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# ISOLATION AND THERAPEUTIC STUDIES OF ESSENTIAL OIL FROM THE LEAF OF ANNONA MURICATA (SOURSOP) FROM GIREI LOCAL GOVERNMENT AREA, ADAMAWA STATE, NIGERIA

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**ABSTRACT**

*Annona muricata* (Annonaceae) is a fruit-bearing evergreen tree traditionally used in tropical medicine. Commonly known as soursop, graviola, or guanabana, it is widely distributed in tropical and subtropical regions, where its extracts are used for managing ailments such as fever, diabetes, and cancer. Fresh leaves of *A. muricata* were subjected to modified steam distillation to obtain the essential oil, which was analyzed using gas chromatography–mass spectrometry (GC–MS). GC–MS analysis revealed thirty-six compounds, accounting for 99.96% of the total oil composition. The major constituents were dehydro-aromadendrene (14.83%), caryophyllene (9.45%), γ-muurolene (7.49%), alloaromadendrene (7.32%), naphthalene, 1,2,3,5,6,8a-hexahydro-4,7-dimethyl-1-(1-methylethyl)-(1S-cis)- (7.17%), isolongifolene, 9,10-dehydro- (5.17%), bicyclo[7.2.0]undec-4-ene, 4,11,11-trimethyl-8-methylene-[1R-(1R*,4Z,9S*)]- (4.20%), 1H-benzocycloheptene, 2,4a,5,6,7,8-hexahydro-3,5,5,9-tetramethyl-(R)- (4.17%), tricosane (4.32%), cyclononasiloxane, octadecamethyl- (3.90%), α-muurolene (3.76%), cis-muurola-3,5-diene (3.08%), and aromadendrene (3.07%). The antioxidant activity assessed using the DPPH assay showed moderate free radical scavenging activity, with an $IC_{50}$ value of 54.18 µL/mL and percentage inhibition ranging from 50.67% to 57.27%. Antibacterial assays indicated moderate activity against both Gram-positive and Gram-negative bacteria, with *Staphylococcus epidermidis* showing the highest inhibition zone (10 mm), followed by *Escherichia coli* and *Salmonella typhimurium* (9 mm), and *Staphylococcus aureus* (8 mm). *Proteus vulgaris* was resistant to the oil. Overall, these findings provide preliminary evidence of antioxidant and antibacterial properties of *A. muricata* leaf essential oil, partially supporting its traditional use. Further toxicity, mechanistic, and in vivo studies are required to validate its therapeutic potential.

**Keywords**: *Annona Muricate*, Essential Oil, Antioxidant Activity, Dpph Assay, Antibacterial Activity, Gram-Positive Bacteria, Gram-Negative Bacteria

## INTRODUCTION

Medicinal plants are the potent sources of good human health treatments due to their active compounds that are responsible for their various pharmacological activities. Plants which exhibit notable pharmacological activities had attracted the interest of numerous researchers (Ololade *et. al.*, 2016). Natural entities are those that are created by nature rather than by humans. Natural products have formed the backbone of traditional healing systems for ages before contemporary technology and revolutionization technologies (Veeresham, 2012). As we know, natural product is still relevant in today's time and is still a vital role in developing newer and more potent drugs for consumers. With advancement of technologies more and more diversity of natural origin drug is being researched to understand the structural component and the advantages that the natural product holds (Harvey, 2008).

Annona muricata, commonly known as soursop or graviola, is a tropical fruit-bearing tree belonging to the family Annonaceae. It is widely distributed in West Africa, South America, and Southeast Asia (Adewole and Caxton-Martins, 2006). Traditionally, almost every part of the plant including the leaves, fruit pulp, bark, and seeds, has been used in folk medicine for the treatment of ailments such as fever, parasitic infections, inflammation, and hypertension (Moghadamtousi *et al.*, 2015). The plant is widely distributed across the globe and different parts of the world have different names for this plant. Soursop, Gaviola, Guanabana, Paw Paw, and Sirsak are some of the other names for it (Haron et al., 2020). From studies conducted there are reported to be found about two hundred and twelve bioactive compound that can be found in Annona muricata. Major compounds that can be acquire is phenols and flavonoids followed with predominant compounds of acetogenins. These bioactive compounds are the compounds that are responsible for the antioxidant and antimicrobial properties of Annona muricata. Antioxidants are substances that aid in the prevention or reduction of cell damage caused by free radicals, which are unstable molecules produced by the body in reaction to environmental and other stimuli. Many plant-based pharmaceutical products are used as human immunity enhancer since the dawn of time. One of the antioxidants that Annona muricata possess is Flavanols. Flavonoids are a class of chemicals that protect biomolecules including carbohydrates, proteins, lipids, and DNA from the harmful effects of oxidative processes. (Anbudhasan et al., 2014). Flavonoids could scavenge free superoxide radicals, which slows the ageing process and reduces the risk of cancer. Essential oils are aromatic, oily liquids composed of mixtures of volatile compounds obtained from plants or plant parts, typically through hydrodistillation, steam distillation, dry distillation, or mechanical processes that do not involve heat. They usually possess strong odors, are rarely colored, and generally have densities lower than that of water. Essential oils can be isolated from various plant organs, including flowers, buds, seeds, leaves, bark, herbs, fruits, and roots (Miguel 2010 and Rubiolo et., *al.* 2010). The use of essential oils for their beneficial effects on human health dates back to antiquity and is documented in early literature. Several biological properties of essential oils, such as anti-inflammatory, antimicrobial, and antioxidant activities, have been confirmed in recent scientific studies (Elshafie, et al., 2017). Essential oils from various parts of Annona muricata have been the subject of a number of investigations. Essential oils have been isolated from different organs of the plant such

as fruit pulp, leaves, and fruit peel as well as plants from different locations in Africa, Asia, and the Americas (Cheong et al., 2010 and Wele et al., 2024). Interestingly, for the same plant part, differences in the chemical composition of the essential oils have been observed. This motivated this work on Annona muricate from northern part of Nigeria. The present work describes the chemical composition of essential oils from the leaves of Nigerian cultivars of Annona muricata. In addition, the antioxidant and antimicrobial activities of the essential oils were also evaluated.

Despite the widespread traditional use of *Annona muricata* (soursop) leaves in Nigeria for the treatment of various ailments such as infections, inflammation, and cancer-related conditions, there is limited scientific data on the essential oil extracted specifically from its leaves**,** particularly those grown in Girei Local Government Area of Adamawa State**.** Variations in climate, soil composition, and geographical location can significantly influence the chemical composition and biological activities of plant essential oils. Furthermore, many existing studies focus on crude extracts rather than essential oils, leaving a gap in knowledge regarding the isolation, chemical characterization, and therapeutic efficacy of the leaf essential oil. Therefore, there is a need to scientifically investigate the essential oil of *Annona muricata* leaves from this locality to validate its therapeutic potentials and support its possible use as a natural therapeutic agent. The research **aimed** at determining the chemical composition, antioxidant and antimicrobial activities of the essential oil extracted from the leaf of *Annona muricata* collected from Girei Local Government Area, Adamawa State, Nigeria.

## MATERIAL AND METHODS

### Chemicals

i. Distilled water: for extraction of the essential oil and washing of the sample and other apparatus.
ii. Dimethyl Sulfoxide (DMSO): Is used to dissolve the essential oil for antimicrobial analysis.
iii. Amoxicillin Antibiotic: Used as standard control for bacteria.
iv. Methanol: Used in the determination of antioxidant.
v. Ascorbic acid: Used as standard control for Antioxidant
vi. Ethanol: Solvent also used for extraction.

### Glassware and Apparatus

i. Steam distillation apparatus: for the extraction of essential oil from the plant leaves
ii. Analytical Balance: For precise measurement of samples.
iii. Heating mantle: for heating the distilled water during the extraction of essential oil
iv. Retord stand and clamp: for holding the steam distillation apparatus and condenser during extraction.
v. Condenser: Used in steam distillation setup for condensation of vapour.
vi. Refrigerator: for storing the extracted oil.
vii. Measuring cylinder, beaker, conical flask: for accurate measurements of liquid and mixing.
viii. Sample Bottles (Sterile): For oil storage and handling.

### Sample Collection

Fresh leaf of soursop (*Annona muricate*) were collected in September 16th, 2025 in two places, in Mr. Kazhigilla garden, Barrack's road, Yola north L.G.A and Professor's quarters in Girei L.G.A and were taken to the department of Botany Modibbo Adama University, Yola for proper identification and authentication.

Botanical classification of Annona *muricate*, Kingdom: "*Plantae"*, Phylum: "*Magnoliophyta"*, Class: "*Magnoliopsida"*, Order: "*Magnoliales"*, Family: "*Annonaceae"*, Genus: "*Annona"*, Species: "*Annonamuricata"*
Figure 1: Soursop Plant **(**Fruit and Leaf**)**

### Sample Preparation and Extraction

For the extraction of the essential oil, the fresh leaf was collected and was separated from the stalk, washed and rinsed with distilled water. 1kg of the pulverized form of each sample of the plant fresh leaf was subjected to steam distillation, according to the British Pharmacopoeia (BP) method. the extraction was conducted for $3^1/2$ hours according to the method described by Kubmarawa *et al.*, 2016. At the end of the extraction, 838.3g of the *Annona muricate* leaf were used.

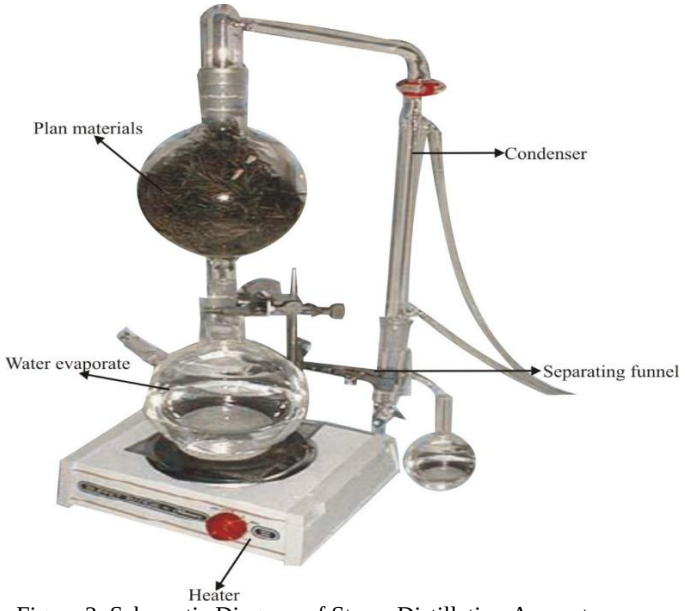


Figure 2: Schematic Diagram of Steam Distillation Apparatus

**Antioxidant Activity**

***DPPH Radical Scavenging Test***

The free radical scavenging activity of essential oil of *Annona muricata* was measured by using 2,2-diphenyl-1-picrylhydrazyl (DPPH). The scavenging activity for DPPH free radical was carried out according to the procedure described by Gowsalya *et al.,* 2021. An aliquot of 2ml DPPH solution in methanol and 5 to 100 µL/mL of essential oil at various concentration various concentration were mixed (working concentrations 5, 10, 25, and 100 µL/mL). The mixture was shaken vigorously and allowed to reach a steady state at room temperature for 30 minutes. Decolourization of DPPH was determined by measuring the absorbance at 517 nm. A control (Ascorbic acid) was prepared in methanol at similar concentrations for comparison. The percentage inhibition of DPPH radicals by the essential oil determined by comparing the absorbance values of the control and the experimental tubes.

$$\%\text{Inhibition} = \frac{\text{Ab}control - \text{Ab}sample}{\text{Ab}control} \times 100 \qquad (1)$$

Where:

Ab*sample* = absorbance of the test sample

Ab*control* = absorbance of the control

The concentration of essential oil required to scavenge 50% of DPPH radicals ($IC_{50}$) was determined from the graph of % inhibition against sample concentration. A lower $IC_{50}$ indicates higher antioxidant potential.

***Antimicrobial activity Test***

Antibacterial activities of leaf essential oil of A. muricata were measured against Gram-positive organisms (Staphylococcus aureus and Staphylococcus epidermidis) and Gram-negative organisms (Escherichia coli, Proteus vulgaris and Salmonella typhimurium) and using agar well diffusion method. (Palaksha et al., 2010).

**Media Preparation**

Nutrient Agar (NA): Composition (per 1000 mL distilled water): Peptone 5 g, Beef extract 3 g,Sodium chloride (NaCl) 5 g, Agar 15 g

***Procedure:***

i. Dissolve all ingredients in distilled water.
ii. Adjust pH to 7.0.
iii. Sterilize by autoclaving at 121°C for 15 minutes.
iv. Allow to cool to ~45–50°C.
v. Pour into sterile Petri dishes and allow to solidify.

***Nutrient Broth (NB):*** Prepared using the same formulation without agar, sterilized at 121°C for 15 minutes.

***Inoculum Preparation***

i. Each microbial strain was revived in sterile nutrient broth.
ii. Cultures were incubated at 37°C for 18–24 hours.
iii. The turbidity of the cultures was adjusted to 0.5 McFarland standard (≈ $1.5 \times 10^8$ CFU/mL) to standardize inoculum density.

***Agar Well Diffusion Assay***

i. Sterile nutrient agar plates were uniformly swabbed with the prepared microbial inoculum.
ii. A sterile 6 mm cork borer was used to punch wells in the agar.
iii. Controls:
   a. Positive control**:** Amoxicillin (standard antibiotic)
   b. Negative control: DMSO or sterile water (solvent without oil)
iv. Plates were incubated at 37°C for 24 hours.
v. Zones of inhibition were measured in millimeters (mm) using a ruler or caliper.

Data were recorded in structured tables showing: Concentration of oil (mg/mL), Zone of inhibition (mm), Presence or absence of growth.

The antimicrobial potential of *A. muricate* leaf essential oil was interpreted by comparing oil performance against that of standard antibiotics.

**Gas Chromatography Mass Spectrometry (GC-MS) Analysis**

Gas chromatography-mass spectrometry (GC-MS) analysis of the essential oils from the leaves of Annona muricata were performed using a gas chromatograph (7890A) interfaced to a Agilent mass spectrometer (5975C) equipped with Elite-5MS (5% diphenyl/95% dimethyl poly siloxane) fused

capillary column (30 × 0.25 mm ID × 0.25 $\mu$m DF). At first, the oven temperature was maintained at 100°C for 2 minutes, and then it was ramped up to 180°C at a rate of 20°C/minute and finally to 280°C at a rate of 10°C/minute where it was held for 16 minutes. For mass spectrometer detection, an electron ionization system was operated in the electron impact mode. Helium was used as a carrier gas at a constant flow rate of 1 mL/minute, and an injection volume of 1 $\mu$L was employed. The injector temperature was maintained at 250°C, and the ion-source temperature was kept at 150°C. Mass spectra were taken at 70 eV with a scan interval of 0.5 seconds over a mass range of 50 to 450 Da. The solvent delay was 0 to 3 minutes, and the total GC/MS run time was 48 minutes. Constituents were identified by comparison of their retention indices relative to n-alkanes and fragmentation patterns from mass spectra, which were compared to the mass spectra from the NIST 14 database. The assigned compound names were made solely by using the similarity indices obtained from the NIST library for the GC-MS system used and some published literature on spectral data.

## RESULTS AND DISCUSSION

**Table 1: Percentage Yield of the Essential Oil of *Annona Muricate***

| Plant | Plant part and form | Weight (g) | Weight of essential oil | Appearance | Percentage yield (%) |
|---|---|---|---|---|---|
| *Annona muricate* (soursop) | Fresh leaf | 838.3 | 0.54 | Pale green | 0.0644 |

Weight of the plant leaf= 838.3 g
weight of essential oil= 0.54

$$\text{Percentage yield (\%)} = \frac{\text{weight of essential oil}}{\text{weight of leaves}} \times 100 \quad (2)$$

$$\text{Percentage yield (\%)} = \frac{0.54}{838.3} \times 100$$

$$\text{Percentage yield (\%)} = 0.0644\%$$

**Table 2: Antioxidant Activity of the Essential Oil of Annona Muricata**

| Concentration (µL/mL) | *Annona muricate* (essential oil) | Ascorbic acid |
|---|---|---|
| 5 | 57.27 | 64.37 |
| 10 | 56.68 | 58.18 |
| 25 | 55.93 | 57.92 |
| 100 | 50.67 | 48.08 |

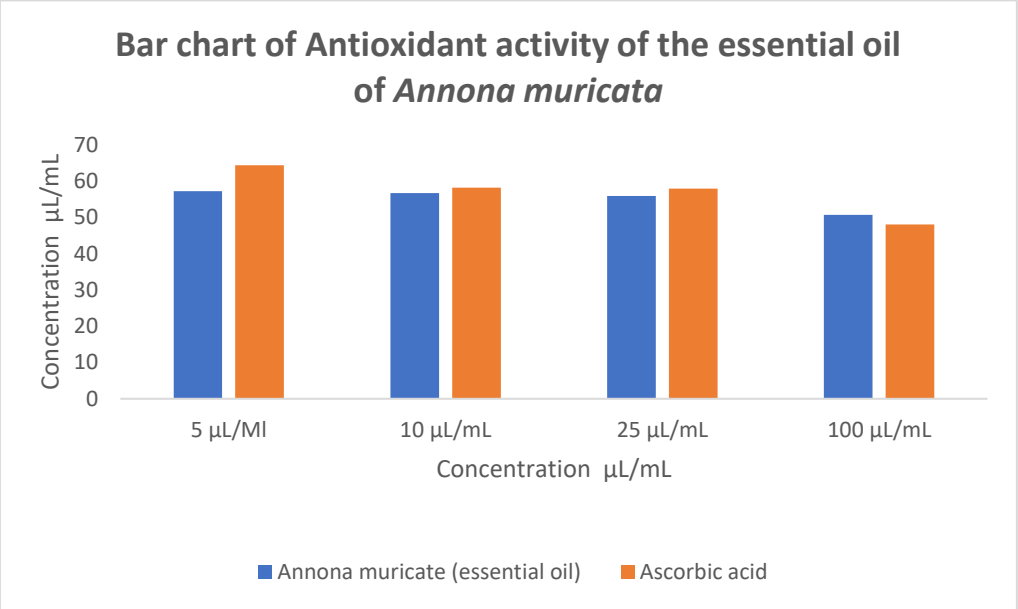


Figure 3: Bar Chart of Antioxidant Activity of the Essential Oil of Annona Muricata

**Table 3: Antimicrobial Activity of *Annona Muricata* Essential Oil**

| Microorganism | *Annona muricate* (essential oil) | Amoxicillin (standard) |
|---|---|---|
| *Staphylococcus aureus* | 8mm | 22mm |
| *Escherichia coli* | 9mm | 32mm |
| *Staphylococcus epidermidis* | 10mm | 22mm |
| *Proteus vulgaris* | - | 18mm |
| *Salmonella typhimurium* | 9mm | 22mm |

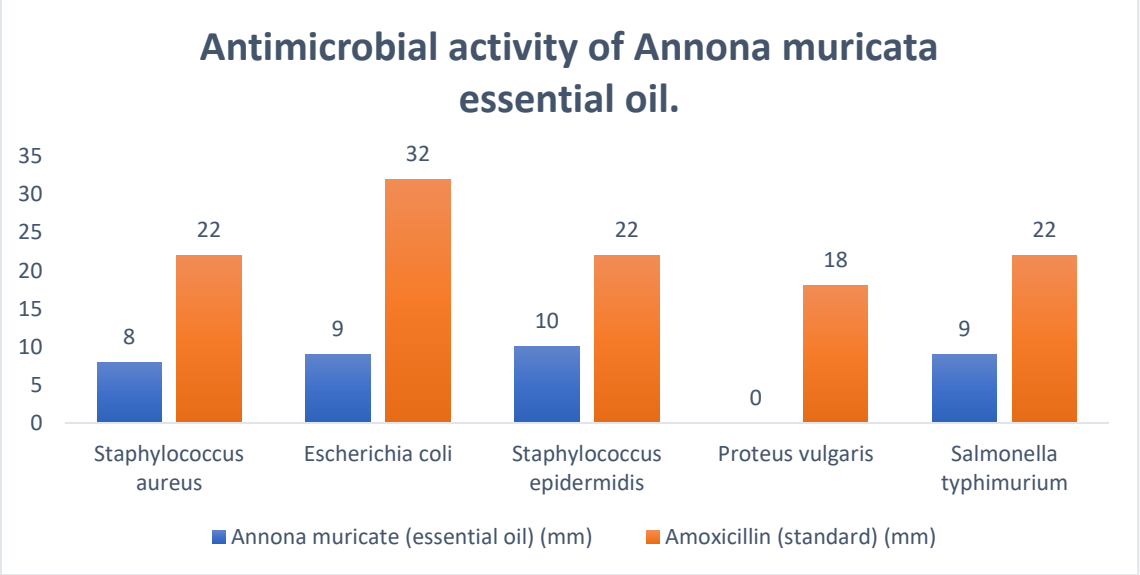


Figure 4: Bar Chart of Antimicrobial Activity of the Essential oil of Annona Muricata

**Table 4: Gas Chromatography Mass Spectrometry (GC-MS) Analysis of Essential Oil of *Annano Muricata* Leaf**

| Constituents | RT (min) | Area % |
|---|---|---|
| Bicyclo[7.2.0] undec-4-ene, 4,11,11-trimethyl-8-methylene-,[1R-(1R*,4 Z,9S*)]- | 5.258 | 4.20 |
| 1-(3-Methylbutyl)-2,3,4-trimethylbenzene | 5.213 | 0.01 |
| Cyclohexane, 1-ethenyl-1-methyl-2, 4-bis(1-methylethenyl)-, [1S-(1.alpha.,2.beta.,4.beta.)]- | 5.628 | 2.82 |
| Caryophyllene | 5.843 | 9.45 |
| Aromandendrene | 6.213 | 3.07 |
| .alpha.-Muurolene | 6.361 | 3.76 |
| Naphthalene, 1,2,3,5,6,8a-hexahydro-4,7-dimethyl-1-(1-methylethyl)-,(1S-cis)- | 6.465 | 7.17 |
| cis-muurola-3,5-diene | 6.724 | 3.08 |
| .gamma.-Muurolene | 6.910 | 7.49 |
| 1H-Benzocycloheptene, 2,4a,5,6,7,8-hexahydro-3,5,5,9-tetramethyl-, ( R)- | 6.961 | 4.17 |
| Naphthalene, 1,2,3,5,6,7,8,8a-octahydro-1,8a-dimethyl-7-(1-methylethenyl)-, [1S-(1.alpha.,7.alpha.,8a.alpha.)]- | 7.221 | 1.77 |
| .tau.-Cadinol | 7.339 | 1.99 |
| Alloaromadendrene | 8.095 | 7.32 |
| beta.-Vatirenene | 8.376 | 3.40 |
| Aromadendrene, dehydro- | 8.687 | 14.83 |
| Isolongifolene, 9,10-dehydro- | 9.183 | 5.17 |
| Cyclononasiloxane, octadecamethyl- | 9.813 | 3.90 |
| (2,2,6-Trimethyl-bicyclo[4.1.0]hept-1-yl)-methanol | 10.013 | 1.77 |
| Tricosane | 10.457 | 4.32 |
| Thunbergol | 10.561 | 0.32 |
| Bacchotricuneatin c | 10.717 | 1.64 |
| Heneicosane | 11.272 | 0.88 |
| Phthalic acid, di(2-propylpentyl)ester | 11.465 | 2.09 |
| 1,4-Methanoazulen-3-ol, decahydro-1,5,5,8a-tetramethyl-, [1S-(1.alpha.,3.beta.,3a.beta.,4.alpha.,8a.beta.)]- | 11.931 | 0.26 |
| 1-Bromodocosane | 12.028 | 0.66 |
| Eicosane, 2,6,10,14,18-pentamethyl | 12.161 | 0.28 |
| Cyclohexane, 1,2,4,5-tetraethyl- | 12.250 | 0.23 |
| 1-Bromo-11-iodoundecane | 12.309 | 1.09 |
| Phthalic acid, 3,4-difluorobenzyldecyl ester | 12.842 | 0.81 |
| Pentadec-7-ene, 7-bromomethyl- | 12.939 | 0.24 |
| Eicosane | 13.116 | 0.94 |
| Oxirane, tetradecyl- | 13.457 | 0.31 |
| cis-1-Chloro-9-octadecene | 13.953 | 0.51 |
| Octatriacontyl pentafluoropropionate | 14.087 | 0.30 |
| Cyclotriacontane | 14.657 | 0.01 |
| Heptacosane | 14.694 | 0.01 |

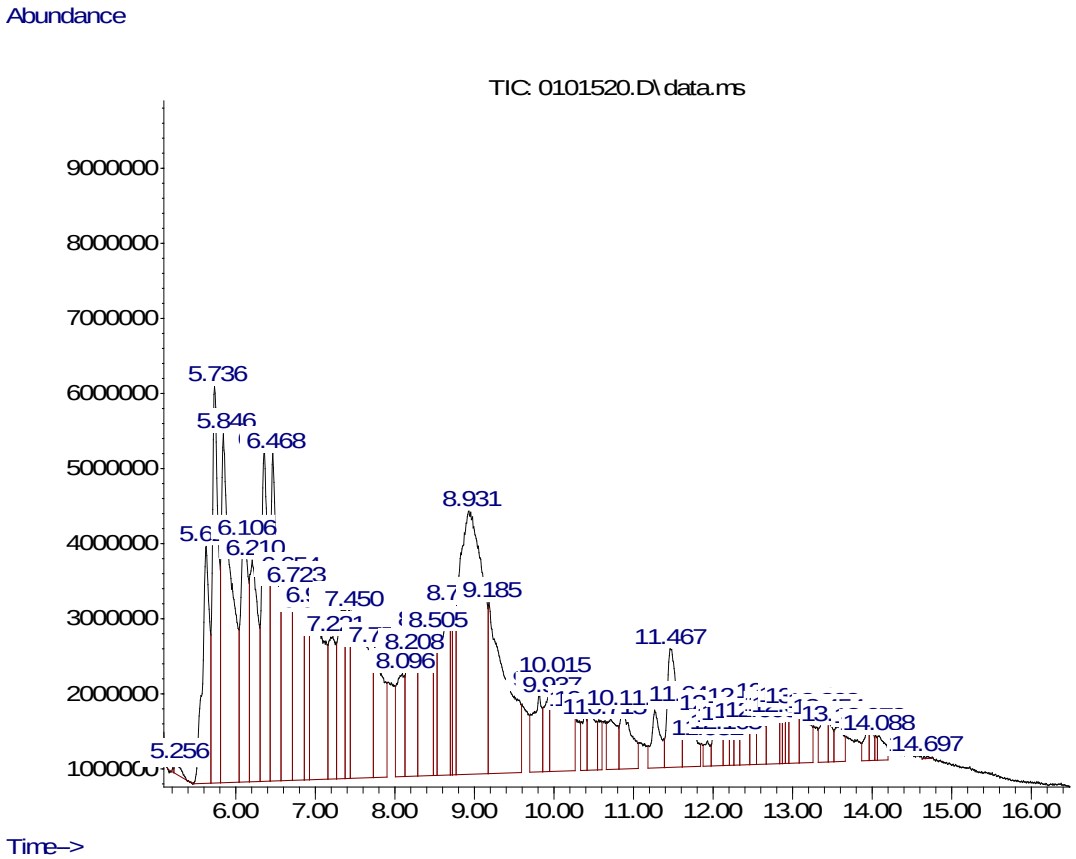


Figure 5: Gas-chromatography-mass Spectrometry Chromatogram of the Constituent oil from A. Muricate Leaf

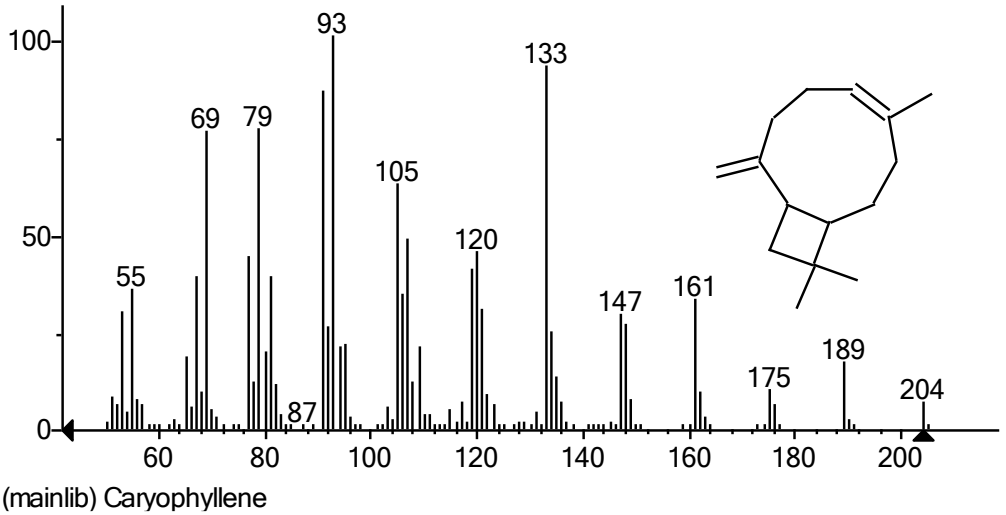


Figure 6: Mass Spectra of Caryophyllene Obtained from the Analysis of Essential Oil of *Annona Muricata*

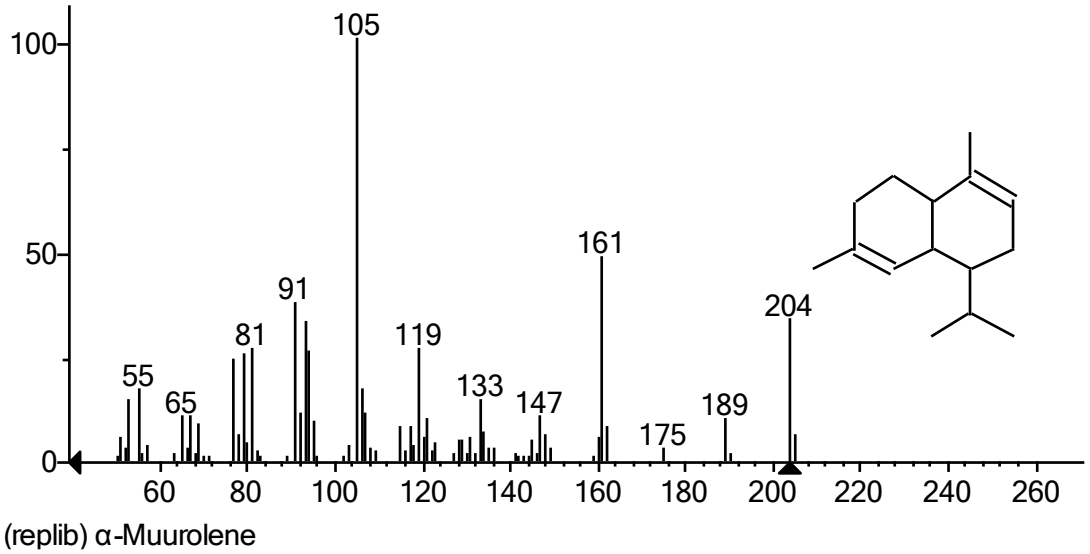


Figure 7: Mass Spectra of a-Muurolene Obtained from the Analysis of Essential Oil of *Annona Muricata*

**Discussion**

The yield of the essential oils obtained in this work was in a similar range to that obtained from *Annona muricata* by other researchers. In general, essential oil yields are less than 1%. Different plant organs produce different amounts/levels of essential oils, and this usually reflects the function of the oils in that plant organ. The leaf essential oils were mainly terpenes and aliphatic hydrocarbons. The essential oil obtained from this work was pale green in nature and imparted aromatic odour (Table 1). The GC-MS analyses of the essential oil of the leaf *Annona muricata* revealed the presence of thirty-six compounds making up 99.96% of the oil (Table 4). The most abundant component of the essential oil was Aromadendrene, dehydro-(14.83%). Other major compounds present in the essential oil were Caryophyllene (9.45%), gamma.-Muurolene (7.49%), Alloaromadendrene (7.32%), Naphthalene,1,2,3,5,6,8a-hexahydro-4,7-dimethyl-1-(1-methylethyl)-,(1S-cis)-(7.17%), Isolongifolene, 9,10-dehydro- (5.17%), Bicyclo[7.2.0]undec-4-ene, 4,11,11-trimethyl-8-methylene-,[1R-(1R*,4 Z,9S*)]- (4.20%), 1H-Benzocycloheptene, 2,4a,5,6,7,8-hexahydro-3,5,5,9-tetramethyl-, (R)- (4.17%), Cyclononasiloxane, octadecamethyl- (3.90%), Tricosane (4.32%), alpha.-Muurolene (3.76%), cis-muurola-3,5-diene (3.08%) Aromandendrene (3.07%), Cyclohexane, 1-ethenyl-1-methyl-2, 4-bis(1-methylethenyl)-, [1S-(1.alpha.,2.beta.,4.beta.)]- (2.82%), (2,2,6-Trimethyl-bicyclo[4.1.0]hept-1-yl)-methanol (2.77%), Phthalic acid, di(2-propylpentyl)ester (2.09%). The total of 16 compounds contained about 88.67%, the remaining bulk of 20 compounds covers only 11.33%. The composition of the essential oil in Annona *muricata* showed to be different from the classes of constituents found in the other species of Annona. Generally, esters were found to be the dominant compounds in other species, i.e. methyl (E)-2-hexenoate, methyl (E)-2- butenoate, methyl butanoate and methyl hexanoate. Likewise, in Annona foetida sesquiterpenes bicyclogermacrene (35.12%), (E)-caryophyllene (14.19%) and α copaene (8.19%) were the most abundant compounds (Costa et al., 2009), some of these compounds were found in the leave essential oil of *Annona muricata*. The constituents of the leaf essential oil obtained in the present study were predominantly sesquiterpenes. This finding is consistent with the work of Joseph et al. (2019), who reported that most compounds identified in the leaf essential oil of *Annona muricata* were terpenes, particularly sesquiterpenes such as α-muurolene, τ-cadinol, α-cadinol, α-humulene, and β-caryophyllene. Similarly, Pelissier et al. (1994) observed that sesquiterpenes constitute the major components of *A. muricata* leaf essential oil. However, variations in the chemical composition of *A. muricata* leaf essential oil have been widely reported. Differences may occur even when the same plant species and organ are studied. Such variations in essential oil composition can be attributed to several factors. Seasonal changes have been documented to influence the chemical profile of essential oils, and these seasonal variations may also affect their biological activities (Hussain et al., 2008). Additional factors contributing to compositional differences include environmental and genetic influences, geographical location, chemotypic diversity, stage of plant maturity, and the nutritional status of the plant (Viljoen et al., 2005).

**Antimicrobial Activities**

The antimicrobial activities of the leaf essential oil of Annona *muricata* against some multi drug resistant Gram positive and Gram-negative bacteria were shown in Table 3, figure 2. The results showed that the leaf essential oil possesses significant antibacterial potentials, the highest inhibitory effects were observed against Staphylococcus epidermidis (10mm), followed by Escherichia coli and Salmonella typhimurium with the same inhibition (9mm) and the moderate inhibition against Staphylococcus aureus (8mm). Proteus vulgaris showed resistant to the essential oil. The tested bacteria showed a reasonable inhibition against Amoxicillin (the standard). The results of this study were, however better than that or closely related to species in Annonaceae family such as leaf extracts of Annona squamosa which has lower activities against S. aureus, S. pneumoniae, alpha-haemolytic streptococci, K. pneumoniae, P. aeruginosa, Proteus spp. The ethanolic extract of the leaf of Annona *muricata* showed the highest zone of inhibition which demonstrated that ethanol was a better extracting medium for antimicrobial activity (Andrew *et.* al., 2019). The leaf essential oil of *Annona muricata* in this present study showed moderate antibacterial activity against both Gram-positive and Gram-negative bacteria. This activity may be attributed to the presence of sesquiterpenes such as β-caryophyllene and α-muurolene identified in the oil. Previous studies have reported that

terpenes, including β-caryophyllene, α-humulene, and germacrene D, possess significant antimicrobial properties, which may contribute to the observed inhibitory effects. Plants having antimicrobial compounds have enormous therapeutic potential as they can act without any side effect as often found with synthetic antimicrobial products (Ololade. et al., 2016). Resistance to antibiotics poses a serious and growing problem, because some infectious diseases are becoming more difficult to treat. Resistant bacteria do not respond to most synthetic antibiotics and continue to cause infection. These resistant bacteria can be treated with natural antibiotics from plants. The prevalence of natural product-derived antibiotics is due to the evolution of secondary metabolites as pharmacologically active phytochemicals that have potentials to penetrate cell membranes of bacteria and interact with specific protein targets (Nazzaro et al., 2013).

**Antioxidant Activities**

Antioxidant potential of the leaf essential oil was done using DPPH radical scavenging where principle of the method was based on the ability of the compounds to act as free radical scavenges or hydrogen ion donor. The percentage inhibitions of the essential oil and the reference drug at various concentrations (100, 25, 10, 5 µL/mL) were 50.67, 55.93, 56.68, 57.27% respectively while the $IC_{50}$ value was found to be 54.18µL/mL. In comparison to ascorbic acid which gave 48.08, 57.92, 58.18, and 64.37% as the percentage inhibition with $IC_{50}$ value of 54.64µL/mL. (Table 2, figure 3). The free radical scavenging and antioxidant activity of the essential oil was increased from 50.67% up to 57.27% significantly. The essential oils, however, displayed a significant antioxidant activity, as seen in Table 2, figure 3. The essential oil had a good level of sesquiterpenes and some phenolic compounds, and this may have contributed to the antioxidant activities observed. It has been postulated that phenolic compounds possess high reactivity towards peroxyl radicals via a formal hydrogen atom transfer, and this is the basis of their antioxidant activity (Amorati et al., 2013). Phenolic compounds are therefore categorized as chain breaking antioxidants. Many reports on the antioxidant potential of essential oils exist (Dhakad et al., 2018), and this report further confirms the importance of essential oils as antioxidative agents.

## CONCLUSION

The essential oil obtained from the leaves of *Annona muricata* was found to contain a rich and diverse mixture of bioactive constituents, with thirty-six compounds accounting for nearly the entire oil composition. The predominance of sesquiterpenes such as dehydro-aromadendrene, caryophyllene, and muurolene derivatives suggests that these compounds may be responsible for the observed biological activities. The oil demonstrated moderate antioxidant activity in the DPPH assay, indicating its potential to neutralize free radicals and reduce oxidative stress. In addition, it exhibited measurable antibacterial activity against both Gram-positive and Gram-negative bacteria, with the greatest susceptibility observed in Staphylococcus epidermidis, while Proteus vulgaris showed resistance. These findings provide scientific support for the traditional medicinal use of *A. muricata* in managing infections and conditions associated with oxidative stress.

However, the observed activities were moderate, suggesting that the oil may be more suitable as a complementary therapeutic agent rather than a separate treatment. Further studies focusing on toxicity evaluation, mechanism of action, isolation of active constituents, and in vivo validation are necessary to confirm its safety, efficacy, and potential pharmaceutical applications.

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