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Research Article

Formulation And Evaluation Of Mosquitoes Repellent Candles

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ABSTRACT

With the number of diseases spread by mosquitoes on the rise, mosquito control is becoming increasingly important. With the correct equipment and a little work, mosquitoes must be eradicated. Applying a chemical to the skin, clothing, or other surfaces that deters mosquitoes (and other arthropods) from landing or climbing on them is known as a mosquito repellent. One efficient strategy to stop the transmission of diseases carried by vectors is to decrease the quantity of host-vector contacts. Nowadays, the majority of commercially available formulations for human protection against mosquitoes and other bloodsucking arthropods contain only a few active components. Insect repellents often contain DEET (N,N-Diethyl-meta-toluamide) as an active component. Unfounded concerns about potential DEET adverse effects have led to a significant industry for "natural" DEET-free repellents using a range of active components. Mosquito repellents including picaridin, IR 3535, and a wide variety of essential oils, such lemongrass and eucalyptus, are available as sprays, lotions, and wearable devices. By lessening the attraction of individuality to mosquitoes, repellents lessen the likelihood that they may smell humans. The Environmental Protection Agency (EPA) states that when used properly, natural oil painting- based insect repellents are safe for adults and children over the age of two months

INTRODUCTION

Repellents for mosquitoes can be a useful way to protect yourself against bothersome mosquito bites that could potentially spread diseases including the Zika virus, chikungunya virus, dengue virus, and plasmodia. There are currently many commercially accessible products on the

market; some are quite effective, while others are ineffective. In impoverished nations, access to efficacious repellent products is sometimes restricted. Individuals who are at a heightened risk of contracting diseases transmitted by vectors frequently lack or have inadequate self-defence mechanisms. Mosquito repellent is a common

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home remedy and traditional practice used by people worldwide. While some of these cures, like DEET, are pricey and hard to find, others are probably very effective. Furthermore, certain tried-and-true strategies—like using mosquito nets—are not routinely employed by community members because they are impractical in some circumstances[1]. The traditional usage of local plants as insect repellents has been the subject of several ethnobotanical research initiatives. The public contacted us with information regarding additional personal hygiene items that are utilised as mosquito repellents, and these findings were extensively covered by the media. Mosquitoes come in around 3500 different species, and they are found in tropical and subtropical regions. The primary mosquito species that act as vectors for a wide range of diseases are Anopheles (filariasis, malaria), Culex (Japanese encephalitis, West Nile, chikungunya), and Aedes (chikungunya, dengue fever, and unheroic fever) given fig.



Night or day, mosquitoes are annoying. When the weather becomes colder, they start looking for warm spots because they live outside all the time. Mosquito season typically begins in the summer and lasts until autumn. There's more to mosquito sucking than just irritation or itching. It can cause illness and, in extreme circumstances, even lead to death. Mosquito repellent actually doesn't kill mosquitoes. The way that mosquito repellents work is as follows: Warm-blooded animals'

perspiration contains lactic acid, carbon dioxide, and other waste products that attract female mosquitoes. Mosquito antennae include chemoreceptors, which are responsible for detecting odours. Repellants prevent mosquitoes from flying upwind by blocking their lactic acid receptors, which causes the mosquitoes to lose contact with their host. Typically, insect repellents function by disguising human odours or by employing scents that insects steer clear of by nature. In actuality, permethrin is a contact pesticide, which makes it unique. Using a natural repellent that can make you appear unappealing to mosquitoes is acceptable.

METHODS OF MOSQUITOES CONTROL[2]

Mosquito-borne diseases affect millions of people worldwide each year. The bite of a mosquito can result in anything from skin irritation to contracting malaria. Clearly, mosquitoes are not just a nuisance, but also potentially harmful. By taking measures such as wearing long pants in wooded areas or disposing of standing water, you can minimise the chances of attracting mosquitoes. These measures, however, are often not enough, and specialty products like mosquito repellent used to combat mosquitoes are required. Each of the products used for mosquito control have varying degrees of effectiveness, and it is important to know that some may be better than others.

MECHANISM OF ACTION OF MOSQUITOES REPELLENT[2-3]

Warm-blooded animals' perspiration contains lactic acid, carbon dioxide, and other waste products that attract female mosquitoes. Mosquitoes perceive odours through chemoreceptors located in their antennae. Repellants prevent mosquitoes from flying upwind by blocking their lactic acid receptors, which causes the mosquitoes to lose contact with their host. Typically, insect repellents function by

disguising human odours or by employing scents that insects steer clear of by nature. In actuality, permethrin is a contact pesticide, which makes it unique.

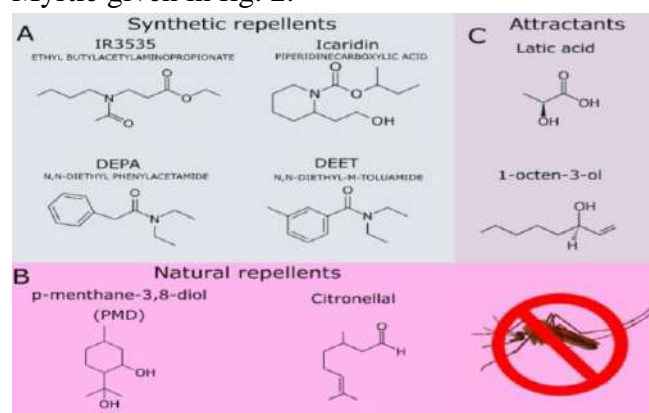
TYPES OF MOSQUITOES REPELLENT

1. CHEMICAL METHOD –

Mosquitoes can be repelled by a variety of natural and synthetic repellents. The most powerful repellent is DEET, a synthetic molecule. It is essentially a toxin that covers up the body's natural odour and carbon monoxide emissions.

A. Synthetic repellents

Comparative studies showed that IR3535 (3-[N-Butyl-N-acetyl]-aminopropionic acid, ethyl ester) was just as effective as DEET in repelling mosquitoes and that it also lasted longer than "natural" repellents. But some repellents made of plants might also work well to relieve the problem. Since essential oils might evaporate entirely, their function as repellents can be fleeting. Exposure to DEET increased the risk of sleeplessness, mood swings, and cognitive decline. DEET (N,N-diethyl-m-toluamide), Icaridin, often called picaridin, Bayrepel, and KBR 3023 Nepetalactone, sometimes called "catnip oil," are a few examples. IR3535 (3-[N-Butyl-N-acetyl]-aminopropionic acid, ethyl ester) Permethrin, Bog Myrtle given in fig. 2.



Advantages of Synthetic repellents

Synthetic repellents containing DEET or picaridin are more effective than repellents with "natural"

active ingredients. All the synthetics gave almost 100% [3-4] repellency for the first 2 hours, where the natural repellent products were most effective for the first 30 to 60 minutes, and required reapplication to be effective over several hours.

Disadvantages of Synthetic repellents

cause rashes, swelling, eye irritation, and worse problems, though they're unusual including brain swelling in children, anaphylactic shock, low blood pressure, and one report of death. DEET must be used with caution, especially with children. It has been known to cause dizziness and can severely irritate the skin. DEET may even cause cancer and defect in child birth. For these reasons, many people choose to use a natural mosquito repellent like a citronella spray. Citronella has active ingredients that repel mosquitoes and for some, the lemon smell is very appealing. It is fine to use a natural repellent which can make you unattractive in the eyes of mosquitoes. Dermatologists advise some plant oils such as Citronella Oil, Eucalyptus Oil, and Lavendula which can fluently repel mosquitoes.

B. Natural repellents[5]

These days, repellents are readily available and effective at keeping mosquitoes away, but they are bad for your health since they contain the toxic chemical DEET. Using a natural repellent that can make you appear unappealing to mosquitoes is acceptable. In the United States, citronella oil-infused candles that repel mosquitoes are commercially available given in fig. 3.



Advantages: non-sticky;

non-toxic and environmentally friendly; safer on sensitive skins and some can be used on children as young as 3 months; reduced irritation; harmless to most plastics and fabrics.

Disadvantages more expensive;

may need more frequent reapplication to maintain full protection Essential oil repellents can be short-lived in their effectiveness, since essential oils can evaporate completely may need more frequent reapplication to maintain full protection Cannot apply directly on the skin, if applied can cause rashes on skin.

Insect repellents from natural sources

There are numerous naturally occurring preparations that deter specific insects. While some of these are merely repellents, others function as insecticides. Basil Ocimum , Castor oil (Ricinus communis), Catnip oil (Nepeta species) (nepetalactone against mosquitos), Cedar oil (mosquitos, moths), Celery extract (Apium), Cinnamon oil (leaf oil kills mosquito larvae), Citronella oil (repels mosquitos), Clove oil (mosquitos) (NB: a dose similar to the one as a food ingredient should be used for the time being),

Eucalyptus oil (70%+ eucalyptol), (cineol is a synonym), (mosquitos,) Fennel oil (Foeniculum vulgare) (mosquitos), Garlic (Allium) (rice weevil, wheat flour beetle) (NB: a dose similar to the one as a food ingredient should be used for the time being), Geranium oil (also known as Pelargonium [6]. Lavender (repels insects) ,Lemon eucalyptus (Corymbia) essential oil and its active ingredient p-menthane-3,8-diol (PMD) ,Lemongrass oil (Cymbopogon species) (mosquitos) ,Neem oil (Azadirachta indica) (Repels or kills mosquitoes, their larvae and a plethora of other insects including those in agriculture) ,Peppermint oil (Mentha x piperita) (mosquitos) ,Rosemary (Rosmarinus) (mosquitos) ,Solanum berry juice (against Stegomyia aegypti(mosquitoes), Nepetalactone, also known as "catnip oil".

Preparations of repellent compounds –

Besides being used in their natural state or ‘straight’, repellents have been very commonly embodied in lotions, creams, pastes or other preparations, either to facilitate their application or to ensure a more lasting effect. The following are the chief forms such preparations take.

Sr. No.	Compound Name	Preparation
1	Lotions	Mixtures containing the repellent dissolved in or diluted with alcohol or other thin fluid, or thickened with castor oil or arachis oil.

2	Creams (ointment type)	Admixtures of the repellent with some solid greasy base such as hard and soft paraffin, petroleum jelly, cetyl alcohol, lanolin, magnesium stearate with or without modifying materials. Early repellent creams were mostly of this type.
3	Creams (vanishing cream type)	Essentially oil in water emulsions which 'disappear' on application seem to be absorbed by the skin, largely due to evaporation of the watery phase during manipulation. The chief requirements are an oily or greasy base, an emulsifier such as triethanolamine, triton X, etc. and water.
4	Creams (waxy base type)	Mixtures of the repellent with wax and such solvent (which may be the repellent itself) as is necessary to give a correct consistency.
5	Gum tragacanth preparations	Various creams or pastes of gum tragacanth have been employed as vehicles, especially for pyrethrum. They dry leaving a thin adherent film which is not dislodged by sweating. Such preparations would be unsuitable for repellents of these preparations; creams of the ointment type have frequently been noted as greasy and unpleasant in a hot climate though some, e.g. the stearate cream given as an example under this head, are cosmetically excellent. The use of paraffin as a base as has been common in citronella preparations appears to have a reducing effect on repellency. Vanishing creams have not generally been found satisfactory. O

2. Non-chemical methods[6-7]

Physical method

Emptying the stagnant water in rain gutters, Old tires, buckets, plastic covers, etc. you Must regularly change the water in bird Baths, fountains, pools, rain barrels etc at Least once in a week. Protecting yourself With full sleeved clothing is also highly essential particularly during the dawn and Dusk times. Repair your windows or door Screens to prevent mosquito entry.

Mosquito Net

Mosquito nets are thought to offer superior mosquito protection compared to coils and other potentially harmful repellents. You can ensure your protection from insects by sleeping beneath

mosquito netting. These days, medicated mosquito nets are seen to be the best option given in fig.4.



Medicated Net

K-O tablets (25% deltamethrin) could be used to medicate mosquito nets that are currently in use. According to Vasanth of Sumangala Agro Supplies, one pill needs to be combined with one litre of water. After soaking the net in this mixture for ten minutes, it should be dried on the ground in a cool place. The medication has an approximately

six-month duration of impact[8].The tablet repels mosquitoes and contains 25% deltamethrin. In a similar way, window meshes could potentially be medicated. The World Health Organisation had certified medicated nets as being safer than coils and liquidators. Since the user does not breathe in the chemical residue, K-O tablets are safe. The residue simply stays on the net. chemical inhalation from coils.

Non Medicated Net

Mosquito netting is a protective covering that prevents mosquitoes and other insects from biting you. There are different shapes and sizes of mosquito netting, and they also come in different materials such as cotton, polyester, and polyamide. Each style of net has its advantages, and ensuring that you are using the most suitable one increases your chances of eliminating mosquitoes. It is crucial to find a net that has a mesh size large enough to allow air to circulate, but small enough to keep the mosquitoes out. Mosquito nets can be used to cover small and large areas such as your bed or your porch. Mosquito nets are an effective way to naturally combat mosquitoes.

Mosquito Traps

Female mosquitoes are drawn in and trapped by mosquito traps. The trap imitates many mosquito attractants, including body heat, human odours, and carbon dioxide breathed. The insect advances, drawn in by these compounds, and is drawn in by an impeller fan. After that, it sticks to a sticky part of the apparatus and eventually gets electrocuted. Mosquito traps are a safe, chemical-free way to keep mosquitoes away. They run on electricity or propane given in fig.5.



Mechanical methods[8-9]

It is also found that yellow light attracts mosquitoes less than white lights.

Electric mosquito zapper –

An electric zapper works by using ultraviolet light to lure in bugs and then kills them upon contact with its lethal dose of electrical charge given below in fig.6



Mosquito Magnet –

The Mosquito Magnet mimics mammals by giving off carbon dioxide, heat and moisture. Once the mosquito gets too close to the magnet, it is sucked in and eventually dies of dehydration these are combined with an attractant called octenol which is a natural plant pheromone. As an advantage, the Mosquito Magnet not only captures mosquitoes, but will also kill biting midges, black flies, and sand flies[10]. It vacuums the insects into a net where they dehydrate and die. The mosquito magnet works by releasing a carbon dioxide spray, heat and moisture. Insect repellents help prevent and control the outbreak of insect-borne diseases such as malaria, Lyme disease, Dengue fever, Bubonic plague, and West Nile fever. Pest animals commonly serving as vectors for disease include the insect's flea, fly, and mosquito; and the arachnid tick given in fig.7.



MATERIALS AND METHODS[11-12]

Samples collection and preparation

1. LEMONGRASS EXTRACT

For this, fresh lemongrass leaves are used. Ethanol served as the study's solvent. To lower the moisture level, leaves were cleaned and dried in an oven for eight hours. To protect them from the sun, the dried lemongrass leaves were stored in a sealed bag. The dried lemongrass leaves were then chopped into smaller pieces using a knife.

Experimental method

The Soxhlet extractor was used to carry out the experiment. A weighing balance was used to weigh 100g of lemongrass samples with a 0.5 cm particle size. After the material was weighed and placed in an extractor thimble, 300 millilitres of ethanol were poured to the flask. The boiling point of the solvent was used to set the heating mantle at a fixed temperature of 78oC° given in fig. 8.

2. MARIGOLDS LEAVES EXTRACT







Researchers hope to employ marigold plant parts as appropriate parts for the mosquito coil, incense stick, and candle that will be made. It repels mosquitoes without harming the environment and doesn't include any dangerous chemicals like other commercial treatments. It has a distinct odour that many insects find repulsive. "A-terthienyl" is the chemical responsible for the odour. It gives marigold a built-in insecticidal quality. Also, it has pyrethrin, a naturally occurring substance that effectively kills mosquitoes.

3. BEESWAX

A naturally occurring biological polymer, beeswax is made up of a variety of inexpensive, non-toxic ingredients, such as alcohols, acids, and fatty acid esters. Furthermore, it is a stable and water-repellent material from a chemical perspective[13].A highly crystalline natural product, beeswax finds applications in the food, cosmetics, and medicinal industries. It is also widely utilised in the process of making medication formulations with controlled release.It is a natural pesticide that is also present in candles that ward off mosquitoes.

Formulation Table

Sr. No	Ingredients	Quantity
1	Beeswax 	800ml
2	Lemongrass extract	2ml

		
3	<p>Marigold Leaves extract</p> 	2ml
4	<p>Coconut Oil</p> 	3ml
5	<p>Camphor Oil</p> 	4 ml
6	<p>Perfume</p> 	q.s
7	<p>Rose water</p> 	2ml

PROCEDURE

1. Take a beeswax and Weigh the beeswax accurately.
2. Cut the beeswax in small cuts and Melt the beeswax in a beaker with the help of a heating mantle.
3. After the properly melting Start combining the Lemongrass extract & marigold leaves extract in a beaker.
4. After adding the extract then Start the mechanical stirrer slowly.
5. Then add the camphor oil for antimicrobial activity.
6. After adding all ingredients including coconut oil , Keep stirring for up to 15 minutes.
7. Add rose water and perfume for fragrance.
8. Pour the above mixture in a suitable size mould.

9. Allow the mould to be cooled at room temperature.
10. After 3-5 hours remove the candle from the mould.



11. The formulation of mosquito repellent candles were given in Fig.9



EVALUATION OF MOSQUITOES REPLENT CANDLES[13-15]

1. Uniformity of mass:

Ten candles of each group were selected at random and weighed individually. The weight of the individual group was noted. Average weight was calculated, and the individual weights were compared with the average weight.

2. Organoleptic test of repellent candles:

This test was done visualising the formulation to evaluate the texture, colour and scent.

3. Melting point of repulsive candles:

The melting point was determined by the maximum temperature that allowed the changing of state of the candle. For this, small quantities of candles were put in a capillary tube and immersed in the disintegrator. The temperature was set at 50°C. Temperature was increased until a change in state was observed and the temperature noted.

4. Flame test of repulsive candles:

The wick was lighted to appreciate the behaviour, colour, residue and stability of the flame

5. Burning rate (BR) of candles:

For this test, initial mass of candle (M1) and the time of lighting (T1) were noted. Once the candle stops burning the time (T2) and mass (M2) were once again noted. The time of burning was T2 – T1 in hours and the mass burnt was M2 – M1 in

grams. The burning rate was calculated according to the follow formula $(M2-M1/T2-T1)$ In grams per hour[16-17].

6. Field candle mosquito repellent test:

The repellent tests were conducted in October 2021 (rainy month) from 6 to 9 pm during 3 days. 10 The site was selected based on the high density and large diversity of mosquitoes species previously prospected around the place. The average temperature of the site during the experiments ranged from 26 to 28°C with relative humidity fluctuating from 68 to 72 %. To start the test, three volunteers (2 males and 1 female) were selected and were therefore fully informed of the nature and purposes of the test. The legs and arms of each volunteer were used as the test areas. Before each trial, the exposed body parts of each volunteer were cleaned with distilled water and volunteers avoided applying any perfume or fragrance products during the whole test period[18-20]. For test design, 4 tests and control candles were lighted and placed all at a distance of 1 m for the first trial, 2 m for the second trial and 3 m for the third trial around each volunteer. Between each test set and control, a distance of 10 m from each other was maintained and the volunteers rotated their positions during the repetitions. Each test and control were done for 20

minutes with a 5 minutes break for the three replicates. Thus, mosquitoes biting, probing, and landing on volunteers were recorded. Mean totals were converted to percentage of repellency following the equation below: Repellency rate (%) = $[1 - \text{number of mosquitoes recorded in the test} / \text{number of mosquitoes recorded in the control}] \times 100$.

CONCLUSION

According to the study on mosquito repellent methods reviewed above, natural repellents work best when compared to synthetic ones. However, because natural repellents can evaporate completely, they may need to be reapplied more frequently to maintain full protection. This can be avoided by creating different dosage forms of volatile oil, such as creams, ointments, and lotions, using different water-removable bases given in fig.10.



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CONFLICTS OF INTEREST :

The authors declare no conflict of interest

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