



Formulation And Assessment Of Herbal Mosquito Repellent Dhoop Sticks

¹Vaibhavi Kailas Jagtap, ²Smt.Vidya Namdeo Dange, ³Shri.Sagar Bhaskar Patil, ⁴Shubhangi Jagannath Shid

¹ B.Pharm, ² M.Pharm (Pharmaceutics), ³ M.Pharm (Pharmaceutics), ⁴ M.Pharm (Pharmaceutics)

¹Rajarambapu College of Pharmacy Kasegaon, Sangli, Maharashtra, India-415404

Abstract: Mosquito-borne diseases remain a significant public health concern globally, necessitating the development of effective, safe, and eco-friendly mosquito control strategies. The present study focuses on the formulation and evaluation of a polyherbal mosquito repellent dhoop using natural plant-based ingredients with proven repellent properties. Herbal components such as *Azadirachta indica* (Neem), *Vitex negundo* (Nirgudi), camphor was incorporated into a combustible base composed of Rice husk powder. These ingredients were selected based on their traditional and scientifically validated mosquito repellent activity. The formulated dhoop were prepared by blending the herbal powders with water molding them, followed by shade drying. Evaluation was conducted based on parameters such as burning time, smoke consistency, organoleptic properties, and repellent efficacy was determined based on public responses to questionnaire. The results indicated that the polyherbal formulation exhibited significant repellent activity, comparable to commercial mosquito repellents, while offering the advantages of being biodegradable, non-toxic, and free from synthetic chemicals.^[1]

Index Terms. - Mosquito Repellent, Incense stick, Herbal, Neem, Nirgudi, Camphor, Ricehusk

I. INTRODUCTION

Mosquito-Borne Diseases: A Global Health Concern

Mosquitoes are known vectors for a wide range of infectious diseases, including malaria, dengue fever, chikungunya, Zika virus, and yellow fever. According to the World Health Organization (WHO), malaria alone affects over 200 million people worldwide and causes hundreds of thousands of deaths annually. Similarly, diseases like dengue and Zika have emerged as major health threats in tropical and subtropical regions, leading to an urgent need for effective mosquito control measures. While various methods, such as chemical sprays, nets, and insecticides, have been employed to control mosquito populations, their long-term use raises concerns regarding environmental impact, human health risks, and the development of resistance by mosquito species. In response to these concerns, the search for sustainable, eco-friendly, and non-toxic alternatives to conventional chemical repellents has intensified. Herbal-based products, particularly those using plant extracts with known repellent properties, have gained attention as promising solutions. Among these alternatives, mosquito repellent incense sticks formulated with polyherbal blends represent a safe and effective approach. These incense sticks not only provide protection against mosquitoes but also offer a pleasant aromatic experience without the adverse side effects associated with chemical repellents.^[2]

Myiasis

Myiasis is a condition caused by certain parasitic insects, particularly botflies, that feed on the living tissue of humans or animals. One such species, *Dermatobia hominis*—commonly known as the human botfly—employs a unique method to infect hosts. It lays its eggs on the underside of a mosquito. When the mosquito bites a human, the warmth of the skin causes the eggs to hatch, allowing the larvae to enter the host's skin.

These larvae develop inside the tissues, often leading to localized tissue damage and, in some cases, necrosis. While myiasis is rare in regions with improved hygiene and medical access, it still occurs in parts of the developing world with poor sanitation.

Viral Diseases Transmitted by Mosquitoes

Mosquitoes of the *Aedes aegypti* species are known to spread several serious viral infections such as dengue fever, chikungunya, and yellow fever. These illnesses can present with a range of symptoms, including high fever, joint swelling, muscle pain, and in severe cases, coma or death. These viruses continue to pose significant health threats, especially in tropical and subtropical regions.

Helminthic Infections (Helminthiasis)

Some mosquito species are vectors for parasitic worms like those causing lymphatic filariasis. This disease can lead to severe swelling of body parts, a condition often referred to as elephantiasis. The worms are transmitted through repeated mosquito bites over time and can cause long-term disability. Efforts to control mosquito populations are vital in preventing such parasitic diseases.

Anatomy of a Mosquito

Mosquitoes are small, winged insects with three main body segments: the head, thorax, and abdomen. The head contains sensory structures like compound eyes that detect movement, as well as feathery antennae that are highly sensitive to the carbon dioxide humans exhale—detectable from distances up to 100 feet. Close to the antennae are the maxillary palps, which sense body odors, especially compounds like octenol found in human sweat.

The proboscis, located between the antennae, functions as a specialized mouthpart that pierces the skin to draw blood. The thorax connects the head and houses the wings and three pairs of legs, which end in tiny claws that help the insect grip surfaces. The abdomen contains internal organs, including the digestive and respiratory systems.

Both male and female mosquitoes consume plant nectar. However, only females require a blood meal after mating, as the proteins in blood support the development of their eggs. Due to this feeding behavior, female mosquitoes play a key role in transmitting viruses and parasites from one host to another, making them one of the most dangerous vectors in public health.

Preventing Mosquito Breeding and Ensuring Protection

Controlling mosquito populations begins with eliminating stagnant water sources where mosquitoes lay their eggs. It's essential to ensure there are no water-filled containers or puddles in and around residential areas. In larger water bodies like ponds, introducing guppy fish (*Poecilia reticulata*), which feed on mosquito larvae, can help reduce breeding.

Inside homes, installing mesh screens on windows and sleeping under mosquito nets are effective ways to prevent bites. However, these measures may not completely eliminate the risk, as even a single mosquito bite can transmit serious diseases. This is especially true during the monsoon season in countries like India, where water accumulation is common. Hence, the use of mosquito repellents and dhoop products becomes essential in offering an additional layer of protection.^[3]

2. Polyherbal Formulation: The Concept of Synergy

The idea of formulating polyherbal mosquito repellents is rooted in the principle of synergy—the combined effect of multiple herbs that enhances their individual mosquito-repellent activity. Traditional knowledge from various cultures around the world has long utilized natural plant extracts for repelling insects. Herbs such as *Azadirachta indica* (Neem), *Vitex negundo* (*nirgudi*) are well known for their mosquito-repellent properties. Each of these plants contains bioactive compounds, such as azadirachtin in neem, caryophyllene in nirgudi, which are believed to interfere with the mosquito's sensory system, either by masking attractants or by disrupting feeding behaviour.

The formulation of polyherbal dhoop involves the combination of these herbs into a single product, leveraging their complementary effects to enhance the overall efficacy of mosquito repellency. In addition to their repellent properties, these herbs also possess antimicrobial, anti-inflammatory, and soothing qualities, which further contribute to their desirability as ingredients in natural repellent formulations.^[4]

3.Dhoop as a Medium for Mosquito Repellency

Dhoop have been used for centuries in various cultures for purposes such as spiritual rituals, aroma therapy, and insect repellent applications. The traditional method of burning incense produces a steady stream of smoke, which, depending on the composition of the stick, can effectively drive away mosquitoes and other pests. In this regard, dhoop offer a dual benefit: they act as an insect repellent while simultaneously providing a pleasant fragrance that is often associated with relaxation and well-being.

The use of dhoop as a medium for releasing mosquito-repellent compounds offers several advantages. First, the smoke created during burning can disperse the active compounds into the surrounding air, thus creating a mosquito-free zone in both indoor and outdoor environments. Additionally, dhoop are convenient to use, relatively easy to produce, and provide long-lasting protection. Their controlled burn time and slow-release nature make them more effective over extended periods compared to other types of mosquito repellents.

However, conventional dhoop often rely on synthetic chemicals and artificial fragrances, which can pose health risks when inhaled over prolonged periods. By utilizing a polyherbal formulation, it is possible to create a more natural and safer alternative to synthetic incense, while still achieving effective mosquito repellent action.^[5]

4.Rationale for the Study

The primary objective of this project is to develop and evaluate a polyherbal mosquito repellent incense stick made from a blend of natural, plant-based ingredients. The formulation focuses on selecting herbs known for their mosquito-repellent activity, such as neem, nirgudi and incorporating them into a base mixture of rice husk and cow dung powder. This combination not only ensures effective mosquito repellency but also minimizes the environmental impact and health risks associated with synthetic chemical repellents.

The study will investigate the effectiveness of the polyherbal incense sticks in terms of their repellent activity, burning characteristics, and sensory properties.^[6]

MATERIAL AND METHODS

Material- Neem powder, Nirgudi powder, Camphor powder, Sandalwood powder
Rice husk powder, Tragacanth powder

Neem (*Azadirachta indica*)

Neem, scientifically known as *Azadirachta indica*, is a tropical evergreen tree that belongs to the Meliaceae family. It is native to the Indian subcontinent and has been widely used in traditional medicine for centuries due to its various therapeutic properties. Neem is often referred to as the "village pharmacy" in India because of its vast range of uses, including its insecticidal, antimicrobial, and anti-inflammatory properties.

In the context of mosquito repellent formulations, neem is particularly valued for its ability to deter a variety of insects, including mosquitoes. The primary active ingredients in neem that contribute to its insect-repellent properties include:

- **Azadirachtin:** The most well-known active compound in neem, azadirachtin, has insecticidal and repellent effects. It works by interfering with the mosquito's feeding and reproductive processes, thus reducing their numbers.
- **Nimbin:** Nimbin is another active compound in neem with demonstrated insect repellent properties. It is believed to act as a deterrent by disrupting the mosquito's sensory mechanisms.
- **Azadiradione:** This compound has been shown to possess both repellent and toxic effects on mosquitoes, making it useful in controlling mosquito populations.
- **Meliantriol:** Meliantriol acts as a mosquito repellent and has shown effectiveness in deterring various insect species.

The combination of these bioactive compounds makes neem a powerful natural insect repellent, particularly against mosquitoes. Neem oil, extracted from the seeds and fruits of the neem tree, is widely used in various forms, including creams, lotions, and incense sticks, to keep mosquitoes at bay.^{[7][8]}

Nirgudi (*Vitex negundo*)

Nirgudi, also known as *Vitex negundo*, is a medicinal plant that belongs to the Lamiaceae family. It is native to Asia, particularly the Indian subcontinent, and has been traditionally used in Ayurvedic and folk medicine for its wide range of therapeutic benefits. Nirgudi is well-known for its properties such as anti-inflammatory, analgesic, antimicrobial, and insecticidal effects. In particular, Nirgudi has gained attention for its ability to repel mosquitoes and other insects, making it an ideal herb for inclusion in mosquito repellent products.

The active ingredients in Nirgudi that contribute to its insect-repellent properties include:

- **Iridoid Glycosides:** These compounds have been shown to exhibit insecticidal and repellent activity. Iridoid glycosides are responsible for much of Nirgudi's mosquito-repelling effects, interfering with the sensory mechanisms of insects.
- **Flavonoids:** Flavonoids in Nirgudi, including compounds like vitexin, also play a role in its mosquito repellent properties. These compounds work by disrupting the mosquito's ability to detect and respond to attractants.
- **Essential Oils:** Nirgudi contains essential oils that have been found to possess strong insect-repellent qualities. These oils are thought to mask the pheromones used by mosquitoes for navigation, thus making it more difficult for mosquitoes to locate humans.

Nirgudi is also valued for its antimicrobial properties, and it is often used in the treatment of wounds, skin infections, and respiratory issues. As a natural insect repellent, it is highly effective against mosquitoes and has a long history of use in traditional mosquito control methods. ^{[9][10]}

Camphor

Camphor is originally a white and oily resin of the tree *Cinnamomum camphora*. Its crystals are also widely available in market. It has been used for generations as an effective repellent of mosquitoes and ants. ^[11]

Sandalwood Powder

Sandalwood powder is a finely ground, aromatic powder derived from the heartwood of the sandalwood tree (*Santalum album*). Revered for its calming fragrance and spiritual significance, it is a key ingredient in the preparation of dhoop – a type of incense used in meditation, prayer, and purification rituals.

This natural powder emits a warm, woody, and slightly sweet aroma when burned, creating a serene and sacred atmosphere. When mixed with other herbs, resins, or a natural binder like ghee or cow dung, it forms a powerful, non-toxic incense blend. It is ideal for making dhoop. ^[12]

Rice Husk

Rice husk is the protective outer layer of rice grains, naturally fibrous and combustible, making it an excellent eco-friendly base for dhoop (incense) formulations. When used in mosquito repellent dhoop, rice husk acts as a natural binder and slow-burning agent that supports the release of active repellent ingredients like neem, citronella, or camphor.

It contributes minimal smoke and a neutral scent, allowing the aroma and efficacy of added herbs and oils to dominate. Due to its lightweight and porous structure, rice husk helps maintain the shape and texture of dhoop cones or sticks while ensuring even burning. ^[13]

Tragacanth Gum powder

Tragacanth gum is a natural resin obtained from the sap of *Astragalus* plants. It is widely valued for its excellent binding, thickening, and emulsifying properties, making it an ideal eco-friendly binder in herbal dhoop and incense preparations. When used in mosquito repellent dhoop, tragacanth helps hold together dry ingredients like neem powder, citronella, and rice husk, forming firm and long-lasting sticks or cones.

Its ability to absorb water and form a sticky gel ensures that the mixture retains its shape without cracking during drying. Unlike synthetic binders, tragacanth is non-toxic, odourless, and completely biodegradable, supporting a natural formulation. ^[14]

Method for preparation of dhoop

1. Prepare the binder by mixing tragacanth gum with a small amount of water. Let it soak for 3–4 hours until it forms a gel-like paste. This will serve as a natural binder.
2. In a large bowl, combine neem powder, nirgudi powder, sandalwood powder, and rice husk powder.
3. Add crushed camphor to the dry mixture. Camphor acts as a mosquito repellent and enhances the fragrance and burning quality of the dhoop cones.
4. Gradually incorporate the tragacanth gum paste into the dry ingredients. Knead the mixture thoroughly to form a uniform, dough-like consistency. Add small amounts of water if needed to help bind the ingredients.
5. Shape the dough into cones by hand or using moulds.
6. Place the shaped cones on a tray and allow them to air-dry in a shaded, well-ventilated area for 3–5 days or until they are fully dry and hard.
7. Once dried, store the cones in an airtight container to preserve their potency.
8. To use, light the tip of a cone and let it smolder, releasing mosquito-repelling smoke into the environment. ^[1]

Formulation Table

Sr. No	Name of Ingredient	Quantity of Ingrdient	Role of Ingredient
1	Neem powder	20g	Insecticidal, Antimicrobial
2	Nirgudi Powder	10g	Mosquito repellent
3	Camphor powder	2g	Insect repellent; Antimicrobial
4	Sandalwood powder	15g	Fragrance
5	Rice husk powder	25g	Base material, binder
6	Tragacanth Powder	5g	Binder
7	Distilled water	As required	Aqueous phase

Evaluation

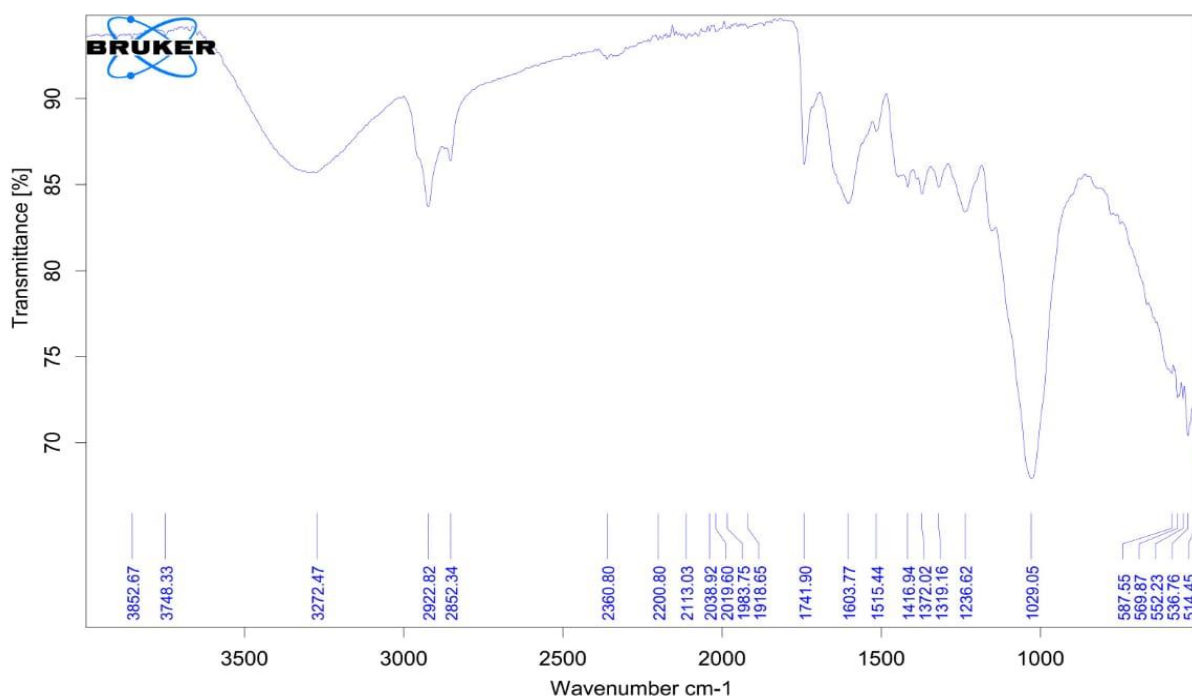
1.IR SPECTROSCOPY-

Place a small amount of powder directly onto the ATR crystal, such as diamond or ZnSe, and gently press it to ensure it covers the surface evenly. Then, use the pressure arm to apply firm contact between the sample and the crystal, which is essential for accurate measurement. Once proper contact is established, run the IR scan and collect the spectrum, typically in the range of 4000to 400 cm^{-1} .

2. The parameters such as product appearance, smoke, Fragrance, burning time, and mosquito repellence, Overall satisfaction was evaluated through feedback from 15 people using a Google Form survey.

RESULT AND DISCUSSION

1. IR Spectroscopy



D:\IR results M.Pharm\B.Pharm\Vaibhavi Jagtap\Poly herbal mixture.0

Poly herbal mixture

Poly herbal mixture

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Page 1/1

Specific IR Peaks & Their Corresponding Functional Groups

Wavelength(cm-1)	Functional Group	Assignment
3392,3732	O-H stretching	Alcohol, phenol, or water content
3272	N-H stretching	Primary or secondary amines
2922,2853	C-H stretching	Alkane group
2360,2342	CO ₂ Presence	Minor likely atmospheric CO ₂
2100-2200	C≡C or C≡N	Alkynes or nitriles
1741	C=O	Ester, ketone, aldehyde or carboxylic acid
1651,1607,1584	C=C stretching	Aromatic compound
1451,1419	C-H bending	Alkane
1230-1020	C-O stretching	Alcohol, esters, ethers
657,617,563,549,514	C-H out of plane bending	Substituted benzene rings

The mixture contains Alcohols/phenols (broad O–H)

Aromatic compounds (C=C, C–H out-of-plane bending)

Alkanes (C–H stretching and bending)

Carbonyl groups (likely esters or acids from the C=O stretch)

C–O bonds (alcohols, ethers, esters)

Possible traces of amines/amides (from 3272 cm⁻¹)**Feedback from 15 volunteers:**

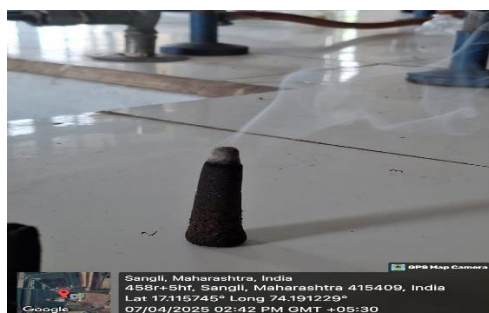
Fifteen people were asked to comment on the mosquito-repelling dhoop via a Google Form and to rate the formulation containing polyherbal ingredients.

Parameters	Excellent	Good	Average	Poor
Product appearance	—	12	3	—
Smoke characteristics	—	11	5	—
Fragrance	—	2	13	—
Mosquito repellence	—	3	12	—
Overall satisfaction	—	7	8	—

Burning time—Less than 20 minutes

CONCLUSION

The mosquito-repellent dhoop formulated with polyherbal ingredients was generally well-accepted in terms of appearance and smoke characteristics, with most volunteers rating these parameters as Good. However, the fragrance received predominantly Average feedback, indicating a need for improvement. The mosquito repellence was found to be moderately effective, with the majority rating it as Average. Overall satisfaction was balanced between Good and Average. The burning time was noted to be less than 20 minutes, which may be considered short for prolonged action.



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