UNIVERSITI TEKNOLOGI MARA

EXTRACTION OF *PELARGONIUM RADULA* LEAVES BY GREEN TECHNOLOGY SUPERCRITICAL CARBON DIOXIDE FOR MOSQUITO REPELLENT

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ABSTRACT

This study investigates the potential of the aromatic plant *Pelargonium radula (P. radula)* as a natural mosquito repellent, specifically targeting *Aedes aegypti (A. aegypti)*. Despite its promising properties, *P. radula* remains underutilized in repellent formulations. To address this, the study focuses on applying green extraction technology—specifically, Supercritical Fluid Extraction (SFE) using the SFT-100 system from Supercritical Fluid Technologies. The SFE was employed as an alternative to conventional extraction methods to overcome challenges such as thermal degradation, limited durability, and environmental impact. *P. radula* leaves were extracted at various temperatures (40–60 °C) and pressures (200–450 bar), using a constant CO_2 flow rate of 24 mL/min for 60 minutes. The goal was to determine the optimal pressure and temperature conditions for maximizing extraction yield. Additionally, the solubility of *P. radula* extract in supercritical carbon dioxide (SC-CO_2) was analyzed based on the data collected. The extracts were then characterized using Fourier-Transform Infrared Spectroscopy (FTIR) and Gas Chromatography–Mass Spectrometry (GC-MS) to confirm the presence of mosquito-repellent compounds, particularly effective against *A. aegypti*. The optimal extraction conditions were found to be 400 bar and 60 °C. Under these conditions, the increased density and solvating power of SC-CO_2 enhanced penetration into the plant matrix and improved mass transfer of target compounds. The solubility of *P. radula* extract in SC-CO_2 was determined to be 0.0315 mg/g CO_2, indicating a strong interaction between solute and solvent under high-pressure, high-temperature conditions. The FTIR and GC-MS analyses confirmed the presence of bioactive compounds such as citronellol, geraniol, and 10-epi-γ-eudesmol—known for their mosquito-repellent properties. Overall, this study demonstrates that the SFE is an effective and eco-friendly method for extracting high-value, plant-based mosquito repellents from *P. radula*, without the risk of thermal degradation or solvent contamination.

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CHAPTER 1
INTRODUCTION

1.1 Research Background

Dengue fever is one of the vector-borne diseases caused by the dengue virus that can harm health and even cause death. *Aedes* mosquitoes spread the dengue virus: *Aedes aegypti (A. aegypti)* and *Aedes albopictus (A. albopictus).* The dengue virus can spread through mosquito bites, infecting humans or being transmitted from animals to humans. According to Mohiddin et al. (2015). Peninsular Malaysia recorded its first case of dengue fever in 1902, while Penang's first case of dengue hemorrhagic fever was reported in 1962. There were 61 cases of dengue fever, with five deaths reported from 1962 to 1964. However, this figure increased to 65 cases in 1964, and the number of dengue fever cases continued to grow in the subsequent years (Mohiddin et al., 2015; Sulaiman & Er, 2016).

The trend of dengue cases in Malaysia from 2020 to 2024 shows significant fluctuations, indicating changing dynamics in the spread and control of the disease. In 2020, a total of 90,304 cases and 145 deaths were reported, marking a 30.6% decrease in cases compared to 2019, which had 130,101 cases and 182 deaths (World Health Organization, 2022). In 2021, Malaysia recorded the lowest number of dengue cases in eight years, with only 26,365 cases. This marked a dramatic 71% decline from 2020, when 90,304 cases were reported. The drop in cases was likely influenced by pandemic-related restrictions, such as lockdowns and limited public movement, which reduced exposure to mosquitoes. Additionally, public health measures and increased hygiene awareness during the COVID-19 pandemic may have contributed to reducing mosquito breeding sites and transmission.

However, the number of cases surged again in 2022 to 66,102, more than double the number from the previous year. The situation worsened in 2023, with cases soaring to 123,133, and in 2024, the total number of dengue cases was 122,423. This sharp rise coincided with the easing of pandemic restrictions, leading to increased human movement and social activities, which provided mosquitoes with more opportunities to spread the virus. Additionally, climatic factors, such as increased rainfall, may have contributed to the resurgence.