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YST008 - FROM PEEL TO PROTECTION: ECO-FRIENDLY INSECT REPELLENT FROM POMELO

Muhammad Nazarudin Afiq Mohd Nizam, Nurazira Mohd Nor, and Boon Yih Tien*

Faculty of Applied Sciences Universiti Teknologi MARA (UiTM), Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia

*Corresponding author: boonyihtien@uitm.edu.my

ABSTRACT

Synthetic insect repellents are widely used to prevent insect-borne diseases but they often cause adverse effects on human health and the environment. In response, this poduct explores the potential of pomelo (*Citrus maxima*) peel, an abundant agricultural waste as a natural insect repellent. The peels are rich in bioactive compounds such as limonene and α-pinene which are known for their insecticidal properties. Essential oils will be extracted using hydrodistillation and soxhlet extraction and the processes will be optimized using Response Surface Methodology (RSM) for higher yield and quality. The chemical composition of the extracts will be analysed through Gas Chromatography-Mass Spectrometry (GC-MS). The repellency efficacy of the optimized extracts will be evaluated and compared with commercial insect repellents at various concentrations by using excito repellency chamber assay made from the recylce materials. Aligned with Malaysia's National Agrofood Policy (NAP 2.0) and Pesticides Act 1974 which advocate for bio-based pest control, this product supports Sustainable Development Goals (SDGs) 3 (Good Health), 12 (Responsible Consumption), and 15 (Life on Land) by reducing reliance on synthetic chemicals and valorizing waste. The product aims to produce a safe, effective and eco-friendly alternative to synthetic repellents thus contributing to public health improvement and sustainable agricultural waste utilization.

Keywords – pomelo peel, natural insect repellent, extraction, GC-MS, RSM optimisation.

INTRODUCTION

Insects are major vectors of disease worldwide, transmitting numerous life-threatening illnesses and causing millions of deaths each year. Flies and cockroaches can also mechanically spread pathogens such as Escherichia coli, Salmonella spp., and other harmful microorganisms by carrying them on their bodies or in their digestive tracts, contaminating food and surfaces (Abdullah, 2017). To combat these diseases, insect repellents remain one of the most effective strategies. Synthetic repellents like N,N-Diethyl-3-Methylbenzamide (DEET) are widely used for their proven effectiveness (Misni, 2017). However, they have notable drawbacks including unpleasant odour, greasy texture, high skin permeability, and potential allergic reactions, along with adverse effects such as irritant dermatitis, breathing difficulties, and concerns about long-term ecological impact.

These limitations have driven consumer demand for natural, sustainable alternatives. Citrus maxima (pomelo), a popular fruit, generates large amounts of peel waste rich in bioactive compounds such as flavonoids, coumarins, and essential oils, which are known for antimicrobial and insecticidal properties. The motivation for this product lies in addressing health and environmental concerns while valorizing agricultural waste. It also aligns with Malaysia's National Agrofood Policy (NAP 2.0) and the Pesticides Act 1974, which promote sustainable and low-risk pest control solutions. Furthermore, it supports UN SDGs 3 (Good Health), 12 (Responsible Consumption), and 15 (Life on Land) by reducing chemical dependence and utilizing waste. This innovation provides a cost-effective, eco-friendly repellent for households and industries, bridging gaps in policy-driven sustainable development.

OBJECTIVE

i. To optimise the extraction parameters of pomelo peels extract such as time (hours) and temperature (°C) for hydrodistillation method and soxhlet extraction method by using Response Surface Methodology (RSM).
ii. To analyse the compound of extracted pomelo peels by using Gas Chromatography-Mass Spectrometry (GC-MS).
iii. To compare the efficiency of optimised hydrodistillation and soxhlet extraction method of extracted pomelo peels with commercial insect repellent product in different concentration.

DESCRIPTION OF THE PROJECT

The project utilizes two conventional extraction methods which are hydrodistillation and soxhlet extraction to obtain essential oils from pomelo peels. Optimisation of process parameters is conducted using RSM to maximize the oil yield. The extracted essential oils are then subjected to GC-MS analysis to identify major bioactive compounds. An excito repellency chamber assay is used to test the effectiveness of the oils against insects and the results are compared with commercial repellents at different concentrations. This project showcases a practical and eco-friendly alternative to synthetic repellents which demonstrating the potential of pomelo peel in developing natural repellent products. Figure 1 shows the sketch diagram and Figure 2 shows the 3D diagram of excito repellency chamber assay. The test will be conducted in modified chambers as shown in figure below. A escape chamber which is a modified plastic container is connected to an exposure chamber via a escape tunnel. In order to allow sample insect delivery into the chamber, a small entry hole equipped with a short netting sleeve on the outside. Treated surface will be placed on the floor of the exposure chamber to observe the insect movement towards the escape chamber in response to the chemical stimulus or contact irritancy. This treated surface made up from paper or fabric and will be impregnated with treated solution. Insecticide impregnation of treated surface will be carried out by standard dipping procedures. A total 6 different treated surfaces will be compared which are 75% and 100% concentration of pomelo peels extract from hydrodistillation, soxhlet method and commercial insect repellent product. The paper drenched with solution will be air dried and used for repellency test. It provides insight into the repellency or attractancy of a chemical substance toward an insects being tested. This assay measures an irritant's or repellent's effect by observing how many exposed insects attempt to escape the treated area (exposure chamber) to an untreated one (escape chamber).

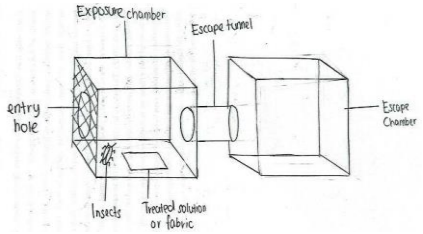

Figure 1: The sketch experimental setup of the excito repellency chamber assay used to assess the effects of extracted pomelo peel product

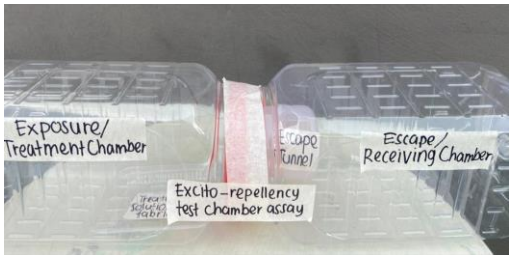

Figure 2: The 3D excito repellency chamber assay from recycled materials used to assess the effects of extracted pomelo peel compared to a commercial insect repellent product

NOVELTY

This product introduces a dual-approach extraction method with RSM optimisation that will enhancing essential oil yield and effectiveness from pomelo peels. Unlike existing studies, this project combines chemical profiling with functional bioefficacy testing against commercial products. The integration of optimisation, GC-MS analysis, and comparative repellency assessment offers a comprehensive framework for developing scientifically validated natural plant-based insect repellents. The valorization of agricultural waste into a high value bioactive product presents a novel sustainable solution for public health protection.

CONCLUSION

This project demonstrates that pomelo peel essential oils can serve as an effective natural insect repellent when optimized through hydrodistillation and soxhlet extraction methods. The combination of RSM optimisation, chemical profiling via GC-MS, and efficacy testing ensures high-quality extract production. The findings suggest that pomelo peel repellent formulations can match or exceed the performance of commercial synthetic products offering a safer and more sustainable alternative. This innovation aligns with environmental sustainability goals and promotes the use of agricultural waste for health-beneficial applications.

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