

A REVIEW ON: MOSQUITO REPELLENT METHODS

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ABSTRACT

Control of mosquitoes is something of utmost importance in the present day with rising number of mosquito borne illnesses. Deforestation and industrialized farming are also two of the factors causing an alarming increase in the range of mosquitoes. Specialty products like mosquito repellent used to combat mosquitoes are required. Each of the products used for mosquito control have varying degrees of effectiveness. Carbon dioxide and lactic acid present in sweat in warm- blooded animals act as an attractive substance for mosquitoes. The perception of the odor is through chemo-receptors present in the antennae of mosquitoes. Insect repellents work by masking human scent; a number of natural and chemical mosquito repellents were studied in this review that work to repel mosquitoes. Chemical mosquito repellents has a remarkable safety profile, but they are toxicity against the skin & nervous system like rashes, swelling, eye irritation, and worse problems, though unusual -- including brain swelling in children, anaphylactic shock, and low blood pressure. Hence it was concluded that natural mosquito repellents were preferred over chemical mosquito repellents.

Key words: Mosquito repellents, chemo-receptors, mosquito borne illnesses.

INTRODUCTION

Control of mosquitoes is something of utmost importance in the present day with rising number of mosquito borne illnesses. Mosquitoes need to be exterminated using the right tools and with a little bit of effort. These blood thirsty beasts don't care about boundaries and they can bite you if your neighborhoods are allowing its breeding. So the mosquito control measures can be successful only if public mosquito programs are designed. First and foremost thing is to destroy the breeding areas of these mosquitoes. The mosquitoes are horrific -- they're highly aggressive, you can be bitten

hundreds of times without protection, its torture, impossible to bear. Deforestation and industrialized farming are also two of the factors causing an alarming increase in the range mosquitoes¹.

The World Health Organization says global warming is also expanding the range of mosquitoes that carry malaria, yellow fever, and dengue fever, putting millions more humans at risk. Malaria mosquitoes are appearing in upland areas where they've never been seen before. A child dies of malaria every 12 seconds. Mostly in the Third World, In the history of the world, more people have died from diseases

transmitted by mosquitoes than from all the fighting in all the wars, says appropriate technology company Jade Mountain."The world's most dangerous animal is the mosquito," according to a BBC World Service health program: malaria now infects approximately 110 million people annually, causing 2-3 million deaths, and with increasing drug resistance, the problem is worsening, while attempts to control the mosquitoes with pesticides have proved ineffective. Escaping from mosquito is nowadays a great necessity in the world as they are posing much irritation and even throwing many to death. They are the carriers of many harmful diseases like West Nile Virus disease; Malaria, Dengue Fever, Chikungunya, Lyme disease etc. Dengue Fever and Dengue Hemorrhagic Fever are the most common mosquito-borne viral diseases that affect a wide range of people in the world. It is caused due to the bite of an infected Aedes Mosquito. It is a threatening disease as there is no proper vaccine or treatment yet found. These diseases are caused only due to our carelessness. Actually we our self is getting in to the danger. The only way to get away from these diseases is by taking proper protection as soon as possible. There are number of things you should take care to avoid being bitten by mosquitoes. Wear long-sleeved shirts and long pants tucked into socks while you are working outdoors. While indoors, stay in air-conditioned or

screened areas or use bed nets. Avoid mosquito breeding by clearing stagnant water from drains. Another important method to break out from mosquitoes is by the usage of Repellent^{1,2}.

Methods of mosquito control

Mosquito-borne diseases affect millions of people worldwide each year. The bite of a mosquito can result in anything from a 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 minimize 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 others².

Definition of mosquito repellent

A mosquito repellent is a substance applied to skin, clothing, or other surfaces which discourages insects (and arthropods in general) from landing or climbing on that surface. There is also mosquito repellent products available based on sound production, particularly ultrasound (inaudibly high frequency sounds)³.

Classification of mosquito repellents

1.			Chemical methods
	A		Synthetic repellents e.g. DEET, Permethrin
	B		Natural repellents e.g. Neem oil, citronella oil,
2.	A		Non-chemical methods
			Physical method
	a		Medicated Net
	b		Non Medicated Net
	c		Mosquito Traps
	B		Mechanical methods
	a		Electric mosquito zapper
	b		Mosquito Magnet
3.			Biological methods
			Biological methods by growing some fish species that feeds on mosquito larvae in the water bodies

Mechanism of action of mosquito repellents

Carbon dioxide, excretory products and lactic acid present in sweat in warm-blooded animals act as an attractive substance for female mosquitoes. The perception of the odor is through chemoreceptors present in the antennae of mosquitoes. The repellents block the lactic acid receptors thus destroying upwind flight and as a result the mosquitoes loses its contact with the host [2, 3]

Usually insect repellents work by masking human scent, or by using a scent which insects naturally avoid. Permethrin is different in that it is actually a contact insecticide.

Mosquito Repellent

1] Chemical methods

There are a number of natural and chemical mosquito repellents that work to repel mosquitoes. The synthetic chemical repellent, DEET, is the most effective. It is essentially a poison that masks the natural odor and carbon monoxide that is released from the human body.

A) Synthetic repellents

More effective and longer lasting than "natural" repellents in comparative studies, IR3535 (3-[N-Butyl-N-acetyl]-aminopropionic acid, ethyl ester) was as effective as DEET in protection against mosquitoes. However, some plant-based repellents may provide effective relief as well. Essential oil repellents can be short-lived in their effectiveness, since essential oils can evaporate completely. DEET exposure were more likely to have insomnia, mood disturbances and impaired cognitive function. Examples are

- DEET (*N,N*-diethyl-*m*-toluamide)
- Icaridin, also known as picaridin, Bayrepel, and KBR 3023
- Nepetalactone, also known as "catnip oil"
- Permethrin
- Bog Myrtle
- IR3535 (3-[N-Butyl-N-acetyl]-aminopropionic acid, ethyl ester)

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 % 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.

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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. Dermatologist advice some plant oils such as Citronella Oil, Eucalyptus Oil, and Lavendula which can fluently repel the mosquitoes³.

B) Natural repellents

Many repellents are nowadays available which can easily fend off the mosquitoes but are not good for the health as it contain a harmful chemical called DEET. It is fine to use a natural repellent which can make you unattractive in the eyes of mosquitoes. Mosquito-repellent candles containing citronella oil are sold widely in the U.S.

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

Insect repellents from natural sources

There are many preparations from naturally occurring sources that are repellent to certain insects. Some of these act as insecticides while others are only repellent. Basil *Ocimum basilicum*, Castor oil (*Ricinus communis*), Catnip oil (*Nepeta* species) (nepetalactone against mosquitos), Cedar oil (mosquitos, moths), Celery extract (*Apium graveolens*), 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 sativum*) (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 graveolens* Lavender (repels insects), Lemon eucalyptus (*Corymbia citriodora*) essential oil and its active ingredient p-menthane-3,8-diol (PMD), Lemongrass oil (*Cymbopogon* species) (mosquitos), Neem oil (*Azadirachta indica*) (Repels or kills mosquitos, their larvae and a plethora of other insects including those in agriculture), Peppermint oil (*Mentha x piperita*) (mosquitos), Rosemary (*Rosmarinus officinalis*) (mosquitos), Solanum villosum berry juice (against *Stegomyia aegypti* (mosquitoes), Nepetalactone, also known as "catnip oil"^{3,6}.

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.

Lotions

Mixtures containing the repellent dissolved in or diluted with alcohol or other thin fluid, or thickened with castor oil or arachis oil.

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.

Creams (vanishing cream type)

Essentially oil in water emulsions which 'disappear' on application seeming 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.

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 consistence.

Gum tragacanth preparations

Various creams or pastes of gum tragacanth have been employed as vehicles more 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. Owing to their 'disappearing' property, unless used in large amount, they are apt to give patchy distribution of the repellent. A waxy cream would seem to be the most effective in prolonging repellent effect and if of suitable consistence such creams spread extremely well and are

pleasant to use. Lotions have not been much used.

2] Non-chemical methods

A) 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.

I) Mosquito Net - Mosquito nets are considered better protection from mosquitoes than coils and other repellents that cause health hazards. Sleeping under mosquito netting can also guarantee you protection from mosquitoes. Medicated mosquito nets are now considered the best solution.

a) Medicated Net

Existing mosquito nets could be medicated by using K-O (25% deltamethrin) tablets. Vasanth of Sumangala Agro Supplies reported that one tablet should be mixed in one liter of water. The net should be soaked in this solution for 10 minutes, and dried on the ground in a cool area. The effect of the medicine lasts for about six months. The tablet contains 25 per cent deltamethrin and keeps mosquitoes away. Window meshes could also be medicated in a similar fashion. Medicated nets were safer than coils and liquidators, and had been approved by the World Health Organization. "K-O tablets are not harmful as the residue of chemicals remains only on the net and the user does not inhale it. Inhalation of chemicals from coils and liquidators causes respiratory tract infections, headaches and aggravates asthma," K-O tablets might cause skin irritation in some people [4], as shown in Figure 1.

b) 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 mosquitoes⁵.

II) Mosquito Traps

Mosquito traps lure and capture female mosquitoes. The trap mimics the different mosquito attractants such as exhaled carbon dioxide, human scents and body heat. Attracted by these chemicals, the insect approaches and an impeller fan draws it in. It then adheres to a sticky surface on the device and is eventually electrocuted. Mosquito traps are powered by electricity or propane and are a safe, chemical free method of mosquito control⁶.

B) Mechanical methods

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

a) 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 charge⁷ as shown in Figure 2.

b) 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. It vacuums the insects into a net where they dehydrate and die. The mosquito magnet works by releasing a carbon dioxide spray, heat and moisture⁷.

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 tick⁹.

Catnip Repels Mosquitoes More Effectively Than DEET -- Researchers report that nepetalactone, the essential oil in catnip that gives the plant its characteristic odor, is about ten times more effective at repelling mosquitoes than DEET -- the compound used in most commercial insect repellents⁸.

Safety Measures to be taken with insect repellent while using in children and pregnant women¹⁰

- Children may be at greater risk for adverse reactions to repellents, in part, because their exposure may be greater.
- Keep repellents out of the reach of children.
- Do not allow children to apply repellents to themselves
- Use only small amounts of repellent on children.
- Do not apply repellents to the hands of young children because this may result in accidental eye contact or ingestion.
- Try to reduce the use of repellents by dressing children in long sleeves and long pants tucked into boots or socks whenever possible. Use netting over strollers, playpens, etc. As with chemical exposures in general, pregnant women should take care to avoid exposures to repellents when practical, as the fetus may be vulnerable.

Alternatives to mosquito repellent

- Small electrical mats,
- Alternative is incense coils, which you burn -- they fill the air with smoke containing insecticides.
- Mosquito repellent vapor,
- DEET-impregnated wrist bands,
- Mosquito coils containing a form of the chemical allethrin

"Village Pharmacy"

- In India, a homemade mosquito repellent is proving particularly effective against the Anopheles mosquito which spreads malaria. It's made from low-cost neem oil from the amazing neem tree (*Azadirachta indica*, the "Village Pharmacy") mixed with coconut oil

in concentrations of 1-2%.Neem is also proving effective against malaria itself, not just the mosquito that carries the parasite. One active component of the plant, gedunin, is said to be as effective as quinine on malaria infected cell cultures⁹.

- Other oils showing good repellent qualities are eucalyptus, cinnamon, castor, rosemary, cedar, and peppermint. It is always a good idea to test them on a small portion of skin to ensure you don't react to them¹¹.

- Garlic is a very good repellent. You can ingest it and it will eventually work its way into your system, thus the mosquitoes stay away. Or you can plant garlic all around your property, giving you the herb in the fall as it keeps the bugs away during the summer. Lastly, you can purchase concentrated garlic oil, which is designed to be sprayed around your yard¹⁷.

- A small amount of citronella oil on your pulse points is helpful.

- Yarrow tea can be brewed put into a mister and sprayed onto you. This is particularly effective for kids¹⁸.

- Natural vanilla oil repels mosquitoes. Not the synthetic, it will draw them, but good pure vanilla put on your pulse points (wrist, neck, and temples).

- Cloves are another excellent repellent. Again, use the oil and dab it on your pulse points, just be careful as it can cause skin irritation.

- Lavender is a fantastic repellent. You can either use the flowers and rub them on your skin, or use the oil and place it on your pulse points¹⁹.

- There is a tremendous amount of research being done on fennel, thyme, celery extract, and neem (a tropical tree) in combinations and alone.

- Place marigolds near your patio area. Not only are they an eye-catching plant, but they keep away mosquitoes.

- Geranium plant and oil will repel mosquitoes if there are not a lot of them. A good technique is to use both geranium and marigolds to create a border around your outside sitting area²⁰.

- **Lemon grass** (*Cymbopogon citratus*) grown into a composite clump about 15" across. We cut the tops every couple of weeks because it shaded out the other

herbs in the herb bed (lots of green stuff for the compost), but it quickly grew back. And we found it keeps the mosquitoes away. It contains something very similar to citronella oil, it's a safe and natural insect repellent that's just as effective as the commercial chemical products, especially when it's fresh. In fact lemon grass is more effective than true citronella. Rubbing the long, grassy leaves on the skin worked well, but the stalk worked even better. Take one stalk of fresh lemon grass (grip it near the ground and give it a sharp sideways tug to break it off from the clump), peel off the outer leaves, snap off the grass blades behind the swollen stem at the base. Bend the stem between your fingers, loosening it, then rub it vigorously between your palms so that it fractures into a kind of fibrous juicy mass, and rub this mess over all exposed skin, covering thoroughly at least once. Pleasant on the skin and effective: 98% protection at the Beach House at sundown, 100% any other time, and the effect lasts about 4-5 hours. In most places, where the mosquitoes are less fanatical, use less and it'll last longer²¹.

Recent Advances in Mosquito Repellent Methods

Fogging

This method of controlling mosquitoes, flies and other such pests is temporary but is indeed necessary in many instances, including health threats from severe bug populations and to prepare for an outdoor activity where these pests are unwanted. A thermal fogger (as opposed to a cold fogger) produces a pesticide fog or smoke by heating the fogging solution with a coil inside of the unit. Once this coil warms up, it will produce a nice insect fog that is directed to areas where you would like to kill mosquitoes, ready-to-use fogging solution, each gallon contains 0.5% Pyrethrins and 5.0% Piperonyl Butoxide

Mosquito Patch™, -The patch a 2×2-in body patch that uses a revolutionary **trans-dermal technology** to deliver a natural mosquito repellent nutrient directly into the blood stream for a complete 24-hour mosquito protection. The only ingredient in the patch is **Vitamin B1 or Thiamine**. Thiamine is known to be the most effective

natural mosquito repellent discovered to date. It was discovered that female mosquitoes are repulsive to the scent of Thiamine. So, the patch works by inducing a controlled amount of Vitamin B1 or Thiamine into the blood stream. The infusion of excess Thiamine into the blood makes the body respond by excreting the excess nutrient through sweat; and a human body has about 26 million sweat glands spread throughout the entire body – that's 26 million Thiamine excretion spots

CONCLUSION

From above study on review of mosquito repellent methods it is concluded that the natural mosquito repellents are the best methods to repelled mosquito as compare to synthetic methods, but the disadvantage of natural mosquito repellents that it can evaporate completely may need more frequent re-application to maintain full protection and can be overcome by formulating different dosage forms of volatile oil like creams, ointments, lotions using various water removable bases.

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Fig. 1: Medicated net



Fig. 2: Electric mosquito zapper

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