Excito-repellency of essential oils against an *Aedes aegypti* (L.) field population in Thailand

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ABSTRACT: An investigation of the behavioral responses of *Aedes aegypti* (= *Stegomyia aegypti*) to various concentrations of essential oils (2.5, 5, and 10%) extracted from hairy basil (*Ocimum americanum* Linn), ginger (*Zingiber officinale* Roscoe), lemongrass (*Cymbopogon citratus* Stapf), citronella grass (*Cymbopogon nardus* Rendle), and plai (*Zingiber cassumunar* Roxb) were performed using an excito-repellency test chamber. Results showed that *Ae. aegypti* exhibited varying levels of escape response in both the contact and noncontact chambers in response to different essential oils. The magnitude of the behaviors changed in a dose-response fashion depending on the percent volume to volume concentration of oil used. A 2.5% concentration of hairy basil oil produced a significantly greater escape response compared to the other extracts at the same concentration ($P< 0.05$). Oils of ginger, lemongrass, and citronella produced stronger irritant and repellent responses at the median 5% concentration compared to the lowest and highest concentrations. There was marked suppression of escape for both contact and noncontact tests using 10% concentrations of hairy basil, lemongrass, and citronella, with high knockdown for all three oils after 30 min. Hairy basil and lemongrass had the highest insecticidal activity to *Ae. aegypti*, with LC_{50} values of 6.3 and 6.7 percent, respectively. We conclude that the essential oils from native plants tested, and likely many other extracts found in plants, have inherent repellent and irritant qualities that should to be screened and optimized for their behavior-modifying properties against *Ae. aegypti* and other biting arthropods of public health and pest importance. ***Journal of Vector Ecology* 39 (1): 112-122. 2014.**

Keyword Index: Behavior, excito-repellency, *Aedes aegypti*, plant extracts, Thailand.

INTRODUCTION

Dengue remains one of the most important vector-borne diseases endemic to most countries of the tropical and subtropical zones. An average of 50 million cases are documented annually, resulting in tens of thousands of deaths. The viruses responsible for dengue are spread by the bite of an infected *Aedes* mosquito (Gubler 1997). *Aedes aegypti* (*Stegomyia aegypti*) is the primary urban and epidemic vector of dengue fever viruses and is highly anthropophilic in its feeding behavior. It is often found in close association with humans and prefers to live in and around human dwellings (Chan et al. 1971). Despite major advances in dengue research, an effective and reliable dengue vaccine is not yet available. Prevention of this disease remains almost entirely dependent on vector control, which is considered to be the most effective method for reducing virus transmission in dengue endemic areas of the world (Grieco et al. 2007).

One of the most successful methods for mosquito vector control is the use of chemicals, especially the use of synthetic pyrethroids. However, long-term use of pyrethroids to control the vectors has resulted in the development of insecticide resistance in mosquito populations (Chandre et al. 1998, Penilla et al. 1998, Misni et al. 2009). To delay or avoid insecticide resistance in mosquito populations, one could adopt an approach in which protection from the bite of the mosquito could be achieved through behavioral modification rather than toxicity. Protection from mosquito bites could be achieved by avoiding physical contact with mosquitoes using insect repellents. However, little is known of how these chemical actions function to repel insects. In general, there are two different types of behavioral responses found in mosquitoes in response to exposure to chemicals: irritancy and repellency (Roberts et al. 2000). Irritancy results only after physical contact with chemically-treated surfaces. Repellency, however, is a response that results from an insect detecting and avoiding the treated surface without physical contact (Chareonviriyaphap et al. 1997, Roberts et al. 1997, Potikasikorn et al. 2005). Using the excito-repellency test system developed by Chareonviriyaphap et al. (2002), it is now possible to observe both irritant and repellent responses and thus quantitatively measure behavioral responses of mosquitoes following exposure to test compounds. N, N-diethyl-3-methylbenzamide (DEET), the most effective repellent compound, is widely used to prevent the bite of mosquitoes around the world (McCabe et al. 1954, Yap 1986). This compound has generally been regarded as safe, but adverse effects when misapplied can be severe (Yang and Ma 2005). To avoid these harmful effects, several researchers are now focusing on the repellent qualities of products derived from natural plant extracts. This work has recently led to a number of essential oils being recommended as