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## Behavioral avoidance and biological safety of vetiver oil and its constituents against *Aedes aegypti* (L.), *Aedes albopictus* (Skuse) and *Culex quinquefasciatus* Say

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## ABSTRACT

Numerous plant-based repellents are widely used for personal protection against host-seeking mosquitoes. *Vitiveria zizanioides* (L.) Nash essential oil and its constituents have demonstrated various mosquito repellent activities. In this study, three chemical actions of vetiver oil and five constituents (terpinen-4-ol,  $\alpha$ -terpineol, valencene, vetiverol and vetivone) were characterized against *Aedes aegypti*, *Aedes albopictus* and *Culex quinquefasciatus* by using the high-throughput screening assay system (HITSS). Significant contact escape responses in *Ae. aegypti* and *Ae. albopictus* to all test compounds at concentrations between 2.5 and 5% were observed. Spatial repellency responses were also observed in some tested mosquito populations depending upon concentrations. The most significant toxic response on mosquitoes was found at the highest concentration, except for vetivone which had no toxic effect on *Ae. aegypti* and *Ae. albopictus*. Results on phototoxic and genotoxic hazard revealed that vetiver oil and their constituents showed no phototoxic potential or any significant genotoxic response. In conclusion, vetiver oil and two constituents, valencene and vetiverol, are potentials as active ingredients for mosquito repellency and present no toxicity.

## 1. Introduction

Mosquitoes are the most detrimental insect in terms of public health concerns. Some blood-feeding female mosquitoes play a role in the transmission of a large number of pathogens responsible of vector-borne diseases, such as malaria, filariasis, dengue, Japanese encephalitis, to cite a few, causing an estimated 700,000 deaths annually (WHO, 2020). *Aedes aegypti* (L.) is the principal vector that carries arboviruses responsible for dengue, chikungunya, Zika and other arboviruses (Sukhralia et al., 2019). Moreover, *Aedes albopictus* (Skuse), the Asian tiger mosquito, originated from Southeast Asia, has the potential to transmit 26 arboviruses including those cited above for *Ae. aegypti* and is considered to be the fastest and most invasive mosquito species in the world as it is now well established on every continent (Kamal et al., 2018; Paupy et al., 2009; Pereira-dos-Santos et al., 2020). *Culex quinquefascia-*

*tus* Say represents a major nuisance as a night-biting mosquito in semi-urban and urban areas and is a potential vector of Japanese encephalitis virus (JEV) in Thailand (Phumee et al., 2019). This species can transmit both arboviruses responsible for several encephalitis and parasite of the Bancroftian lymphatic filariasis in urban areas, where this species is widely distributed (Manguin et al., 2010; Tawatsin et al., 2019).

Synthetic insecticides are the first baseline strategies to control mosquitoes at the adult stage (Buxton et al., 2020). However, repeated usage of insecticides for vector management, as well as for agriculture, has resulted in their lesser efficacy and higher resistance rates and, more importantly, greater environmental risks and potential human health loss due to this indiscriminate usage of synthetic chemicals (Yogarajalakshmi et al., 2020). The phyto-compounds present in the natural based insecticides have proved their effective properties as observed by several scientists (Amala et al., 2021; Senthil-Nathan, 2020;

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