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Formulation And Evaluation Of An Eco-Friendly Mosquito Repellent Candle From Plant Extracts

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ABSTRACT : Mosquito-borne diseases pose a significant threat to public health, necessitating thedevelopment of effective and eco-friendly mosquito control solutions. This study explores the formulation of a herbal mosquito repellent candle incorporating neem (Azadirachta indica) and cinnamon (Cinnamomum verum) extracts as active ingredients. These botanical extracts are known for their strong insecticidal and repellent properties. The candle was prepared using natural wax as a base, ensuring a sustainable and non-toxic alternative to synthetic repellents.The effectiveness of the formulated candle was evaluated through mosquito repellent tests and anti-larval study.The mosquito repellent test assessed the ability of the candle to deter adult mosquitoes, while the anti-larval test determined the growth and survival of mosquito larvae that confirming the dual action of the candle as both a repellent and a larvicide. This research highlights the potential of herbal-based mosquito control strategies as an environmentally friendly and health-conscious alternative to chemical repellents. The neem and cinnamon- i.Modern and conventional herbal therapy for illness prevention primarily derives from herbal plants, which contain a variety of biologically active substances that are beneficial for enhancing one's quality of life. as an environmentally responsible substitute for chemical repellents. Combining a suitable wax base for maximum burning, the candle contains a blend of natural essential oils, such as lemon, lavender, and rosemary, that are known for their ability to repel insects. The number of illnesses brought on by mosquitoes is increasing day by day.Yellow fever, dengue, zika virus, filariasis, malaria, and chicken-gunya are among the illnesses that are frequently brought on by mosquitoes.

Keyword : Candle, anti-larvae, Peppermint, Cinnamon, Neem.

INTRODUCTION:

Mosquitoes are one of the most common disease-carrying insects, responsible for spreading repellents illnesses such as malaria, dengue, chikungunya, and Zika virus. Chemical mosquito, such as those containing DEET (N,N-Diethyl-meta-toluamide), are widely used, but they can cause skin irritation, respiratory problems, and environmental pollution. As a result, there is an increasing demand for natural and eco-friendly mosquito control solutions.

This study focuses on developing a herbal mosquito repellent candle using extracts of neem (Azadirachta indica) and cinnamon (Cinnamomum verum). Neem is well known for its insect- repellent and larvicidal

properties, primarily due to active compounds such as azadirachtin and salannin. Similarly, cinnamon contains cinnamaldehyde and eugenol, which have been proven to repel mosquitoes and inhibit larval growth.

The candle is designed to work in two ways:

1. Repelling adult mosquitoes through the release of plant-based essential oils when burned.
2. Disrupting the growth of mosquito larvae through the insecticidal properties of neem and cinnamon extracts.

o evaluate the effectiveness of the formulated candle, two tests were conducted:

1.Mosquitoes repellent test – To check how well the candle repels mosquitoes

2.Anti-larval test – To observe its effect on mosquito larvae.

By using **natural ingredients**, this study aims to provide a safe, cost-effective, and **sustainable alternative** to chemical mosquito repellents. If proven effective, herbal mosquito repellent candles can help reduce mosquito-borne diseases while minimizing health and environmental risks. The mosquito is arguably the most dreadful bloodsucking insect that humans encounter. Many diseases, such as dengue fever, yellow fever, and malaria, are known to be spread by Anopheles, Culex, and Aedes fly species. The Zika virus, chikungunya, Japanese encephalitis, Rift Valley disease, West Nile virus, and lymphatic filariasis can also be spread by mosquitoes. An immune response is triggered whenmosquitoes inject their saliva into a host's bloodstream, where the antigens bind to IgG and IgE antibodies. In addition to causing excruciatingly painful skin irritation, mosquito bites can cause allergic reactions in humans who come into touch with the insects' saliva. [1] Medical professionals who care for patients depend on this polyherbal mixture's important logical approach. The methodical objective of polyherbal formulations was to use experimental techniques to show the efficacy of herbal extracts.[2]Considerable attempts were previously made to employ polyherbal remedies to stop diseases from being transmitted by mosquitoes.formulations. [3] Natural repellents: Although most repellents available on the market today work well at quickly keeping mosquitoes away, they are not the safest choice due to the presence of the dangerous chemical N,N-diethyl-meta-toluamide (DEET). Mosquito-repelling candles made of citronella oil are commonly accessible in the United States. [4] Every year, mosquitoes infect about 700 million people, resulting in over a million deaths worldwide. We attempt to use natural herbal ingredients and essential oils with demonstrated mosquito-repelling properties, such as beeswax, camphor, tulsi, neem, orange, lemongrass, marigold, rosemary oil, lavender oil, and lemonoil, to create a safe and non-toxic mixture.

OBJECTIVES:

1.Prepare extract of the powdered drug.

2.To check the activity against larvae.

3.To check the repellent activity .

4.To prepare eco-friendly mosquito candle.

5.To evaluate prepared candle.

6.To Repel Mosquitoes: Emits scents that deter mosquitoes.

7.To Safe Alternative: Provides a chemical-free option for protection.

8.To Ambiance: Creates a pleasant, relaxing atmosphere.

9.To Long-Lasting Protection: Offers continuous mosquito defense.

10.To Portable: Easy to use in outdoor settings.

11.To Reduce Disease Risk: Helps prevent mosquito-borne illnesses.

METHODES AND MATERIALS:

Herbal Selection :A kind of candle used to repel insects using natural components is called a polyherbal mosquito repellent candle. Typically, natural herbs derived from plants are used, together with their essential oils, which have the ability to repel mosquitoes. Mosquito control treatments with a chemical base are frequently utilised, however because of their synthetic ingredients, they are harmful to humans. There is a rising need in the market for the creation of herbal-based insect repellents as a result of these toxicity issues.[5] Advantage of Natural Insect Repellent Candle Natural Insect Repellent Candles are portable, lightweight, and simple to use.They are eco- friendly as well as biodegradable.In which contain the essential oil show the repellent activity.They are non-irritating, non-poisonous, simple to produce, and have insect-repelling properties.

Peppermint:

Synonym: Mentha piperita
Biological Source: It consists of the dried leaves and flowering tops of Mentha piperita Linn.
Family: Lamiaceae (also known as Labiatae).
Chemical Constituents:Volatile oils (main component: Menthol 30–55%), Menthone, Menthofuran, Methyl acetate, Cineole, Pulegone,Tannins, Flavonoids.
Uses:Natural Mosquito Repellent: Contains menthol and menthone, which repel mosquitoes by disrupting their sensory signals. Eco -Friendly & Non-Toxic: Safe alternative to synthetic chemicals like DEET and allethrin. Pleasant Fragrance : The minty aroma is refreshing for humans but deters mosquitoes. Synergistic Effect: Can be blended with citronella, eucalyptus, or lemongrass oil for enhanced repellent action.[6]

Neem:

Synonym: Nimba, Margosa.
Biological source: Neem is fresh or dry leaves and seed oil of Azadirachta Indica.
Family: Meliaceae**.**
Chemical Constituents: Azadirachtin, Nimbin, Nimbidin**,** Nimbidol**,** Gednin**,** Sodium
Uses : Neem leaves extract can be used as an insecticide or mosquito repellent in herbal mosquito repellent candles. In which Active Ingredient is Azadirachtin,Neem is among the safest ways to prevent mosquitoes from biting your body. Neem's efficacy lasts for around three hours and can repel 70% of mosquitoes.[7] Neem is helpful in the treatment of a variety of skin disorders, wounds, and infections due to its inherent antibacterial and antifungal qualities. Also helpful in Antipyretic.

Cinnamon

Synonym: Dalchini (Hindi),Ceylon cinnamon ,True cinnamon

Biological Source:Cinnamon is obtained from the dried inner bark of the plant Cinnamomum verum (syn. Cinnamomum zeylanicum).

Family: Lauraceae

Chemical Constituents: Volatile oil (main constituent: Cinnamaldehyde), Eugenol , Coumarin (in some species), Tannins Mucilage.

Uses: As a flavoring agent in food and beverages .Carminative and digestive aid Used in aromatherapy. Has antimicrobial, antioxidant, and anti-inflammatory properties .Used in toothpastes and mouthwashes due to its antiseptic nature.[8]

Beeswax

Synonym: white wax, Cera alba

Biological source: Honeycomb of the honey bee, Apis mellifera Linn and other species of Apis.

Family: Apidae.

Chemical constituents: Ester of fatty acids and long – chain alcohols.

Uses: Candles, cosmetics, lubricants, waterproofing agent, polish, lost wax casting, encaustic painting.Beeswax is an inexpensive, naturally occurring biological polymer made up of a variety ofinexpensive, non-toxic ingredients. Additionally, it is often utilised in the manufacturing of medicinal formulations with controlled release.It is a organic insecticide that is also present in candles that ward off mosquitoes. One extremely crystalline natural substance is beeswax.

Camphor

Synonym: Camphora, Gum camphor

Biological source: wood of the camphor Laurel tree (Cinnamomum camphora).

Family: Lauraceae

Chemical Constituent: 1% essential oil (cineol, pinene,thymol, menthol), wood contain around 3%.
Uses: camphor for itchiness, pain, and cough. Insect bites, acne, and numerous other ailments are also treated with it.A powerful sense of smell is possessed by mosquitoes. They use the scent of carbon dioxide emissions from human bodies to locate them. Thus, while burning camphor in a space, the mosquitoes are repelled from it by its potent scent, which also disorients them with their own odour. Your house will release them from their hiding places as soon as they scent it. [9]

Lemon Oil

Synonym: Citrus, Citrus Fruit, Cortex limonis, lemon peel.
Biological Source: It consists of fresh peel of ripe fruit Citrus Limonis.
Family: Rutaceae
Chemical Constituent: It consists of Lemon oil contains terpenes, Sesquiterpenes, aldehydes, esters.
Uses: Chemicals found in lemon eucalyptus destroy fungus and deter insects. Mosquito repellent made with lemon eucalyptus oil is used by people.[10]

Orange oil

Synonym: Sweet orange oil,Citrus oil
Biological Source:Obtained by cold expression of the fresh peel of Citrus sinensis (Linn.)
Family:Rutaceae
Chemical Constituents: d-Limonene (major component), Aldehydes (e.g., decanal), Linalool Citral ,Terpenes.
Uses: Used as a flavoring agent in food and beverages. Aromatherapy and perfumes Carminative and mild antiseptic used in cosmetics, cleaning products, and pharmaceuticals.

Eucalyptus Oil

Synonym: Eucalyptus essential oil , Blue gum oil.
Biological Source : Obtained by steam distillation of the leaves of Eucalyptus globulus
Family: Myrtaceae
Chemical Constituents:1,8-Cineole (Eucalyptol) (major component), Alpha-pinene Limonene,Terpineol,Flavonoids.
Uses: Used as an expectorant and decongestant in cough and cold preparations .Antiseptic and anti-inflammatory properties . Used in inhalants, balms, and toothpastes.Also used in aromatherapy and as an insect repellent.

Turpentine oil

Synonym: Oleum terebinthinae,Spirit of turpentine,Turps
Biological Source:Turpentine oil is obtained by distillation of the oleoresin obtained from Pinus species, especially Pinus palustris and Pinus pinaster.
Family: Pinaceae
ChemicalConstituents: Monoterpenes:,Alpha-pinene (major component),Beta-pinene Camphene,Limonene,Terpinolene.
Uses: Used as a rubefacient and counterirritant in liniments.Acts as a solvent for paints and varnishes.Used in the manufacture of synthetic camphor.Exhibits antiseptic and expectorant properties. Sometimes used in veterinary medicine. [11]

Methodology:

A)Preparation Of Extract:
1.Preparation of cinnamon: For this purpose, about 100 g of the cinnamon bark powder were soaked in 1 liters of distilled water for 72 hours with shaking thrice daily.The mixture was filtered through sterilized Whatman no.1 filter paper. After filtration, the extract was evaporated in water bath (50°C) until the solvent gets completely evaporated.The aqueous extract was labeled and stored in air tight glass containers in refrigerator at 4°C for further experimental use .[12]

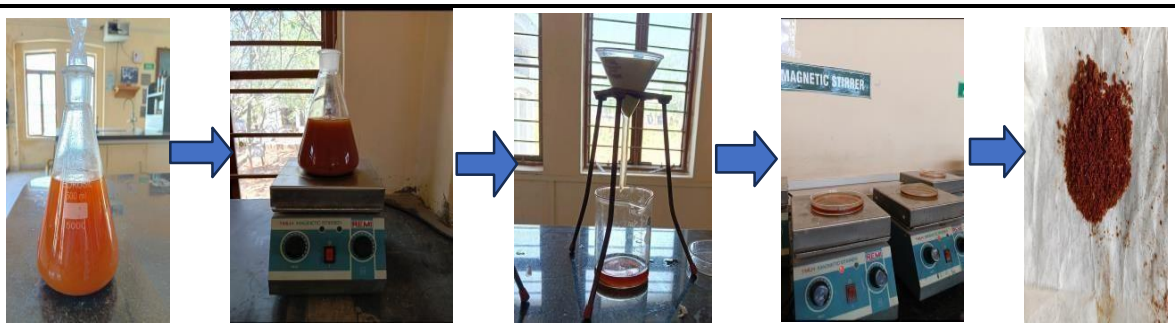


Fig.1.Extaction procedure of cinnamon

2.Preparation of Peppermint Extract

About 100 g of dried peppermint leaves powder was soaked in 1 liter of ethanol for 72 hours at room temperature with occasional shaking.The extract was filtered through Whatman No. 1 filter paper and concentrated using a rotary evaporator at 40°C until complete solvent evaporation.The extract was stored in airtight glass containers at 4°C for further use.

Fig.2.Peppermint extract powder.

3.Preparation of Neem Extract

Soxhlet extraction using 50g of neem powder with a 70:30 solvent ratio (70% ethanol and 30% hexane), This process is commonly used for extracting bioactive compounds from neem. [13]

Fig.3.Neem Extract Powder.

Procedure:

A) **Preparation**: Mix 70% ethanol with 30% hexane to form the solvent mixture.

B) **Setup:** Load 50g of dried neem powder into the Soxhlet thimble and attach it to the Soxhlet apparatus. Fill the boiling flask with the prepared solvent.

C) **Extraction**: Heat the solvent until it boils. The solvent will continuously cycle through the neem powder for approximately 3-4 hours, extracting bioactive compounds such as azadirachtin.

D) **Finishing:** Once the solvent appears clear, indicating complete extraction, remove the thimble, and evaporate the solvent using a rotary evaporator or gentle heat. Dry the extract and store it in an airtight container.

B) Larvicidal activity

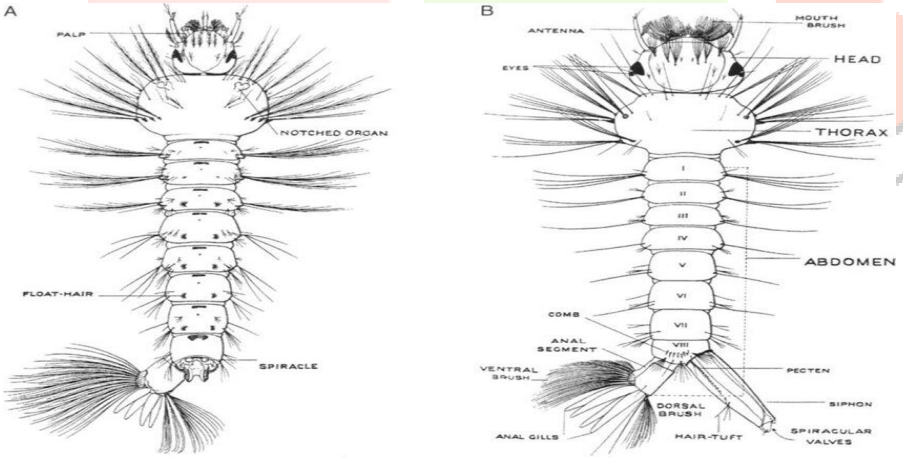
The prepared powder of leaf was soaked in each of water (plant material to solvent ratio was 1:10, w/v) and extracted for 24h at room temperature.Check the larvae at regular intervals (e.g., every 6 hours) for any behavioral changes or mortality. [14]Record the number of dead larvae.

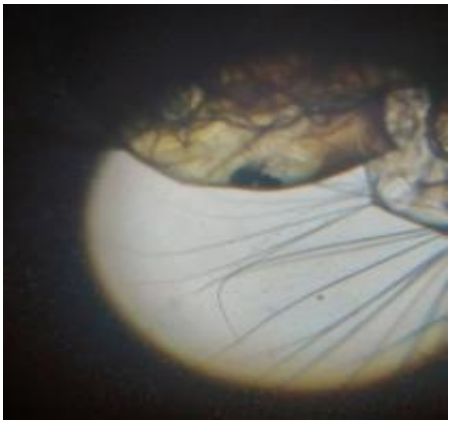
Fig.3. Process of larvicidal activity

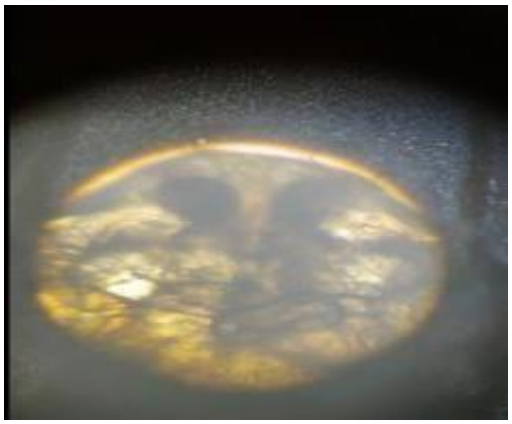
Collection of larvae from pravara college Of Pharmacy (for women) Campus areas and larvae contain at room tempreture.

C) Microscopic examination

Microscopic examination larva By the help of dropper took larva sample and than place it on slide and observe under 10x in compound microscope.







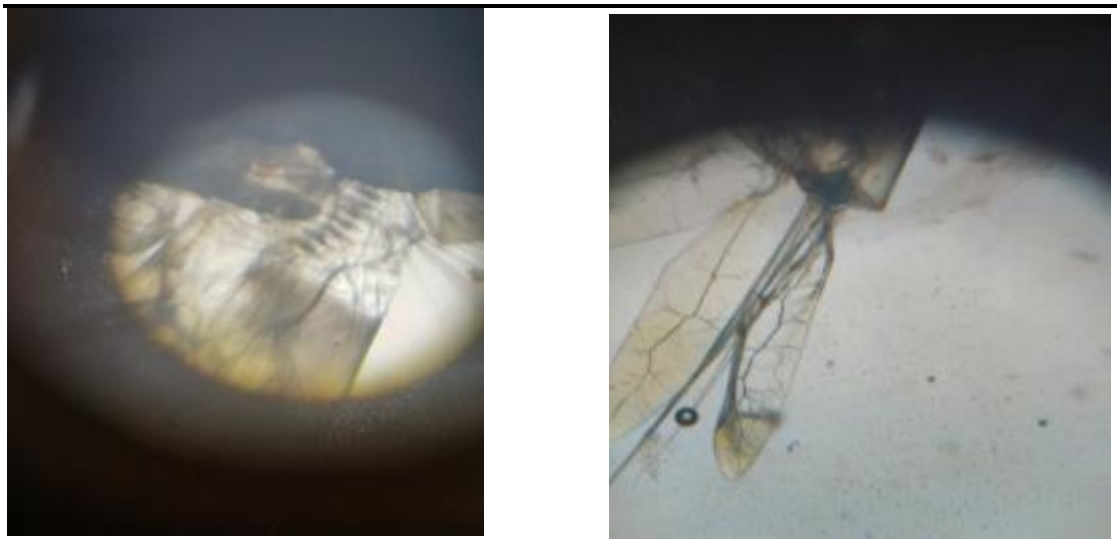


Fig.4.Microscopic examination

Formulation:

Trial No.1

Sr no.	Ingredient Name	Quantity	Uses
1.	Beeswax	50gm	Wax base/ binder
2.	Camphor	2gm	Burning
3.	Peppermint powder	4gm	Repellent
4.	Neem powder	2gm	Insecticide
5.	Cinnamon powder	2gm	Repellent
6.	Orange oil	4ml	Fragrance
7.	Lemon oil	5-7drops	Aroma
8.	Eucalyptus oil	5-7drops	Mosquito deterrent activity
9.	Turpentine oil	5-7drops	Natural insects repellent

Fig.5.Mosquito repellent candle

Process:

Measure out a Beeswax piece and weigh it precisely. Make tiny slices in the beeswax and use a heating mantle to melt it in a beaker. After the ingredients have melted sufficiently, begin combining the camphor, peppermint powder, Neem powder, cinnamon powder in a beaker, stirring continuously. After that, add the Orange oil, Lemon oil, Eucalyptus oil and turpentine oil. After adding each item, whisk for a full fifteen minutes. Pour the mixture into the size mould above. The mould allowed to cool to room temperature. After three to five hours, take the candle out of the mould . [15]

Fig.6.Candle process step by step

Formulation

Trial No.2

Table

Sr no.	Ingredients Name	Quantity	Uses
1.	Beeswax	50gm	Wax base/ binder
2.	Camphor	2gm	Burning

3	Peppermint liquid extract	2 ml	Repellent
4	Cinnamon liquid extract	2ml	Repellent
5	Neem liquid extract	2ml	Insecticide
6	Orange oil	4ml	Fragrance
7	Lemon oil	5-7 drops	Aroma
8	Eucalyptus oil	5-7 drops	Mosquito deterrent activity
9.	Turpentine oil	5-7 drpos	Natural insect repellent

Process:

1.Take a beeswax and Weigh the beeswax accurately.

2.Cut the beeswax in small cuts and Melt the beeswax in beaker with the helpofheating mentle. 3.After the properly melting Start combining the neem liquid extract & peppermint liquid extract,neem liquid extract and camphor In a beaker.

4.After the adding extract then Start the mechanical stirrer slowely.

5.Then add the Orange oil, lemon oil, Eucalyptus oil and turpentine oil in given quantity for the fragrance.

6.After adding all ingradient , Keep stiring upto 15 minutes.

7.pour above mixture in suitable size mould.

8.Allow the mould to be cooled at roomtemperature. o After ½ hour remove the candle from mould.[16]

NOTE :

We conducted two batches of mosquito repellent candle formulations: one using extracted powder and the other using liquid extract. Upon observation, the batch prepared with the liquid extract exhibited phase separation, compromising the uniformity of the candle. In contrast, the formulation using the extracted powder blended smoothly and produced a homogenous mixture. Therefore, the powder extract was selected for the final preparation of the mosquito repellent candle due to its superior compatibility and stability in the formulation**.**

RESULT:

Evaluation parameters:

Organoleptic Characteristics :To evaluate the aroma, shade, and texture of the formulation, visual inspection of the mixture was used in this test.

Colour : Yellow

Fragrance : It was discovered that the formulation's fragrance was pleased.

Texture : A homogeneous formulation was discovered**.**

Testing for irritability : It was found that there was no skin discomfort when a prepared insect repellent candle was lit.

Phytochemical analysis : The phytochemicals and elemental analysis of leaf of Lantana camara showed the presence of useful classes of chemical compounds such as Alkaloids, Glycosides, Carbohydrate, Flavonoid and Tannins compounds**.**

Test Table :

Sr .no	Test	Ethanol	Aqueous
1	Alkaloids	-ve	+Ve

2	Glycosides	+Ve	+Ve
3	Carbohydrate	-ve	+Ve
4	Flavonoids	+Ve	+Ve
5	Tannins	+ve	+Ve

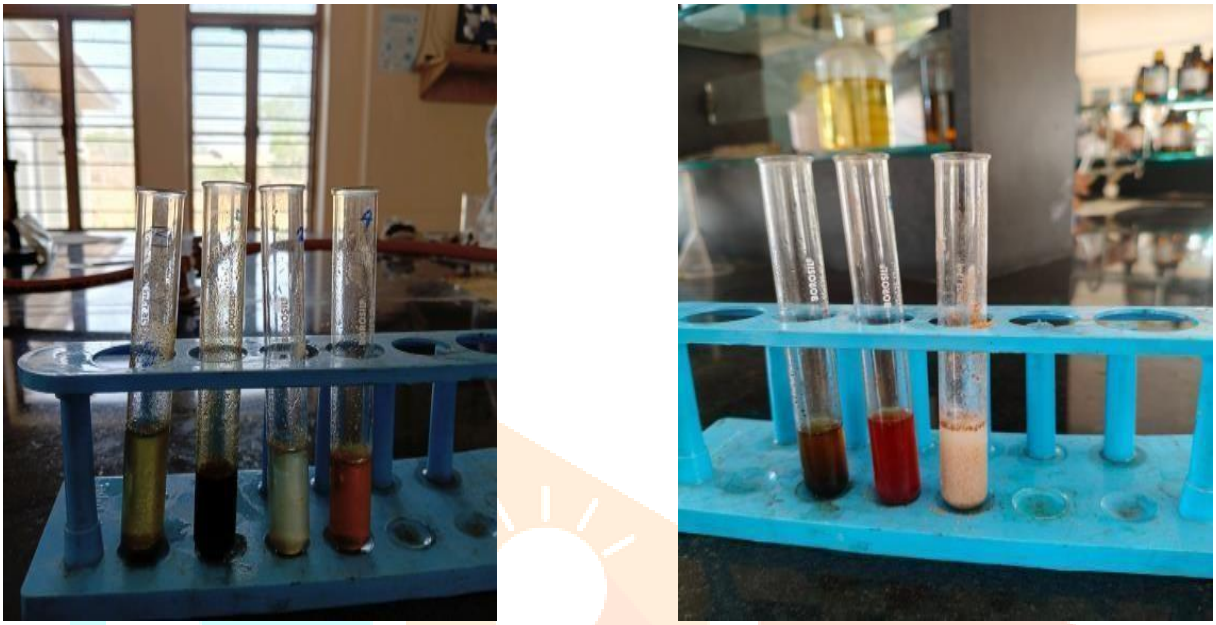


Fig.7.phytochemical testing

Flammable Test : The created candle was evaluated for flammability to find out more about the behaviours that repel insects. It also burned well in terms of burning time. Finally, a flammability test was performed to confirm the candle's apparent flammability in the lab using the spotting technique.[17]

Fig.8. Flammable test

Sr no.	Parameters	Candle evaluation
1.	Weight	62 gm
2.	Burning time	48 min ,43 min
3.	Irritancy	No teary eyes and cough No teary eyes and cough
4.	Emission	Mild soot was produced but has strong odour Mild soot was produced but has pleasant odour.
5.	How many mosquitoes killed ?	6 Mosquitoes

The mosquito repellent and larvicidal action of neem and cinnamon comes from their active chemical compounds:

1.Neem (Azadirachta indica)

Azadirachtin – The primary bioactive compound responsible for mosquito repellency and larvicidal effects. It disrupts mosquito growth and reproduction.

Nimbin & Nimbidin – Have insecticidal and antifungal properties that help repel mosquitoes.

Salannin – Known for its strong mosquito repellent properties, often compared to synthetic repellents like DEET.

Gedunin – Acts as a natural insect growth regulator, preventing mosquito larvae from maturing.

2.Cinnamon (Cinnamomum verum / Cinnamomum cassia)

Cinnamaldehyde – The major compound responsible for repelling mosquitoes due to its strong odor and toxic effects on insects.

Eugenol – A natural insecticide with repellent and larvicidal properties.

Cinnamic acid – Has antimicrobial and insecticidal properties that help in mosquito control.

Conclusion :

Neem and cinnamon contain a combination of repellent, insecticidal, and larvicidal compounds, making them effective for mosquito control. Azadirachtin (from neem) and cinnamaldehyde (from cinnamon) are the most important constituents for repelling mosquitoes and preventing their growth.

DISCUSSION:

Need for Research: In today's world, when we think about health-related issues, diseases caused by mosquitoes are a major concern. These include dengue, malaria, chikungunya, and filariasis, among others. Various formulations are available in the market to protect against mosquitoes. However, these formulations contain different types of chemicals, which can be harmful to our health. These chemicals can lead to various health problems, making it necessary to find alternative solutions.

Market-Available Mosquito Repellents and Their Harmful Effects

Fig.9. Mosquito Repellent Coil

Fig.10. Mosquito Repellent Bat

Fig.11.Mosquito Repellent liquid

Fig.12. Mosquito Repellent Paper Card

Fig. 13.Mosquito Repellent Cream

Fig. 14.Mosquito Repellent Candle

1.Mosquito Repellent Coil - Harmful Effects:Produces smoke that is harmful to the respiratory system.Causes irritation to the eyes**.**

2.Mosquito Repellent Bat - Harmful Effects:Requires continuous effort to kill mosquitoes.The process of eliminating mosquitoes is time-consuming**.**

3.Liquid Vaporizer - Harmful Effects:Requires electricity to function.Leads to a high financial burden over time.

4.Paper Card (Fumigation Strip) - Harmful Effects:Emits a strong smell, which can cause discomfort.Causes irritation to the eyes.

5.Mosquito Repellent Cream - Harmful Effects:Contains chemical ingredients that can cause itching and redness.Prolonged use may pose a risk of cancer.

6.Mosquito repellent candle - Natural insect repellent candle portable, lightweight and simple to use .They are eco-friendly as well as biodegradable.In which contain the essential oils shows the Repellent activity.

Conclusion:

This study demonstrates that a herbal mosquito repellent candle made with neem and cinnamon extracts is an effective and eco-friendly way to repel mosquitoes and control their larvae. The mosquito repellent test showed that the candle significantly reduced the number of mosquitoes in the treated area, while the anti-larvae test confirmed its ability to inhibit mosquito growth. These findings suggest that natural plant-based repellents can be a safe and sustainable alternative to chemical repellents, reducing the risk of mosquito-borne diseases without harming the environment. Further research and large-scale testing can help improve the formulation and effectiveness of such herbal solutions.

Summary: The increasing health concerns related to chemical-based mosquito repellents such as coils, mats, and sprays have led to a growing interest in natural, eco-friendly alternatives. This project focuses on the formulation and evaluation of a mosquito repellent candle using natural ingredients with known insect-repelling properties. The primary aim is to create a product that is safe, effective, non- toxic, and suitable for individuals sensitive to synthetic repellents.The formulation involves the use of natural essential oils like citronella, lemongrass, and eucalyptus, which are proven to have strong repellent effects against mosquitoes. These oils are incorporated into a wax base (typically paraffin or soy wax) along with other additives to ensure proper consistency, fragrance diffusion, and effective release of active compounds during combustion.

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