emphasizing the importance of natural compounds in vector control.[2]

2. Understanding Herbal Mosquito Repellents

In exploring the realm of herbal mosquito repellents, it becomes evident that these natural solutions offer a promising alternative to their synthetic counterparts. The foundation of herbal mosquito repellents lies in the potent essential oils derived from specific plants known for their insect-repelling properties. This section delves into the characteristics and efficacy of such plant-based repellents.

- **Plant-Based Ingredients and Their Properties**:
- **Tagetes erecta L. (Marigold) and Mentha piperita L. (Peppermint)**: Both have been rigorously studied and shown to possess significant mosquito repellent properties. Their natural compounds offer a safer, more environmentally friendly approach to mosquito control [3] [6], [9], [10], [11].
- **Advantages of Herbal Repellents**:
    - **Safety and Accessibility**: Plant oils are generally safer and more accessible compared to synthetic repellents. They are less likely to cause skin irritations and can be easily found or grown in many parts of the world [3]
    - **Environmental Impact**: Being derived from natural sources, these repellents are biodegradable and have minimal environmental impact. This aspect is particularly important considering the growing concerns over the ecological effects of synthetic chemicals [3]
    - **Regulatory Approvals**: Essential oils such as peppermint have been recognized by regulatory bodies like the FDA as Generally Recognized As Safe (GRAS) for use in food, and by the USDA's National Organic Program (NOP) for application on food crops. This regulatory acceptance underscores the safety profile of herbal repellents [1]
- **Efficacy Against Mosquitoes**:
    - **Peppermint Oil**: Exhibits remarkable repellent properties against *Ae. aegypti*, the primary vector for dengue fever, with menthol being the primary active ingredient contributing to its efficacy. It's effective not only as a repellent but also as an insecticide, showcasing versatility in mosquito control [1] [4]

In summary, the exploration of herbal mosquito repellents reveals a diverse array of plant-based solutions that are not only effective in repelling mosquitoes but also offer advantages in terms of safety, accessibility, and environmental impact. The evidence supports the potential of these natural alternatives to play a significant role in global mosquito control efforts, particularly as concerns over the safety and ecological impact of synthetic repellents grow.

3. The Science Behind Tagetes erecta L. and Mentha piperita L.

Exploring the potency of *Mentha piperita L.* (peppermint oil) in mosquito repellency and larvicidal activity reveals a multifaceted approach towards combating mosquito-borne diseases. The scientific evidence underscores the

effectiveness of peppermint oil against various stages of mosquito development, from larvae to adults, providing a comprehensive strategy for mosquito control.

- **Larvicidal Activity**:
    - Initial bioassays have shown that peppermint oil exhibits significant larvicidal properties with an LC50 (lethal concentration to kill 50% of the population) value of 111.9 ppm and an LC90 (lethal concentration to kill 90% of the population) value of 295.18 ppm after 24 hours of exposure [4]
    - The mortality rate of mosquito larvae, including species such as *Anopheles stephensi*, *Aedes aegypti*, and *Culex quinquefasciatus*, increased substantially when exposed to peppermint oil, highlighting its effectiveness as a larvicide [4]
    - Notably, the toxicity of peppermint oil heightened by 11.8% when the exposure period was extended to 48 hours, indicating a time-dependent increase in larvicidal efficacy [4]
- **Repellency Against Adult Mosquitoes**:
    - Peppermint oil has demonstrated remarkable repellent properties against adult *Ae. aegypti* mosquitoes, providing 100% protection up to 150 minutes post-application [4]
    - In human trials, the application of peppermint oil on the skin resulted in a significant reduction of mosquito bites, with an 84.5% protection rate against *C. quinquefasciatus* for a duration of 6.7 hours [1]
    - Further studies identified peppermint oil as the most effective among five essential oils tested, deterring *Ae. aegypti* females from ovipositing (laying eggs) in laboratory conditions, which is critical in disrupting the mosquito life cycle [1]
    - Several studies have evaluated the efficacy of peppermint oil and its nanoemulsion formulations against mosquitoes, including Anopheles stephensi and Aedes aegypti [12], [13], [14].
- **Comparative Analysis and Safety Considerations**:
    - When compared to other essential oils, peppermint oil's larvicidal and repellent efficacy stands out, particularly against the dengue vector *Aedes aegypti*. However, in a comparative study of 41 essential oils, peppermint showed varied results, indicating the need for formulation optimization [4]
    - The main constituent of peppermint oil, menthol, has been utilized beyond mosquito control, demonstrating its versatility by controlling tracheal mites in honey bees, further attesting to the oil's broad-spectrum pesticidal properties [1]
    - While peppermint oil is celebrated for its effectiveness and safety, it's crucial to acknowledge potential side effects such as skin irritation, underscoring the importance of proper formulation and application methods to mitigate adverse reactions [2]

This evidence-based exploration into the science behind *Tagetes erecta L.* and *Mentha piperita L.* provides a robust foundation for considering peppermint oil not only as a viable natural mosquito repellent but also as a potent larvicide. The dual action against both larvae and adult mosquitoes offers a promising avenue for integrated mosquito management strategies, emphasizing the need for further research to optimize formulations and application methods for enhanced efficacy and safety.

4. Formulation Process

Ingredients:

1. Marigold Extract

- 5% of the total weight

2. Peppermint Oil

- 1% of the total weight

3. Cream Base:

- Water: 60% of the total weight

- Emollients (e.g., shea butter): 15% of the total weight

- Emulsifiers (e.g., cetearyl alcohol): 4% of the total weight

- Thickeners (e.g., stearic acid): 2% of the total weight

4. Beeswax

- 3% of the total weight

5. Vitamin E Oil

- 1% of the total weight

. Prepare Marigold Extract

- Infuse marigold flowers in a carrier oil to yield 5g of marigold extract.

2. Prepare Cream Base

- Combine water, emollients, emulsifiers, and thickeners to yield a total weight of 81g (60g water + 15g shea butter + 4g cetearyl alcohol + 2g stearic acid).

3. Combine Marigold Extract and Peppermint Oil with Cream Base

- Mix 5g of marigold extract, 1g of peppermint oil, and 3g of beeswax with the cream base.

4. Add Vitamin E Oil

- Add 1g of vitamin E oil.

5. Mix Well

- Stir the mixture thoroughly to ensure even distribution of all ingredients.

6. Cooling, Transfer to Containers, Labeling, and Storage

- Allow the cream to cool to room temperature while stirring intermittently. Transfer the cream into clean, airtight containers, and label them with the ingredients and date of preparation. Store the cream in a cool, dry place.5

S.no	**INGREDIENTS (MG)**	**F1**	**F2**	**F3**	**F4**	**F5**	**F6**	**F7**	**F8**	**F9**	**F10**

1.	Distilled water (ml)	6	6	6	6	6	6	6	6	6	6
2.	Extract (gm)	3	3.5	4	4.5	5	5.5	6	6.6	7	7.7
3.	Beeswax (gm)	3	3	3	3	3	3	3	3	3	3
4.	Cetyl Alcohol (gm)	4	4	4	4	4	4	4	4	4	4
5.	Vitamin E oil (ml)	1	1	1	1	1	1	1	1	1	1
6.	Shea butter (gm)	15	15	15	15	15	15	15	15	15	15
7.	Stearic acid (gm)	2	2	2	2	2	2	2	2	2	2
9.	Peppermint oil (ml)	1	1	1	1	1	1	1	1	1	1

Table-Composition of the cream

The cream formulation is expected to have good physical and sensory properties, such as a smooth texture, pleasant odor, and easy spreadability.[15]

5. Evaluation of Mosquito Repellent Efficacy

In evaluating the efficacy of mosquito repellents, The formulated cream will be evaluated for various parameters, including appearance, pH, viscosity, spreadability, and stability.

Organoleptic Properties

The cream was examined for its appearance, texture, and odor. It was observed to have a smooth texture and an off-white color.

pH

The pH of the cream was determined using pH paper, and it fell within the range of 5.5-6.0, indicating an acidic pH suitable for the skin.

Homogeneity

On visual inspection, the cream was smooth

Layering test

The cream left a smooth, non-greasy layer on skin without any stickiness. Got absorbed well.

Type of smear

On application to skin, the cream spread easily forming a thin, uniform smear without residue.

Removal by water

The cream rinsed off easily with water without leaving any oily layer, indicating good washing properties.

Evaluation Test	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
Color	white	white	white	white	white	white	Off-white	Off-white	Off-white	Off-white

Odor	mint-like	mint-like	mint-like	mint-like	mint-like	mint-like	mint-like	mint-like	mint-like	mint-like
Consistency	Thin	Thin	Thin	Thin	Thick	Thick	Thick	Thick	Thick	Thick
pH	5	5.62	6	6.25	6.42	6.95	6.71	6.6	6.92	6.96

6. Result

The essential oils of T. erecta and M. piperita are expected to show significant mosquito repellent activity when incorporated into the cream formulation. The repellent effect may be attributed to the presence of bioactive compounds, such as limonene, linalool, and menthol, which can interfere with the olfactory receptors of mosquitoes and prevent them from locating their hosts

7. Conclusion

The formulation of a herbal mosquito repellent cream using the essential oils of T. erecta and M. piperita is a promising approach to develop a natural and eco-friendly alternative to synthetic repellents. The repellent activity of these plants has been demonstrated in several studies, and their incorporation into a cream base can provide a convenient and effective way to deliver their benefits.

However, further research is needed to optimize the formulation, evaluate its long-term stability, and assess its safety and efficacy in real-world settings. The development of herbal mosquito repellents can contribute to the sustainable management of mosquito-borne diseases, while reducing the reliance on synthetic insecticides and their associated risks.

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