



MOSQUITO REPLENT FROM HERBAL PLANTS: A 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 chikungunya, dengue, 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. An attempt has been made to prepare herbal formulations from natural products such as flowers, leaves and whole plants. The present study is attempted to highlight the plants claimed to be used or associated with mosquito repellent activities obtain from forest of gondia region.

KEYWORDS: Repellents, Ethnobotanical plants, Essential oils, Azadirachta indica, Datura metel.

INTRODUCTION

Today's world is gradually turning to herbal formulations which are known to be effective against a large repertoire of diseases and ailments. Many of the herbs and shrubs are found to have promising medicinal properties, and mosquito repellent properties. From the dawn of Civilisation, man has been exploiting the secrets of nature. The drugs used by the ancient Civilisation were mainly the extract of plants, animals and few inorganic salts. Though several approaches to unravel the intricacies of ethnobotanical practices are envisaged, field recording of plant uses directly from the ethnic people and Tribal healers has priority and most reliable. Plant based repellents have been used for traditional practice as a personal protection measure against host seeking mosquitoes. The plant is a component of a number of commercially available herbal formulations and has also shown potential as an effective bio-control agent. Employment of techniques such as cell and tissue culture would provide means of rapid propagation and conservation of the plant species and from the point of view of phytochemistry, give scope for enhancement of the quality and quantity of the bioactive secondary metabolites occurring in the plant. Knowledge on traditional repellent plants obtained through ethnobotanical surveys, is a valuable resource for the development of new natural products. The following approaches give in brief the whole gamut of ethnobotany. Mosquitoes are among the most disturbing blood sucking insects afflicting human beings.^[1] As most of the

mosquito repellent products and devices available in the market are reported to have harmful effects on human beings, the objective of the present study is to develop effective plant-based mosquito repellent products:

1. Several mosquito species belonging to genera Anopheles, Culex and Aedes are vectors for the pathogens of various diseases like Dengue fever, Malaria, Yellow fever, Japanese Encephalitis and several other infections.^[2]
2. Mosquitoes alone transmit diseases to more than 700 million people and over one million deaths are reported annually across the globe.^[3]
3. 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.

How Do Mosquito Repellents Work^[4]

Repellents make humans unattractive to a mosquito so that it will avoid areas of the body that have been treated with the product. Repellents do not kill mosquitoes. The best repellents will provide protection from bites for a long period of time (> one hour) with a single application. University of Florida mosquito researchers test and evaluate the effectiveness of mosquito repellents based on the amount of time the product will continue to repel mosquitoes after one application to the skin. This is known as Complete Protection Time (CPT).



Figure 1: Mosquito repellent plants.

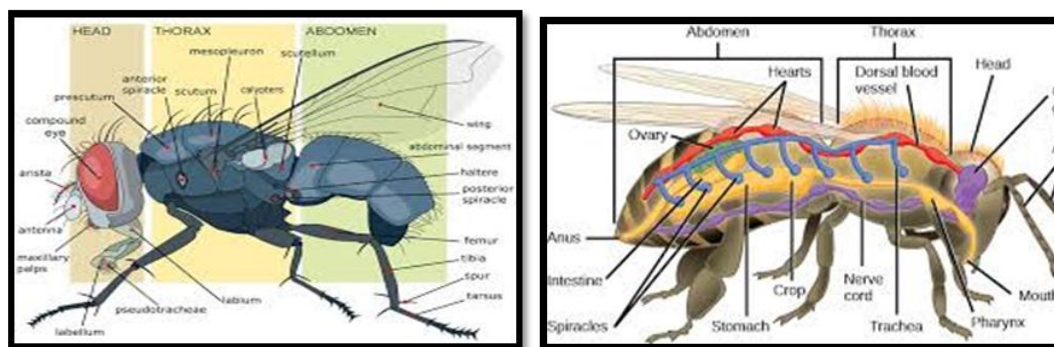


Figure 2: Mosquito Anatomy.

Kingdom: Animalia
 Phylum: Arthropoda
 Class: Insecta
 Family: Culicidae
 Order: Diptera

Mosquitoes are relatively small insects which compose the family Culicidae. Mosquito anatomy is divided into three basic parts, namely, head, thorax and abdomen.^[5] Mosquito's head is consisting of sensors that help the mosquito to find and feed on people and animals. Mosquitoes have two large compound eyes covered with tiny lenses that are capable of detecting even slight movements. Simple photo-sensitive eyes are located on top of their heads to detect variations in light. Mosquito-antennae are long feathery organs which are positioned in front of their heads and those antennae contain sensitive receptors that detect carbon dioxide in human breath from distances of more than 100 feet.^[6] Male mosquitoes will not bite human beings and female mosquitoes start biting human beings after mating with males as female mosquitoes require human blood protein for the maturation of their eggs.^[7] Therefore, some of these female mosquitoes act as vectors for diseases.^[8] Controlling mosquitoes is of utmost importance in the present-day scenario with rising numbers of mosquito-borne diseases.^[9] An alarming increase in the range of

mosquitoes is mainly due to deforestation, industrialized farming and stagnant water. Thus, special products like mosquito repellents for combating mosquitoes are required. The use of mosquito repellent compounds dates back to antiquity.^[10]

Azadirachta indica is an evergreen and fast-growing tree that can reach a height of 15-20m. The Neem branches are spread widely. The fairly dense crown is roundish or oval. The white and fragrant flowers arise from the junction of the stem and petiole. An individual flower is 5-6 mm long and 8-11 mm wide. Neem fruit is a smooth olivelike drupe.^[11] The fruit skin is thin and turns yellow when ripe. The bitter-sweet pulp is yellowish-white. The white, hard inner shell of the fruit encloses one, rarely two or three, elongated seed having a brown seed coat. All parts of the tree such as seeds, leaves, flowers and bark, are used in the preparing of various different medical preparations.^[12] Neem products have medicinal properties that prove to be anti-fungal, anti-diabetic, antibacterial, antiviral and anti-fertility. *Azadirachta indica* (Neem)^[13]

Kingdom: Plantae
 Order: Sapindales
 Family: Meliaceae
 Genus: *Azadirachta*
 Species: *A. indica*



Figure 3: *Azadirachta indica*. Neem Mosquito coil.

3. Lemongrass is a tropical perennial plant which yields the Cochin oil of commerce.^[14] It is known as Bhustarah in Sanskrit, Gandhatran in Hindi, Injippullu in Malayalam, Vasanapullu in Tamil, Majjigehallu in Kannada and Nimmagaddi in Telugu.^[15] The name of lemongrass is derived from the typical lemon-like odour of the essential oil present in the shoot. *Cymbopogon citratus* (C. citratus) flourishes in sunny, warm, humid conditions of the tropics. In Kerala short periods above 30°C have little general effect on plants, but severely reduce oil content. Lemongrass flourishes in a wide variety of soil ranging from rich loam to poor laterite. Calcareous and water-logged soils are unsuitable for its cultivation. Plants growing in sandy soils have higher leaf oil yield and citral content.^[16] Lemongrass will grow and produce average herbage and oil yields on highly saline soils. In Nepal and India, lemongrass is traditionally used as a sedative, in addition to a treatment for fever, and an indigenous cure for infectious diseases. The herb has also been used as an external treatment for skin complaints like ringworm, athlete's foot and scabies. Because lemongrass has been known to control overactive oil glands, it can also be used as a toning astringent to cleanse oily skin and tighten pores.^[17] In some countries, it is used to reduce acne, pimples and blackheads. Lemongrass is also used as a treatment for lice and dandruff.

Datura metel (devil's trumpet)^[18]

Kingdom: Plantae

Order: solanales

Family: solanaceae

Genus: datura

Species: metel



Figure 4: Lemongrass spray for mosquito.

Datura metel is an annual herb or perennial undershrub belonging to the family Solanaceae or Nightshade family and widely distributed in South America, Africa, tropical area especially Asia including Thailand.^[20] *Datura metel* L has a long history usage in Thai traditional medicine as

a remedy for many ailments. Small dosage of dried seeds powder of *Datura* plant was used to treat fever and as a cerebral tonic.^[21] The dried flower was smoked by asthmatics as a bronchodilator and also curbs nausea.



Figure 5: *Datura metel*.

Citronella Oil

Source: *Cymbopogon winterianus* Jowitt Citronella (Cardiophoridae) 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.^[22] 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.^[23] 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. Citronella oil repels insects such as mosquitoes, black flies, fleas and ticks, therefore, preventing its bites.^[24] 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.^[25] 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.^[45]



Figure 6: Citronella Plant.

Lavender Oil

Source: *Lavandula angustifolia* *Lavandula angustifolia* (Lamiaceae) is also known as Lavender, True Lavender, Garden Lavender,^[26] 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. Lavender has many medicinal uses.^[27]



Figure 7: Lavender Plant.

Table 1: Crude drug and chemical constituent.

Sr. no.	Crude drug	Chemical constituents
1)	Azadirachta indica (Neem) ^[28]	protein (7.1%), carbohydrates (22.9%), minerals, calcium, phosphorus, vitamin C, carotene, glutamic acid, tyrosine, aspartic acid, alanine, quercetin (flavonoid) and nimbosterol (β -sitosterol), liminoids, nimocinoline and isonimocinoline
2)	Cymbopogon citratus ^[29]	OIL CONTENT : 0.2 – 0.4% Main constituent : Citral:70% Linalool: 1.34% Geraniol: 5.00% Citronellol, nerol: 2.20% Citronellal: 0.37%
3)	Datura metel (devil's trumpet) ^[30]	ATROPINE 0.426%, 0.35% hyoscyamine (5,6,7,12,15,22R)-6,7-epoxy-5,12,15-trihydroxy-1-oxowitha-2,24-dienolide (baimantuoluoline A), (5,6,15,22R)-5,6,15,21-tetrahydroxy-1-oxowith-24-enolide (baimantuoluoline B),

Homemade Insect Repellent^[47]

Using the research results of scientific studies, your best homemade insect repellent would include *at least one* of the following oils:^[31] lemon eucalyptus, catnip, neem, soybean and citronella. Then, you would add pure vanilla extract to boost its effectiveness. If you were to add a carrier oil to the mix, the best choice would be either coconut and/or soybean oil because they both have been proven to increase the protection time of repellent essential oils.^[32]

Other Plant Oils with Insect-Repellent Effects^[33]

These oils are good to use in your homemade mosquito repellent, but are best used in combination (as opposed to a single ingredient) with any of the other oils listed above:

- Castor Seed
- Cedar Leaf
- Clove Flower
- Geranium
- Lavender
- Lemon
- Lemongrass
- Patchouli
- Peppermint
- Rosemary
- Turmeric

Important Precautions Before Using Natural Repellents^[34]

1. Never use 100% pure essential oils on your skin; always use a dilution. As a general rule for skin applications, use no more than a 5% essential oil concentration.
2. Test your repellent on a small area of skin for 24 hours to see if it causes any kind of irritation because of skin allergies or sensitivities to the oils.^[35]
3. Use your hands to apply the repellent to your face, keeping away from your eyes, nostrils and mouth. Avoid getting it into any open sores, wounds or cuts. Wash hands with soap and water after applying.
4. Do a test patch on clothing to see if it stains. If you leave out the soybean oil, it will have a reduced chance of staining. You could always make up one mix to put on clothing (no soybean or coconut oil) and a separate bottle for applying to skin (with soybean or coconut oil).^[36]
5. Avoid getting the repellent on leather, vinyl or other similar fabrics; the oil may permanently stain them.
6. Do not use on children under 3 years old or any child that may rub their eyes or lick skin that has been treated. This isn't DEET, but it's not meant to be ingested either. Use natural mosquito repellent sparingly on young children. Check with your family physician before using.

Physicochemical test of plant extracts^[37]***Datura metel* / *lemongrass* / *Azadirachta indica* (Neem)****a) Determination of Acid Value^[38]**

2g of the test portion was dissolved in some neutral solvent (toluene/ethanol mixture) the solution was thoroughly mixed and then titrated with 0.1 KOH using 1ml of phenolphthalein indicator or solution.^[44] The end point was reached when pink colour persisted for 30 seconds. Two determinations were carried out on the same test sample. The acid value is given by the expression.

$$\text{Acid value} = \frac{V \cdot C \cdot 56.1}{M}$$

where V is volume of potassium hydroxide (ml),
C is concentration of potassium hydroxide
M is mass of the test portion (g), and
56.1 - Molar mass of potassium hydroxide.

b) Determination of iodine value^[39]

2 g of the sample was weighed into a conical flask and 20ml of carbon tetrachloride was added to dissolve the oil. Then 25ml of Dam's reagent was added to the flask using a safety pipette influenced chamber. A stopper was then inserted and the content of the flask was vigorously swirled. The flask was then placed in the dark for 1 hour and 30 min. At the end of this period, 20 ml of 10% aqueous potassium iodide and 150 ml of water were added using a measuring cylinder. The content was titrated with 0.1 M sodium thiosulphate solution until the yellow due to iodine has almost disappeared. A few drops of 1% starch indicator were added and the titration continued by adding thiosulphate drop-wise until blue coloration disappeared after vigorous shaking. The same procedure was used for the blank test and for other samples. The iodine value (IV) is given by the expression.

$$IV = \frac{12.69c(V1-V2)}{m}$$

where: c – concentration of sodium thiosulfate used,
V1 – volume of sodium thiosulfate used for the blank
V2 – volume of sodium thiosulfate used for determination
m – mass of the sample.

3) *Azadirachta indica* (Neem)^[40]**Tests for Triterpenes (liminoids)**

i) Salkowski test:- Chloroform solution of the extract when shaken with concentrated sulphuric acid, lower layer turns to yellow on standing.

ii) Lieberman Burchardt test:- Chloroform solution of the extract with few drops of acetic acid and one ml concentrated sulphuric acid gives deep red at the junction of 2 layers.

iii) Tschugajen test:- Chloroform solution of the extract with excess of acetyl chloride and pinch of zinc chloride and warming on water bath gives Eosin red colour.^[41]

Tests for Flavonoids (Quercetin)^[42]

i) Ferric chloride test:- Alcoholic solution of the extracts mixed with few drops of neutral ferric chloride solution gives green colour.

ii) Lead acetate tests:- Alcoholic solution of the extracts mixed with few drops of 10 % lead acetate gives yellow precipitate.^[43]

Marketed Formulation**CONCLUSIONS**

- ✓ Lemongrass, Neem represents a class of herbal drug with very strong conceptual or traditional base as well as strong experimental base for its use. 2) *Datura metel* shows the synergistic effect with lemongrass and neem for mosquito repellent activity.
- ✓ Thus this plant has great potential to be developed as a drug by pharmaceutical industries. 4) The extract is having excellent mosquito repellent properties.
- ✓ Insect repellent properties of the leaf are also proved.

The results of this investigation confirmed that *gratissimum* grown in eastern Nigeria has insect-repellent activity and could be used effectively to control the nuisance and adverse health impact of mosquito bites particularly at 30% (v/v) in both the olive and palm kernel oil bases. The findings are in conformity with the observations of earlier researchers who tried the insect repellent activity of the volatile oil against mosquitoes, and against blackflies. The disparity found in the percentage repellency of the formulations of the volatile oil at 30% (v/v) and 20% (v/v) concentrations in olive oil and palm kernel oil tend to suggest that palm kernel oil presented some hindrances to the full expression of the repellent activity of the volatile oil.

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