

## LARVICIDAL ACTIVITY OF HERBALS: A REVIEW

Sonia Ninan\*, K Krishnakumar, Dineshkumar B\*

Department of Pharmaceutics

St James College of Pharmaceutical Sciences, Chalakudy, Kerala

St James Hospital Trust Pharmaceutical Research Centre (DSIR Recognized), Chalakudy,

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### ABSTRACT

Mosquitoes are the important and major blood-sucking vectors and it transmits parasites and pathogens which cause devastating impact on human beings. The most common diseases associated with mosquitoes are dengue fever, chikungunya, yellow fever and the worst, dengue hemorrhagic fever where *Aedes aegypti* is one of the mosquito species responsible for the transmission of these vector borne diseases. Natural products of plant origin are preferred over synthetic insecticides due to their eco-friendly nature. Plant essential oil have been valued as insecticides owing to their broad spectrum of activity. Mosquito control includes targeting the adult mosquito through spraying chemical insecticides or by killing the mosquito larvae before they emerge into adults via using synthetic larvicides or botanical extracts as an alternative larvicide.

**Keywords:** Larvicidal activity, Herbal oil, Herbal extract

### 1. INTRODUCTION

Mosquitoes are responsible for the spread of more diseases than any other group of arthropods. Mosquito borne diseases still remain a major health problem in both human and veterinary sectors<sup>[1]</sup>. Mosquitoes belonging to three genera *Culex*, *Anopheles* and *Aedes* are known to transmit major mosquito borne diseases. Mosquitoes belonging to the genera *Anopheles*, *Culex* and *Aedes* are the vectors for the pathogens of different diseases such as malaria, filariasis, Japanese encephalitis, dengue and dengue haemorrhagic fever, epidemic polyarthritis, yellow fever and chikungunya. These diseases devastate Indian economy every year. Tropical areas are more vulnerable to parasitic diseases and the risk of contracting arthropod-borne illnesses is increased due to climate change and intensifying globalization. Worldwide, mosquitoes transmit diseases to more than 700 million people annually and are responsible for 1 death for every 17 people currently alive<sup>[2]</sup>. Mosquito control has become increasing difficult of the indiscriminate uses of synthetic chemical insecticides which has an adverse impact on the environment and disturb ecological balance. Majority of the chemical pesticides are harmful to man and animals, some of which are not easily degradable and spreading toxic

effects. The herbal preparations are the ones that do not produce any adverse effects in the non-target organisms and are easily biodegradable. Phytochemicals derived from plant sources can act as larvicides, insect growth regulators, repellents, and oviposition attractants<sup>[3]</sup>.

### 2. MOSQUITO LIFE CYCLE

Egg - hatch when exposed to water;

Larva - (pl. - larvae) lives in the water; molts several times; most species surface to breathe air;

Pupa - (pl. - pupae) non-feeding stage just prior to emerging as adult;

Adult - flies short time after emerging and after its body parveve have hardened.

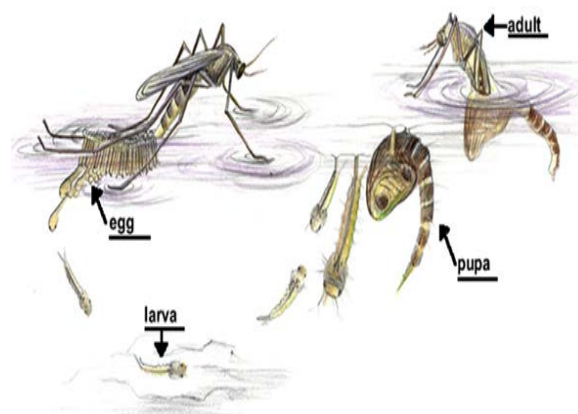


Figure 1: Mosquito life cycle

## 2.1 HERBAL OIL:

Essential oils play an important role in controlling several mosquito species. In general, essential oils from plants have been considered important natural resources to act as insecticides. Essential oils derived from various plants not only exhibit inhibitory activity against bacteria, fungi and termites but also show strong mosquito repellent and larvicidal activities. Herbs are obtained from the leaves of herbaceous or non-woody plants and various forms of herbs including dried leaves and teas<sup>[4]</sup>.

## 2.2 NEEM OIL

Neem seed oil is very bitter. Neem consists of the fresh or dried leaves and seed oil of *Azadirachata indica* of the family Meliaceae. With a garlic/sulfur smell and contains vitamin E and other essential amino acids. The various components of the oil are oleic acid, stearic acid, palmitic acid, linoleic acid and various lower fatty acids<sup>[5]</sup>. Oil contains azadirachtin, which is the most predominant insecticidal active ingredient, having antifeedant, ovipositional deterrence repellency, growth disruption, sterility and larvicidal action against insects. Azadirachtin acts as anti-ecdysteroid and kills larvae by growth inhibition effect. A neem oil formulation containing 32% neem seed oil, an emulsifier (5%) and 63% isopropanol (solvent). The larvae were exposed to different concentration of the formulation. The larvicidal activity of the formulation was evaluated against *Anopheles*, *Culex* and *Aedes* mosquitoes. The neem oil formulation was found effective in controlling mosquito larvae in different breeding sites under natural field conditions<sup>[6]</sup>.

## 2.3 CALAMUS OIL

*Acorus calamus L.* is a semi-evergreen perennial with scented rhizomes. The plants have long creeping roots that spread out just below the surface of the soil. These rhizomes spread horizontally and can grow to almost 2m in length for old, well-established specimen soil against the filarial vector mosquito, *Culex quinquefasciatus*. The essential oil was isolated by hydro-distillation and the chemical composition of the oil was analyzed by gas chromatography and gas chromatography-mass spectroscopy analysis. The larvicidal activity of the essential oil was analyzed at different concentrations, viz., 12.5, 25.0, 50.0, 100.0 and 200.0 mL/L. Early 4<sup>th</sup> instar larvae were used for the larvicidal assay. The larval mortality was

calculated after 24h of the exposure. The gas chromatography and gas chromatography-mass spectroscopy analysis showed that the essential oil extracted from the rhizome of *Acorus calamus* contained 20 chemical compounds representing about 99.99% of the total oil. Beta-asarone (33.36%), cis-beta-terpineol (23.44%), limonene (13.08%), carvone (5.64%) and amyl isovalerate (4.92%) were identified as the major chemical compounds. The essential oil had promising larvicidal effect against the early 4<sup>th</sup> instar larvae of *Culex quinquefasciatus* with LC50 value of 63.43 mL/L and LC90 value of 145.95 mL/L. The essential oil of *Acorus calamus* rhizome can be used as a natural larvicidal agent against the larvae of filarial vector mosquito, *Culex quinquefasciatus*<sup>[7]</sup>.

## 2.4 FENNEL OIL

Fennel is a flowering plant species in the carrot family. It is a hard, perennial herb with yellow flowers and feathery leaves. Highly aromatic and flavorful herb with medicinal uses. The main constituents are trans-anethole, fenchone, estragole, limonene and cis-anethole. The isolated oil from fennel aerial parts collected in Cape Verde and from a commercial fennel oil of Portugal were analysed by NMR, GC and GC-MS. Trans-Anethole (32 and 30%, respectively), limonene (28 and 18%, respectively) and fenchone (10% in both cases) were the main compounds identified in the oil isolated from fennel from Cape Verde and Portugal, respectively. The larvicidal activity of the oil and its major constituents were evaluated, using WHO procedures, against third instar larvae of *Aedes aegypti* for 24 h. Pure compounds, such as limonene isomers, were also assayed. The lethal concentrations LC50, LC90 and LC99 were determined by probit analysis using mortality rates of bioassays. A 99% mortality of *Aedes aegypti* larvae was estimated at 37.1 and 52.4 µL L<sup>-1</sup> of fennel oil from Cape Verde and Portugal, respectively. Bioassays showed that fennel oil from both countries displayed strong larvicidal effect against *Aedes aegypti*, the Cape Verde oil being as active as one of its major constituents, (-)-limonene<sup>[8]</sup>.

## 2.5 PEPPERMINT OIL

Peppermint oil is obtained from the leaves of the perennial herb, *Mentha piperita* L. and *Mentha arvensis* var. *piperascens* a member of the Labiatae family. Oil is colorless, pale yellow or pale

greenish-yellow liquid having characteristic odour and taste followed by a sensation of cold. It is freely soluble in ethanol (70%). India is world's largest producer and exporter of mint oil. The constituents and derivatives of mint oil are used in food, pharmaceutical and perfumery and flavouring industry. Its main constituent, menthol, is used in the manufacture of lozenges, toothpastes, pain balms, cold balms, Dabur Pudina Hara. The oil is present on the undersides of the leaves which can be extracted by steam distillation method. The oil obtained is further processed by rectification and fractionation before use<sup>[9]</sup>. Perkin Elmer 3920B Gas chromatograph was used for the chemical analysis of oil. The major components identified were menthol (81.1%), menthone (5.8%), isomenthone (4.9%), menthyl acetate (1.6%) and neomenthol (2.9%). *Aedes aegypti*, *Anopheles stephensi* and *Culex quinquefasciatus* by exposing third instar larvae of mosquitoes in enamel trays 6×4 inch sq size filled to a depth of 3 inch with water. Out of the 3 species tested *Culex quinquefasciatus* was more susceptible followed by *Aedes aegypti* and *Anopheles stephensi*. The oil showed strong repellent action against adult mosquitoes when applied on human skin<sup>[10]</sup>.

### 3. HERBAL EXTRACT

Plants are found to be alternative agents for control of mosquitoes as they possess bioactive chemicals, that has activity against species including specific target-insects. Many secondary metabolites present in plants shows defense mechanism against insect attacks. So these bioactive chemicals may act as insecticides, antifeedants, moulting hormones, oviposition deterrents, repellents, juvenile hormone mimics and growth inhibitors. The plant extracts and isolated compounds from different plant families were evaluated for their larvicidal activities.

Recent research proved the effectiveness of plant derived compounds, such as saponins, steroids, isoflavonoids, essential oils, alkaloids and tannins has potential mosquito larvicides. Plant secondary metabolites and their synthetic derivatives provide alternative source in the control of mosquitoes<sup>[11]</sup>.

#### 3.1 ALOEVERA LEAF EXTRACT

Aloe vera is a perennial plant belonging to the family Liliaceae. *Bacillus sphaericus* is a naturally occurring soil bacterium and its unique property is to control

mosquito larvae in water. *Aedes aegypti* is an arbovirus which is responsible for dengue fever. Aloe vera leaf extract and *Bacillus sphaericus* showed synergistic activity. They can also reduce physiological resistance in mosquito population<sup>[12]</sup>.

#### 3.2 SOLANUM VILLOSUM BERRY EXTRACT

*Solanum villosum* is an ayurvedic herb and commonly known as red-fruit night shade with multiple medicinal properties. Aqueous and polar/non-polar solvent extract of fresh, mature, green berries of *solanum villosum* is used. The isolated bioactive phytochemical from the plant could be used in stagnant water bodies which are known to be the breeding grounds for mosquitoes. It shows larvicidal activity against dengue vector *Stegomyia aegypti*<sup>[13]</sup>.

#### 3.3 PINUS CARIBAEA LEAF EXTRACT

*Pinus caribaea* is also known as Brazilian pine and it contains a chemical compound known as lignin. It is mainly used in wood industry. It contains resin used for the manufacture of gums, cleaning materials. The extract of *Pinus caribaea* were obtained by macerating dried leaves in alkaline hydroethanol, ethanol and acetone solutions followed by evaporation under reduced pressure. The lignin content was quantified using the thioglycolic acid complexation method. The acetone extract of *Pinus caribaea* is more active compared to other extracts and it shows its larvicidal activity against *Aedes aegypti*<sup>[14]</sup>.

#### 3.4 Elettaria Cardamomum Leaf Extract

Cardamom is a dried fruit of an herbaceous perennial plant belonging to the genus *Elettaria* and *Cardamomum* of the family Zingiberaceae. This plant is mainly found in southern India and Sri Lanka. Four different types of solvents are used for extraction and they are hexane, ethyl acetate, methanol and chloroform. The extraction was done by using Soxhlet apparatus. The larvicidal activity of crude extract was performed against the vector *Anopheles stephensi*. The maximum larvicidal activity was observed for methanol extract followed by chloroform, ethyl acetate and hexane leaf extract. The leaf extracts of plant *Elettaria cardamomum* was found to control the larvae stages of vector mosquitoes<sup>[15]</sup>.

### 3.5 VITEX NEGUNDO EXTRACT

*Vitexnegundo* is a large aromatic shrub up to 4-5 meters in height and they belong to the family Verbenaceae. It is used for its anti-inflammatory and analgesic activity. The extraction of the plant is done by using two solvents such as water and methanol. The aqueous and methanolic extract of *Vitexnegundo* has significant larvicidal activity against all the three species *Culexquinquefasciatus*, *Anopheles stephensi* and *Aedesaegypti*. The relationship between percentage mortality of larvae and logarithmic concentration of the substance was determined by probit regression model. Corrected mortality can be determined by Abbott's formula. Fractions of methanolic and aqueous extracts can be screened for its larvicidal activity and this would help to formulate an effective larvicidal drug<sup>[16]</sup>.

### 3.6 CASSIA OCCIDENTALIS EXTRACT

The plant *Cassia occidentalis* is described in Ayurveda and Siddha as a potent drug. The seeds are bitter, sweet, acrid, diuretic, expectorant and useful in ulcer, cough, fever, hiccup. The leaves are bitter, acrid, sweet, thermogenic and useful in the vitiated condition of vata and kapha leprosy. *Culexquinquefasciatus* is an important vector of Bancroftian filariasis in tropical and subtropical regions. The extraction was performed in Soxhlet apparatus. The solvents used for the extraction are petroleum ether and N-butanol. Larvicidal activity was performed in accordance with WHO guidelines. The percentage of crude mortality was corrected by Abbott's formula<sup>[17]</sup>.

### 4. CONCLUSION

The control of mosquito vectors has become more difficult because some mosquitoes have rapidly become resistant to insecticides and synthetic repellents. The plants high larvicidal activity is supported by the presence of phytochemicals such as alkaloids, saponins, flavonoids, steroids and tannins which showed combination effects in terms of larvicidal action to mosquito larvae. The plants are sources of potential mosquito larvicides and can be effectively used to produce less expensive and safe compounds to control mosquito vectors in India.

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