Original Research Article

EXTRACTION AND GC-MS ANALYSIS OF OIL FROM RED POTATO PEELS (*SOLANUM TUBEROSUM*)

ABSTRACT

Extraction and GC-MS analysis of oil from red potato peel was carried out. The potato used for this research work was obtained from the Amassoma market, Southern Ijaw, Bayelsa State. The potatoes were washed severally with water and peeled. The peels were sun-dried for three (3) days and then pulverized to powder with a grinding engine to increase the surface area. 250 g of the pulverized sample was weighed into a brown bottle, and 900 mL of n-hexane was added and allowed to macerate for 72 hours.

The solvent was evaporated at room temperature (250°C) to get the oil. 18 components were detected by the GC. The mass spectrometer identified the structure and names of the compounds. The compounds found are 2-ethyl-1,4-dimethy benzene 1.094 %, bicyclo [4.4.0] decan %, 2-hydroxy-4-methoxybnezaldehyde 10.715 %, 1-hexadecanyl-4-methybenzylsulfonate 5.825 %, 2-heptadecanl 3.0045 %, N-hexadecanoic acid 27.124 %, Z-8 heptadecene 4.090 %, 2-heptadecenal 7.516 %, tricyclo [4.3.1.1(3.8) undecan-3-1ol 2.9962 % , oleic acid 20.199 %, linolenic acid 3.062 %, 2-Methylhexacosane 2.488%, Cholestero acetate 0.863 %, 5-cholestine-3-ol-2methy 1.982% and 4-(2-methylpropxyphenyl)-2-methylpropylpenoate 3.067%. From the result, it can be said that red potato oil has both pharmaceutical and cosmetic uses.

Keywords: Extraction, characterization, oil, Red potato, Peels

1.0 INTRODUCTION

Tubers are underground plant organs that are swollen and enlarged to store nutrients (David, 2018). Some of the most important tubers that are edible include potatoes. (*Solanum tuberosum*), cassava (*Manihot esculenta*), and yam (*Dioscorea batatas*) from Michael (2018). Potato (*Solanum tuberosum*) is a starchy tuber grown from vegetative leaves; it originated in South America, most likely from the central Andes in Peru. Abraham (2022). However, potatoes (*Solanum tuberosum*) are a globally important crop, ranking fourth in annual production, after maize, rice, and wheat. It is also the most economically viable food crop that is not a grain. Fabia, Vanessa, Edvar (2018). Potatoes are a great source of fiber, potassium, vitamins, and other essential nutrients, and they have many health benefits when consumed, such as improving digestion, reducing inflammation, and improving insulin sensitivity in diabetes (Food Savvy). Megan (2015).

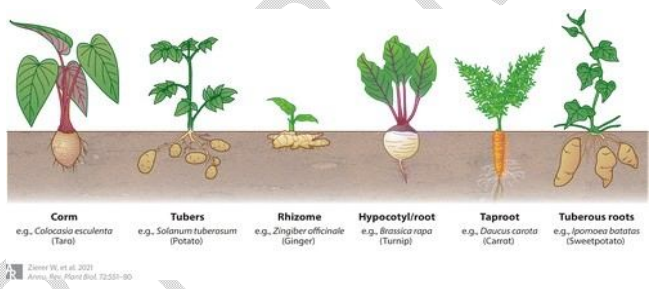

Fig1.0 picture showing tuber and tuberous plants

Fig2 . Image showing potato peels and tubers

Potatoes are generally consumed in different ways by different people daily; therefore, the shifting of consumption rates from fresh to more processed food such as potato chips, crisps, purees, and French fries has increased the generation of potato peel waste, which accounts for about 40% of its original weight. Niran, Khalife, Pankaj, Dhanapati, Utpal, and Biraj (2022). Before consumption, the potato plants are peeled, and if the by-products, which are agro-industrial waste, are not processed carefully, they decompose rapidly by bacteria, resulting in the release of foul odour and causing air pollution (Pranav, Sachin, Mandavgane, Nikhil, Swpnil, and Bhaskar, 2017). Instead of accumulating waste products in the environment, these waste peels from potato plants can be processed into various forms, which could be used as antioxidants, antimicrobial pharmaceutical ingredients, and pig feed (Haftom, Gebrechristos, and Weihua, 2018).

The application of essential oils has been given much attention as they are a better source of several bioactive compounds; they are currently preferred over the synthetic oils Giovanna, Ksenia, Christine, and Scampicchio. (2020). Essential oils are aromatic volatile liquids that are obtained from plant material through steam distillation. The name of an essential oil indicates the plant from which it is derived; for example, lavender essential oil is obtained from the lavender plant (Jose-Luis, 2016). The present study is therefore based on the extraction of oil from red potato peels. The quest for knowledge on how to get oil that is more conducive for consumption and industrial and pharmaceutical utilization has led man to consider what is considered waste to be raw material for another purpose. Hence, this potato **(*Solanum tuberosum*)** peel seen as waste will be seen as a raw material/resource for oil extraction or production.

Oil extraction from plants uses many methods, including pressurized liquid extraction. However, to maintain bioactivity, suitable extraction techniques such as hydrodistillation, steam distillation, and Soxhlet extraction require professionals and skilled operators. The availability of the instruments listed above is limited, and financial resources are also required.

Earlier studies revealed that essential oils are of great importance and have specific characteristics. Orodu and Ivan (2021). The first evidence of essential oils was recorded from ancient India, Persia, and Egypt. Both Greece and Rome carried out extensive trade in odoriferous oils and ointments. The products were obtained by placing flowers, roots, and leaves in fatty oils, but with the coming of advanced technology, the Arab culture developed for the distillation of essential oils. According to the report, the major constituents of odorous plants are geraniol (a monoterpenoid component of rose oil) and citronellol, which is found in citronellol oil; both oils are used as components of many fragrances and food flavorings. Michele (2023).

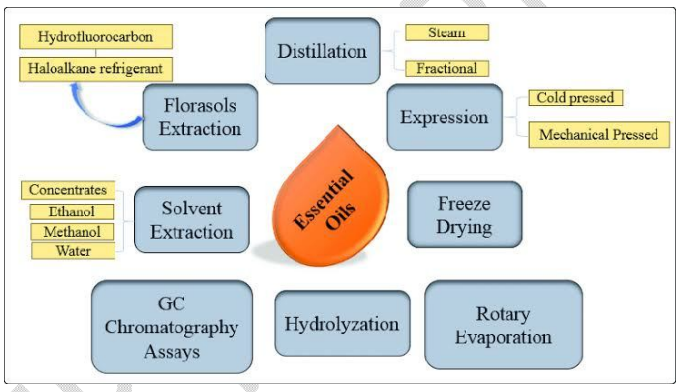

Fig. 3***Several method for extracting essential oil from different plants.***

The processing of fruits on an industrial scale generates a significant amount of waste in the form of peels, seeds, cores, pulp, and other discards. This waste material is often fed to livestock or simply disposed of, placing a burden on the environment. This has led to efforts to find new uses for fruit processing waste, such as the extraction of valuable compounds or the production of biofuels (Shweta, Anupama, and Prabhat, 2022). The conversion of food processing waste into valuable products represents an innovative way to make use of these materials in a more suitable manner (National Library of Medicine). Harsh, Kanchan, Kamil,

Daljeet, Eugenie, Ruchi, Rachina, Somesh, and Dinesh (2016). According to Mercy, Mub, and Jenifer (2022), who have done research on the application of different fruit peels as a natural fertilizer, fruit peels can be used as a neutral natural fertilizer because they contain vitamins that promote plant growth as well as benefits for both the environment and human health (the strength of the fruit peel).Adel, Mohamed, Awad, and Moamed (2010) used a spectrophotometer instrument with methanol as a reagent and reported that extracts from potato peel can be applied as a source of antioxidant and antimicrobial substances in food, also as a medium of achieving additional income and a means of minimizing waste disposal issues.Due to the abundance of nutrients and minerals found in banana peels, there is the potential to use them in a variety of food and non-food applications. It was reported that banana peels can be used in food, pharmaceutical, and other industries. Wafaa, Hussein, Amra, Kirill, Jauad, Miroslava, Mohamed, and Atanassova (2022). Mordi, Fadiaro, Owoeye, Olanrewegu, Uzoamaka, and Olorunshola (2016) identified components present in the oil of banana peel extract using GC-MS. Two varieties of banana (Musa sapientum and Musa acuminata colla) were obtained from Nigeria and identified in the biological science department of Covenant University. The peels of the bananas were cut into small pieces and soaked in methanol for extraction; the extraction process was performed in a Soxhlet extractor. The methanolic extract was analyzed for its phytochemical composition, revealing the presence of steroids, saponins, terpenoids, anthraquinone, and tannins. The chemical constituents of the oil were identified and characterized by GC-MS, and the most abundant component was fatty acids.

According to Hevze and Archimede (2016), banana peels (Musa sapientum) have been shown to contain a range of nutrients, including protein, fats, and carbohydrates. The minerals include phosphorus, iron, calcium, magnesium, and amino acids such as leucine, valine, phenylalanine, and threonine. Hamid, Abdollaah, and Masripan reported that the research performed on three types of banana peels using N-hexane as a solvent and morphological studies shows that the presence of follicular gel in the banana peels plays a critical role in the formation of essential oil; without the gel, it would have been more difficult to extract the oil from the peels. Orodu *et*

al. (2021) reported that the oil extracted from pineapple peels, characterized by GC-MS, contains several different components, including limonene, palmitic acid, n-decimal, 1-cyclohexane, 1-carboxaldehyde, alpha-farnesene, tarus caryophyllene, and myrcene. The most abundant component is limonene, while the other components are present in smaller amounts.

Melkiyas, Bulcha, Abnet, and Ramesh (2022) extracted oil from avocado. peels using N-hexane as a solvent after the extraction, the oil was characterized For its physicochemical properties, the acid content was found to be higher in value while free fatty acid content was lower in value. In another study on the properties of oil extract from the avocado peel, it was reported that the oil is low in saturated fat, it can be used in cosmetic industries, and it contains a high amount of anti-cholesterol agent (Tafere 2021). According to Shweta *et al.* (2022), citrus waste, like other types of waste, can have negative environmental impacts if not managed properly. Darwin, Favian, Edison, and Morayma (2020) in research extracted oil from peels of orange, and it was recorded. that sodium bicarbonate can be used to enhance the extraction of essential oils from orange peels by a simple distillation method. Bli, Smith, and Hossain (2006) determined the phenolic content of citrus peels (Citrus lemon), and to optimize the extraction of phenolic compounds from citrus peels, various factors were studied, including the condition of the peel sample, solvent type, solvent concentration, and extraction temperature.

The report showed that ethanol was found to be the most effective solvent for the extraction of phenolic compounds from citrus peels. Recent studies revealed that lemon peels are rich in oil. Essential oils, extracted from lemon peels, can vary depending on the type of lemon grown and the specific location where it was grown. These oils are used in the perfumery, food, and pharmaceutical industries. In the food industry, they are used to flavour and scent a variety of products such as sweet beverages and cakes. In the pharmaceutical industry, they are used to improve the taste of distasteful medication.

2.0MATERIALS AND METHODS

2.1 Materials: The material required for this research work is cotton wool, a funnel, a retort stand, an extraction bottle, an electrical weighing balance, a measuring cylinder, a sample bottle, and red potato peels. The reagent required for this research work is N-hexane and is of analytical grade gotten from Onitsha market, Anambra State. The potato used for this research work was gotten from Amassoma market, Southern Ijaw, Bayelsa State.

2.2Method:The method of extraction used for this research work is cooled extraction method

2.3 **Sample preparation**

The potatoes were washed severally with water and peeled; the peels were sun-dried for 2 days and then pulverized to powder with a grinding engine to increase the surface area. 250 g of the pulverized sample was weighed into a brown bottle, and 900 mL of n-hexane was added and allowed to macerate for 72 hours. The reagent was filtered from the sample into a beaker and allowed to vapourize till the extracted oil was left. The oil extract was then transferred into a small brown bottle for GC-MS analysis.

2.4 INSTRUMENTATION:

The technique known as Gas chromatograph –massspectrometry (GC-MS) combines the capabilities of mass spectrometry and gas chromatoraph to identify various compounds present in a test sample.

Fig 4: GC-MS Agilent Technologies – 7890A

2.5 CHEMICAL IDENTIFICATION

Agilent technologies GC-MS7890A GC. Gas Chromatogram with Agilent technologies 5975C MSD mass spectrometer connected to triple axis detector and capillary column HP5MS(30 m x 025mm ID 0.25u) made of 5% diphenyl 95% dimethyl polysiloxane for Agilent technologies GCSM. A70 eV ionizing energy electron indication system was employed. The carrier gas which was 99.99% helium gas was utilized at a steady flow rate of mL/min. an injection volume of 1 µL was used at split ratio of 50:1 the injection temperature was set at 50^0C while the ion source temperature was set at 250^0C. With the software of GCSM mass Hunter the relative percentage amount of each component was determined by comparing its average peak area to the total areas for the examination of chromatograms and spectra

3.0RESULTS AND DISCUSSION

3.1 RESULTS

The abundance of component present in oil exract of potato was determined analytically as shown in figure 4and table.1 with the use of Agilent technologies 5975C MSD Mass spectrometer connected to triple axis detector.

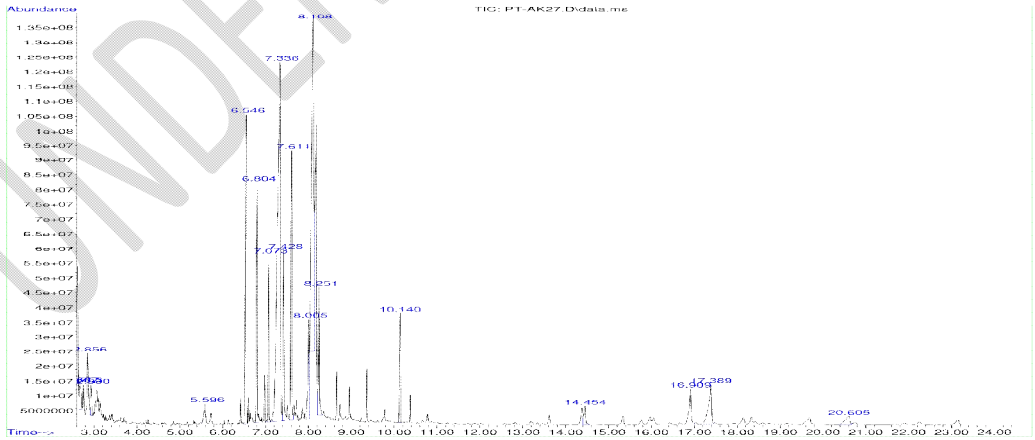

Fig4 Chromatogramof components of red potato peels

TABLE 1 Showning Components andtheir Composition in the oil extract

PEAK No	COMPONENT NAME	RETENTION TIME (MIN)	%
1	2-ethyl-1,4-dimethy benzene	2.669	1.094
2	Bicyclo [4.4.0]decane	2.753	0.896
3	1,2 benzenedimethanol	2.850	2.376
4	O-cymene	2.930	0.823
5	Dodecanoic acid	5.596	0.910
6	2-hydroxy 4- methyl bnezaldehyde	6.546	10.751
7	1-hexadecanyl 4-methybenzylsulfonate	4.073	5.825
8	2-heptadecanol	7.073	3.045
9	N-hexadecanoic acid	7.336	27.124
10	Z-8-hexadecene	7.428	4.090
11	2-heptadecenal	7.611	7.516
12	Tricyclo [4.3.1.1(3.8) undecan-3-ol	8.005	2.962
13	Oleic acid	8.108	20.199
14	linolenic acid	8.251	3.062
15	2-methylhexacosane	10.140	2.488
16	cholestero acetate	14.454	0.863
17	5-cholestie 3-ol 2methy	16.909	1.982
18	4-(2-methylpropxyphenyl)-2-methylpropylpenoate	17.389	3.067

3.2 DISCUSSION

2-ETHYL-1,4-DIMETHY BENZENE : Is a colourless nonpolar organic solvent with the molecular formula $C_{10}H_{14}$.. Its concentration in potato peel oil was found to be 1.094% with a retention time of 2.667. It serves as an indispensable component in diverse industries, including pharmaceutical, food, and beverage testing, and a wide range of chemical processes with the molecular formula $C_{10}H_{14}$.Ispresented in figure 5 below.

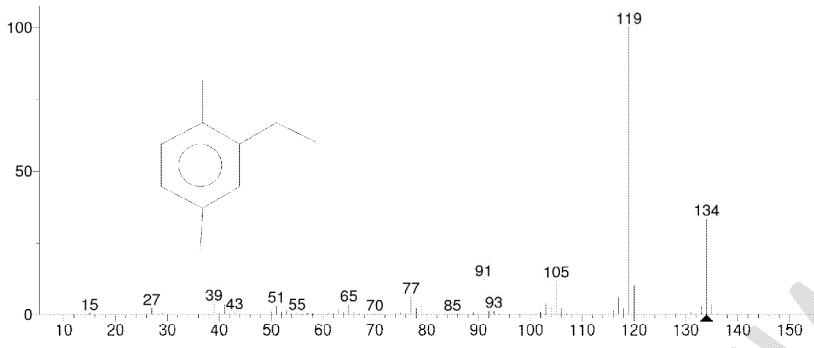

Fig 5:Spectrum of 2-Ethyl-1,4-dimethyl-benzene

BICYCLO [4.4.0]DECANE:The structure is shown in Fig. 6 It is a bicyclo organic compound with a molecular formula $C_{10}H_{18}$. The percentage present in the oil is 0.896% with a retention time of 2.753. It is an industrial solvent, a colourless liquid with an aromatic odour it is used as a solvent for many resins or fuel additives; it is the saturated analog of naphthalene.

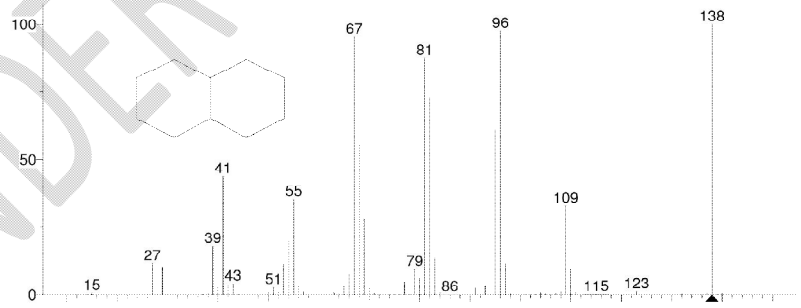

Fig 6SpectrumofBicyclo [4.4.0]decane

1,2 BENZENEDIMETHANOL:The structure is presented in Fig. 7. It has a chemical formula of $C_8H_{12}O_3$, The percentage present in the oil is 2.376%, with a retention time of 2.856. It is a substance with a wide range of industrial uses. It is a colourless liquid with hydroxyl and benzene functional groups. It is also known as O-benzenlresorcinol, it is frequently employed as a precursor in the production of polymer dyes and medications, because of its antibacterial qualities. 1,2- benzenedimethanol is frequently used as a preservative in cosmetic and personal hygiene products.

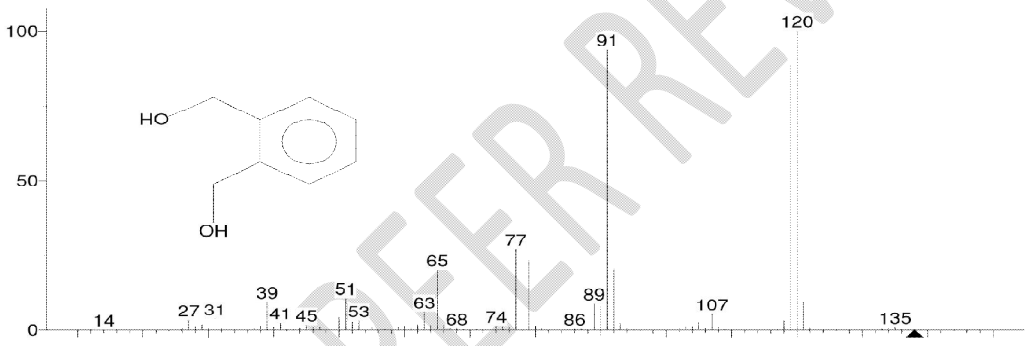

Fig 7Spectrum of1,2-Benzenedimethanol

O-CYMENE: O-cymene also known as p-isopropytoluene is a naturally occurring aromatic organic compound with a chemical formula of $C_{10}H_{14}$, and its structure is given in Fig. 8 below. Its concentration in potato peel oil was found to be 0.823% with a retention time of 2.930. It is classified as a hydrocarbon related to a monoterpene; It is used in flavour and fragrance industry.

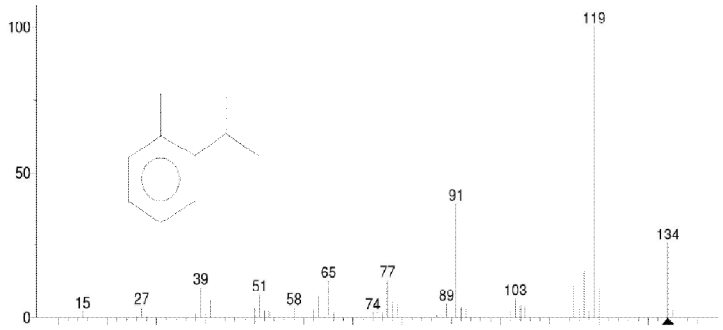

Fig 8Spectrum ofO-Cymene

DODECANOIC ACID: Its structure is shown in Fig. 9. It is a saturated fatty acid used as an intermediary for food-grade additives and to create esters for fruit flavours and scents. Saturated fatty acids with carbon-intensive chains function as a valuable oil component, an algal metabolite, a human metabolite, an antibacterial agent, and an anti-inflammatory agent. Its concentration in potato peel oil was found to be 0.910% with a retention time of 5.596.

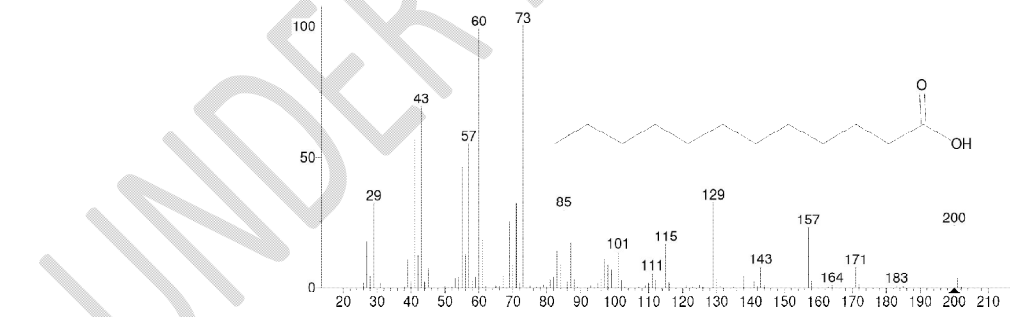

Fig 9SPECTRUM OFDODECANOIC ACID

2-HYDROXY-4-METHOXY BENZALDEHYE:Its structure is presented in Fig. 10. It is a flavour compound that is found in the roots and rhizomes of medicinal plants. With a chemical formula of $C_8H_8O_3$ and a molecular weight of 152.147, its concentration in potato peel oil was

found to be 10.715% with a retention time of 6.546. It is used in the synthesis of a ligand; it functions as a bacterial metabolite, urine metabolite in humans, and insect repellent.

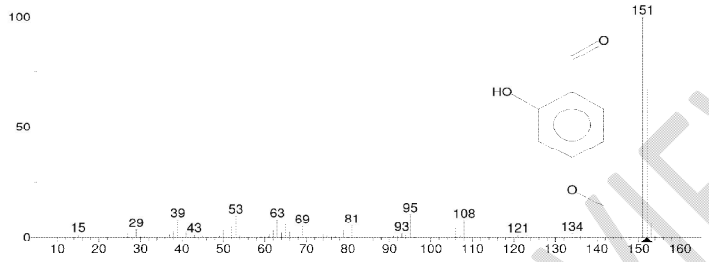

Fig 10Spectrum of2-Hydroxy-4-methoxy benzaldehyde

1-HEXADECANYL-4-METHYBENZYLSULPHONATE:Its structure is presented in Fig. 11 It has a molecular formula of $C_{23}H_{40}O_8S$. Its concentration in potato peel oil was found to be 5.825% with a retention time of 6.804. 1-hexadecanyl-4-methylbenzylsulphonate is applied in the cosmetic industry as an opacifier in shampoos or as an emollient, emulsifier, or thickening agent in the manufacture of skin creams and lotions.

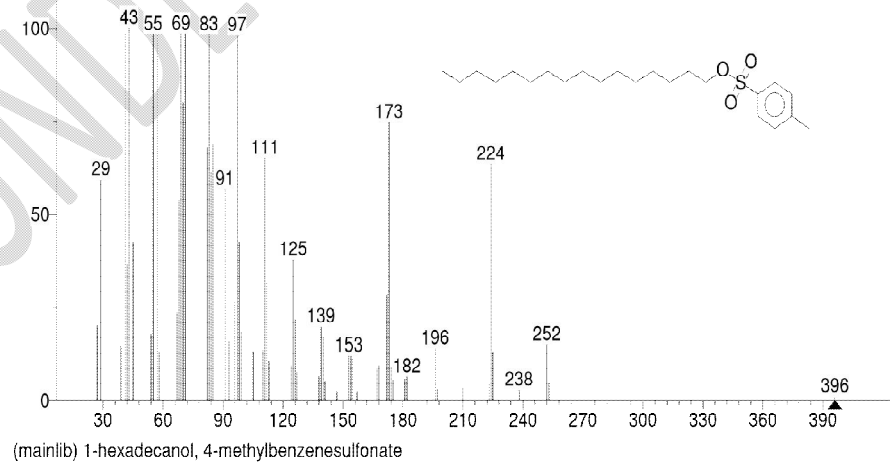

Fig 11 Spectrum of1-Hexadecanyl-4-methybenzyl sulphonate

2-HEPTADECAINOL: The structural formula is shown in Fig. 12. It is a secondary fatty alcohol with a molecular formula of $C_{17}H_{36}O$ having 3.045% as its percentage concentration present in the oil with a molecular weight of 2565 g/mol and a retention time of 7.073. It functions as an animal metabolite, a plant metabolite, and a bacterial metabolite.

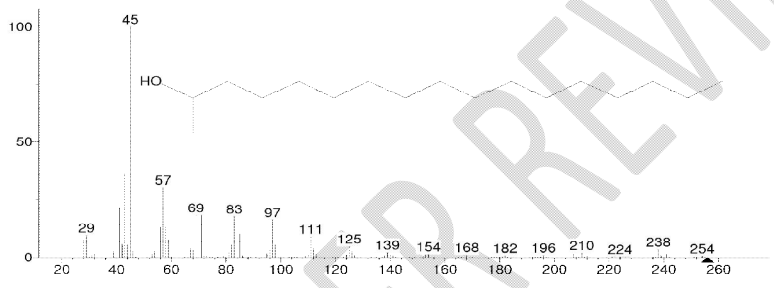

Fig 12Spectrumof2-Heptadecanol

N-HEXADEANOIC ACID: Is known as palmitic acid, as presented in Fig. 13. It is a fatty acid that has 16 carbon chains that are found in animals, plants, and microorganisms. It possesses antioxidant, antimicrobial, and anti-inflammatory activities. Its molecular formula contains $C_{16}H_{32}O_2$ with a percentage concentration of $_{27.124\%}$ and a retention time of 7.336.

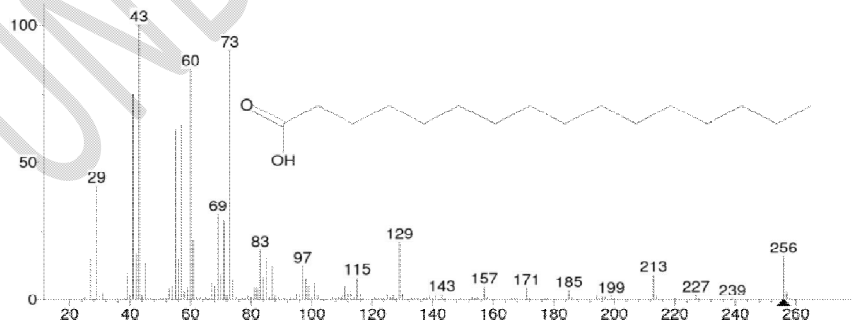

Fig 13 Spectrum of N-Hexadeanoic acid

Z-8-HEXADECENE: It is a colourless liquid. with a molecular formula of $C_{16}H_{34}$. It is a non-polar solvent. Z-8-hexadecene has a percentage concentration of 4.090% with a retention time of 7.428 in potato oil. It is an aliphatic alkene that is a component of essential oil; it is used as a lubricant and grasses in cosmetics. The structure is presented in Figure 14.

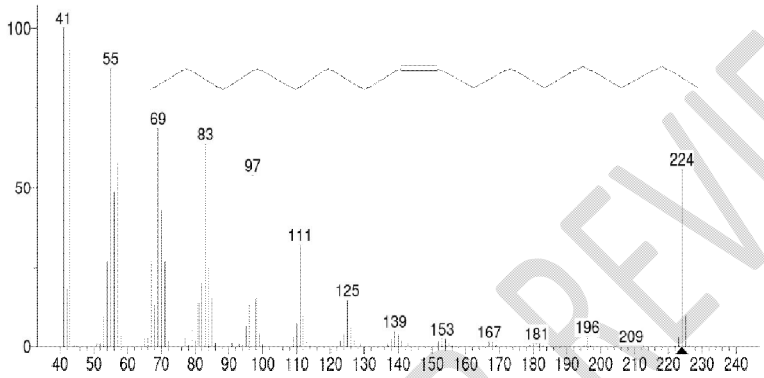

Fig 14Spectrum of Z-8-Hexadecene.

2-HEPTADECENAL: $C_{17}H_{32}O$ it belongs to a group of organic compounds called fatty aldehydes. It served as the proper suspending solvent for the concentration and extraction of essential oil. The concentration of 2-heptadecenal in potato oil is7.516% with a retention time of 7.611.The structure is shown in figure 15.

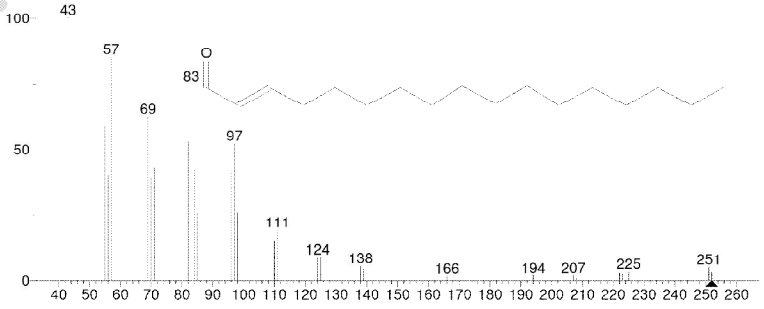

Fig 15 Spectrum of2-Heptadecenal

TRICYCLO[4.3.1.1(3,8)]UNDECAN-3-OL:It is used as intermediate or raw materials in some drugs synthesis, it be can be used as an ingredient in perfumes and flavorings. Its concentration in oil extract of potato peel is 2.962% with a retention time of 8.005.Figure 16 below showing the structure of the compound.

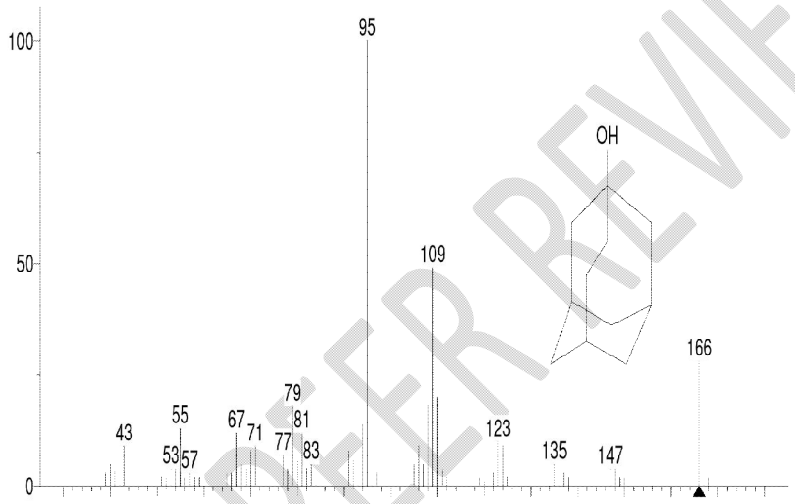

Fig 16.Spectrum ofTricyclo[4.3.1.1(3,8)]undecan-3-ol

OLEIC ACID: This is one of the mono-unsaturated omega-9 fatty acids that can be found in both plants and animals. It is an odourless, colourless oil; it has a molecular formula of $C_{18}H_{34}O_2$. The structure is given in Figure 17. Oleic acid is used in soap and detergent making and aerosol products; it lowers inflammation and cholesterol. The concentration of oleic acid in potato oil is 20.199 % with a retention time of 8.108.

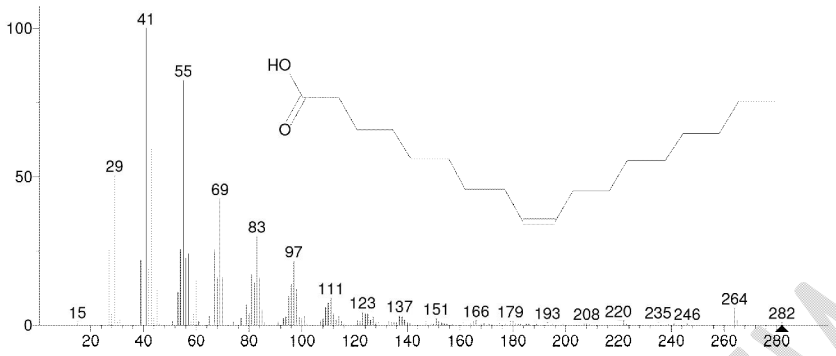

Fig 17Spectrum of Oleic acid

9,12,15-OCTADECATRIENOIC ACID, (Z,Z,Z): It is also known as linolenic acid, and its structure is given in Figure 18. Is an omega-3 polyunsaturated fatty acid with a molecular formula $C_{18}H_{30}O_2$. It is essential to human nutrition and a common ingredient in many vegetable oils. Its potential health benefits are antidiabetic and antiobesity. The concentration of 9, 12, 15-octadecatrienoic acid in potato oil is 3.062% with a retention time of 8.251.

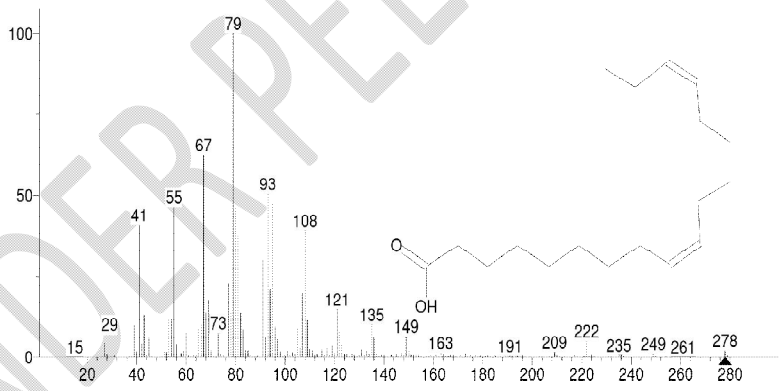

Fig 18Spectrum of9,12,15-octadecatrienoic acid, (Z,Z,Z)

2-METHLHEXACOSANE:Is a non-polar saturated hydrocarbon found in (*solanum tuberosum)* with a molecular of $C_{27}H_{56,}$ it is an insect pheromone. 2.488 % concentration with a retention value of 10.40 was found in potato oil. Figure 19 shows the structure.

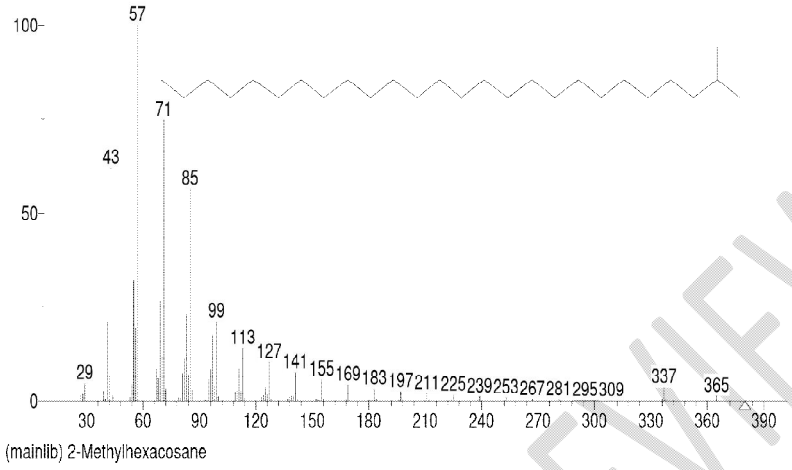

Fig 19Spectrum of2-Methylhexacosane

CHOLESTERO ACETATE: It has a molecular formula of $C_{29}H_{48}O_2$, It is used in the cosmetic and pharmaceutical industries. In cosmetics, it functions as a skin-conditioning and viscosity-booster agent. It is used as an antimalarial, anticancer, and antiviral agent in pharmaceutical industries. The concentration of cholesterol acetate in potato oil is 0.863% with a retention time of 14.454. Figure 20 below is the structure.

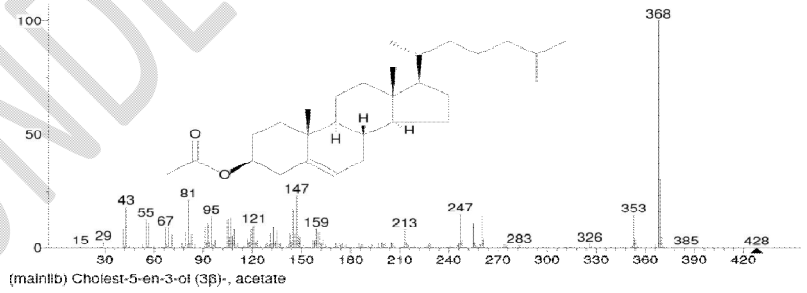

Fig 20Spectrum ofcholestero acetate

5-CHOLESTINE 3-OL, 24-METHYL:Presented in Figure 21. is a phytosterol with a molecular formula of $C_{28}H_{40}O$ that has the ability to inhibit any cancer cells, including those from the stomach, ovaries, and lungs. The concentration of 5-cholestene-3-ol, 24-methyl in potato oil is 1.982% with a retention time of 16.909.

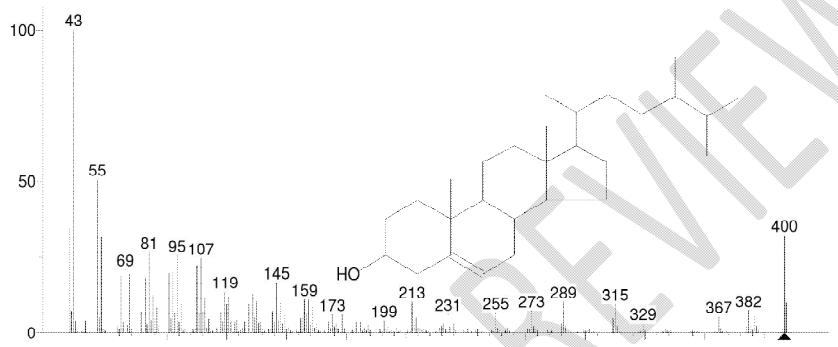

Fig 21 Spectrum of5-Cholestine 3-ol, 24-methyl

P-COUMARIC ACID, 2-METHYLPROPYL ETHER, 2-METHYLPROPYL ESTER: It is a natural metabolite found in many edible plants; It has a molecular formula of $C_{17}H_{24}O_3$ also referred to as 4-(2-methylpropxyphenyl)-2-methylpropylpenoate. It is used in cosmetic and personal care products. It is mostly used in the formulation of eye makeup, skin makeup, and lipstick it gives the skin a soft and smothering appearance. The concentration of p-coumaric acid, 2-methylpropyl ether, 2-methylpropyl ester in potato oil is 3.067 % with a retention time of 17.389. This is presented in Figure 22

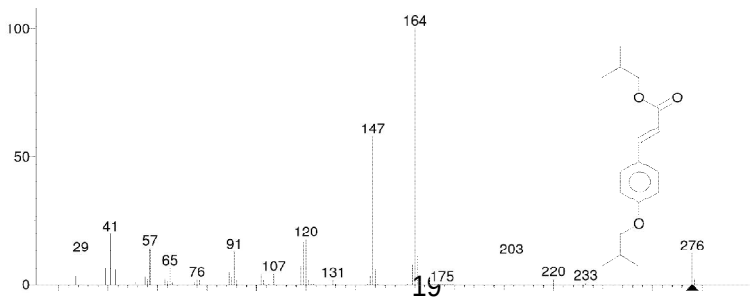

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Fig 22 Spectrum of P-coumaric acid, 2-methylpropyl ether, 2-methylpropyl ester

4.0 CONCLUSION AND RECOMMEDATION

4.1 CONCLUSION:

To highlight the problem statement, the background of this study was completed. To gain additional knowledge regarding oil extract from plants, a large body of literature was reviewed. However, the quest for knowledge on how to get oil that is more conducive for consumption, industrial, and pharmaceutical Utilization has led to analyzing what is considered a waste to be a raw material. for other purposes; hence, the oil extract from potato peel was analyzed. The result obtained from the oil The extract using the GC-MS was found to be as follows: N-hexadecanoic acid (27.124%), oleic acid (20.19%), 2-hydroxy-4-methoxybenzaldehyde (10.715%), 1-hexadecanyl-4-methylbenzylsulfonate (5.825%), linolenic acid (3.062%), and 1,2-benzenedimethanol (2.376%). Based on this result, the oil extract from the potato peel is useful for both the pharmaceutical and cosmetics industries.

4.2 RECOMMEDATION:

The study has shown that potato peel has useful components, which will be beneficial to humanity, so we recommend that the government provide machinery that could readily collect this waste to be agro waste to be a raw material for both the pharmaceutical and cosmetics industries.

Disclaimer (Artificial intelligence)

Option 1: It was not used.

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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Details of the AI usage are given below:

1.

2.

3.

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