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A Review on Herbal Dhoop from Temple Waste for Mosquito Repellent Activity

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Abstract: *Mosquito-borne diseases have become a serious health concern in recent times. Illnesses such as dengue, malaria, and yellow fever are primarily spread by mosquitoes. This research emphasizes the principles of Recycle, Reuse, and Recover (3Rs), which are essential in any waste management process. The study explores the use of marigold waste to produce herbal dhoop. Unlike the many chemical-based mosquito repellents available in the market that harm both humans and the environment, this formulation is developed entirely from natural ingredients and temple flowers.*

The prepared dhoop was evaluated on several parameters, including mosquito-repellent activity, microbiological safety, moisture content, consistency, irritability, burning time, ash value, color, and odor. The central aim of this research is the development and evaluation of a natural, herbal dhoop formulation designed for environmental purification. The study further suggests that with a focused approach and reliance on natural materials, dhoop production could emerge as a promising market in the future.

It was found that the herbal dhoop sticks are more cost-effective, nontoxic, and efficient than commercially available chemical repellents, while also promoting a mosquito-free and healthy environment. Since this formulation is safer, eco-friendly, and prevents insects from developing resistance, it serves as a viable alternative to chemicalbased repellents. The findings highlight that certain plant combinations—such as camphor, neem, tulsi, and marigold—possess strong mosquito-repelling properties without causing irritation, making them safe and environmentally beneficial..

Keywords*:* Herbal Dhoop, Mosquito repellent, Marigold flower, Microbiological evaluation

I. INTRODUCTION

Mosquito-borne diseases:

According to the World Health Organization (WHO), malaria—one of the most common mosquito-transmitted illnesses—claims around 3 million lives globally each year [1]. These diseases, which spread solely through mosquito bites, currently lack effective vaccines for prevention or treatment. Therefore, avoiding mosquito bites remains one of the most effective strategies to reduce or prevent transmission [2]. Although various treatments for malaria and other mosquito-borne illnesses exist, prevention is always the better approach. This gave rise to the concept of "mosquito repellents." Repellents are compounds that create conditions unpleasant for mosquitoes, thus preventing them from landing on the skin or other surfaces [3].

In today's world, environmental changes present one of the biggest challenges. Increasing pollution has raised widespread concern, as a clean environment is vital for human survival. Clean air, safe drinking water, fertile soil, and sustainable energy are all essential for life [4,5]. To improve air quality, many purification methods are currently in use. While chemical options dominate the market, they often cause harmful side effects to living organisms [6,7]. Herbal alternatives provide a safer substitute, offering not only purification but also benefits such as fragrance and positive energy in the environment where they are used.

This study emphasizes the development of dhoop sticks using entirely natural ingredients, aiming to reduce airborne microorganisms without chemicals. Ingredients include clarified butter, herbs, cow dung, and cow milk. Cow dung, long recognized as a disinfectant [8], has been used traditionally in religious rituals alongside cow ghee, camphor, and

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cow urine during practices like *havan* to cleanse surroundings and create a pleasant atmosphere [9]. By applying traditional knowledge, a technique for producing dhoop sticks from easily available resources has been developed.

The concept of the 3Rs—Recycle, Reuse, and Recover—plays a key role in sustainable waste management. Issues such as environmental degradation, climate change, waste disposal, and sustainable development are major concerns for human society. In India, temples attract millions of devotees, who offer garlands, coconuts, flowers, chocolates, and other items to deities. While edible offerings are later distributed as *prasad* or consumed by priests and staff, non-edible items like flower garlands are discarded. Municipal solid waste (MSW), which often includes such offerings, is largely biodegradable (>70%), leading to greenhouse gas emissions if not managed properly [10].

Rapid urbanization in India has further intensified the waste management crisis. With 7,935 towns and cities housing over 377 million urban residents, the country generates about 62 million tons (Mt) of MSW annually. Of this, 31 Mt is dumped in landfills, 11.9 Mt is treated, and only 43 Mt is collected. Among the total waste, 1.5 Mt is electronic, 7.90 Mt hazardous, 0.17 Mt biomedical, and 5.6 Mt plastic. However, just 22–28% of the collected municipal waste undergoes treatment, while over 90% is disposed of in unscientific ways [11–13].

India's cultural and religious diversity means temples and other places of worship are widespread, each contributing to the generation of floral waste, also known as temple waste, which forms part of MSW. Annually, nearly 800 million tons of flowers are offered in temples, mosques, gurudwaras, and other religious sites across the country [12]. Unlike kitchen waste, floral waste decomposes more slowly [14], highlighting the need for eco-friendly disposal methods. Transforming flower waste into valuable products offers a sustainable solution. For instance, temple flowers can be used to manufacture herbal incense sticks. Roses are processed into rose water, while flowers like marigold can be repurposed into incense products. A Review on Herbal Dhoop from Temple Waste for Mosquito Repellent Activity

Table: List of Herbal Dhoop Ingredients (Temple Waste and Related Herbs) for Mosquito Repellent Activity (Up to 2025)

No.	Ingredient / Source	Scientific Name	Role in Dhoop / Form	Evidence / Notes
1	Marigold (waste flower petals)	Tagetes spp.	Dried/powdered petals or essential oil in dhoop; binder or active repellent	Used in formulations with measurable repellent activity (IJPS 2024).
2	Neem leaves / oil	Azadirachta indica	Powdered leaves, neem oil impregnation — widely used as repellent active	Field studies show neem-based repellency; common in herbal dhoop.
3	Holy basil (Tulsi)	Ocimum sanctum / O. tenuiflorum	Powder or essential oil added for repellency and fragrance	Included in polyherbal dhoop sticks with proven repellency.
4	Camphor	Cinnamomum-derived / synthetic	Volatile burning agent — acts as repellent and aids smoke dispersion	Traditional repellent; used in modern herbal dhoop formulations.
5	Clove	Syzygium aromaticum	Powder or oil used for aromatic repellent properties	Shows repellency in indoor mosquito exposure studies.
6	Cinnamon	Cinnamomum verum / C. zeylanicum	Powder or oil — aromatic repellent component	Contributes volatile repellents; included in herbal dhoop blends.
7	Jatropha (seeds/powder)	Jatropha spp.	Seed/biomass used as botanical active	2025 formulation studies report effective mosquito repellency.
8	Orange peel / citrus waste	Citrus spp.	Dried peel powder or oil — adds limonene and	Citrus peel adds aromatic and repellent volatiles in

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			fragrance	dhoop.
9	Rose petals / rose water (temple waste)	Rosa spp.	Dried petals, rose water — binder/fragrance with mild repellency	Used in sustainable temple waste dhoop production.
10	Cow dung / ghee	—	Binder and combustible matrix for herbal powders	Traditional dhoop binder; ensures proper combustion and smoke.
11	Pudina / Mint	Mentha spp.	Powder or oil — volatile menthol compounds add repellency	Effective aromatic repellent herb used with tulsi/neem.
12	Guggul (Commiphora) / benzoin	Commiphora wightii / benzoin resin	Resinous binder, slow-burning, fragrance and insect-active smoke	Adds stability and fragrance; traditional incense resin.
13	Sandalwood	Santalum spp.	Powder or oil for fragrance	Traditional inclusion in temple dhoop; mild repellent.
14	Tagetes minuta essential oil	Tagetes minuta	Essential oil with documented larvicidal/repellent action	Low LC50 values against Anopheles and Culex larvae.
15	Temple waste (mixed flowers: marigold, rose, etc.)	Mixed floral waste	Recycled temple flowers processed into incense/dhoop	Sustainable waste valorization for repellent incense production.

Problems Caused by Mismanagement of Flower Waste

Temple offerings are considered sacred, and therefore discarding them in landfills is discouraged. However, most temples dispose of these offerings into nearby lakes, rivers, and ponds. In many regions of India, one of the least eco-friendly practices is the dumping of flowers into water bodies. Each year, nearly 8 million tons of floral waste end up in Indian rivers [15]. The volume of pollutants generated from such disposal is alarming.

When floral waste decomposes in water, the organic matter triggers eutrophication and algae blooms, which deplete oxygen levels and threaten aquatic life. Additionally, discarded flowers can contaminate soil, further disturbing the environment. Such practices, especially common in temples along the Ganga basin, worsen river pollution, as waste is dumped daily without separating biodegradable from nonbiodegradable materials. While flower waste is not the sole factor behind Ganga's pollution, it contributes significantly—around 16% of the total contamination [12].

Table: Mosquito Repellent Herbs Evaluated Until 2025

This table summarizes the major herbal ingredients and plant extracts evaluated for mosquito repellent activity up to the year 2025.

No.	Common Name	Plant Part / Form Used	Active Constituents / Mechanism	Reported Activity / Notes	Reference Type
1	Neem	Leaf, oil, seed	Azadirachtin, nimbin	Strong repellent & larvicidal against Anopheles & Aedes spp.	Multiple studies 2018–2024
2	Tulsi (Holy Basil)	Leaf, oil, powder	Eugenol, linalool	Effective repellent smoke; included in herbal dhoop	Herbal dhoop formulations 2020–2025
3	Lemon Grass	Essential oil	Citral, geraniol	>90% repellency for 2–3 hours in lab	Insect repellency trials (2020–2024)

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				tests	
4	Marigold	Flower, oil	Ocimene, limonene	Used in temple-waste dhoop; larvicidal & adulticidal	Dhoop studies (2023–2025)
5	Citronella	Oil	Citronellal, citronellol	WHO-approved natural repellent	Standard reference herb
6	Clove	Bud, oil	Eugenol	Repels Aedes aegypti for 3–4 hours	Lab studies (2019–2024)
7	Eucalyptus	Oil, leaves	Eucalyptol (1,8-cineole)	Used in herbal incense/dhoop sticks	Aromatherapy & repellent trials
8	Orange Peel	Peel powder, oil	Limonene	Recycled from temple/fruit waste; mild repellent	Waste valorization studies
9	Camphor	Resin/crystals	Camphene, camphor	Acts as smoke-based repellent	Common in dhoop formulations
10	Mint (Pudina)	Menthol	Reduces mosquito landing rates	Herbal dhoop research (2022–2025)	
11	Sandalwood	Santalol	Fragrant smoke; mild repellent	Dhoop formulation ingredient	
12	Lavender	Flower oil	Linalool, linalyl acetate	Mosquito repellent & soothing aroma	Aroma-based repellent studies
13	Guggul / Benzoin	Resin	Guggulsterone, benzoic acid	Binding and aromatic agent in dhoop	Traditional & modern use
14	Garlic	Extract, oil	Allicin	Mosquito deterrent odor	Comparative trials 2021–2024
15	Turmeric	Rhizome powder	Curcumin	Repels Anopheles stephensi	Lab-based repellency tests
16	Lemongrass + Tulsi Blend	Mixed oils	Eugenol + citral	Synergistic blend with extended repellency	Herbal blend formulations
17	Cow Dung (Binder)	Dry dung cakes	—	Combustible base for herbal dhoop	Carrier in incense formulation
18	Rose Petals / Rose Water	Dried petals, water	Geraniol, citronellol	Fragrant, mild repellent; used from temple waste	Eco-friendly dhoop studies

Major Mosquito-borne Diseases

Malaria – caused by Plasmodium spp. (protozoa) → transmitted by Anopheles mosquito.
Dengue fever – caused by dengue virus → transmitted by Aedes aegypti.
Chikungunya – caused by chikungunya virus → transmitted by Aedes mosquitoes.
Yellow fever – caused by yellow fever virus → transmitted by Aedes aegypti.
Zika virus infection – caused by Zika virus → transmitted by Aedes aegypti & Aedes albopictus.

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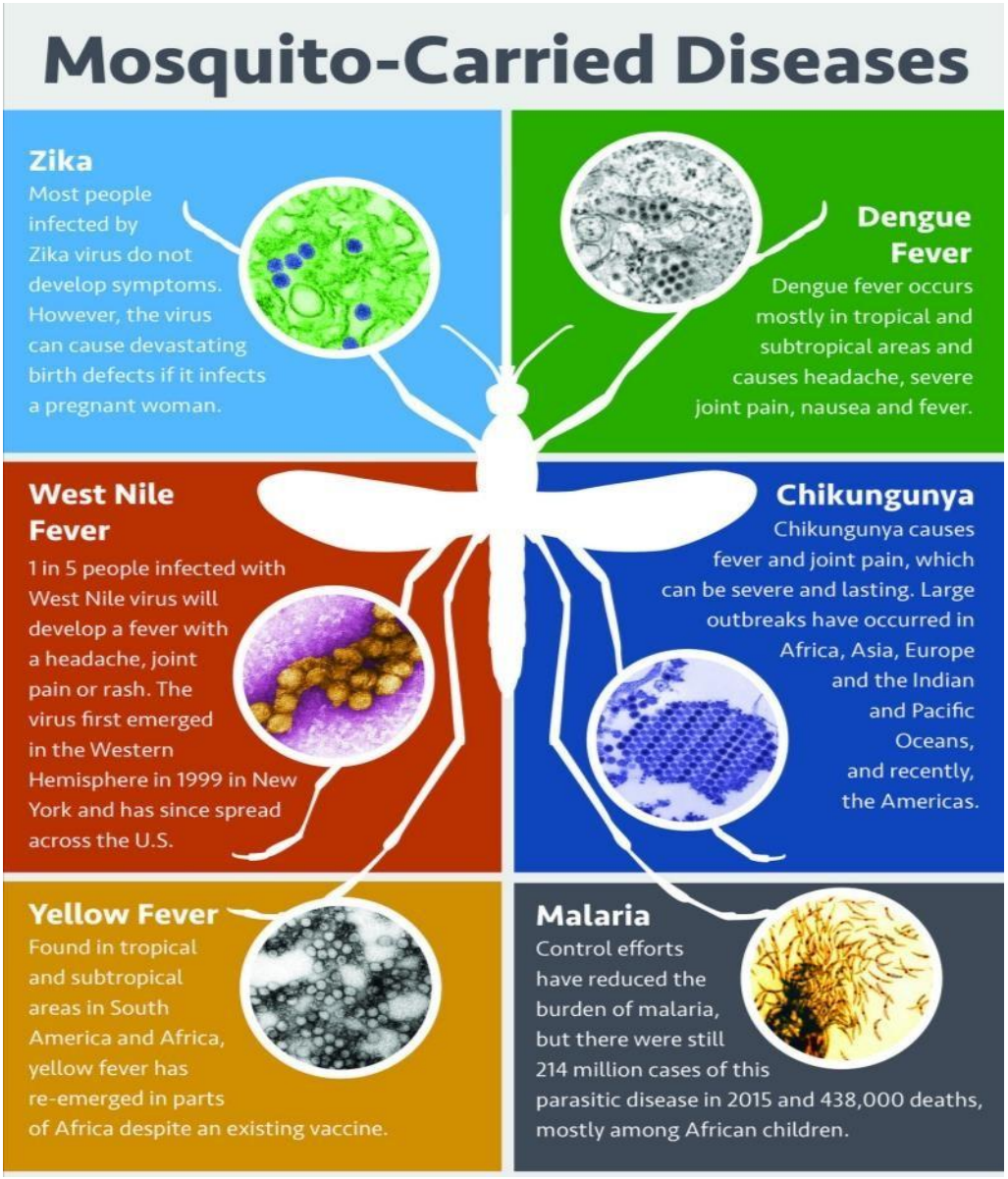
Japanese encephalitis – caused by JE virus → transmitted by Culex mosquitoes.
West Nile fever – caused by West Nile virus → transmitted by
Culex mosquitoes.



II. MARKETED FABRICATION OF HERBAL DHOOP

1. Introduction

Short overview of how herbal dhoop is manufactured at commercial scale, differences from traditional temple-prepared dhoop, and the importance of standardization for mosquito-repellent efficacy and consumer safety.

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2. Marketed Product Forms

Dhoop sticks (straight sticks, spiral coils)
Dhoop cones
Dhoop cakes / tablets
Ready-to-burn briquettes
Incense chips / granules for electric burners

3. Commonly Used Ingredients in Marketed Formulations

Active botanicals (raw or extracts): neem, tulsi, citronella, eucalyptus, lemongrass, neem bark, marigold, pudina (mint), orange peel, sandalwood, neem oil, camphor.
Binders & fillers: powdered charcoal, wood powder, rice powder, starch, sawdust
Combustion aids: makko powder (tabu no moto), frankincense (guggul) powder
Fragrance & fixatives: essential oils, resins, sandalwood powder
Preservatives & anti-microbial agents: (used rarely; usually not required if dry)

4. Scaled Fabrication Processes

4.1. Small-scale (Artisanal / Cottage Industry)

1. Raw material preparation: Dry and powder plant wastes (leaves, peels, flowers) from temples; sieve to uniform particle size.
2. Blending: Mix powders (active botanicals, charcoal, wood powder) in a dry mixer.
3. Binder addition: Prepare binder slurry (starch + water) and gradually add to powder mix to achieve dough-like consistency.
4. Shaping: Extrude into sticks or press into molds for cones/cakes. Hand-rolling for sticks is common.
5. Drying: Air-dry or use low-temperature ovens (40–60 °C) until moisture <10%.
6. Scenting (optional): Spray or coat with essential oil post-drying.
7. Packaging: Pack in moisture-resistant paper or boxes with labeling.

Phytochemical investigation
Marigold
Neem
Tulsi
Pudina
1) Marigold [16]
Biological Name:*Calendula officinalis*, *Tagetes erecta*
Family: Asteraceae
Chemical Constituents: Alkaloids, flavonoids, steroids, terpenoids
Uses: Antifungal, Antioxidant, Antibacterial

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Figure No. 3: Calendula officinalis (Marigold)

The researchers propose utilizing parts of the marigold plant (*Tagetes erecta*) as effective ingredients in the production of mosquito candles, dhoop, or incense sticks. Unlike some commercial repellents that contain harmful chemicals, this formulation is eco-friendly and repels mosquitoes without harming the environment. Marigold emits a distinct odor that many insects find unpleasant. This smell is due to the presence of a compound called α-terthienyl, which imparts natural insecticidal properties to the plant. In addition, other active compounds found in the ingredients include alkaloids and papain.

2) Neem
Biological Name: Azadirachta indica A. Juss.
Family : Meliaceae (Mahogany family)
Major Chemical Constituents
Limonoids / Triterpenoids: Azadirachtin, Nimbin, Nimbidin, Nimbolide, Salannin,
Gedunin.Flavonoids: Quercetin, Kaempferol, Rutin. Sterols: β-sitosterol, Stigmasterol, Campesterol.Tannins & Phenolics: Gallic acid, Catechin, Coumarins.Fatty acids (seed oil): Oleic acid, Linoleic acid, Stearic acid, Palmitic acid.
Uses : Medicinal: Antibacterial, antifungal, antiviral, anti-inflammatory, anticancer, hepatoprotective.
Traditional: Used in Ayurveda for skin diseases, fever, diabetes, dental care.Agricultural: Natural pesticide, insect repellent (Azadirachtin = powerful antifeedant).Industrial: Neem oil in soaps, cosmetics, and pharmaceutical

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3) Tulsi
Biological Name:Ocimum sanctum L. (syn. Ocimum tenuiflorum L.)
Family: Lamiaceae (Mint family)
Chemical constituents:eugenol, linalool), flavonoids, phenolic acids, terpenoids, and sterols,
Uses
Antimicrobial: Effective against bacteria, fungi, and viruses.
Antioxidant: Due to flavonoids and phenolics
Anti-inflammatory & Analgesic: Eugenol provides pain relief.
Anticancer: Ursolic acid and rosmarinic acid show cytotoxic activity.
Adaptogenic / Stress relief: Used in Ayurveda for stress and anxiety.Respiratory health:
Beneficial in cough, cold, asthma

5) Pudina
Biological Name: Mentha arvensis / Mentha piperita
Family:Lamiaceae
Chemical constituents: Menthol, Menthone, Menthyl acetate, Pulegone, Cineole, Limonene, β-Caryophyllene, Rosmarinic acid, Flavonoids, Tannins.
Uses: Carminative (relieves gas, indigestion)
Antispasmodic (relieves stomach cramps)
Antimicrobial and antifungal
Cooling agent in food, cosmetics, toothpaste Used in cough, cold, headache, and nausea relief
Flavoring in food and beverages.

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Herbal Mosquito Repellent Dhoop Sticks

Dhoop sticks release soothing aromas that calm the mind and create a serene atmosphere. Many plants possess mosquito-repelling properties, which play an important role in disease prevention. Since these sticks are made from natural plant materials, they are environmentally safe and do not cause harmful side effects. Unlike synthetic mosquito coils that pose health risks, herbal dhoop sticks are both safe and effective, making them an excellent alternative to chemical-based repellents that negatively impact people and the environment.

The term *dhoop* originates from the Dhoop tree, native to eastern India. When burned, the tree releases a pleasant fragrance. Unlike agarbatti (incense sticks), dhoop or dhoopbatti differs in both form and texture—dhoop is generally prepared in a moist paste-like form.

Formulation of Dhoop

The preparation involved blending herbal powders and other natural ingredients as follows:

All ingredients were gathered.

Powdered marigold, neem, tulsi, and pudina were passed through mesh no. 60.

The powders were weighed as per the formula.

Mixing was done in a mortar and pestle.

Fine camphor powder was incorporated.

Other ingredients such as cow dung, guggul, loban, and sandalwood powder were weighed and mixed.

Starch was dissolved in water.

Cow ghee was added with continuous mixing.

Rose water and distilled water were incorporated to prepare a uniform dough.

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Table 1: The details of ingredients of Herbal Dhoop

Sr. No.	Ingredients	Quantity Taken
1	Marigold powder	1.5 gm
2	Neem powder.	1.5 gm
3	Tulsi powder.	1 gm
4	Pudina powder.	1 gm
5	Sandalwood powder.	1 gm
6	Starch	2 gm
7	Camphor	5 gm
8	Guggul	5 gm
9	Orange peel oil	1 ml
10	Rose water	2 ml
11	Cow dung	4 gm
12	Cow ghee.	5 ml
13	Raad	5 gm
14	Kapurkachari	5 gm
15	Loban	5 gm
16	Distilled water	As per requirement

Evaluation of Mosquito Repellent Dhoop

Physical Analysis:

The prepared dhoop was assessed for its physical properties, including color and odor. It was observed to be brown in color with a characteristic aroma.

Moisture Content:

The initial weight of the dhoop was recorded before burning, and its final weight was measured after drying. The calculated moisture content was 17.7%.

Flammability & Burning Time:

To test flammability and burning duration, the dhoop was ignited. It burned completely with minimal smoke, and the average burning time was recorded as 20 minutes.

Ash Value

The prepared dhoop stick was burned completely, and the resulting ash was collected and weighed. The ash content was found to be 0.140 g.

Mosquito Repellent Activity

The dhoop was tested in mosquito-prone areas during evening and nighttime hours. To evaluate its repellent effect, observations were made for any side effects such as irritation, coughing, or tearing of the eyes.

Irritability

The dhoop was burned to assess its irritancy. Observations focused on whether it caused nasal irritation, coughing, or sneezing.

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III. RESULTS & DISCUSSION

Identification and Authentication of Leaves:

The herbs used in the research were authenticated by Dr. Jagdish Baheti, confirming that the collected plant material matched the intended species.

Percentage Yield of Extraction:

Following the extraction process, the solvent was recovered through distillation, and the concentrated extract was poured into Petri dishes for complete evaporation.

Table 3: Evaluation parameters of Dhoop

Sr. No.	Parameter	Observation
1	Colour	Brown
2	Odour	Characteristic
3	Burning time.	20 min
4	Ash value	0.140 gm
5	Mosquito repellant activity	Positive
6	Microbiological evaluation	Pass
7	Moisture content	17.7%
8	Consistency	Solid
9	Irritability.	Non-irritant

Benefits of Using Dhoop [17]

Dhoop benefits the body, mind, and spirit. It is known to enhance concentration, making it useful for learning and meditation. Additionally, it helps reduce depression, prevent infections, ease headaches, and relieve stress and anxiety.

The calming fragrance contributes to a peaceful environment and supports mental relaxation.

The herbs and resins used in dhoop provide relief for individuals suffering from asthma, colds, and bronchitis.

Non-edible items such as flower garlands offered to deities can be repurposed for making dhoop instead of being discarded.

Uses of Dhoop

Antimicrobial:

Dhoop is well known for its antibacterial action. Antimicrobial agents work by either killing microorganisms (*microbicidal*) or inhibiting their growth (*biostatic*). Depending on the target, antibiotics fight bacteria, while antifungal agents combat fungi. Since herbal dhoop sticks are made using herbs with natural antimicrobial properties, the process of preparing them enhances their microbial resistance [18].

Mosquito Repellent:

Mosquitoes are major carriers of life-threatening diseases. Species from the genera *Anopheles, Culex,* and *Aedes* transmit illnesses such as dengue, malaria, yellow fever, and others. The mosquito-repelling ability of dhoop helps in controlling these vectors and protecting human health [19].

Classification of Mosquito Repellents:

Mosquito repellents can generally be categorized into the following types:

Physical methods of Mosquito Repellents

Chemical methods of Mosquito Repellents

Natural mosquito repellents

Synthetic mosquito repellents

Mechanical methods of Mosquito Repellents

Physical Methods:

This approach focuses on preventing mosquito bites by creating barriers. It involves eliminating stagnant water from places such as buckets, old tires, rain gutters, and plastic coverings to reduce mosquito breeding. Wearing long-sleeved

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clothing, especially during early morning and evening hours, can help protect against bites. Additionally, repairing window and door screens can prevent mosquitoes from entering homes. Regularly changing water in bird baths, fountains, pools, and rain barrels is also recommended as part of this preventive strategy.

2. Chemical Method

This method involves using repellents that are chemically formulated. Chemical repellents are one of the most effective ways to protect against insect bites and reduce the risk of insect-borne diseases. They can be categorized based on their source:

Natural repellents:

These repellents are derived from natural substances. Herbal insect repellents have been used since ancient times and remain a safe and eco-friendly option. They help reduce the spread of vector-borne diseases in humans and animals. Examples include:

Essential oils: Oils such as citronella, eucalyptus, lavender, lemongrass, and peppermint can be applied to the skin or diffused into the air.

Garlic and neem: The strong odors of garlic and neem oil are known to repel mosquitoes.

Herbs and plants: Plants like catnip, marigold, and basil can be placed around the home to keep mosquitoes away.

Burning camphor: Produces smoke that acts as a mosquito deterrent.

Synthetic repellents:

Because natural repellents have certain limitations, such as short-lasting effects and higher costs, synthetic alternatives were developed. Synthetic repellents are generally more long-lasting and cost-effective compared to plant-based ones. Although natural plant-based chemicals have traditionally been used to repel mosquitoes, their shorter duration and other limitations have driven the development of synthetic options.

3. Mechanical Method

This approach relies on mechanical devices to prevent mosquito bites. For example:

Yellow light traps: Yellow light attracts fewer insects than white light.

Electric mosquito zappers: These use ultraviolet light to lure mosquitoes and eliminate them with an electric shock.

Advantage of using herbal compound

Ingredients

Sr no	Herbal compound
1	Marigold powder
2	Neem powder
3	Tulsi powder
4	Pudina powder
5	Sandalwood
6	Starch
7	Camphor
8	Guggul
9	Orange peel
10	Rose water
11	Cow dung
12	Cow ghee

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1.marigold powder

Marigold is a widely available ornamental and medicinal plant. Traditionally, its flowers and leaves have been used in folk medicine for antimicrobial, antifungal, and insect repellent purposes. The characteristic pungent odor of marigold flowers is mainly due to terpenoids and flavonoids, which are effective in repelling mosquitoes and other insects.

Benefits

Eco-Friendly & Biodegradable

Unlike chemical repellents, marigold-based dhoop does not release harmful residues into the environment.

Safe for Humans & AnimalsWhen used in controlled amounts,marigold smoke is less toxic compared to synthetic repellents like DEET.

Antimicrobial & Antifungal ActionMarigold has antimicrobial properties, which help purify the surrounding air and reduce microbes.

Pleasant AromaProduces a soothing fragrance, unlike chemical repellents that often have a pungent odor.

Readily Available & Cost-EffectiveMarigold flowers are abundant in India, often available as waste from temples, making the raw material inexpensive.

Additional Therapeutic BenefitsThe smoke may have mild relaxing and mood-enhancing effects due to volatileoils.

2) Neem powder

Neem (Azadirachta indica; family Meliaceae) is a versatile medicinal tree whose leaves, bark, seeds, flowers and fruits have long been used in traditional systems of medicine. Neem powder—prepared by drying and grinding one or more plant parts (commonly leaves or seed kernels)—is rich in bioactive constituents such as azadirachtin, nimbin, nimbidin and various limonoids and flavonoids. These compounds exhibit antimicrobial, anti-inflammatory, antioxidant and insect-deterrent activities, making neem a promising natural ingredient for pest-management formulations.

In the context of herbal mosquito-repellent dhoop, neem powder offers several advantages: it can act as a behavioural repellent and reduce mosquito landing and biting, it may have larvicidal or growth-regulating effects on some mosquito species, and it is biodegradable and comparatively safe for non-target organisms and humans when used appropriately.

Benefits 1. Natural Insect Repellent – Neem powder contains compounds like azadirachtin, nimbin, and salannin that repel mosquitoes effectively.

Non-toxic & Eco-friendly – Unlike chemical repellents, it is safe for humans, pets, and the environment.

Long-lasting effect – The strong odor of neem persists, giving protection for several hours.

Antimicrobial properties – Apart from repelling, it reduces the risk of mosquito-borne infections (like malaria, dengue, chikungunya).

Smokeless/Safe burning – When used in dhoop sticks or coils, neem powder produces mild smoke that drives away mosquitoes without causing major irritation.

3) Tulsi powder

Tulsi (Ocimum sanctum Linn. / Ocimum tenuiflorum), belonging to the family Lamiaceae, is a sacred and medicinal herb widely used in Ayurveda and traditional systems of medicine. Tulsi leaves contain essential oils rich in eugenol, ursolic acid, carvacrol, and linalool, which impart therapeutic, aromatic, and insect-repellent properties. Tulsi powder is obtained by drying and grinding its leaves, retaining the volatile oils and bioactive compounds. Due to its strong fragrance and antimicrobial activity, Tulsi powder is often used in herbal formulations such as mosquito repellent dhoop. Benefits

Mosquito Repellent Activity – The volatile oils (especially eugenol) mask human odor and repel mosquitoes effectively.

Air Purification – The smoke of Tulsi dhoop helps to purify the atmosphere by killing airborne bacteria and fungi.

Eco-Friendly & Non-Toxic – Provides a safe alternative to chemical mosquito repellents, suitable for use around children and pets.

Aromatic Property – Produces a soothing and pleasant aroma, reducing foul odor while repelling insects.

Synergistic Effect – Enhances the activity of other herbal ingredients (like neem, pudina, marigold) when combined in mosquito repellent formulations.

4) pudina powder

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Pudina (Mentha arvensis or Mentha piperita), belonging to the family Lamiaceae, is a well-known aromatic herb widely used in Ayurveda, Unani, and folk medicine. Pudina leaves are rich in essential oils, mainly menthol, which provides a cooling sensation, refreshing aroma, and medicinal value. Pudina powder is obtained by drying and grinding the leaves, retaining its volatile oils and phytochemicals. Owing to its strong fragrance and insecticidal properties, Pudina powder is effectively used in herbal formulations such as mosquito repellent dhoop.

Benefits

Natural Insect Repellent – The menthol and essential oils present in Pudina produce a strong aroma that masks human scent and repels mosquitoes.

Eco-Friendly Alternative – Unlike chemical repellents, Pudina-based dhoop is safe, biodegradable, and non-toxic to humans and pets.

Antimicrobial Properties – The smoke from Pudina dhoop not only repels insects but also exhibits antibacterial and antifungal effects, helping purify the surrounding air.

Aromatic and Refreshing – It gives a cooling, refreshing fragrance, creating a pleasant environment while driving away mosquitoes.

5) Sandalwood

Sandalwood (Santalum album), belonging to the family Santalaceae, is a highly valued aromatic wood traditionally used in medicine, rituals, and fragrance products. Sandalwood powder is obtained from the heartwood of the tree, known for its distinctive, soothing aroma and bioactive compounds such as santalol. Due to its natural fragrance and therapeutic properties, sandalwood is widely incorporated into incense, dhoop, and herbal formulations.

Benefits

Natural Insect Repellent – The volatile oils, particularly santalol, release a fragrance that repels mosquitoes and other insects.

Non-toxic and Eco-friendly – Unlike chemical repellents, sandalwood dhoop is safe, biodegradable, and less harmful to humans and the environment.

Long-lasting Aroma – Provides a calming and pleasant fragrance while also keeping mosquitoes away.

Antimicrobial Properties – Helps in purifying the air by reducing microbial load, creating a healthier indoor environment.

6) Starch

Starch is a naturally occurring polysaccharide carbohydrate that is widely present in plants, especially in cereals (like rice, maize, and wheat), tubers (such as potato), and roots. It is composed mainly of two molecules, amylose and amylopectin, which serve as the primary energy reserve in plants. In powder form, starch is white, tasteless, and odorless, and has been extensively used in food, pharmaceutical, and industrial applications due to its binding, adhesive, and thickening properties.

In herbal mosquito repellent dhoop stick formulation, starch plays an important role as a natural binder and filler, ensuring proper consistency, burning quality, and stability of the product.

Benefits

Binder – Helps in holding together different herbal powders (like neem, tulsi, pudina, sandalwood) in dhoop sticks.

Combustion Aid – Ensures uniform and sustained burning of dhoop without breaking.

Filler/Volume Enhancer – Provides bulk to the formulation, making it cost-effective and easy to mold into sticks or cones.

Eco-Friendly – Being a natural and biodegradable substance, starch is safe for the environment compared to synthetic binders.

Non-toxic – Does not release harmful fumes when burned, thus maintaining the herbal and safe character of mosquito repellent dhoop

7) camphor

Camphor is a white, crystalline substance with a strong aromatic odor, traditionally obtained from the wood of the camphor tree (Cinnamomum camphora), though it can also be synthesized. It is widely used in medicine, aromatherapy, and religious rituals due to its antimicrobial, anti-inflammatory, and insect-repelling properties. Camphor is highly

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volatile, releasing fumes easily when burned, which makes it useful in mosquito repellent formulations like dhoop, coils, and vaporizers.

Benefits

Strong Repellent Action – Its pungent aroma masks human odors (like carbon dioxide and sweat) that attract mosquitoes.

Fumigant Effect – On burning, camphor vapors spread quickly and deter mosquitoes in the surrounding area.

Antimicrobial Property – Provides additional protection by inhibiting certain bacteria and fungi, keeping the environment hygienic.

Natural and Safe – When used in controlled amounts, camphor is eco-friendly compared to chemical mosquito repellents.

Synergistic Role – Enhances the effectiveness of other herbal ingredients (like neem, tulsi, sandalwood) in mosquito repellent dhoop.

8) Guggul

Guggul is a natural resin obtained from the plant Commiphora mukul, a small tree belonging to the Burseraceae family. It has been used since ancient times in Ayurveda for medicinal, aromatic, and spiritual purposes. Guggul resin is rich in volatile oils, resins, and guggulsterones, which are responsible for its therapeutic and aromatic properties. Traditionally, it has been burned as incense to purify the air, ward off insects, and create a soothing environment.

Benefits

Natural Insect Repellent – The smoke released on burning guggul has insecticidal and repellent properties that help drive away mosquitoes.

Aromatic Property – Produces a pleasant fragrance that masks human body odors which attract mosquitoes.

Combustion Aid – Acts as a resinous substance that ensures steady and uniform burning of dhoop sticks.

Antimicrobial Effect – Provides additional protection by reducing bacteria and germs in the surrounding environment.

9) orange peel

Orange peel, obtained from the fruit of Citrus sinensis (family: Rutaceae), is a rich source of natural bioactive compounds, especially essential oils like limonene, flavonoids, and phenolic compounds. Traditionally, orange peel has been used in herbal medicine, perfumery, and as an aromatic agent. Its essential oil is well known for strong insecticidal, antimicrobial, and deodorizing properties, making it an effective eco-friendly option for mosquito repellent formulations, including dhoop sticks and cones.

Benefits

Mosquito Repellent Property – The essential oil in orange peel, mainly d-limonene, effectively repels mosquitoes and other insects.

Eco-Friendly Alternative – Provides a safe, biodegradable, and natural substitute to chemical repellents like DEET.

Aromatic Fragrance – Adds a refreshing citrus aroma to dhoop, which masks human odors (sweat and carbon dioxide) that attract mosquitoes

Antimicrobial Effect – Helps in reducing microbial load in the environment, maintaining a hygienic atmosphere.

10) Rose water

Rose water is a fragrant liquid obtained by distilling fresh rose petals with steam. Traditionally used in cosmetics, medicine, and rituals, rose water carries therapeutic and aromatic properties. It contains volatile oils, flavonoids, and phenolic compounds that contribute to its soothing fragrance and mild antimicrobial effects. In herbal formulations like dhoop, rose water can act as a natural binder, fragrance enhancer, and functional agent.

Benefits

Natural Fragrance Enhancer – Provides a pleasant floral aroma to the dhoop, balancing the strong odors of herbs like neem or guggul.

Mosquito-Repelling Properties – Rose essential oil present in rose water contains compounds such as citronellol and geraniol, which are known to repel mosquitoes naturally.

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11) Cow dung

Cow dung, also called cow manure, is the natural excreta of cows. It mainly consists of digested plant matter, cellulose, hemicellulose, lignin, and minerals, along with beneficial microorganisms. In traditional Indian practices, cow dung has been widely used as fuel, fertilizer, disinfectant, and in religious rituals. When dried, it burns slowly and produces smoke with insect-repellent properties, making it an important base ingredient in herbal mosquito repellent dhoop formulations.

Benefits

Natural Fuel Base – Provides a slow-burning base material for dhoop, ensuring continuous smoke release without the need for chemical binders.

Mosquito-Repelling Smoke – The smoke produced on burning dried cow dung naturally repels mosquitoes and other insects due to its pungent odor.

Physical Evaluation Parameters

Appearance: Color, shape, texture, and uniformity of the dhoop cone/stick.

Weight variation: Ensures consistency between samples.

Moisture content: Affects burning quality and shelf life.

Burning time: Duration of complete combustion (measured in minutes).

Smoke generation: Quantity and uniformity of smoke emitted during burning.

Ash value: Amount of residual ash left after burning.

Hardness/Firmness: Determines mechanical strength and handling stability.

Chemical/Phytochemical Evaluation

Qualitative phytochemical screening: Detection of terpenes, alkaloids, flavonoids, phenols, essential oils, etc.

GC–MS/HPTLC profiling: Identification of active volatile compounds responsible for repellency.

pH of aqueous extract: For stability and compatibility.

Volatile oil content: Measures amount of repellent-active constituents.

Biological Evaluation (Mosquito Repellent Activity)

Repellency test:

% repellency or protection time measured using arm-in-cage or field test methods.

Species tested: Aedes aegypti, Culex quinquefasciatus, or Anopheles stephensi.

Control groups:

Positive control (DEET-based repellent)

Negative control (placebo or blank dhoop)

Efficacy parameters:

Landing count reduction

Bite protection duration

Knockdown effect or mortality (if applicable)

Environmental and Safety Evaluation

Toxicity study: Skin irritation, respiratory irritation, or allergenicity.

Smoke composition: Measure CO, SO_2, particulate matter (PM2.5/PM10).

Eco-friendliness: Assessment of biodegradability and sustainability of ingredients (temple waste reuse).

Organoleptic Evaluation

Odor: Pleasantness intensity of aroma.

Color: Natural vs artificial coloration.

Smoke acceptability: Comfort level and absence of pungency.

Stability and Storage Studies

Moisture absorption test: Under humid conditions.

Shelf-life test: Monitoring physical and repellent properties over time.

Packaging compatibility: Effect of different storage materials.

Statistical Analysis

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Replication and data reliability (Mean ± SD).
Statistical tests (ANOVA, t-test) to confirm significance of repellency.
Sustainability and Societal Impact Parameters
Use of temple waste: Waste reduction, cultural and ecological value.
Cost-effectiveness: Low-cost raw materials and production.

IV. CONCLUSION

The mosquito-repelling effect is attributed to the phytochemical constituents of plant extracts combined with the components of cow dung. In contrast, commercial mosquito coils release large amounts of smoke, which can trigger respiratory problems, especially in individuals suffering from asthma, COPD, and other breathing disorders. Cow dung, when used as an alternative, provides a long-lasting, herbal repellent that is safe for humans, domestic animals, and the environment. It does not irritate the skin and has no adverse ecological effects.

The formulated mixture delivers strong mosquito-repelling activity while remaining safe, costeffective, eco-friendly, and easy to use. Additionally, producing these natural repellents from cow dung and marigold waste could help generate additional income for local communities.

This research highlights that dhoop production, if developed with a focused approach and reliance on natural ingredients, has strong potential as a future market. The herbal dhoop formulation not only creates a mosquito-free and healthier environment but also proves to be more affordable, non-toxic, and efficient compared to chemical-based repellents. Furthermore, because it is eco-friendly and reduces the likelihood of insects developing resistance, it represents a sustainable substitute for conventional synthetic mosquito repellents.

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