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A Comprehensive Review: Extraction, Isolation and Separation Techniques of Zingeberene from Zingiber Officinale by using Soxhlet Distillation

Kashish Shabbir Patel, Prachi N Padwal, Prajwal Rajendra Satpute, Saniya Shabbir Patel, Vaishanavi Rajendra Rahane
Department of Pharmacognosy
Samarth Institute of Pharmacy, Belhe, Maharashtra, India

Abstract: *One of the most sought-after natural items on the domestic or global market is essential oils. Numerous plant components can be used to extract essential oils. Collectively, essential oils lack any particular chemical or medicinal properties. Rather, what defines them is what they communicate distinctive scents. Consequently, the widespread propensity to discuss crucial oils as a group, as though that suggested something specific regarding their health, medicinal or culinary qualities are quite erratic and frequently genuinely hazardous. Ginger is a very helpful herb plant that has been utilized extensively in both traditional and modern natural medicine up until recently. Research on this product should be conducted to determine how to meet the nation's need for ginger oil and the most effective method and the least expensive way to increase the product's yield. One of the traditional techniques for extracting essential oils is Soxhlet Distillation. The purpose of Soxhlet distillation is to producing effective ginger oil in a large amount This is because some components cannot be extracted using a particular approach, yet they could be effectively removed with the Soxhlet Extarctor.*

Keywords: Zingiberene, Ginger (Zingiber officinale), Soxhlet extraction, Essential oils, Volatile compounds, GC-MS (GasChromatography-Mass Spectrometry

I. INTRODUCTION

For thousands of years, people have used herbs and spices to improve the color, flavor, and perfume of food. Herbs and spices are known for their anti-oxidant, antibacterial, preservative, and other therapeutic properties in addition to their ability to enhance flavor.4. However, there is a lot of interest in creating high-value, natural goods that are functional and free of solvent or additive residues and chemical alteration. Since the pharmaceutical and nutritional industries are very interested in essential oils, which are naturally occurring volatile extracts of plant components, they have a significant potential for export. For several centuries, plant extracts and essences that are now known as essential oils were widely used in Egypt, Greece, Rome, and other parts of the Middle and Far East.

Chemical Structure and Properties of Zingeberene

Zingiberene is a sesquiterpene hydrocarbon, primarily found in the essential oil of ginger (Zingiber officinale). It contributes to the characteristic aroma and flavor of ginger and has various biological activities.

Chemical Structure

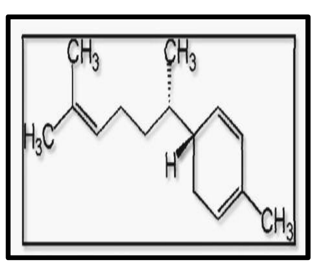

Figure: Molecular Structure of Zingeberene (adapted from wikimedia.org, 2010)

IUPAC Name: 1,4,7,10,10-pentamethyl-3,6-dodecadiene
Molecular Formula: C15H24
Molecular Weight: 204.36 g/mol

The structure of zingiberene consists of a 15-carbon backbone (dodecadiene) with several methyl groups (–CH3) attached at different positions on the molecule. Specifically, it contains:
A diene (C=C) functional group, which gives it its unsaturated nature.
A series of methyl groups (–CH3) attached to the carbon atoms along the chain.

Properties:

1. Volatility: Zingiberene is a volatile compound, which is why it is commonly found in the essential oils of ginger.
2. Hydrophobicity: As a non-polar hydrocarbon, zingiberene is hydrophobic and is insoluble in water but soluble in organic solvents like ethanol, ether, and chloroform.
3. Aroma and Flavor: Zingiberene imparts a spicy, slightly sweet, and peppery aroma to ginger and contributes to its characteristic flavor.
4. Biological Activity:

Antioxidant Properties: Zingiberene has been shown to exhibit antioxidant activity, which can help protect cells from oxidative damage.
Antimicrobial Activity: Some studies have suggested that zingiberene may possess antibacterial and antifungal properties.
Anti-inflammatory Effects: Like other compounds found in ginger, zingiberene may contribute to ginger's known anti-inflammatory effects.

Occurrence:
Zingiberene is primarily found in ginger essential oil, but it is also present in smaller amounts in other plants such as cardamom, turmeric, and some species of the Zingiberaceae family.
In summary, zingiberene is a key compound in the essential oil of ginger, contributing both to its sensory characteristics (taste and smell) and its potential therapeutic effects.

II. GENERAL SIGNIFICANCE OF GINGER (ZINGIBER OFFICINALE) IN FOOD HEALTH AND INDUSTRY

Ginger (Zingiber officinale) is valuable in food, health, and industry because of its many uses and adaptable qualities. An outline of its significance in these domains is as follows:

1. In Food

Flavoring Agent: Ginger is a common spice that gives savory and sweet foods a distinct, zesty flavor.
Preservative Property:-Natural antibacterial qualities found in ginger contribute to food preservation and prolong its shelf life.
Digestive Aid: As a food ingredient, ginger is believed to aid digestion and help alleviate symptoms of nausea and indigestion, often used in teas or as a remedy for motion sickness.

2. In Health

Anti-inflammatory and Antioxidant Properties:Zingeberene, one of the bioactive substances found in ginger, has analgesic, anti-inflammatory, and antioxidant properties. Arthritis and other inflammatory diseases are treated with it.
Immune System Support:Vitamin C and other antioxidants found in ginger can boost immunity and aid in the battle against illnesses.

3. In Industry

Pharmaceutical Industry:Because of its medicinal qualities, ginger is a common component of over-the-counter medications, natural treatments, and supplements for conditions like motion sickness, nausea, and joint pain.
Essential Oils:The rhizome of ginger is used to extract essential oil, which is utilized in massage and aromatherapy for its alleged calming and energizing benefits on circulation.

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III. OBJECTIVES OF THE REVIEW

1. To Summarize the Methods of Zingiberene Extraction:Review the various techniques used for extracting zingiberene from ginger, with a focus on Soxhlet extraction.
2. To Examine the Soxhlet Extraction Process:Provide a detailed explanation of the Soxhlet extraction process, including the principles behind it (e.g., continuous solvent reflux) and the types of solvents typically used
3. To Highlight the Applications of Extracted Zingiberene:Investigate the potential industrial applications of zingiberene extracted from ginger, particularly in the pharmaceutical, food, cosmetic, and fragrance industries.
4. To Address Environmental and Economic Considerations:Discuss the environmental impact of the Soxhlet extraction process, such as the use of solvents and energy consumption.
5. To Identify Gaps and Future Research Directions:Identify knowledge gaps in the extraction and application of zingiberene, and propose areas where further research is needed, such as the development of greener solvents or more efficient extraction methods.

IV. GINGER COMPOSITION:ZINGEBERENE VS OTHER BIOACTIVE CHEMICAL

An overview of the main elements in ginger's chemical profile is provided below. Ginger (Zingiber officinale) has a complex chemical profile that includes a wide range of bioactive compounds that contribute to its flavor, aroma, and therapeutic properties. These include essential oils, phenolic compounds, carbohydrates, proteins, vitamins, and minerals.

Ginger's characteristic aroma and flavor come primarily from its essential oil, which contains a variety of terpenoid compounds. The most significant constituents include:

1. Essential Oils (Volatile Compounds): Zingiberene, gingerol, shogaol, beta-bisabolene, cineole.
2. Phenolic Compounds: Gingerol, shogaol, paradol, and gingerdiol.
3. Carbohydrates: Starch and natural sugars (glucose, fructose).
4. Proteins and Amino Acids.
5. Minerals: Potassium, magnesium, calcium, phosphorus.
6. Vitamins: Vitamin C, Vitamin B6, and trace amounts of Vitamin E.
7. Fatty Acids: Linoleic acid.
8. Dietary Fiber: Contributes to gastrointestinal health.

Concentration of zingiberene in ginger:-

The concentration of zingiberene in ginger can vary depending on several factors, including the variety of ginger, growing conditions, and the method of extraction. However, typical estimates for the zingiberene content in ginger essential oil range from 25% to 35% of the total oil.

Essential Oil Content: Zingiberene is one of the main ingredients of ginger essential oil, which is a combination of chemicals derived from the rhizomes. While the overall amount of essential oil extracted from ginger might vary, it usually ranges between 1 and 3% of the fresh ginger rhizome's weight.

Essential Oil Concentration: Typically, between 25% and 35% of ginger's essential oil is composed of gingerrene. According to certain research, it is approximately 35%.

Variation by Extraction Method: The extraction technique employed may also have an impact on the zingiberene concentration. Different essential oil yields can be obtained using techniques including steam distillation and Soxhlet extraction, and the amount of zingiberene in the finished product may vary depending on the extraction solvent used.

Variation in concentration across different ginger variety and growing condition

The factors influence the chemical composition of ginger, including the concentration of essential oils and specific compounds like zingiberene. Here's a closer look at how these factors can affect the zingiberene content:

Variety of Ginger: The amount of zingiberene in different types of ginger can vary; mature ginger usually has more of it than younger ginger. In comparison to Chinese or other kinds, Indian varieties could possibly have higher levels of zingiberene.

Growing Conditions: The biosynthesis of zingiberene is influenced by soil type, agricultural techniques, and climate (temperature, humidity). For example, ginger cultivated under ideal circumstances (balanced irrigation, nutrient-rich soil) is more likely to contain zingiberene and other essential oils.

Geographical Differences: Due to variations in growth circumstances, altitude, and cultivation methods, ginger from different regions (such as China versus India) may show variances in zingiberene concentration.

Processing and Storage: During processing (such drying) and prolonged storage in unfavorable conditions, the amount of zingiberene in ginger may drop.

Example of Concentration Range:

In Fresh ginger (variety-dependent) zingiberene may make up 25% to 35% of the essential oil content.

The oil content of mature ginger rhizomes grown under ideal conditions is generally higher, which may be correlated with higher quantities of zingiberene.

The concentration of zingiberene in young ginger or ginger grown in less-than-ideal conditions (such as poor soil or inadequate irrigation) may be lower, occasionally falling below 20% of the total oil.

V. FACTOR INFLUENCING ZINGEBERENE YIELD

Numerous elements, including the genetic traits of the ginger plant, the growing environment, and the extraction techniques, affect the amount of zingiberene that is produced in ginger. The following are the main elements influencing zingiberene yield:

1. Ginger Type

a) Genetic Variations:

The output of zingiberene is directly impacted by the unique chemical profiles of various ginger varieties, such as Chinese, Indian, young, and mature ginger. Certain cultivars may naturally contain higher levels of zingiberene and other essential oils, while others may have lower levels.

b) Age of Ginger Rhizomes:

Compared to young ginger, mature ginger rhizomes usually have higher levels of zingiberene and more essential oils. As the ginger plant ages, its levels of gingiberene rise, particularly in the latter stages of growth cycle.

2. Conditions for Growth

a) Climate:

Two important environmental elements are temperature and humidity. Ginger grows best in tropical regions with high humidity and moderate temperatures (around 25 to 30°C), which can promote the development of essential oils like zingiberene.

The plant may become stressed by extreme heat or cold and be less able to produce essential oils, which could diminish the amount of zingiberene produced.

b) Rainfall and Watering:

For ginger plants to yield superior rhizomes, they need enough water. Lower essential oil yields can result from stressing the plant with too much or too little water. Higher oil concentrations are usually produced under regular, moderate watering circumstances.

3.Fertility and Soil Type:

a) Nutrient-rich soils:-

Ginger grows best in nutrient-rich soils that drain well, which also encourages the development of essential oils. Healthy growth and higher oil yields, particularly zingiberene, are supported by soils high in organic matter.

b) Soil pH:-

Another factor is the pH of the soil; ginger usually grows best in slightly acidic soils (pH 5.5–6.5). Unbalanced nutrient levels or poor soil quality can inhibit the synthesis of zingiberene.

c) Altitude and Geographical Location:

Because of differences in temperature, soil composition, and growing conditions, ginger cultivated at higher elevations or in particular geographic regions may yield variable amounts of essential oil. For instance, ginger from mountainous areas, such as India's Western Ghats, typically contains higher levels of zingiberene and other essential oils.

4. Environmental Stress and Plant Health

a) Diseases& Pests: When illnesses or pests are present, ginger plants may become stressed, which lowers their capacity to generate zingiberene and other essential oils. The amount of bioactive chemicals produced by a healthy plant is often higher.

b) Environmental Stress: Because the plant puts survival before oil production, stressors including drought, heavy rains, or unfavorable soil conditions can cause a reduction in the production of zingiberene and essential oils.

By carefully managing these variables, zingiberene yield and quality can be increased for usage in a variety of industries, such as food, medicine, and cosmetics.

VI. LITERATURE REVIEW

1. Ginger (Zingiber Officinale Roscoe)

Ginger is a very useful herb plant that originated from India, China and Java and yet is also native to Africa and the West Indies. It is indigenous to the Asia Southeast (Khaki et.al., 2009; K. C. Zancan et.al., 2002; Khairu Aizam, 2006; Lee, 2007) especially in Indo-Malaysia. It is stated that the main producer of ginger is in Jamaica (Alfaro et.al., 2003; Amir Shadmani, 2004;Khairu Aizam, 2006) and also with India, China, Indonesia and Nigeria (Wohlmuth et.al., 2006).

Figure-Zingiber Officinale Rhizome (adapted from wordpress.com)

Figure:- Plant of Zingiber Officinale

Ginger is scientifically name as Zingiber Officinale Roscoe which is one of the plants that belongs to the Zingiberaceae family and it is a monocotyledonous (Jiang et.al., 2005; K. C. Zancan et.al., 2002; Lee, 2007; Natta et.al., 2008). Two major groups of compounds which is including gingerol related compounds and diarylheptanoids have been reported as a bioactive components from this plant. 2,3 Gingerol relatedcompounds, comprising distinct groups which is homologous series that are differentiated by the length of their unbranched alkyl chains is actually have recently gained attention in a variety of biological activity studies (Jiang et.al., 2005) and it is found that zingiberene is a major component of a Zingiber Officinale (K. C. Zancan et.al., 2002; Yang et.al., 2009) and its derivatives, and compounds of pharmacological activity of ginger are gingerols and its derivatives

2. Main Chemical Compound in Zingiber Officinale (Zingiberene)

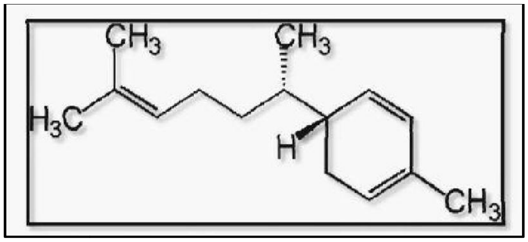

Figure- Molecular Structure of Zingeberene (adapted from wikimedia.org, 2010)

Zingiberene is a monocyclic sesquiterpene that is the predominant constituent of the oil of Zingiber officinale from which it gets its name. It is synonyms as a (S-(R*,S*))-5-(1,5-dimethyl hexen-4-yl)-2-methyl-1,3-cyclohexa-1,3-diene or (S-(R,S))-5-(1,5- dimethyl-4-hexenyl)-2-methyl-1,3-cyclohexadiene or(5R)-2-methyl-5-[(2S)-6methylhept-5-en-2-yl]cyclohexa-1,3-diene or α-zingiberene.

3. Uses of Zingeber Officinale

Both traditional and modern natural medicine make extensive use of ginger, commonly known as Zingiber Officinale (Haghighi et al., 2005; Jiang et al., 2005; K. C.Yang et al. (2009); Zancan et al. (2002). According to reports, ginger has been utilized in India has long used medicine (Lee et al., 2007).Ginger is used in Chinese and Unani-Tibb medical systems to treat Gingivitis, toothache, rheumatism, mental disorders, uncomfortable menstruation,migraine, diabetes, constipation, asthma, and stroke. It is utilized in Asian medicine as a carminative, also referred to as an anti-emetic, stimulant, diuretic, or digestive aid.Chronically ill patients frequently look for alternative therapies, and now One of the most often used herbal treatments for rheumatic conditions is ginger.

Since ancient times, (Zingiber officinale) has been utilized for therapeutic purposes. It has been a crucial plant for traditional Indian and Chinese remedies in especially (Haghighi et al., 2005). Ginger has a wide range of medicinal applications, including comprise the management of colds, illness, diarrhea, colic, dyspepsia, and poor appetite.Additionally, ginger is suggested as an anti-inflammatory treatment for rheumatoid arthritis and muscle diseases and to lengthen life. Ginger's use is supported by clinical trials. Measures to avoid pregnancy-related motion nausea and vomiting, while for musculoskeletal problems, the data is less clear (Lee et al.,2007; Zancan, K. C. et al., 2002).

Products made from ginger, like oleoresin and essential oils, are sold for use in the manufacturing of food and medications. It is frequently used to a variety of cuisines and drinks and is prized for its volatile ingredients, particularly the aromatic substances that provide a strong, spicy, and agreeable scent (Purnomo,2010) and that the volatile substances that give ginger its distinct flavor Zancan, K. C. et al. (2002). Ginger's distinctive scent is caused by a volatile oil.It is found in 1-3% concentrations. Ginger oleoresin is responsible for its pungency (Lee).et al., 2007).

4. Essential Oil

Essential oils are liquid, volatile fragrance molecules that come from plants or other natural sources. Additionally, it contains extremely concentrated aromatic plant essences (Khairu Aizam, 2006). Although essential oils are not strictly speaking oils, they frequently have a low water solubility. It is believed that the plant extracts are more palatable andThey are unquestionably less dangerous than the synthetic chemical (Jenny Jobling).Typically, essential oils comprise a complex blend of chemical molecules, and they are mostly made up of various saturated or somewhat unsaturated linear and cyclic comparatively small molecular mass molecules, and within this range a range .There are oxygenated molecules and hydrocarbons (Ozel and Kaymaz, 2004).

5. Usage of Essential Oil

Since ancient times, essential oils have been employed in a wide variety of purposes. It has been discovered to be used traditionally in insect repellents, flavorings, scents, medicines, and preservatives. Since essential oils frequently smell, they are utilized in fragrance and food flavoring. In reality, they are composed of several.Oil composition and volatile chemicals frequently differ between species.Typically, cold pressing, distillation, or other extraction techniques are used to extract the oils.These oils are frequently employed as masking and flavoring agents in many.In addition to aromatherapy, cuisine, cosmetics, and medications (Mushtaq Ahmadin addition to Salim-ur-Rehman (2006). They are utilized in soap, cosmetics, fragrances, and other items for adding taste to meals and beverages, as well as for smelling incense and cleaning products.

VII. METHOD OF EXTRACTION

1. Extraction of Ginger Oil by Soxhlet Distillation

One of the lab tools specifically made for removing lipids from solid materials is Soxhlet extraction, which is widely used (Ayuso et al., 1998) and has gained formal recognition in numerous nations. Nevertheless, this Soxhlet Extractor can be used for more than just extracting lipids exclusively, however any solution can be used with this technique if desired.The impurities are insoluble in the solvent, and the compound has a specific solubility in solvent. When it's necessary to remove a substance with limited solubility from a solid combination, a Soxhlet extraction can be performed. The method positions a specialized glassware that sits between a condenser and a flask. The solvent that is refluxing extracts the desired component into the flask by periodically washing the solid.

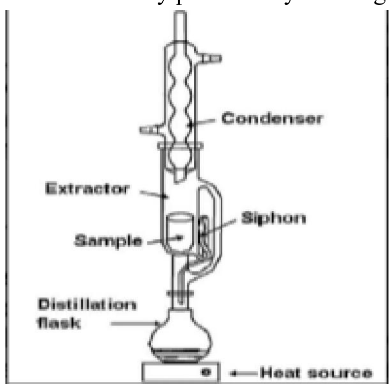

Figure. Soxhlet Extractor (adapted from technologylodging.com)

2. Theory of Soxhlet Extraction

Soxhlet extraction is actually one of the methods to extract essential oils such as Origanum Onite and Coriandrumsativum L (Ozel and Kaymaz, 2004). This extraction method use chemical solvents to extract oils by repeated washing or percolation with an organic solvents.The extraction of the ginger essential oils began when steam contact to the ginger in the extraction tank. The steam carried out the essential oils from the ginger out of the rhizome and go through the condenser. Then, the steam with the essential oils will be condensed into liquid phase and will collected in the beaker.

Soxhlet extraction shows more significant matrix compare to the ultrasonic method and that matrix effects depend heavily on the solvent used for the extraction (Schmeck and Wenclawiak, 2005).The Advantage of this method is that instead of many portions of warm solvent being passed through the sample, just one batch of solvent is recycled. Using stronger extraction conditions then the complete extraction is achieved (Schmeck and Wenclamiak, 2005).

However, the Soxhlet extraction is about time consuming and labour intensive (Ozel and Kaymaz, 2004) where it is need large amount of solvents about up to 150 ml and large samples size which is up to 10 g (Saifuddin andChua, 2003).

The most protruding advantages in using this Soxhlet method is when the sample phase is repeatedly bring into contact with fresh portion of the solvent, so then enhancing the displacement of the analyte from the matrix and no filtration is required (Ayuso et.al., 1998).Nevertheless, the Soxhlet extraction is still the preferred method because of its comparative extraction results despite the nature of matrix sample. Besides,Soxhlet extraction yields similar results with methods such as the supercritical fluid extraction (SFE), microwave-assisted extraction (MAE), accelerated solvent extraction (ASE) and ultrasonic methods. Some more the results also show small variations with low relative standard deviations (Lau et.al., 2010).

However, the soxhlet extraction is still gave higher yield for certain components or materials to be extracted. It is proven in the Figure 2.4 when comparative studies were carried out, it was found that the highest efficiency of Petroleum Ether Extracts (PEE) from tobacco was obtained by Soxhlet extraction and this method is especially suited to sterols that cannot usually be extracted by Accelerated Solvent Extraction (ASE) or are seldom extracted byultrasonically assisted extraction (Shen and Shao, 2005).

3. Nature of Solvent

Solvent can be a liquid, solid or gas that dissolves another solid, liquid or gas solute but usually the solvent is in a liquid form that capable to dissolves or dispersing one or more substances. Below Table shows that there is the best solvent to be used in the extraction which is depending on the materials to be extracted.

Solvent	**Relative Yield**
Hexane	1.00
Petroleum ether (60-80)	0.784
Dicholoromethane	1.04
Ethanol	1.13

Table 2.1 : Relative yield of conventional of 2 hours Soxhlet extraction of Ginger (Zingiber Officinale) in various solvents (Alfaro et.al., 2003).

4. Extraction Time

Time that consumes to run the extraction process is known as extraction time. Extraction time is one of the important parameter that need to be optimized even in order to minimized energy cost of the process (Spigno et.al., 2006). The optimum extraction time will give the optimum of extraction yield where it is proven in the Table as shown below.

Extraction Time (h)	**The yield of the extract (%)**
3	9.54
4	10.90
5	12.19
6	13.40
7	15.70
8	16.97
9	16.97
10	16.97

Table : Effect of extraction time on the yield of the extracts (Li et.al., 2009)

5. Rotary Evaporator

Rotary evaporator is a device which is used to separate or remove the solvent from the mixture by undergoes evaporation. Itconsists of heated rotating vessel which is maintained under a vacuum and connected to a condenser. Rotation of the vessel improved heat transfer to the contained liquid. The solvent vapor will leave the vessel through the connecting tube and then condensed in the condenser flask. It is a very efficient way of rapidly removing large quantities of the solvents.

6. Gas Chromatpgraphy- Mass Spectrometer (GC-MS)

The gas chromatography- mass spectrometer (GC-MS) is simply a gas chromatograph with a very large and very expensive detector but one that can give a definitive identification of the separated compounds. The combination of gas liquid chromatography (GC) for separation and mass spectrometry (MS) for detection and identification of the components of a mixture of compounds.GC-MS system is used for both qualitative and quantitative analyses (Shen and Shao, 2005) and it is stated that the volatile compounds of all extracts will be analyzed by GC-MS (Natta et.al., 2008).

VIII. METHODOLOGY

1.Materials

The extraction was performed using a sample of Zingiber officinale. Acetone, one of the chemical reagents utilized as the solvents in this extraction study, Benzene, methanol, and dichloromethane have a boiling point of 56.53 degree C, 39.6 degree C, 64.7 degree C, 80.1 degree C respectively.In this study, hexane was also utilized to dilute the oil samples prior to GC-MS analysis

2. Apparatus

The primary tools utilized in the Zingiber extraction process.The Soxhlet extractor is officinale. To separate the materials, a rotary evaporator was utilized. solvent as well as the oil that the Soxhlet extractor produces. The GC-MS was then employed for identification and detection of the oil samples' constituent parts.

3. Experimental Procedure

There were 4 main steps in this experiment which is sample preparation, extraction of ginger oil (Zingiber officinale), separation of the solvent from the oil and the last one was sample analysis.

3.1. Sample Preparation

The rhizome of Zingiber officinale was sliced into small pieces and then that pieces has been dried in the oven for 24 hours to 48 hours. After the rhizome was totally dried, then it was grinded into very small particles (powders) by using the blender.

Figure: Grinding of dried ginger

3.2 Extraction of ginger (Zingiber officinale) oil by using Soxhlet Distillation

30 gram of ginger powders was placed into the thimble and then the thimble has been inserted into the Soxhlet chamber. The solvent was poured into the volumetric flask at the bottom part of the Soxhlet extractor. The extraction was started once the heating was begun to heat the solvent with the constant temperature. Lastly, the product was collected in the flask.

Figure : Soxhlet Extractor with the thimble inside.

3.3 Separation of the mixture

In this step, the solvent has been separated from the extracted oil by using the rotary evaporator.The mixture was poured into the boiling flask and the temperature was setting above the boiling point of that solvent. The solvent was collected in the condenser flask and the oil was remained in the boiling flask.Then, the mass of oil was obtained in order to get the yield percentage.

Figure : Rotary Evaporator

3.4 Sample Analysis

The Zingiber Officinale oil was analyzed by GC-MS Agilent 6890 gas chromatography instrument coupled to an Agilent 5973 mass spectrometer and an Agilent Chem. Station software to determine qualitative analysis of the volatiles.Firstly, every 0.1 ml of oil sample has been diluted by hexane with ratio of 1:10 of hexane. Then, the diluted oil sample was inserted in each vial and they were analyzed by using GC-MS system.

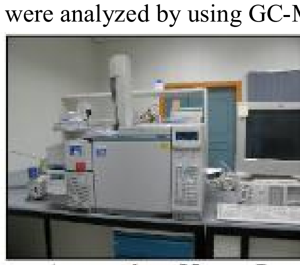

Figure : Gas Chromatography- Mass Spectrometer.

The column temperature was at 50 C for injection, maintained for 2 minute then heated to 230 C at 10 C/min where it held for 15 minutes. Split injection(1µl) was conducted with a split ratio of 1:10 and helium was used as the carrier gas of 1 l/hr flow rate. Temperature of injector was maintained at 250 C. A solvent delay time of 2 min was used.

IX. CONCLUSION

Conventional Soxhlet extraction has been the most used extraction technique worldwide for a number of decades, surpassing the performance of other extraction alternatives and being used as an efficiency reference for the comparison of its conventional and new counterparts. From this research, it shows that Soxhlet extraction method can be used to extract essential oil of Zingiber Officinale.

The most efficient condition in extraction of Zingiber Officinale oil by using Soxhlet extraction method was found to be running at 8 hours extraction time by using methanol as the solvent extraction.

X. RECOMMENDATION

To improve this research, instead of using alternative Soxhlet Distillation, it will be much better if the method is changing to the Focused microwave-assisted extraction (FMASE) technique. This technique is based on the same principles as conventional Soxhlet extraction but using microwaves as auxiliary energy to accelerate the process (Luque-Garcia & Luque de Castro, 2004). FMASE has been used as a function of the surprising results compared with the conventional extraction methods.

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