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Natural Essential Oils Based Polyherbal Candle: An Efficient Eco-friendly Mosquito Repellent

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Abstract: Diseases transmitted by mosquitoes are rising worldwide and impact hundreds of millions of human lives annually. Commonly known diseases caused by mosquitoes are malaria, dengue, chicken gunya, filariasis, yellow fever and Zika virus. The herbal mosquito repellent candles offer an effective solution to overcome mosquito problems. This research focuses on preparation and evaluation of new mosquito repellent candles aimed at providing safe and nono-toxic protection from mosquitoes. We survey the effectiveness of mosquito repellent candles made from natural ingredients in reducing mosquito populations and their impact on the environment and human health. The candle is formulated using natural wax (e.g. bee wax, soy wax) and essential oils such as Basil or Tulsi, Neem, Marigold, Eucalyptus and Lavender oil which are known for their mosquito repellent activity. The prepared candle is evaluated for its flammability, burning rate, irritancy, stability, presence of smoke and its repellent activity. Burning test shows effectiveness because of natural ingredients and essential oils present in candle. It does not cause any irritation to skin or any allergic reaction. The burning rate and time and the mosquito repellent efficiency of the prepared candles were compared with the commercially available scented candles.

Index Terms - Component, formatting, style, styling, insert.

I. INTRODUCTION

Mosquitoes represent one of the most significant threats to human and veterinary health around the world. Their ability to transport and propagate diseases to humans causes millions of deaths each year [1-4]. For instance, the worldwide incidence of dengue fever has increased 30-fold in the past 30 years, and more countries are reporting their first outburst of the disease (WHO, 2019) [5-7]. Presently, there is no effective prophylactic anti-malarial vaccine and no suitable preventive measure other than vector control is available. Thus, shielding from mosquito bites is one of the best approaches to reduce the disease incidence [8-11].

The use of repellents to secure people from mosquito bites previously has been acknowledged as part of an overall integrated insect-borne disease control programme [12-15]. Most of the commercial repellents are produced by using chemical components such as N, N-diethyl-metatoluamide (DEET), Allethrin, N, N-diethyl mendelic acid amide, and Dimethyl phthalate etc. It has been identified that chemical repellents are not safe for public health and should be used with caution because of their detrimental impacts on synthetic fabric and plastic as well as toxic reactions, such as allergy, cardiovascular and neurological side effects, which have been reported generally after misapplication. The frequent use of synthetic repellents with chemical origin for mosquito control has also disturbed natural ecosystems and resulted in the development of resistance to insecticides, resurgence in mosquito populations, and adverse impact on non-target organisms. Accordingly, the idea of using natural mosquito repellent products as an alternative to develop new eco-friendly repellents could be an amicable solution to scale back the undesirable effects on environment and human health [16-26].

In recent years, interest in plant-based repellents has been revived, as they contain a rich source of bioactive phytochemicals that are safe and biodegradable into nontoxic by-products, which could be screened for insecticidal activities and mosquito repellent. Many studies have reported evidence of repellant activities of plant extracts or essential oils against malaria vectors around the world.

Candles offer a convenient and pleasant method of repelling mosquitoes [27-30]. By incorporating natural herbal ingredients and essential oils known for their mosquito repellent properties, such as neem, eucalyptus, marigold, basil, and lavender, we aim to create a formulation that is both safe and non-toxic. In this study we focus on the formulation and evaluation of polyherbal mosquito repellent candle utilizing plant-based ingredients known for their mosquito repellent properties.

II. Materials and Methods

2.1. Materials

Soy wax and beeswax were purchased form Dolloz and IKALAA INNOVATIONS respectively via amazon.in. The essential oils are purchased form Naturalis and Deve Herbs via amazon.in.

Table 1: Formulation of candle

Sl. No.	Ingredient name	Quantity
1	Bee Wax	60 gm
2	Soy wax	30 gm
3	Basil Essential oil	2 ml
4	Eucalyptus Essential oil	2 ml
5	Neem Essential oil	2 ml
6	Marigold Essential oil	2 ml
7	Lavender Essential oil	2 ml
8	Tocopherol or Vit-E oil	1 ml
9	Rose oil	10 drops
10	Camphor oil	10 drops

Procedure:

The Bee wax and Soy wax were weighted precisely and taken in a double boiler. The wax mixture was then melted by boiling at a temperature of 70-85 ˚C. Following an appropriate amount of antioxidant (Vitamin-E oil) is added to the mixture. The stove was then turned off and the essential oils were added to the mixture while stirring. The overall mixture was then stirred for few minutes. The moulds were prepared by the side and the wax mixture was poured into the moulds. The moulds were allowed to cool to room temperature to form the candles.

2.2. Determination of Knockdown Effect

Ten mosquitoes captured and released in a mosquito net (8 ft × 7 ft) where the candles produced were lit in turns for a period of 120 minutes. The number of mosquitoes still flying after for 15, 30, 45, 60 minutes was counted and the difference expressed as percentage of mosquitoes knockdown by the smoke (Eq. 1) from the burning candles

$Efficiency$ = No. of mosquitoes knockdown /Total No. of mosquitoes × 100……(1)

III. Results and Discussion

Organoleptic test: This test was done visualising the formulation to evaluate the texture, colour and Fragrance.

Colour: colour of formulation was found to be yellow (Figure 1).

Figure 1: Formulated candle with essential oil variant used in it.

Fragrance: Fragrance of formulation was found to be satisfied.

Texture: A uniform (homogeneous) formulation was discovered (Figure 1).

Irritancy test: It found that prepared mosquito repellent candle did not cause any irritation or discomfort to skin during or after the burnings.

Uniformity of mass: Five candles of each group were selected and weighed individually. The weight of individual group was noted. Average weight was calculated, and the individual Weights were compared with the average weight. Average weight calculated for all the variants are in the range 24.6-25.5 gm.

Burning rate: Burning rate of prepared candles were tested and compared. For this test, initial mass of candle (M1) and the time of lighting (T1) were noted. Once the candle stops burning the time (T2) and mass (M2) were once again noted. The time of burning was T2 – T1 in hours and the mass burnt was M2 – M1 in grams. The burning rate was calculated according to the follow formula ($M2-M1/T2-T1$) in grams per hour (Figure 2). Burning rate experiments data were shown in Table 2.

Table 2: Detremination of burning rates for the prepared polyherbal candles (PC).

Sample	Burning Rate (gm/hr)				Average Burning Rate (gm/hr)	Comments
	1 hr	2 hr	3 hr	4hr		
PC-1	2.61	2.68	2.49	2.52	2.575	The burning rate of the prepared candle was found uniform over time. The irregularity in some cases may be due to change in environmental condition (wind flow, Temperature etc.)
PC-2	3.34	3.24	3.13	3.047	3.189	
PC-3	2.49	2.57	2.68	2.71	2.612	
PC-4	3.23	3.86	4.04	4.002	3.783	
PC-5	3.28	3.015	2.873	2.921	3.022	
	2.99	3.073	3.052	3.04		average burning rate at each hour

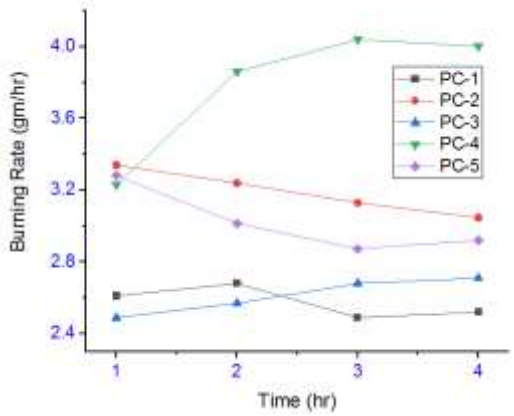

Figure 2: Burning rate of the prepared candles.

Mosquito repellent activity net Test: Test conducted using small net (8 ft × 7 ft). 10 mosquitoes are collected in net and checked for its activity over time. Out of 10 mosquitoes 9 mosquitoes were knocked down at 1 hour. The repelling percentage is 90 % at 1 hr which is higher than our previous report with basil essential oil variant [30].

Table 3: Knockdown Effect of the Prepared Polyherbal Candle

Time (minutes)	M_i	M_f	M_n	Repelling percentage (%)
15	10	10	0	0
30	10	7	3	20
45	10	5	5	50
60	10	1	9	90

M_i: Initial number of mosquitoes, M_i: Final number of mosquitoes, M_n: Number of mosquitoes knocked down.

On basis of evaluation test studies and observations, it is found that the candles were done successfully using various try outs. The optimum wax ratio was found to be 2:1 for bee wax and soy wax (Table 4). Increasing soy wax percentage increases softness and decreases burning rate whereas increasing bee wax percentage increases harness.

Table 4. Optimisation of bee wax/soy wax ratio

Bee wax : soy wax	Characteristics
1:2	very soft, smooth
1:1	soft, smooth
2:1	hard, smooth
3:1	very hard, not smooth

During burning of candle, the used essential oil may oxidised by the flame. To overcome this limitation, anti-oxidant has to be used. There is report of the use of different acids (citric acid, oxalic acid, quinol, stearic acid etc.) as anti-oxidant but those acids have limitations of solubility [29]. So, herein we used natural anti-oxidant tocopherol (Vitamin-E oil) as anti-oxidant which is easily soluble in the wax mixture. Amount of essential oil is also optimised by fixing the other constituents (e.g. bee wax, soy wax, vitamin-E oil, rose and camphor oil) and we found that 9-10 % oil content is satisfactory for the fragrance and efficiency. Using excess essential oil causes uneven burning and increases burning rate.

Burning efficiency and mosquito repelling efficiency of the prepared candles were tested at laboratory room temperature. The prepared candle showed very good repelling efficiency compared to commercial candles (Figure 3). We also compared other properties of the prepared candles with commercially available scented candles (Table 5). The fragrances of the commercial candles are quite good compared to our prepared candle. The burning rates of the commercial candles are also very slow and not uniform over time. As can be seen in Figure 4 and 5 the burning rate and flame height of the commercial candles decreases with time. The mosquito repelling efficiency of the commercial candles was also found to be very poor with respect to the prepared candle (Figure 3, Table 5).

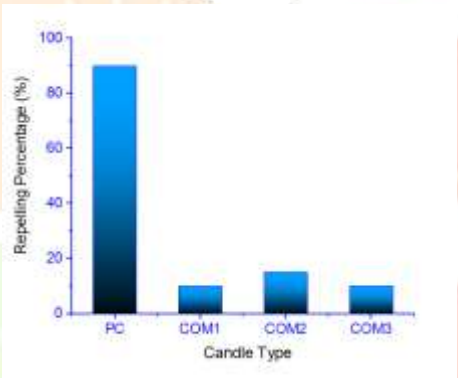

Figure 3: Mosquito repelling percentage (at 1 hr) of prepared scented candle and the commercial candles. PC: Polyherbal Candle, COM1, COM2 and COM3 are commercial candles.

Table 5: Comparison between prepared candles and commercial scented candles

Properties	PC	COM1	COM2	COM3
Flame height (cm) (initial)[a]	1.0	1.8	1.3	0.9
Flame height (cm) (after 30 mins)	1.0	1.0	0.7	0.5
Flame height (cm) (after 1 hr)	1.2	0.7	0.4	0.5
Burning rate[b]	3.04	1.36	1.11	1.32
Burning time (hr)	6	>6	>6	>6
Repelling percentage	90	10	15	10

[a]The commercial candle's flame height decreases with time brightness and burning rates also reduced sharply. [b]average burning rate

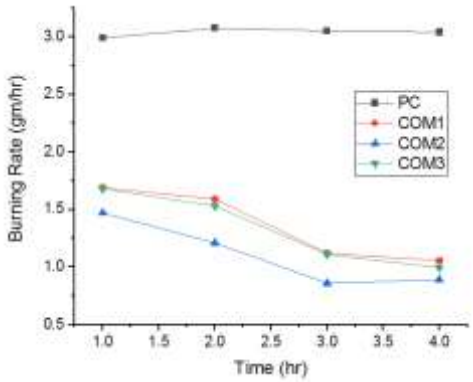

Figure 4: Comparison of burning rate between prepared candle and commercial candles.

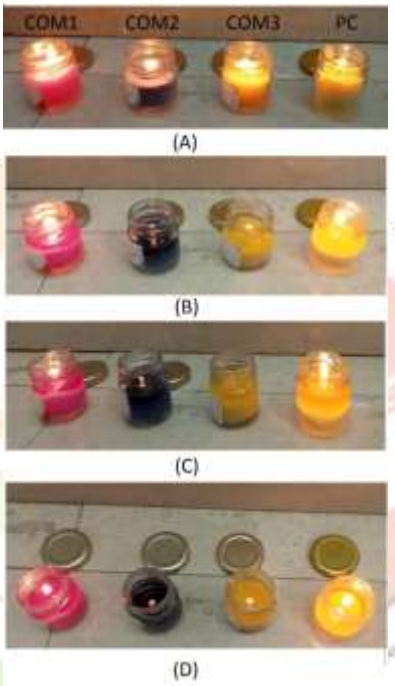

Figure 5: Comparison of flammability between prepared candle and commercial candles. (A) after 5 minutes (B) after 30 minutes (C) and (D) after 1 hour of lit

IV. **Conclusion**

The herbal candle proved to be effective in repelling mosquitoes, providing a safer alternative to chemical repellents. The use of natural ingredients ensures that the candle is non-toxic and safe for humans and pets, making it suitable for both indoor and outdoor use. The result reinforced the viability of creating environmentally friendly products that do not harm the ecosystem. The inclusion of essential oils not only enhances the mosquito-repellent properties but also provides a pleasant fragrance and potential therapeutic benefits. The candles are easy to prepare and can be used in homes.

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VI. References

1. Wu P, Yu X, Wang P, Cheng G. Arbovirus lifecycle in mosquito: acquisition, propagation and transmission. Expert Rev Mol Med (2019) 21:e1. doi: 10.1017/erm.2018.6
2. Leta S, Beyene TJ, De Clercq EM, Amenu K, Kraemer MUG, Revie CW. Global risk mapping for major diseases transmitted by Aedes aEgypti and Aedes albopictus. Int J Infect Diseases. (2018) 67:25–35. doi: 10.1016/j.ijid.2017.11.026
3. Ferguson NM. Challenges and opportunities in controlling mosquito-borne infections. Nature (2018) 559(7715):490–7. doi: 10.1038/s41586-018-0318-5.
4. McCarroll L, Paton M, Karunaratne S, Jayasuryia H, Kalpage K, Hemingway J. Insecticides and mosquito-borne disease. Nature (2000) 407(6807):961–2. doi: 10.1038/ 35039671.
5. WHO. 2019. https://www.who.int/neglected_diseases/vector_ecology/mosquito-bornediseases/ en/.
6. WHO. Global strategy for dengue prevention and control, 2012–2020. Geneva, World Health Organization, 2012.
7. WHO. World Malaria Report 2018. Geneva, World Health Organization, 2018.
8. Caragata E, Dong S, Dong Y, Simões M, Tikhe C, Dimopoulos G. Prospects and pitfalls: next-generation tools to control mosquito-transmitted disease. Annu Rev Microbiol (2020) 74:455–75. doi: 10.1146/annurev-micro-011320-025557.
9. Paluch G, Bartholomay L, Coats J. Mosquito repellents: a review of chemical structure diversity and olfaction. Pest Manage Science. (2010) 66(9):925–35. doi: 10.1002/ps.1974
10. Luker HA. A critical review of current laboratory methods used to evaluate mosquito repellents. Front. Insect Sci. (2024) 4:1320138. doi: 10.3389/finsc.2024.1320138.
11. Norris, E.J., Coats, J.R., 2017. Current and future repellent technologies: The potential of spatial repellents and their place in mosquito-borne disease control. Int. J. Environ. Res. Public Health 14. https://doi.org/10.3390/ijerph14020124.
12. Dickens JC, Bohbot JD. Mini review: Mode of action of mosquito repellents. Pesticide Biochem Physiol (2013) 106(3):149–55. doi: 10.1016/j.pestbp.2013.02.006.
13. Patel EK, Gupta A, Oswal RJ. A Review On: Mosquito Repellent Methods. International Journal of Pharmaceutical, Chemical and Biological Sciences (2012) 2(3): 310-317.
14. Frandin M. S., Day J. F., Comparative Efficacy of Insect Repellents Against Mosquito Bites, New England Journal of Medicine,2002:34(7):13-18.
15. Mohomed A. A., Tarek I. A., Zarrag I. A., Extracts Against the Dengue Fever Mosquito, Journal Saudi Soc,2012:20(1):13-16.
16. Priyanka S., Sandhya G., Nandu K., Development and Evaluation of Herbal Mosquito Incense Repellent, International Journal of Research Publication and Reviews, 2023:4(3):4714-4718.
17. Grison C, Carrasco D, Pelissier F, Moderc A. Reflexion on bio-sourced mosquito repellents: nature, activity, and preparation. Front Ecol Evol (2020) 8. doi: 10.3389/ fevo.2020.00008.
18. Kalita B, Bora S, Sharma AK. Plant essential oils as mosquito repellent-a review. Int J Res Dev Pharm Life Sci (2013) 3(1):741–7.
19. Regnault-Roger C, Vincent C, Arnason JT. Essential oils in insect control: lowrisk products in a high-stakes world. Annu Rev Entomology. (2012) 57(1):405–24. doi: 10.1146/annurev-ento-120710-100554.
20. Rehman JU, Ali A, Khan IA. Plant based products: Use and development as repellents against mosquitoes: A review. Fitoterapia (2014) 95:65–74. doi: 10.1016/ j.fitote.2014.03.002.
21. Schultz G, Peterson C, Coats J. Natural insect repellents: activity against mosquitoes and cockroaches. Natural Products for Pest Management (2006) 927:168–81. doi: 10.1021/bk-2006-0927.ch013.
22. Sneha A, Nidhi H, Aniket J. Formulation of Natural Mosquito Repellent. International journal of advance research, ideas and innovations in technology (2018) 4(1): 11- 17.
23. Ranasinghe MSN, Arambewela L, Samarasinghe S. Development of Herbal Mosquito Repellent Formulations. International journal of collaborative research on internal medicine and public health (2016) 8(6): 341-342.
24. Chaiyakunapruk N., Kongkaew C., Sakunrag I., Tawatsin., Effectiveness of Citronella Preparations in Preventing Mosquito Bites Systematic Review of Controlled Laboratory Experimental Studies, Tropical Medical International Health, 2011:16(7):802-810.
25. Megha T. S., Ganesh B. P., Tejas S. S., Nandkishor R. R., Formulation of Herbal Mosquito Repellent from Laurus Nobile, International Journal of Innovative Science and Research Technology, 2020:5(4):771-772.
26. Deepak KG, Revathi AG. Formulation and Evaluation of Poly Herbal Mosquito Repellent candle. Journal of the Gujarat research society (2019) 21(14): 2144- 2145.

27. Shaily S, Hansika V, Anshika S (2024) Formulation and Evaluation of Mosquito Repellent candles. International journal of pharmaceutical sciences 2(4): 684-688.
28. Sanjay T. S., Santosh J., Waghmare D. M., Formulation and Evaluation of Herbal Mosquito Repellent Candle, International Journal of Relative Research Thoughts, 2023:11(6):93-104.
29. Pham, H.D., Pham, T.N., Nga, D.T.K., Nhung, N.T.T., Lam, T.D., Toan, T.Q., 2020. Preparation and Characterization of Naturally Scented Candles Using the Lemongrass (Cymbopogon citratus) Essential Oil. MSF 977, 212–217.
30. Dey, S.K., Scented Candles Based on Natural Essential Oils and Anti-oxidants: An Effective Eco-friendly Control of Mosquitoes (2025**),** 14 (3): 1786-1794.