EXTRACTION AND PHYSICOCHEMICAL ANALYSIS OF MONDORA MYRISTICA SEED OIL

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CERTIFICATION PAGE

This is to certify that this project titled "**EXTRACTION AND PHYSICOCHEMICAL ANALYSIS OF MONODORIA MYRISTICA SEED OIL**" has been read, certified and approved as meeting part of the requirements of the Department of Science Laboratory Technology, in partial fulfilment of the requirement for the award of National Diploma (ND) in Science Laboratory Technology, (Chemistry/Biochemistry Unit), Institute of Applied Sciences, Kwara State Polytechnic, Ilorin

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DEDICATION

We dedicate this research work to Almighty God for his grace and guidance, and to our families for their constant support and encouragement throughout the duration of this project.

AKNOWLEDGEMNT

Our sincere gratitude goes to Almighty God for the privilege given to us to complete this project work; He has been helping us from the beginning till the end of our program.

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ABSTRACT

This study investigated the physicochemical properties and biochemical composition of Monodora myristica (African nutmeg) seed oil to evaluate its potential for nutritional, medicinal, and industrial applications. The oil was extracted using ethanol-based solvent extraction, yielding 18.38%. The oil displayed a dark brown appearance with a strong aroma, and its physical parameters such as density (0.9971 g/cm³) and specific gravity (1.029) were consistent with those of edible seed oils.

Key physicochemical values included an acid value of 21.61 mg KOH/g, free fatty acid content of 14.83%, iodine value of 69.54 g I_2/100g, saponification value of 60.01 mg KOH/g, and peroxide value of 232.0 mEq/kg. While these values suggest unsaturation and potential industrial use, the elevated acid and peroxide values indicate significant lipid degradation, likely due to oxidation or poor post-harvest handling.

In conclusion, Monodora myristica seed oil shows promising bioactive and nutritional properties but requires refining to reduce its acidity and oxidative levels. These findings contribute valuable data supporting the wider utilization of this underexploited seed oil in food, cosmetic, and pharmaceutical industries.

CHAPTER ONE

1.0 INTRODUCTION

The global demand for plant-based oils has witnessed a significant surge in recent years due to their nutritional, medicinal, and industrial applications. Natural oils are increasingly preferred over synthetic alternatives because they are biodegradable, environmentally friendly, and often possess bioactive compounds that contribute to human health (Akinoso et al., 2011). Among various plant sources, *Monodora myristica* commonly referred to as African nutmeg is a lesser-known tropical plant with high potential for oil extraction and utilization. Indigenous to West and Central Africa, this plant is valued for its seeds, which are widely used as spices in traditional cooking and herbal medicine (Burkill, 2000).

The seeds of *Monodora myristica* are known to contain significant amounts of oil, which is believed to possess various beneficial properties. Traditional practices have linked the seed oil to therapeutic effects, such as analgesic, antimicrobial, and anti-inflammatory activities (Edeoga et al., 2005). However, scientific investigations into the physicochemical and biochemical characteristics of the oil remain limited. Understanding these properties is crucial for assessing the oil's quality, stability, shelf life, and suitability for food, cosmetic, and pharmaceutical applications.

Physicochemical parameters such as acid value, iodine value, peroxide value, and saponification value are essential indicators of oil purity, freshness, and industrial usability (AOAC, 2010). These parameters help determine the oil's resistance to rancidity and its performance under processing

or storage conditions. In addition, the biochemical assessment especially the identification of antioxidant compounds like phenolics, flavonoids, and carotenoids provides insight into the oil's potential health benefits. Such bioactive compounds help combat oxidative stress and may contribute to the prevention of chronic diseases (Halliwell & Gutteridge, 2007).

Given the increasing interest in nutraceuticals and natural food preservatives, *Monodora myristica* seed oil presents a promising candidate for further research and development. Despite its rich ethnobotanical background, there is a notable gap in empirical data that scientifically validates its physicochemical integrity and biochemical richness. This study seeks to address that gap by conducting a comprehensive evaluation of the seed oil using standardized analytical techniques.

By characterizing the oil's chemical and functional properties, this research aims to promote the broader utilization of *Monodora myristica* in food, health, and industrial sectors. It also hopes to contribute to the diversification of locally sourced plant oils in Nigeria and other tropical regions where the plant is abundantly found.

1.1 BACKGROUND OF THE STUDY

The exploration of plant-derived oils has garnered significant global interest, particularly due to the increasing awareness of their potential nutritional, medicinal, and industrial applications. Seed oils from underutilized or indigenous plants have become a focus of research as sustainable alternatives to synthetic compounds and as renewable sources of essential nutrients. One such plant that has recently drawn scientific attention is *Monodora myristica*, commonly known as African

nutmeg. This aromatic spice, native to the tropical rainforests of West and Central Africa, is primarily cultivated for its seeds, which are widely used as condiments in traditional African cuisines (Burkill, 2000).

The seed of *Monodora myristica* is rich in oil, and previous studies suggest that it may possess a wide range of bioactive compounds including flavonoids, tannins, alkaloids, and essential fatty acids (Ojezele & Agunbiade, 2013). These compounds contribute not only to the medicinal and antioxidant properties of the oil but also to its possible industrial utility. Furthermore, the oil is reputed to exhibit analgesic, anti-inflammatory, antimicrobial, and hypotensive effects, making it of interest in pharmacognosy and natural product chemistry (Edeoga et al., 2005).

Despite its traditional usage, the scientific basis for the physicochemical and biochemical properties of *Monodora myristica* seed oil remains limited. For any plant oil to be considered for large-scale application whether in the food, cosmetic, or pharmaceutical industry it must undergo rigorous analysis to determine its physicochemical characteristics, such as iodine value, saponification value, acid value, and peroxide value. These properties not only determine the oil's stability and usability but also influence its shelf life and reactivity under storage or industrial conditions (Akinoso et al., 2011).

Given the widespread traditional use of *Monodora myristica* and the growing need for novel bioresources, it becomes imperative to scientifically assess the oil extracted from its seeds. This study aims to bridge the knowledge gap through systematic analysis and to potentially introduce *Monodora myristica* seed oil as a viable natural resource for health and industrial purposes.

1.2 STATEMENT OF THE PROBLEM

Although *Monodora myristica* is well known across several African cultures for its culinary and ethnomedicinal importance, there is a lack of comprehensive scientific evaluation of its seed oil, particularly regarding its physicochemical and biochemical composition. Most traditional applications are based on anecdotal knowledge, and without empirical data, the full potential of the oil cannot be harnessed for commercial or therapeutic use (Okwu & Morah, 2007). This knowledge gap poses a challenge to standardizing its application in modern industries and restricts its exploitation in pharmacological innovations.

Moreover, synthetic food additives and preservatives currently used in many products have raised health concerns, ranging from allergies to carcinogenic effects. As a result, there is a growing demand for safer, natural alternatives with antioxidative and antimicrobial properties. However, the absence of standardized scientific data on the biochemical components of *Monodora myristica* seed oil hinders its qualification as a candidate for such substitution (Iwu, 1993).

Another critical problem is the potential underutilization of the plant, despite its richness in oil. Due to the unavailability of verified data on its yield, quality, and stability, the seed oil is not industrially exploited, especially in regions outside Africa. This under exploitation could be linked to the absence of research that comprehensively evaluates its physicochemical indices and antioxidant properties (Nwosu et al., 2008).

Furthermore, most existing studies have focused on either the phytochemical composition of the seed powder or the essential oil derived from the seeds, neglecting the cold or hot-expressed seed oil that could serve food or therapeutic purposes. The physicochemical characteristics such as peroxide and acid values are essential for assessing oil rancidity and quality, especially in industrial production and storage (AOAC, 2010).

Therefore, there is a compelling need to analyze the seed oil of *Monodora myristica* using standardized laboratory methods to determine its safety, stability, and biological relevance. This research seeks to address these challenges and provide valuable scientific insight that will promote the informed utilization of the oil.

1.3 JUSTIFICATION OF THE STUDY

The increasing trend toward natural remedies and organic products has placed significant value on indigenous plants with nutritional and medicinal potentials. *Monodora myristica*, an underutilized plant species, presents an opportunity for such exploration. Conducting physicochemical and biochemical analysis of its seed oil will provide empirical data essential for validating traditional claims and for exploring new commercial applications (Ajayi et al., 2014).

Given the global health crisis stemming from oxidative stress-related conditions such as cancer, cardiovascular diseases, and neurodegenerative disorders, natural antioxidants are in high demand. The assessment of the oil's biochemical properties such as phenolic and flavonoid content, as well as its free radical scavenging ability, is crucial in determining its therapeutic potential (Halliwell,

2006). If found effective, *Monodora myristica* seed oil may contribute significantly to the nutraceutical and pharmaceutical sectors.

Moreover, this study could serve as a precursor for future pharmacological and toxicological investigations. With a solid physicochemical foundation, researchers can determine its suitability for drug formulation or as a dietary supplement. It can also inform guidelines for proper storage and handling if the oil is to be marketed or integrated into food and cosmetic products (Akinoso et al., 2011).

In addition, the economic benefits of promoting *Monodora myristica* cannot be overstated. Indigenous communities engaged in its cultivation and trade can gain from its commercial exploitation, contributing to sustainable rural development. Establishing the oil's industrial viability could encourage local processing and value addition, reducing import dependence on foreign oils and additives (Oladele & Oshodi, 2008).

Ultimately, the justification for this study lies in bridging the gap between traditional use and scientific validation. It is a step toward developing a comprehensive profile for *Monodora myristica* seed oil and positioning it as a bioresource of high nutritional, medicinal, and industrial relevance.

1.4 AIM AND OBJECTIVES OF THE STUDY

Aim:

The main aim of this study is to extract, and evaluate the physicochemical property of *Monodora myristica* seed oil to determine its potential for nutritional, medicinal, and industrial applications.

Objectives:

1. To extract oil from *Monodora myristica* seeds using appropriate laboratory techniques.
2. To determine the physicochemical properties of the extracted oil, including acid value, iodine value, saponification value, peroxide value, Ester value, specific gravity, %Free Fatty Acid, Density and % Oil yield
3. To compare the results obtained with standard values and existing literature for possible industrial or pharmaceutical application.

This study's objectives are designed to generate a multidimensional profile of *Monodora myristica* seed oil, offering insights that can support its commercial development and health applications.

1.5 SCOPE OF THE STUDY

This research is limited to the extraction and analytical evaluation of oil obtained from *Monodora myristica* seeds. The oil will be subjected to standard laboratory procedures to analyze its physicochemical characteristics. The focus will be on parameters relevant to food, cosmetic, and

medicinal applications, particularly acid value, iodine value, saponification value, and antioxidant activity.

The study does not cover the pharmacodynamics, pharmacokinetics, or toxicological effects of the oil on living organisms. Similarly, no clinical or in vivo tests will be conducted.

Geographically, the research is localized to seeds obtained from selected markets or locations in Nigeria, and results may not fully represent samples from other regions or countries. Seasonal variation and agronomic factors affecting the oil yield are also not considered within the scope of this work.

Only laboratory-grade reagents and standardized protocols, such as those recommended by the Association of Official Analytical Chemists (AOAC), will be employed. Therefore, deviations from standard conditions, as may be experienced in industrial settings, are outside the scope.

In summary, the study emphasizes characterization of *Monodora myristica* seed oil for its potential as a bioresource through in-laboratory physicochemical and biochemical assessments.

1.6 SIGNIFICANCE OF THE STUDY

This study offers both scientific and socioeconomic significance. From a scientific standpoint, it contributes new knowledge to the relatively under-researched area of *Monodora myristica* seed oil. The findings will provide empirical data on its quality and safety, facilitating the understanding of its nutritional and health-promoting potentials (Edeoga et al., 2005).

The study may also serve as a benchmark for future pharmaceutical and nutraceutical research. If the oil demonstrates favorable physicochemical properties, it could be explored for use in formulating drugs, dietary supplements, or cosmetic products. This could drive innovation in natural product development and reduce reliance on synthetic substances.

From a public health perspective, the research is aligned with efforts to identify plant-based interventions for managing oxidative stress-related illnesses. As the burden of non-communicable diseases rises, identifying natural products with therapeutic properties becomes increasingly important (Halliwell, 2006).

In terms of economic implications, validating the properties of *Monodora myristica* seed oil could stimulate its commercialization, providing new opportunities for farmers, traders, and local industries. This supports agricultural biodiversity, conservation, and sustainable use of indigenous resources.

Lastly, the study has educational value as it enriches the literature available for students, researchers, and practitioners in fields such as food science, biochemistry, pharmacognosy, and agricultural science. It will encourage more research into indigenous plants and promote knowledge transfer between tradition and science.

CHAPTER TWO

2.0 LITERATURE REVIEW

Monodora myristica, commonly known as African nutmeg, is a tropical plant that belongs to the family Annonaceae. It is a medium-sized evergreen tree that grows up to 35 meters tall and is primarily found in the rainforests of West and Central Africa, including Nigeria, Cameroon, Ghana, and Angola (Burkill, 2000). The tree has a cylindrical trunk with smooth, grey bark and spreading branches that form a dense crown. Its leaves are simple, alternate, and elliptical, ranging between 10 to 30 cm in length. The tree produces large, solitary, and pendulous flowers that are strikingly beautiful with yellow-green petals marked with reddish or purple blotches.

The fruit of *Monodora myristica* is a woody capsule, about the size of an orange, containing numerous aromatic seeds enveloped in a yellowish pulp. These seeds resemble true nutmeg in appearance and aroma, hence the name "African nutmeg." Upon ripening, the fruit splits open to reveal the seeds, which are harvested, dried, and used as spice or medicine. The seeds are ovoid, dark brown, and covered in a hard seed coat. The inner kernel, which contains the oil, is the part of most scientific and commercial interest (Okwu & Morah, 2007).

The plant thrives in humid tropical climates with adequate rainfall and can be propagated through seeds or vegetative means. Its adaptability to various soil types and resistance to drought make it suitable for cultivation in diverse ecological zones. Despite its potential, *Monodora myristica* remains underexploited compared to other spice crops, primarily due to limited agronomic data and commercial awareness (Nwosu et al., 2008).

Botanically, the plant shares similarities with other members of the Annonaceae family, including *Annona muricata* and *Xylopia aethiopica*, which are also known for their aromatic and medicinal seeds. However, *Monodora myristica* is distinguished by its unique floral structure and highly aromatic seeds. The seed oil extracted from the kernels has been reported to possess a rich profile of volatile oils and fatty acids (Ajayi et al., 2014).

Scientific interest in the plant has increased in recent years due to its potential pharmacological and nutritional benefits. A thorough botanical understanding of *Monodora myristica* is essential for its identification, propagation, and utilization in various scientific and industrial applications.

2.1 TAXONOMICAL CLASSIFICATION OF *Monodora myristica*

Taxonomic Rank	**Classification**
Kingdom	Plantae
Clade	Angiosperms
Clade	Magnoliids
Order	Magnoliales
Family	Annonaceae
Genus	*Monodora*
Species	*Monodora myristica* (Gaertn.) Dunal

This classification places *Monodora myristica* among the flowering plants that are recognized for aromatic seeds, many of which hold both culinary and medicinal value. The Annonaceae family,

to which it belongs, includes other notable genera like *Annona* and *Xylopia*, known for their nutraceutical properties.

2.2 ETHNOMEDICINAL AND NUTRITIONAL IMPORTANCE

Monodora myristica has been traditionally employed in various African cultures for its ethnomedicinal benefits. The seeds, in particular, have been used to treat ailments such as headaches, hypertension, stomach disorders, and rheumatism (Iwu, 1993). In local herbal medicine, ground seeds are often mixed with other botanicals to enhance efficacy. The seed's volatile oil is believed to have analgesic, anti-inflammatory, and antimicrobial effects, which support its wide use in traditional healing practices (Ojezele & Agunbiade, 2013).

In addition to its medicinal applications, the seeds are highly valued for their nutritional content. They are rich in proteins, carbohydrates, lipids, and essential minerals such as calcium, potassium, and magnesium. These nutrients make the seeds a potential dietary supplement, especially in regions where protein-energy malnutrition is prevalent (Oladele & Oshodi, 2008). The presence of essential fatty acids in the seed oil further enhances its nutritional value and potential use in food fortification.

The seed oil has also shown promise in reducing oxidative stress, a key factor in the development of chronic diseases such as diabetes and cardiovascular disorders. Its antioxidant properties, attributed to its high content of polyphenolic compounds, support its use in promoting health and

preventing disease (Halliwell & Gutteridge, 2007). The oil is also being explored as a functional ingredient in nutraceuticals and health-promoting formulations.

Culinarily, *Monodora myristica* seeds are used as a spice to flavor soups, stews, and sauces. The seeds are typically roasted, ground, and added to dishes to impart a nutmeg-like aroma. Their pleasant taste and aroma have earned them a place in traditional African cuisines, particularly among the Igbo and Yoruba ethnic groups in Nigeria. Beyond its nutritional and medicinal uses, the seeds have also been used in spiritual and cultural ceremonies (Burkill, 2000).

Despite these benefits, the full potential of *Monodora myristica* remains untapped. There is a need for more detailed nutritional profiling and clinical validation of its health effects. Increased awareness and research could promote its cultivation, processing, and commercialization as a valuable functional food and therapeutic agent.

2.3 OVERVIEW OF SEED OILS AND EXTRACTION TECHNIQUES

Seed oils are triglyceride-rich lipids derived from the seeds of various plants and serve as significant sources of edible fats and bioactive compounds. These oils are critical in food, pharmaceutical, and cosmetic industries due to their diverse properties. Extraction of oil from seeds can be achieved through various techniques, each influencing the yield, purity, and composition of the oil obtained (Akinoso et al., 2011).

The most common extraction methods include mechanical pressing (cold or hot), solvent extraction, and supercritical fluid extraction. Cold pressing involves mechanical crushing of the

seeds without external heat application, thereby preserving sensitive bioactive compounds such as vitamins and antioxidants. However, the yield from cold pressing is often lower compared to other methods. Hot pressing, though more efficient in yield, may degrade heat-sensitive constituents (Ajayi et al., 2014).

Solvent extraction, typically using organic solvents like hexane, is widely used in industrial settings for its efficiency in recovering oil. The method involves soaking the crushed seeds in a solvent to dissolve the oil, followed by solvent recovery through distillation. Although efficient, concerns about solvent residues and environmental impact have spurred interest in greener alternatives. Supercritical CO_2 extraction is one such method that uses carbon dioxide under high pressure and temperature, offering high purity and minimal thermal degradation (AOAC, 2010).

The choice of extraction technique can influence the physicochemical and biochemical profile of the oil. For instance, oils obtained through solvent extraction may have higher free fatty acid content due to prolonged exposure to solvents, while cold-pressed oils tend to retain more antioxidants. Therefore, the selection of the extraction method must balance between yield and quality based on the intended use of the oil (Eromosele et al., 1994).

In the case of *Monodora myristica*, both solvent and cold pressing methods have been explored. Recent studies suggest that solvent extraction yields more oil, but cold pressing better retains its flavor and bioactive compounds. Understanding these techniques is crucial for optimizing oil extraction and ensuring the integrity of its nutritional and therapeutic components.

2.4 PHYSICOCHEMICAL PROPERTIES OF SEED OILS

Physicochemical analysis is essential for determining the quality, stability, and suitability of seed oils for various applications. Common physicochemical parameters include acid value, iodine value, saponification value, peroxide value, refractive index, and specific gravity. These properties provide insights into the oil's rancidity, oxidative stability, and usability in food and industrial formulations (AOAC, 2010).

The acid value indicates the free fatty acid content in the oil and reflects the degree of hydrolytic rancidity. A high acid value suggests deterioration, making the oil less suitable for consumption. Iodine value measures the degree of unsaturation in the oil and is directly related to its drying capacity; higher iodine values are characteristic of oils used in paints and cosmetics (Akinoso et al., 2011).

Saponification value quantifies the amount of alkali needed to saponify a given quantity of oil and reflects the average molecular weight of the fatty acids present. Oils with high saponification values are ideal for soap production due to their high fatty acid content. Peroxide value measures the extent of primary oxidation and is used to assess freshness and shelf life. An increase in peroxide value indicates the onset of rancidity (Eromosele et al., 1994).

Refractive index and specific gravity provide additional information about oil purity and composition. These parameters are influenced by the degree of unsaturation and the presence of impurities. For *Monodora myristica* seed oil, studies have shown favorable physicochemical

properties comparable to those of established edible oils like soybean and palm kernel oils (Nwosu et al., 2008).

Physicochemical characterization is not only crucial for determining oil quality but also for standardizing its processing and storage. Regulatory bodies such as the Codex Alimentarius and national food safety authorities rely on these parameters to classify oils for food, cosmetic, and pharmaceutical use.

2.5 FACTORS AFFECTING PHYSICOCHEMICAL STABILITY

Several factors influence the physicochemical stability of seed oils:

- **Moisture Content**: Excessive moisture can catalyze hydrolysis and elevate acid values.
- **Temperature**: High processing or storage temperatures can lead to thermal oxidation and increased peroxide values (Gunstone, 2011).
- **Exposure to Light and Air**: Ultraviolet light and oxygen accelerate lipid peroxidation, affecting both iodine and peroxide indices (Martínez et al., 2012).
- **Storage Duration**: Prolonged storage without antioxidants results in oxidative deterioration, reducing oil quality and safety (Oladele & Oshodi, 2008).

2.6 COMPARATIVE ANALYSIS WITH OTHER INDIGENOUS OILS

When compared with other indigenous seed oils such as *Irvingia gabonensis*, *Telfairia occidentalis*, and *Xylopia aethiopica*, *Monodora myristica* oil shows comparable or slightly higher

acid and peroxide values. However, it also demonstrates unique properties such as strong aroma, deep coloration, and viscous texture, making it a candidate for specialized cosmetic or industrial applications (Ijarotimi & Keshinro, 2012). Its moderate iodine value positions it between drying and non-drying oils, giving it versatile functional potential.

2.7 APPLICATIONS AND LIMITATIONS

Given its density, moderate yield, and rich physicochemical profile, *Monodora myristica* seed oil holds promise for:

- **Food industry**: As a flavoring agent or low-volume cooking oil if refined.
- **Cosmetic applications**: In moisturizers and massage oils due to its viscosity and aroma.
- **Industrial applications**: For semi-drying oil formulations in soaps and varnishes.

However, its high acid and peroxide values demand pretreatment and refining processes to reduce oxidative and hydrolytic instability (Edeoga et al., 2005).

CHAPTER THREE

3.0 MATERIALS AND METHOD USED

3.1 SAMPLE COLLECTION AND PREPARATION

Seeds of *Monodora myristica* were purchased from Oja-Oba market in Ilorin-West L.G.A, Ilorin, Kwara State, in North central of Nigeria.

The seed coats were peeled, and pulverized (grounded) using a grinding machine.

3.1.1 MATERIALS USED

The materials utilized for this study include *Monodora myristica* seed, Thimble, Grinding machine, Magnetic stirrer, Tissue paper, White thin rope, Distillation apparatus, Heating mantle, Measuring pipette, Analytical balance, Erlenmeyer flask, 250ml volumetric cylinder, Micropipette, Mortar, Pestle, Titration setup (burette, pipette, conical, retort stand).

3.1.2 REAGENTS USED

Ethanol, Ethanol:Ether (1:1), Phenolphthalein, 0.1M NaoH (Sodium Hydroxide) solution, Chloroform, Wij's solution, 0.1M $Na_2S_2O_3$ (Sodium Thiosulphate), 5% KI (Potassium Iodide), Starch solution, Ethanolic KOH (Potassium Hydroxide), 0.5M H_2SO_4 (Sulfuric Acid), 7% Na_2CO_3 (Sodium Carbonate), Distilled water.

3.2 PROCEDURE FOR EXTRACTION

The weight of an empty thimble was measured on a weighing balance and was recorded as W1, then the pulverized sample was placed in the thimble and all were weighed. This was recorded as W2. The weight of the pulverized sample was calculated by subtracting W2-W1.

The samples were wrapped and placed in the extraction chamber and 450ml of ethanol was added as solvent. The beaker was placed on magnetic stirrer for about 8hours for the extraction of the sample oil.

The solvent extraction process was carried out using steam distillation for 4hours. The extracted oil was collected in a beaker. The solvent was removed using a heating mantle.

3.3 PHYSICOCHEMICAL ANALYSIS

The physicochemical properties of the seed oil were performed using standard titrimetric method.

3.3.1 DETERMINATION OF ACID VALUE AND % FREE FATTY ACID

- 0.2g of oil sample was weighed on an analytical balance into a clean dry Erlenmeyer flask using a micropipette
- 25ml of Ethanol:Ether (1:1) mixture was added
- 0.5ml phenolphthalein was added as indicator
- The solution was titrated against 0.1M NaoH solution to a a faint pink end point.

Acid Value Calculation:

$$\text{Acid Value} = \frac{\text{Mw NaOH} \times \text{Av} \times \text{M NaOH}}{\text{Sample weight}}$$

Where:

- *Mw* = molecular weight of NaOH used (g/mol) = 40.1g/mol
- *Av* = average titer value = 2.70ml
- *M NaOH* = molarity of NaOH used = 0.1M
- *Sample weight = 0.5g*

Percentage Free Fatty Acid:

$$\% \text{ Free Fatty Acid (based on oleic acid)} = \frac{\text{Acid value} \times \text{Mw Oleic acid}}{10 \times \text{Mw NaOH}}$$

Where:

- Mw Oleic acid = molecular weight of Oleic acid = 282g/mol
- Mw NaOH = molecular weight of NaOH = 40.01g/mol

3.3.2 DETERMINATION OF IODINE VALUE

- 0.5g of sample was weighed on an analytical balance into a 350ml clean and dry Erlenmeyer flask
- 10ml of chloroform was added and swirled to mix
- 25ml of Wij's solution was added, swirled to mix, and all was stood in the dark for 1hour.
- A clean burette was filled with 0.1M $Na_2S_2O_3$ solution and was adjusted to mark
- 20ml of 5% KI solution was added to the solution kept in the dark after 1hour of been kept, then we swirled to mix.
- 0.1M $Na_2S_2O_3$ was titrated against the solution to a faint yellow, 0.5ml of starch solution was added (a blue-black color was observed). The volume of thiosulphate consumed was recorded.
- Blank titration was performed.

Iodine Value:

$$\text{Iodine Value} = \frac{126.90 \times (V_B - V_T) \times \text{Molarity of thiosulphate}}{10 \times \text{Weight of sample}}$$

Where:

- V_B = volume of blank = 30.20ml
- V_T = volume of test = 2.70ml
- Molarity of thiosulphate = 0.1M
- Weight of sample = 0.5g

3.3.3 DETERMINATION OF PEROXIDE VALUE

- 0.5g of oil sample was weighed into an Erlenmeyer flask
- 30ml of NaoH:Chloroform mixture was added and swirled to mix to obtain a homogenous solution
- 0.5ml of saturated KI solution was added
- The solution was shaken carefully for 2minutes
- 0.5ml of starch solution was added
- The solution was titrated against 0.01M $Na_2S_2O_3$ solution to a blue-black solution end point
- Blank titration was performed.

Peroxide value:

$$\text{Peroxide value} = \frac{1000 \times (V_T - V_B) \times M\ Na_2S_2O_3}{\text{Weight of sample}}$$

Where:

- V_B = volume of blank = 15.50ml
- V_T = volume of test = 3.90ml
- M $Na_2S_2O_3$ = molarity of sodium thiosulphate = 0.01M
- Weight of sample = 0.5g

3.3.4 DETERMINATION OF SAPONIFICATION AND ESTER VALUE

- 0.5g of oil sample was weighed into an Erlenmeyer flask
- 25ml of Ethanolic KOH was added, and well shaken
- The mixture was placed on heating mantle for 10minutes
- The mixture was left to cool for 1hour
- Phenolphthalein indicator was added to turn pinkish color
- 0.5M H_2SO_4 was titrated against the mixture until a faint yellow color was observed

Blank titration was performed

Saponification value:

$$\text{Saponification value} = \frac{M_w \text{ NaoH} \times (V_B - V_T) \times \text{Molarity of } H_2SO_4}{0.5}$$

Where:

- V_B = volume of blank = 23.00ml
- V_T = volume of test = 21.50ml
- M H_2SO4 = molarity Of Sulfuric acid = 0.05M
- Weight of sample = 0.5g
- Mw NaOH = Molecular weight of NaOH = 40.01g/mol

Ester value:

Ester value = Saponification value – Acid value

CHAPTER FOUR

4.0 RESULTS

The results of the oil physical properties and % yield is shown in Table 1. Table 2 shows the physicochemical properties of *Monodora myristica* oil extract.

TABLE 1: % OIL AND SOME PHYSICAL PROPERTIES

PARAMETERS	**RESULTS**
% Oil yield	18.38%
Color	Dark brown
Odor	Aromatic
Appearance	Oil viscous
Density	0.9971g/ml
Specific gravity	1.029

TABLE 2: PHYSICOCHEMICAL PROPERTIES OF OIL EXTRACT

Parameters	Results
Acid value	21.61mg/NaoH/gOil
% Free fatty acid	14.83%
Iodine value	69.54mgI_2/gOil
Peroxide value	232.0mEquiv.I_2/gOil
Saponification value	60.01mg/NaoH/gOil
Ester value	38.40mgNaoH/gOil

4.1 DISCUSSION

The extraction and subsequent analysis of *Monodora myristica* seed oil yielded important insights into the oil's physicochemical properties. While the sample displayed valuable characteristics for potential food, nutraceutical, or industrial applications, certain results deviated from the expected or ideal range and warrant further interpretation.

4.1.1 OIL YIELD AND PHYSICAL CHARACTERISTICS

The oil yield of *Monodora myristica* seed was **18.38%**, which is moderately high for underutilized oil seeds. This result aligns with previous studies, suggesting that *Monodora myristica* contains considerable oil content, though not as high as other major oilseeds like soybean or groundnut. The relatively moderate yield may be attributed to the extraction method (ethanol-based solvent extraction), seed maturity, or post-harvest handling. Cold pressing or hexane extraction may have resulted in a higher yield.

The physical appearance of the oil dark brown, aromatic, and viscous is consistent with oils rich in polyphenolic compounds and essential oils. The **density (0.9971 g/ml)** and **specific gravity (1.029)** are slightly above that of water and fall within the expected range for most vegetable oils. These values suggest a dense oil, likely due to high content of unsaturated fatty acids and bioactive phytochemicals.

4.1.2 PHYSICOCHEMICAL PROPERTIES

The **acid value (21.61 mg KOH/g oil)** and **% free fatty acid (14.83%)** was notably high compared to standard values for edible oils. Typically, acid values below 4 mg KOH/g and FFA

below 2% are acceptable for edible oil use. The high values obtained may indicate hydrolytic rancidity, which can occur due to prolonged storage, enzymatic activity, or moisture contamination. It may also result from overexposure to air or heat during processing.

The **iodine value (69.54 mg I_2/g)** reflects a moderate degree of unsaturation, placing *Monodora myristica* oil in the semi-drying category. This level of unsaturation is advantageous for both nutritional and industrial purposes, especially for soap and cosmetic formulations. The iodine value falls within acceptable limits, suggesting potential use in food applications as well.

The **peroxide value (232.0 mEq I_2/g)** is extremely high and significantly exceeds the safe limit for fresh oils (usually below 10 mEq/kg). This indicates advanced oxidation, likely due to prolonged storage, high exposure to light or oxygen, or poor handling conditions. Such high peroxide levels could compromise oil stability and safety, limiting its edible applications unless refined.

The **saponification value (60.01 mg KOH/g oil)** was lower than typical values for common oils (usually between 180–200 mg KOH/g), suggesting the presence of longer-chain fatty acids or complex esters with lower molecular weights. Similarly, the **ester value (38.40 mg KOH/g)**, derived from the difference between saponification and acid values, supports this finding. This indicates potential for industrial use, though its soap-making efficiency may be relatively low.

4.1.3 DEVIANT RESULTS AND POSSIBLE CAUSES

- **High Acid and Peroxide Values**: These strongly suggest oil degradation, possibly due to improper storage, high moisture, or enzyme activity during or after extraction.
- **Low Saponification Value**: May indicate the presence of long-chain fatty acids or impurities that require further purification.

CONCLUSION

The comprehensive analysis of *Monodora myristica* seed oil in this study has provided valuable insights into its physicochemical and biochemical properties, confirming its potential as a nutritionally and industrially relevant plant oil. The seed oil yield of 18.38% reflects its viability as a moderate oil-producing crop, while its dark brown, viscous, and aromatic nature is indicative of a rich bioactive composition. The measured density and specific gravity fall within acceptable ranges, affirming the oil's similarity to other edible and industrial seed oils.

The physicochemical evaluations revealed both strengths and limitations. While the iodine value indicates a favorable level of unsaturation and potential utility in cosmetics and semi-drying applications, the high acid and peroxide values suggest oxidative instability and hydrolytic rancidity likely caused by handling, storage, or processing conditions. These results highlight the importance of refining and preserving *Monodora myristica* seed oil to ensure safety and usability in food and pharmaceutical products.

APPENDIX

A. Calculations of **% Oil yield** after distillation process. Parameters given are as follows.

Weight of thimble W1 = 11.10g

Weight of thimble containing sample W2 = 105.62g

Weight of sample only W3 = W2 – W1 =105.62g – 11.10g = 94.52g

Weight of beaker W4 = 87.92g

Weight of beaker containing extract W5 = 105.30g

Weight of extract only W6 = W5 -W4 = 105.30g – 87.92g = 17.38g

$$\% \text{ Oil yield} = \frac{\text{weight of oil}}{\text{weight of sample}} \times 100$$

$$\frac{17.38}{96.52} \times 100 = 18.38\%$$

B. Calculation of **oil density**. Parameters is given as follows:

$$\text{Density of oil} = \frac{\text{Weight of oil}}{\text{Volume of oil}}$$

Where:

Volume of oil = 7ml

Weight of oil is calculated as:

Weight of empty cylinder W1 =28.18g

Weight of cylinder containing 7ml of oil W2 = 35.16g

Weight of 7ml of oil W3 = W2 – W1 = 35.16g – 28.18g = 6.98g

$$\text{Density of oil} = \frac{6.98\text{g}}{7\text{ml}} = 0.9971\text{g/ml}$$

C. Calculation of **specific gravity** of oil. Parameters is given as:

$$\text{Specific gravity} = \frac{\text{Density of oil}}{}$$

Density of water

Where density of water is calculated as

$$\frac{\text{Weight of measuring cylinder containing 10ml of water (W1) – weight of empty cylinder (W2)}}{\text{Volume of water}}$$

W1 = 36.33g

W2 = 26.64g

$$\text{Density of water} = \frac{36.33\text{g} - 26.64\text{g}}{10\text{ml}} = \frac{9.69}{10} = 0.969\text{g/ml}$$

$$\text{Specific gravity} = \frac{0.9971}{0.969} = 1.029$$

Calculations of Physicochemical Properties

D. **Acid Value (AV)**

Formula:

$$\text{Acid Value} = \frac{\text{Mw NaOH} \times \text{Av} \times \text{M NaOH}}{\text{Sample weight}}$$

Where:

- *Mw* = molecular weight of NaOH used (g/mol) = 40.1g/mol
- *Av* = average titer value = 2.70ml
- *M NaOH* = molarity of NaOH used = 0.1M
- *Sample weight = 0.5g*

Acid value = $\frac{40.01 \times 2.70 \times 0.1}{0.5}$ = 21.61mg/ml

E. % Free Fatty Acid:

% Free Fatty Acid (based on oleic acid) = $\frac{\text{Acid value} \times \text{Mw Oleic acid}}{10 \times \text{Mw NaOH}}$

Where:

- Mw Oleic acid = molecular weight of Oleic acid = 282g/mol
- Mw NaOH = molecular weight of NaOH = 40.01g/mol
- AV = 21.61
- M = Molecular weight of oleic acid = 282

%FFA = $\frac{21.61 \times 282}{10 \times 40.01}$ = 14.83%

F. Saponification Value (SV)

Saponification value = $\frac{M_w \text{ NaoH} \times (V_B - V_T) \times \text{Molarity of } H_2SO_4}{0.5}$

Where:

- V_B = volume of blank = 23.00ml
- V_T = volume of test = 21.50ml
- M H_2SO4 = molarity Of Sulfuric acid = 0.05M
- Weight of sample = 0.5g
- Molecular weight of NaOH = 40.01g/mol

SV = $\frac{40.01 \times (23.00 - 21.50) \times 0.05}{0.5}$ = 60.01mgNaOH/gOil

G. Ester value = Saponification value – Acid value

60.01 – 21.61 = 38.40mgNaOH/gOil

H. **Iodine Value (IV)**

$$\text{Iodine Value} = \frac{126.90 \times (V_B - V_T) \times \text{Molarity of thiosulphate}}{10 \times \text{Weight of sample}}$$

Where:

- V_B = volume of blank = 30.20ml
- V_T = volume of test = 2.70ml
- Molarity of thiosulphate = 0.1M
- Weight of sample = 0.5g

IV = $\frac{126.90 \times (30.20 - 2.70) \times 0.1}{10 \times 0.5}$ = 69.54mEquivI_2/gOil

I. **Peroxide Value (PV)**

$$\text{Peroxide value} = \frac{1000 \times (V_T - V_B) \times M\ Na_2S_2O_3}{\text{Weight of sample}}$$

Where:

- V_B = volume of blank = 15.50ml
- V_T = volume of test = 3.90ml

- M $Na_2S_2O_3$ = molarity of sodium thiosulphate = 0.01M
- Weight of sample = 0.5g

$$PV = \frac{1000 \times (3.90 - 15.50) \times 0.01}{0.5} = 232.0 mEquiv I_2/gOil$$

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