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Extraction and GC-MS Analysis of Oil Extract from Christmas Tree (*Araucaria Heterophylla*) Leaf

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Abstract

For ease of powdering, the leaves were oven-dried for five minutes at 80^0C after being air-dried for twenty-one days. The cold extraction process was then used to extract the oil. The oil extract was dark brown in colour. Nineteen chemicals were found in the oil extract by GCMS analysis, beginning with 2(1H)-Naphthalenone, 4a,5,8,8a-tetrahydro-1,1,4a-trimethyl-, trans (8.23%), Palmitic acid (6.27%), and Bicyclo [7.2.0]. 4,11,11-trimethyl-8-methylene, undec-4-ene (4.94%) Hibaene (16.18%), 13-Isopimaradiene (1.14%), Atis-16-ene (5.82%), 1,5,9-Decatriene, 2,3,5,8-tetramethyl- (1.31%), β-Selinene (8.75%), Kaur-16-ene (15.29%), 9,12,15-Octadecatrienoic acid, (Z,Z,Z)- (1.42%), Cembrene (3.4-d) [1,3]oxazole-4-carbonitrile (1.20%), neophytadiene (1.35%), abietic acid (2.50%), ferruginol (4.07%), and 5-(furan-3-yl)-2-methylpent-1-en-3-ol (7.10%). These findings suggested that the biological activities of the oil extract from Christmas tree leaves (Araucaria heterophylla) may have prospective uses in the pharmaceutical and cosmetic industries.

Keywords: Extraction, GCMS, Christmas Tree Leaves, Oil

1. Introduction

The Christmas tree's botanical name is Araucaria. The genus Araucaria belongs to the Araucariaceae family of evergreen coniferous plants. About nineteen (19) species make up the genus Araucaria (Peralta & Ferreira 2016), two of which are found in South America and two in Eastern Australia. The remaining species are found in Oceania along the island arc that stretches from Norfolk Island to New Caledonia. The majority of species are maritime, and they are often found in stands of pure coastal forest that are exposed to onshore breezes that are heavy with salt.

Their leaves are shielded from salt damage by a thick layer of surface wax, which helps them survive (Banks 2004) [4]. The species of Araucaria that we are studying, Araucaria heterophylla, is a striking evergreen conifer that is native to Norfolk Island. With symmetrical branches and straight vertical stems, the tree grows slowly to a height of 50–65 meters (160–210 feet) (Rogermccart 2024) [25]. Its outstanding qualities, stately stature, elegant leaves, and incredible durability have piqued the interest of numerous botanists, horticulturalists, and enthusiasts. This species has been important in both cultural narratives and botanical lore. Several parts of Araucaria heterophylla are utilized to make traditional remedies in addition to their aesthetic value. In the past, the bark was used to heal cuts, wounds, and skin infections. Cough, colds, and bronchitis are among the respiratory conditions that the leaves and branches aid to relieve. It is receiving more attention and investigation in ethnobotanical studies due to its increasingly acknowledged therapeutic qualities (Kumari, Sharma, Mujat, Das, Ghosh & Mohanty 2024) [11].

There is an urgent need to protect and sustainably manage populations of this amazing tree species as scientific knowledge of its therapeutic qualities expands. We can unlock Araucaria heterophylla's full medicinal potential and open up new avenues for healthcare by fusing traditional knowledge with modern scientific study.

Fig 1.1: Araucaria heterophylla tree

Fig 1.2: Araucaria heterophylla leaf leaf

Chromatography by Gas One analytical method that combines gas chromatography is mass spectrometry (GC-MS). MS is used for compound identification and quantification, while GC is used for operation. It can identify the chemicals in a combination, even at very low concentrations, and is employed in the investigation of mixtures with many components. Araucaria heterophylla oil extract and GC-MS analysis offer chances to find potentially useful bioactive chemicals. Gas chromatography (GC) uses heating delivered by a gas, such as helium, known as the carrier gas or mobile phase, to turn a liquid sample into a vaporized form in order to separate volatile components in a mixture. The identification and measurement of the vaporized compound separated in the GC are aided by the mass spectrometer (MS) (Agilent, n.d.) [1]. This study offers a thorough summary of the bioactive substances found in Araucaria heterophylla. The entire therapeutic potential of Araucaria heterophylla is unlocked by its use for ornamental appeal and the growing scientific and traditional understanding of its medicinal qualities, which stems from the urgent need to protect this species. The quantity and quality of the bioactive chemicals present in the oil extraction combination, however, have not been thoroughly studied. Thus, this study's research topic is to examine their bioactive chemicals and use gas chromatography mass spectrometry to determine the analytes and their quantity. The goals are to extract oil from Araucaria heterophylla and detect and quantify analytes in the oil extract using gas chromatography mass spectrometry.

Orodu & Dikio (2020) [22] used gas chromatography mass spectrometry to extract oil from unripe plantain (Musa paradisiaca) peels by oven drying the peels and extracting the oil after soaking them in n-hexane for 72 hours. A GCMS machine then examined the oil and found ten distinct bioactive compounds. Oyedeji, Erazua, and Adeleke (2018) [8] use GC-MS analysis to assess the chemical makeup of oil extracted from four cultivars of Mangifera indica mango seed kernels. Gomathi, Kalaiselvi, Ravikumar, Devaki & Uma (2015) [6] carried out the identification of bioactive compounds found in the whole plant ethanolic extract of *Evolvulus alsinoide*s by GCMS standard equipment Thermo GC-Trace ultra-version 5.0 and Thermo MS DSQII, revealing the presence of different compounds that could make Evolvulus alsinoides have anti-cancer, anti-oxidant, and anti-inflammatory activities due to the presence of secondary metabolites. Extraction and GC-MS analysis of oil obtained from ripe (*Carica papaya l.*) pawpaw by Orodu & Otakpa (2021) detected 10 different compounds present in the oil extracted from evaporated, ground pawpaw peels soaked in n-hexane for 24 hours at 35°C in a water bath and detected the compounds in the oil using the GC-MS Clarus 500 version 6.2. 0.0:B34 machine.

The GCMS analysis of bioactive compounds discovered in the oil extracts of Plant Rhazya stricta using different solvents was discussed by Nabuh, Yaaser, Mohamed, Ammar, Haytham, Naseebh, Masleh, Aaser & Mohammed (2023). It was found that the characteristics of the extraction solvent had a significant impact on the extraction yield and the photochemical components of the extracted oil. Orodu & Dakitima (2024) [21] discussed the GCMS analysis and oil extraction of red cocoyam peels (Colocasia esculenta) utilizing n-hexane solvent and cold extraction techniques. A GCMS machine was used to determine the chemicals in the extracted oil.

Nine chemicals were found in the ethyl acetate root extract of Guiera senegalensis J.F. Gmel using GC-MS analysis by Shettima, Kerumi, Sodipo, Usman, and Tijjani (2013) [29]. The phytochemical profiling and GCMS analysis of the aqueous methanol fraction of Hibiscus asper leaves were discussed by Njoku, Umeh, and Ogugofor (2021) [20]. The results showed the existence of bioactive chemicals with significant therapeutic value. Zhang, Xin-Yuan, Wang, and Yan's (2021) [5] GCMS analysis of essential oil extracted from (Acori tatarinowii) Rhizoma reveals the two extraction techniques, Soxhlet and Clevenger, which the GCMS machine further separated and identified.

Marin, Rodny, Paredes, Alarcón, Balmaseda, Roberto, Miriam, and Guerra (2018) [24] discussed the GC-MS analysis and bioactive characteristics of extracts from Clusia Minor L. leaves. The oil was extracted from the sample using four (4) extracting solvents: hexane, ethyl acetate, methanol, and ethanol. This led to additional research into the identification of the bioactive components present using GC-MS analysis. Rubab, Rizwani, Bahadur, Shala, Alsamadany, Alzahrani, Shuaib, Hersan, Hobani, and Shah (2020) [28] determined the GC-MS analysis of seed oil and evaluated the pharmacokinetics of Camellia sinensis L. leaf extract. sought to develop a quantitative analysis of phytochemicals and a nutritional evaluation of C. sinensis seed oil, which is rich in vital biological ingredients. The GC-MS analysis reveals the rich source of fatty acid and helps fulfill pharmaceutical need.

The GCMS analysis, molecular docking, and pharmacokinetic studies of Multidenia crassa extracts were discussed by Chikowe, Bwaila, Ugbaja, and Abouzied (2024) [10]. Their investigations revealed us that plant

extracts have been advantageous to oral health. To assess the advantages of Heirns for dental health. The GCMS study of the plant discovered 58 bioactive phytocompounds, which have varied pharmacological actions favorable to oral health. The GCMS analysis of various organic crude oil extracts from the local medicinal plant Thymus vulgaris L. was discussed by Hashmi, Hossain, Wali, Al-Riyami, and Jamal (2013) [15]. This analysis revealed the various high- and low-molecular-weight compounds present in the crude oil extract, essentially with biological significance.

The GCMS analysis and antioxidant and antibacterial properties of acetone fractions derived from Guiera senegalensis leaves and Quercus infectoria nutgall extracts were discussed by Satti, Abdelgadir, Hago, Ahmed, and Elimam (2021) [3]. Four (4) chemicals were found in the G. G. Senegalensis extract by GCMS analysis, whereas pyrogallol, a significant phytoconstituent, was found in the Q. infectoria extract. In conclusion, Q. Q. infectoria and G. senegalensis leaves have strong antibacterial and antioxidant properties. Using a pylorus-ligated rat model, Ayaz, Junaid, Ullah, Sadiq, Shahid, Ahmed, Ihsasn, Ashfaq, and Syed (2017) [18] investigated the antiulcer potential of polygonum hydropiper crude extract. Several substances with antiulcer, antiurease inhibitory, and antiproteus properties were found in the sample by GC-MS analysis.

About forty (40) bioactive chemicals were found in the oil extracts using the GC-MS equipment in Qadar, Salah, and Rasul's (2017) [13] investigation of the phytochemical variety of the essential oil of tarragon (Artemisia dracunculus L.) leaves and stems. Amin, Elwekeel, Alshariedh, Abdel-Bakky, and Hassan (2022) [7] investigated the bioactivities and GC-MS analysis of the essential oil of Suaeda aegyptiaca. Three distinct extraction techniques were employed, and GCMS analysis identified twenty (20) and twenty-eight (28) chemicals depending on the extraction technique. The outcome demonstrates that extraction techniques significantly affect an essential oil's biological potential.

The methanolic extracts of Cassia alata made using a Soxhlet apparatus were discussed by Kavipriya & Chandran (2018) [14]. GCMS and FTIR were used to identify the bioactive photocompounds. Using GCMS and FTIR analysis, Shithya & Krishnaveni (2022) [27] examined the chemicals present in Bridelia montana (ROXB) stem extract. Eight phytocompounds were found by the GCMS, while five main compounds were found by the FT-IR. In 2019, Hongbo, Wei, Younshua, Haizhen, Jinshui, and Liangblin conducted a GC-MS analysis of the essential oil extracted from Anethum graveolens L (dill) seeds using supercritical carbon dioxide. The results showed that the essential oil included 38 components.

Mequanint & Dominic (2020) [17] discussed the extraction and GC-MS analysis of the essential oil from the peel of Solanum incanum and its antibacterial activity studies using three solvents: hexane, diethyl ether, and ethyl acetate. The extraction produced two immiscible fractions of oil, which were then analyzed using GCMS to identify 17 components. Additionally, four pathogens at four different concentrations were used in the antibacterial investigations.

Carmona & Castro (1999) [12] used subcritical water extraction to isolate eucalyptus essential oil for GC-MS analysis. G-MS analysis of the essential oil from Artemisia aucheri Boiss fruits was studied by Mahsa & Jinous (2017). The GC-MS analysis of the essential oil, metal profile, and physiochemical characteristics of Citrus macrophylla Wester fruits from Sudan by Abdelhafeez, Alrayeh, Moawia, and Nawal (2021) [2] revealed a number of elements that may be used in food as nutritious juice.

2. Materials and Methods

2.1 Materials

2.1.1 Apparatus: The following apparatus was used during the extraction process in the laboratory. Oven, weighing balance, jar, beaker (153.26 g), cotton wool, foil paper, measuring cylinder, conical flask, and funnel.

2.1.2 Reagent used: n-hexane

2.1.3 Sample used: 250 g of *Araucaria heterophylla* (Christmas tree) leaves

2.1.4 Equipment: Gas Chromatography Mass Spectrometry Model 2007

2.2 Methods

2.2.1 Sample preparation

Araucaria heterophylla was air-dried for 21 days, then taken to the laboratory for oven drying at 80^0C for 5 minutes, making it crunchy. It was then ground to powder and kept in a desiccator (airtight container) to avoid moisture.

Fig 2.1: Araucaria heterophylla leaves on a mat for air drying (21 days)

2.2.2 Extraction of Oil

Four (4) jars were filled with 250 g of measured leaves. To ensure appropriate maceration, 500 mL of n-hexane was measured, put to each jar, and thoroughly mixed. The jars were then kept in a dark area to prevent the n-hexane from evaporating for 72 hours. After that, it was filtered twice into a beaker using a cotton wool funnel to obtain a pure extract. After that, the beaker was placed in a water bath for a full day, leaving the oil extracts in the beaker, and covered with foil paper that had holes in it to facilitate the easy evaporation of n-hexane. After being put in a little sample container, the oil extract was brought to the lab for GCMS analysis.

Percentage Yield of extract:
Weight of beaker = 291.35 g
Weight of extract in beaker = 311.67 g
Weight of extract: 311.67 – 291.35 = 20.32 g
Percentage yield = weight of extract in gram / weight of leaves X 100
20.32g / 250g X 100
= 0.081 X 100
= 8.13%

Fig 2.2: Maceration process

Fig 2.3: After filtration

Fig 2.4: Evaporation after fourteen days

Fig 2.5: Oil extract

3. Results and Discussion

The results gotten from the analysis are discussed as follow. The oil extract was thick and is dark brown in colour. The chromatogram showed seventeen (17) peak as shown in Fig 3.1. The peak identified seventeen compounds.

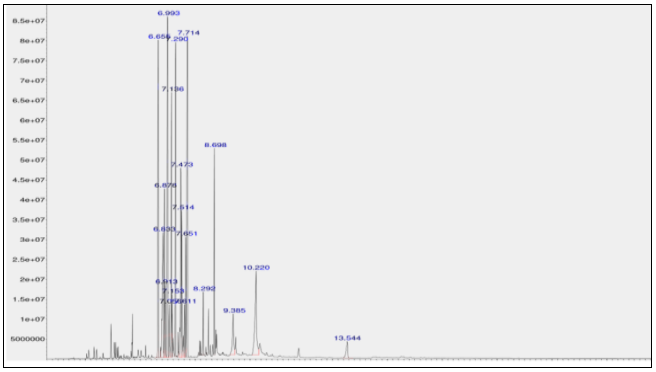

Fig 3.1: Chromatogram

Table 3.1: Components identified by the GC-MS

Peak No	Name of compound	RT Min	Percentage composition
1	Naphthalenone, 4a,5,8,8a-tetrahydro-1,1,4a-trimethyl-, trans	6.655	8.23
2	Palmitic acid	6.833	6.27
3	Bicyclo[7.2.0]undec-4-ene, 4,11,11-trimethyl-8-methylene	6.878	4.94
4	Rimuene	6.913	1.57
5	Hibaene	6.993	16.18
6	13-Isopimaradiene	7.056	1.14
7	Atis-16-ene	7.136	5.82
8	1,5,9-Decatriene, 2,3,5,8-tetramethyl	7.153	1.31
9	β-Selinene	7.290	8.75
10	Kaur-16-ene	7.514	15.29
11	9,12,15-Octadecatrienoic acid, (Z,Z,Z)	7.611	1.42
12	Cembrene	7.651	3.47
13	2-Amino-6-(4-methylphenyl)thieno[3,4-d][1,3]oxazole-4-carbonitrile	8.292	1.20
14	Ferruginol	8.698	4.07
15	Abietic acid	9.385	2.50
16	5-(Furan-3-yl)-2-methylpent-1-en-3-ol	10.220	7.10
17	Neophytadiene	13.544	1.35

The first compound identified was Naphthalenone, 4a,5,8,8a-tetrahydro-1,1,4a-trimethyl-, trans (8.23%), and has the molecular formula $C_{13}H_{18}O$, a molecular weight of 190, and a retention time of 6.655 min, as shown in Figure 3.2.1. The second compound identified is palmitic acid, also known as palmitic acid (6.27%), and has the molecular formula $C_{16}H_{31}O_2$, molecular weight 256, and retention time of 6.833 min (Figure 3.2.2.) The third compound identified was Bicyclo [7.2.0] undec-4-ene, 4,11,11-trimethyl-8-methylene- (4.94%), and has the molecular formula $C_{15}H_{24}$ and a molecular weight of 204 with a retention time of 6.878 min (Figure 3.2.3.). The fourth compound identified was Rimuene (1.57%) and has the molecular formula $C_{20}H_{32}$, a molecular weight of 272, and a retention time of 6.913 min (Figure 3.2.4.) The fifth compound identified was Hibaene (16.18%), which has the molecular formula $C_{20}H_{32}$, a molecular weight of 272, and a retention time of 6.993 min.. (Figure 3.2.5.) The sixth compound identified was Phenanthrene, 7-ethenyl-1,2,3,4,4a,4b,5,6,7,9,10,10a-dodecahydro-1,1,4a,7-tetramethyl-, [4aS-(4aα,4bβ,7β,10aβ)], also known as 13-Isopimaradiene (1.14%), and has the molecular formula $C_{20}H_{32}$, a molecular weight of 272, and a retention time of 7.056 min (Figure 3.2.6.) The seventh compound identified was Atis-16-ene, (5β,8α,9β,10α,12α) (5.82%), and has the molecular formula $C_{20}H_{32}$, a molecular weight of 272, and a retention time of 7.136 min (Figure 3.2.7).

The eight compounds identified were 1,5,9-Decatriene, 2,3,5,8-tetramethyl- (1.31%), and the molecular formula $C_{14}H_{24}$, with a molecular weight of 192 and a retention time of 7.153 min (Figure 3.2.8.) The ninth compound identified was β-Selinene (8.75%) and has the molecular formula $C_{15}H_{24}$, a molecular weight of 204, and a retention time of 7.290 min (Figure 3.2.9.) The tenth compound identified is Kaur-16-ene (15.29%) and has the molecular formula $C_{20}H_{32}$, a molecular weight of 272, and a retention time of 7.514 min (Figure 3.2.10.) The eleventh compound identified was 9,12,15-Octadecatrienoic acid, (Z,Z,Z)- (1.42%), and has the molecular formula C18H30O2, a molecular weight of 278, and a retention time of 7.611 min (Figure 3.2.11.)

The twelfth compound identified was 1,3,6,10-Cyclotetradecatetraene, 3,7,11-trimethyl-14-(1-methylethyl)- (3.47%) and has the molecular formula $C_{20}H_{32}$, a molecular weight of 272, and a retention time of 7.651 min (Figure 3.2.12.) The thirteenth compound identified was 2-Amino-6-(4-methylphenyl)thieno[3,4-d][1,3]oxazole-4-carbonitrile (1.20%) and has the molecular formula C13H9N3OS, a molecular weight of 255, and a retention time of 8.292 min (Figure 3.2.13.) The fourteenth compound identified was ferruginol (4.07%) and has the molecular formula $C_{20}H_{30}O$, a molecular weight of 286, and a retention time of 8.698 min (Figure 3.2.14.) The fifteenth compound identified was abietic acid (2.50%) and has the molecular formula $C_{20}H_{30}O_2$, a molecular weight of 302, and a retention time of 9.385 min (Figure 3.2.15.) The sixteenth compound identified was 5-(Furan-3-yl)-2-methylpent-1-en-3-ol (7.10%) and has the molecular formula C10H14O2, a molecular weight of 166, and a retention time of 10.220 min (Figure 3.2.16.) The seventeenth compound identified was Neophytadiene (1.35%) and has the molecular formula $C_{20}H_{38}$, a molecular weight of 278, and a retention time of 13.544 min (Figure 3.2.17.)

3.2 Compounds Elucidated by Mass Spectroscopy of the GCMS

3.2.1 Naphthalenone, 4a,5,8,8a-tetrahydro-1,1,4a-trimethyl-, trans, is a synthetic naphthalenone derivative with potential applications in pharmaceuticals due to its potential as an anti-inflammatory, antimicrobial, and anticancer agent.

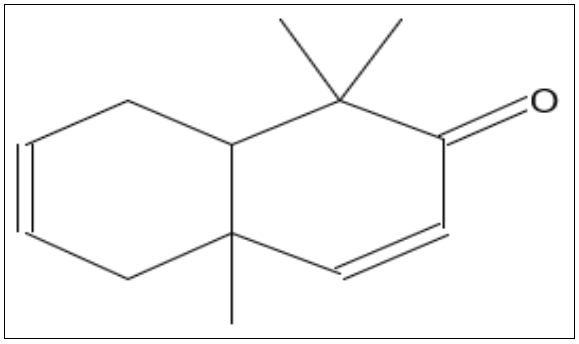

Fig 3.2.1: Naphthalenone, 4a,5,8,8a-tetrahydro-1,1,4a-trimethyl-, trans (8.23%)

3.2.2 n-Hexadecanoic acid, commonly known as palmitic acid, is a saturated fatty acid with a 16-carbon chain. It's a major component of many fats and oils. It has several uses, including in the production of soaps and cosmetics and as a mold release agent.

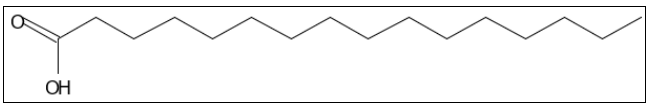

Fig 3.2.2: n-Hexadecanoic acid (6.27%)

3.2.3 Bicyclo [7.2.0] According to a patent, undec-4-ene, also known as 4,11,11-trimethyl-8-methylene, is a naturally occurring sesquiterpene hydrocarbon that is frequently employed as a flavoring agent, fragrance ingredient, and component of lubricating oil compositions.

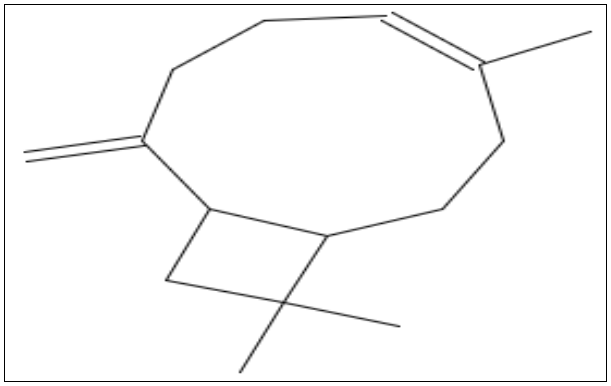

Fig 3.2.3: Bicyclo[7.2.0]undec-4-ene, 4,11,11-trimethyl-8-methylene (4.94%)

3.2.4 Rimuene

Plants and resins contain rimuene, a diterpenoid that may have biological activity like antibacterial, antifungal, or anti-inflammatory qualities. and applications in perfumes or conventional medicine.

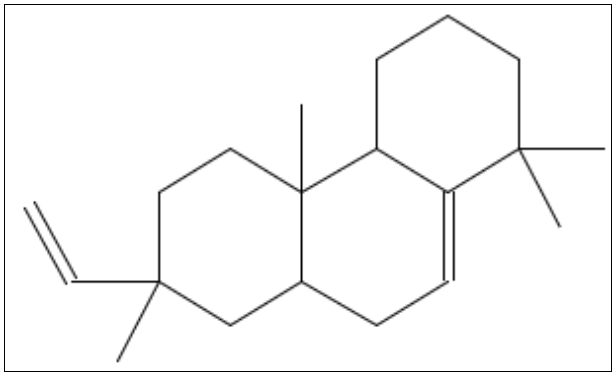

Fig 3.2.4: Rimuene

3.2.5 Hibaene also known as17-Norkaur-15-ene, 13-methyl-, (8β,13β)- is a diterpene compound, found in various plants. It's a naturally occurring substance with potential antibacterial properties against Gram-positive bacteria like Staphylococcus aureus.

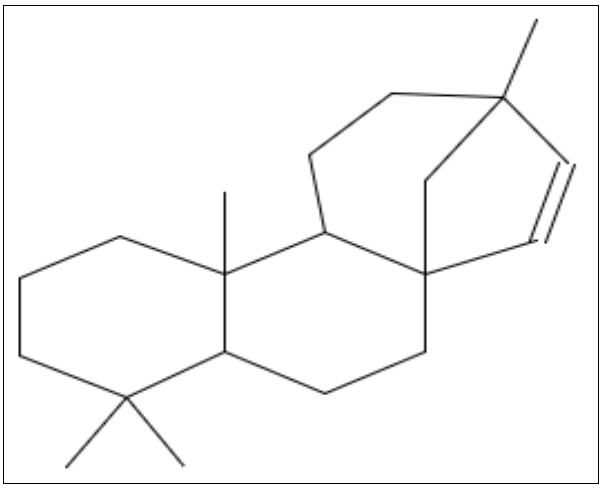

Fig 3.2.5: Hibaene

3.2.6 13-Isopimaradiene

13-Isopimaradiene is a kind of diterpenoid, a chemical molecule that occurs naturally in plants and other living things. In particular, it is a diterpenoid of the pimarane class. Numerous biological actions, such as anticancer, anti-inflammatory, analgesic, and antibacterial properties, are known for these substances.

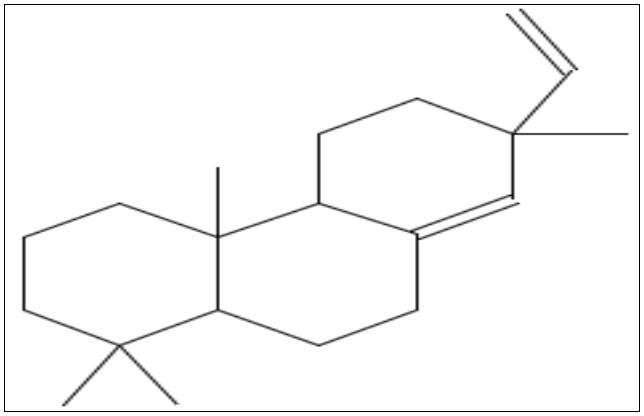

Fig 3.2.6: 13-Isopimaradiene

3.2.7 Atis-16-ene is not used as a drug or chemical in itself. Its importance lies in its function as a structural core for other naturally occurring diterpenoids.

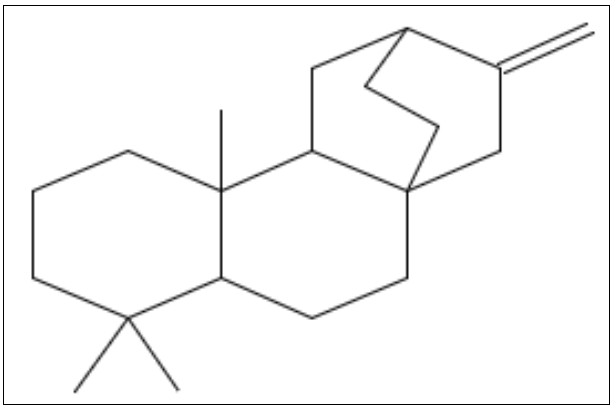

Fig 3.2.7: Atis-16-ene

3.2.8 1,5,9-Decatriene, 2,3,5,8-tetramethyl is used as a fragrance ingredient in perfumes, laundry products, and cosmetics. It is a synthetic woody odorant.

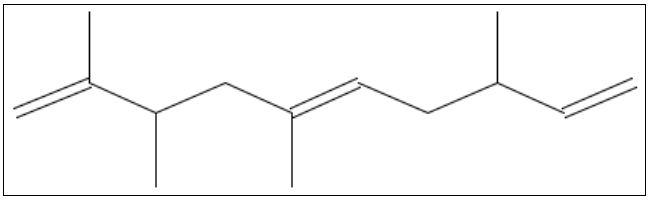

Fig 3.2.8: 1,5,9-Decatriene, 2,3,5,8-tetramethyl

3.2.9 β-Selinene

Essential oils contain β-selinene, which may have antibacterial and anti-inflammatory qualities. It can be utilized in various chemicals and lubricants.

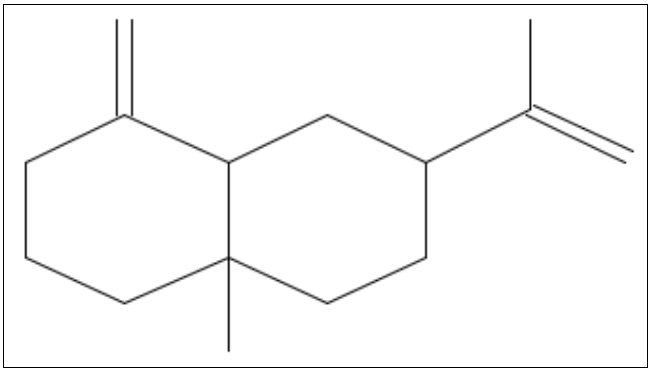

Fig 3.2.9: β-Selinene

3.2.10 Kaur-16-ene

Diterpenes, which are naturally occurring chemical compounds found in plants, include kaur-16-ene. It is distinguished by a double bond in the kaurane structure at position 16. Its possible therapeutic qualities have been investigated. For instance, the analgesic, anti-inflammatory, and antibacterial properties of kaurenoic acid, a derivative of kaur-16-ene, have been investigated. The structure is shown in figure 3.2.10.

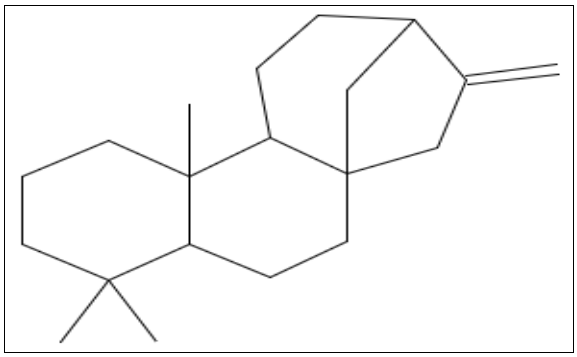

Fig 3.2.10: Kaur-16-ene

3.2.11 9,12,15-Octadecatrienoic acid, (Z,Z,Z)- also known as Linolenic acid Linolenic acid, or 9,12,15-Octadecatrienoic acid (Z,Z,Z), is a polyunsaturated omega-3 fatty acid that is essential for the development of the brain and eyes as well as general cognitive function. It is an essential nutrient associated with a number of possible health advantages, such as lowered cholesterol, decreased risk of cardiovascular disease, and possible anti-inflammatory actions. participating in numerous physiological processes and acting as a precursor for additional omega-3 fatty acids.

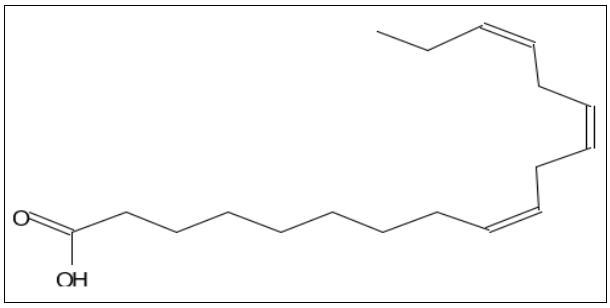

Fig 3.2.11: 9,12,15-Octadecatrienoic acid, (Z,Z,Z)-

3.2.12 Cembrene given in figure 3.2.12 below.
Plants, animals, and marine life all contain cembrene, a naturally occurring diterpene. Its significance as a chemical entity is modest, but it provides the structural framework for many other natural products, including those with a variety of biological activity.

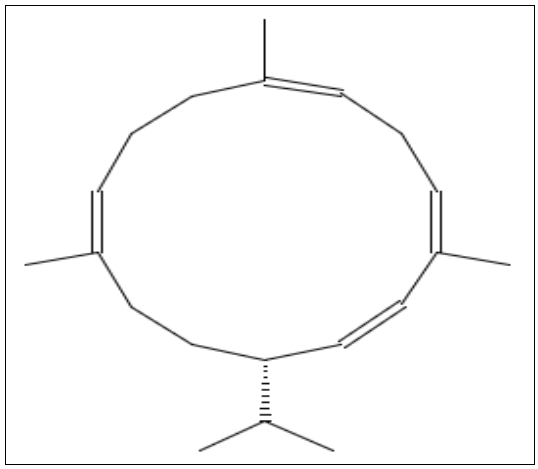

Fig 3.2.12: Cembrene

3.2.13 2-Amino-6-(4-methylphenyl)thieno[3,4-d]oxazole-4-carbonitrile is presented in figure 3.2.13 below. It is a complicated organic compound. It's a thienooxazole derivative, including a thieno[3,4-d]oxazole ring system, a 4-methylphenyl group, an amino group, and a nitrile group. The existence of these diverse functional groups can alter the molecule's characteristics and its possible biological effects.

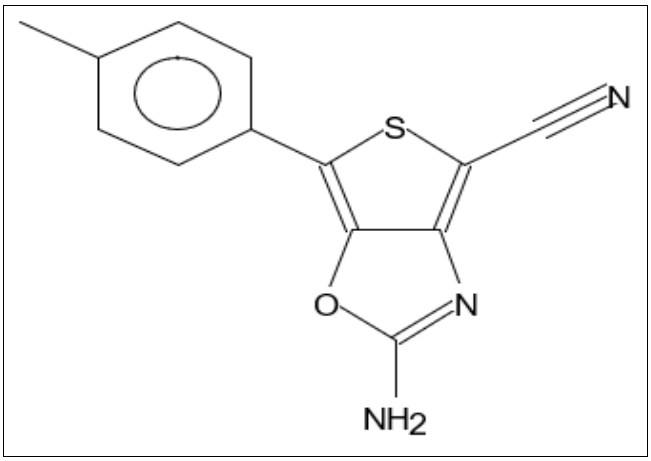

Fig 3.2.13: 2-Amino-6-(4-methylphenyl)thieno[3,4-d]oxazole-4-carbonitrile

3.2.14 Ferruginol is a diterpenoid compound primarily known for its potential as an anti-tumor agent and neuroprotective compound.

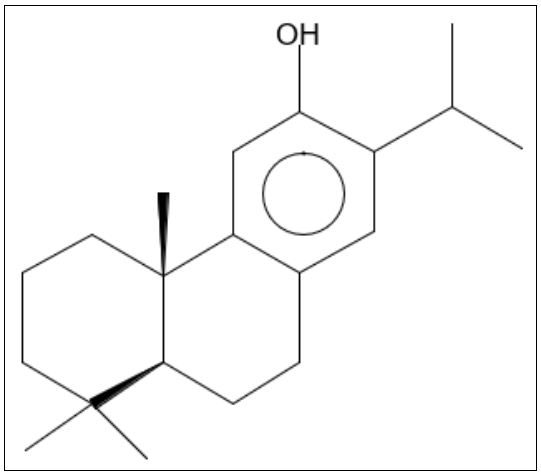

Fig 3.2.14: Ferruginol

3.2.15 Abietic acid is a naturally occurring organic acid, having the main component of rosin from the solid part of tree resin. The formula is illustrated in figure 3.2.15. It's utilized in several purposes, including making lacquers, varnishes, and soaps and as a component in dental materials, cosmetics, and other products. It has showed antibacterial, antiviral, antimalarial, and other biological actions, making it a focus of current investigation for potential medical purposes.

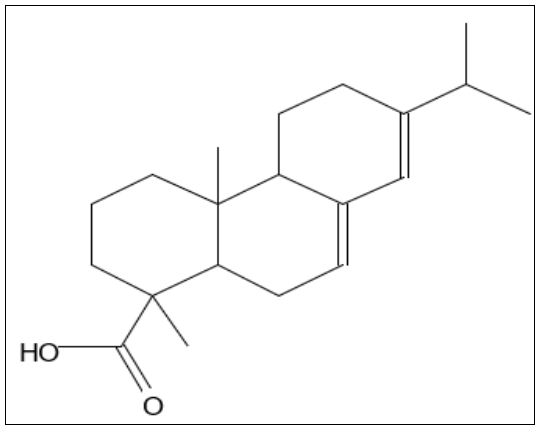

Fig 3.2.15: Abietic acid

3.2.16 5-(Furan-3-yl)-2-methylpent-1-en-3-ol is a chemical compound, specifically a furan derivative and is illustrated in figure 3.2.16. The principal usage is as a component in the manufacturing of resins, where it's part of a broader chemical process. Furan derivatives like this one are significant in the production of different chemicals with biological activity, including camptothecin, which is used as an anti-cancer medication, and other naturally occurring molecules with potential therapeutic uses.

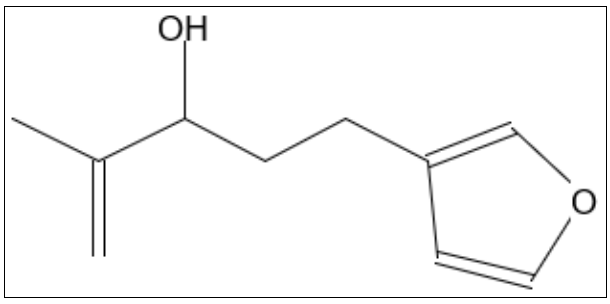

Fig 3.2.16: 5-(Furan-3-yl)-2-methylpent-1-en-3-ol

3.2.17 Neophytadiene

Numerous plants contain the diterpene chemical neophytadiene (NPT). It demonstrates a spectrum of biological actions, including anti-inflammatory, antibacterial, and antioxidant effects. Furthermore, it shows promise in different uses like medicine, agriculture, and even as an additive in liquid cigarettes. Fig. 3.2.17 provides it.

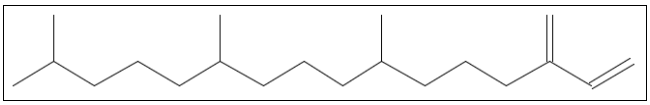

Fig 3.2.17: Neophytadiene

4. Conclusion and Recommendation

4.1 Conclusion

This study looked at extracting oil from Araucaria heterophylla and analyzing the oil extract using GCMS. To get insight into the research effort, a large body of literature including similar study was examined. The cold extraction process was effectively used to extract the oil. Nineteen compounds were found in the oil extract according to the GCMS analysis, with Hibaene having the highest abundance concentration (16.18%), Kaur-16-ene (15.29%), and 2-Amino-6-(4-methylphenyl)thieno[3,4-d][1,3]oxazole-4-carbonitrile (1.20%) having the lowest abundance concentration. These findings indicate that the biological activities of the oil extract from Christmas tree leaves (Araucaria heterophylla) may have prospective uses in the pharmaceutical industry.

4.2 Recommendation

We recommend that the results of this research be implemented in the pharmaceutical industries due to the bioactive components identified in the oil extract.

5. Conflict of interest

There is no conflict of interest

6. References

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