A Study on the Repellent Efficacy of Essential Oils Against Forcipomyia Taiwana

Jia-Horng Lin, Ming-Chun Hsieh, Chao-Tsang Lu, Mong-Chuan Lee, Chiung-Yun Chang and Ching-Wen Lou

ABSTRACT

The majority of commercially available mosquito repellents contains N, N-diethyl-3-methylbenzamide compound (DETT). The long term uses of DETT have a negative influence on the nervous and immune systems. Therefore, the development of mosquito repellents that are DETT-free is important. In this study, essential oils of lavandula angustifolia, Melaleuca Alternifolia, Mentha piperita, Eucalyptus globules, and Eucalyptus citriodora are evaluated in terms of the repellent efficacy against F. taiwana by using a Y-tube olfactometer test. Their repellent efficacy is then compared. The combination of 200 μl lavandula angustifolia and Eucalyptus citriodora attains a repellent efficacy of 70% and 65%, respectively. Conversely, using Melaleuca Alternifolia, Mentha piperita, and Eucalyptus globules does not result in any significant repellence against F. taiwana, which may be ascribed to the high concentration. When 1μl of these essential oils are added, they have a repellent efficacy of 61-65%. The repellent efficacy of different essential oils is ranked as Eucalyptus globules > Mentha piperita = Melaleuca Alternifolia > lavandula angustifolia > Eucalyptus citriodora.

Jia-Horng Lin¹,²,³, Ming-Chun Hsieh¹, Chao-Tsang Lu⁴,⁵, Mong-Chuan Lee⁵, Chiung-Yun Chang⁶ and Ching-Wen Lou⁴,⁵

¹Laboratory of Fiber Application and Manufacturing, Department of Fiber and Composite Materials, Feng Chia University, Taichung City 40724, Taiwan.
²School of Chinese Medicine, China Medical University, Taichung City 40402, Taiwan.
³Department of Fashion Design, Asia University, Taichung City 41354, Taiwan.
⁴Institute of Biomedical Engineering and Materials Science, Central Taiwan University of Science and Technology, Taichung 40601, Taiwan, R.O.C.
⁵Graduate Institute of Biotechnology, Central Taiwan University of Science and Technology, Taichung City 40601, Taiwan, R.O.C.
⁶Department of Dental Technology and Materials Science, Central Taiwan University of Science and Technology, Taichung 406, Taiwan, R.O.C.

Corresponding author: cwlo@ctust.edu.tw, bctlu@ctust.edu.tw

1829
INTRODUCTION

Forcipomyia taiwana (F. taiwana) are classified into Diptera, Ceratopogonidae, Forcipomyia, Lasiohelea, and were found by a Japanese scholar, Shiraki, in 1913. Female F. taiwana are miniature haematophagous and harassing insect pests. [1] Their bites cause sensitive skin swelling and itchiness, and also cause allergic people to have allergic reaction that lasts for hours or even days. F. taiwana are distributed in eastern, central, and southern Taiwan where the environment is dark and damp. The hazard zone in Taiwan where problematic F. taiwana invasion occurs has extended from remote mountain areas into densely populated areas. [2] People are also engaged in leisure tourism, and thus make outdoor recreation their primary holiday activity at locations where F. taiwana habitats are found. Wearing long-sleeved tops or spraying chemical agents are two ways to prevent bites. However, it is uncomfortable to wear long-sleeved tops on hot summer days and it also causes bacteria growth, which can give the residents or tourists in the mountains inconvenient and unpleasant experiences [3].

N, N-diethyl-3-methylbenzamide compound (DETT) is a common ingredient found in the majority of mosquito repellents. Although the DETT content in a mosquito repellent is within the safe range, spraying a mosquito repellent with a higher DETT content and a higher concentration may result in the penetration of DETT through the skin and into the blood. It takes months for the metabolism to discharge the accumulated DETT. Moreover, long-term usage of these mosquito repellents has negative effects on the skin, nervous and immune systems, and results in mosquitoes becoming drug-resistant while contaminating the environment[4-5]. Due to the aforementioned shortcomings, most people prefer to use natural mosquito repellents that feature a virulence and natural degradation, and do not contaminate the environment. The action mechanism of natural mosquito repellents is more complex than chemosynthesis repellents, and natural mosquito repellents jeopardize multiple organ systems of mosquitoes, which improves their drug resistance. [6]

The mosquito repellents on the market are composed of one or many liquors of Eucalyptus globules, Melaleuca Alternifolia, Cymbopogon excavates, Cedrus deodara, Eucalyptus maculate, Pelargonium reniforme, Mentha piperita, and Melia azedarach Linn. The repellent efficacy of these essential oils has been introduced in previous studies. For example, they have powerful repellence against Aedes aegypti and Aedes albopictus [7-8]. However, there are few studies on their repellent efficacy against F. taiwana. Therefore, in this study, the repellent efficacy of essential oils of lavandula angustifolia, Melaleuca Alternifolia, Mentha piperita, Eucalyptus globules, and Eucalyptus citriodora against F. taiwana is examined and compared.

EXPERIMENTAL

Materials

Essential oils of lavandula angustifolia, Melaleuca Alternifolia, Mentha piperita, Eucalyptus globules, Eucalyptus citriodora are purchased from O'ddenio International Company. The Y-tube olfactometer is custom made.
Experimental Procedure

Essential oils of *lavandula angustifolia*, *Melaleuca Alternifolia*, *Mentha piperita*, *Eucalyptus globules*, and *Eucalyptus citriodora* at 200μl are dripped onto a filter paper via a micropipette. The filter paper is moist at this particular quantity of essential oils. A Y-tube olfactometer is used for the repellent test in order to examine the effectiveness of the essential oils. Moreover, the different contents of essential oils are compared for differences in their repellent efficacy against *F. taiwana*.

Tests

Figure 1 shows an illustration of a Y-tube olfactometer. Essential oils are dripped onto a filter paper that is placed on the odor end (B) and the opposite end (C) is the filter paper for the control group. The essential oils diffuse naturally inside the Y-tube olfactometer for five minutes, after which the valve of the odor mixture end (A) is opened to release the *F. taiwana*. The mosquitoes are allowed to fly freely inside the olfactometer for ten minutes in order to observe their distribution, thereby determining the repellent or lure efficacy of the essential oils. Those essential oils with repellent efficacy are then compared in terms of different contents in relation to their repellent efficacy.

![Figure 1. Illustration of Y-tube olfactometer.](image)

RESULTS AND DISCUSSION

Repellent Efficacy against *F. taiwana* in Relation to the Types of Essential Oils

Figure 2 indicates the results of the Y-tube olfactometer test in terms of *Melaleuca Alternifolia*, *Mentha piperita*, *lavandula angustifolia*, *Eucalyptus citriodora*, and *Eucalyptus globules*, and the data is presented in percent. A filter paper with a specified content of essential oils (200 μl) is used for the odor end. As shown in the bar chart, the amount of *F. taiwana* at the odor mixture end (A) with corresponding essential oils of *Melaleuca Alternifolia*, *Mentha piperita*, and *Eucalyptus globules* is 70%, indicating that *F. taiwana* do not show any preference or distaste. These three essential oils are quite highly concentrated, and need to be adjusted to a lower level for the subsequent examination. Moreover, the amount of *F. taiwana* at the control end (C) is 70% for *lavandula angustifolia* and 65% for the *Eucalyptus citriodora*. More than half of the *F. taiwana* show a distasteful response to these two essential oils, indicating their repellent efficacy.
Repellent Efficacy against F. taiwana in Relation to the Content of Essential Oils

Figure 3 (a) shows that when the content of *Melaleuca Alternifolia* is decreased, the amount of *F. taiwana* at the odor mixture end (A) is also decreased. As mentioned previously, a high concentration results in a fully diffusion that does not allow the *F. taiwana* to show their preference or distaste. However, with a content of 10ul *Melaleuca Alternifolia*, the smell is less pungent for *F. taiwana* and this allows them to show whether they are repelled or attracted. The amount of *F. taiwana* at the control end (C) is increased from 15% to 61%. There is a distinctive repellent efficacy of *Melaleuca Alternifolia* at 10ul. Similarly, Figure 3 (b, c) *Mentha piperita* and *Eucalyptus globules* show the same trend in their repellent efficacy against *F. taiwana*. There is a decrease in amount of *F. taiwana* at the odor mixture end (A) from 70% to 15%, and a simultaneous increasing amount at the control end (C), from 10-15% to 65%. The pungent concentration of these two essential oils is decreased when their content is decreased. In particular, 1ul of *Mentha piperita* and *Eucalyptus globules* exhibits a significant repellence. In a comparison of these three essential oils, *Eucalyptus globules* possess the best repellent efficacy against *F. taiwana*, followed by *Melaleuca Alternifolia* and *Mentha piperita*. 
CONCLUSION

This study successfully examines repellents that contain natural essential oils. The test results indicate that *Melaleuca Alternifolia*, *Mentha piperita*, *lavandula angustifolia*, *Eucalyptus citriodora*, and *Eucalyptus globules* are repelling to *F. taiwana*. When used at a content of 200 ul, the repellent efficacy is 65% for *lavandula angustifolia* and 70% for *Eucalyptus citriodora*. Specifically, only 1ul of
Melaleuca Alternifolia, Mentha piperita, and Eucalyptus globules is required for a 65% repellent efficacy. Of all five essential oils, Eucalyptus globules have the maximum repellent efficacy against F. taiwana.

ACKNOWLEDGE

The authors would especially like to thank Ministry of Science and Technology of Taiwan, R.O.C. for financially supporting this research under Contract MOST 104-2622-E-166-001-CC3.

REFERENCES


