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# Ftir, Gc-Ms, Phytochemical, and Antimicrobial Screening of the Seed Oil of Monodora Myristica (Africa Nut Meg)

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**ABSTRACT**
Phytochemical screening of Monodota myristica seed oil revealed the presence of flavonoids, saponins, and terpenes. Antimicrobial testing demonstrated the biological activity of the oil against the evaluated organisms, with the largest inhibition zone observed for Staphylococcus aureus, followed by Escherichia coli; the weakest activity was noted against Candida albicans. These results indicate a stronger antibacterial than antifungal potential. FT-IR analysis identified sfunctional groups in the seed oil, including alkyl, methylene, ester, and carboxylic moieties, corroborating the phytochemical findings and suggesting that these groups contribute to the observed bioactivity. GC–MS profiling detected 26 compounds, with p-cymene (an aromatic hydrocarbon) and linoleic acid (an unsaturated fatty acid) among the predominant constituents; these compounds likely underpin the oil's phytochemical properties and antimicrobial effects. Together, the data support Monodota myristica seed oil as a promising source of bioactive compounds for therapeutic applications.
Keywords: Monodota myristica; FT-IR; phytochemicals; antimicrobial screening; African nutmeg
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## I. INTRODUCTION

Monodora Myristica, commonly known as African nutmeg, is a tropical perennial tree belonging to the Annonaceae family. This tree is cultivated in various regions, including India, Sri Lanka, and several African countries. In the southern part of Nigeria, like Anambra, Abia, Delta, and Enugu states, it goes by different names. It can reach heights of 10 to 35 meters and spans about 2 meters in width, boasting striking and fragrant flowers. The plant is referred to as "ehuru ofia" in Igbo and "Ariwo" in Yoruba, with other names including "awerewa," "lubushi," "Ghana seed," and "orchid nutmeg" [1]. Seed production occurs seasonally from April to June, yielding globular and ovoid fruits that are 3-4 inches long and 3-5 inches in diameter. However, the most economically significant parts are the seeds, found within the sweet-smelling pulp of the fruit. These seeds are commonly used as a seasoning in West African soups and stews or as a nutmeg-like flavoring in baked goods and desserts.

The seeds are encased in a hard shell and exude a potent aroma. They are primarily employed as flavoring condiments in culinary preparations and are rich in dietary minerals. Research by Enabuleleet al. (2014) has demonstrated the seed extract's ability to scavenge free radicals, attributed to its phytochemical constituents, including alkaloids, glycosides, flavonoids, tannins, saponins, and steroids. These seeds are known to have a stimulating effect, making them useful for alleviating constipation, and the crushed bark can be used to relieve stomach aches. Furthermore, the seed acts as an insect repellent, and the bark's juice is employed to treat itching and wounds. A lotion made by combining it with the bark of Monodora tenuifolia is used to treat various eye diseases. The African nutmeg seed extract is also utilized to alleviate headaches, migraines, and colds. Traditionally, the plant is widely used to relieve toothaches and treat dysentery. Roasted and ground seeds are applied to the skin to treat skin diseases [3], suggesting germicidal or antiseptic properties. These roasted and ground seeds are also chewed, spat into the hand, and rubbed on the forehead to relieve headaches. The seeds can be crushed and used as an insecticide, while the root is used to alleviate toothaches when crushed [4].

The seed oil of Monodora myristica, African nutmeg, contains essential compounds like oleic and linoleic acids, which have industrial applications in the formulation of perfumes, soaps, and washing detergents. The oil can also be used for cooking, serving as a cooking oil. Chewing and spitting the seeds on a patient is believed to cure rheumatism. Previous studies have highlighted the anti-inflammatory and antimicrobial properties of the Monodora seed extract against microorganisms,

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as well as its cholesterol-lowering effects in the human body [5].

Checker et al. (2008) reported its ability to lower cholesterol and reduce lipid peroxidation, indicating potential anti-hyperlipidemia properties. The African nutmeg oil extract not only benefits the skin but also extends the shelf life of oil-based cosmetics, as these products are prone to contamination by microorganisms that can spoil emulsions and harm users' skin. The therapeutic and health-promoting properties of the seed have been known since ancient times. The oil is rich in compounds such as squalene, tocopherol, and essential vitamins A and E. Additionally, it contains fatty acids like linoleic and oleic acid, which provide protection against microbes and soothe the skin [7].

Tocopherols found in Monodora myristica seeds have nutritional and antioxidant value, safeguarding fats from autoxidation. African nutmeg seed oil is suitable for cooking and is a valuable source of essential nutrients, making it a favorable option compared to other seed oils. Chemical analysis reveals low fatty acid and saponification values, making it economically advantageous for the cosmetics industry. Phytochemical screening suggests that the oil can help lower cholesterol and address heart-related issues, including irregular heartbeat. It can also be employed as a natural food colorant and as a stimulant to alleviate constipation.

## II. MATERIAL AND METHOD

2.1 Material

The chemical reagents used are n-Hexane, Methanol, chloroform (AR, Kermel, > 99%), Glacial acetic acid (36%, Loba Chemie), Hydrogen peroxide (AR, JHD, 99%). Other chemicals used were analytical grade and distilled water.

2.1.1 COLLECTION OF PLANT MATERIAL

Monodora Myristica (Africa Nut Meg) seeds were purchased from Oja Oba market, Ado-Ekiti, Ekiti state, Nigeria, and identified at the Department of Science laboratory Technology (Microbiology unit), Federal Polytechnic, Ado-Ekiti, Ekiti state, Nigeria.

2.2 **METHODS**

2.2.1 MATERIAL PREPARATION

After the Monodora Myristica seeds were collected in bulk, the seedswere laid out on a laboratory bench for several days, using the dry method to keep the colour.

2.2.2 PULVERISATION OF THE PLANT MATERIAL

The dried seeds of Monodora Myristica were ground into a fine powder.

2.2.3 EXTRACTION PROCEDURE

50g of the powdered sample was Soxhlet extracted using n-hexane solvent.The extraction with the solvent is stopped when the extractant becomes colourless in the stem of the Soxhlet extractor.

The extract obtained was concentrated by distillation. The extract percentage yield was calculated using the expression below:

$$\% \text{ Yield} = \frac{\text{Extractedweight}}{\text{spondiasmombinpowderweight}} \times 100\%$$

The extract of the solvent was thereafter stored in an airtight container (glass) under cool conditions before use.

2.3. DETERMINATION OF PHYTOCHEMICAL PROPERTIES OF SEEDS EXTRACT OF MONODORA MYRISTICA

2.3.1 Procedure

The standard procedures to determine phytochemical properties of Monodora Myristica were described and strictly followed according to the Association of Official Analytical Chemists [8, 9, and 10]. The following tests were carried out on the extracts of the plant.

2.3.2 Test for Alkaloids

0.5g of the extract was stirred with 5ml of dilute hydrochloric acid on a steam bath and filtered. The filtrate was then treated with Mayer's, Wagner's, and Dragnendroff's reagents. The test solutions were observed for turbidity or precipitate.

2.3.3 Test for Flavonoids

- 2ml of sodium hydroxide was added to 2ml of each stem bark extract. The mixture was observed for any colour change.
- 3ml of concentrated tetraoxosulphate (VI) acid was added to 2ml of seed extracts. The mixture was observed for any colour change.
- 2ml of aqueous ammonia was added to 2ml of the extracts, and the mixture was observed for any colour change.

2.3.4 Test for Tannins

•Three matches' sticks were introduced into the seed extracts, and a few drop of hydrochloric acid

International Journal of Pharmaceutical Research and Applications
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was added. The mixture was observed for any colour change.

2.3.5 Test for Saponins and Terpenes

- 2ml of the extract was shaken with 3ml of water in a test tube for about 2minutes, and the mixture was observed for any floating.
- 2ml of chloroform and 2ml of glacial acetic acid with a few drops of concentrated $H_2SO_4$ were added to the extract, and the mixture was observed for any colour change.

2.3.6 Test for Glycosides

•2ml of extract was mixed with 2.5ml of concentrated sulphuric acid and then boiled in a water bath for about 15 minutes, cooled, and neutralized with 20% potassium hydroxide. Then, 5ml of the mixture of Fehling solution A and B was added, and the mixture boiled again. The mixture was observed for a change of colour.
•5ml of 10% Ammonia solution was added to the extract, and the mixture was observed for colour change.

2.3.7 Test for Cardiac Glycosides (Keller-Killian test)

The extract was stirred with 1 mL of acetic acid containing a trace of ferric chloride. Carefully poured this solution into the surface of about 1ml of concentrated sulphuric acid in a test-tube to form two layers. The mixture was observed for any colour change in each layer.

2.4 Antimicrobial screening of the seed extract.

2.4.1 Test Microorganisms

The antimicrobial activity was evaluated against selected clinical isolates: Escherichia coli, Staphylococcus aureus, Pseudomonas aeruginosa, Bacillus subtilis, and Candida albicans. All test organisms were obtained from the Microbiology Laboratory, Federal Polytechnic Ado EKITI, and were maintained on nutrient agar and Sabouraud dextrose agar at 4 °C until use.

2.4.2 Antimicrobial Susceptibility Test

The agar well diffusion method described by CLSI (2020) and Irobiet al. (1994) was employed. Briefly, 0.1 mL of standardized microbial suspension (0.5 McFarland standard ~$10^6$ CFU/mL) was evenly spread on the surface of Mueller-Hinton agar plates (for bacteria) and Sabouraud dextrose agar (for fungi). Wells of 6 mm diameter were punched and filled with 100 µL of extract (100 mg/mL). Plates were incubated at 37 °C for 24 hours (bacteria) and at 28 °C for 48 hours (fungi). Zones of inhibition were measured in millimeters.

2.4.3 Determination of Minimum Inhibitory Concentration (MIC)

The MIC of each extract was determined using the broth microdilution method in 96-well plates (Eloff, 1998). Two-fold serial dilutions ranging from 0.195 to 100 mg/mL were prepared. Each well received 100 µL of microorganism and was incubated at 37 °C for 24 hours. Resazurin (10 µL, 0.2 mg/mL) was added. A blue-to-pink color change indicated growth. MIC was the lowest concentration without a color change.

**2.5 GAS CHROMATOGRAPHY-MASS SPECTROMETRY (GC-MS)**

The extract of Monodora myristica (African nutmeg) was analyzed using GC-MS (Agilent GC-MS 7890B/5970MSD) equipped with a DB-WAX capillary column. Helium was used as a carrier gas. Temperature ranges between 280°c and 325°c. Initially, column temperature was set at 60°c and further increased to 325°c. A dilute sample (2/50 in hexane) of 0.2 µL was used. The components were identified on the basis of their mass Spectra using the National Institute for Standards and Technology (NIST) mass spectrometry data center (2023) library data of the GC-MS system.

2.6 FOURIER TRANSFORM INFRARED (FTIR) SPECTROSCOPY Analysis

Fourier Transform Infrared Spectroscopy Spectrum of Monodora Myristicaseeds extract was obtained using FTIR Spectrophotometer (Agilent Technologies). FTIR is used for chemical identification as each molecule and chemical structure creates a unique spectrum. The IR spectra were recorded in % transmittance. The wave number region for analysis was 4000-650 $cm^{-1}$ (mid infrared range) with a resolution of 0.15$cm^{-1}$.

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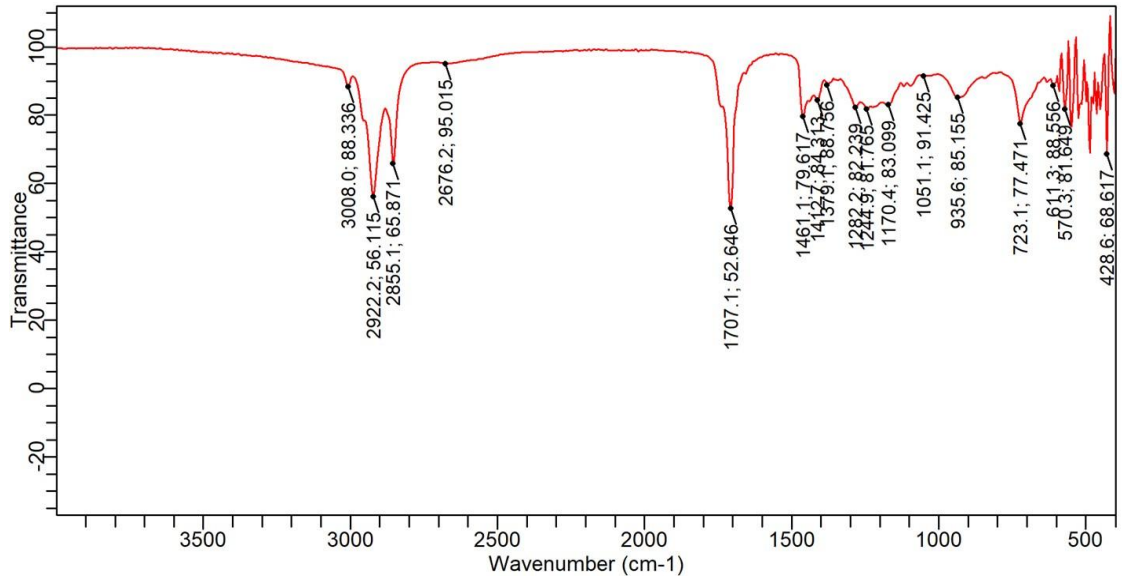

Figure 1: FT-IR spectra for the seed extract of Monodora Myristica

**Table 1: SUMMARY TABLE FOR PHYTOCHEMICALS SCREENING ANALYSIS OF SEED EXTRACT OF MONODORA MYRISTICA RESULT.**

| **Parameters** | **Seed Extract** |
|---|---|
| Flavonoids | ++ |
| Saponins | + |
| Tannins | - |
| Terpenes | ++ |
| Alkaloids | - |

**Keys :** ++ Largely present**,** + Partly present**,** - absent

**Table 2: Antimicrobial Activities of Monodora Myristica seed extract against Selected Microorganisms**

| S/N | Test Organism | Zone of Inhibition (mm) | MIC (mg/mL)* |
|---|---|---|---|
| 1 | Staphylococcus aureus | 23 | 7.25 |
| 2 | Salmonella typhi | 20 | 12.5 |
| 3 | Escherichia coli | 21 | 12.5 |
| 4 | Pseudomonas aeruginosa | 16 | 25.0 |
| 5 | Bacillus subtilis | 12 | 25.0 |

**TABLE 3: RESULT OF GC-MS ANALYSIS OF MONODORA MYRISTICA SEED OIL**

| **Compound name** | **Relative Molecular weight** |
|---|---|
| Benzene, 1- methyl 1-3-(1-methylethyl) | 5.746 |
| Linalool | 6.532 |

International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 4 July-Aug 2025, pp: 955-962 www.ijprajournal.com ISSN: 2456-4494

| | |
|---|---|
| Bicyclo [3.1.0] hexan-3-ol, 4 -methyl ene | 7.502 |
| 3- methyl-4-isopropylphenol | 8.280 |
| 2-pyrrolidine carboxamide | 8.835 |
| 3-ethoxy-5-methyl-2-Piperidinimine | 9.116 |
| Naphthalene, 1,2,4a,5,6,8a-hexahydro-4,7-dimethyl-1-(1-methylethyl) | 9.509 |
| 1-Isopropyl-4,7-dimethyl-1,2,3,5,6,8a-hexahydronaphthalene | 9.790 |
| 17-octadecen-14-yn-1-ol | 10.094 |
| Spiro[bicyclo [6.1.0] nonane-9,1-cyclopentane] | 10.205 |
| Cadinol | 10.546 |
| P-menth-8 (10)-en-9-ol | 10.879 |
| 1-((1S,3aR,4R,7S,7aS) -4-Hydroxy-7-isopropyl-4-methyloctaahydro-1H-inden-1-yl) ethanone | 11.116 |
| 1,3,6,10-Dedecatetraene | 11.590 |
| n-Hexadecanoic acid | 12.175 |
| 9,12-octadecadienoic acid | 23.146 |
| Tricyclo[4.4.0.0(2,8) ] dec-4-ene | 13.857 |
| Benzene, 1- fluoro-2- ( 2- methoxyethenyl)-, ( Z ) | 14.034 |
| (9Z,12Z) - (E) -3,7- Dimethylocta-2,6-dien-1-yl octadeca-9,12-dienoate | 14.242 |

| | |
|---|---|
| 9,17-octadecadienal | 14.479 |
| 9,12-octadecadienoic acid | 14.886 |
| o-mentha-1 (7) | 15.131 |
| 2-chloropropionic acid | 15.442 |
| 7-tetradecyne | 15.694 |
| 2-methyl-Z,Z-3,13-octadecadienol | 15.879 |
| Linoelaidic acid | 16.042 |
| 2-methyl-Z,Z-3,13-octadecadienol | 16.175 |

International Journal of Pharmaceutical Research and Applications
Volume 10, Issue 4 July-Aug 2025, pp: 955-962 www.ijprajournal.com ISSN: 2456-4494

| | |
|---|---|
| Bicyclo [3.3.1] non-2-en-9-ol | 16.456 |
| 14-methyl-8-hexadecan-1-ol | 16.790 |
| Nahpthalene | 17.049 |
| 2-methyl-Z,Z-3,13-octadecadienol | 17.316 |
| 4-Tetradecyne | 17.627 |
| 3,6-octadienal | 18.101 |
| 9,12-octadecadienoic acid | 18.590 |
| Nahpthalenone | 18.752 |
| 2-methyl-Z,Z-3,13-octadecadienol | 18.886 |

## III. RESULTS AND DISCUSSION

3.1 Phytochemical analysis of the seedoil of Monodora Myristica

The phytochemical activity for the seed oil of Monodora Myristica was summarized in Table 1. It was observed that the seed oil of Monodora Myristica showed that it contains flavonoids and terpenes, which are largely present in oil, and also observed that the oil contains saponins, which are partly present, which has importance in medicine and pharmacology to humans[14]. Medicinally, saponins are used as an anticancer agent, and their amphipathic properties promote the penetration of proteins through the cell membranes and are used to reduce blood cholesterol levels. Flavonoids to enhance antioxidant properties [15]. In this research work, the results are in line with the results reported byDangogoet al. (2006)

3.2 FT-IR RESULTS

FT-IR analysis was employed to identify surface functional groups on the seed oil of Monodota Myristica. Results are shown in Figure 1. An absorption band of 3008.1Cm$^{-1}$ shows the presence of =C-H stretching vibration, which indicates unsaturated fatty acids. While 2922.2 and 2855.1cm$^{-1}$ are C-H stretching of the methylene group, which indicates an alkyl chain in the seed oil. The band at 1707.1 due to C=O stretching vibration, this indicates the presence of carboxylic acids or esters, 1461,1 cm$^{-1}$: C-H bending vibration found in alkyl chains,1282.2, 1244.9, and 1170.4 cm-1 stretching vibration, indicating the presence of carboxylic acids, and 1051.1 cm$^{-1:}$ C-O stretching vibration indicating carbohydrate group or glycosides. All these absorption bands in the FTIR spectra probably confirmed the results of phytochemical screening of the seed oil of Monodota Myristica.

3.3 GASCHROMATOGRAPHY MASS SPECTROMETRY(GC-MS)RESULTS

GC-MS analysis was used to determine the molecular structures and chemical composition of the seed oil of Monodota Myristica.Gas chromatography–mass spectrometry analysis revealed the presence of twenty-six (26) compounds, most of which were derivatives of aromatic, ketone, unsaturatedaldehyde compounds, and fatty acids: palmitic acids, linoleic acid, etc.The active principles with their peak area (%) and retention time (RT) are presented in Table 3. The prevailing compounds were aromatic hydrocarbons of metal-cymene with the least molecular weight (5.75) and a fatty acid, linoleic acid, with the largest molecular weight (23.15).It provides detailed information about the compounds that are present in the seed oil of Monodota Myristica. This is in line with the research work reported by Adewole et al. (2013).

3.3 Antimicrobial screening of the leaf extract of Monodota Myristica

The antimicrobial screening of Monodora Myristica seed oil demonstrated varying degrees of inhibition across the five selected bacterial pathogens, revealing its potential as a natural antimicrobial agent. The results show a promising spectrum of activity, especially against Gram-positive and some Gram-negative organisms.

The extract exhibited the highest zone of inhibition (23 mm) against Staphylococcus aureus,

International Journal of Pharmaceutical Research and Applications
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with an estimated Minimum Inhibitory Concentration (MIC) of 7.25 mg/mL. This strong activity aligns with previous reports that M. Myristica contains bioactive phytochemicals such as flavonoids, terpenes, and saponins, which have been widely documented for their effectiveness against Gram-positive bacteria [16]. The thick peptidoglycan layer of S. aureus, though normally protective, appears vulnerable to the multi-target mechanisms of plant-derived compounds, including disruption of cell walls, inhibition of enzyme systems, and interference with nucleic acid synthesis.

Salmonella typhi and Escherichia coli:

The extract also demonstrated significant activity against Salmonella typhi (21 mm, MIC = 12.5 mg/mL) and Escherichia coli (20 mm, MIC = 12.5 mg/mL), both of which are enteric Gram-negative bacteria. These findings suggest that the plant extract contains non-polar and polar compounds capable of penetrating the outer lipopolysaccharide layer characteristic of Gram-negative organisms. Phenolic compounds and organic acids in plant extracts can disrupt membrane integrity and inhibit bacterial efflux mechanisms, contributing to enhanced susceptibility in such strains [17].

In contrast, Pseudomonas aeruginosa showed moderate sensitivity (zone = 16 mm; MIC = 25.0 mg/mL). This is consistent with its known multidrug-resistant nature and the presence of a highly selective outer membrane and efflux pump systems that limit the permeability of antimicrobial agents. The reduced activity observed may reflect a partial inhibition due to the presence of compounds that affect protein synthesis or quorum-sensing pathways, as previously proposed [18]

The weakest activity was recorded against Bacillus subtilis (12 mm; MIC = 25.0 mg/mL), a Gram-positive spore-forming bacterium. Despite being susceptible to many antibiotics, the relative resistance here may be due to the formation of endospores or specific resistance mechanisms that limit the action of plant extracts. Nevertheless, the inhibition observed supports a degree of susceptibility, suggesting that higher concentrations or synergistic use with other bioactives may be more effective.

The spectrum of antimicrobial activity observed highlights the potential of Persea americana extract in managing bacterial infections, particularly in resource-limited settings. Its superior efficacy against Staphylococcus aureus and significant activity against enteric pathogens like Salmonella and E. coli may make it useful for skin, gastrointestinal, and urinary tract infections [19].

These results support the traditional medicinal uses of avocado leaves and fruits in ethnomedicine for treating diarrhea, wound infections, and respiratory tract infections [20]. However, the variation in sensitivity among bacterial species emphasizes the need for further purification, mechanism-of-action studies, and eventual in vivo validation to confirm efficacy and safety.

## IV. CONCLUSION

This study examined the phytochemical composition and antimicrobial activity of Monodota myristica seed oil, employing FT-IR for functional group identification and GC-MS for chemical profiling. Phytochemical analysis revealed the presence of flavonoids, terpenes, and saponins. Antimicrobial tests demonstrated significant activity of the seed oil against the tested microorganisms, with the strongest inhibition observed against Staphylococcus aureus, followed by Escherichia coli, and the least effect against Candida albicans, indicating a broader antibacterial than antifungal potential. FT-IR spectra confirmed functional groups such as methylene, alkyl, ester, and carboxylic groups consistent with the phytochemical constituents. GC-MS analysis identified 26 compounds, including aromatic hydrocarbons like p-cymene and unsaturated fatty acids such as linoleic acid. These findings validate the rich bioactive compound content of Monodota myristica seed oil and support its potential use in treating infections caused by pathogens like Staphylococcus aureus and Escherichia coli, which are responsible for conditions such as fever, food poisoning, urinary tract infections, infant meningitis, wound infections, septicemia, osteomyelitis, and pulmonary abscesses.

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