RESEARCH ARTICLE

LARVICIDAL ACTIVITY OF THE ESSENTIAL OIL FROM Cestrum Nocturnum (SOLANACEA) AGAINST THREE SPECIES OF VECTOR MOSQUITOES

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ABSTRACT

The present investigation was carried out to evaluate the larvicidal activity of potential essential oil from Cestrum Nocturnum (Solanacea) against early third stage larvae of three mosquito species Anopheles gambiae, Culex quinquefasciatus and Aedes aegypti (Diptera: Culicidae). Essential oil was isolated by hydro-distillation and the chemical composition of the oil was analyzed by gas chromatography and gas chromatography mass spectroscopy. The larvicidal activity of the essential oil was analyzed at different concentrations, viz., 20, 40, 60, 80, 100 ppm and was assayed in the laboratory by using the protocol of WHO, 2005. Early third stage larvae were used for the larvicidal assay. The larval mortality was calculated after 24 h of exposure. The larvicidal assay was conducted to record the LC50 and LC90 values and the larval mortality was observed after 24 h of exposure treatment. The LC50 values of Cestrum nocturnum essential oil against third stage larvae of An. gambiae, Cx. quinquefasciatus and Ae.aegypti were 52.86, 52.44 and 56.38ppm. The LC90 values of Cestrum nocturnum essential oil against third stage larvae of An. gambiae, Cx. quinquefasciatus and Ae.aegypti were 90.91, 87.36 and 92.44ppm. The results showed susceptibility of the larvae of the three mosquito species to the essential oil tested even at low concentrations, and hence its potential use in the development of new agent with less toxic bioactive compounds from indigenous plant for mosquito control could be recommended.

INTRODUCTION

Mosquito-borne diseases including malaria, filariasis, dengue and different types of encephalitis are of public health concern. The malaria has been a major killer disease in many countries of Africa and Asia, where it affects approximately 300-500 million people annually, most often children (Garcia, 2010). In India 2-3 million cases of malaria and about 1,000 deaths are reported every year (Lal et al., 2010). So, the transmission of malaria is best reduced by the control of vector mosquitoes. In India, malaria is transmitted by six vector species, in which Anopheles stephensi is responsible in urban areas (Senthilkumar et al., 2009). Culex quinquefasciatus (Cx. quinquefasciatus) is a vector of lymphatic filariasis, while this disease is widely distributed in tropical areas with around 120 million people infected worldwide. Lymphatic filariasis alone affects at least 120 million people in 73 countries in Africa, Southeast Asia and Pacific Islands. These diseases not only cause high levels of morbidity and mortality but also inflict great economic loss and social disruption on developing countries such as India and China (Madhumathy, 2007). India alone contributes around 40% of global filariasis burden and the estimated annual economic loss is about 720 crores (Hotez, 2004). Also, owing to poor drainage system, especially during rainy seasons, the presence of many fish ponds, irrigation ditches and the rice fields provide abundant mosquito breeding places. Mosquito vector-borne diseases contribute to the major disease burden in India (Prabhu et al., 2011). Aedes albopictus, commonly known as the ‘tiger mosquito’ is an important vector of many arboviruses, including dengue and yellow fever (Aranda et al., 2006). It is widely distributed in the tropical and subtropical zones (Hales et al., 2002).

Ae. aegypti (L.) is very closely associated with the human habitat. The geographical range of Ae. aegypti (L.) is increasing rapidly due to excessive urbanization and increased global movement of people and cargo (Kyle and Harris, 2008). Some of the control strategies adopted includes the use of synthetic chemicals either as larvicides targeting the larvae in their breeding sites usually stagnant water or as insecticides to kill the adult mosquitoes. Instead of the much expected results, the use of synthetic insecticides has led to the disruption of natural biological control systems, development of resistance and resurgence in mosquito populations. Most often the use of synthetic insecticides results in undesirable effects on non-target organisms with the consequence of environmental pollution. The adverse effects associated with the use of synthetic insecticides had led to the search for alternative method of vector control. In this context, essential oils have received much attention as potentially useful bioactive compounds against insects (Mathew and Thoppil, 2011; Chowdhury et al., 2008). The application of easily degradable plant compounds is considered one of the safest methods in controlling insect pests and vectors (Sun et al., 2006). Recent studies showed that essential oils extracted from plants are those with the best results in this field and become potential candidates for the development of natural insecticides to control the mosquito borne diseases (Senthilkumar et al., 2008; Cheng et al., 2009).

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Essential oils can be used as an alternative to synthetic insecticides for vector control programmes. Essential oils are natural volatile substances found in a variety of plants. When isolated from plants, essential oils are not usually extracted as chemically pure substances but consist of mixtures of many compounds. It is well known that plant-derived natural products are extensively used as biologically active compounds. Among them, essential oils were the first preservatives used by man, originally in their natural state within plant tissues and then as oils obtained by water distillation (Bakkali et al., 2008). The essential oil (EO) extracted from fresh leaves of Hyptis suaveolens, and its main constituents were evaluated for larvicidal and repellent activity against the Asian tiger mosquito, Aedes albopictus (Conti et al., 2012). Liu et al. (2012) reported that the essential oil derived from the roots of Saussurea lappa and the isolated constituents had potential effect against the larvae of the mosquito Aedes albopictus. The present study was focused on the larvicidal activity of the essential oil from Cestrum nocturnum (Solanaceae) against early third stage larvae of Anopheles gambiae, Culex quinquefasciatus and Aedes aegypti (Diptera: Culicidae).

MATERIALS AND METHODS

Essential oil

Cestrum nocturnum essential oil (Solanaceae) was commercially purchased from Madras Oil Company, 174, Govindappa Naicken Street, Parrys, Chennai, Tamilnadu - 600 001.

Test organisms

The mosquitoes Anopheles gambiae, Culex quinquefasciatus and Aedes aegypti were reared in the vector control laboratory, Department of Zoology, Annamalai University. The larvae were fed on dog biscuits and yeast powder in 3:1 ratio. Adults were provided with 10% sucrose solution and blood meal from one week old chick. Mosquitoes were reared at 28 ± 2°C temperature, 70 - 85 % relative humidity (RH), with a photo period of 12 h light, 12 h dark.

Larvicidal activity

Larvicidal activity of the Cestrum nocturnum essential oil was evaluated according to WHO protocol (WHO). Based on the wide range and narrow range tests, the essential oil was tested at 20, 40, 60, 80 and 100 ppm. Essential oil was dissolved in 1 ml DMSO, and then diluted in 249 ml of filtered tap water to obtain each of the desired concentrations. The control was prepared using 1 ml of DMSO in 249 ml of water. Twenty late third instar larvae were then introduced into each solution. For each concentration, five replicates were performed, for a total of 100 larvae. Larval mortality was recorded at 24 h after exposure, during which no food was given to the larvae. The lethal concentrations (LC50 and LC90) were calculated by probit analysis (Finney, 1971).

Statistical analysis

The average larval mortality data were subjected to probit analysis for calculating LC50, LC90 and other statistics at 95% of upper confidence limit and lower confidence limit, and Chi-square values were calculated using the SPSS 12.0 (Statistical Package of Social Sciences) software. Results with p<0.05 were considered to be statistically significant.

RESULTS

The efficacy of Cestrum nocturnum essential oil was tested against the early third larvae of Anopheles gambiae, Culex quinquefasciatus and Aedes aegypti. The data were recorded and statistical data regarding the LC50, LC90, Chi-square and 95% confidence limits were calculated. The LC50 values of Cestrum nocturnum essential oil against third stage larvae of An. gambiae, Cx. quinquefasciatus and Ae.aegypti were 52.86, 52.44 and 56.38 ppm respectively. The LC90 values of Cestrum nocturnum essential oil against third stage larvae of An.gambiae, Cx. quinquefasciatus and Ae.aegypti were 90.91, 87.36 and 92.44 ppm respectively (Table). No mortality was observed in the control. The chi-square values were significant at p<0.05 level.

DISCUSSION

The results of the present study showed that Cestrum nocturnum essential oil was effective against Anopheles gambiae, Culex quinquefasciatus and Aedes aegypti. The petroleum ether extract of Z. limonella (fruit) had repellent activity against Aedes aegypti and An. stephensi respectively. The essential oil of C. citratus was observed to have an LC50 of 69 ppm against Ae. aegypti larvae (Cavalcanti et al., 2004) and 165.7ppm against Cx. quinquefasciatus larvae (Pushpanathan et al., 2006). LC50 of C. longifolia essential oil against Ae. aegypti and Cx. quinquefasciatus were 12.5 and 9.2 mg/l respectively (Ranaweera et al., 1996).

<table>
<thead>
<tr>
<th>Mosquito species</th>
<th>Concentration (ppm)</th>
<th>Percentage of mortality ± SD</th>
<th>L50 (LCL- UCL)</th>
<th>L90 (LCL- UCL)</th>
<th>χ2</th>
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<tbody>
<tr>
<td>Anopheles gambiae</td>
<td>20</td>
<td>22.1 ± 1.4</td>
<td>52.86 (39.07-66.15)</td>
<td>90.91 (75.58-122.81)</td>
<td>21.681</td>
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<td>40</td>
<td>45.0 ± 1.0</td>
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<td>60</td>
<td>66.1 ± 0.5</td>
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<td></td>
<td>80</td>
<td>88.9 ± 1.6</td>
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<td>100</td>
<td>99.0 ± 1.8</td>
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<td>25.3 ± 1.6</td>
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<td>40</td>
<td>41.0 ± 1.9</td>
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<td>63.0 ± 1.6</td>
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<td>80</td>
<td>83.1 ± 1.0</td>
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<td>20</td>
<td>26.0 ± 1.9</td>
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<td>48.1 ± 1.8</td>
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<td>60</td>
<td>68.8 ± 0.6</td>
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<td>80</td>
<td>89.2 ± 1.8</td>
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<td></td>
<td>100</td>
<td>95.1 ± 1.8</td>
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</table>

Table Larvicidal activity of Cestrum nocturnum essential oil (Solanaceae) against three mosquito species.
The essential oil of Cestrum nocturnum was found to have larvicidal activity against Cx. quinquefasciatus with the LC50 of 50.78 ppm (Pushpanathan et al., 2008). The essential oil of Mentha longifolia had been reported for larvicidal activity against Culex pipiens. The oil contained 20% of limonene and had the LC50 value of 78.28 mg/L after 48 h of exposure. Koliopoulos et al. (2010), Eleni et al. (2009) reported the larvicidal activity of limonene rich essential oil from Citrus aurantium subsp. bergamia against West Nile virus vector, Culex pipiens. The oil had the LC50 value of 58.73 mg/L (Eleni et al., 2009). The essential oil from the leaves of C. anisata exhibited significant larvicidal activity, with 24 h LC50 values of 140.96, 130.19 and 119.59 ppm, respectively. The results of the present study suggest that the essential oil of Cestrum nocturnum may be found effective in controlling mosquito larvae in different breeding sites under natural field conditions. Cestrum nocturnum is cultivated as a major aromatic plant in Tamil Nadu and these essential oil formulations are relatively less toxic, eco-friendly and insects are unable to develop resistance and may be used as an alternative to other pesticides for the control of vector-borne disease.

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References


