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Research Article

OVICIDAL EFFICACY OF *AGERATINA ADENOPHORA* (FAMILY:ASTERACEAE) AGAINST *ANOPHELES STEPHENSI* (DIPTERA: CULICIDAE)

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ABSTRACT

Mosquitoes are blood-feeding insects and serve as the most important vectors for spreading human diseases such as malaria, yellow fever, dengue fever, and filariasis. The continued use of synthetic insecticides has resulted in resistance in mosquitoes. Synthetic insecticides are toxic and affect the environment by contaminating soil, water, and air, and then natural products may be an alternative to synthetic insecticides because they are effective, biodegradable, eco-friendly, and safe to environment. Botanical origin may serve as suitable alternative biocontrol techniques in the future. The ovicidal efficacy of different extracts of *Ageratina adenophora* (*A. adenophora*) against *Anopheles stephensi* (*An. stephensi*) (Diptera: Culicidae). Larvicidal efficacy of the crude leaf extracts of *A. adenophora* with five different solvents like hexane, benzene, chloroform, ethyl acetate and methanol was tested against the early third instar larvae of *An. stephensi*. The ovicidal activity was determined against *An. stephensi* mosquito species to various concentrations ranging from 75-450 mg/L under the laboratory conditions. Among five solvent extracts tested, the methanol extract have most promising ovicidal activity. The methanol extract exerted zero hatchability (100% mortality) at 300 mg/L. From the results it can be concluded the crude extract of *A. adenophora* was a potential for controlling *An. stephensi* mosquito eggs.

Keywords: *Anopheles stephensi*, *Ageratina adenophora*, Leaf, Ovicidal activity.

INTRODUCTION

Mosquitoes are responsible for more diseases than any other group of arthropods. Mosquito-borne diseases, such as malaria, filariasis, dengue/DHF, yellow fever, and Japanese encephalitis, contribute significantly to disease burden, death, poverty, and social debility in tropical countries. Among these diseases, malaria continues to be a major public health problem in most tropical countries. *Anopheles stephensi* L. is the primary vector of malaria in India and other West Asian countries, and improved methods of control are urgently needed (Burfield and Reekie 2005). Malaria infects more than 500 million humans each year, killing approximately 1.2 to 2.7 million/year. About 90 % of all malaria cases occur in Africa, as does approximately 90 % of the world's malaria-related deaths (Breman *et al.*, 2004). Malaria, caused by *Plasmodium falciparum*, is one of the leading causes of human morbidity and mortality from infectious diseases, predominantly in tropical and subtropical countries (Snow *et al.*, 2005).

Mosquito control relies heavily on synthetic insecticide application. However, over and injudicious application of synthetic insecticides resulted into resistance to these insecticides and unwarranted toxic or lethal effects on non target organisms, as well as environmental/health problem. As an alternate, biological control of mosquitoes could be very promising being eco-friendly as well as cost effective. Hence, there is

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a constant need for developing biologically active plant materials as insecticides, which are expected to reduce the hazards to humans and other organisms by minimizing the accumulation of harmful residues in the environment. Natural products of plant origin are generally preferred because of their less harmful nature to nontarget organisms and their innate bio-degradability (Govindarajan and Sivakumar, 2012a). Botanicals can be used as alternative synthetic insecticides or along with other insecticides under integrated vector control programmes. The larvicidal and ovicidal potential of the crude hexane, benzene, chloroform, ethyl acetate and methanol solvent extracts from the medicinal plant *Pithecellobium dulce* against the mosquito vectors, *An. stephensi* and *Ae. aegypti* (Govindarajan *et al.*, 2013). The ovicidal and repellent activities of acetone, benzene, ethyl acetate, hexane and methanol extracts of *Melothria maderaspatana* against *Ae. aegypti* (Baluselvakumar *et al*., 2012). The adulticidal activity of hexane, ethyl acetate, benzene, chloroform and methanol leaf extracts of *C. halicacabum* against *Cx. quinquefasciatus*, *Ae. aegypti* and *An. stephensi* (Govindarajan and Sivakumar 2012b). The leaf extract of *A. indica* with different solvents viz., benzene, chloroform, ethyl acetate, and methanol was tested for larvicidal, ovicidal activity, and oviposition attractancy against *An. stephensi* (Govindarajan *et al*., 2008a). Govindarajan *et al*. (2011) evaluated the ovicidal and repellent activities of methanol leaf extract of *Ervatamia coronaria* and *Caesalpinia pulcherrima* against *Cx. quinquefasciatus, Ae. aegypti*, and *An. stephensi*. The larvicidal and repellent properties of essential oils from various parts of four plant species *Cymbopogan citrates, Cinnamomum zeylanicum, Rosmarinus officinalis*, and *Zingiber officinale* against *Cx. tritaeniorhynchus* and *An. subpictus* (Govindarajan, 2011). The present investigation was undertaken to study the effect of *A. adenophora* leaf extracts against eggs of *An. stephensi* in a search for effective natural products to be used in the control of malaria.

MATERIALS AND METHODS

Collection of plants

Fully developed leaves of *A. adenophora* were collected from hilly regions of the Nilgiris District, Tamil Nadu, India. It was authenticated by a plant taxonomist from the Department of Botany, Annamalai University. A voucher specimen is deposited at the herbarium of Plant Phytochemistry Division, Department of Zoology, Annamalai University, India.

Extraction

The leaves were washed with tap water, shade-dried, and finely ground. The finely ground plant leaf powder (1.0 kg/ solvent) was loaded in Soxhlet apparatus and was extracted with five different solvents, namely hexane, benzene, chloroform, ethyl acetate, and methanol, individually. The solvents from the extracts were removed using a rotary vacuum evaporator to collect the crude extract. Standard stock solutions were prepared at 1% by dissolving the residues in ethanol. From this stock solution, different concentrations were prepared, and these solutions were used for ovicidal bioassays.

Test organisms

An. stephensi were reared in the vector control laboratory, Department of Zoology, Annamalai University. The larvae were fed on dog biscuits and yeast powder in the 3:1 ratio. Adults were provided with 10% sucrose solution and 1-week-old chick for blood meal. Mosquitoes were held at 28±2°C, 70–85% relative humidity (RH), with a photoperiod of 12 h light, 12 h dark.

Ovicidal activity

The ovicidal activity, slightly modified method of Su and Mulla (1998) was performed. The eggs of *An. stephensi* were collected from vector control laboratory, Annamalai University. The leaf extracts were diluted in the ethanol to achieve various concentrations ranging from 75 to 450 mg/L. Eggs of these mosquito species (100) were exposed to each concentration of leaf extracts. After treatment, the eggs from each concentration were individually transferred to distilled water cups for hatching assessment after counting the eggs under microscope. Each experiment was replicated six times along with appropriate control. The hatch rates were assessed 48 h post-treatment by the following formula.

$$\% \text{ of egg hatchability} = \frac{\text{No. of hatched larvae}}{\text{Total no. of eggs}} \times 100$$

RESULTS

The result of the ovicidal activity of crude hexane, benzene, chloroform, ethyl acetate, and methanol solvent extracts of leaf of *A. adenophora* against the vector mosquito *An.*

Table 1. Ovicidal activity of *Agerantina adenophora* plant leaf extracts against *Anopheles stephensi.*

Name of the solvent	Percentage of egg hatch ability						
	Concentration (ppm)						
	Control	75	150	225	300	375	450
Hexane	100±0.0	69.1±2.1	56.4±1.6	49.1±1.9	36.7±1.4	23.9±2.0	NH
Benzene	100±0.0	64.6±1.0	53.6±1.8	46.5±2.0	33.8±1.6	21.5±1.5	NH
Chloroform	100±0.0	58.2±1.4	49.2±1.9	38.6±1.8	26.2±1.5	NH	NH
Ethyl acetate	100±0.0	52.8±1.1	45.8±1.2	29.4±1.5	NH	NH	NH
Methanol	100±0.0	48.4±1.2	36.9±1.0	24.9±1.4	NH	NH	NH

NH- No hatch ability.

stephensi are presented in Table 1. Among the extracts tested for ovicidal activity against *An. stephensi* the leaf methanol extract of *A. adenophora* exerted 100% mortality (zero hatchability) at 300 mg/L. The leaf extract of *A. adenophora* was found to be most effective against eggs of vector mosquito. Control eggs showed the 100% hatchability.

DISCUSSION

Crude extracts from plants have been used as insecticides in many countries for centuries. Crude plant extracts often consist of complex mixtures of active compounds. Advances of using complete mixture may act synergistically, they may show greater overall bioactivity compared to the individual constituents. In the present result is also comparable to earlier report of Xue and Barnard (2006) reported that the oviposition deterrent effectiveness (76–100% repellency) against *Ae. albopictus* of 21 commercial insect repellent products (at 0.1% concentration), including 12 botanical, six deet-based, and three synthetic organics. The larvicidal, ovicidal, and repellent activities of crude benzene and ethyl acetate extracts of leaf of *Ervatamia coronaria* and *Caesalpinia pulcherrima* were assayed for their toxicity against three important vector mosquitos (Govindarajan *et al*., 2011). The leaf methanol, benzene, and acetone extract of *C. fistula* were studied for the larvicidal, ovicidal, and repellent activity against *Ae. aegypti*, and the mortality was observed in 24 h LC_{50} concentration of the extracts at 10.69, 18.27, and 23.95 mg/l, respectively (Govindarajan *et al*., 2008b). Autran *et al*. (2009) have reported that the essential oil from leaves and stems of *Piper marginatum* exhibited an oviposition deterrent effect against *Aedes aegypti* at 50 and 100 ppm in that significantly lower numbers of eggs (<50%) were laid in glass vessels containing the test solutions compared with the control solution. Govindarajan (2010) evaluated larvicidal activity of crude extract of *Sida acuta* against three important mosquitoes with LC_{50} values ranging between 38 to 48 mg l-1.

CONCLUSIONS

From these results, it was concluded that the plant *A. adenophora* exhibits ovicidal activity against vector mosquito. The flora of India has rich aromatic plant diversity with potential for development of natural insecticides for control of mosquito and other pests. These results could encourage the search for new active natural compounds offering an alternative to synthetic insecticides from other medicinal plants.

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CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest associated with this article.

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