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Research Article

Effect of plant essential oils on the important mosquito vector, *Culex quinquefasciatus* (Say)

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Abstract

Objectives: Mosquitocidal activity of essential oils, *Mentha piperita* (L.), *Citrus limon* L. and *Rosmarinus officinalis* L. were tested against three mosquitoes. **Methods**: Twenty five early fourth instar larvae of *Culex quinquefasciatus* (*Cx. quinquefasciatus*) were exposed to various concentrations (20-100 ppm) and the 24 hrs LC_{50} and LC_{95} values of the *M. piperita*, *C. limon* and *R. officinalis* oils was determined by probit analysis. **Results**: The LC_{50} and LC_{90} values of *M. piperita* oil against *Cx. quinquefasciatus* were 47.16 and 92.65 ppm, respectively; *C. limon* were 51.12 and 98.18 ppm, respectively; For, *R. officinalis* were 55.75 and 105.57 ppm, respectively. **Conclusion**: The outcome clearly shows that larvicidal activity was dose reliant. From the results it can be concluded the *M. piperita* oil was an outstanding potential for controlling the vector mosquito *Cx. quinquefasciatus.*

Keywords: Larvicidal activity, *Mentha piperita, Citrus limon, Rosmarinus officinalis, Culex quinquefasciatus*

Introduction

Mosquito-borne diseases threaten the lives and livelihoods of millions of people worldwide. Malaria continues to be a major disease, infecting 300 million Africans annually, despite the progress that has been achieved using indoor residual spraying and insecticide treated bednets. It is increasingly difficult to control due to the spread of insecticide resistance in the mosquito vectors and also resistance of the parasite to the available drugs. Among them most important vector is *Cx. quinquefasciatus*. Lymphatic filariasis is one of the most important vector-borne diseases in India. In India high microfilarial rates have been recorded in northern and coastal parts of Andhra Predesh, Bihar, Tamil Nadu and Kerala and Coastal parts of Orissa and Eastern parts of Uttar Predesh. About 2.5 million people are exposed to the risk factors with about 2 million microfilarae carriers and 1.2 million disease cases occurs in India (Patel 2002).

Cx. quinquefasciatus, a vector of lymphatic filariasis affects 119 million people living in 73 countries, with India accounting for 40% of the global prevalence of infection (Ramaiah *et al.,* 2000). Japanese encephalitis a mosquito-borne viral disease is a serious public health problem in Asia (Libraty *et al.,* 2002) and it is highly endemic in few districts of Tamil Nadu, Southern India (Ravi *et al.,* 1989; Reuben and Gajanana1997). Increased mosquito nuisance in most urban areas is mainly because of *Cx. quinquefasciatus* (Batra *et al.,* 1995).

Therefore, this study provides first report on the mosquitocidal activity effect of *M. piperita*, *C. limon* and *R. officinalis* oils leaf extracts against *Cx. quinquefasciatus* as target species.

Materials and Methods

Collection of Plant

Some of the plant oils were extracted in the lab and some oils were purchased commercially from the authorized dealers in Ayurvedha Medical Shop, Keelaveethi Street, Nagapattinam, Tamil Nadu, India.

Culture of *Culex quinquefasciatus*

The egg rafts of *Cx. quinquefasciatus* were obtained from Vector Control Research Center (VCRC), Puducherry. The egg rafts were placed in Petri dishes (10.5 diameter) containing tap water. Larvae were fed with finely ground mixture of yeast and dog biscuits in 3:1 ratio. The first instar larvae developed into pupae through four stages in about 8 – 10 days. The pupae were transferred into mosquito cage for emergence. Blood meal from a pigeon was given to adult mosquitoes after three days of emergence. After 3 – 4 days of blood feeding for adult mosquitoes, the Petri dishes filled with tap water were placed inside the cage for oviposition. The egg rafts were separated and placed in glass Petri dishes for hatching.

Larvicidal activity

Larvicidal activity of the essential oil from *M. piperita*, *C. limon* and *R. officinalis* oils leaves were evaluated according to WHO (2005) protocol. Based on the wide range and narrow range tests, essential oil was tested at 20, 40, 60, 80 and 100 ppm. Essential oil were dissolved in 1 mL DMSO, and then diluted in 249 mL of water. Twenty five late third instar larvae were then introduced into each solution. For each concentration, five replicates were preformed, for a total of 100 larvae. Larval mortality was given to the larvae (Abbott, 1925).

Statistical analysis

The average larval mortality data were subjected to probit analysis for calculating LC_{50}, LC_{95} and other statistics at 95% fiducial limits of upper confidence limit and lower confidence limit, and chi-square values were calculated by using the software using Statistical Package of Social Sciences (SPSS). 12.0 For windows, significance level was set at $P<0.05$.

Results

Medicinal plants are potential on mosquito control. These plants can be used to develop environmentally safe vector and pest managing agents. The Chi-square value (Based on Probit Analysis) between the concentrations of plant oils against *Cx. quinquefasciatus* after 24 h exposure are represented in Table 1 and the *M. piperita, C. limon* and *R. officinalis* oils reported in the present study showed the larvicidal activity in the plant signifying their use in mosquito population control Figure 1.

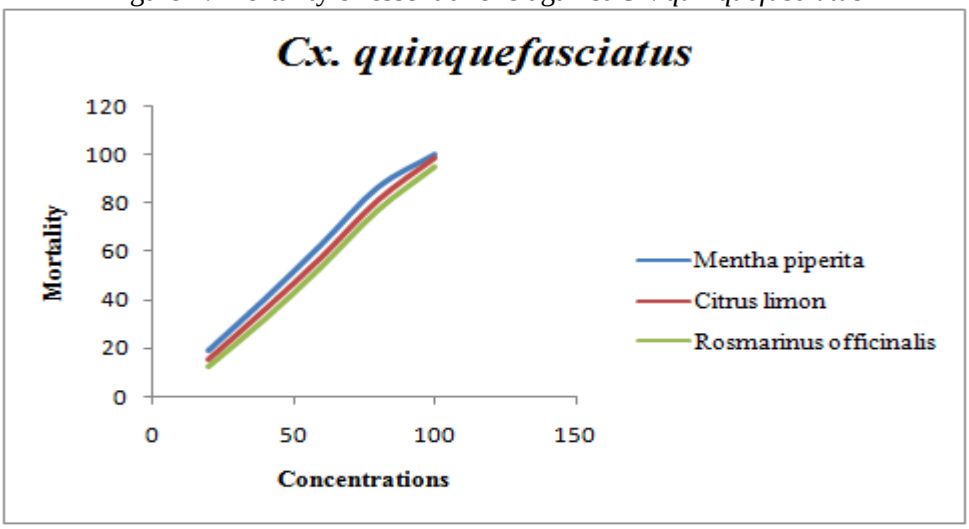
Table 1: Larvicidal activity of essential oils against *Cx. quinquefaciatus*

Essential oils	LC_{50} (mg/L)	95%Confidence limits		LC_{95} (mg/L)	95%Confidence limits		Chi-square (*df*)
		LCL	UCL		LCL	UCL	
M. piperita	47.16	43.26	50.83	92.65	86.15	101.20	4.858 (*3*)
C. limon	51.12	47.23	54.84	98.18	91.37	107.13	4.233 (*3*)
R. officinalis	55.75	51.79	59.61	105.57	98.18	115.33	1.063 (*3*)

LC_{50}= Lethal concentration that kills 50% of the exposed parasite, LC_{95}= Lethal concentration that kills 90% of the exposed parasite. LCL- Lower Confident Limit, UCL- Upper Confident Limit.

The result clearly indicated that petroleum ether and benzene whole plant extract at very low concentrations was toxic against the entire three mosquito species tested when compared to *pepper mint, lemon* and *rose merry* oils. The LC_{50} and LC_{95} value for *M. piperita* oil were 47.16 and 92.65 ppm, respectively. Further, the LC_{50} and LC_{95} value for *C. limon* oil were 51.12 and 98.18 ppm and LC_{50} and LC_{95} value for *R. officinalis* oil were 55.75 and 105.57 ppm, respectively.

Figure 1: Mortality of essential oils against *Cx. quinquefasciatus*



Discussion

Using essential oils to control mosquitoes is a better and environmentally safe option than the use of synthetic chemical pesticides. In the preliminary investigation, *M. piperita* oil showed 100% larvicidal activity against *Cx. quinquefasciatus*.

Pathak *et al.,* (2000) also reported higher susceptibility (LD_{90} 26, 27 and 18 ppm) of the three mosquito species (*Ae. aegypti*, *An. stephensi* and *Cx. quinquefasciatus*) to *T. erecta* essential oil, extracted from leaves. Conversely, studies conducted by Macedo *et al.,* (1997) showed that ethanol extract of *T. patula* was less active and only 50% larvae were killed at higher concentration (100 ppm). The variations in the toxicity of essential oil against different mosquito species are not uncommon (Sukumar *et al.,* 1991). It has been demonstrated that insecticidal activity and chemical composition of marigold species vary considerably depending on geographic location, growing conditions, plant parts from which they are extracted, developmental stage of plant, solvent used for extraction, photosensitivity of some of the compounds in the extract, and the methods used to isolate the essential oils (Singh *et al.,* 2001; Wells, 1993). Traboulsi *et al.,* (2005) reported that the larvicidal activity of essential oils of *Citrus sinensis*, *Eucalyptus* spp., *Ferrula hermonis*, *Laurus nobilis*, and *Pinus pinea* against *Cx. pipiens*. LC_{50} values were 60, 120, 44, 117, and 75 ppm, respectively. Zhu *et al.,* (2006) reported that LC_{50} value of 84 and 66 ppm against *Ae. albopictus* and *C. pipiens pipiens*, respectively. Eucalyptus oil in the present study showed LC_{90} value of 247.18 and 294.00 ppm against *An. stephensi* and *Cx. quinquefasciatus*, respectively at 24 h exposure. At 24 h exposure, eucalyptus oil showed LC_{90} value of 274.00 and 264 ppm against *Ae. albopictus* and *Cx. pipiens*, respectively. Tarelli *et al.,* (2009) reported that the knockdown time (KT_{50}) values obtained for orange oil was 10.1 minutes against the housefly, *Musca domestica.* KT_{50} values of 14, 20 and 18 min against *An. stephensi*, *Cx. quinquefasciatus and Ae. aegypti*, respect tively (Dua *et al.,* 2010) were recorded for an essential oil isolated from *Lantana camara*. Eucalyptus oil in the present study showed the KT_{50} values of 33.38, 31.34 and 32.33 min against *An. stephensi*, *Cx. quiquefasciatus* and *Ae. aegypti*, respectively.

Conclusion

In conclusion, the present plant oils have potential for the development of new and safe control products for mosquitoes. As naturally occurring insecticides, these plant-derived materials could be useful as an alternative for synthetic insecticides. In the present study, plant oils are easily available. Therefore, the usage of traditional plants oils should be promoted among the local residents in order to reduce the man–vector contact as well as vector-borne diseases. The screening results suggest that the *M. piperita* is promising in mosquito control.

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