EXTRACTION OF ESSENTIAL OIL FROM POTENTIAL RESOURCES (CYMBOPOGON CITRATUS) PLANT WITH INSECT REPELLENT PROEPRTIES

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EXTRACTION OF ESSENTIAL OIL FROM POTENTIAL RESOURCES (CYMBOPOGON CITRATUS) PLANT WITH INSECT REPELLENT PROPERTIES

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A dissertation submitted in partial fulfilment
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ABSTRACT

Cymbopogon citratus or also known as lemongrass, is a fast-growing species can be found abundantly in all houses such as in Sarawak. The unique characteristics of its chemical compound enhance the possibility of producing safer insect repellent to overcome the side effects of synthetic insect repellent. In this study, a comparison of various solvents used in extraction as well as the extraction parameters (extraction time and extraction temperature) has been studied to determine the suitable condition for extracting the essential oil from *Cymbopogon Citratus*. Apart from that, the suitability of models (Pseudo First Order Model and Pseudo Second Order Model) to describe the kinetic analysis of extraction together with process optimization using Response Surface Methodology (RSM) also been conducted. By the end of this study, extraction using Soxhlet extraction found that water was chosen as the most suitable solvent in extracting essential oil from *Cymbopogon Citratus* and based on the FTIR characterization of the extracted essential oil, all three solvents (water, ethanol and n-hexane) able to extract the main active compound with repellent properties(*geranial* and *neral* under aldehyde group and *citronellos* and *geranio*l under aliphatic alcohol group). Pseudo First Order Model and Pseudo Second Order Model as well as the RSM model able to predicts the extraction kinetic together with process optimization with the value of T=51.27°C and t=8h which resulting a 74% of extracted essential oil.

***Keywords**: Insect repellent; Essential oil; Cymbopogon Citratus; Soxhlet Extraction; Fourier-Transform Infrared Spectroscopy (FTIR); Response Surface Methodology (RSM)*

ABSTRAK

Cymbopogon citratus atau lebih dikenali sebagai “serai wangi” adalah sejenis tumbuhan yang mampu tumbuh dengan cepat dan sering banyak ditemui di setiap rumah seperti di Sarawak. Keunikan dalam komponan kimia yang terdapat di dalam minyak pati *Cymbopogon citratus* menyebabkan peningkatan kecenderungan dalam menghasilkan penghalau serangga yang lebih selamat untuk menangani kesan negatif penghalau sintetik. Sehubungan dengan itu, perbandingan pelbagai jenis pelarut dan parameter dalam pengesktraksan (suhu dan masa) telah dijalakan demi menentukan jenis pelarut dan parameter pengesktraksan yang terbaik untuk mengesktrak minyak pati dari *Cymbopogon citratus*. Di samping itu, kesesuaian modal (*Pseudo First Order* dan *Pseudo Second Order*) untuk menjelaskan analisis kinetik dan proses pengoptimuman menggunakan RSM juga dijalankan dalam kajian ini. Sebagai kesimpulan, jenis pelarut air mempunyai nilai esktrak minyak pati yang tertinggi berbanding pelarut yang lain dan berdasarkan analisis FTIR, kesemua pelarut berjaya mengesktrak kesemua komponen aktif yang mempunyai sifat penghalau. Kesemua modal analisis kinetik yang terpilih juga mampu menjelaskan analisis pengesktrak kinetik dengan baik dan berdasarkan nilai pengoptimumam analisis menggunakan RSM, modal tersebut mampu memperoleh 74% minyak pati dengan suhu optimum sebanyak 51.27°C dan 8 jam masa mengesktrak.

***Kata kunci**: Penghalau serangga; minyak pati; Cymbopogon Citratus; kaedah Soxhlet; proses pengoptimuman;FTIR; RSM*

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

DEET	:	N,N-diethyl-meta-toluamide (DEET)
RSM	:	Response Surface Methodology
FTIR	:	Fourier-Transform Infrared Spectroscopy

NOMENCLETURE

°C	:	Degree Celsius
%	:	Percentage
g	:	Gram

CHAPTER 1

INTRODUCTION

1.1 Background of insect repellent

Oppositely to the properties of an insecticides, an insect repellent is a chemical that often being applied to human skin to create a protective barrier against insect, mites, lice, or mosquitoes' bites (Peterson & Coats, 2001). Various type of insect repellent has been invented over the past decades, including both natural and synthetic repellents. Typically, chemical compounds including N,N-diethyl-meta-toluamide (DEET), N,N-diethyl mendelic acid amide, and Diethyl phthalate are often found in synthetic repellents (Alayo et al., 2015). In fact, the first synthetic insect repellent, N,N-diethyl-meta-toluamide (DEET),was first discovered in 1950s and invented by the United States government in 1956 after screening over 20,000 potential mosquito repellent compounds. Up until this day, DEET is still one of the most prevalent compounds in most synthetic insect repellent however, several issues arise on the usage of synthetic repellent as these products promotes some environmental and health effects. Sanghong et al. (2015) claimed that these substances are not safe for public health and therefore must be used with caution as their negative impacts towards synthetic fabric and plastic as well as toxic reactions, such as allergy, dermatitis, and cardiovascular and neurological side effects, which have been reported frequently following their misuse.

Moving to next is natural-based insect repellent, precisely plant-based repellent. Over the past generations, plant-based insect repellent is being utilised as a personal protective strategy against insects and arthropods. One of the oldest approaches and yet still being practice up until this day is the act of hanging bruised plants in house (Moore et al., 2006).The majority of plants contains a variety of chemical qualities, including repellents, growth regulators, feeding deterrents, and toxicity. In fact, these distinct chemical qualities may be divided into five (5) key chemical compounds: growth regulators, terpenoids, primary alkaloids, phenolics, and proteinase inhibitors (Maia & Moore, 2011). Not only these chemicals' primary role is to protect against phytophagous insect,

these compounds also practical against mosquitoes' repellences. Traditionally, rural communities will burn the plant to produce a crude fumigant to repel nuisance mosquitoes. This approach is still intensively practiced in rural area because not only it is the only accessible protection against mosquito bites, communities in North America and Europe claimed this "natural" scented repellents are safer yet reliable in controlling mosquito bites (Trumble, 2002). *Corymbia citriodora, Cymbopogon citratus, Mentha spp. M. pipera*ta and *Citrus limon peel* are the typical plant-based repellent in which their essential oils are being extracted before further processed into repellent products. Among these species, the most common plant species to be used is the *Cymbopogon citratus* or also known as lemongrass, as is a fast-growing species can be found abundantly in all houses as it able to grow well under the hot and humid climate in Malaysia. In fact, this plant can be found abundantly in Sarawak, the largest land in Malaysia and able to hold over 1000 known plant species with medical properties (Chai, 2020). Hence, this *Cymbopogon Citratus* not only has benefits in producing a safer insect repellent, due to its unique characteristics of chemical compound in repelling insect, but it also able to be one of the income generation choice for farmers as they can become the supplier to the manufacturing industry as this plant is easy to grow and can be harvested frequently during active growing season, up to once every month.

1.2 Problem statement

Insect repellents are useful for both civilians and military personnel during outdoor activities such as fighting, peacekeeping, and training. One of the typical synthetic repellents that is usually found in household is mosquito coils. Although mosquito coils apply the same concept of usage with the natural repellent, which is by burning, mosquito coil according Lawrance & Croft (2004) is an incense-like product that is made from a mixture of granulated pesticide and a filler, such as sawdust or other solid materials, and then extruded into a coiled shape. Although this product able to provide a protection up until 8 hours, it gradually releases some toxic pollutants including CO, SO2 , NO2 and others (Jetter et al., 2004). Synthetic repellents bring many side effects although it promotes to a long and fast protection towards consumer. Hence, to overcome the side effect of synthetic repellent, natural repellents made from plants, such as essential oils, might be an excellent option.

Shukla et al (2018) claimed that traditional plant-based repellents such as *Cymbopogon Citratus* are still widely utilised in rural communities across the Asian subcontinent, notably in India and Sri Lanka. Over the years, many research has been conducted discussing on the good effect of implementing plant-based repellent. In comparison to synthetic repellents, they are considered harmless and ecologically beneficial. Essential oils and their components have received a lot of interest in recent years due to their relative safety for both the environment and human health, well accepted by consumers, and they may be used for a variety of purposes. However, one of the big issues when dealing with natural based insect repellent is how to fully extract the oil from potential plant. Most research found on extraction of essential oil focusses on techniques in extracting the essential oil from *Cymbopogon Citratus* and limited information found on the kinetics analysis of *Cymbopogon Citratus* oil extraction for using RSM. Next, according to Khater et al (2019), the availability of natural repellent is still low due to lack of understanding the chemical compound that available in the extracted essential oils. Therefore, this research is conducted to study the extraction of essential oils from local resources with insect repellent properties such as *Cymbopogon Citratus*, a potential safer repellent, focussing on the kinetics study as well as modelling of oil extraction using Pseudo Model (First and Second Model) and Response Surface Methodology (RSM).

1.3 Research questions

The research questions to be discussed in this study are listed as below:

i. What is the best method in extracting essential oil and how to analyse the properties of the extracted essential oils?
ii. What are the effects of different types of solvent, temperature, and extraction time towards yield of extracted essential oil?
iii. How does the extraction profiles to illustrate the kinetics of essential oil extraction at different temperature and time?; Can the pseudo-first order or pseudo-second order models illustrate the kinetics of essential oil extraction?

1.4 Research gap

There are quite number of studies have been conducted on essential oil extraction from potential plant for different objectives and extraction methods. **Table 1** shows several research papers published with similar research scope. According to **Table 1**, several research on essential oil extraction has been conducted using different types of extraction methods and all of the listed research use the same type of solvent in extracting essential oil which is water. However, the effect of different solvents on the oil extraction have not been studied in depth. Next, less study found on the kinetic study of essential oils particularly Soxhlet extraction using Response Surface Methodology (RSM) analysis. In addition, there also seems to be less study on relating Pseudo-First Order and Pseudo-Second Order Models to illustrate the kinetics of essential oil extraction for Soxhlet extraction. Therefore, in the present research, Soxhlet extraction is used as the main method in extracting essential oil of *Cymbopogon Citratus* and the operating parameters include type of solvent, extraction temperature and time are optimised by RSM to obtain the highest essential oil yield. The kinetics of extraction process will also be investigated.

Table 1.1: Summary of several research done on extracting of essential oils form potential natural plant.

Research scope	Properties being analysed	Extraction method	Chemical solvent	Time of extraction	Research by
Research on the antifungal activity and volatile compound of essential oil from Cymbopogon species plant *(C.flexuosus,*	Aroma and volatile components were analysed using solid-phase microextraction-gas-chromatography-mass spectrometry	Hydrodistillation	Water	4hours	(Devi et al., 2021)

C.winterianus, C.martini)					
Research of chemical composition and antimicrobial activity of essential oils from leaves and flowers of Lamiaceae Plant *(Salvia hydrangea)*	Chemical components were observed by using Gas chromatography/mass spectrometry (GC-MIS) analysis	Water distillation	Water	5hours	*(Ghavam et al, 2020)*
Research on extraction of jasmine essential oils	Antibacterial compounds were analysed by using Gas chromatography/mass spectrometry (GC-MIS) analysis	Hydrodistillation	Water	4-8hours	*(Dinh et al, 2019)*