
FACULTY OF ENGINEERING

# PRODUCTION OF ESSENTIAL OIL DERIVED FROM LOCAL GINGER (ZINGIBER OFFICINALE)

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Bachelor of Engineering with Honours
(Chemical Engineering)
2020

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PRODUCTION OF ESSENTIAL OIL DERIVED FROM LOCAL GINGER (ZINGIBER OFFICINALE)

NURUL MIRZHA SYERLIZA BINTI HALIMIN

A dissertation submitted in partial fulfillment

of the requirement for the degree of

Bachelor of Engineering with Honours

(Chemical Engineering)

Faculty of Engineering

Universiti Malaysia Sarawak

2020

Dedicated to my beloved parents and my family who always bestow me sustainable motivations and encouragements

# ACKNOWLEDGEMENT

First and foremost, praise is to Allah SWT for giving the blessing, the strength and opportunity for the author to learn and completing this research study. The author wishes to thank every individuals, parties and organizations that have contributed and cooperated throughout this study especially to Department of Chemical Engineering and Energy Sustainability, Faculty of Engineering, Universiti Malaysia Sarawak (UNIMAS). Sincere gratitude and thanks to the supervisor, Prof Dr. Mohammad Omar Abdullah for his willingness to share knowledge, invaluable experiences, guidance, advice as well as his invaluable supervision and kind cooperation to contribute towards the completion of this research. Last but not least, the author would like to express her special appreciation to her beloved parents, family and friends for their never-ending supports and motivation in completing this report.

# ABSTRACT

Ginger is a herb plant with an aromatic underground stem called rhizome and it is known by its scientific name as *Zingiber officinale Roscoe.* Ginger is commonly used in various ways such as flavoring agents, food preservative, cosmetic and health purpose. Nowadays, the study of zingiber officinale (ginger) has become one of the important study to extract essential oil due to its effectiveness to provides medicinal properties in the health treatment. Various methods are produced to extract essential oil from the raw material and solvent extraction is one of the most widely used method to extract components. This research focuses on the production of essential oil from local ginger which is iban ginger by using Soxhlet method with an appropriate solvent and the study of bioactive compounds or chemical constituents in iban ginger for its suitability for medicinal purpose. Soxhlet extraction method is stated to be one of the applicable solvent extraction that can give high yield of ginger essential oil. Quality of an extract is commonly affected by 3 parameters which are the sample of material to be extracted, choice of solvent for extraction process and the procedure involved in the process. Next, applying analytical method using gas chromatography mass spectrometry (GC-MS) and fourier transform infrared spectroscopy (FTIR) analysis for plant active compound study to determine chemical constituents for iban ginger. This research outcomes shows the yield of ginger oil depends on the effectiveness of the extraction parameters. The yield of the oil increase with the increase of extraction time, fresh ginger yield oil better than dried ginger and ethanol is the best solvent for extracting bioactive compound from ginger. The organic compounds that are able to be identified are phenolic compounds, carboxylic acid group, aldehydes, ketones, esters and aromatic compounds. This study managed to identify main constituents of ginger oil for terpene compounds which are α-farnesene, β-bisabolene, β-sesquiphellandrene, zingiberene and α-curcumene and major constituents of phenolic compounds which are zingerone, shogaols and gingerols. This components provides pharmacological properties such as antioxidants, anti-inflammatory, anti-cancer, anti-arthritic, antitussive and anti-microbial activity.

Keywords: Ginger, Soxhlet extraction, Bioactive compound

# ABSTRAK

*Halia adalah tumbuhan herba dengan batang aromatik yang disebut sebagai rizom dan dikenali dengan nama saintifik sebagai Zingiber officinale Roscoe. Halia biasanya digunakan dalam pelbagai cara seperti agen perasa, pengawet makanan, kosmetik dan untuk tujuan kesihatan. Pada masa kini, kajian mengenai Zingiber officinale Roscoe (halia) telah menjadi salah satu kajian penting untuk mengekstrak minyak pati disebabkan oleh keberkesanannya dalam ciri- ciri perubatan dalam rawatan kesihatan. Pelbagai kaedah dihasilkan untuk mengekstrak minyak pati dari bahan mentah dan kaedah mengekstrak menggunakan pelarut adalah salah satu kaedah yang paling banyak digunakan untuk mengekstrak komponen. Penyelidikan projek ini memberi fokus kepada pengeluaran minyak pati dari halia tempatan iaitu halia iban dengan menggunakan kaedah soxhlet dengan pelarut yang sesuai dan kajian bioaktif komponen dalam halia iban untuk kesesuaian tujuan perubatan. Kaedah pengekstrakan soxhlet dinyatakan sebagai salah satu pengekstrakan menggunakan pelarut yang sesuai boleh memberikan hasil minyak halia yang tinggi. Kualiti ekstrak selalunya dipengaruhi oleh 3 parameter iaitu sampel bahan yang akan diekstrak, pelarut untuk proses pengekstrakan dan langkah-langkah yang terlibat di dalam proses. Seterusnya, mengunakan kaedah analisis menggunakan analisis chromatography mass spectrometry (GC-MS) dan fourier transform infrared spectroscopy (FTIR) untuk mengkaji komponen bioaktif tumbuhan untuk menentukan konstituen kimia untuk halia iban. Hasil kajian ini menunjukkan hasil minyak halia bergantung kepada keberkesanan parameter pengekstrakan. Hasil minyak meningkat dengan peningkatan masa pengekstrakan,halia segar lebih baik daripada halia kering dan etanol adalah pelarut terbaik untuk mengekstrak sebatian bioaktif dari halia. Komponen organik yang dapat dikenal pasti ialah fenolik, keton, ester dan sebatian aromatik. Kajian ini berjaya mengenal pasti komponen utama minyak halia untuk komponen terpene iaitu α-farnesene, β-bisabolene, β-sesquiphellandrene, zingiberene dan α-curcumene dan komponen utama sebatian fenolik, zingerone, shogaols dan gingerols. Komponen ini memberikan sifat farmakologi seperti antioksidan, anti-radang, anti-barah, anti-arthritic, antitussive dan anti-microbial aktiviti.*

*Kata Kunci: Halia, Pengekstrakan soxhlet, Komponen bioaktif*

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# ABBREVIATIONS

| | |
|---|---|
| FTIR | Fourier Transform Infrared Spectroscopy analysis. |
| GC | Gas Chromatography |
| GC-MS | Gas Chromatography - Mass Spectrometry analysis |
| GI | Gastrointestinal |
| $H_2O$ | Water |
| i.d | Internal diameter |
| IR | Infrared light |
| KBr | Potassium bromide |
| LPO | Lipid peroxide |
| MAE | Microwave assisted extraction |
| MF | Microfiltration |
| MS | Mass spectrometer |
| NF | Nanofiltration |
| NIST | National Institute of Standards and Technology |
| pH | Potential of hydrogen |
| ppm | Parts per million |
| RO | Reverse osmosis |
| ROS | Reactive oxygen species |
| SE | Soxhlet extraction |
| UAE | Ultrasound assisted extraction |
| UF | Ultrafiltration |
| α | Alpha |
| β | Beta |

# NOMENCLATURE

| | |
|---|---|
| amu | Atomic mass unit |
| $cm^{-1}$ | Per centimeter |
| % | Percentage |
| °C | Degree Celcius |
| ∞ | Completely miscible |
| g | Gram |
| hr | Hour |
| min | Minute |
| M | Miscible |
| mL | Millilitre |
| m/z | Mass-to-charge-ratio |
| µ | Micro |

# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction

This section will discussed on the overview of ginger, chemical constituents of ginger, usage of ginger, problem statement, aim, scope and objectives of study, expected outcomes from the research study as well as the project significance.

## 1.2 Overview of Ginger

Ginger is known by its scientific name as *Zingiber officinale Roscoe,* a member of *Zingiberaceae* family. Ginger is a herb plant which has a green - purple flowers with aromatic underground stem called rhizome. Rhizome is a stem which grows horizontally under the soil and able to produce shoot and root system. According to Bhatt et al. (2013), ginger is a herbacious perennial plant with height between one to three feet and have about 12 inches of stem sticks up above the ground. The stem is surrounded by the leaves. Next, ginger rhizome has length about 5 to 15 cm with wide of 1.5 to 6cm and thickness of 2cm and it is relying on the difference types such as white, yellow or red in colour (Bhatt et al., 2013).

## 1.3 Chemical Constituents of Ginger

There are many chemical constituents with more than 400 different compounds are found in ginger such as carbohydrates, lipids, terpenes and phenolic compounds (Prasad & Tyagi, 2015). Ginger consist of two groups of chemical which are volatile oil that is

consist of terpenes component and pungent compound that consist of phenolic compound. About 1.0% - 3.0% of volatile oils contained in the ginger (Stoner, 2013). Phenolic components in ginger consist of gingerol, shogaols and paradols, while terpene components of ginger are β-bisabolene, α-curcumene, zingiberene, α-farnesene and β-sesquiphellandrene (Mao et al., 2019). Both terpenes and phenolic components are recognized as the main components of ginger essential oil. According to Grzanna et al. (2005), there are a few causes that determined relative amount of gingerols, shogaols and paradols in the extraction of ginger. It caused by geographic origin, maturity of rhizomes at time of harvest and extract preparation method. The major polyphenols in fresh ginger are gingerols and its have various chain length from n6 to n10 with [6]-gingerol as the most abundant pungent compounds (Zick et al., 2008). Jolad et al. (2004) stated that the thermal processing and drying of gingerols which are dehydrated form of gingerols lead to the formation of shogaols with [6]-shogaol as the most abundant compounds. This is due to the production of double bond between C-4 and C-5 and elimination of O-H group. Next, paradol is formed due to hydrogenation of shogaol. **Figure 1.1** shows the chemical structure of gingerol and shogaol isolated from ginger rhizomes.

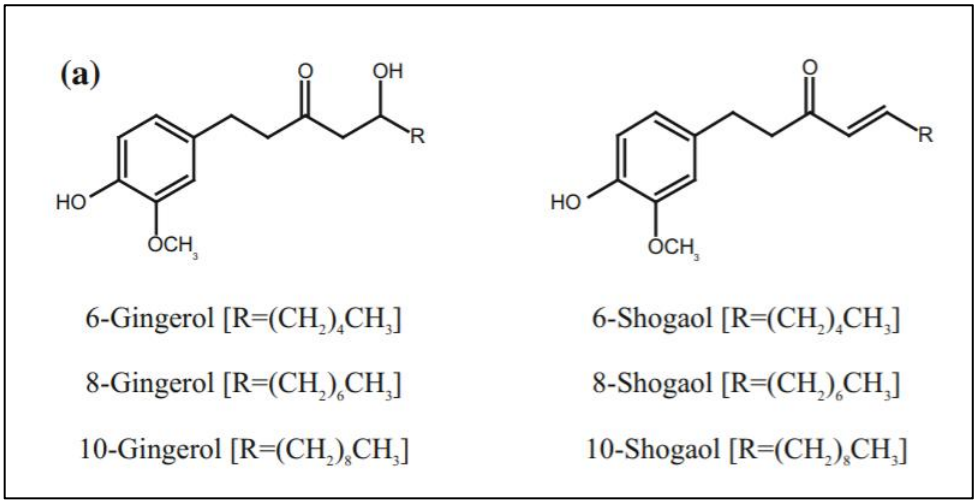


**Figure 1.1:** Chemical structure of gingerol and shogaol isolated from ginger rhizome (Mohd Yusof, 2016)

## 1.4 Usage of Ginger

Ginger is one of the most popular spices in the world and it is commonly used in various ways such as flavoring agents, food preservative, cosmetic and health purpose. Rhizome (root) is a medicinal part of ginger where it contains a lot of bioactive components that are effective for the health treatment. It is claimed to have medicinal qualities where it helps to reduce inflammation, pain, nausea, lower cholesterol and also for digestion. According to Wave (2017), the phenolic compounds contains in the ginger help to reduce gastrointestinal (GI) irritation, stimulate saliva and bile production. Ginger also claimed to be one of the substance that have strong and effective anti-inflammatory and antioxidants effects due to high in gingerol which is the main bioactive compound in ginger (Leech, 2012). Thus, the presence of this bioactive compound provides medicinal properties in the ginger.

## 1.5 Problem Statement

Nowadays, ginger has become one of the herb plants that is often used for medicinal purpose due to the presence of bioactive compound in the ginger that provides medicinal properties which helps to improve health. Thus, there are a lot of research that have been conducted to study the usage of ginger especially in medicinal field. Red ginger is the most often type of ginger to be used for medicinal purpose compared to other ginger. It is claimed to have strong odor, have a spicier flavor of gingerol and contained active component of zingerone that give powerful anti-inflammation and antioxidant activities (Deltomed, 2019). As red ginger is known to be one of effective herb for medicinal compared to other ginger, this research study will identify the usage of iban ginger. The gap of this research includes the identification of suitability of iban ginger for medicinal purpose. This is to identify if iban ginger also posses similar bioactive component or chemical constituents that provides medicinal properties as red ginger.

Next, solvent extraction is the most widely used method of extraction to extract the component. Soxhlet extraction method is known to be one of the best and suitable method for extracting essential oil from ginger as it is proven to give highest yield of ginger essential oil compared to other extraction methods (Kanadea & Bhatakhandeb, 2016). It is also one of the simple methods for extracting essential oil from ginger.

However, the extraction conditions and procedure involving the control of the parameters such as type or conditions of the ginger, operating temperature, length of extraction time and extraction solvent are a crucial parts in the extraction process for obtaining the desired compound. All of this extraction parameters are one of the main factors that affecting to the efficiency and resulting output of the extraction process.

According to World Health Organization, WHO (2017), the length of the extraction process relies on the intend of the extraction process itself, but it must be observed and controlled properly. If the length of the extraction time is insufficient, it will resulted to incomplete of extraction process. Meanwhile, taking too long period of extraction can causes excessive extraction of unwanted constituents or deterioration of substances. Next, the longer the extraction time, the greater the yield of essential oil. This is due to the contact between the solvent and the ginger as well as the solubility of the ginger are increases when the extraction time increases (Supardan et al, 2011). However, the optimum period of extraction must be considered for the optimum extraction condition.

Moreover, selection of solvent is also one of the crucial parts to extract the essential oil. An appropriate and suitable solvent should be selected in order to obtain higher yield of essential oil along with safety consideration where it can gives low toxic potential for the resulting compounds. Also, type and condition of ginger whereby using dry or fresh ginger also gives effect to the yield of the production of essential oil.

It is necessary to choose the suitable and correct extraction parameters to guarantee the maximum extraction output is obtained as well as potential active components or constituents are not destroyed during conducting the extraction process. Hence, solvent extraction method which is soxhlet extraction is selected in this research study in order to obtain the yield of essential oil with different condition of ginger, solvent and length of extraction process as well as the effect of this parameters on the chemical composition in the ginger essential oil.

## 1.6 Aim, Scope and Objective of Study

The main aim of this study is to extract essential oil from iban ginger by using Soxhlet method with an appropriate solvent and to identify and study bioactive compounds or chemical constituents in iban ginger for its suitability as medicinal

purpose. Soxhlet extraction is chosen as the extraction method in this project due to its process simplicity, efficiency and requires less energy. Thus, the scope of this project will be focusing on the extraction parameters which can affect the output of the extraction process, analysis of chemical composition and selection of suitable condition of ginger to produce high yield of essential oil. The objectives of this project are as follows:

**i. To synthesis essential oil derived from local gingers**

Iban ginger is selected as the raw material in this research study. In order to achieve the aim of this project, solvent extraction method which is soxhlet extraction is used to extract the essential oil from iban ginger. The principles of this soxhlet extraction method are based on hot continuous solid/liquid extraction.

**ii. To compare the effectiveness of the extraction parameters**

There are many factors affecting the efficiency of the extraction process. In order to obtain and produce high yield of extraction oil, some of the parameters such as length of extraction time, dryness of ginger (dried and fresh ginger) and extraction solvent (acetone and ethanol) are considered in this study. Thus, optimize conditions will be decided based on the best type of sample and optimal parameters.

**iii. To analyze and conduct characterization of ginger essential oil**

Ginger is stated to have two groups of chemical compounds which are volatile oil and pungent compound. The volatile oil of the ginger consists of terpenes component, while pungent compound includes gingerols, shogaols and paradols which are known as a phenolic compound that present in ginger. This bioactive components in the ginger are claimed to be an effective component used for health treatment. Thus, characterization of ginger essential oil from ginger rhizome will be performed in this study to identify the

chemical constituents in the ginger which are the presence of bioactive components. Analysis of chemical components in ginger essential oil will be done by using Gas Chromatography - Mass Spectrometry (GC-MS) analysis and Fourier Transform Infrared Spectroscopy (FTIR) analysis.

## 1.7 Project Significance

The study of solvent extraction method whereby using soxhlet extraction can be one of the economical and effective way to extract essential oil from iban ginger. The main aim of using soxhlet extraction method is complete extraction can be obtained as it allows the extraction process to be conducted multiple times. This method is applying the principles of hot continuous solid/liquid extraction. Next, only small solvent dosage is used as it only requires one batch of solvent (recycle), high operational efficiency as well as due to its process simplicity to extract oil from the components. The target of this research is to identify the chemical constituents that are present in the iban ginger essential oil using the analysis of GC-MS and FT-IR along with achieving high yield of essential oil. Essential oil from herb plants have been widely used for over the years and have a highly demand especially in medicinal field. Systematic study to identify and analyze the bioactive compound, characterization, and activities of the herb plant have become essential due to its benefits and chemical properties as a source in both therapeutic and flavoring industries. Thus, the study of ginger essential oil is essentially valuable due to its effectiveness to provides medicinal properties which is found to be anti-inflammatory and have high antioxidants activity that helps in the health treatment. This research study can help to discover the benefits of the ginger, effectiveness of extraction method and appropriate conditions and parameters for ginger essential oil.

## 1.8 Summary

Ginger is a herb plant known by its scientific name as *Zingiber officinale Roscoe* and it is commonly used in various ways such as flavoring agents, food preservative, cosmetic and health purpose. Nowadays, the study of zingiber officinale (ginger) has become one of the important study to extract essential oil due to its effectiveness to provides medicinal properties in the health treatment. Soxhlet extraction method is stated to be one of the applicable solvent extraction that give high yield of ginger

essential oil. This chapter provides an overview of the project in which the aim of this research is to extract essential oil from local ginger using soxhlet extraction method with a suitable solvent and it is focuses on the extraction parameters which are using different types of ginger (dried and fresh ginger), extraction solvent (acetone and ethanol) and length of extraction time. Next, analytical method using GC-MS and FT-IR analysis is applied in this research to study the bioactive compound in ginger essential oil. At the end of this study, iban ginger is expected to posses similar bioactive component as red ginger and its suitability for medicinal purpose.