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Excito-repellent activity of β-caryophyllene oxide against *Aedes aegypti* and *Anopheles minimus*

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ABSTRACT

Contact irritant and non-contact repellent activities of β-caryophyllene oxide were evaluated against laboratory strains of female *Aedes aegypti* (USDA strain), a major arbovirus vector and *Anopheles minimus* (KU strain), a major malaria parasite vector, compared with the synthetic repellent DEET, using an excito-repellency test system. β-caryophyllene oxide and DEET were tested at concentrations of 0.1, 0.25, 0.5 and 1.0% (v/v). *Anopheles minimus* was found to be more sensitive to β-caryophyllene oxide than that of *Ae. aegypti* and exhibited high avoidance response rates (86–96% escape) at 0.5% and 1.0% concentrations in contact and non-contact trials compared with *Ae. aegypti* (22–59% escape). However, at the same concentrations, DEET displayed lower irritancy and repellency capacities against these two mosquito species (range 0–54% escape) compared to β-caryophyllene oxide. The analysis of escape responses showed significant differences between mosquito species at all concentrations ($P < 0.05$) except for 0.1%. For both species, there were significant differences in irritant and repellent responses between β-caryophyllene oxide and DEET at higher concentrations (0.5 and 1.0%).

1. Introduction

Thailand is located in the tropical region, where the environmental conditions are suitable for the spread of many vector-borne diseases. Dengue fever, due to a virus belonging to the family Flaviviridae, is considered one of the most dangerous mosquito-borne diseases because it can lead to serious health complications and deaths. *Aedes* (*Stegomyia*) *aegypti* (Skuse) is the primary vector of dengue virus in Thailand, while *Aedes* (*Stegomyia*) *albopictus* (Skuse) is considered as a secondary vector (Hutamai et al., 2007). *Aedes aegypti* is commonly found to live and breed in artificial containers near human dwellings and has a high tendency to blood-feed on humans (Baak-Baak et al. (2013)). Besides dengue, both mosquito species can also be vectors of yellow fever, chikungunya, and Zika viruses (Grard et al., 2014). Malaria is another mosquito-borne disease that can be severe and fatal, due to five species of *Plasmodium* parasites including *Plasmodium falciparum*, *P. vivax*, *P. ovale*, *P. malariae*, and *P. knowlesi* (Wilson et al., 2011). The high majority of reported malaria cases in Thailand are caused by *P. falciparum* and *P. vivax* and occur along the international borders, especially the Thai-Myanmar and Thai-Cambodia borders (Parker et al., 2015). These border areas are also epicenters for malaria drug resistance, especially Artemisinin Combination Therapy (ACT) resistance (Bhumiratana et al., 2013; Phyo and Nosten, 2018).

Many strategies have been used to reduce or eliminate vectors of dengue and malaria for preventing the spread of diseases. For decades, chemical control has been the most effective means because it provides the fastest and most efficient way to control vectors, especially important in dengue or malaria risk areas (Chareonviriyaphap et al., 2013; Silva et al., 2014). However, the use of repellents for personal protection is also an important strategy that is acclaimed by the local population such as forest-goers in Vietnam who declared willing to use mosquito repellent for 89% of them (Ohrt et al., 2018). The personal protection products against mosquitoes is commonly found in Thailand (Mulla et al., 2001). Mosquito repellents are used sparingly and can

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