



## Essential Oil Repellents- A short Review

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### Abstract:

Mosquitoes are the most important of insects in terms of public health importance which transmit a number of diseases such as dengue, chikungunya, Japanese B encephalitis, filariasis and malaria, causing millions of deaths every year. Mosquito control and personal protection from mosquito bites are currently the most important measures to prevent these diseases. Essential oils from plants have been recognized as important natural resources of insecticides because some are selective, biodegrade to non-toxic products and have few effects on non-target organisms and environment. Essential oils are volatile mixtures of hydrocarbons with a diversity of functional groups, and their repellent activity has been linked to the presence of mono - terpenes and sesquiterpenes. In some cases, these chemicals can work synergistically, improving their effectiveness. The aim of this review is to highlight the significance of essential oil from *Cymbopogon winterianus* Jowitt, *Azadirachata indica*, *Lavandula angustifolia*, *Mentha piperita* for control of vector- borne disease.

**Keywords:** Mosquitos, Essential oils, insect repellants, Vector-borne disease.

### INTRODUCTION

Vector-borne diseases are infections transmitted by the bite of infected arthropod species, such as mosquitoes, ticks, triatomine bugs, sandflies, and blackflies. They are a serious threat to public health transmitting several dangerous diseases. These diseases profoundly restrict socioeconomic status and development in countries with the highest rates of infection, many of which are located in the tropics and subtropics.(1) Mosquito control and personal protection from mosquito bites are currently the most important measures to prevent these diseases. The common approach for the control of mosquito vectors and reducing the transmission of human pathogens is based on the chemical insecticide-based intervention measures. 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.(2) Insect repellents work by masking human scent. A number of natural and chemical mosquito repellents were studied that work to repel mosquitoes. Mosquito repellents based on chemicals has a remarkable safety profile, however frequent and repeated use of chemical insecticides has resulted in the development of insecticide resistance and toxic effects on human beings which include rashes, swelling, eye irritation, and worse problems, though unusual including brain swelling in children, anaphylactic shock, and low blood pressure.(3) Thus, there is an urgent need to develop new insecticides for controlling mosquitoes which are more environmentally safe, biodegradable and target-specific against the vectors. In recent years, much effort has, therefore, been focused on plant extracts or phytochemicals as potential sources of mosquito control agents. Natural anti mosquito agents are likely to offer a cheaper and effective

tool that can be used to prevent as well as drive away vector mosquitoes from human dwellings. (4)The potential of plants as sources of essential oils with mosquito repellency effect offers great scientific promise and deplorable opportunity for incorporation into integrated vector management.

#### Essential oil insect repellents

Insect repellent is a substance applied to skin, clothing or other surfaces which discourages insects from landing or climbing on that surface. Most common insect repellents available contain N,N – diethyl -3- methylbenzamide or also called DEET has shown strong protection against mosquitoes. Long term application of chemical substances for controlling, repelling and killing of hazardous insects make serious anxieties for environment and human health. Therefore uses of environment friendly and biodegradable natural insecticides of plant origin have received renewed attention as agents for vector control.(5) Plants have been used for centuries in the form of crude fumigants where plants were burnt to drive away nuisance mosquitoes and later as oil formulations applied to the skin or clothes. Many plant extracts and oils repel mosquitoes, with their effect lasting from several minutes to several hours. Essential oils are volatile naturally occurring, complex compounds characterized by a strong odour and are formed by plants as secondary metabolites. Essential oils extracted from different families have shown high repellency against arthropod species. The metabolites like the monoterpenes such as  $\alpha$ -pinene, cineole, eugenol, limonene, terpinolene, citronellol, citronellal, camphor and thymol are the common constituents in a number of essential oils having mosquito repellent activity.(6)

## CITRONELLA OIL

Source: *Cymbopogon winterianus* Jowitt

Citronella (*Cardioperidaceae*) is native to India and tropical Asia. It is widely used as a herb in Asian cuisine. It has a subtle citrus flavor and can be dried and powdered, or used fresh. It is a perennial, shallowly rooted rhizome. Culms are tufted, robust, up to 2 m tall. Leaf sheaths are glabrous, reddish inside; leaf blades relatively thin, drooping 2/3 of their length. Citronella oil is extracted, by cutting small segments of the finely chopped fresh, dried or part-dried grass. Citronella oil has a number of different but diverse therapeutic properties. It is antiseptic, bactericidal and a deodorant. It is also used as a diaphoretic, an insecticide, a tonic and a stimulant.(7)



**Fig 1:** *Cymbopogon winterianus* Jowitt plant

#### Characteristics of Citronella Oil:

Citronella oil is a colourless or light yellow liquid with a characteristic woody, grassy or lemony odour. Citronella oil has minimal or no risk to wildlife and environment due to its toxic levels being low and its use being limited. Therefore, it can be used around the home with no expected adverse effects.

Active Component: *C. winterianus* essential oil is rich in citronellal, geraniol and citronellol. There are other constituents like citronellyl acetate, L-

limonene, ellemol and other sesquiterpene alcohols present in citronella.(8)

Citronella as Insect repellent:

Citronella oil repels insects such as mosquitoes, black flies, fleas and ticks, therefore, preventing its bites. It is used on humans and their clothing – in the form of oil, liquid and patch. Citronella oil is a natural, non-toxic alternative to chemical insect repellents such as DEET, therefore, is usually the preferred choice. They are available as solid products such as citronella oil insect repelling candles and cartridges. Citronella oil is also used in a tablet or pellet form in recreational or outdoor household areas and around trees and shrubs.(9) In addition, there are animal collars and tags containing citronella oil for pets and other domestic animals to repel fleas. A combination of the citronella oil and cedar wood virginian oil also helps to repel mosquitoes. The active compounds in citronella oil for repelling mosquitoes are camphor, eucalyptol, eugenol, linalool, citronellal and citral.(10) Some evidence suggests that these compounds interfere with mosquito olfactory receptors. The olfactory co-receptor, Or83b, which is required for the response to the synthetic repellent DEET, contributed to citronellal repulsion, and was essential for citronellal-evoked action potentials. The most recent study of citronellal's mode of action proposes that *Anopheles gambiae* is able to detect citronellal molecules by olfactory neurons in the antenna controlled by the TRPA1 gene, activated directly by the molecule with high potency.(11)

### NEEM OIL

Source: *Azadirachta indica*

The Neem tree (*Azadirachta indica*) is a tropical evergreen tree native to India and is also found in other southeast countries. Neem belongs to the

botanical family *Meliaceae*. The *Meliaceae* family is also called the mahogany family. It has a straight trunk and the tree can reach a height of 30 metres and more, though 15 to 20 metres is the average. The bark is hard, rough and scaly, fissured even in young trees. Spreading branches with dark green leaves form a dense, round canopy, up to 20 metres across. Leaves are alternate and consist of several leaflets with serrated edges. The flowers are large clusters of up to 250 individual white blooms. The whole cluster can be quite large, but the individual flowers are only a few mm across. The olive like, edible fruit is oval to round and thin skinned. It is green initially and turns yellow when ripe. Neem is easy to grow in a wide range of temperatures and conditions, and the tree can live for 150 to 200 years. In India, neem is known as "the village pharmacy" because of its healing versatility, and it has been used in Ayurvedic medicine for more than 4,000 years due to its medicinal properties.(12) The seeds, bark and leaves contain compounds with proven antiseptic, antiviral, antipyretic, anti-inflammatory, anti-ulcer, anti fungal properties.(13)



Fig 2: *Azadirachta indica* leaves and flowers

Characteristic of Neem oil

Neem oil is a naturally occurring pesticide found in seeds from the neem tree. It is yellow to brown,

has a bitter taste, and a garlic/sulfur smell. It has been used for hundreds of years to control pests and diseases. It is composed mainly of triglycerides and contains many triterpenoid compounds, which are responsible for the bitter taste. Azadirachtin is the most active component for repelling and killing pests and can be extracted from neem oil.

Active ingredient: Azadirachtin, Nimbin, Nimbidin, Nimbidol, Sodium nimbinat, Gedunin, Salannin, Quercetin. (14)

Neem oil as insect repellent

Neem's natural mosquito repellent properties are an important weapon in the fight against malaria. In 1994 the Malaria Research Centre of Delhi, India, tested and proved that kerosene lamps with 1% neem oil can protect people from mosquito bites. The protection was greater against *anopheles* species (the ones that transmit malaria) than against *culex*.

In a study, Sharma V.P. *etal* proved that two percent neem oil mixed in coconut oil, when applied to the exposed body parts of human volunteers, provided complete protection for 12 h from the bites of all anopheline species. Application of neem oil is safe and can be used for protection from malaria in endemic countries.(15) V. P. Sharma, in another study proved the repellent action of neem oil against sand flies under laboratory and field conditions. Concentrations of 2% neem oil mixed in coconut or mustard oil provided 100% protection against *Phlebotomus argentipes* throughout the night under field conditions; against *Phlebotomus papatasi* it repelled for about 7 h in the laboratory.(16) In another study, Sharma S.K., evaluated repellent action of neem oil against different mosquito species. 2% neem oil mixed in coconut oil provided 96-100% protection from

*anophelines*, 85% from *Aedes*, 37.5% from *Armigeres* whereas it showed wide range of efficacy from 61-94% against *Culex* spp. Therefore, neem oil can be applied as a personal protection measure against mosquito bites.(17) Neem derivatives neutralise nearly 500 pests worldwide, including insects, mites, ticks, and nematodes, by affecting their behaviour and physiology. Neem does not normally kill pests right away, rather it repels them and affects their growth. As neem products are cheap and non-toxic to higher animals and most beneficial insects, it is well-suited for pest control in rural areas.

## LAVENDER OIL

Source: *Lavandula angustifolia*

*Lavandula angustifolia* (Lamiaceae) is also known as Lavender, True Lavender, Garden Lavender, Lavanda, Lavandula. It is an evergreen, perennial shrub. It can grow up to 1 meter in height. Both leaves and stems have specific, silver-green color. Leaves are usually long and narrow. The flowers are borne in whorls, aromatic and spiky, violet blue in color, produced from June to September. (18) Lavender has many medicinal uses. Essential oil is used in aromatherapy in treatments of anxiety, nervousness, mental stress, insomnia and fatigue. Lavender oil is also an antiseptic and can be used for wound disinfection. It is also useful in treatment of alopecia areata, fungal infections, acne and eczema. Used internally, in form of a tea, lavender is used as a mild sedative and antispasmodic. It is useful in cases of stomach disorders, loss of appetite and excessive gas.(19)



Fig 3: *Lavandula angustifolia* flowers

#### Active Components

The medicinal components present in it are linalool, linalyl acetate, cineol, pinene, limonene, geraniol, borneol, tannins.(20)

Lavender oil as insect repellent

Bosly and A Hanan studied the essential oils of peppermint, *Mentha piperita* and lavender, *Lavandula angustifolia* for their larvicidal and pupicidal activities against the house fly, *Musca domestica* L. (Diptera: Muscidae) and revealed that the essential oils of peppermint and lavender have a control potential against *M.domestica*.(21)

Barbara Conti *et al* studied the insecticidal activity of essential oils extracted from six Mediterranean plants (*Achillea millefolium*, *Lavandula angustifolia*, *Helichrysum italicum*, *Foeniculum vulgare*, *Myrtus communis*, and *Rosmarinus officinalis*) against the larvae of the *Culicidae* mosquito *Aedes albopictus*, showed that all tested oils had insecticidal activity, with differences in mortality rates as a function of both oil and dosage.(22) Jaeson *et al* studied the repellency of oils of lemon eucalyptus, geranium, and lavender and the mosquito repellent MyggA natural to *Ixodes ricinus* (Acari: Ixodidae) in the laboratory and field. Lavender oil and geranium oil, when diluted to 1% in 1,2-propanediol, had weak repellent activities on *I. ricinus* nymphs, but

when diluted to 30% in 1,2-propanediol had 100% repellencies.(23)

## PEPPERMINT OIL

*Mentha piperita* L (Labiatae) is a perennial herb, 30-90 cm high. Stems square erect or ascending, branched, the upper portion always quadrangular. Leaves opposite, petiolate, ovateoblong to oblong-lanceolate, serrate, pointed; dark green on the upper surface. Flowers purplish, occur in thick, terminal, spicoid racemes of verticillasters. Peppermint oil has the most uses, and use data on the oil are considered relevant to the leaf extract formulations as well. This herbal preparation is used in cosmeceuticals, personal hygiene products, foods, and pharmaceutical products for both its flavoring and fragrance properties. Peppermint oil possesses a fresh sharp menthol odor and a pungent taste followed by a cooling sensation. It also has a variety of therapeutic properties and is used in aromatherapy, bath preparations, mouthwashes, toothpastes, and topical preparations. Also used to treat bronchitis, bacillary dysentery, diabetes, diarrhoea, dysmenorrhoea, fevers, hypertension, jaundice, nausea, pain, and respiratory and urinary tract infections. (24)



Fig. 4: *Mentha piperita* L

Characteristics of peppermint oil:

Peppermint oil has a fresh, sharp, menthol smell, is clear to pale yellow in color and watery in viscosity.

Active Components:

Menthone. p-Menthane-3, 8-diol is also a major breakdown product of menthol, the alcohol in mint oils used as peppermint flavouring. p-Menthane-3, 8-diol has been registered with EPA as a mosquito repellent since 2000.(25)

Peppermint oil as insect repellent

The essential oil of *M. piperita* has promising and remarkable repellent activity against *Ae. aegypti* adults. Sarita Kumar *et al* has proven and established efficacy against the dengue vector larvae. (26) Ansari *et al* evaluated it for larvicidal activity against different mosquito species: *Aedes aegypti*, *Anopheles stephensi* and *Culex quinquefasciatus*. The oil showed strong repellent action against adult mosquitoes when applied on human skin. Percent protection obtained against *An. annularis*, *An. culicifacies*, and *Cx. quinquefasciatus* was 100%, 92.3% and 84.5%, respectively. (27)

## CONCLUSION:

Naturally occurring botanical compounds contain a broad range of chemical active ingredients which can intervene in all biological processes of the mosquito, thus interrupt its life cycle and dispersal and reduce harms to humans and animals. Many medicinal plants were tested for their pesticide and repellent potential, as crude material, essential oils or individual active ingredients. Essential oils are natural volatile substances found in a variety of plants. Commercially, essential oils are used in four primary ways: as pharmaceuticals, as flavor

enhancers in many food products, as odorants in fragrances, and as insecticides. The plant oils have received much attention as potentially useful bioactive compounds against insects showing a broad spectrum of activity, low mammalian toxicity and degrading rapidly in the environment. The various phytochemicals like Citronellal, Azadirachtin, linalool and p-Menthane-3,8-diol obtained from citronella plant, neem, lavender and mentha plant respectively are found to be responsible for the mosquito repellent activity. So this review can certainly bring awareness to public to keep away from mosquitoes in a natural way.

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