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ORIGINAL PAPER

Behavioral responses of *Aedes aegypti* and *Culex quinquefasciatus* (Diptera: Culicidae) to four essential oils in Thailand

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Abstract The behavioral effects of four essential oils extracted from orange peel (*Citrus aurantium* L.), cinnamon leaf (*Cinnamomum verum* J. Presl), citronella grass (*Cymbopogon winterianus* Jowitt), and clove flower [*Syzygium aromaticum* (L.) Merrill & Perry] were evaluated against two medically important species of mosquitoes, *Aedes aegypti* (L.) and *Culex quinquefasciatus* Say, using an excito-repellency test system. *Ae. aegypti* was collected from a small village in Kanchanaburi Province and *Culex quinquefasciatus* was captured from an urban area of Bangkok. Mosquitoes from the F1–F3 generations were tested in the excito-repellency test chamber for contact excitation and non-contact spatial repellency. Results showed that both species demonstrated varying levels of behavioral escape responses to different essential oils, showing a clear dose response depending on percent w/v concentration used. Orange oil produced the least response in both mosquito species, while citronella and clove the greatest. In general, *Cx. quinquefasciatus* exhibited much stronger behavioral responses to all four essential oils than *Ae. aegypti.* From this study, we conclude that the essential oils from various botanical sources should continue to be screened for protective properties against mosquitoes and other biting arthropods.

Keywords *Aedes aegypti* · *Culex quinquefasciatus* · Essential oils · Behavioral responses · Excito-repellency test system

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Introduction

Approximately 4,000 known species of mosquitoes have been described throughout the world with some species having wide cosmopolitan distributions in the urban and peri-urban settings in close association with humans, most notably *Aedes* (*Stegomyia*) *aegypti* L. and *Culex quinquefasciatus* Say. *Ae. aegypti*, the primary epidemic vector of dengue viruses, is a predominately urban, day-biting mosquito, often found in and around human dwellings and preferentially feeds on humans, whereas *Cx. quinquefasciatus* is a common urban and rural species with strong night biting patterns and is a major vector of Bancroftian filariasis (*Wuchereria bancrofti*) and several arboviruses in various parts of the world (Sasa 1976). Both mosquito species have been extremely refractory to common control