



CODEN [USA]: IAJPBB

ISSN : 2349-7750

**INDO AMERICAN JOURNAL OF  
PHARMACEUTICAL SCIENCES**

SJIF Impact Factor: 7.187

<https://doi.org/10.5281/zenodo.6814987>Available online at: <http://www.iajps.com>

Review Article

**A REVIEW ON HERBAL PLANTS FOR MOSQUITO  
REPELLENT ACTIVITY****Dr. Yelmate A.A.\***, **Dr. Satpute K.L.<sup>1</sup>**, **Ms. Polawar rutuja<sup>2</sup>**, **Mr. Kande Suyog<sup>2</sup>**,  
**Mr. Atharv Homkar<sup>2</sup>**<sup>1</sup>Dayanand College of Pharmacy, Latur, Maharashtra, India.<sup>2</sup>Dayanand College of Pharmacy, Latur, Maharashtra, India.**Article Received:** June 2022**Accepted:** June 2022**Published:** July 2022**Abstract:**

*The mosquito is a common flying insect that is found around the world having about 3,500 species. Mosquitoes spread dengue, malaria, yellow fever, filarial and other diseases. Mosquito repellents play a key role in the prevention of mosquito bites. Different types of mosquito repellents such as synthetic compounds, herbs, and aromatic oils are used against mosquitoes. Chemical mosquito repellents have an extraordinary protection profile but are noxious as compared to plant-based mosquito repellents. Mainly DEET (N, N-Diethyl-3methyl benzamide) is the most widely used chemical mosquito repellent. DEET gives faster action but is hazardous. Instead of using DEET which is fully chemically based, one can utilize aromatic essential oils for keeping mosquitoes away. Aromatic essential oils provide health benefits. Essential oils obtained from lavender, basil, pine, peppermint, lemongrass, lemon, eucalyptus, thyme, tea tree, camphor, neem, etc, have mosquito repellent properties also promote health benefits. Natural repellents are found to be safe and better for the skin. Plant-based repellents are chemical-free and have many advantages over chemical-based repellents. Varieties of plant-based mosquito repellents are available in the market. As well as, one can easily prepare mosquito repellent formulations with the natural ingredients available at home. Ingredients like garlic, neem, cloves, camphor, cinnamon, bay leaves, and lavender are easily available at home and are utilized to prepare mosquito repellents that are safe and effective, and are chemical-free. The homemade formulations are found to be effective as well as promote a good safety profile.*

**Corresponding author:****Yelmate A.A.\***,*archanayelmate1@gmail.com***Mob. 09822336268**

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Please cite this article in press Yelmate A.A et al, *A Review On Herbal Plants For Mosquito Repellent Activity.*, Indo Am. J. P. Sci, 2022; 09(7).

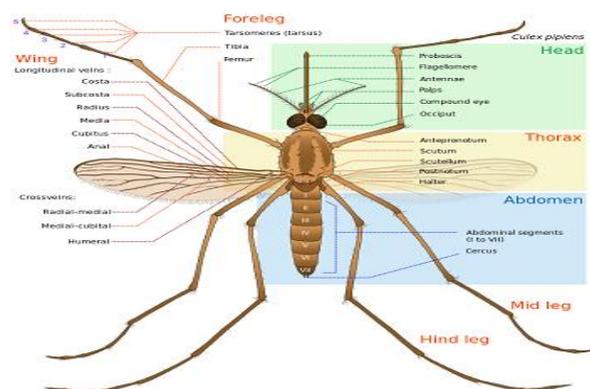
## INTRODUCTION:

N, N – diethyl-3-methylbenzamide (DEET), used by millions of people worldwide is a synthetic mosquito repellent. In spite of its safety profile, a number of reports have shown its toxicity against the skin, usually when the repellent is used incorrectly (or) in the long term [1]. The undesirable effects of DEET are undesirable odor, subchronic toxicity, mutagenicity, and reproductive and neurological toxicity.

Citronella (*Cymbopogon nardus*) is a resilient grass that is native to Sri Lanka and Java. It is one of the most dominant insect repellents before DDT. It is used in combination with cedarwood to produce a pleasant swelling as a natural repellent. It has antiseptic, antifungal deodorant, insecticide, and as well as stimulant medicinal properties.

Peppermint (*Mentha piperita*) is native to Europe, India, and North America. Its most important constituent is menthol which is used for respiratory congestion, headache and muscle pain. It has a mild insect repellent property and is used as a carminative, antispasmodic, antiviral, and antifungal. [2]

## 2. Kingdom: Animalia



Phylum: Arthropoda

Class: Insecta

Order: Diptera

Family: Culicidae

Mosquitoes are relatively small insects which compose the family Culicidae. Mosquito anatomy is divided into three basic parts, namely, head, thorax and abdomen. 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 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. The thorax is connected to the head and it has a pair of wings. The legs also come out of the thorax, six in all, with tiny claws at the end of each to help the mosquitoes stay attached to surfaces. The abdomen hangs from the thorax and serves as the mosquito's stomach and lungs. Normally, both male and female mosquitoes use plant juice as food. 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. Therefore, some of these female mosquito's act as vectors for diseases. Typically, these mosquitoes transmit diseases from one human or animal to another by picking up a virus or parasite along with the blood meal while biting an infected human or animal. The mosquito and the virus do not harm one another but the virus reproduces inside the mosquito. Later, the mosquito passes the viruses to other humans while biting. A mosquito repellent is a substance applied to skin, clothing or other surfaces which discourages mosquitoes from landing or climbing on that surface. Usually, mosquito repellents work by masking human scent or by using a scent which mosquitoes naturally avoid. Carbon dioxide and lactic acid present in sweat in warm-blooded animals act as an attractive substance for mosquitoes. The perception of the odour is through chemo-receptors which are present in the antennae of mosquitoes. The repellents block the lactic acid receptors and 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. An alarming increase in the range of mosquitoes is mainly due to deforestation, industrialised 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. Prior to the discovery of synthetic organic insecticides, herbal products such as Nicotine from *Nicotiana tabacum* (Tobacco) leaves, alkaloids extracted from *Anabasis aphylla* (Russian weed), Rotenone from *Derris elliptical* and Pyrethrums from *Chrysanthemum cinerifolium* flower were used as natural mosquito repellents in the interruption of the transmission of mosquito-borne diseases both at the individual and the community level. Before the Second World War, there were only four principal repellents, namely, Citronella oil, Dimethyl Phthalate, Indalone® and Rutgers 612. Other military-developed mosquito repellent formulae

for use on clothing were developed during the war, but they all failed to provide the desired protection of military personnel deployed around the world. As a result, by 1956, the United States government had screened over 20,000 potential mosquito repellent compounds. In 1953, the mosquito and other insect repellent properties of N, Ndiethyl-3-toluamide (DEET) were discovered and the first DEET product was introduced in 1956. DEET spray is still the most widely used mosquito repellent. It has generally been regarded as safe. However, toxic effects have been recorded, including encephalopathy in children, urticaria syndrome, anaphylaxis, hypotension and decreased heart rate. Several other compounds have been evaluated for repellent activity, but none has had the commercial success of DEET. Nowadays, there are many types of mosquito repellents which are commercially available. Spray mosquito repellents are very common and maybe sprayed on the clothing or skin. Some of the best sprays contain high concentrations of DEET and are effective for several hours even when walking through deep woods where there are thousands of mosquitoes. Cream or lotion repellents are applied directly to the skin and rubbed creating a repellent barrier. Mosquito repellent clothing is specially designed with a tight fiber weave and infused with a long-lasting natural mosquito repellent to prevent mosquito bites. Additionally, mosquito coils are also widely known as efficient mosquito repellents. The major active ingredient of the mosquito coils is Pyrethrums, accounting for about 0.3-0.4% of coil mass. When a mosquito coil is burned, the insecticides evaporate with the smoke which will then prevent the mosquitoes from entering the room. However, many people dislike the smell of the mosquito coils when they are burnt as people feel that the coils may be harmful for their health as they cause headaches, nausea, and dizziness. Currently, mosquito repellent liquidizers are also widely used all around the world. The mosquito repellent liquidizers contain synthetic Pyrethroids that produce neurological toxicity on accidental ingestion. Recently, these are emerging as a source of hydrocarbon poisoning. There are physical methods to repel mosquitoes such as mosquito nets which are considered as better protection from mosquitoes than coils and other repellents that cause health hazards. Sleeping under mosquito netting can guarantee the protection from mosquitoes. Nowadays, some of the mosquito nets are medicated by using 25% deltamethrin and these nets are considered to be safer than mosquito coils and liquidizers as inhalation of chemicals from coils and liquidizers cause respiratory tract infections and headaches. In addition, there are mosquito traps which mimic the different mosquito

attractants such as exhaled carbon dioxide, human scents and body heat. Attracted by these chemicals, mosquito approaches and an impeller fan draws it in. It is then adhered to a sticky surface on the device and is eventually electrocuted. Moreover, there are mechanical methods such as Electric Mosquito Zappers that work by using ultraviolet light to lure in mosquitoes and then kill them upon contact with its lethal dose of electrical charge. There are also mosquito repellent products available based on sound productions, particularly ultrasound. After mating once, female mosquitoes will not mate with males again and they avoid the presence of males. Females detect the presence of males by sensing the ultrasound produced by the males. Therefore, an ultrasound generator imitates the sound waves produced by the beating of male mosquitoes' wings and this will repel female mosquitoes. However, this theory is implausible since the hearing ability of the females is relatively weak. It is the hearing system of males that is relatively strong and the presence of numerous sound and vibration receptors on their plumose antennae enable them to detect the vibrations in the environment as well as the sound of female mosquitoes. Thus, ultrasound waves are not effective in repelling mosquitoes. Since the discovery of DDT, mosquito control approaches have been almost completely based on synthetic organic insecticides. However, the extensive use of synthetic insecticides during the last five decades has resulted in environmental hazards and also in the development of physiological resistance in major vector species. Even though, mosquito repellents based on chemicals have remarkable safety profiles, they are toxic against the human skin and nervous system and may cause rashes, swelling and eye irritations. This has therefore necessitated the need for research and development of environmentally safe, biodegradable, low cost, indigenous methods for vector control which can be used with minimum care by individuals and communities. According to the past researches, the essential oils of the leaves of *Cymbopogon nardus* (Citronella), *Cymbopogon citratus* (Lemongrass), *Cymbopogon winterianus* (Citronella), *Ocimum basilicum* (Sweet Basil), *Ocimum sanctum* (Tulsi), *Ocimum americanum* (Hairy Basil), *Eucalyptus citriodora* (Eucalyptus), *Eucalyptus globulus* (Eucalyptus), *Rosmarinus officinalis*, *Melissa officinalis*, *Curcuma longa* (Turmeric) rhizomes, *Citrus sinensis* (Sweet Orange) peels, *Citrus hystrix* (Kaffir Lime) peels, *Citrus limonum* (Lemon) peels, *Syzygium maromaticum* (Clove) buds and *Pinus roxburghii* resins have shown very high mosquito repellent activity. Moreover, the extracts of *Azadirachta indica* (Neem) seeds, leaves of *Alpinia*

*galangal* (Greater Galangale), *Vitexnegundo* (S. Nika) and *Tribulus terrestris* (S. Gokaru) also have been studied as possible mosquito repellents. The selection of these plants was based on their availability as raw materials, scientific evidence and folkloric use as mosquito repellents. [3]

### The Objective of the Study

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 study effective plant-based mosquito repellent products.

### Plants known for mosquito repellent activity:

The plants were selected based on the traditional knowledge and experience. Traditionally we used repellent agents have been blended with some new ingredients. The most important traditional and popular ways to repelling mosquitoes was by using Neem leaves, Tulsi leaves along with camphor. It is an excellent antiviral agent when sublimated or burnt. Tulsi is the most important and most generally used medicinal plant in Indian homes and it has best antiviral and insecticidal properties. In this addition to above mentioned traditional and Natural herbal insecticides number of medicinal herbs have been selected as raw material for preparing novel herbal mosquito repellent cake. Herbal resources which are reported in traditional official books of Ayurveda with insect repellent activity would be selected. Essential oils with traditional claims will also be used and blended with natural bases like pharmaceutical natural bases.

### HERBS COMMONLY USED IN FORMULATION:

#### *Cymbopogon nardus* (Citronella)



Kingdom : Plantae

Order : Poales

Family : Poaceae

Genus : Cymbopogon

Species : C. Nardus[3]

*Cymbopogon nardus* or Citronella grass (S. Pengiri) is a coarse and clump-forming tropical grass native to Sri Lanka. Citronella grass can grow up to 1.5-1.8 m tall and citronella stems are like canes. Citronella essential oil is extracted by steam-distillation of citronella leaves. Citronella essential oil is used as an insect repellent and it can be found in dozens of registered pesticide products such as sprays, lotions and candles. Due to its antifungal properties, citronella oil is also used to treat insect bites. Additionally, citronella essential oil is one of the most common oils used in aromatherapy as it has the ability to treat and prevent fever and headache. The oil of citronella is also widely used in fragrances and personal care products. Because of citronella oil's antiseptic properties, it is used in soaps, household cleaners, and detergents. Moreover, citronella oil is added to food and beverage flavorings, such as in alcoholic drinks and frozen dairy. These plants were to carry out a study to evaluate the repellency of mosquitoes in the university. The attempt of doing so is to see how a natural-based mosquito repellent "Citronella" is more effective, cheaper, environmentally friendly, and non-hazardous to the environment. Evidence has shown that plant products have been used in many parts of the world for killing plants (Seyoum A et al). Various plants were used for agricultural and domestic pest control in China and other countries reported by Secoy and Smith (1983) and Yang and Tang (1988).[3][5][6]

#### Basil:



Basil is another herb that can also double as pest repellent. The pungent smell the basil leaves gives off are what keep pests at bay. And since all kinds of basil work to keep flies and mosquitoes at bay, feel free to explore and find the right types of basil to mix into your garden. This herb likes to be kept damp, needs good drainage, and enjoys lots of sun. The use of plant-based insecticides is an alternative in controlling *Aedes aegypti* larvae. Vegetable insecticide is an insecticide made from active compounds of plant secondary metabolites that is able to provide one or more biological activities, both influences on aspects of physiology and behavior of insects, such as inhibition of feeding and spawning activities, regulating growth and development of insects, death or mortality, etc. One of the plants that have potential as natural larvicides is the basil leaves of the forest (*Ocimum sanctum*). Based on studies on the genus *Ocimum*, this plant contains alkaloids, flavonoids, tannins, saponins, triterpenoids, and essential oils. So, this research was held to see the ability of the extract of the basil leaves of the forest (*Ocimum sanctum*) as larvaside against third instar larvae of the *Aedes aegypti* mosquito. In previous studies, which have been conducted by researchers in various parts of the world, one of them is in India. Basil leaves have great potential in killing dengue mosquitoes. In addition, the results of the research prove that, some people whose intensity of consuming basil leaves are quite high, are more awake from DHF due to *Aedes aegypti* mosquitoes. Instar III larvae are considered sufficient to represent the condition of larvae with a size that is not too small so it is easy to observe, and can be used as research material because in this phase the larvae are very active in moving and foraging on water media. On this basis, larvicide was created to break the life cycle of the *Aedes aegypti* mosquito. [7]

#### **Eucalyptus globules:**



Kingdom : Plantae

Order : Myrtales

Family :Myrtaceae

Genus : Eucalyptus

Species : E. Globules

*Eucalyptus globulus* (S. *Eucalyptus*) is named “Blue Gum” and it is a medium to very tall forest tree which may reach 70 m in ideal conditions. However, *Eucalyptus globulus* is more commonly 15-25 m in height and it has a rough, grayish bark that is shed on the upper trunk and branches in long ribbons. *Eucalyptus globulus* leaves are glossy, dark green, thick, and leathery. The white flowers occur from winter to early summer and they are followed by hard, woody capsules containing grayish fruits which are named “Gum Nuts”.

*Eucalyptus* essential oil which is extracted by steam distillation of eucalyptus leaves is taken orally for pain and inflammation of respiratory tract mucous membranes, coughs, asthma, and bronchitis. It is also used as an antiseptic, insect repellent, and treatment option for wounds. *Eucalyptus* oil is also popularly used as a fragrance in perfumes and cosmetics and it is found in mouthwashes, toothpaste and cough drop as well. The main chemical constituent present in eucalyptus oil is cineole (60-70%). The major component of *Eucalyptus globulus* is 1, 8- Cineol (*Eucalyptol*) and has been recognized as a high ovipositional repellent and mild mosquito feeding repellent. Chemical instability, volatility, propensity for oxidation, and poor water solubility of essential oils make them inconvenient for extensive use. Consequently, the incorporation of essential oils in Nano-formulations, such as micro-emulsions, could solve these problems through an increase in dissolution rate, water-solubility, dispersion uniformity, and stability after topical application. Micro-emulsions are transparent isotropic formulations, which are thermodynamically stable and are prepared by dispersion of two immiscible liquids (water and oil) containing appropriate amounts of surfactant. The dispersed phase is composed of small Nano-sized droplets with a diameter of 10 to 100 nm. Because of their small droplet size, micro-emulsions may appear transparent, and Brownian motion prevents creaming or sedimentation, hence offering increased stability. Accordingly, this study was designed to evaluate the repellent activity of nano-sized micro-emulsion of *Eucalyptus globulus* essential oils.[8]

***Curcuma longa* (Turmeric):**

Kingdom : Plantae

Order : Zingiberales

Family : Zingiberaceae

Genus : *Curcuma*

Species : *C. Longa*[3]

*Curcuma longa* (Turmeric) is an upright, relatively short and stout plant that rarely grows more than about 1 m in height. Its leaves are elongated, dark green, and pointed, often curling slightly along the margins. Each leaf arises on an individual stalk directly from the fleshy rhizome at its base. The rhizome appears scaly due to the remaining rings of previous leaves. Its outer skin is brownish but its flesh is deep orange-yellow inside. Rhizomes grow to about 5-8 cm x 1.5-2.5 cm. The flower stalk will appear among the leaves, also directly rising from the rootstock. The yellow-reddish flowers are arranged spirally along the cylindrical spike which may be partially protected by a leaf sheath.

Turmeric is mainly used in culinary preparations and for medicinal purposes. Turmeric when used in powdered form can provide a specific taste and a rich yellow colour in food preparations. For chemical purposes, it is used as an indicator and can identify a base. Turmeric turns red when it comes in contact with

a base. Monoterpene hydrocarbons (46.9%) constitute the bulk of the *Curcuma longa* rhizome essential oil which is obtained by hydro-distillation and has antiseptic and anti-carcinogenic properties. [9]

***Ocimum sanctum* (Tulsi):**

Kingdom : Plantae

Order : Lamiales

Family : Lamiaceae

Genus : *Ocimum*

Species : *O. Tenuiflorum*

*Ocimum sanctum* or Tulsi is a branched sub-shrub which is 30-60 cm tall, with simple opposite green or purple leaves that are strongly scented. Tulsi leaves have petiole and are ovate, up to 5 cm long, usually slightly toothed. Flowers are purplish in elongate racemes in close whorls. Tulsi is native throughout the tropics and wide-spread as a cultivated plant. It is cultivated for religious and medicinal purposes and for its essential oil.

Tulsi essential oil is used as a medicine for fever, headache, lung disorders, heart disorders and many other diseases. Tulsi essential oil has antibacterial, anti-viral and anti-fungal properties as well. Tulsi essential oil is also used in massage oils, perfumes, aromatherapy baths, soap making and candle making.

**(Clove): Syzygium aromaticum**

Kingdom : Plantae

Order : Myrtales

Family :Myrtaceae

Genus :Syzygium

Species : S. Aromaticum

*Syzygium aromaticum* (Clove) is a triangular-shaped evergreen tree growing about 12 m tall with smooth grey bark and about 12 cm long, glossy opposite leaves that resemble bay leaves. The attractive red and white bell-shaped flowers have four tiny petals surrounded by a long, four-parted calyx and numerous stamens. The clove buds are pink but calyx changes from yellow to deep red after the stamens fall. The fruit, called the mother of cloves, is an edible purple berry about 2.5 cm long. The entire *Syzygium aromaticum* plant is extremely aromatic.

Cloves are used in cooking, either in whole or in ground form as a spice throughout Europe and Asia. Clove essential oil is widely used and well known for its medicinal properties. Traditional uses of clove oil include use in dental care as an antiseptic and analgesic. The oil is active against oral bacteria associated with dental caries and periodontal diseases. Additionally, clove oil has anti-carcinogenic, anti-allergic, antioxidant, and insecticidal properties. [3,12] *Syzygium aromaticum* (Syn. *Caryophyllus aromaticus*, *Eugenia aromaticum*, *E. caryophyllata*) commonly known as clove tree belongs to the family Myrtaceae. It is a pyramidal or conical evergreen tree, about 9-12 meters high. The plant has numerous medicinal properties. The flower buds (cloves) are carminative, stimulant, and antimalarial. It is used in dyspepsia, gastric trouble, nausea, and vomiting. Its oil is a strong germicide, antiseptic, analgesic, local anesthetic,

emetic and spasmolytic. It contains eugenol which is an effective local anesthetic and has long been used in dentistry [1-3]. Repellent activity of essential oil of cloves has been reported earlier against mosquitoes including *Ae. Aegypti*. [13]

**Marigold :**

Kingdom :Plantae

Order :Asterales

Family :Asteraceae

Genus :Tagetes

Species :Tagetes erecta

The researchers intend to use marigold plant (*Tagetes erecta*) parts as suitable components of the mosquito coil/ incense stick to be produced. It does not contain a harmful chemical that is present in some commercial products it repels mosquitoes without destroying the environment. It contains a particular smell that many insects find unappetizing. The smell is caused by a chemical known as "α-terthienyl". Which lends a natural insecticidal property to marigolds. Other toxic compounds available in all the ingredients are alkaloid, papain, terpenes, and cyanogenic glycosides that are objectionable to human health. It also contains pyrethrin a natural compound effective as a mosquito killer. Marigold is said to deter some common insect pests, as well as nematodes. Marigold is hence often in companion planting for tomato, chili, and potato. Due to antibacterial thiophenes exuded by the roots, marigold should not be planted near any legume crop. Thiophenes repel aphids, whiteflies, maggots, and many other pests. Simultaneous steam distillation extractions (SSDE) volatiles isolated from the flower of the *erecta* species are believed to have higher insecticidal activity. Flowers contain pyrethrum an ingredient found in many insect repellents.[14]

***Citrus sinensis* (Sweet Orange)**

Kingdom : Plantae

Order : Sapindales

Family:Rutaceae

Genus: Citrus

Species: C. Sinensis[3]

*Citrus sinensis* or Sweet Orange is a small shallow-rooted evergreen tree that is about 6-13 m in height with an enclosed conical top and spiny branch. *Citrus sinensis* leaves which are 5-15 cm long and 2-8 cm wide are dark green in color, glossy and oval-shaped. The greenish-white *Citrus sinensis* flower is small and it has five petals. *Citrus sinensis* fruits are reddish-green to yellowish-green in color and consist of a leathery and tightly adhered peel that is 6 mm thick. <sup>31</sup> *Citrus sinensis* peel, protects the juicy inner pulp of the Sweet Orange fruit. Sweet Orange peels, leaves and flowers contain fine essences of oils that are used in the manufacture of cosmetic products and medicines. It has been scientifically proved that citrus peel have the tendency to repel mosquitoes. The extract from these two fruits is collected by using 100% ethanol and it is applied on to the cotton mosquito nets by padding method. [3]

***Azadirachta indica* (Neem)**

Kingdom : Plantae

Order : Sapindales

Family :Meliaceae

Genus :Azadirachta

Species : A. Indica[3]

*Azadirachta indica* is an evergreen and fast-growing tree that can reach a height of 15-20 m. 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 olive like drupe. 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. Neem products have medicinal properties that prove to be anti-fungal, anti-diabetic, antibacterial, antiviral and anti-fertility.

Limonoid compounds contained in Neem seed extract seem to have the insecticide and pesticide properties. The main limonoid in Neem seed extract is azadirachtin. Additionally, azadiradione, fraxinellone, nimbin, salannin, salannol, vepinin and vilasinin are also present in Neem seed extract.[3]

*Azadirachta indica* is a fast growing, long-live tree with unpleasant smelling wood that's about 12 meters in height. It has evergreen pinnate leaves and small fragrant yellow-white flowers, followed by green-yellow berries (Zillur and Shamim, 1993). Its name is derived from the Persian word *azadiddiraki* which means noble tree and this plant is native to India and Pakistan. *Azadirachta indica* also known as neem, is a member of the *meliaceae* family and a botanical cousin of mahogany (Zillur et al., 1996). This plant is reputed to be responsible for the pesticidal, larvicidal, antifeedant or repellent action on various insects (Premila, 2006). The Azadirachtine is found in all parts of the plants but in a higher concentration in the seed. Studies have shown that neem is a natural mosquito repellent plant (Kilonzo et al., 2007). Traditionally, *Azadirachta indica* is used as oil cake obtained from seeds, used as fertilizer and manure (Birendra, 2012). The Green twigs are used as tooth brushes and as prophylactic mouth and teeth compliance. The leaves are kept in suit cases to repel insects and to preserve woollens. Seeds yield famous magose oil of disagreeable garlic like flavor. The oil is

said to be effective in treatment of leprosy and skin diseases. It is also used as a cure for management of dog disease. The leaves in poultice are used for healing of wounds. The oil from neem seed provides significant protection from various mosquitoes (Chatter et al., 1994). Research has proven that besides azadirachtin, salanim, gedunin, azadinone, nimbin, nimbidine, nimbicidine, nimitinol, are also important liminods which act as an excellent effect on insects and pest (Su et al., 1998). This study is to evaluate the mosquito repellent action of the fruit bark and seed kernel of the plant on female anopheles mosquito and culex mosquito species. [16]

oils were carried along with the steam into the graduated distillate receiving tube and excess water returned to the flask. A layer of solvent, mixture of dichloromethane and diethyl ether, was added to the distillation arm. The essential oils dissolved in the organic solvent mixture which was in the graduated distillate receiving arm. Heating was continued for about 5 hours and assembly was allowed to cool. At last, aqueous layer and organic layer were collected separately. Then the organic layer was allowed to dry over anhydrous Sodium Sulphate and aqueous layer was extracted twice with dichloromethane. Finally, solvents were evaporated and essential oil was obtained. Essential oil weighed and stored in refrigerator at 4oC until it was used for the experiment. [3]

### DISCUSSION:

A review of literature related to herbal mosquito repellent carried out to collect the information about different plant extracts and the essential oils which had been tested before for their mosquito repellent activity. Many researchers have shown that plant essential oils have better repellent efficacy rather than plant extracts. However, all the essential oils are highly volatile and this contributes to their poor longevity as mosquito repellents. Therefore, many essential oils are not suitable to be used as sole mosquito repellents. This problem is addressed in the study by reviewing two herbal mosquito repellent formulations using highly volatile essential oils together with herbal extracts.

Some study results shown that no skin irritations or rashes were observed on the arms of the test volunteers with extracts, essential oils and the two mosquito repellent formulations. However, a hot sensation was observed on the arms of the test volunteers with Clove bud essential oil. Therefore, the slight hot sensation which was observed on the arms of the test volunteers with two mosquito repellent formulations may also be due to Clove bud essential oil. Further improvements for the two mosquito repellent formulations can be

done by reducing the Clove bud essential oil to the level where no hot sensation is observed. Also, formulations containing lower percentages of active ingredients have to be prepared and evaluated for their efficacy. Further investigations are needed to elucidate the efficacy of the herbal mosquito repellent formulations against a wide range of mosquito species and also to identify active compounds responsible for mosquito repellent activity in order to utilize them, if necessary, in preparing a commercial product to be used as a mosquito repellent.

### CONCLUSION:

This review concludes that plant essential oils showed higher mosquito repellent activities compared to plant extracts. The most of research study shows that when 10% (V/V%) extracts and essential oils were compared, the mosquito repellent activities occurred in the following order: Citronella essential oil and Eucalyptus essential oil (100%) > Tulsi essential oil (97.94%) > Clove bud essential oil (95.81%) > Sweet Orange essential oil (93.75%) > Turmeric essential oil (89.56%) > Nika extract (85.44%) > Neem extract (81.25%).

As per literature when 20% (V/V%) extracts and essential oils were compared, the mosquito repellent activity was found to be in the following order: Turmeric essential oil (100%) > Nika extract and Neem extract (97.94%).

Some research study also concludes that the mosquito repellent gel and the mosquito repellent spray which contained 16% (V/V %) total active ingredients each, showed 100% mosquito repellency for outdoor and indoor field trials which were carried out for six hours each day for two days.

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