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FORMULATION AND EVALUATION OF POLYHERBAL NOVEL MOSQUITO REPELLENET CONES

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ABSTRACT

Currently the use of synthetic or chemical based mosquito repellents have several health related issues. Which has scientifically proven to cause illness to the humans. Hence, This project was formulated and developed to have safer mosquito repellent that are therapeutic and are also free from carcinogenic containing harmful chemicals. They are significantly economical and are much simpler to formulate. In this formulation we have typically used dried powders of herbs like neem, eucalyptus, tulsi, rose petals, bay leaf, camphor, benzoin, sandalwood powder was used develop herbal mosquito repellent that are non-carcinogenic and are known since ancient for their therapeutic properties that aids in healing various respiratory related concerns associated with lungs in general.

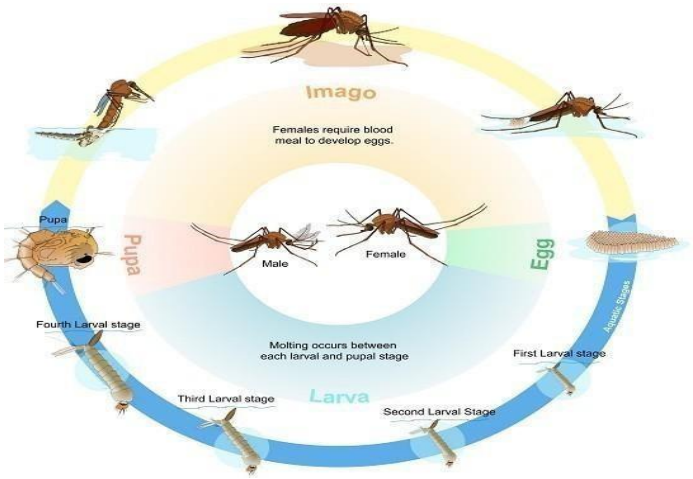
The dried powdered blend were mixed together with the binders and additives like joss and charcoal powder. Here, Charcoal accelerates the igniting power of the mosquito repellent cones and also depicts synergistic effect. The semi-solid formulation was then rolled in the form of incense cones. Further to add value, it was later scented with essential oil like rose oil and also sandalwood powder to enhance the fragrance while also repelling mosquitoes later they were kept for drying under shade for an ample amount of time till the cones are ready to get burnt. when ignited, the natural cones releases vapours along with the pleasant fragrance which repel the mosquitoes. Furthur, The potency of the incense cones was tested by burning near the mosquito net cage with sufficient

mosquitoes. The cones were also distributed to random people inside the college premises for there feedback regarding the cones and the result were positive and the consumers were appealed by the pleasant odour of the cones while being effective in controlling the mosquitoes alongside showing its therapeutic health benefits which finally contributed to the success of this project.

INTRODUCTION

Herbs have been long used as the basis of traditional Chinese herbal medicine, in India, the Ayurveda medical system is based on herbs. Medicinal use of the herbs in the western cultures has its roots in the Hippocratic (Greek) elemental healing system. Modern pharmaceuticals had their origins in crude herbal medicines, and to this day, some drugs are still extracted as fractionate or isolate compounds from raw herbs and then purified to meet pharmaceutical standards. Herbal plants are used for various purposes like, cooking, dental care, hair care, cosmetic preparations, veterinary medicines and also in repelling the insects especially mosquitoes. Mosquitoes are the main cause for spreading the diseases; they act as the vectors or carriers for the diseases. Mosquitoes are among the most disturbing blood sucking insects affecting human beings.[2] These are members of a group of almost 3,600 species of small flies with the most important genera *Anopheles, Culex, Aedes and Mansonia* within the family Culicidae belong to kingdom Animalia. The ‘mosquito’ is Spanish word for ‘little fly’. Mosquitoes have a slender segmented body, one pair of wings, one pair of wings, three pairs of long hair like legs, and elongated mouthparts. Typically, female mosquitoes live for few weeks, while male mosquitoes live for about one week.

Mosquito life cycle



Mosquito life cycle.

By knowing all the different stages of the mosquito's life will help you prevent mosquitoes. Around your home and also help you choose the right pesticides for your needs, if you decide to use them. All mosquito species go through four distinct stages during their life cycle:

- **Egg –** hatches when exposed to water.
- **Larva –** (plural: larvae) "wriggler" lives in water; molts several times; most species surface to breathe air.
- **Pupa –** (plural: pupae) "tumbler" does not feed; stage just before emerging as adult.
- **Adult –** flies short time after emerging and after its body parts have hardened.
  The first three stages occur in water, but the adult is an active flying insect. Only the female mosquito bites and feeds on the blood of humans or other animals.
- After female mosquito obtains a blood meal, the female mosquito lays the eggs directly on or near water, soil and at the base of some plants in places that may fill with water. The eggs can survive dry conditions for a few months.
- The eggs hatch in water and a mosquito larva or "wriggler" emerges. The length of time to hatch depends on water temperature, food and type of mosquito.
- The larva lives in the water, feeds and develops into the third stage of the life cycle called, a pupa or "tumbler". The pupa also lives in the water but no longer feeds.
- Finally, the mosquito emerges from the pupal case after two days to a week in the pupal stage.
- The life cycle typically takes up two weeks, but depending on conditions, it can range from 4 days to as long as a month. The adult mosquito emerges onto the water's surfaces and flies away, ready to begin its begin its lifestyle.

Nowadays there is increase in mosquito-borne diseases. Mosquito-borne diseases are those spread by the bite of an infected mosquitoes. Diseases that are spread to people by the mosquitoes include Zika virus, West Nile virus, Chikungunya virus, Dengue, and Malaria. These are caused by biting of the mosquitoes, as the mosquito is feeding, it injects saliva into our skin. Our body reacts to the reacts to the saliva resulting in bump and itching. Some people have only a mild reaction to bites, some people react more strongly, and a large area of swelling, soreness, and redness can occur.

An alarming increase in the range of mosquitoes is mainly due to deforestation, industrialized farming and stagnant water. Several mosquitos' vectors for the pathogens of various diseases

of various diseases like Dengue fever, Malaria, Yellow fever, Japanese Encephalitis and several other infections.

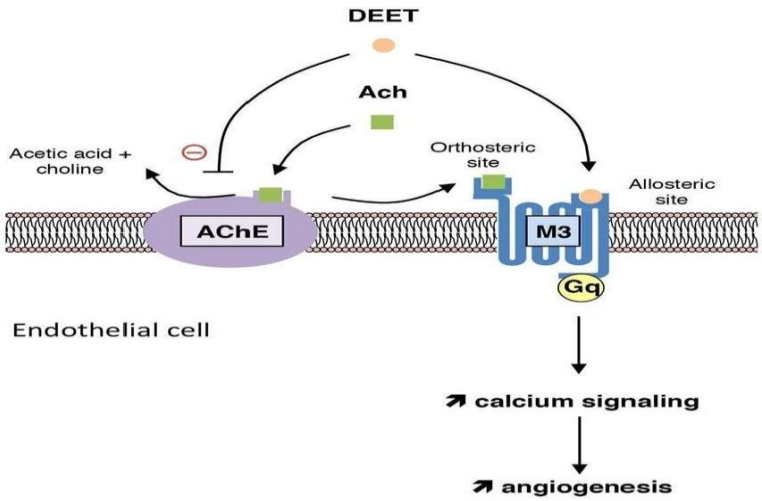
Epidemiology

Mosquitoes alone transmit disease to more than 700 million people and over one million deaths are reported annually across the globe. Malaria which is caused by Plasmodium parasites transmitted through the bites of female Anopheles mosquitoes continues to impart a major disease burden on infants and young children in endemic regions. The Aedes aegypti mosquito which spreads Dengue fever is responsible for more than 100 million infections worldwide every year, leading to thousands of deaths and more than 2.5 billion people or over 40% of the world's populations are now at risk of dengue. Yellow fever which is transmitted by the Heamogogus and Aedes species of mosquitoes between monkeys and human. Every year there are around 200,000 cases of illness and 30,000 deaths worldwide from yellow fever. Therefore, the control of mosquitoes is an important public health concern around the world. One of the approaches for control of these mosquito-borne diseases is the interruption of the disease transmission by either killing the mosquitoes or preventing them from biting individuals.[2]

For killing or preventing the mosquitoes from biting mosquito repellents are used, there are both synthetic and natural (herbal) mosquito repellent available; "Mosquito repellents are the substance that deters mosquitoes from approaching settling" or a mosquito repellent is a substance designed to keep away mosquitoes, thereby preventing them from biting humans and feeding on human blood. Mosquito repellents are available as creams, lotions, oils, sticks and cones, aerosols and pump spray products. Mosquito repellents are different from insecticides which are used to kill the insects.[3]

As synthetic repellents are harmful to humans, therefore, non-toxic means of repelling insects is preferred and desired; many natural substances from plant extracts are known to repel insects and mosquitoes. Especially DEET (*N*,*N*-Diethyl-*meta*-toluamide, also called diethyltoluamide), can be readily absorbed through the skin, causing many accidental poisoning, especially of children. They also can poison wildlife. DEET in particular has been shown to be very harmful to the environment, and DEET is suspected to be carcinogen, teratogen and mutagen. Accordingly, the idea of using natural mosquito repellent products as an alternative to develop new eco-friendly repellents could be an amicable solution to scale back the undesirable effects on environment and human health.

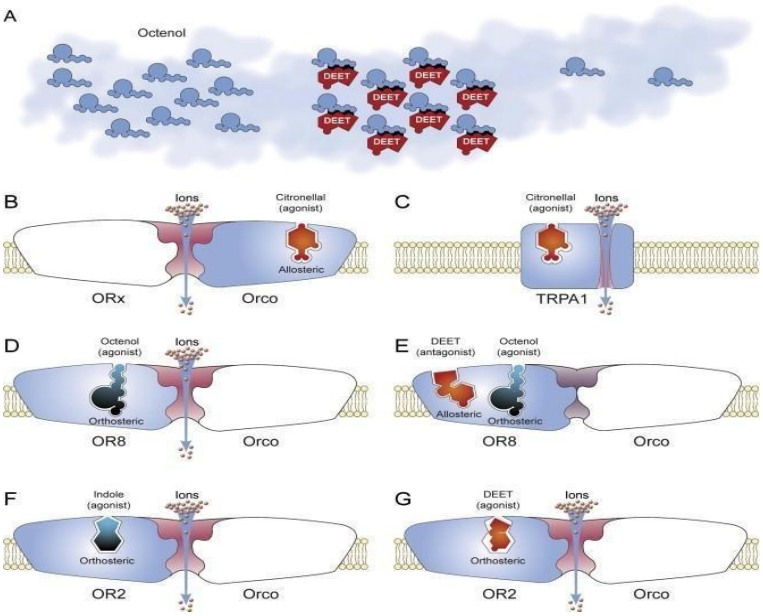
Mechanism of action of DEET(Diethyltoluamide)



MOA of DEET.

Mechanism of action herbal mosquito repellent[4]

Carbon dioxide and lactic acid present in sweat in warm-blooded animals act as an attractive substance for mosquitoes. Mosquito repellents work by masking human scent or by using a scent which mosquitoes naturally avoid. The repellents block the lactic acid receptors destroy upwind flight. Therefore, mosquitoes lose its contact with the host. Controlling mosquitoes is of utmost importance in the present-day scenario with rising numbers of mosquito-borne diseases. The use of mosquito repellent decreases the contact between mosquito and their host (animals and humans), and may even lower the rate of disease transmission in many instances.



MOA of polyherbal mosquito repellent.

Properties of mosquito repellent[5]

- Active against a wide variety of biting insects.
- Prolonged activity (remain effective for at least 8 hours between applications)
- Non-irritating to the skin and mucous members.
- Cosmetically appealing (odourless or have a pleasant odour andgreaseless). No systemic toxicity.

The phytochemicals derived from plants resources can act as larvicidal, insect growth regulators, repellents and ovipositional attractants, having deterrent activities observed by different researches. The plants products have been used traditionally to repel or kill the mosquitoes in many parts of the world.[6] Most plants contain compounds that they use in preventing attack from insects like phytophagous (plant eating insects). These chemical compounds fall into several categories, including repellents feeding deterrents, toxins and growth regulators. Most of these components are effective against mosquitoes.

These are various plants and herbs that naturally repel mosquitoes, for exampleneem, eucalyptus, rose petals, tulsi, bay leaf, benzoin, sandalwood.

These are various plants and herbs that naturally repel mosquitoes, for exampleneem, eucalyptus, rose petals, tulsi, bay leaf, benzoin, sandalwood.

- Neem has very strong aroma than other mosquito repellents that contain neem, which masks the other scents, and keeps mosquitoes from being attracted to things located around it. It is the great choice for repelling mosquitoes naturally.[7]
- Eucalyptus contains cineol, an ingredient found in many insect repellents, and they have unique aroma which bugs find repulsive.[8]
- Rose petals contains the essential oils that act as a very good mosquito repellent. It has the scent that is detested by the mosquitoes.[9]
- The odour and taste of tulsi is despised by the bugs, thus keeps the bugs away from us. If you happen to get bitten, tulsi leaves rubbed directly onto the skin make a great bite relief treatment.[14]
- Bay leaf contains eugenol which acts as a natural mosquito repellent, when bay leaves are crushed or burned, these oils are released into the air, creating a scent that mosquitoes find unpleasant.[13]

- Therefore, by using herbal plants we are formulating the mosquito repellents. Hence the present investigations aim to explore the formulation and development of poly herbal mosquito repellent cones.
- The main ingredients used in the formulation are neem, eucalyptus, rose petals, bay leaf and the adjustments used along with these are joss powder, guggul, benzoin, camphor and charcoal.

DRUG PROFILE

Neem[7]

Botanical Name: ***Azadirachta Indica.***

Biological Source: *Azadirachta indica* (commonly known as neem, nimtree and Indian lilac) is a tree in the mahogany family of Meliaceae. Neem consist of the fresh or dried leaves and seed oil of *Azadirachta indica J.*

Family: Meliaceae

Genus: Azadirachta

Species: *A. indica*

Chemical constituents: Various parts of plant is used for various therapeutic and commercial purposes due to presence of different types of chemicals in different parts of this plant. Some of them being:

- **Leafs:** Quercetin, Nimbosterol, Nimbin.
- **Flower:** Nimbosterol, Kaempferol, Melicitrin.
- **Bark:** Nimbin, Nimbidin, Nombosterol, margosine.
- **Seed:** Azadirachta, Azadiradione, Nimbin, Vepinin, Vilasinin, Fraxinellone.

Uses

- Helps in treating malaria.
- Used as plant protectant, commercial pesticide.
- Helps in treating fungal infection, good for dandruff removal.

Mechanism of action

In insects moulting is governed by an enzyme ecdysone

↓

When the neem components, especially Azadirachta enter into the body of larvae, the activity of ecdysone is suppressed and the larvae fails to moults, remains in the larval stage and ultimately dies.

↓

If the concentration of Azadirachtin is not sufficient, the larva manages to enter the pupal stage but dies at this stage.

↓

If the concentration is still less the adult emerging from the pupa is 100% malformed, absolutely sterile without any capacity for reproduction.

Tulsi[14]

Botanical Name: *Ocimum sanctum.*

Biological Source: The drug of tulsi consists of fresh and dried leaves and root of Ocimum species like *Ocimum sanctum L*. and *Ocimum basilicum L.*

Family: Lamiaceae.

Genus: Ocimum

Species: *O.tenuiflorum*

Active Ingredients

Active ingredient	Property	Mechanism
1.Essential oils: Eugenol, Limonene,Citronellol.	Mosquito repellent property	These oils can acts as natural deterrents to mosquitoes, making them less likely to approach areas where the scent of tulsi is present.
2. Strong aroma: Tulsi has a strong and distinct aroma that mosquito find unpleasant.	Mosquito repellent property	The strong scent of the plant can interfere with the mosquito's ability to locate human hosts by masking the human scent, making it more challenging for them to find and bite humans.
3.Repellentchemicals: Eugenol.	Insect repellent property	When mosquitoes come into contact with eugenol or other repellent compounds in tulsi, they may avoid the area altogether.
4.Toxicity to mosquitoes:	Mosquito repellent property	Some components of tulsi may have toxic effects on mosquitoes, leading to repulsion or even death.

Tulsi is natural and safe alternative to chemical- based mosquito repellent, which often contain synthetic compounds like DEET. Using tulsi as a repellent reduces the risk of exposure to potentially harmful chemical found in commercial products.

Uses

- Malaria fever.
- Relieve from insects pain and sting bites.
- Relieves cough and respiratory problems.
- Good anti-oxidant.

Eucalyptus[8]

Botanical Name: *Eucalyptus globules.*

Biological Source: Eucalyptus oil is the essential oil obtained by the distillation of fresh leaves of *Eucalyptus globules* and other species like *E. polybractea*, *E*. *viminalis*, and *E. smithii*.

Family: Myrtaceae

Species: *Eucalyptus oblique*

Active Ingredients

Active ingredients	Mechanism of Action
1. Citronellal	Citronellal has a strong citrus-like scent that masks the human body's natural odor, which mosquitoes are attracted by camouflaging the human scent, mosquitoes find it more challenging to locate potential hosts and are, therefore, less likely to bite.
2. Para-menthane-3,8diol (PMD)	It works by disrupting the mosquito's ability to detect carbon dioxide and lactic acid, both of which are chemicals produced by the human body and are attractive to mosquitoes. By interfering with mosquito's ability to sense these chemical cues, PMD makes it harder for mosquitoes to locate their hosts.

Uses

- It is highly effective as a mosquito repellent.
- Relieves respiratory problems.
- Controls diabetes.

Charcoal[10]

Common Name: Coke, Carbon Black, Soot.

Source: Common charcoal is made from peat, coal, wood, coconut shell, or petroleum.

Nature: Carbon residue of dehydrated, burned organic material that has been heated to a very high temperature.

Mechanism: Charcoal, particularly activated charcoal, is sometimes used as a mosquito repellent due to its ability to adsorb odors and volatile compounds that attract mosquitoes.

It can help mask the scent of body odors and sweat, making it more difficult for mosquitoes to locate potential hosts.

Uses

- Used in mosquito bites and bee stings.
- Used to treat acne.
- Used to treat poisoning and overdoses.
- Used in air and water purification.

Camphor

Botanical Name: *Cinnamomum camphora.*

Biological source: Camphor is a waxy, white crystalline solid substances, obtained from the tree Cinnamomum camphora with a strong scent. Its terpenoid is originally obtained by distillation of bark from camphor tree Composition: It is a bicyclic monoterpene ketone which is found plants like Cinnamomum Camphora. The molecular or chemical formula of camphor is C10H16O.

Mechanism: Camphor works as a mosquito repellent due to its strong odour and vaporization properties.

When camphor is vaporized, it releases a pungent smell that interferes with a mosquito's ability to locate its target through scent. This disruption in the mosquito's olfactory receptors makes it difficult for them to find humans or animals to bite. Additionally, the volatile nature of camphor causes it to evaporate quickly, creating a temporary barrier that keeps mosquitoes away.

Uses

- Used as insects &bud repellent.
- Use it in the diffuse to fumigate the room as the aroma repels viruses & bacteria.
- Provides relief from cold cough, chest congestion, bronchitis & asthma.
- Relieve anxiety &dizziness.

Rose oil[9]

Botanical Name: *Rosa damascene.*

Family: Rosaceae

Color & odor: Deep yellow to brownish red thick liquid with floral, honeylike, intense and sweet odor.

Biological Source: Rose oil is obtained from the petals of difference Rosa species especially Rosa centifolia L. and Rosa damascena Mill.

Chemical constituents: Rose oil has various chemical compounds that include citronellol, phenyl ethanol, nerol, farnesol and stearpoten with traces of nonanol, linalool, phenyl acetaldehyde, citral, carvone, citronellyl acetate, 2phenylmethyl acetate, methyl eugenol, eugenol, rose oxide.

Uses

- Used as flavoring agents and also used as additive to drinks, beverages and yogurt.

- It fights depression.
- Used as astringent.

Sandalwood Powder[17]

Botanical Name: *Santalum album L*.

Species: *S. album*,

Genus: Santalum

Biological Source: powder, also known as Chandan or Sandal Churna, is obtained by boiling the heartwood of the Indian Sandalwood tree.

Chemical Composition: Sandalwood oil contains more than 90% sesquiterpenic alcohols of which 50-60% is the tricyclic α-santalol. β-Santalol comprises 20-25%.

Mechanism: Sandalwood powder acts as a mosquito repellent due to its natural compounds, particularly sesquiterpene alcohols.

These compounds have a strong odor that mosquitoes find unpleasant. When sandalwood powder is applied to the skin or burned, these compounds are released into the air, creating a barrier that deters mosquitoes from approaching. Additionally, sandalwood's aroma may interfere with the mosquito's ability to locate potential hosts, making it less likely for them to bite.

Uses

- Anti-inflammatory properties of sandalwood heal acne, treat minor insect bites and wounds.
- The goodness of natural oils and cooling properties in sandalwood lessen suntan and redness.
- it is known to reduce the skin itching and provide relief.

Bay leaf[13]

Botanical Name: Cinnamomum tamala.

Species: C. tamala,

Genus: Cinnamomum

Biological source: Bay leaf (Laurus nobilis) is an evergreen perennial shrub that belongs to the laurel family (Lauraceae).

Active Ingredients.

Active Ingredients	Mechanism
1. Essential Oils: Eugenol	Eugenol has insect-repelling properties and acts as a natural mosquito repellent. When bay leaves are crushed or burned, these oils are released into the air, creating a scent that mosquitoes find unpleasant.
2. Aromatic Volatiles:	The aromatic compounds in bay leaves evaporate at room temperature, releasing a scent that mosquitoes find unpleasant. This aroma masks the attractants that mosquitoes usually use to locate their hosts, making it harder for them to find and bite humans.
3. Interfering with Scent Receptors:	The strong scent from bay leaves can interfere with the mosquito's scent receptors. This confusion makes it difficult for mosquitoes to identify their prey and reduces their attraction to the area.
4. Mild Smoke:	Burning bay leaves can also produce a mild smoke, which further contributes to keeping mosquitoes away. The smoke disrupts their flight patterns can deter them from approaching the area.

Uses

- Bay leaves are used as an insect repellent in pantries.
- Bay leaf powder is good for diabetes management.
- It helps to improve digestion.

- It helps to treat respiratory conditions.

Jigat /Joss Powder[14]

Common Name: Jigat / incense powder / agarbatti / wood bark.

Synonym: Joss / jigat powder

Biological source: It is a herbal/botanical product made completely from red bark, green bark and leaves of listseaglutinose tree in the central highlands. This plant is mainly found in regions like E.Asia, Southern china, Indian subcontinents, Myanmar, Thailand, Cambodia, Laos, Vietnam, Malaysia, Indonesia, Philippines to Australia. In Karnataka litseachinesissyn. L. glutinosa is found in topical wet green forests of coorg and maland district.

Raw material: Cortex of stalk

Uses

- It is used as binder for making incense sticks, cones and pellets due to its excellent viscosity and adhesive properties which aid continuous burning.
- It is used in the preparation as it has the odour which deter the mosquitoes, thus has the repellent property.

Benzoin[15]

Botanical Name: ***Sumatra benzoin, Loban(Luban), Benzonium, Gum benjiamin, Siam*** **benzoin.**

Biological Source: Benzoin resin is a balsamic resin obtained from the incised stem of *Styrax benzoin, Styrax paralleloneurus*.

Genus: Styrax

Family: Styraceae

Chemical Composition: Generally it contains a mixture of aromatic compounds, including: Benzoic acid, Benzyl benzoate, Coniferyl benzoate, cinnamic acid, Vanillin, Siam benzoin. These compounds contribute to the resin's fragrance and properties.

Mechanism of action: Benzoin acts as a mosquito repellent due to its aromatic compounds that release strong odors.

These odors interfere with the mosquito's ability to locate hosts by disrupting their olfactory receptors. Additionally, benzoin's volatile nature allows it to evaporate quickly, creating a barrier that mosquitoes tend to avoid.

Uses

- Loban, which is a good natural insecticide and an excellent repellent of insects and mosquitoes.
- It helps to reduce stress and improve blood circulation
- It promotes and facilitates urination.
- It provides relief from inflammation in case of measles, rashes.

Guggul[18]

Botanical Name: ***Commiphora weightii, Indian bdellium tree, Scented bdellium, Gum Guggul.***

Biological Source: Gum resin is obtained by incision of the bark of "Commiphora mukul".

Family: Burseraceae

Chemical Constituents: 32% Gum, 1.45% Essential oil, Sterols, Beta sterols, Z-E-guggulsterone, Sugar, Ellagic acid, Amino acids, Myricyl alcohol, Flavonoids, Alpha camphorene.

Mechanism of action: Guggul, a resin derived from the Commiphora weightii tree which contains compounds like guggulsterones that possess insect-repelling property.

These compounds likely interfere with the olfactory receptors of mosquitoes, disrupting their ability to detect human scent and making individuals less attractive to them.

Uses

- Control Cholesterol.
- Helps lose weight.
- Manage Thyroid.
- Regulate Blood Sugar Levels.

OBJECTIVE OF STUDY

Primary Objectives of the study

1. To formulate and develop the poly-herbal mosquito repellent.
2. To evaluate the mosquito repellent using mosquito net cage method.
3. To check the behavior of mosquito by burning mosquito repellent cone.
4. To get feedback by questionnaire method.

S K Sharma. *et al* (1995)., They developed mosquito repellent by using neem oil & evaluated at different conseridation. Therefore neem oil can be applied as a personal protection.[7]

1. Daizy R. Batish. *et al* (2008)., They developed mosquito repellent by using eucalyptus oil & the oil possesses a wide spectrum of biological activity including anti-microbial, fungicidal & can be predominantly used as an insect repellent.[8]
2. Meilinah Hidayat. *et al* (2010)., This article discusses citronella complexes in rose essential oil are powerful in preventing pests like mosquitoes and flies from stinging thebody.[9]
3. L Zhang. *et al* (2010)., They developed charcoal powder as base material and to compare its emission rates with those of several current- market brands and several brands tested in the previous study.[10]

4. M Ferreira Maia. *et al* (2011)., Plant-based repellents will be used for generations in traditional practice as a personal protection measure against host-seeking mosquitoes. Recently, commercial repellent products containing plant-based ingredients have gained increasing popularity among consumers, as these are commonly perceived as "safe" in comparison to long-established synthetic repellents although this is sometimes a misconception. To date insufficient studies have followed standard WHO pesticide evaluation scheme guidelines for repellent testing.[11]
5. MSN Ranasinghe. *et al* (2016)., The present study will be conducted to determine the mosquito repellent activities of some selected plant materials in order to obtain safe andefficient herbal mosquito repellent.[12]
6. Saima Batool. *et al*(2020)., They prepared this by using bay leaf essential oil which traditionally has been used as an antibacterial and insect repellent.[13]
7. Ismalia Husna. *et al* (2020)., They developed tulsi the mosquito repellent to determine the most effective concentration of extract that kills the mosquito.[14]
8. Aditi Bahadur. *et al* (2020)., They developed mosquito repellent by using benzoin. The incense sticks when ignited releases vapours with a pleasant fragrance and herbs which repels the mosquito.[15]
9. B Aditi. *et al* (2020)., This article discusses the powdered blend was mixed with binders and additives like joss powder, charcoal powder. The solid formulation was rolled in the form of incense sticks. Further to add value, it was later scented with essential oil like rose oil and dried.[16]
10. Prabhat Desai. *et al*(2023)., This article discusses about the effective method for personal protection against mosquito bites that are contagious & carry the risk of transmission of mosquito borne pathogens like plasmodia. Many home remedies of unknown efficacy also widely used.[17]
11. Sheethal Bhat. *et al* (2023)., They developed when burn it releases a lively fragrance which makes it unbearable for mosquitoes and bugs in it surrounding, making it extremely effective to ward them off.[18]

MATERIAL AND METHOD

The present investigation on “mosquito repellent by using poly herbs” was carried out in the urban area of the Bengaluru, Karnataka during 2023. The details of the experimental material used and techniques adopted in the investigation are presented in this chapter.

Geographical Location and Climate

Bengaluru is located in northern dry zone (KA-03) of Karnataka. It is positioned in 12.16˚N land 77.46˚E longitudinal, at an altitude of 920m from mean sea level. Its average rainfall of Bengaluru is 970mm.

Material used in experiment

Neem, Eucalyptus, Tulsi, Bay leaves, Sandalwood powder, Joss powder, Rose petals, Rose oil, Benzoin, Charcoal, Camphor.

Equipments: Mortar pestle, sieve, mixer and jar, hot air oven, spatula,moulds, petri dish.

Source of Data

- Review articles from journals.
- Published research papers.
- Electronic data (internet).
- Library of Vydehi Institute of Pharmacy, Bengaluru.
- Ingredients are collected from the local areas of urban area of EthnoMedicinal Garden, Yelahanka, Bengaluru.
- Authentication received by Dr. Lakshmayya (Principal), Department of Pharmacognosy, Vydehi Institute of Pharmacy, Bengaluru.

Preparation of Mosquito Repellent

Table 01: Formula:100gms of Polyherbal dough for 35 cones.

By Using Rose Oil:

Ingredients	Working Formula
1.Neem	5gms
2.Eucalyptus	10gms
3.tulsi	5gms
4.Bay leaves	5gms
5.Rose petals	10gms
6.Rose oils	5ml
7.Joss Powder	5gms
8.Benzion	5gms
9.Charcoal	45gms
10.Camphor	5gms

Table 02: By Using Sandalwood Powder.

Ingredients	Working Formula
1.Neem 2.Eucalyptus 3.Tulsi 4.Bay leaves 5.Rose petals 6.Sandalwood Powder 7.Joss Powder 8.Benzion 9.Charcoal 10.Camphor	5gms 10gms 5gms 5gms 10gms 5gms 5gms 5gms 45gms 5gms
1.Neem 2.Eucalyptus 3.Tulsi 4.Bay leaves 5.Rose petals 6.Sandalwood Powder 7.Joss Powder 8.Benzion 9.Charcoal 10.Camphor	5gms 10gms 5gms 5gms 10gms 5gms 5gms 5gms 45gms 5gms

Table 03: Ingredients and their uses.

Ingredients	Uses
1. Neem, Tulsi, Eucalyptus, Bay leaves, Rose petals	Active ingredients with insectrepellent activity.
2. Rose oil,Sandalwood powder	Fragrance
3. Charcoal,joss powder &Benzoin	Igniting agent,Binders &Fuming agent

Process

- All the dried herbs were finely powdered in a mixer and then passed through a sieve (mesh no.80). The powder must be very fine or else problems would arise in binding and burning.

- Water was added gradually to the fine powder until it attains dough like consistency. Mixer should not be too watery.
- The dough was then divided into portion and will be molded using the molds. This process is carried out in machines in large scale production.
- The cones were kept to dry for about 24 hours under shade.
- The dried cones were then scented with rose oil for the fragrance. The oil was also sprinkled while mixing the powders.
- Cones were finally packed in a suitable packaging container.

Some standard evaluation methods for poly herbal mosquito repellent[19]

Mosquito repellent

For creams, sprays and roll on	For cones, coils and agarbatti
1. Screened Cage Test	1.Net cage method
2. Cone test	2.Questionnaire method
3. Excito chamber test	3.Behavioral method
4. Physicochemical parameters	4.Ash value
5. Skin sensitivity	5.Carbon emission test

Methods of development of mosquito repellent cones

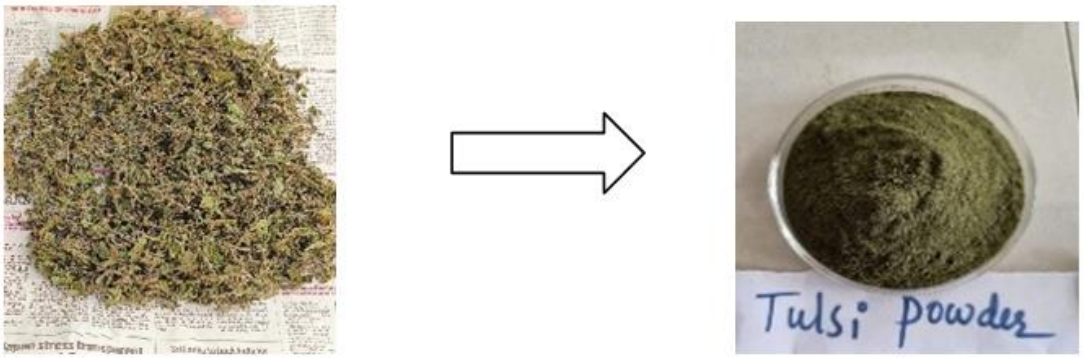
Neem

Preparation of Neem Powder.

Eucalyptus

Preparation of Eucalyptus Powder.

Tulsi



Preparation of Tulsi Powder.

Bay leaf

Preparation of Bay Leaves Powder.

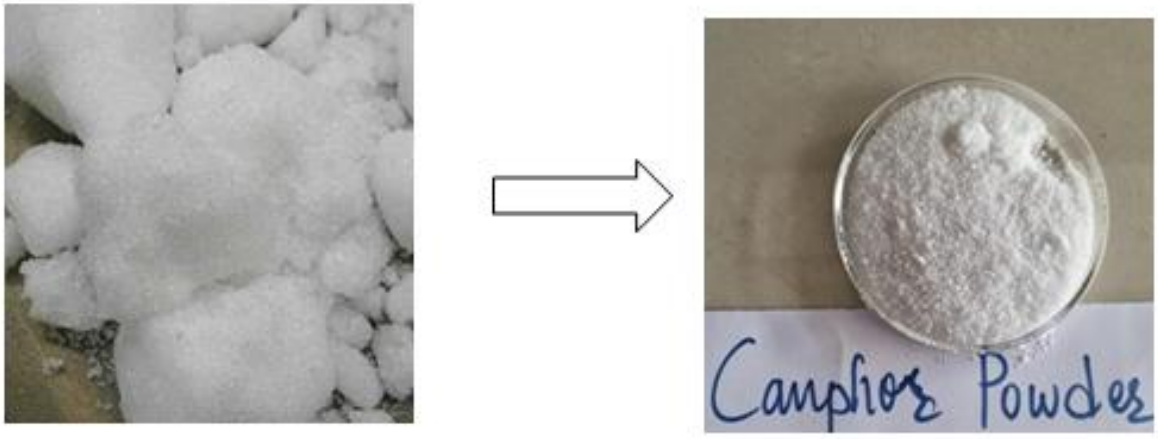
Rose petals

Preparation of Rose Petals Powder.

Benzoin

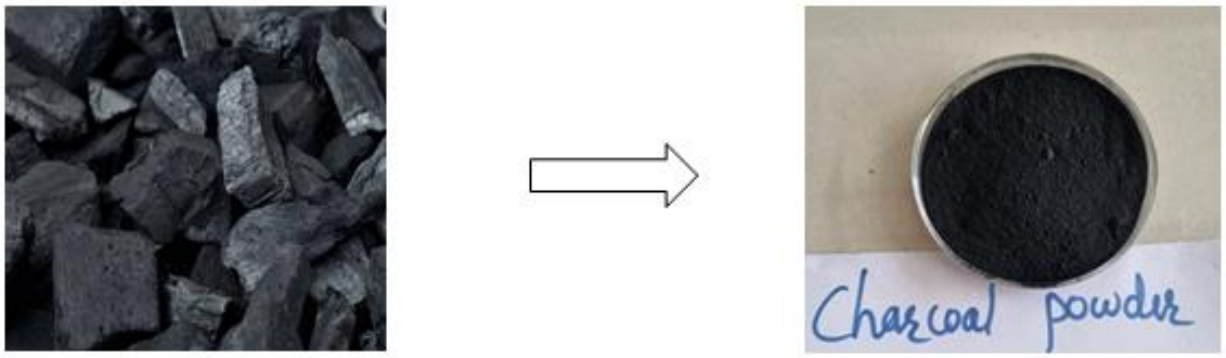
Preparation of Benzoin Powder.

Camphor

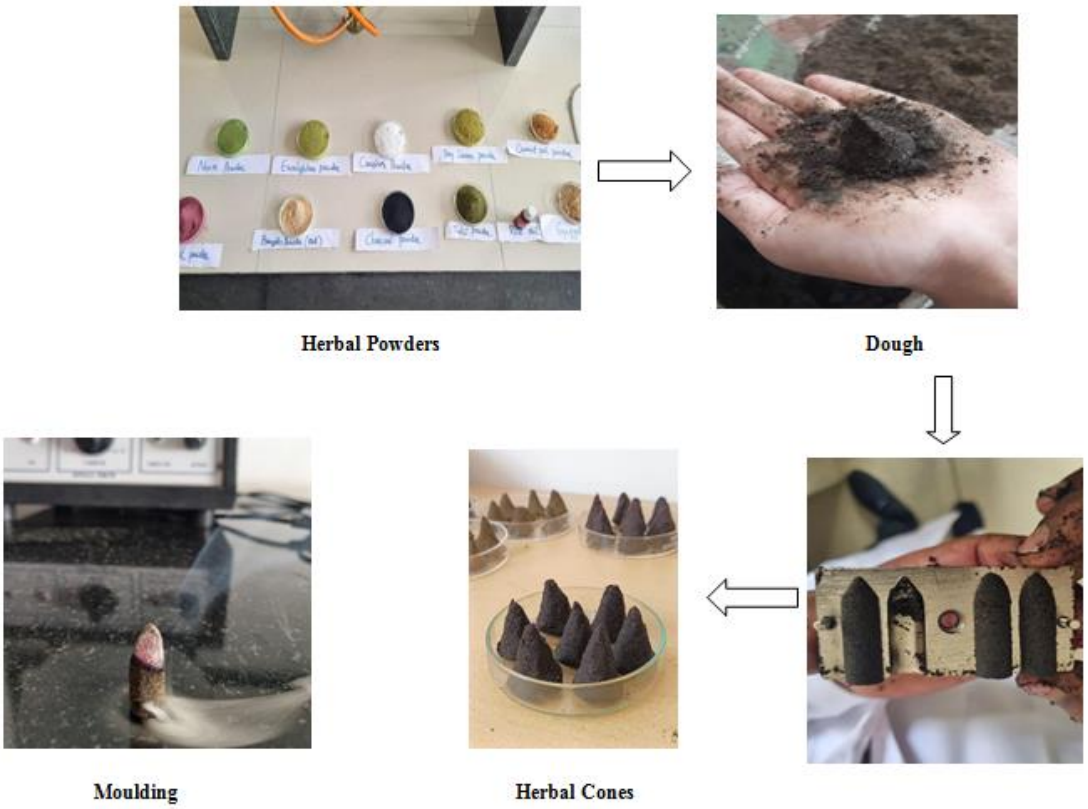


Preparation of Camphor Powder.

Charcoal



Preparation of Charcoal Powder.



Development of Polyherbal Mosquito Repellent Cones.

EVALUATION PARAMETERS[20,21]

1. Net cage method

The mosquitoes used in this experiment were caught by big plastic cover and transferred carefully in the net cage. About 35 mosquitoes are transferred in the net cage between 7pm to 8pm, since most of the mosquitoes bite at that time. The 2 full mosquito repellent cones were burned in the room and the mosquito net cage is kept at the centre of the room and duration

of exposure is 1hour. The behaviour of the mosquito was assayed. The behaviour of the mosquitoes were given below.

Mosquito net cage with mosquitoes.

Mosquitoes with no movement.

2. Questionnaire method

The developed cones were distributed among the teachers and other staffs (total 20 members), for questionnaire method. They were asked to observe the burning time, odour of the cones, effectiveness of cones against the mosquitoes, and if any side effects present. Later, the feedback from them were received and the ratings from 1-5 were recorded.

Table 04: Behaviour of the mosquitoes when cones are burned.

Behaviour of the mosquitoes	7pm to 7:15pm	7:15pm to 7:30pm	7:30pm to 7:45pm
Mosquitoes freely moving in the net	20	8	0
No. of mosquitoes aligned in the net	15	6	2
Mosquitoes struggling for life	5	12	1
No movement and lying on the floor	-	14	37

The mosquitoes net cage method was used to assess the behaviour of the mosquitoes when the cones are burned near the cage about one hour.[22] Around two cones were burned near the cage from 7pm to 8pm. The results are given in the table 04. And the mosquitoes are with no movement are lying on the floor number noted every 15mins, first second and third interval result shows 0, 14, 37 respectively, whereas 3 mosquitoes aligned on the net after 1hour. The figure 2 shows that mosquitoes with no movement after 1 hour of exposure.[23]

Feedback of mosquito repellent cones taken from 20 people and asked to evaluate the formulation. The feedback results are given in the table 05.

Table 05: Individual report: By Questionnaire Method from 20 peoples.

Ratings: Excellent- 5, Good- 4, Average- 3-2, Poor- 1

Individuals	Odour	Repellence activity	Allergic issues	Product elegance	Rating from 1-5
1	Good	Good	No	Good	4
2	Good	Excellent	No	Good	4
3	Average	Good	No	Excellent	3
4	Excellent	Excellent	No	Good	5
5	Good	Good	No	Good	3
6	Excellent	Excellent	No	Excellent	5
7	Excellent	Excellent	No	Good	5
8	Good	Average	No	Good	3
9	Good	Excellent	No	Excellent	4
10	Average	Good	No	Excellent	3
11	Excellent	Excellent	No	Good	5
12	Excellent	Excellent	No	Excellent	5
13	Excellent	Excellent	No	Good	5
14	Good	Good	No	Excellent	4
15	Excellent	Excellent	No	Excellent	5
16	Good	Excellent	No	Excellent	4
17	Good	Excellent	No	Good	4
18	Excellent	Good	No	Excellent	5
19	Good	Excellent	No	Excellent	5
20	Excellent	Good	No	Good	4

Table 06: Overall Feedback Rating by questionnaire method from 20 people.

Parameters	Excellent	Good	Average	Poor
Product elegance	10	10	_	_
Repellence Activity	12	7	1	_
Odour	9	9	2	_
Allergic issue	_	_	_	_
Ratings (1-5)	9(5)	7(4)	4(3)	_

The questionnaire method was used to assess the feedback about the effectiveness against mosquitoes, burning time, odour of the developed coned and the ratings are recorded. The results are recorded in the above table 05, and overall feedback ratings from 1-5 are recorded in the above table 06.[24,25]

CONCLUSION

A thorough survey was carried out after formulation of the mosquito repellent cones. Plants having mosquito repellent activity like camphor, benzoin, neem, eucalyptus, tulsi, bay leaves, rose petals, rose oil, sandalwood powder were selected, powdered and made repellent cones by adding binders (charcoal, joss powder) and dried under shade. The repellent cones are

subjected for evaluation by using net cage method and questionnaire method and the results were satisfactory in repelling the mosquitoes. The feed back of the product were also satisfactory. Ovreall the product is safe to use and have significant mosquito repellent activity.

REFERENCES

1. Herbs –Wikipedia,-https://en.wikipedia.org/wiki/Herb.
2. Ranasinghe MS, Arambewela L, Samarasinghe S. Development of herbal mosquito repellent formulation. Int J. Pharm. Sci. Res., 2016, 1; 7(9): 3643 – 48.
3. Ponkiya N, Desai S, Mistry J, Patel S, Ingalhalli R. Developmentof economical mosquito repellent using marigold plant. International Journal for Research Trends and Innovation, 2018; 3(11): 2456-3315.
4. Bhide MS, More BH. Gajare SP, Tembhurne SV. Development of mosquito repellent formulations and evaluation for its activity. World Journal of Pharmaceutical Research. 2014, 10; 3(2): 2910-2917.
5. Sing Y, Gupta A, Kannojia P. *Tagetes erecta* (Marigold)-a reviewon its phytochemical and medicinal properties. Curr. Med. Drugs Res., 2020; 4(1): 1-6.
6. Ojewumi M.E., Banjo M.G., Oresegun M.O., Ogunbiyi T.A., Ayoola A.A., Awolu O. O., Ojewumi E. O. Analytical investigation of the extract of lemon grass leaves in repelling mosquito. International Journal of Pharmaceutical Sciences and Research, 2017, 1; 8(5): 2320-5148.
7. S K Sharma, V.K. Dua, V P. Sharma : Field studies on the mosquito repellent action of neem oil. Southeast Asia Journal, 1995 Mar; 26(1): 180-182.
8. Daizy R. Batish, Harminder Pal Singh, Ravinder Kumar Kohli, Shalinder Kaur.: Euclyptus Essential oil as a Natural pesticide. Forest Ecology and Management, 2008 Dec; 21662174.
9. Meilinah Hidayat, Rosnaeni R, Katrin Fitria, Hendranata.: Field study of repellent activity or effects of rose oil in the mosquito. Journal Medica Planata, April 1 2010; 65-67.
10. Zhang L, Jiang Z, Tong J, Wang Z, Han Z, Zhang J. Using charcoal asbase material reduces mosquito coil emissions of toxins. Indoor air, 2010 Apr; 20(2): 176-184.
11. M. Ferreira Maia, Moore S. J. Plant-based insect repellents a review of their efficacy, development and testing. Journal of University of Oxford. 15 Mar 2011; 34-35.

12. M. S. N. Ranasinghe, L. Arambewela and S. Samarasinghe: Development of herbal mosquito repellent formulations. International Journal of Pharmaceutical Sciences and Research., 14 July 2016; 9: 3643-3648.
13. Saima Batool, Rasheed Ahmed Khera, Muhammad Asif Hanif, Muhammad Adnan Ayub Field Studies of bay leaf on mosquito repellent. Medicinal Plants of South Asia, Sep. 2020; 63-74.
14. Ismalia Husna, Endah Setyaningrum, Tundjung Tripeni Handayani, Yogi Kurnia : A case study of basil leaf extract as an antirepellent on mosquitoes. Journal of Physics Conference Series, March 2020; 1467(1).
15. Aditi Bahadur, KS Chandrashekar, Vasudev Pai : Formulation And Development of Polyherbal Mosquito Repellent Incense Sticks. Research Journal of Pharmacy and technology., 2020; 13(1): 124-128.
16. Bahadur A, Chandrashekar K.S, Pai V. Formulation and developmentof polyherbal mosquito repellent incense sticks. Research Journal of Pharmacy and Technology, 2020; 13(1): 124-128.
17. Probhat Dessai, Harsha Pangam : Field study of repellent activity oreffects of sandalwood Powder. Research Journal of Pharmacy and Technology, 2023; 16(6): 2941-2944.
18. Sheethal Bhat, Hariprasad Shetty Formulation and evaluation of herbal mosquito repellent in two forms used in folklore practise. Journalof Ayurveda and Integrated Medical Sciences. March 2023; Vol.8, Issue 3.
19. Barnard DR, Bernier UR, Xue R, Debboun M. Standard methods for testing mosquito repellents. Insect Repellents Principles Methods, Uses; Debboun, M., Frances, SP, Strickman, D., 2006 Oct 1; 103-110.
20. KIM JK, KANG CS, LEE JK, KIM YR, HAN HY, YUN HK. Evaluation of repellency effect of two natural aroma mosquito repellent compounds, citronella and citronellal. Entomological Research, 2005 Jun; 35(2): 117-120.
21. Maia MF, Moore SJ. Plant-based insect repellents: a review of their efficacy, development and testing. Malaria journal, 2011 Dec; 10(1): 1-15.
22. Pichersky E, Gershenzon J: The formation and function of plant volatiles: perfumes for pollinator attraction and defense. Cur OpinionPlant Biology, 2002; 5: 237-243.
23. Adeogun AO., Adewuyi GO., Etatuvie SO., Fawehinmi A.B., Lawal HO. Bioassay of Herbal Mosquito Repellent Formulated from the Essential Oil of Plants. 2012; 5: 109-115.

24. Hindustan AA, Kishor KR, Chitta SK, Krishna PU, Ravindra BV, Chandra SK, Anil KG, Vamsi MG. Formulation and Evaluation of Home Made Poly Herbal Liquids Mosquito Repellent. JITPS, 1(2): 98- 105.
25. Chen SC, Wong RH, Shiu LJ, Chiou MC, Lee H. : Exposure tomosquito coil smoke may be a risk factor for lung cancer in Taiwan. *J. Epidemiology*., 2008; 18(1): 19-25.