

Preparation And Evaluation of Mosquito Repellent Activity

Dr. M. Sri Ramachandra¹, Ms. B. Ankitha², Ms. K. Nandini³, Ms. M. Harshitha⁴, Mr. Shaik Arshad Ul – Haq⁵, Mr. S. Sainath Reddy⁶

Professor & HOD, Dr. K. V. Subba Reddy Institute of Pharmacy, Kurnool, Andhra Pradesh, India Dr. K. V. Subba Reddy Institute of Pharmacy, Kurnool, Andhra Pradesh, India

Corresponding Author: Dr. M. Sri Ramachandra

Date of Submission: 12-09-2026

Date of Acceptance: 22-09-2026

Abstract

Mosquito-borne diseases such as malaria, dengue, chikungunya, and yellow fever remain major global health problems, particularly in tropical and subtropical regions. Although synthetic mosquito repellents are widely used for protection, their continuous use may cause health and environmental concerns. Therefore, the development of safe, eco-friendly, and cost-effective herbal mosquito repellents has gained increasing importance. The present study aimed to formulate and evaluate herbal mosquito-repellent incense sticks and gel using natural plant-based ingredients. The formulations were prepared using herbal materials such as *Tinospora cordifolia*, *Pongamia pinnata*, neem, marigold, and chrysanthemum powders along with essential oils including eucalyptus, lavender, lemongrass, clove, and peppermint oils. Incense sticks were formulated using herbal powders, charcoal, camphor, benzoin, and acacia as a binder, while the repellent gel was prepared using aloe vera gel, glycerin, polyethylene glycol, Carbopol-940, methyl paraben, and essential oils. Six incense-stick formulations and four gel formulations were developed. The prepared formulations were evaluated for physical appearance, burning time, ash content, smoke visibility, pH, spreadability, skin irritation, and repellent activity. Among the formulations, F2 of both the incense sticks and gel showed better overall performance with effective mosquito repellency and acceptable evaluation parameters. The study suggests that herbal mosquito repellents may provide a safe and environmentally friendly alternative to chemical repellents.

Keywords: Herbal mosquito repellent; incense sticks; mosquito-repellent gel; essential oils; *Pongamia pinnata*; *Tinospora cordifolia*; natural insect repellent; mosquito-borne diseases.

I. Introduction

Repellent activity is the ability of a substance to keep organisms such as insects and

pests away by preventing them from approaching, biting, feeding, or settling. Repellents are mainly used to protect people from mosquito, tick, and other arthropod bites that may spread diseases.

Since ancient times, people have used methods such as smoke from fire, bed nets, screened windows, protective clothing, mud, animal fats, herbs, and poultices to avoid insect bites. Chemical repellents act by masking human scent or disturbing insect sensory mechanisms. Synthetic repellents such as DEET and picaridin provide long-lasting protection, while natural repellents include tea tree oil, citronella, and lemongrass, eucalyptus, lavender, and peppermint oils.

Common household mosquito-repellent products include coils, mats, liquid vaporizers, citronella candles, mosquito nets, and electric mosquito bats. Natural repellents may be eco-friendly, biodegradable, locally available, and suitable for different dosage forms such as gels, creams, sticks, sprays, and coils. However, natural products can have shorter duration of action because of volatility, stability problems, variation in active components, and possible irritation at high concentrations.

II. Materials and Methods

2.1 Materials

The materials used in the study included *Tinospora cordifolia* powder, *Pongamia pinnata* powder, neem powder, marigold powder, chrysanthemum powder, cow dung, camphor, benzoin, acacia/agar, lavender oil, lemongrass oil, neem oil, eucalyptus oil, mustard oil, rose oil, tea-tree oil, clove oil, menthol, peppermint oil, eutectic mixture, charcoal, myrrh, and water. Other formulation materials included Carbopol-940, polyethylene glycol, glycerin, methyl paraben, vitamin E, and aloe vera gel. The reported equipment included a pH meter, ultrasonicator, desiccator, and hydro-distillation apparatus.

2.2 Preparation of Menthol by Hydro-distillation

Fresh mint leaves (20 g) were washed with water and transferred to a round-bottom flask. Distilled water (100 mL) was added. A Clevenger apparatus was assembled and the mixture was heated using a heating mantle at 60°C for 60 min. The vapours were condensed, and the oil-water mixture collected in the Clevenger tube. The oil layer was separated because of immiscibility and collected.

2.3 Preparation of Eutectic Mixture

The eutectic mixture consisted of *Mentha spicata*, ajwain flower, and edible or raw camphor. It was used to provide fragrance in the incense sticks.

2.4 Preparation of Mosquito-Repellent Incense Sticks

- All dried herbs were collected and ground into a fine powder using a mixer grinder.

2.5 Formulation of Mosquito-Repellent Incense Sticks

Ingredient	F1	F2	F3	F4	F5(P)	F6(N)
Tinospora cordifolia powder	5 g	3 g	3 g	3 g	—	—
Pongamia pinnata powder	5 g	3 g	3 g	2 g	4 g	—
Neem powder	3 g	2 g	2 g	3 g	—	4 g
Marigold powder	3 g	2 g	2 g	3 g	3 g	3 g
Chrysanthemum powder	3 g	2 g	2 g	2 g	3 g	3 g
Cow dung	5 g	2 g	3 g	1 g	1 g	1 g
Camphor	1 g	1 g	3 g	2 g	2 g	2 g
Benzoin	—	—	1 g	0.3 g	0.5 g	0.5 g
Acacia	—	4 g	4 g	5 g	5 g	5 g
Agar-agar	5 g	—	—	—	—	—
Lavender oil	2 drops	2 drops	2 drops	2 drops	2 drops	2 drops
Lemongrass oil	—	2 drops	2 drops	2 drops	—	—
Neem oil	—	2 drops	2 drops	—	—	—
Eucalyptus oil	2 drops	2 drops	2 drops	2 drops	2 drops	2 drops
Mustard oil	—	2 drops	2 drops	2 drops	—	—
Rose oil	—	2 drops	2 drops	2 drops	2 drops	2 drops
Tea-tree oil	—	2 drops	2 drops	2 drops	2 drops	2 drops
Clove oil	2 drops	2 drops	2 drops	—	—	—
Peppermint oil	2 drops	—	—	—	—	—
Eutectic mixture	2 drops	2 drops	2 drops	2 drops	2 drops	2 drops
Myrrh	—	—	1 g	0.2 g	—	—
Charcoal	—	—	1 g	0.5 g	—	—
Water	50 mL	20 mL	20 mL	20 mL	20 mL	20 mL

- The fine powder was sieved through mesh no. 80.
- Acacia/agar was dissolved in the required quantity of water and heated for 5 min.
- The fine powders were transferred to a mortar and the selected essential oils were added and triturated until properly mixed.
- Acacia binder was added and triturated continuously until a dough-like consistency was obtained.
- The dough was divided into small equal portions and rolled by hand onto bamboo sticks.
- The sticks were rolled in sawdust and dried at room temperature for 24 h.

2.6 Preparation of Mosquito-Repellent Gel

- 5 mL glycerin was dissolved in 5 mL water.
- Aloe vera gel was extracted from the plant; where specified, 5 mL was incorporated into the solution.
- Polyethylene glycol (2 mL), rose oil and coconut oil (2 drops each), and 2 mL Pongamia

oil/lemongrass oil were incorporated as described in the formulation.

- One vitamin-E capsule was added.
- The mixture was triturated and Carbopol-940 (2 g) was added and mixed well.
- The finished formulation was transferred into a clean container.

2.7 Formulation of Mosquito-Repellent Gel

Ingredient	F1	F2	F3	F4
Glycerin	5 mL	5 mL	5 mL	5 mL
Carbopol 940	2 g	2 g	2 g	2 g
Lemongrass oil	2 drops	–	–	–
Rose oil	2 drops	2 drops	2 drops	2 drops
Coconut oil	2 drops	2 drops	2 drops	2 drops
Polyethylene glycol	2 mL	2 mL	2 mL	2 mL
Methyl paraben	1 g	1 g	1 g	1 g
Vitamin-E capsule	400 mg	400 mg	400 mg	400 mg
Aloe vera gel	–	5 mL	5 mL	5 mL
Pongamia pinnata oil	–	2 mL	–	2 mL
Neem oil	–	–	2 mL	2 mL

III. Evaluation Parameters

The incense sticks were evaluated for physical appearance, burning time, ash content, smoke visibility, irritability, repellent activity, suffocation, product elegance, mosquito repellency, odour, and allergy responses. The gels were

evaluated for physical appearance, colour, odour, consistency, skin irritability, pH, repellent activity, spreadability, product elegance, mosquito repellency, odour, and skin irritation. The source manuscript also reports graphical evaluation based on responses collected through a Google Form.

IV. Results

4.1 Physical Appearance of Incense Sticks

Formulation	Colour	Odour	Size	Shape	Surface nature	Homogeneity
F1	Earthy brown	Pleasant	19 cm	Rod	Slightly rough	No
F2	Earthy brown	Pleasant	19 cm	Rod	Slightly rough	Yes
F3	Dark green	Pleasant	19 cm	Rod	Slightly rough	Yes
F4	Earthy brown	Pleasant	19 cm	Rod	Slightly rough	Yes
F5	Earthy brown	Pleasant	19 cm	Rod	Slightly rough	Yes
F6	Earthy brown	Pleasant	19 cm	Rod	Slightly rough	Yes

All six formulations had a pleasant odour, rod-shaped appearance, 19 cm length, and slightly rough surface. Except F1, the remaining formulations showed uniformly distributed dough. The sticks were earthy brown except F3, which was dark green.

4.2 Evaluation of Mosquito-Repellent Incense Sticks

Formulation	Burning time	Ash content	Smoke visibility	Irritability	Repellent activity	Suffocation
F1	126 min	0.3 g	Yes	No	Yes	No
F2	122 min	0.3 g	Yes	No	Yes	No
F3	90 min	0.4 g	Yes	No	Yes	No
F4	93 min	0.4 g	Yes	No	Yes	No
F5	82 min	0.5 g	Yes	No	Yes	No
F6	81 min	0.5 g	Yes	No	Yes	No

The reported burning time decreased in the order F1 > F2 > F4 > F3 > F5 > F6. Ash content increased in the order F1 = F2 < F3 = F4 < F5 = F6. All six formulations showed smoke visibility and repellent activity, while no irritability or suffocation was reported. The source manuscript states that F2 showed evaluation parameters comparable with the standard formulation.

4.3 Product Elegance of Incense Sticks

Formulation	Excellent	Good	Average	Poor
F1	57	33	10	0
F2	80	20	0	0
F3	50	43	7	0
F4	73	27	0	0
F5	73	23	3	0
F6	17	53	17	0
STD	78	22	0	0

4.4 Mosquito Repellency of Incense Sticks

Formulation	Excellent	Good	Average	Poor
F1	67	30	3	0
F2	87	13	0	0
F3	52	45	3	0
F4	73	27	0	0
F5	80	20	0	0
F6	50	33	17	0
STD	85	15	0	0

4.5 Odour and Allergy Response of Incense Sticks

Formulation	Odour Excellent	Odour Good	Odour Average	Odour Poor	Allergy No	Allergy Yes
F1	57	37	3	3	97	3
F2	67	20	13	0	100	0
F3	33	47	20	0	90	10
F4	57	43	0	0	100	0
F5	53	37	10	0	97	3
F6	23	53	17	7	83	17
STD	65	20	15	0	100	0

4.6 Physical Appearance of Repellent Gel

Formulation	Colour	Odour	Consistency
F1	White	Pleasant	Gummy
F2	Pale yellow	Pleasant	Gelly
F3	Light brown	Pleasant	Gelly
F4	Light brown	Pleasant	Gelly

All four formulations had pleasant odour. F1 had a gummy consistency, whereas F2–F4 had gelly consistency.

4.7 Evaluation of Repellent Gel

Formulation	Skin irritability	pH	Repellent activity	Spreadability
F1	No	6.7	Yes	Yes
F2	No	5.8	Yes	Yes
F3	No	6.1	Yes	Yes
F4	No	5.9	Yes	Yes

The pH values followed the order $F4 < F2 < F3 < F1$. All four formulations showed repellent activity without reported skin irritation and showed spreadability considered suitable in the source manuscript. F2 was reported to be comparable with the standard formulation for physical appearance, skin irritability, pH, repellent activity, and spreadability.

4.8 Product Elegance of Repellent Gel

Formulation	Excellent	Good	Average	Poor
F1	0	52	48	0
F2	98	2	0	0
F3	72	24	4	0
F4	78	16	6	0
STD	95	5	0	0

4.9 Mosquito Repellency of Repellent Gel

Formulation	Excellent	Good	Average	Poor
F1	56	34	10	0
F2	66	34	0	0
F3	64	22	14	0
F4	44	42	54	0
STD	65	35	0	0

4.10 Odour and Skin Irritation of Repellent Gel

Formulation	Odour Excellent	Odour Good	Odour Average	Odour Poor	Skin irritation No	Skin irritation Yes
F1	16	34	44	6	96	4
F2	52	0	48	0	100	0
F3	46	40	14	0	100	0
F4	50	40	10	0	92	8
STD	53	0	47	0	100	0

V. Discussion

All six incense-stick formulations showed similar odour, size, shape, and surface characteristics, with slight differences in colour. The source manuscript attributes repellent activity to the combined herbal ingredients and essential oils, including *Tinospora cordifolia*, *Pongamia pinnata*, neem, eucalyptus, clove, lavender, lemongrass, mustard, and rose oils.

F2 was identified as the best incense-stick formulation because it showed high burning time, low ash content, good physical appearance without cracking, and good repellent activity. F1 also

showed a high burning time but had limitations including excessive water use, cracking, and lack of homogeneity associated with agar. F6 showed the lowest burning time, which the source manuscript associates with the higher amount of charcoal.

All four repellent-gel formulations showed repellent activity and pleasant odour, with no skin irritation reported in the principal evaluation table. F2 was identified as the best gel formulation because of its good physical appearance, pleasant odour, suitable pH, and absence of reported irritation. F1 also showed repellency but had a

gummy nature, attributed in the source manuscript to lack of moisture.

The developed incense-stick and gel formulations were compared with standard formulations. The source manuscript reports that the developed formulations exhibited equivalence to the standard formulation for the evaluated parameters, with F2 showing the closest overall performance.

VI. Conclusion

The present study developed herbal mosquito-repellent incense sticks and gel using natural plant powders and essential oils. Six incense-stick formulations and four gel formulations were prepared and evaluated using physical and functional parameters. Based on the reported results, F2 was the best-performing formulation for both dosage forms, showing acceptable physical characteristics and effective repellent activity. The study suggests that herbal incense sticks and repellent gels may serve as economical and environmentally friendly alternatives to synthetic chemical repellent products. Further standardized efficacy, stability, and safety studies would be required to establish their performance more comprehensively.

References

- [1]. Baruah PS, Borthakur SK. Creation of a herbal mosquito repellent. *Annals of Plant Sciences*. 2016;5(12):1463–1465.
- [2]. Makhaik M, Tewary DK, Naik SN. Assessment of essential oils' anti-mosquito qualities. *Journal of Scientific and Industrial Research*. 2005;64:129–133.
- [3]. Munir T. *Gujrat EZS*. 2016;45:73–77.
- [4]. Intergovernmental Panel on Climate Change (IPCC). *Climate Change 2014: Impacts, Risks, and Adaptation. Section A: Sectoral and Global Aspects*. 2014.
- [5]. Kumar et al. A review of herbal insect repellents. *Herbal Medicine Journal*. 2019;15:100243.
- [6]. Com, Vakada Nagabhushana Rao, Kumar I, Krishna B, Madhulata N, Anudeep M. Analytical Comparative Analysis of Gas Turbine Blade Materials Used in Marine Applications. *International Journal of Engineering Sciences & Management Research*. 2014.
- [7]. Mishra S, Kumar A, Kumar P. A review of herbal insect repellents. *Journal of Entomology and Zoology Studies*. 2019;7(3):124–131.
- [8]. Yadav VK, Kumar P, Kalasariya H, Choudhary N, Singh B, Gnanamoorthy G, Gupta N, Khan SH, Khayal A. How the Indian Economy Is Affected by the Present Incense Sticks Market Situation. *Pure & Applied Biosciences in India*. 2020;8(3):627–636.
- [9]. Natural Mosquito Repellents: Benefits and Advantages. *Natural Health Products Review*. 2020;5(1):12–15.
- [10]. World Health Organization (WHO). *Mosquito-borne diseases*. 2019.
- [11]. Abzal, Prabhu AN, Shibin A, Chithra, Coralinanisha, Senthil Kumar M, Valarmathi S. A comparative analysis of herbal insect repellent incense sticks and commercial products. *International Journal of Pharmaceutical Research*. 2021;33(57A):128–132.
- [12]. Kushwah H. *Formulation and Evaluation of Herbal Mosquito Repellent Gel*.
- [13]. Selvadurai S, Swetha V, Anbazhagan S, Shanmugapandiyan P. Developed and formulated Dhoop, a natural insect repellent, using *Azadirachta indica* and *Vitex negundo*. *Journal of Herbal Medicine International*. 2023;11(4):15–17.
- [14]. Kiernan-Linn K, et al. Why is a mosquito's sense of smell so important? *Young Minds, Frontiers*. 2022.
- [15]. Colarossi J. According to a study, mosquitoes have an odd sense of smell. 2023.