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Short communication

Larvicidal activity of some essential oil hydrolates against dengue and filariasis vectors

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Essential oil hydrolates are aqueous solutions obtained during the steam distillation of medicinal and aromatic plants. The hydrolates of four plants - *Zanthoxylum limonella, Zingiber officinale, Curcuma longa* and *Cymbopogon citratus* were evaluated for their larvicidal activity against two laboratory reared mosquito species - *Aedes albopictus* and *Culex quinquefasciatus*. The hydrolate of *Z. limonella* was most effective against both *Ae. albopictus* and *Cx. quinquefasciatus* with LC_{50} 11 and 15.5 (%v/v) respectively. The larvicidal activity of hydrolates of *Z. officinale*, *C. longa* and *C. citratus* were also found promising with LC_{50} of at 15.8, 24.7 and 33.7 (%v/v) respectively against *Ae. albopictus* and 21.8, 35.5 and 38.8 (%v/v) against *Cx. quinquefasciatus*. The results suggest the potential utilisation of hydrolates of essential oils for the control of mosquito populations.

Keywords: Essential oil ;Hydrolates ;Larvicidal activity ; *Aedes albopictus ;Culex quinquefasciatus.*

INTRODUCTION

Mosquito-borne diseases such as malaria, filariasis, dengue, yellow fever and Japanese encephalitis are major public health problems in tropical and subtropical regions (Dua et al., 2010). *Aedes albopictus*, commonly known as the 'tiger mosquito' is an important vector of many arboviruses, including dengue and yellow fever (Aranda et al., 2006) whereas the tropical house mosquito *Culex quinquefasciatus* is the principal vector of lymphatic filariasis (Ramaiah et al., 2000). The control of these diseases is largely dependent on spraying of chemical insecticides to kill mosquito adults or larvae. Larviciding is an effective method to reduce the mosquito densities before they emerge as adults and synthetic insecticides have been widely used for this purpose (Tiwary et al., 2007). However, the overreliance on synthetic chemicals for mosquito control has resulted in the development of insecticide resistance in mosquitoes (Hemingway et al., 2000). Repeated use of synthetic insecticides has given rise to several environmental and health concerns and has highlighted the need for novel strategies for control of mosquito larvae (Cheng et al., 2009). Hence, there is a renewed interest in the exploration and use of plant products with insecticidal properties for mosquito control.

Essential oils are volatile fractions obtained by steam or water distillation of medicinal and aromatic plants. The major constituents of essential oils are monoterpenes and sesquiterpenes (Mohamed et al., 2010). These oils have characteristic fragrances and are used in perfumes, cosmetics and as food additives(Ebrahimi et al., 2011)

Essential oils of many plants were observed to have mosquito larvicidal property (Phasomkusolsil et al., 2010) and are used for the treatment in various diseases. The aqueous solutions obtained as the by-products of steam distillation of essential oils are known as the hydrolates, which contain many bioactive hydrophilic compounds (De Lima et al., 2006). Alcohol terpenes and phenols are reported to be present in the condensed waters (hydrolates), which make them potential alternatives to be used in industry and can enhance added values in new endeavours (Lira et al., 2009). Hydrolates are being used in traditional medicine for the treatment of various ailments (Esfahani et al., 2004). The hydrolates of some plants have been observed to have mosquito larvicidal activity (Carvalho et al., 2003; De Lima et al., 2006). In the present study, the hydrolates of *Zanthoxylum limonella* (Rutaceae), ginger (*Zingiber officinale*; Zingiberaceae), turmeric (*Curcuma longa*; Zingiberaceae) and lemon grass (*Cymbopogon citratus*; Poaceae) were evaluated for their larvicidal activity against *Aedes albopictus* and *Culex quinquefasciatus* (Table 1).

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Table 1: Mosquito larvicidal efficacy of essential oil hydrolates against *Aedes albopictus* and *Culex quinquefasciatus*

Plant species	Part used	*Aedes albopictus*			*Culex quinquefasciatus*		
		LC_{50} (% v/v)	LC_{90} (% v/v)	Regression equation	LC_{50} (% v/v)	LC_{90} (% v/v)	Regression equation
Zanthoxylum limonella	Pericarp	11.0	19.4	Y=5.0418x-0.2528	15.5	25.8	Y=5.3049x-1.3348
Zingiber officinale	Leaf	15.8	37.2	Y= 3.3737x + 0.9331	21.8	51.7	Y=3.3793x+0.4231
Curcuma longa	Leaf	24.7	43.8	Y= 4.7407x – 1.6069	35.5	52.5	Y=6.9789x-5.8296
Cymbopogon citratus	Leaf	33.7	49.2	Y= 6.9568x –5.6468	38.8	61.3	Y=5.8635x–4.3547

MATERIALS AND METHODS

The hydrolates of *Zanthoxylum limonella* (pericarp), *Zingiber officinale* (leaf), *Curcuma longa* (leaf) and *Cymbopogon citratus* (leaf) were obtained from a steam distillation plant in Sonitpur district of Assam, India. The larvicidal properties of the hydrolates were evaluated under laboratory conditions (27±2ºC and 75±5% RH) against laboratory reared third instar larvae of *Aedes albopictus* and *Culex quinquefasciatus* as per WHO standard of larval susceptibility test method (WHO 1981). Hydrolate concentrations ranging from 5 to 65 (percent volume/volume) were prepared by diluting with water. The percent larval mortality after 24 hours of treatment was recorded and corrected by using Abbott's formula (Abbott WS, 1952) and probit analysis (Finney DJ, 1971) was carried out to establish LC50 and LC90.

RESULTS AND DISCUSSION

Zanthoxylum is a large genus of aromatic, prickly trees or shrubs distributed in the pantropics and subtropics. Many aromatic compounds have been isolated from the essential oil while vitamin E was detected in the seed oil of *Z. limonella* (Somanabandhu et al., 1992). The essential oil and petroleum ether extract of *Z. limonella* (fruit) have repellent activity against *Aedes albopictus* mosquitoes (Das et al., 2003).The chloroform extract of the fruits was shown to have antimalarial and antituberculosis activities (Charoenying et al., 2008) The hydrolate of *Z. limonella* was most effective against both *Ae. albopictus* and *Cx. quinquefasciatus*. Studies on the larvicidal activity of *Z. armatum* essential oil against *Ae. aegypti* and *Cx. quinquefasciatus* indicated LC50 of 54 and 49 ppm respectively (Tiwary et al., 2007). In the present study, the LC50 and LC90 of *Z. limonella* hydrolate were recorded as 11 and 19.4 (% v/v) respectively against *Aedes albopictus* and 15.5 and 25.8 (% v/v) against *Culex quinquefasciatus* larvae.

Ginger (*Z. officinale*) is an important ingredient in Chinese, Ayurvedic and Unani medicines for the treatment of arthritis, rheumatism, gingivitis, asthma and diabetes. The yield of volatile oil ranges from 1 to 3% and it contains mainly mono and sesquiterpenoids (Ali et al., 2008). The essential oil was found to have larvicidal activity against *Cx. quinquefasciatus* with LC50 of 50.78ppm (Pushpanathan et al ., 2008). The LC50 and LC90 values of *Z. officinale* hydrolates were 15.8 and 37.2 (%v/v) respectively against *Ae. albopictus* and 21.8 and 51.7 (%v/v) against *Cx. quinquefasciatus*. Turmeric (*C. longa*) is widely used as a spice and a colouring agent. Sesquiterpenes and curcuminoids isolated from the rhizome are shown to have anti-inflammatory, antioxidant and antimicrobial activities (Singh et al., 2002). LC50 of *C. longa* essential oil against *Ae. aegypti* and *Cx. quinquefasciatus* were 12.5 and 9.2 mg/l respectively (Ranaweera et al., 1996). The hydrolate of *C. longa* was having LC50 and LC90 of 24.7 and 43.8 (%v/v) against *Ae. albopictus* and 35.5 and 52.5 (%v/v) against *Cx quinquefasciatus* respectively. The ethanol extracts of *Z. officinale* and *C. longa* had LC50 of 270.6 and 106.38 mg/l against the larvae of *Ae. aegypti* (Komalamisra et al., 2005).

The genus *Cymbopogon* has about 55 species of grasses and is distributed in the tropics and subtropics (Matasyoh et al., 2011) The essential oil obtained from Lemon grass (*C. citratus*) has a lemon flavour and contains citral as the major constituent. Lemon grass oil is used as a food additive and for treatment of respiratory infections (Ha et al., 2008) and also in perfumery and body care products (Koffi et al., 2009). The essential oil of *C. citratus* was observed to have an LC50 of 69ppm against *Ae. aegypti* larvae (Cavalcanti et al., 2004) and 165.7ppm against *Cx. quinquefasciatus* larvae (Pushpanathan et al., 2006). The hydrolate of *C. citratus* was found to have the least larvicidal activity among the four plants tested, having LC50 and LC90 of 33.7 and 49.2 against *Ae. albopictus* respectively and 38.8 and 61.3 against *Cx quinquefasciatus*.

The management of vector mosquitoes is an important component in the strategies to manage mosquito-borne diseases. Synthetic insecticides have been in use for the control of mosquito larvae around the world. However, due to the environmental concerns over the safety of these chemicals, the focus has been shifted to the use of natural products for larval control. The present studies revealed the potential use of essential oil hydrolates as mosquito larvicides. Since, hydrolates are byproducts of steam distillation of essential oils they can be easily obtained from the distillation plants. These can be used as an eco-friendly and safe alternative to the chemical larvicides. More studies need to be conducted on the larvicidal activities and chemical composition of hydrolates from other plant sources.

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