

Behavioral responses of *Aedes aegypti*, *Aedes albopictus*, *Culex quinquefasciatus*, and *Anopheles minimus* against various synthetic and natural repellent compounds

Sunaiyana Sathantriphop¹, Sabrina A. White², Nicole L. Achee³, Unchalee Sanguanpong⁴, and Theeraphap Chareonviriyaphap¹✉

¹Department of Entomology, Faculty of Agriculture, Kasetsart University, Bangkok 10900, Thailand: faasthc@ku.ac.th

²Department of Entomology and Nematology, University of Florida, Gainesville, FL 32611, U.S.A.

³Eck Institute for Global Health, Department of Biological Sciences, University of Notre Dame, Notre Dame, IN 46556, U.S.A.

⁴Institute of Research and Development, Rajamangala University of Technology Thanyaburi, Patumthani 12110, Thailand

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ABSTRACT: The behavioral responses of colony populations of *Aedes aegypti*, *Aedes albopictus*, *Culex quinquefasciatus*, and *Anopheles minimus* to four essential oils (citronella, hairy basil, catnip, and vetiver), two standard repellents (DEET and picaridin), and two synthetic pyrethroids (deltamethrin and permethrin) were conducted in the laboratory using an excito-repellency test system. Results revealed that *Cx. quinquefasciatus* and *An. minimus* exhibited much stronger behavioral responses to all test compounds (65-98% escape for contact, 21.4-94.4% escape for non-contact) compared to *Ae. aegypti* (3.7-72.2% escape (contact), 0-31.7% (non-contact)) and *Ae. albopictus* (3.5-94.4% escape (contact), 11.2-63.7% (non-contact)). In brief, essential oil from vetiver elicited the greatest irritant responses in *Cx. quinquefasciatus* (96.6%) and *An. minimus* (96.5%) compared to the other compounds tested. The synthetic pyrethroids caused a stronger contact irritant response (65-97.8% escape) than non-contact repellents (0-50.8% escape for non-contact) across all four mosquito species. Picaridin had the least effect on all mosquito species. Findings from the current study continue to support the screening of essential oils from various plant sources for protective properties against field mosquitoes. **Journal of Vector Ecology 39 (2): 328-339. 2014.**

Keyword Index: *Aedes aegypti*, *Aedes albopictus*, *Culex quinquefasciatus*, *Anopheles minimus*, excito-repellency, non-contact repellent, contact irritant.

INTRODUCTION

There are various mosquito-borne diseases transmitted to humans by the bites of infected mosquitoes, including malaria (protozoa), dengue (virus), Japanese encephalitis (virus), chikungunya (virus), and yellow fever (virus). *Aedes aegypti* is the main vector of dengue and yellow fever viruses, whereas *Aedes albopictus* is a secondary dengue vector and a main vector of chikungunya virus (Thavara et al. 2009). *Culex quinquefasciatus* is an abundant nuisance mosquito in urban areas. It has been reported that *Cx. quinquefasciatus* in Thailand is a potential vector of Japanese encephalitis virus (JEV) (Nitapattana et al. 2005). Moreover, *Cx. quinquefasciatus* in Thailand was first reported to be susceptible to the nocturnal periodic strain of Myanmar *Wuchereria bancrofti* that causes human lymphatic filariasis (Triteeraprapab et al. 2000). *Anopheles minimus* is now the most important malaria vector in Thailand and occurs in hilly, forested areas. Malaria is a serious and sometimes fatal disease that is routinely reported along the Thai-Cambodia and Thai-Myanmar borders as well as the southern part of Thailand (Chareonviriyaphap et al. 2013, Suwonkerd et al. 2013).

Among the many strategies that have been used for mosquito control are insecticides and repellents. Synthetic pyrethroids are widely used for controlling adult mosquitoes, especially deltamethrin and permethrin, as recommended by the World Health Organization. The Ministry of Public

Health of Thailand has used these two pyrethroid insecticides for space spraying applied via fogging or misting machines and mosquito net treatments (Chareonviriyaphap et al. 1999, Jirakanjanakit et al. 2007). Previous studies have found that both deltamethrin and permethrin elicit strong contact irritant response in mosquito vectors (Chareonviriyaphap et al. 2004, 2012, 2013, Kongmee et al. 2004, Mongkalagoon et al. 2009).

The term “excito-repellency” is used to describe mosquito behavior that is triggered by the combination of either irritancy or repellency. Irritancy results from direct tarsal contact with an insecticide that can cause a mosquito to leave treated surfaces before acquiring a lethal dose, therefore repeated contact is required before mortality occurs (Roberts et al. 2000). On the other hand, repellency refers to the stimulation by a chemical that orients mosquito movement away from the treated surfaces without making tarsal contact (Roberts et al. 2000). These forms of behavioral responses can be quantitatively assessed by using an excito-repellency test system (Roberts et al. 1997).

For personal protection, DEET (N,N-Diethyl-metaltoluamide) is the most common active compound used as insect repellents with a strong effect against mosquitoes (Fradin and Day 2002, Klun et al. 2006). However, DEET has been shown to have toxic effects on humans, especially when misapplied at very high concentrations and used often or over a long period of time (Robbins and Cherniack 1986, Qui et al.