

Formulation and Evaluation of Herbal Mosquito Repellent Candle Containing Combination of Essential Oils

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Abstract: The quantity of biologically active compounds found in medicinal plants, which may be utilized to heal and prolong life, is the primary source of both synthetic and traditional herbal medicine. Plants are a source of many elements required for life, which is why researchers have been investigating them to discover possible uses. The objective of the project was to use curcumin and Embelia longa's ribs, which were extracted to make an insect repellent product, to make a mosquito repellent. The isolation of curcumin and embelin was verified by TLC. Bands were compared to standards by computing R_f 0.74 and 0.60, respectively, at visual detection and 254 nm. A variety of aspects were taken into consideration when evaluating the cream's composition, including its smooth texture, spreadability, and pH 7, which indicates skin safety. Phase separation does not take place during thermal stability. It was concluded from the current study that a cream with 1.5% Embelin and 1% Curcumin is safe, effective, and stable for application on the skin.

Keywords: natural mosquito repellent, embelin, and curcumin

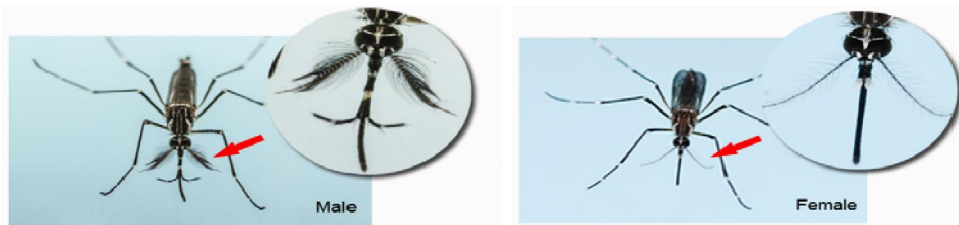
I. INTRODUCTION

One of the most unsettling bloodsucking insects that affect people is the mosquito. Many diseases, including dengue fever, malaria, yellow fever, and others, are spread by mosquito species that belong to the Anopheles, Culex, and Aedes genera [1].

Mosquito species included in the genera Anopheles, Aedes, and Culex are vectors for various disease pathogens like malaria, dengue fever, myiasis, yellow fever, encephalitis, etc. The death rate increased to one million as of 2018, according to the American Association of Mosquito Control. High fever and chills are its symptoms. [2]

Mosquitoes act as a vector for a variety of fatal illnesses that spread viruses or parasites from one person or animal to another [3].

Mosquitoes feed on plant juice to survive, both male and female. Male mosquitoes do not bite humans; however, after mating, female mosquitoes draw blood from humans because proteins are needed for the eggs to mature. [4]



Male and female mosquito

Furthermore, mosquito bites can cause severe skin irritation due to an allergic reaction to the insect's saliva when a human comes into touch with it. Mosquitoes are equipped with a range of senses that enable them to keep an eye out for their prey. Among these sensors are:

1. **Chemical Sensors:** Research has shown that mosquitoes can detect chemicals up to several yards away, including lactic acid, carbon dioxide, and propen-3-ol. These substances are released by both humans and

animals when they breathe or perspire. This explains why the species targets those who perspire more, whereas those who perspire less are less likely to be bitten.

2. **Heat Sensors:** Mosquitoes are also capable of sensing heat, which allows them to quickly locate warm-blooded animals when they approach close enough.
3. **Visual Sensors:** Studies have shown that mosquitoes are intelligent insects since they can recognize you by your attire, especially if it stands out against the background. They can easily find you since they believe that anything that moves is alive and thus bloody. [5]

The labellum, cibarium, and labrum of the mouth parts as well as various tarsal segments of the legs are examples of internal structures that serve as mosquito taste organs. At the tip of one of the mouth sections is the labellum, and at the tip of that component is the labrum, which looks like a needle and acts as a conduit for food and blood to travel through the cibarium.

Sensillas are a plethora of hair-like structures seen on mosquitoes. Its four varieties are papilla sensilla, subapical sensilla, apical sensilla, and trichod sensilla.[6]

Because mosquitoes spread several viruses and are the source of fatal illnesses like dengue, public health is in danger. Within 41 genera, the mosquito family has hundreds of species. Anopheles, Aedes, and Culex species are the three main cryptic species of mosquitoes.[7]

Control of Diseases Spread by Mosquitoes

Currently, the most crucial steps to control this disease are mosquito control and human protection from mosquito bites. Avoiding mosquito bites is the first step in preventing this kind of illness. [8] Mosquito control methods include habitat change, biological control, physical control, and chemical control, including individual safeguards from mosquitoes. Among the approaches for controlling these mosquito-borne diseases is the interruption of disease transmission by killing or preventing mosquitoes from biting a human being. This can be achieved by using repellents. [9]

1. Malaria

Malaria is the most prevalent parasite disease worldwide, a protozoal infection of red blood cells transmitted by bites from female Anopheles mosquitoes. Four species of Plasmodium often infect humans and produce clinical illness: falciparum, vivax, ovale, and malaria. Of the 172 species of Plasmodium, the majority only infect birds, reptiles, and nonhuman animals.[10].

2. Dengue

Dengue fever is a mosquito-borne sickness that has recently returned to the world. Humans can develop dengue fever anywhere in the world. DENVs 1-4 are what cause dengue fever. It is a disease that is transmitted to people by mosquitoes, mostly female Aedes mosquitoes. Since the disease is mostly found in tropical and subtropical regions, most people on the planet are at risk.[11]

3. Chikungunya fever

The Makonde term "to bend up" or "become deformed," which describes the twisted posture of an affected person, is where the name "chikungunya" originates. Chikungunya fever (CHIKF) is caused by the Chikungunyavirus (CHIKV). One alpha virus infection that is a member of the Gavriridae family is chikungunya. Zika and dengue fever are caused by the same virus, known as CHIKV, which spreads in two cycles: sylvatic and urban in nature. Whereas the sylvatic cycle deals with transmission from animal to mosquito to human, the urban cycle explains transmission from human to human.[12]

4. Zikavirus

The Flaviviridae viral family includes the Zika virus. Aedes aegypti and Aedes albopictus mosquitoes are the main carriers of the Zika virus. The virus earned its name after it was found in 1947 in the Zika Forest in Uganda. The Zika virus is in the same genus as the West Nile virus, yellow fever, dengue fever, and Japanese encephalitis. Like a mild case of dengue fever, the Zika virus infection, also known as Zika fever or Zika virus sickness, usually causes little to no symptoms. While there isn't a specific treatment for the symptoms, acetaminophen, or paracetamol, and rest may be helpful.[13]

5. Yellow fever

Globally, there are thought to be 121 million cases of lymphatic filariasis (LF), and an additional 856 million people require prophylactic treatment due to their increased risk of infection. Most infections are caused by *Wuchereriabancrofti*, which causes lymphatic filariasis. Elephantiasis, or lymphatic filariasis, is a parasitic disease spread by mosquito bites. Edema results in thicker, less functional skin surrounding the affected area, giving the sick person an elephant-like look.

6. Lymphatic filariasis

An estimated 121 million cases of lymphatic filariasis (LF) are reported to exist globally, and an additional 856 million persons need preventative therapy because of their elevated risk of infection. *Wuchereriabancrofti* causes the majority of infections resulting in lymphatic filariasis. Bites from mosquitoes transmit lymphatic filariasis, a parasitic condition known as elephantiasis. Edema causes the skin around the affected area to thicken and lose function, giving the affected individual an elephant-like appearance.[15]

What is a mosquito repellent?

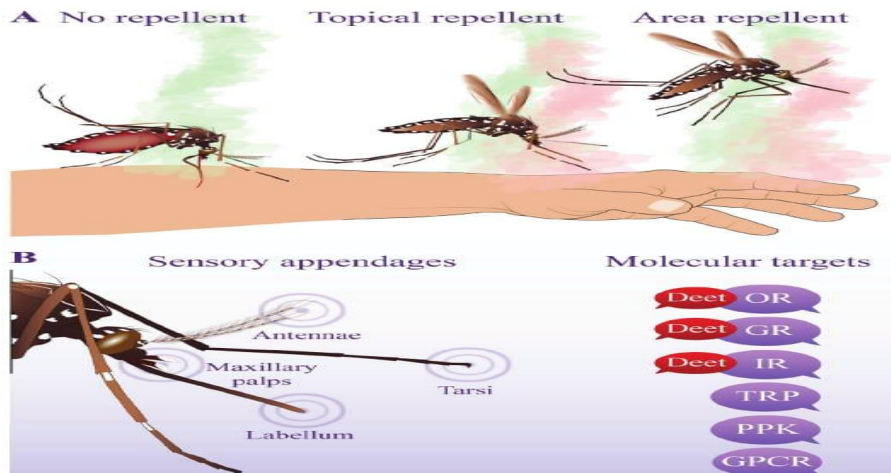
A mosquito repellent is a substance that is applied to skin, clothing, or other surfaces to prevent mosquitoes from landing there. It's a man-made substance intended to reduce mosquito-human contact by making surfaces uncomfortable and undesirable to mosquitoes. Mosquito repellents work by repelling insects rather than killing them. They aren't precisely pesticides or insecticides as a result. They aid in the treatment and prevention of illnesses carried by mosquitoes, such as yellow fever, malaria, dengue fever, and Japanese encephalitis. [5] The only thing that keeps mosquitoes away is their active element, which blocks their sense of lactic acid and carbon dioxide, which are produced when a person perspires. These products also contain a few more ingredients that aid in cosmetic finishing. [8]

Mosquito repellents of natural origin

Natural ingredients are present in certain insect repellent formulations. In the US, citronella is a common plant ingredient found in insect repellent formulations. This oil was once applied to hair to manage lice and fleas after its insecticidal properties were discovered in 1901. Despite popular perception, there was no reduction in the probability of mosquito bites when incense or citronella candles were burned. Neem oil (*Azadirachta indica*) offers 12-hour protection against *Anopheles* mosquitoes when diluted at a rate of 2% in coconut oil.[16]

Mosquito repellent mode of action

It has frequently been noted that a variety of physiological or metabolic processes might result in actions that fall under the repulsive category. DEET is thought to keep mosquitoes away because it binds to lactic acid receptors, which hinders upwind flying and makes the bug "lost" on its host. Researchers have also discovered more proof that lactic acid plays a part in host hunting. Looking at the biology of mosquitoes that have eaten blood, *Aedes aegypti* stops exhibiting host-seeking behavior after feeding on blood. The receptive neurons' sensitivity to lactic acid decreases in tandem with this. The immunity against lactic acid recovers to normal after oviposition. [17]



Mode of action mosquito repellents

Control of mosquitoes

Synthetic insecticides

The fact that synthetic pesticides have less-than-lethal effects can come as a surprise. reduced output, in *Aedes aegypti*, for example. Only phenothrin and d-allethrin decreased blood engorgement among the three pyrethroids (d-phenothrin, d-allethrin, and tetramethrin) that were investigated. Dieldrin, when given topically, demonstrated dose-dependent effects on *Aedes aegypti*'s ability to lay eggs and eat, but had no effect on offspring.[18]

Because of their great efficacy and potent mosquito-repelling qualities, pyrethroids are the only insecticides that are now authorized for use with bed nets or drapes. They can be divided into several classes according to their chemical makeup, toxicity mechanism, and penetration manner. Phenyl pyrazole, pyrethroids, organochlorines, and synthetic carbamates are a few examples of synthetic carbamates. Pyrroles are used to maintain order in everything.[19]

Facts About Mosquitoes

- Mosquito adults can live both outside and indoors.
- Biting mosquitoes can occur day or night.
- A mosquito's lifespan as an adult can range from two to four weeks, depending on its species, environment, humidity, and other elements.
- In most cases, female mosquitoes have longer lifespans than male ones.
- Only female mosquitoes bite humans and other animals in order to feed on their blood.
- In order to lay eggs, female mosquitoes require a blood meal.
- When mosquitoes bite infected humans or animals, they can contract diseases and parasites.

II. DRUG PROFILE

1. CURCUMIN (turmeric powder):



Synonyms: Indian Saffron, Turmeric, Haldi, and Haridra

BIOLOGICAL SOURCE: Turmeric consists of dried as well as fresh "rhizomes of the plant *Curcuma longa*."

FAMILY: Zingiberaceae

ORGANOLEPTIC CHARACTERS:

Color: deep orange

Odor: Aromatic

Taste: pungent

CHEMICAL CONSTITUENTS: About 5% of turmeric is made up of resin, zingiberaceous starch grains, volatile oil, and curcuminoids, which are compounds that give turmeric its yellow color. The majority (50–60%) of curcuminoids are referred to as curcumin. Chemically, curcumin, starch, and volatile oil are present in *Curcuma* species. Certain species are said to have a yellow color due to curcumin and other related curcuminoids like demethoxy and bis-demethoxy curcumin. Mono and sesquiterpenes such as α and β pinene, α -phellandrene, camphor, camphene, DL-ar-termerone zingiberene, and α , β curcumenes make up the 1–6.5 percent volatile oil concentration. Certain species, such as *C. angustifolia* and *C. caulina*, are used in place of arrow root because of their high starch content.

USES:

- It is used as an anti-inflammatory.

- It is used as a very strong antioxidant.
- It is used to lower the risk of heart disease.
- It is used to delay aging.
- It is used to fight depression.

2. LEMON OIL:



Synonym: Cortex limonis

BIOLOGICAL SOURCE: Lemon peel is the outer part of the pericarp of the ripe (or nearly ripe) fruits of *Citrus limon* Burm.

FAMILY: Rutaceae

ORGANOLEPTIC CHARACTERS:

- Color: pale yellow or greenish yellow
- Odor: reminiscent of lemon
- Taste: Aromatic

CHEMICAL CONSTITUENTS:

It mainly contains terpenes.

90% Limonene

Other Terpenes 10% of the oil is oxygenated by the compounds citral and citronellal. Terpeneless lemon oil is prepared by concentrating lemon oil in a vacuum or by solvent partition.

USES:

- It is used to boost immunity.
- It is used for skin cleansing and nourishing.
- It is used as cough or sore throat relief.
- It is used as a cleanser and purifier.
- It is used as a calming
- It is used as a food or drink enhancer.

3. EUCALYPTUS OIL



Synonyms: blue gum, stringy bark tree, Tasmanian blue gum

BIOLOGICAL SOURCE: It is the volatile oil obtained from the steam distillation of fresh leaves of *Eucalyptus globulus*.

FAMILY: Myrtaceae

ORGANOLEPTIC CHARACTERS:

Appearance: Slightly viscous liquid Color:

pale yellow aroma: camphor-like woody aroma

CHEMICAL CONSTITUENTS: Up to 3.5% volatile oil (with up to 70% eucalyptol/cineole, plus terpineole and pinene, geraniol), polyphenolic acids (including caffeic and gallic), flavonoids (including eucalyptin, hyperoside, and rutin), tannins, aldehydes, and bitter resin.

USES:

- It is used as an antiseptic,
- It is used as a deodorant.
- It is used as an antispasmodic.
- It is used as a febrifuge.
- It is used as an expectorant.
- It is used as a stimulant and reduces sugar levels.
- It is used as a vermifuge.
- It is used as an aromatic, secretolytic, rubefacient, and decongestant.

4. STEARIC ACID:



IUPAC NAME: octadecanoic acid

CHEMICAL FORMULA: C₁₈H₃₆O₂

MOLECULAR WEIGHT: 284.484 g/mol

DENSITY: 0.9408 g/cm³

MELTING POINT: 69.3 °C

BOILING POINT: 361 °C

USES:

- Stearic acid is used as a lubricating agent.
- It is used as a food additive.
- Used in the production of detergents.
- It is widely used in cosmetics, soaps, and shampoos.
- It is used in the manufacturing of pharmaceuticals.
- It is used in making insulators.
- Used in the food packaging industry.

5. HARD PARAFFIN:



CHEMICAL FORMULA: C_nH_{2n+2}

BOILING POINT: 370 °C (698 °F)

MOLECULAR WEIGHT: 300-550

DENSITY: 0.88–0.92 g/cm³

Appearance: white, solid

Odor: Odorless

USES:

- It is used as a lubricator for many products, including skis, surfboards, and bullets.
- It is also a great waterproofing agent for matches and wood.
- Food-grade paraffin wax is used in chewing gum and as a coating on cheese and candy.
- Crayons, candles, and cosmetics also use the wax.

III. MATERIALS AND METHODS

1. Materials

Stearic acid and hard paraffin were obtained from the laboratories, while curcumin extract was prepared in the laboratory. Pure lemon oil, turmeric powder, and eucalyptus oil were purchased from the market.

- **Stearic acid:** Stearic acid (also known as palm stearin acid) is used to help the candle harden more than is usual, provide a greater level of opaqueness when no dye is used, or enhance the color of any candle dye that is applied. As a consequence of a harder candle, the burning time is slightly improved.
- **Hard paraffin:** Hard paraffin wax is a mixture of solid hydrocarbons of high molecular weight that are obtained from crude petroleum. It is characterized by relatively large crystals and is insoluble in water or alcohol but sparingly soluble in benzene, turpentine, chloroform, ether, carbon disulfide, and oils.
- **Lemon oil:** Overall, we found that lemon essential oil was a tricky product to work with in candles. First, this essential oil has a medium-hot throw in candles, rating two leaves out of three on our soy performance scale. Testing can be difficult. We recommend not going over our recommended usage rate of 6%. We found candles had a nice lemon scent at 6%, but at 9%, the hot throw transforms into an unpleasant scent. If you're seeking a strong, lemon-fresh scent in soy wax with less trouble, we recommend trying Litsea cubeba essential oil instead.
- **Eucalyptus oil:** Our range of natural aromatherapy candles uses the purest ingredients of soy wax blended with essential oils. Instantly bring a moment of calm and balance with the added benefits of aromatherapy. Awaken the senses and aid congestion with the invigorating and refreshing scent of eucalyptus essential oil.
- **Turmeric powder:** For hundreds of years, people around the world have linked turmeric to healing properties and cosmetic benefits. The bright, yellow-orange spice is related to ginger. Turmeric gets its health benefits primarily because of curcumin, a bioactive component. Curcumin has anti-inflammatory and antioxidant properties. The curcumin found in turmeric can help wounds heal by decreasing inflammation and oxidation. It also lowers the response of your body to cutaneous wounds. This results in your wounds healing more quickly.

2. Methods

Method of extraction of curcumin

Turmeric (*Curcuma longa*) powder was purchased from Patanjali Ayurved Limited, Mumbai, India. Curcumin, the active ingredient of turmeric, was extracted from turmeric powder by using a Soxhlet extractor. 50 g of dried powder was placed in a porous bag or “thimble” made of Whatmann filter paper, which was placed in the chamber of the Soxhlet apparatus. 225 ml of ethanol was heated in a round bottom flask that was attached to the Soxhlet extractor, and its vapors were condensed in the condenser. The condensate was then dripped into the thimble containing the turmeric powder and extracted by contact. When the level of solvent in the chamber reached the top of the siphon tube, the liquid contents of the chamber were flooded into the flask, and then the cycle began again. This process was carried out for a total of 21 hours. Yellow, solid crude curcumin was obtained. Embelin was obtained from our college colleagues. Apparatus used: Soxhlet extractor, condenser, heating mantle, round bottom flask. Reagents used: ethanol.

Formulation of a herbal mosquito repellent candle

The candle was made up of a mixture of hard paraffin and stearic acid as the hydrocarbon bases. The formula for the insect repellent candle is as follows:

Formulation of herbal mosquito repellent candle

Sr.no	Ingredient	F1	F2	F3
1	Curcumin / Embelin	0.5ml	1ml	1.5ml
2	Lemon oil	10ml	10ml	10ml
3	Eucalyptus oil	10ml	10ml	10ml
4	Stearic acid	19ml	19ml	19ml
5	Stearic acid	q.s.	q.s.	q.s.

Preparation of herbal mosquito repellent candle

- The candle was prepared by heating (70°C) hard paraffin and stearic acid until they were melted.
- The essential oils were added when temperature dropped to 55°C± 600 C.
- Active ingredients- Curcumin & Embelin were then added to separate formulations.
- The wick was plunged repeatedly in liquid wax, in order to obtain the required diameter.
- It was introduced into a cup shaped mould, which was then filled with liquid wax.
- After cooling, the solidified candle was removed from it.



Prepared Herbal Mosquito Repellent Candle

Evaluation parameters:

- **Burning time (minutes):** Mosquito repellent cone from each formulation were burned and time was noted down.
- **Smoke visibility:** Individually each mosquito repellent cone was burned and its smoke visibility was checked.
- **Odor:** Individually each mosquito repellent cone was burned and its odor was checked.

- **Irritation test:** Individually each mosquito repellent cone was burned and its irritancy was checked. Mark an area (1sq.cm) on the left hand dorsal surface. The cream was applied to the specified area and time was noted. Irritancy, erythema, edema, was checked if any for regular intervals up to 24 hrs and reported.
- **Ash weight (g.):** Ashes of each formulation were individually taken and carefully weight on weighing machine using butter paper. 6. Appearance The appearance of the cream was judged by its colour, texture, roughness and its odour.

OBSERVATION :

Evaluation of herbal mosquito repellent candle

Sr. no	parameter	F1	F2	F3
1	Burning time (min)	41	37	45
2	Irritability	no	no	no
3	Odour	good	good	good
4	Smoke visibility	average	low	low
5	Ash weight	1.72	1.76	1.84

IV. RESULT

Each formula candle was put to the test in a lab setting, a typical room with a smaller area and a higher concentration of mosquitoes. The tests included flammability rate comparisons with a similar-sized aromatic herbal candle, burning efficiency in terms of burning time, and overall effective repellent performance. Compared to the commercialized candle, the test revealed higher quality and efficacy.

V. CONCLUSION

Using natural chemicals, herbal mosquito repellent candles offer a promising way to reduce mosquito bites. The type and concentration of herbal extracts—like citronella, lemongrass, and eucalyptus—that have been shown to effectively repel mosquitoes determines how effective they are. These candles are an environmentally sustainable and safer substitute for artificial chemical repellents that pose a threat to human and pet health.

In conclusion, herbal mosquito repellent candles can be a cost-effective and environmentally responsible method of controlling mosquitoes, but they should only be used in conjunction with other preventive measures as part of a larger plan. To maximize their benefits, it is imperative to ensure sustainable sourcing, high-quality production, and adherence to safety regulations.

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