

EXTRACTION AND CHARACTERISATION OF OIL FROM CARICA PAPAYA SEED

Submitted in partial fulfillment of the requirements for the award of
Master of Science in Chemistry

By

VISU.G

(REGISTER NO: 40910012)



**DEPARTMENT OF CHEMISTRY
SCHOOL OF SCIENCE AND HUMANITIES**

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

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JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

MAY - 2022



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DEPARTMENT OF CHEMISTRY BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **VISU G (40910012)** who carried out the project entitled "**EXTRACTION AND CHARACTERISATION OF OIL FROM CARICA PAPAYA SEED**" under our supervision from November 2021 to April 2022.

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I wish success in all his future endeavours.

Chennai

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DECLARATION

I **VISU.G (40910012)**, hereby declare that the Project Report entitled “**EXTRACTION AND CHARACTERISATION OF OIL FROM CARICA PAPAYA SEED**” done by me under the guidance of **Dr.K.CHENNAKESAVULU, M.Sc.,Ph.D.**, Associate professor, Department of Chemistry at **Sathyabama Institute of Science and Technology**, Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai – 600119 is submitted in partial fulfillment of the requirements for the award of Master of Science degree in Chemistry.

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SIGNATURE OF THE CANDIDATE

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VISU G

ABSTRACT

Carica papaya is a fruit known for its great economic values in tropical Africa due to its diverse industrial, medicinal and nutritional benefits. In this study, oil was extracted from dried powdered *C. papaya* seeds using n-hexane as extraction solvent. The physiochemical characterization of *C. papaya* seed oil extract was investigated using AOAC standard procedures. Acute toxicity test was carried out to determine the toxicity of the oil. *Carica papaya* is widely used in folk medicine as herbal remedy to prevent, protect against, and cure several diseases. These curative properties are based on the presence in different parts of the plant of phytochemical nutrients with antioxidant effect. Seeds are the less exploited part; thus, this study is aimed at assessing the antioxidant activities of the *C. papaya* seeds water extract against hydrogen peroxide (H₂O₂) oxidative stress in human skin Detroit 550 fibroblasts. *C. papaya* seeds water extract is not toxic and acts as a potent free radical scavenger, providing protection to Detroit 550 fibroblasts that underwent H₂O₂ oxidative stress. The main objective of the current work was to evaluate the suitability of ultrasound-assisted extraction (UAE) for the recovery of oil from papaya seed as compared to conventional extraction techniques (i.e., Soxhlet extraction (SXE) and solvent extraction (SE)). In the present study, the recovery yield, fatty acid composition and triacylglycerol profile of papaya seed oil obtained from different extraction methods and conditions were compared. *Carica papaya* is a monetarily enthusiastic plant of tropical and subtropical locales, cultivated in more than 50 nations across the world with 6.8 million tons creation. Papaya holds an expansive range of phytochemicals, including polysaccharides, nutrients, minerals, chemicals, proteins, glycosides, saponins, flavonoids, and phytosterols. These bioactive parts are liable for the pharmacological properties of this favorable plant and show its significance in day-to-day admission and sustenance. Moreover, it is a brilliant guide to assimilation and furthermore hydrolyzing gluten, which is a significant viewpoint for dyspeptic and celiac sickness patients. Papaya goes about as a cell reinforcement, antimicrobial, anticarminative, anticancer, and has hepato-defensive, immunological, and other helpful properties.

TABLE OF CONTENT

CHAPTER	TITLE	Pg.No
1.	INTRODUCTION	1
1.1	SAMPLE	1
1.2	CHEMICAL CONSTITUENTS OF FATTY ACIDS	4
1.2.1	HYDROCARBONS	5
1.2.2	TERPENES	5
1.2.3	ALCOHOL	7
1.2.4	ALDEHYDE	7
1.2.5	KETONE	8
1.2.6	ESTER	8
1.2.7	ACIDS	9
1.2.8	FATTY ACIDS	10
1.3	METHODS OF EXTRACTING OIL	14
1.4	TROPICAL PLANT	15
1.5	MINERAL PROCESSING	16
1.6	FROTH FLOTATION	17
1.7	COAL FLOTATION	19
2.	LITERATURE SURVEY	22
3	AIM AND SCOPE OF THE PRESENT INVESTIGATION	25
3.1	OBJECTIVE OF THE STUDY	25

	3.1.1	GENERAL OBJECTIVES	25
	3.1.2	SPECIFIC OBJECTIVES	25
	3.1.3	SCOPE OF THE STUDY	25
	3.1.4	SIGNIFICANCE OF THE STUDY	26
	3.2	AIM OF THE STUDY	26
4		MATERIALS AND METHODS	
	4.1	MATERIALS	28
	4.2	CHARACTERIZATION TECHNIQUES	28
	4.2.1	GAS CHROMATOGRAPHY- MASS SPECTROMETRY (GC-MS)	28
	4.2.2	FOURIER TRANSFORM INFRARED SPECTROSCOPY (FTIR)	31
	4.2.3	NUCLEAR MAGNETIC RESONANCE (NMR)	32
	4.3	EXTRACTION METHODS	36
	4.3.1	DESCRIPTION	36
	4.3.2	ASSEMBLY	36
	4.3.3	OPERATION	37
	4.4	APPLICATION OF FLOTATION METHOD	39
	4.4.1	DESCRIPTION OF EQUIPMENT	39
	4.4.2	EXPERIMENTAL PROCEDURE	42
	4.4.3	PREPARATION OF SAMPLE FOR LABORATORY STUDIES	42
	4.4.4	PROXIMATE ANALYSIS	42
	4.5	COAL GRINDING	44
	4.5.1	WET SIEVE ANALYSIS	44
	4.5.2	LABORATORY FLOTATION STUDIES (PRELIMINARY EXPERIMENTS)	44

	4.5.3 D-12 DENVER SUB-AERATION FLOTATION	45
	CELL-CONDITIONS	
	4.6 REAGENTS USED FOR FLOTATION	46
5	RESULTS AND DISCUSSION	
	5.1 DESIGN OF EXPERIMENT (DOE)	47
	5.2 EFFECT OF SIZE AND OIL YIELD	48
	5.3 RESULTS OF GC-MS	52
	5.4 FTIR RESULTS	77
	5.5 NMR RESULTS	78
6	SUMMARY AND CONCLUSIONS	80

LIST OF ABBREVIATION

FTIR	FOURIER TRANSFORM INFRARED SPECTROSCOPY
NMR	NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY
GC-MS	GAS CHROMATOGRAPHY- MASS SPECTROMETRY

LIST OF TABLES

TABLE	TITLE	Pg.no
1.2.8.b.(ii)	List of monounsaturated fatty acids	12
1.2.8.b.(iv)	List of polyunsaturated acids	14
5.1	DOE method table	48
5.2	Size variation versus oil yield	48
5.3	Size variation versus oil yield	50
5.4	List of fatty acids present in the given sample	75
5.5	Results for coal flotation	79

LIST OF FIGURES

FIGURES	TITLE	Pg.no
1.1	carica papaya	15
1.2	carica papaya seeds	15
1.3	Breaking of ore to smaller fragments results in particles with varying degrees of liberation. The shaded area represents the valuable minerals.	17
1.4	Flotation cell	18
4.1	GC-MS instrument	29
4.2	FTIR two beam absorption spectrometer	32
4.3	NMR spectroscopy instrumentation	33
4.4	Soxhlet apparatus	37
4.5	Soxhlet apparatus with the sample	38
4.6	Rotary Evaporator	39
4.7	Sieves	40
4.8	Riffle sampling	40
4.9a	Ball milling machine	41
4.9b	Grinding media(balls)	41
4.10	D-12 Denver flotation cell	41
4.11	Hot air oven	41
4.12	Muffle furnace	41
4.13	coal flotation machine	46
5.1	Graphical representation of particle size versus oil yield	49

5.2	Graphical representation of particle size versus oil yield	51
5.3	Represents Phthalic acid, hex-3-yl isobutyl ester	54
5.4	Represents n-Hexadecanoic acid	55
5.5	Represents trans-13-Octadecenoic acid	56
5.6	Represents 2,3-Dihydroxypropyl elaidate	57
5.7	Represents 9-Octadecenoic acid (Z)-, oxiranylmethyl ester	58
5.8	Represents 4-Hexyl-1-(7-methoxycarbonylheptyl) bicyclo[4.4.0]deca-2,5,7-triene	59
5.9	Represents 9-Octadecenoic acid (Z)-, oxiranylmethyl ester	60
5.10	Represents 1-cis-Vaccenoylglycerol	61
5.11	. Represents 9-Octadecenoic acid (Z)-, 2-hydroxy-1- (hydroxymethyl)ethyl ester	62
5.12	Represents Squalene	63
5.13	Represents Arg-Leu-Lys	64
5.14	Represents 17-Pentatriacontene	65
5.15	Represents Peiminine	66
5.16	Represents Campesterol	67
5.17	Represents Stigmasterol	68
5.18	Represents γ -Sitosterol	69
5.19	Represents Ethyl iso-allocholate	70
5.20	Represents Stigmasta-5,24(28)-dien-3-ol, (3 β ,24Z)-	71
5.21	Represents Acetic acid, 17-acetoxy-4,4,10,13-tetramethyl-7- oxo-2,3,4,7,8,9,10,11,12,13,14,15,16,17	72
5.22	Represents γ -Sitostenone	73
5.23	Represents Stigmastane-3,6-dione, (5 α)-	74

5.24	GC-MS analysis of carica papaya	75
5.25	Graphical representation of FTIR	77
5.26	Graphical representation of NMR	78

CHAPTER-1

INTRODUCTION

1.1 SAMPLE

Carica papaya Linn is an herbaceous plant which has a place with the Salicaceae family. The plants fill well in the jungles also, can reach up to 10 m high. [1]

In excess of 50 papaya assortments have been recorded, yet unadulterated reproducing assortments are diminishing because of the uncontrolled papaya fertilization. [2,3]

The plant has been utilized as ethnomedicine for quite a long time in jungles and subtropics where it is for the most part developed. [4,5]

The remedial intentions in use fluctuate, with likely the most widely recognized being anthelmintic and as an expected abortifacient specialist [6,7,8]

Ingestion of fat by the body is done by the small digestive system mucosa as unsaturated fats and glycerol. In this manner, counteraction of fat assimilation should be possible by hindering the hydrolysis of fats into unsaturated fats and glycerol, which is catalysed by pancreatic lipase chemicals.[9]

Long haul utilization of against stoutness medications can cause secondary effects like steatorrhea, sleek stools, stomach aggravation, fart, stomach spasms, and absence of fat-dissolvable nutrients.[10]

This full-sustenance organic product is fundamentally utilized for new utilization and papain creation. While, papaya seeds, representing 8 % to 15 % of new organic product weight are as of now arranged furthermore, become biomass in organic product handling units. Moreover, this interaction required work and capital expenses for treatment [11]

The gathering of Marfo detailed a rich wellspring of proteins (27.8 %), unrefined strands (22.6 %), unsaturated fat, calcium and phosphorus in papaya seeds [12]

On account of the great unsaturated fat contain (28.3 %), papaya seeds can be considered as the new wellsprings of utilization oils. The papaya seed oil is high in

valuable triacylglycerols, with overwhelming by triolein (>37 %) and monounsaturated unsaturated fat as oleic corrosive >70 % [13]

Moreover, papaya seed oil displays a high strength against oxidation and extensive cancer prevention agent movement.

The gathering of Vilbett announced the ultrasound-helped extraction of unsaturated fat from papaya seed with abbreviated extraction time [14]. With the above reasons, the ultrasound-helped extraction was chosen to research further under our circumstances to decide the organization, to assess cell reinforcement action of defatted-papaya seed build-up and to upgrade the phenolic compound from defatted-papaya seed build-up [14]

The seeds of papaya have been answered to have therapeutic qualities for digestive parasitosis [15]

The unsaturated fat structure of oil separated from C. papaya explored by Saha and Jackson (2018) showed that it contains: oleic (78.88%), palmitic (15.96%), stearic (4.7%) and arachidic (0.44%) acids with oil yield of 24.01% [16]

From the aftereffects of the greasy acid's examination, it was accounted for that the unsaturated greasy acids of the seed oil were more than the soaked ones.

Be that as it may, the physicochemical properties of oil decide the quality and whether they are appropriate for utilization [16]

Benzyl isothiocyanate (BITC) applications went from vascular unwinding to restraint of malignant growth expansion. Likewise, the seed has been demonstrated to be a decent wellspring of oil (25.6%) and that it might be valuable for therapeutic, biofuel and modern purposes [17]

It might develop for its young leaves, shoots and organic products which are cooked as a vegetable or for its ready organic product which is notable as a well-known drink [18]

It was tracked down that treatment of twisted with Carica papaya further developed proficiency of phagocytic cells that obliterate microscopic organisms [19]

In vitro examinations directed on separates from skin, tissue, and seeds of both ready and unripe *Carica papaya* gave antibacterial exercises against different microorganisms including *Staphylococcus aureus*,

Bacillus subtilis, *Bacillus cereus*, *Escherichia coli*, *Enterobacter cloacae*, *Proteus vulgaris*, *Klebsiella pneumoniae*, *Salmonella typhi*, *Pseudomonas aeruginosa* and *Shigella Flexner* [20]

A fluid concentrate of *Carica papaya* was likewise inspected for its impact on development of different growth cell lines and on human lymphocytes and have shown positive critical outcomes [21]

A fundamental phytochemical examination of *Carica papaya* departs uncovered the presence of tannins, flavonoids, saponins, alkaloids, anthraquinones, cardiovascular glycosides, steroids, diminishing sugars, cardenolides and phenolics compounds [22]

A portion of these oils are utilized for cooking or are ready and eaten in type of margarine while others are utilized for the development of items like cleansers, beauty care products, paints and evaporates, oils also, plastics [22]

sesame seed oil can be utilized to deal with medical conditions like persistent obstruction in seniors and round worms in kids, dysmenorrhea. Subsequently, the significance of vegetable oil to man can't be over accentuated. Nutrients C and E, β -carotene, flavonoids, tannins, anthocyanins, and other phenolic compounds are plant determined compounds with cell reinforcement exercises by scavenging free revolutionaries and address an extraordinary gathering of nutritional supplements.

Food wealthy in these cell reinforcements plays a key job in the counteraction of oxidative pressure-based sicknesses. [23,24]

Leaves separate contains folic corrosive, nutrients B12, A, and C, alkaloids, saponins, glycosides, tannins, and flavonoids. [25]

Seeds remove contains different phenolic compounds, vanillic corrosive, furthermore, L-ascorbic acid with cancer prevention agent and anticancer. [26]

There is a worldwide uproar for feasible turn of events and natural protection. This has additionally expanded the beat of investigates on the utilization of biotechnology for different wellsprings of fuel [27]

The demonstration of creating this fuel, biodiesel, is regularly alluded to as transesterification or alcoholises. The cycle includes reacting seed oils from certain plants, vegetable oils, or creature fats with a short-chain aliphatic liquor [28,29]

The demonstration of delivering this fuel, biodiesel, is generally alluded to as transesterification or alcoholises.

The interaction includes responding seed oils from certain plants, vegetable oils, or creature fats with a short-chain aliphatic liquor (regularly methanol or ethanol) [30,31]

Carica papaya is additionally notable for its restorative properties. Customarily, various pieces of the papaya plant are utilized in the treatment of different afflictions, for example, asthma, ulcers, dermatitis, diabetes, helminth contaminations and fever.

Research additionally illustrated its useful conventional job in injury recuperating, and in the therapy of cardiovascular infections, dengue fever, disease, intestinal sickness, hypoglycaemia, hyperlipidaemia, contagious infections and as a male preventative. Papaya extricates have additionally been accounted for to have critical mitigating action [32]

1.2. CHEMICAL CONSTITUENTS OF FATTY ACIDS

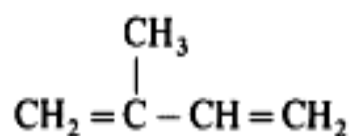
Pure essential oils are mixtures of more than 200 components, normally mixtures of terpenes or phenylpropanic derivatives, in which the chemical and structural differences between compounds are minimal. They can be essentially classified into two groups:

Volatile fraction: Essential oil constituting of 90–95% of the oil in weight, containing the monoterpene and sesquiterpene hydrocarbons, as well as their oxygenated derivatives along with aliphatic aldehydes, alcohols, and esters.

Non-volatile residue: that comprises 1–10% of the oil, containing hydrocarbons, fatty acids, sterols, carotenoids, waxes, and flavonoids.

1.2.1. HYDROCARBONS

Essential oil consists of chemical compounds that have hydrogen and carbon as their building blocks. Basic hydrocarbons found in plants are isoprene having the following structure.



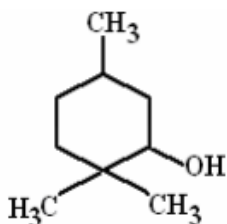
Isoprene

1.2.2. TERPENES

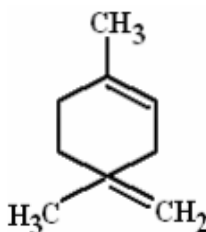
Generally, they end with “ene”. For example: Limonene, Pinene, Piperene, Camphene, etc. Terpenes are anti-inflammatory, antiseptic, antiviral and bactericidal. Terpenes can be further categorized as monoterpenes, sesquiterpenes and diterpenes. Referring back to isoprene units under the hydrocarbon heading, when these isoprene units join head to tail, the result is a monoterpene, when three join then it is a sesquiterpene and if four linked isoprene units are diterpenes.

1.2.2.a. MONOTERPENES [C₁₀H₁₆]

Monoterpenes are naturally occurring compounds, the majority being unsaturated hydrocarbons (C₁₀). But some of their oxygenated derivatives such as alcohols, Ketones, and carboxylic acids known as monoterpenoids.



Menthol



Limonene

The branched-chain C₁₀ hydrocarbons comprises of two isoprene units and is widely distributed in nature with more than 400 naturally occurring monoterpenes identified. Moreover, besides being linear derivatives (Geraniol, Citronellol), the monoterpenes can be cyclic molecules (Menthol – Monocyclic; Camphor – bicyclic; Pinenes (α and β) – Pine genera as well. Thujone (a monoterpene) is the toxic agent found in *Artemisia absinthium* (wormwood) from which the liqueur, absinthe, is made. Borneol and camphor are two common monoterpenes. Borneol, derived from pine oil, is used as a disinfectant and deodorant. Camphor is used as a counterirritant, anaesthetic, expectorant, and antipruritic, among many other uses.

Example

Camphene and pinene in cypress oil.

Camphene, pinene and thujhene in black pepper.

1.2.2.b. SESQUITERPENES

Properties: Anti- inflammatory, antiseptic, analgesic, anti- allergic.

Sesquiterpenes are biogenetically derived from farnesyl pyrophosphate and in structure may be linear, monocyclic or bicyclic. They constitute a very large group of secondary metabolites; some having been shown to be stress compounds formed as a result of disease or injury.

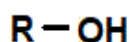
1.2.2.c. DITERPENES

Diterpenes are made of up four isoprene units. This molecule is too heavy to allow for evaporation with steam in the distillation process, so is rarely found in distilled essential oils. Diterpenes occur in all plant families and consist of compounds having a C₂₀ skeleton. There are about 2500 known diterpenes that belong to 20 major structural types. Plant hormones Gibberellins and phytol occurring as a side chain on chlorophyll are diterpenic derivatives. The biosynthesis occurs in plastids and interestingly mixtures of monoterpenes and diterpenes are the major constituents of plant resins. In a similar manner to

monoterpenes, diterpenes arise from metabolism of geranyl pyrophosphate (GGPP). Diterpenes have limited therapeutical importance and are used in certain sedatives (coughs) as well as in antispasmodics and anxiolytics

1.2.3. ALCOHOL

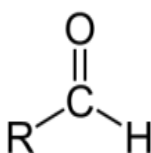
An alcohol is any organic compound in which the hydroxyl functional group (-OH) is bound to a carbon. Alcohols are the compounds which contains hydroxyl compounds. Alcohols exist naturally, either as a free compound, or combined with a terpenes or ester. When terpenes are attached to an oxygen atom, and hydrogen atom, the result is an alcohol. When the terpene is monoterpene, the resulting alcohol is called a monoterpene. Alcohols have a very low or totally absent toxic reaction in the body or on the skin. Therefore, they are considered safe to use.



Alcohol

1.2.4. ALDEHYDE

An aldehyde is an organic compound containing a functional group with the structure -CHO , consisting of a carbonyl centre (a carbon double-bonded to oxygen) with the carbon atom also bonded to hydrogen and to an R group, which is any generic alkyl or side chain. The group without R is the aldehyde group, also known as the formyl group. Aldehydes are common in organic chemistry, and many fragrances are aldehydes.

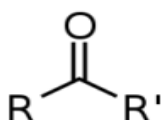


Aldehyde

1.2.5. KETONE

A ketone is an organic compound with the structure $\text{R}(\text{C}=\text{O})\text{R}'$, where R and R' can be a variety of carbon-containing substituents. Ketones and aldehydes are

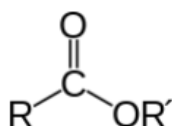
simple compounds that contain a carbonyl group (a carbon oxygen double bond). They are considered "simple" because they do not have reactive groups like –OH or –Cl attached directly to the carbon atom in the carbonyl group, as in carboxylic acids containing –COOH. Many ketones are known and many are of great importance in industry and in biology. Examples include many sugars (ketoses) and the industrial solvent acetone, which is the smallest ketone.



Ketone

1.2.6. ESTER

An ester is a chemical compound derived from an acid (organic or inorganic) in which at least one –OH (hydroxyl) group is replaced by an -O-alkyl (alkoxy) group. Usually, esters are derived from a carboxylic acid and an alcohol. Glycerides, which are fatty acid esters of glycerol, are important esters in biology, being one of the main classes of lipids, and making up the bulk of animal fats and vegetable oils. Esters with low molecular weight are commonly used as fragrances and found in essential oils and pheromones. Phosphoresces form the backbone of DNA molecules. Nitrate esters, such as nitro-glycerine, are known for their explosive properties, while polyesters are important plastics, with monomers linked by ester moieties. Esters usually have a sweet smell and are considered high-quality solvents for a broad array of plastics, plasticizers, resins, and lacquers. They are also one of the largest classes of synthetic lubricants on the commercial market [11].



Ester

1.2.7. ACIDS

An acid is a molecule or ion capable of donating a hydron (proton or hydrogen ion H^+), or, alternatively, capable of forming a covalent bond with an electron pair.

1.2.7.a. AMINO ACIDS

Amino acids are organic compounds containing amine ($-NH_2$) and carboxyl ($COOH$) functional groups, along with a side chain (R group) specific to each amino acid. The key elements of an amino acid are carbon (C), hydrogen (H), oxygen (O), and nitrogen (N), although other elements are found in the side chains of certain amino acids. About 500 naturally occurring amino acids are known (though only 20 appear in the genetic code) and can be classified in many ways.

They can be classified according to the core structural functional groups' locations as alpha (α -), beta- (β -), gamma- (γ -) or 9 delta- (δ -) amino acids; other categories relate to polarity, pH level, and side chain group type (aliphatic, acyclic, aromatic, containing hydroxyl or sulphur, etc.). In the form of proteins, amino acid residues form the second-largest component (water is the largest) of human muscles and other tissues. Beyond their role as residues in proteins, amino acids participate in a number of processes such as neurotransmitter transport and biosynthesis. Because of their biological significance, amino acids are important in nutrition and are commonly used in nutritional supplements, fertilizers, feed, and food technology. Industrial uses include the production of drugs, biodegradable plastics, and chiral catalysts.

1.2.8. FATTY ACIDS

A fatty acid is a carboxylic acid with a long aliphatic chain, which is either saturated or unsaturated. Most naturally occurring fatty acids have an unbranched chain of an even number of carbon atoms, from 4 to 28. Fatty acids are usually not found in organisms, but instead as three main classes of esters: triglycerides, phospholipids, and cholesterol esters. In any of these forms, fatty acids are both important dietary sources of fuel for animals and they are important structural components for cells.

1.2.8.a. SATURATED FATTY ACID

A saturated fat is a type of fat in which the fatty acid chains have all or predominantly single bonds. A fat is made of two kinds of smaller molecules: glycerol and fatty acids. Fats are made of long chains of carbon (C) atoms. Some carbon atoms are linked by single bonds (-C-C-) and others are linked by double bonds (-C=C-). Double bonds can react with hydrogen to form single bonds. They are called saturated, because the second bond is broken and each half of the bond is attached to (saturated with) a hydrogen atom. Most animal fats are saturated. The fats of plants and fish are generally unsaturated. Saturated fats tend to have higher melting points than their corresponding unsaturated fats, leading to the popular understanding that saturated fats tend to be solids at room temperatures, while unsaturated fats tend to be liquid at room temperature with varying degrees of viscosity (meaning both saturated and unsaturated fats are found to be liquid at body temperature).

Various fats contain different proportions of saturated and unsaturated fat. Examples of foods containing a high proportion of saturated fat include animal fat 10 products such as cream, cheese, butter, other whole milk dairy products and fatty meats which also contain dietary cholesterol. Certain vegetable products have high saturated fat content, such as coconut oil and palm kernel oil. Many prepared foods are high in saturated fat content, such as pizza, dairy desserts, and sausage. Guidelines released by many medical organizations including the World Health Organization have advocated for reduction in the intake of saturated fat to promote health and reduce the risk from cardiovascular diseases. Many review articles also recommend a diet low in saturated fat and argue it will lower risks of cardiovascular diseases, diabetes, or death. However, a smaller number of other reviews have come to different conclusions.

1.2.8.b. UNSATURATED FATTY ACID

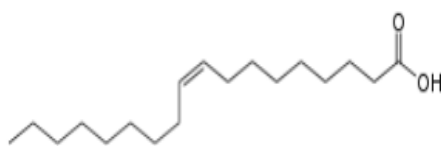
An unsaturated fat is a fat or fatty acid in which there is at least one double bond within the fatty acid chain. A fatty acid chain is monounsaturated if it contains one double bond, and polyunsaturated if it contains more than one double bond. Where double bonds are formed, hydrogen atoms are subtracted from the carbon chain. Thus, a saturated fat has no double bonds, has the maximum number of

hydrogens bonded to the carbons, and therefore it is saturated with hydrogen atoms. In cellular metabolism, unsaturated fat molecules contain somewhat less energy (i.e., fewer calories) than an equivalent amount of saturated fat. The greater the degree of unsaturation in a fatty acid (i.e., the more double bonds in the fatty acid) the more vulnerable it is to lipid peroxidation (rancidity). Antioxidants can protect unsaturated fat from lipid peroxidation.

1.2.8. b.(i). MONOUNSATURATED FATTY ACID

In biochemistry and nutrition, monounsaturated fatty acids (MUFAs) are fatty acids that have one double bond in the fatty acid chain with all of the remainder carbon atoms being single-bonded. By contrast, polyunsaturated fatty acids (PUFAs) have more than one double bond. Fatty acids are long-chained molecules having an alkyl group at one end and a carboxylic acid group at the other end. Fatty acid viscosity (thickness) and melting temperature increases with decreasing number of double bonds; therefore, monounsaturated fatty acids have a higher melting point than polyunsaturated fatty acids (more double bonds) and a lower melting point than saturated fatty acids (no double bonds). Monounsaturated fatty acids are liquids at room temperature and semisolid or solid when refrigerated resulting in an isotopic lattice structure.

Common monounsaturated fatty acids are palmitoleic acid (16:1 n-7), cis-Vaccenic acid (18:1 n-7) and oleic acid (18:1 n-9). Palmitoleic acid has 16 carbon atoms with the first double bond occurring 7 carbon atoms away from the methyl group (and 9 carbons from the carboxyl end). It can be lengthened to the 18-carbon cis-vaccenic acid. Oleic acid has 18 carbon atoms with the first double bond occurring 9 carbon atoms away from the carboxylic acid group. The illustrations below show a molecule of oleic acid in Lewis's formula and as a space-filling model.



Oleic acid skeletal formula

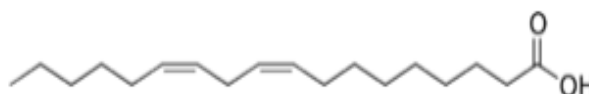
1.2.8.b.(ii) LIST OF MONOUNSATURATED FATTY ACIDS

Common name	Lipid name	Chemical name
Myristoleic acid	14:1 (n-5)	cis-Tetradec-9-enoic acid Palmitoleic acid
Palmitoleic acid	16:1 (n-7)	cis-Hexadec-9-enoic acid
cis-Vaccenic acid	18:1 (n-7)	cis-Octadec-11-enoic acid
Vaccenic acid	18:1 (n-7)	trans-Octadec-11-enoic acid
Paullinic acid	20:1 (n-7)	cis-13-Eicosenoic acid
Oleic acid	18:1 (n-9)	cis-Octadec-9-enoic acid
Elaidic acid (trans-oleic acid)	18:1 (n-9)	trans-Octadec-9-enoic acid
11-Eicosenoic acid (gondoic acid)	20:1 (n-9)	cis-Eicos-11-enoic acid
Erucic acid	22:1 (n-9)	cis-Tetracos-15-enoic acid
Brassicic acid	22:1 (n-9)	trans-Tetracos-15-enoic acid
Nervonic acid	24:1 (n-9)	cis-Tetracos-15-enoic acid
Sapienic acid	16:1 (n-10)	cis-6-Hexadecenoic acid
Gadoleic acid	20:1 (n-11)	cis-9-Icosenoic acid Petroselinic acid
Petroselinic acid	18:1 (n-12)	cis-Octadec-6-enoic acid

1.2.8. b (iii). POLYUNSATURATED FATTY ACID

Polyunsaturated fats are fats in which the constituent hydrocarbon chain possesses two or more carbon–carbon double bonds. Polyunsaturated fat can be found mostly in nuts, seeds, fish, seed oils, and oysters. "Unsaturated" refers to the fact that the molecules contain less than the maximum amount of hydrogen (if there were no double bonds). These materials exist as cis or trans isomers

depending on the geometry of the double bond. Saturated fats have hydrocarbon chains which can be most readily aligned. The hydrocarbon chains in trans fats align more readily than those in cis fats, but less well than those in saturated fats. In general, this means that the melting points of fats increase from cis to trans unsaturated and then to saturated. See the section about the chemical structure of fats for more information.



Chemical structure of the polyunsaturated fat linoleic acid

The position of the carbon-carbon double bonds in carboxylic acid chains in fats is designated by Greek letters. The carbon atom closest to the carboxyl group is the alpha carbon, the next carbon is the beta carbon and so on. In fatty acids the carbon atom of the methyl group at the end of the hydrocarbon chain is called the omega carbon because omega is the last letter of the Greek alphabet. Omega3 fatty acids have a double bond three carbons away from the methyl carbon, whereas omega-6 fatty acids have a double bond six carbons away from the methyl carbon. The illustration below shows the omega-6 fatty acid, linoleic acid. While it is the nutritional aspects of polyunsaturated fats that are generally of greatest interest, these materials also have non-food applications. Drying oils, which polymerize on exposure to oxygen to form solid films, are polyunsaturated fats. The most common ones are linseed (flax seed) oil, tung oil, poppy seed oil, perilla oil, and walnut oil. These oils are used to make paints and varnishes.

1.2.8.b.(iv) LIST OF POLYUNSATURATED ACIDS

Common name	Lipid name	Chemical name
Linoleic acid (LA)	18:2 (n-6)	all-cis-9,12-octadecadienoic

		acid
Gamma-linolenic acid (GLA)	18:3 (n-6)	all-cis-6,9,12-octadecatrienoic acid
Eicosadienoic acid	20:2 (n-6)	all-cis-11,14-eicosadienoic acid
Dihomo-γ-linolenic acid (DGLA)	20:3 (n-6)	all-cis-8,11,14-eicosatrienoic acid
Arachidonic acid (AA)	20:4 (n-6)	all-cis-5,8,11,14-eicosatetraenoic acid
Docosadienoic acid	22:2 (n-6)	all-cis-13,16-docosadienoic acid
Adrenic acid (AdA)	22:4 (n-6)	all-cis-7,10,13,16-docosatetraenoic acid
Docosapentaenoic acid (Osbond acid)	22:5 (n-6)	all-cis-4,7,10,13,16-docosapentaenoic acid
Tetracosatetraenoic acid	24:4 (n-6)	all-cis-9,12,15,18-tetracosatetraenoic acid
Tetracosapentaenoic acid	24:5 (n-6)	all-cis-6,9,12,15,18-tetracosapentaenoic acid

1.3. METHODS OF EXTRACTING OIL

The essential oils are obtained from plant raw material by several extraction methods. The timid technologies about essential oils are processing with the abundant significance and are still overused in the copious parts of the globe. They are Hydro Distillation (HD), Supercritical Fluid Extraction (SFE), Microwave - Assisted Hydro Distillation (MAHD), Ultrasound - Assisted Extraction (UAE), Soxhlet Extraction Method, Steam Distillation, Solvent Extraction method, Water Distillation, Cold Expression etc.

1.4. TROPICAL PLANT

Papaya (*Carica papaya* L.) is a tropical plant mainly produced by Brazil, Mexico, and Nigeria. Seed - best sown as soon as ripe in a position in indirect light.

Germination takes 2 - 6 weeks at 24 - 30°C. Move to a sunny position about 2 weeks after germination. Greenwood cuttings. Grafting. One of the most famous and flavourful of tropical natural products, papaya is generally developed in tropical and subtropical regions all over the planet, The tree likewise has a wide scope of different purposes, especially for the therapeutic worth of its foods grown from the ground.



Fig:1.1. carica papaya



Fig:1.2. carica papaya seeds

The Papaya is regarded as a fair source of iron and calcium, a good source of vitamins A, B and G and an excellent source of vitamin C (ascorbic acid).

The green products of papaya might be permitted to mature and can be eaten locally, or they can be utilized for making dried papaya "cowhide" or powdered Papaya, or might be used as a wellspring of gelatine.

Due to its papain content, a piece of green papaya can be scoured on a part of hard meat to soften it. Once in a while a lump of green papaya is cooked with meat for a similar reason.

One of the most mind-blowing known utilizations of papain is in business items promoted as meat tenderizers, particularly for home use. Papain-treated meat ought to never be eaten "interesting" however ought to be cooked adequately to inactivate the chemical.

Papain has numerous other common-sense applications. It is utilized to explain brew, additionally to treat fleece and silk prior to colouring, to de-hair stows away prior to tanning, and it fills in as an assistant in elastic assembling. It is applied on fish liver before extraction of the oil which is along these lines made more

extravagant in nutrients An and D. Papain goes into toothpastes, beauty care products and cleansers, as well as drug arrangements to help assimilation.

Natural products from sexually unbiased plants are normally tube shaped or pyriform with little seed hole and thick mass of firm tissue which stands taking care of and delivering great. Conversely, natural products from female blossoms are almost round or oval and slim walled. In certain areas, sexually open sorts are in most prominent interest. In South Africa, round or oval Papayas are liked.

Papaya is developed for its ready natural products, leaned toward by tropical individuals, as breakfast natural product, and as a fixing in jams, safeguards, or cooked in different ways; juice makes a famous drink; youthful leaves, shoots, and natural products cooked as a vegetable.

1.5. MINERAL PROCESSING

Production of metals is one of the oldest applied sciences, and it continues to be a fundamental industry that builds our civilisation. Metals are found naturally in native form or more often as minerals contained in ore bodies in the crust of the earth. Most ores are mixtures of extractable minerals and waste gangue materials (Wills, 2005). Extracting metals from their ores can be done by three methods; hydrometallurgy, electrometallurgy, and the most common pyrometallurgy. However, the pyrometallurgical method, i.e., smelting, requires a large amount of energy. It is therefore of interest to reduce the amount of gangue that is sent to the smelter with the minerals. Mineral processing is a series of physical processes during which valuable minerals are firstly liberated from the gangue, then concentrated to produce an enriched product containing the majority of the valuable materials (the concentrate). Mineral processing reduces both smelter energy cost and metal losses (Wills, 2005).

In the liberation stage, valuable minerals are freed from surrounding gangue by crushing and grinding the mined ore to particles. This process of size reduction is called comminution (Fig.1.3.). The size of the particles is important as particles need to be small enough so that the minerals can be liberated but not too small to avoid wasting energy in grinding. The particle size also affects the concentration process.

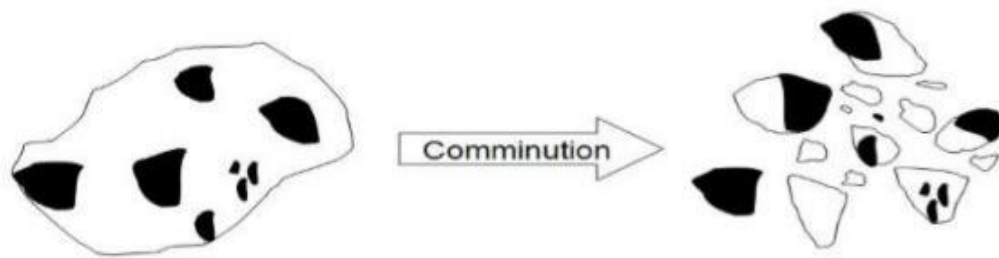


Fig.1.3. Breaking of ore to smaller fragments results in particles with varying degrees of liberation. The shaded area represents the valuable minerals.

The concentration of minerals is carried out using the differences in physical properties between minerals and gangue, such as appearance, density, electrical conductivity, magnetic and surface properties. One of the most important methods of concentration is froth flotation, which exploits differences in surface properties of mineral and gangue species.

1.6. FROTH FLOTATION

Froth flotation is a highly versatile method for physically separating particles based on differences in the ability of air bubbles to selectively adhere to specific mineral surfaces in a mineral or water slurry. The particles with attached air bubbles are carried to the surface and removed, while the particles that remain completely wetted stay in the liquid phase. Froth flotation can be adapted to a broad range of mineral separations, as it is possible to use chemical treatments to selectively alter mineral surfaces so that they have necessary properties for the separation. It is currently in use for many diverse applications, with a few examples being, separating sulphide minerals from silica gangue and from other sulphide minerals; separating potassium chloride (sylvite); from sodium chloride (halide); separating coal from ash – forming minerals; removing silicate minerals from iron ores; separating phosphate minerals from silicates; and even non – mineral applications such as de-inking recycled newsprint. It is particularly useful for processing fine- grained ores that are not amenable to conventional gravity concentration.

Some of the components that involves the flotation system are:

Chemistry component: Collectors, Frothers, Activators, Depressants, pH.

Equipment component: Cell design, Agitation, Air flow, Cell bank configuration.

Operation component: Feed rate, Mineralogy, Particle size, Pulp density, Temperature.

It is important to take all of these factors into account in froth flotation operations. Changes in the settings of one factor will automatically cause or demand changes in other parts of the system. As a result, it is difficult to study the effects of any single factor in isolation and compensation effects within the system can keep process changes from producing the expected effects (Klimpel, 1995). This makes it difficult to develop predictive models for froth flotation, although work is being done to develop simple models that can predict the performance of the circuit from easily-measurable parameters such as solids recovery and tailings solid content (Rao et al., 1995)

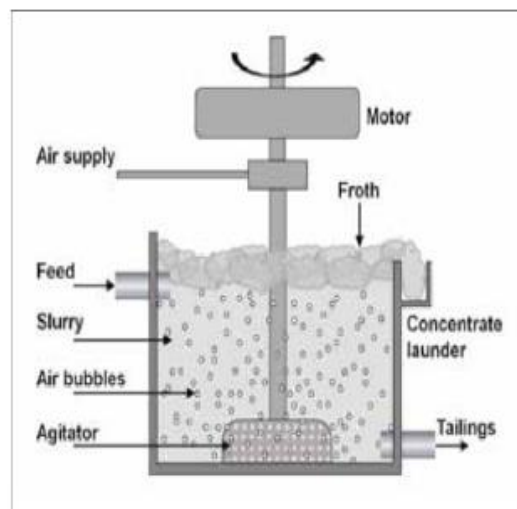


Fig.1.4. Flotation cell

1.7 COAL FLOTATION

Coal flotation is a complicated interaction including a few stages (particles, oil beads and air bubbles). These stages all the while cooperate with one another and with different species like the atoms of an advancing reagent and broke down particles in water.

Coal is a black or brownish-black sedimentary rock that can be burned for fuel and used to generate electricity. It is composed mostly of carbon and

hydrocarbons, which contain energy that can be released through combustion (burning).

Coal contains the energy put away by plants that lived a huge number of years prior in marshy backwoods. Layers of soil and rock covered the plants north of millions of years. The subsequent strain and hotness transformed the plants into the substance we call coal.

coal, one of the main essential petroleum derivatives, a strong carbon-rich material and most frequently happens in separated sedimentary stores. Carbon, which burns to form carbon dioxide and some water from the residual hydrogen present, and gives off heat energy.

Coal is generally carbon with variable measures of different components; mostly hydrogen, sulfur, oxygen, and nitrogen. Coal is framed when dead plant matter rots into peat and is changed over into coal by the hotness and strain of profound internment north of millions of years.

Estimating assumes an imperative part in the exhibition of coal planning plants. Among the different sorts of screens accessible, vibrating screens are prevalently utilized for various sizes of coal, while sifter twists and characterizing tornadoes are explicitly utilized for fine and ultrafine coal.

There are three scattered stages that establish buoyancy mash: coal particles, oil beads and air bubbles. These stages connect in water as the medium through different sub-processes during buoyancy which are distinguished.

The target of washing is to redesign crude coal to deliver various items through various tasks. The washing strategies rely upon the nature of coal and the functioning rule of unit tasks.

coal is made out of macerals, discrete minerals, inorganic components held microscopically by the natural matter, and water and gases contained in submicroscopic pores. Naturally, coal comprises essentially of carbon, hydrogen, and oxygen, and lesser measures of sulfur and nitrogen.

The collaboration of various boundaries of foam buoyancy is examined, including the utilization of reagents, hydrodynamics of the assortment cycle, energy and delivery investigation.

Oxidation brings about warming and self-ignition of coal on open capacity. For each coal, there is a basic temperature ($\sim 60^{\circ}\text{C}$) past which the warming rate pointedly increases and self-start becomes conceivable.

Low positioning bituminous and endured (oxidized) coal might require an amount of frother as incredible as 2.0 kg/t of crude coal. As a rule, how much frother required differs from 0.2 to 0.5 kg/t of crude coal.

Authorities are utilized related to frothers and are expected to support drifting those coals which are less hydrophobic in nature and in this manner less promptly drifted. The essential motivation behind a gatherer is to deliver the surfaces of the particles of coal more hydrophobic to such an extent that the particles of coal and the rising air bubbles which are covered with the frother have more noteworthy contact and bond. The authority is by and large particular in that it specifically sticks to and specially wets the surfaces of the particles of coal however not the particles of contaminations and other matter contained in the slurry. Authorities are generally a hydrocarbon oil. Diesel fuel, fuel oil and lamp oil are the most generally utilized. Endeavors have been made to work on the viability of the gatherer.

In coal buoyancy, just authorities and frothers are by and large utilized as compound reagents. The authority upgrades the hydrophobic property of coal. Buoyancy of coal fines has become progressively significant as a partition and cleaning process where there is a bringing down in both the molecule size and grade of the coal being recuperated from mining activities. The capacity to eliminate the coal fines from coal washery waters or tailings is additionally invaluable to recuperate coal fines missed by different strategies of coal recuperation.

Physical and substance collaborations between fine coal particles could prompt collection, particularly for high position coals. Non-particular molecule total could be supposed to be the primary justification for the selectivity issues in coal buoyancy. It ought to be tended to by functional preparing or substance

(advertisers) pretreatment previously or during buoyancy. Albeit the associations between the oil beads and coal particles are really preferred, adjustment of the oil drops by modest quantities of fine hydrophobic particles might prompt an abatement in selectivity and an expansion in oil utilization.

coal is a non-clastic sedimentary stone. They are the fossilized remaining parts of plants and are in combustible dark and caramel dark tones. Its primary component is carbon, yet it can likewise contain various components like hydrogen, sulfur and oxygen. Dissimilar to coal minerals, it doesn't have a decent synthetic synthesis and precious stone construction. Contingent upon the kind of plant material, fluctuating levels of carbonization and the presence of contaminations, various sorts of coal are framed. There are 4 perceived assortments. Lignite is the most minimal grade and is the mildest and least scorched. Sub-bituminous coal is dull brown to dark. Bituminous coal is the most bountiful and is frequently singed for heat age. Anthracite is the most noteworthy grade and most transformed type of coal. It contains the most elevated level of low-emanation carbon and would be an optimal fuel if not for nearly less.

Coal is chiefly utilized as a fuel. Coal has been utilized for millennia, yet its genuine use started with the development of steam motors after the modern transformation. Coal gives two-fifths of power creation worldwide and coal is utilized as the primary fuel in iron and steel creation offices.

CHAPTER 2

LITERATURE SURVEY

2.1 TITLE - Nutraceutical value of Carica papaya

AUTHOR - Joachim M. Dottoaz, Siri A. Abihudi

YEAR OF PUBLISHED - 6 August 2021

INFERENCE - Papaya (*Carica papaya* L.), one of the broadly concentrated on plants, has a place with the family Caricaceae. Papaya is normally known for its nourishing and therapeutic worth around the world. Many pieces of papaya plant like roots, leaves, strips, organic products, and seeds have dietary also, helpful importance. The point of this survey is to merge the proof-based data on papaya's practical exercises, gathered from online information bases (Scopus, Dimensions, Google Scholar, ScienceDirect, and Web of Science) up to December 2020. A significant writing is accessible enumerating biomedical purposes of various papaya plant parts which made papaya a cherished nutraceutical plant. Papaya plant has significant phytochemicals, for example, phytosterols, tocopherols, flavonoids, alkaloids, and carotenoids. These compounds with intriguing nutraceutical properties assume key parts in enhancing and treating a few ailments, for example, irritation, hyperglycemia, fruitfulness related difficulties, hypertension and have anticarcinogenic exercises. Notwithstanding, further studies are justified to approve the measurement, method of activities, and security profile of papaya seeds, strips, and leaves when utilized as medication.

2.2 TITLE - Identification of Flavonoid Isolates of Papaya (*Carica papaya* L.) Seed and Their Activity as Pancreatic Lipase Inhibitors

AUTHOR - Muntholiba, Dwi Sulistyaningrumb, Subandic, and Siti Marfu'ahd

YEAR OF PUBLISHED - 22 April 2020

INFERENCE - Pancreatic lipase protein assumes a fundamental part in fat absorption. This catalyst hydrolyses fat into unsaturated fats and glycerol to be consumed by the body. Nonetheless, over the top fat admission can cause weight. Past examinations had shown that papaya seed separate contained flavonoids

and was equipped for restraining pancreatic lipase. Be that as it may, the sort and construction of flavonoids contained in the papaya seeds have not been recognized. The reasons for this study were to seclude papaya seed flavonoids, to distinguish their design, and to decide their inhibitory power against pancreatic lipase both in vitro furthermore, in silico. This is a spellbinding labs research directed in five phases, specifically the readiness of papaya seed powder; extraction, separation, and phytochemical examination of flavonoids; ID and design assurance of flavonoid disconnects utilizing UV-Vis, FTIR, and LC-MS/MS spectroscopies; in vitro investigation of the hindrance force of flavonoid disconnects against pancreatic lipase; and in silico investigation by docking strategy utilizing flavonoid segregates as ligands what's more, pancreatic lipases as receptors. This examination had the option to separate a portion of the flavonoid compounds from ethanol extricates of papaya seeds in which every one of them have a higher inhibitory power against pancreatic lipase contrasted with business hostile to stoutness drugs Orlistat. Flavonoid confine of papaya seed having the most elevated inhibitory power (multiple times the inhibitory force of Orlistat) is liquiritigenin. In silico examination shows that liquiritigenin has a limiting situation to the pancreatic lipase chemical, which is somewhat equivalent to Orlistat, yet its limiting partiality is more astounding than Orlistat.

2.3 TITLE - Solvent Extraction and Chemical Characterization of Papaya Seeds Oil

AUTHOR - Jiveri B, Muoki A and Kwanyi M

YEAR OF PUBLISHED - 31 Dec 2018

INFERENCE - Papaya (*carica papaya* L.) is a plant that fills wild in many pieces of the jungles. The seeds of papaya natural products are for the most part disposed of. Be that as it may, in request to make a more proficient utilization of papaya, it merits examining the utilization of the seeds as a wellspring of oil. A compound present in squashed papaya seeds is accepted to have movement against helminthes gastrointestinal parasites, benzyl isothiocynate has displayed to affect vascular constriction utilizing a canine carotid vein in vitro model. Papaya seed oil used in high sums could prompt diminished hazard of coronary illness. Moreover, high oleic oil has adequate strength to be utilized in requesting applications like

fricasseeing, bread kitchen, wafers, oat dried organic product, and shower oil for snacks. Papaya seed oil can be considered as high oleic and thus saw as a solid option in contrast to numerous other vegetable oils. Consequently, it tends to be reasoned that the seed can be used for extraction of oil which has different medical advantages regarding fundamental unsaturated fats. Mass creation of the Oil will speed up industrialization while advancing feasible financial development thus upgrading further developed wellbeing and work which is in accordance with the fundamentals of vision 2030 and the wellbeing related Sustainable Development Goal.

2.4 TITLE - Nutritional and Phyto-Therapeutic Potential of Papaya

AUTHOR - Farhan Saeed, Muhammad Umair Arshad, Imran Pasha, Rabia Naz, Rizwana Batool, Ammar Ahmed Khan, Muhammad Adnan Nasir & Bilal Shafique

YEAR OF PUBLISHED - 21 Mar 2014.

INFERENCE - Papaya holds a wide range of phytochemicals, including polysaccharides, nutrients, minerals, proteins, glycosides, saponins, flavonoids, and phytosterols. These bioactive parts are answerable for the pharmacological properties of this promising plant and show its significance in day today admission and sustenance. Furthermore, it is a fantastic guide to assimilation and furthermore hydrolyzing gluten, which is a significant perspective for dyspeptic and celiac sickness patients. Papaya goes about as a cell reinforcement, antimicrobial, anticarminative, anticancer, and has hepato-defensive, immunological, and other helpful properties. The seed and mash of papaya have bacteriostatic impacts against a few enteropathogens, for example, *Bacillus subtilis* also, *E. coli*. In the current survey, pharmacological traits, healthy benefit of papaya, also, restorative properties of its different parts have been expounded to give aggregate information on this multipurpose business plant. Also, its part in the creation of liquor what's more, carboxymethyl cellulose is additionally the spotlight of the article. Moreover, the present survey article sums up the writing relating to its pharmacokinetics and furthermore partners its wellbeing claims.

CHAPTER – 3

AIM AND SCOPE OF THE PRESENT INVESTIGATION

3.1 OBJECTIVE OF THE STUDY

3.1.1 GENERAL OBJECTIVE

The general objective of this study was production and characterization of locally available carica papaya seed extract for its possible application to extract pure oil.

3.1.2. SPECIFIC OBJECTIVE

The specific objectives of this study were

- To determine the proximate analysis of the carica papaya seeds.
- To extract pure oil from carica papaya seed
- To analyze the physicochemical characteristics of carica papaya seed extract to pure oil.
- To study of Soxhlet extraction method (extraction time, temperature to carica papaya seed ratio).

3.1.3 SCOPE OF THE STUDY

The principle focal point of this exploration was coordinated towards the creation from normal plant seed (carica papaya) inside specific boundaries: extraction time, extraction temperature and hexane to carica papaya seed proportion with (2, 3 and 4 hours), (30, 40 and 50) and (5:1, 7:1 and 9:1v/w) individually.

The general examination of the carica papaya seed were investigated with standard strategies. The item has been portrayed by FTIR examination, GC-MS investigation and NMR.

The measurable meaning of each trial not set in stone and the relating numerical expectation model was created.

3.1.4 SIGNIFICANCE OF THE STUDY

This study is an experimental study of Soxhlet extraction method from carica papaya seed.

- This study is to introduce the application and possibility of carica papaya seed as pure oil which is natural material.
- Provide a means to exploit and manage local available resources
- To create jobs for those will be engaged in planting/cultivating of the fruit as well as establishing to producing plants.

3.2 AIM OF THE STUDY

Plants require specific things to develop effectively. They need biotic things like water, light, supplements, a substrate to fill in, and frequently an appropriate temperature. On the off chance that these are not ideal for a plant, then, at that point, its capacity to develop can be decreased. They can likewise be impacted by abiotic factors such as contamination.

Seeds safeguard and support the undeveloped organism or youthful plant. They normally give a seedling a quicker start than a sporeling from a spore, due to the bigger food holds in the seed and the multicellularity of the encased incipient organism.

Seed establishes now overwhelm organic specialties ashore, from timberlands to prairies both in warm and cold environments.

The principal land plants developed around 468 million years ago,[20] they imitated utilizing spores. The most established seedbearing plants were which had no ovaries to contain the seeds, emerging at some point during the late Devonian time frame (416 million to 358 million years ago) [21].

CHAPTER 4

MATERIALS AND METHODS

4.1. MATERIALS

Soxhlet apparatus with heating mantle and condenser was used for the extraction of oil. n-Hexane was used as a solvent for the extraction of oil from the aromatic plant. Leishman's solution, isopropyl alcohol, Sodium hydroxide (NaOH), Alcoholic potassium hydroxide (KOH), Hydrochloric acid (HCl) and phenolphthalein indicator were used for the characterization and determination of oil from aromatic plant. Coal for used for the froth flotation process.

4.2. CHARACTERIZATION TECHNIQUES

4.2.1. GAS CHROMATOGRAPHY- MASS SPECTROMETRY (GC-MS)

4.2.1.a. INSTRUMENTATION

The GC-MS is composed of two major building blocks: the gas chromatograph and the mass spectrometer. The gas chromatograph utilizes a capillary column which depends on the column's dimensions (length, diameter, film thickness) as well as the phase properties (e.g., 5% phenyl polysiloxane). The difference in the chemical properties between different molecules in a mixture and their relative affinity for the stationary phase of the column will promote separation of the molecules as the sample travels the length of the column. The molecules are retained by the column and then elute (come off) from the column at different times (called the retention time), and this allows the mass spectrometer downstream to capture, ionize, accelerate, deflect, and detect the ionized molecules separately. The mass spectrometer does this by breaking each molecule into ionized fragments and detecting these fragments using their mass-to-charge ratio.

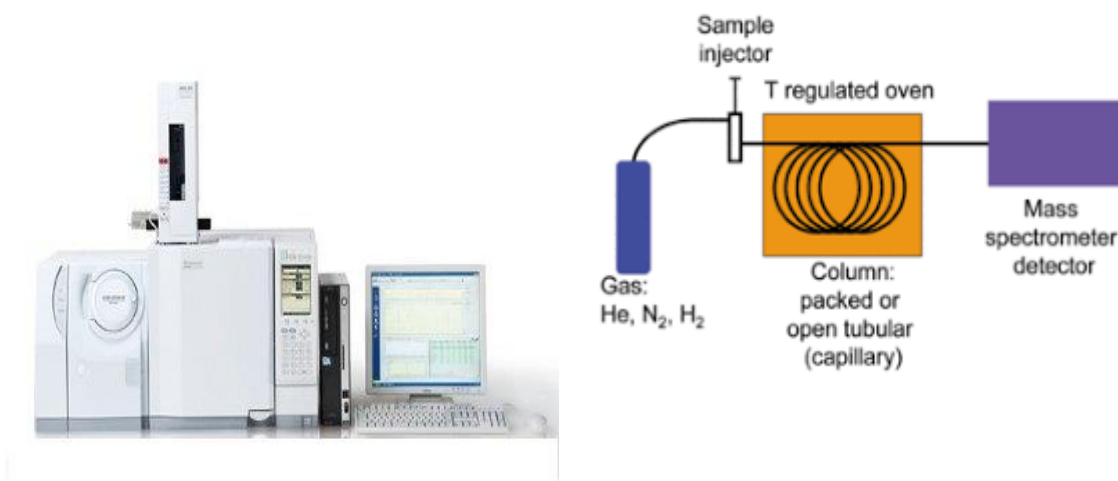


Fig: 4.1. GC-MS instrument

These two parts, utilized together, permit a lot better level of substance distinguishing proof than either unit utilized independently. It is beyond the realm of possibilities to expect to make an exact recognizable proof of a specific particle by gas chromatography or mass spectrometry alone.

The mass spectrometry process typically requires an extremely unadulterated test while gas chromatography utilizing a conventional locator (for example Fire ionization indicator) can't separate between numerous atoms that happen to invest in some opportunity to go through the segment (for example have something very similar maintenance time), which brings about at least two particles that co-elute. Here and there two unique atoms can likewise have a comparative example of ionized sections in a mass spectrometer (mass range). Joining the two cycles lessens the probability of blunder, as it is incredibly far-fetched that two unique particles will act similarly in both a gas chromatograph and a mass spectrometer.

In this manner, while a recognizing mass range shows up at a trademark maintenance time in a GC-MS examination, it normally increments sureness that the analyte of interest is in the example.

For the examination of unstable mixtures, a cleanse and trap (P&T) concentrator framework might be utilized to present examples. The objective analytes are separated by blending the example in with water and cleanse with dormant gas (for example Nitrogen gas) into an impenetrable chamber, this is known as cleansing or sparging. The unstable intensifies move into the headspace

over the water and are drawn along a strain inclination (brought about by the presentation of the cleanse gas) out of the chamber.

The unpredictable mixtures are drawn along a warmed line onto a 'trap'. The trap is a section of adsorbent material at encompassing temperature that holds the compounds by returning them to the fluid stage. The snare is then warmed and the test compounds are acquainted with the GC-MS section by means of a volatiles interface, which is a parted bay framework. P&T GC-MS is especially fit to unstable natural compounds (VOCs) and BTEX compounds (fragrant mixtures related with petrol).

A quicker elective is the "cleanse shut circle" framework. In this framework the idle gas is risen through the water until the groupings of natural mixtures in the fume gradually ease is at balance with focuses in the fluid stage. The gas stage is then investigated straightforwardly.

4.2.1.b. TYPES OF MASS SPECTROMETER DETECTORS

The most widely recognized sort of mass spectrometer (MS) related with a gas chromatograph (GC) is the quadrupole mass spectrometer, at times alluded to by the Hewlett-Packard (presently Agilent 1200) trademark "Mass Selective Detector" (MSD). Another somewhat normal locator is the particle trap mass spectrometer. More over one might observe an attractive area mass spectrometer, but these specific instruments are costly and massive and not ordinarily found in high throughput administration labs. Different finders might be experienced like time of flight (TOF), couple quadrupoles (MS-MS) (see underneath), or on account of a particle trap MS where n demonstrates the number mass spectrometry stages.

4.2.1.c. APPLICATIONS

Gas chromatography-mass spectrometry (GC-MS) is an insightful strategy that consolidates the elements of gas-chromatography and mass spectrometry to recognize various substances inside a test. Utilizations of GC-MS incorporate medication recognition, fire examination, explosives examination, and ID of obscure examples, including that of material examples got from planet Mars during test missions as soon as the 1970s. GC-MS can likewise be utilized in air terminal security to distinguish substances in baggage or on individuals.

Moreover, it can distinguish minor components in materials that were recently thought to have crumbled past recognizable proof. Like fluid chromatography-mass spectrometry, it permits investigation and location even of minuscule measures of a substance.

GC-MS has been viewed as a "best quality level" for scientific substance recognizable proof since it is utilized to play out a 100 percent explicit test, which decidedly distinguishes the presence of a specific substance. A vague test simply shows that any of a few in a classification of substances is available. Albeit a vague test could genuinely propose the character of the substance, this could lead to misleading positive recognizable proof [25].

4.2.2. FOURIER TRANSFORM INFRARED SPECTROSCOPY (FTIR)

Infrared spectroscopy takes advantage of the way that atoms retain frequencies that are normal for their design. These retentions happen at thunderous frequencies, for example the recurrence of the retained radiation matches the vibrational recurrence. The energies are impacted by the state of the sub-atomic potential energy surfaces, the majority of the iotas, and the related vibronic coupling. Specifically, in the Born-Oppenheimer and symphonious approximations, for example when the sub-atomic Hamiltonian relating to the electronic ground state can be approximated by a symphonious oscillator in the neighborhood of the harmony sub-atomic math, the full frequencies are related with the typical modes comparing to the sub-atomic electronic ground state potential energy surface.

The thunderous frequencies are additionally connected with the strength of the bond and the mass of the particles at one or the flip side of it. In this way, the recurrence of the vibrations is related with a specific typical method of movement and a specific bond type.

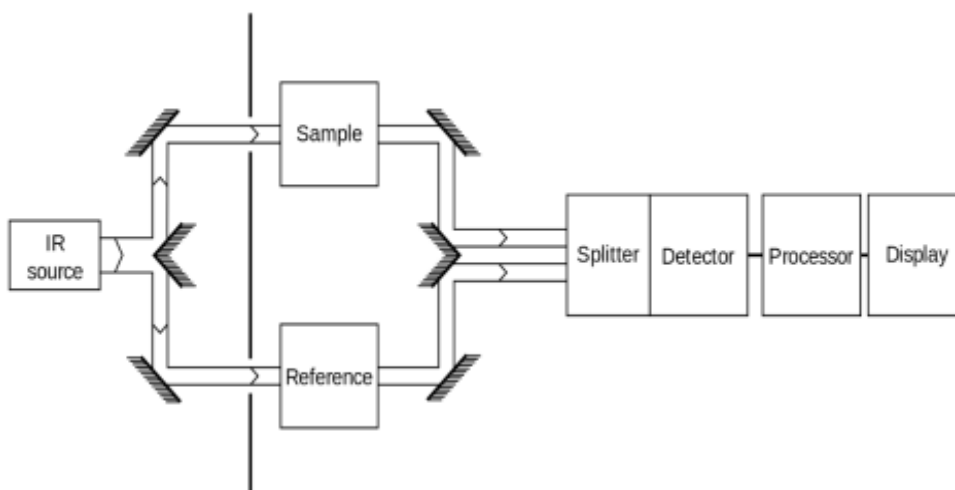


Fig.4.2. FTIR two beam absorption spectrometer

In order for a vibrational mode in a sample to be "IR active", it must be associated with changes in the dipole moment. A permanent dipole is not necessary, as the rule requires only a change in dipole moment. Six of these vibrations involve only the CH₂ portion: symmetric and anti- symmetric stretching, scissoring, rocking, and twisting [26], [27].

4.2.3 NUCLEAR MAGNETIC RESONANCE (NMR)

4.2.3. a. INSTRUMENTATION

When white light is given to the surface of an atom, molecule, or other object, spectrum is seen from it which is called spectroscopy. [29][30]. we can say that the spectrum that is found here depends entirely on the defined atom and molecule or some other substance. And spectroscopy is also used in physics, chemistry and biology. Are and the frequency is the lowest. While violet have the shortest wavelength and the highest frequency [31][32].

When it comes from the sun's rays it is an ultraviolet wave. The shortest wavelength from above is that of gamma radiation (1 picometer). A total of 22 types of the spectroscopy are found. Of which here we will talk about nuclear magnetic resonance spectroscopy [33][34].

strong state atomic attractive reverberation (NMR) is a spectroscopic technique that gives results delicate to the nearby atomic climate and is utilized to

concentrate on a wide assortment of carbon materials, including peat, humic substances, coal, coke and charcoal. It consequently an itemized comprehension of the synthesis of plasma blacks at the nuclear scale is accordingly of interest focused on their likely viable applications and the ionization improvement of their creation strategies. Subsequently the more extensive test approach utilized in the NMR investigation of these carbon substances utilizes cross polarization (CP) to build the polarization of the carbon cores by their collaboration with them bountiful ^1H cores. Commitments are effectively separated in light of or because of gatherings, normally in the scope of 0 to 90 ppm for aliphatic and 110-160 ppm for sweet-smelling gatherings.

Cross Polarization experiments are less time consuming compared to experiments based on the direct polarization (DP) of the ^{13}C nucleus, as the relative longitudinal relaxation time in CP is associated with an abundant ^1H nucleus (T_{1H}). Which means that the spectral intensity in the ^{13}C NMR spectrum recorded with CP will be affected by differences in the rate of polarization transfer in the chemically differentiated ^{13}C nucleus from ^1H [35].

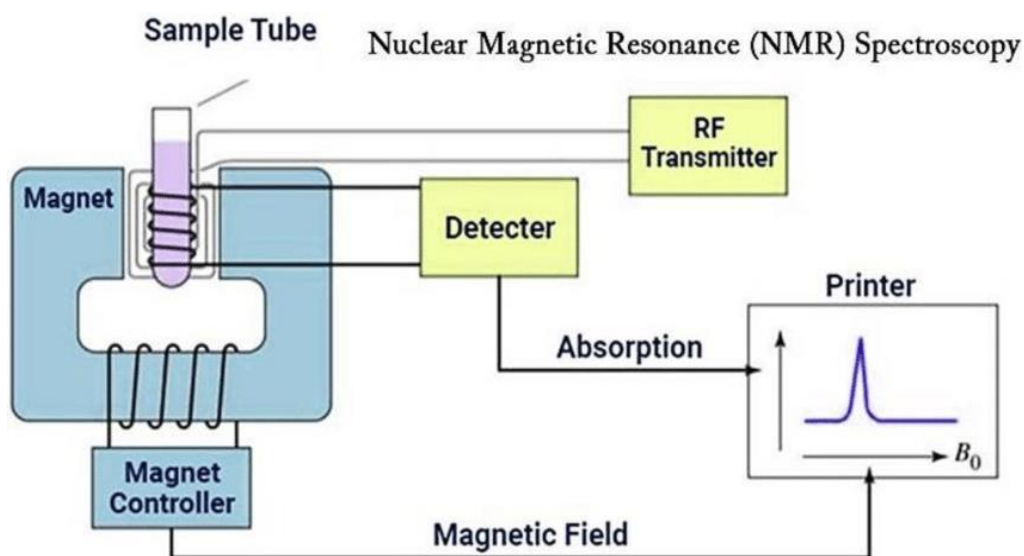


Fig.4.3. NMR spectroscopy instrumentation

It possible to determine the fraction of carbon atoms with sp^2 or sp^3 hybridization, observation of chemical reduction of graphene oxide, study of the relationship between chemical transformation in heat-treated carbon and structural

parameters, the study of relaxation processes of ^{13}C nuclei interacting with paramagnetic centres in nanocarbons and many others. the solid-state ^{13}C NMR spectroscopy was used to study plasma black and carbon deposits produced by thermal cracking of natural gas using different types. i.e., different types of plasma reactors.

Assume there is a core wherein a proton is available while the proton addresses the twist second. This makes the proton go about as a little magnet. There should be a clear rule for deciding if atomic attractive reverberation is dynamic for a particle. the atomic attractive reverberation will be dynamic provided that the twist quantum number of a particle is more noteworthy than nothing. What's more, if the quantum number becomes zero then atomic attractive reverberation won't be initiated. This will be conceivable when the nuclear number and the nuclear mass become equivalent for example their twist quantum will be zero. Consequently, one might say that atomic attractive reverberation will be initiated just when the nuclear number and the nuclear mass are not equivalent.

This recommends that the core ought to contain all the data relating to the core that has protons and neutrons in which the proton has a positive charge and the neutron doesn't have a charge. At the point when the electron spins around the core and the actual electron additionally rotates in its place for example the actual electron has some twist. The actual electron can be clockwise or against clockwise twist second. While the other word is attractive, it infers that the attractive field additionally has an impact.[36][37].

4.2.3.b. TYPES OF NMR

(1) H is used to determine the type and number of atoms in an atom.

(2) Used to determine the types of carbon atoms in an atom.

Atoms are tested on the basis of hydrogen atoms in hydrogen nuclear magnetic resonance. When an atom is tested on the basis of a carbon atom in a carbon nuclear magnetic resonance. Nuclear magnetic resonance is techniques that determine the structure of various compounds.

4.2.3.c. *PRINCIPLE OF NMR*

When energy in the form of radio frequency is applied when applied frequency is equal to precessional frequency absorption of energy occurs nucleus is in resonance and nuclear magnetic resonance signal is recorded.

- (1) Sample holder
- (2) Permanent magnet
- (3) Probe
- (4) Sweep generator
- (5) Radio frequency transmitter
- (6) Radio frequency receiver
- (7) Read out system

4.2.3.d. *NMR APPLICATION*

Atomic attractive reverberation is utilized as quality control of iotas, particles or different surfaces. Discussing its utilization here, atomic attractive reverberation is additionally used to test the immaculateness of an example too as its extents and the organization of the beginning. It is likewise used to decide the atomic construction of a strong state atomic attractive spectroscopy strong.

It can likewise be utilized for the assurance of protein structure. Hence, NMR spectroscopy is a spectroscopy procedure utilized by physicists and natural chemists to research the properties of natural particles however can be applied to an example that has a twist containing core. Subsequently, once the fundamental construction is known, NMR is utilized to decide the sub-atomic profile in arrangements as well as to concentrate on the actual properties at the atomic level, for example, physical trade, stage change, dissemination and dissolvability.[38]. For example, NMR can perform quantitative analysis of mixtures

containing known compounds. NMR can be used to either match spectral libraries or to apply the basic structure directly to unfamiliar combinations.

Nuclear magnetic resonance is a most powerful analytical technique in terms of the range of system that can be studied and the nature of information and can be obtained regarding the system of interest. Provide qualitative & quantitative data. Only require few milligram samples.

4.3. EXTRACTION METHODS

For the extraction of oil Soxhlet apparatus was used. A Soxhlet extractor is a piece of laboratory apparatus invented in 1879 by Franz von Soxhlet. It was originally designed for the extraction of a lipid from a solid material. Typically, Soxhlet extraction is used when the desired compound has a limited solubility in a solvent, and the impurity is insoluble in that solvent. It allows for unmonitored and unmanaged operation while efficiently recycling a small amount of solvent to dissolve a larger amount of material.

4.3.1. DESCRIPTION

A Soxhlet extractor has three main sections: a percolator (boiler and reflux) which circulates the solvent, a thimble (usually made of thick filter paper) which retains the solid to be extracted, and a siphon mechanism, which periodically empties the thimble.

4.3.2. ASSEMBLY

The source material containing the compound to be extracted is placed inside the thimble. the thimble is loaded into the main chamber of the Soxhlet extractor. The extraction solvent to be used is placed in a distillation flask. The flask is placed on the heating element. The Soxhlet extractor is placed atop the flask. A reflux condenser is placed atop the extractor.

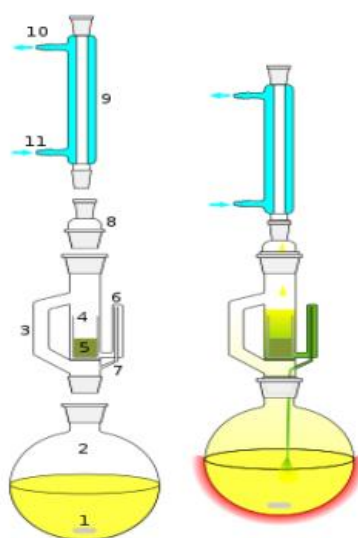


Fig: 4.4. Soxhlet apparatus

A schematic representation of a Soxhlet extractor

- Stirrer bar
- Still pot (the still pot should not be overfilled and the volume of solvent in the still pot should be 3 to 4 times the volume of the Soxhlet chamber)
- Distillation path
- Thimble
- Solid
- Siphon top
- Siphon exit
- Expansion adapter
- Condenser
- Cooling water out
- Cooling water in.

4.3.3. OPERATION

4.3.3.a. SOXHLET EXTRACTION METHOD

The collected aromatic plant was weighed (100g) and dried in oven at 75°C for about 3 hours. This dried material was weighed (98g). Once dried, the aromatic seed was ground using pulverisers for half an hour. Then the size reduction was

made for the pulverized material using different particle size sieve. From this 10g of the sample was introduced into the thimble chamber. Soxhlet apparatus was connected to the distilled flask containing 30mL of n-hexane (1:3 ratio). The solvent is heated to reflux. The solvent vapour travels up a distillation arm, and floods into the chamber housing the thimble of solid. The condenser ensures that any solvent vapour cools, and drips back down into the chamber housing the solid material. The chamber containing the solid material slowly fills with warm solvent. Some of the desired compound dissolves in the warm solvent. When the Soxhlet chamber is almost full, the chamber is emptied by the siphon. The solvent is returned to the distillation flask. The thimble ensures that the rapid motion of the solvent does not transport any solid material to the still pot. This cycle may be allowed to repeat many times, over hours.



Fig.4.5. Soxhlet apparatus with the sample

During each cycle, a portion of the non-volatile compound dissolves in the solvent. After many cycles the desired compound is concentrated in the distillation flask. The advantage of this system is that instead of many portions of warm solvent being passed through the sample, just one batch of solvent is recycled. After extraction the solvent is removed, typically by means of a rotary evaporator, yielding the extracted compound. The non-soluble portion of the extracted solid

remains in the thimble, and is usually discarded. The extracted oil was directly used as the bio-collector for coal flotation.

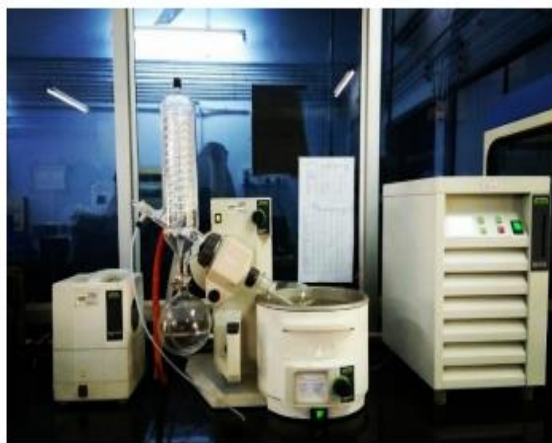


Fig. 4.6. Rotary Evaporator

For each cycle two factors were considered which plays an important role throughout the experiment. Time and temperature are the two factors. Each cycle takes 30 minutes for completion. For each 30 minutes, the temperature of water in the water bath and the solvent with the oil in the round bottom flask varies. For all these variations the oil yield was calculated and the bulk was regenerated. This bulk of oil was used as an application for the froth flotation method.

4.4. APPLICATION OF FLOTATION METHOD

4.4.1. DESCRIPTION OF EQUIPMENT

In the present study, the particle size distribution was carried out using a set of BSS screens or sieves with the top screen as 850 μ m and the bottom sieve as 45 μ m. A set of 350,600,850 and 1000 μ m screens were shown in the fig.4.7. Size reduction of ore is the important parameter which enhances the flotation process and hence grinding of Graphite ore was carried out in Ball Mill with 3.4Kg ball charge. A Hot air oven (fig.4.11.), muffle furnace (fig.4.12) and crucibles are used for determining % moisture and % ash, % volatile matter respectively.

The flotation process is perhaps the most efficient, widely applicable, and for a variety of ores used by the mining industry. Theoretically, it can be applied to any mixture of particles that are essentially free from one another and that are fine

enough to be lifted by rising gas bubbles. Bench scale conventional flotation tests were performed in a standard D12 Denver Flotation machine (fig.4.10) manufactured by the Denver Equipment company. Flotation cells of various sizes ranging from 1.5 to 5 litres were available. In the present study 2.5 lit capacity cell has been used for beneficiation of coal ore (- 0.2 mm). the apparatus provides recirculation and agitation to maintain thorough mixing and solid/liquid suspension.

The vertical position of the agitator can be adjusted by pulling out the stop knob on the left side of the unit and turning the lever on the right-hand side. The rotation speed (rpm) of the agitator is varied by turning the knob at the top of the motor and at the back of the unit. An rpm tachometer is located at the top of the unit. Aeration is controlled using a needle valve.

The equipment used for this experiment are given below,

- Sieves (350, 600, 850, and 1000 μ m)
- Riffle sampling Apparatus
- Ball mill
- D-12 Denver Flotation Cell
- Oven, Muffle Furnace and Crucibles.

APPARATUS



Fig.4.7. Sieves



Fig. 4.8. Riffle sampling



Fig.4.9a. Ball milling machine

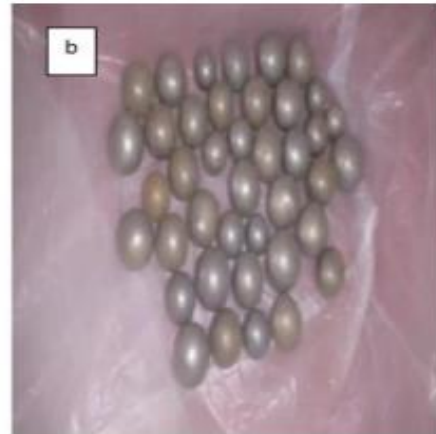


Fig.4.9b Grinding media (balls)



Fig.4.10. D-12 Denver flotation cell



**Fig. 4.11. Hot air oven
furnace**



Fig. 4.12. Muffle

4.4.2. EXPERIMENTAL PROCEDURE

Major steps involved in the experimentation procedure for the beneficiation process are given below:

1. Preparation of sample for laboratory studies includes
 - a. Coning and Quartering
 - b. Grinding
 - c. Proximate analysis
2. Wet screen analysis
3. Flotation
4. Ash analysis.

4.4.3. PREPARATION OF SAMPLE FOR LABORATORY STUDIES

First of all, coal ore was subjected to the crushing and grinding to reduce the size of the bulk sample for experimentation convenience. Afterwards, coning and quartering analysis was done to get the desired amount of sample for further analysis.

4.4.4. PROXIMATE ANALYSIS

The proximate analysis of coal separates the products into four groups:

1. Moisture,
2. volatile matter consisting of gases and vapours driven off during pyrolysis,
3. Fixed carbon, the non-volatile fraction of coal, and
4. Ash, the inorganic residue remaining after combustion.

The proximate analysis of coal is presented as a group of test methods that has been used widely as the basis for coal characterization in connection with coal

utilization. The proximate analysis of coal was done according to an Indian standard IS 14852: 2000.

(a)Moisture content

Determination of moisture is carried out by placing a 1 gm sample of powdered coal material in a tared porcelain dish and covers it with a watch glass. Place the dish in an air oven maintained at temperature $150 \pm 1^{\circ}\text{C}$ and remove the watch-glass from it. Heat the sample for two hours in Hot air oven and cover the dish with the watch-glass before taken it out of the oven. Cool the dish in a desiccator and weigh.

The loss in weight represents moisture

$$\text{Moisture \%} = \frac{\text{weight of moisture}}{\text{weight of sample}} \times 100$$

(b)Volatile Matter (VM)

Introduce in a weighted silica crucible with tightly fitted lid about one gram of the moisture free sample. Heat the crucible in a muffle furnace maintained at a temperature of $925 \pm 25^{\circ}\text{C}$ for 7 min. The bottom of the crucible shall not rest on the muffle floor. Remove the crucible from the muffle after 7 min; Allow it to cool in a desiccator and weigh.

The loss of weight is taken as weight of volatile matter.

$$\text{Volatile matter\%} = \frac{\text{weight of volatile matter}}{\text{weight of original sample}} \times 100$$

(c) Ash content

Weigh accurately about 1 to 2 g of the moisture free material in a silica crucible, keep in a muffle furnace and heat to $500 \pm 10^{\circ}\text{C}$ within one hour and $775 \pm 10^{\circ}\text{C}$ in two hours. A slow stream of air is maintained through the muffle furnace. When the carbon is completely removed as indicated by the absence of black particle

upon stirring with a platinum wire, the temperature is further increased to 950 + 25°C and kept for one hour. Cool in a desiccator and weigh.

The loss of weight is taken as weight of Ash content.

$$\text{Ash \%} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$

(d) Fixed carbon (FC)

Fixed Carbon or FC is derived by subtracting from 100 the value of moisture, volatile matter and ash.

$$\text{Fixed Carbon \%} = 100 - (\text{Moisture \%} + \text{Volatile Matter \%} + \text{Ash \%})$$

4.5. COAL GRINDING

Size reduction of ore is the important parameter which enhances the flotation process and hence grinding of coal ore carried out in Ball Mill with 3.4Kg ball charge, 66% solid percent and depressant dosage of Sodium silicate in variation of time preliminary experiments were performed to optimize the grinding process with varying grinding time and sodium silicate dosage followed by flotation. Grinding was performed for 3 minutes for optimizing grinding time as established in previous experiments conducted by NML was taken into consideration.

4.5.1. WET SIEVE ANALYSIS

Wet sieving is a procedure used to evaluate particle size distribution of a granular material or aid in particle size analysis by removing fines that may impede the separation process. 100g of the sample feed is been grinded in ball mill for 3 min were taken for wet screening consisting of 350, 600, 850 and 1000 mesh screens. After wet sieving analysis, 0.5g of representative sample was collected from the oversize of each screen of the sieve set to determine the ash content. Average overall ash has been computed from wet sieve analysis data.

4.5.2. LABORATORY FLOTATION STUDIES (PRELIMINARY EXPERIMENTS)

100g of grounded coal sample mixing with water and was allowed to conditioned for 2 minutes at the impeller speed of 1250 rpm for each batch

flotation. 37.5mL of (1%) Sodium Silicate was added as a depressant to the pulp and conditioned for five minutes. After conditioning required amount of Collector (extracted oil) was added and allowed the mixture for three minutes for uniform mixing of Collector within the pulp. Now water was added to fill the cell up to the marked height to make the pulp density at 19%. Air inlet valve was opened to allow the air to introduce into the system from the bottom of flotation cell. These air generated air bubbles which carried the coal particles up to the top of the surface as froth. This froth was collected as a concentrate for four minutes whereas the remaining parts collected as tailings. The flotation concentrate and filtered tailing were dried, weighted and analysed for ash content [28].

4.5.3. D-12 DENVER SUB-AERATION FLOTATION CELL – CONDITIONS

Flotation tests were carried at specified conditions:

Size of the feed particle	: below 0.5 mm
PH of the slurry	: Neutral
Impeller speed	: 1250 rpm
Solid concentration of pulp during preparation of Coal slurry solid	: 40%
Concentration of pulp during conditioning	: 33%
Solid concentration of pulp during frothing	: 19%
Wetting time	: 2 minutes
Depressant conditioning time	: 5 minutes
Collector conditioning time	: 3 minutes
Froth Collection time	: 4 minutes



Fig.4.13 coal flotation machine

4.6. REAGENTS USED FOR FLOTATION

According to the test conditions given above, the reagents were used.

Two tests were done:

Test-1:

- 1). 1% Sodium Silicate as depressant
- 2). Extracted oil from aromatic seed using Soxhlet extraction method (Reagent) was used as the collector.

Test-2:

- 1). 1% Sodium Silicate as depressant.
- 2). Oil was used as the collector.
- 3). Extracted oil from aromatic seed using Soxhlet extraction method (Reagent) was used as the frother.

Dosages of the reagents was varied for each test.

CHAPTER 5

RESULTS AND DISCUSSION

As an outcome of this study, the extraction of oil from aromatic plant was performed by Soxhlet extraction method. This method is carried out using a selected organic solvent which is n-Hexane and parameters such as time, temperature and reduction of the particle size. The results are tabulated and the graphs are plotted for each parameter. The determination and characterization of oil from aromatic seed are also outlined in this study.

5.1. DESIGN OF EXPERIMENT (DOE)

Design of experiment techniques, you can determine the individual and interactive effects of various factors that can influence the output results of your measurements. It is a structured approach for collecting data and making discoveries. To determine whether a factor, or a collection of factors, has an effect on the response. the factorial guideline, randomization, replication and hindering. Creating and examining these plans depended fundamentally close by estimation before, up to this point experts began utilizing PC produced plans for a more powerful and effective DOE. To run trials that span the potential experimental region for our factors. Design of experiments (DOE) is defined as a branch of applied statistics that deals with planning, conducting, analysing, and interpreting controlled tests to evaluate the factors that control the value of a parameter or group of parameters. DOE is a powerful data collection and analysis tool that can be used in a variety of experimental situations.

RUN NO	FEED SIZE (μm)	TEMPERATURE ($^{\circ}\text{c}$)
1	350	70
2	350	75
3	600	70

4	600	75
5	850	70
6	850	75
7	1000	70
8	1000	75

Tab: 5.1. DOE method table

5.2 EFFECT OF SIZE AND OIL YIELD

5.2.a. EFFECTS OF SIZE AND OIL YIELD USING AT TEMPERATURE (70°C)

At temperature 70°C

OIL YIELD	FEED SIZE
(%)	(-µm)
1.29	350
2.78	600
2.52	850
2.93	1000

Table 5.2. Size variation versus oil yield

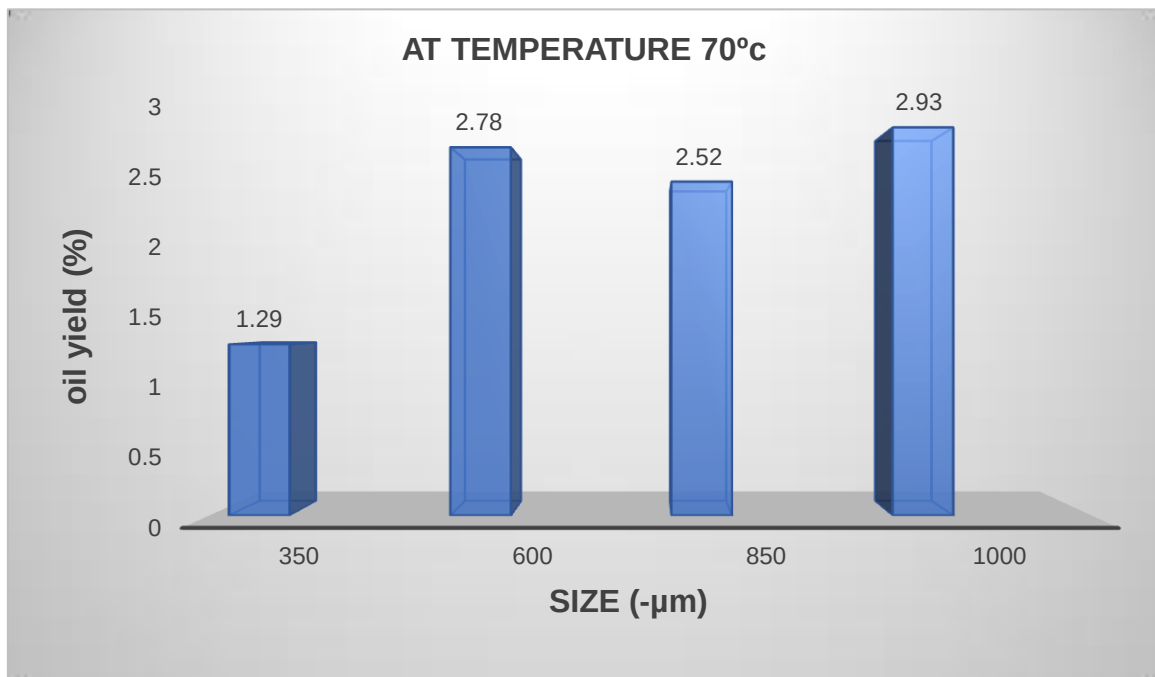


Fig 5.1. Size variation versus oil yield

CALCULATION OF OIL YIELD USING 70°C

(i) The yield of the oil extracted around 70°C (-350µm) using Soxhlet apparatus was calculated using this below equation,

$$\begin{aligned} \% \text{ yield} &= \frac{\text{weight of the oil extracted}}{\text{weight of the sample feed}} \times 100 \\ &= \frac{1.29}{10} \times 100 \end{aligned}$$

Oil yield =12.9 %

(ii) The yield of the oil extracted around 70°C (-600µm) using Soxhlet apparatus was calculated using this below equation,

$$\begin{aligned} \% \text{ yield} &= \frac{\text{weight of the oil extracted}}{\text{weight of the sample feed}} \times 100 \\ &= \frac{2.78}{10} \times 100 \end{aligned}$$

Oil yield =27.8 %

(iii) The yield of the oil extracted around 70°C (-850µm) using Soxhlet apparatus was calculated using this below equation,

$$\begin{aligned}\% \text{ yield} &= \frac{\text{weight of the oil extracted}}{\text{weight of the sample feed}} \times 100 \\ &= \frac{2.52}{10} \times 100\end{aligned}$$

Oil yield = 25.2%

(iv) The yield of the oil extracted around 70°C (-1mm) using Soxhlet apparatus was calculated using this below equation,

$$\begin{aligned}\% \text{ yield} &= \frac{\text{weight of the oil extracted}}{\text{weight of the sample feed}} \times 100 \\ &= \frac{2.93}{10} \times 100\end{aligned}$$

Oil yield = 29.3%

5.2.b. EFFECTS OF SIZE AND OIL YIELD USING AT TEMPERATURE (75°C)

At temperature 75°C

OIL YIELD (%)	FEED SIZE (-µm)
1.26	350
1.85	600
1.91	850
3.17	1000

Table :5.3. size variation versus oil yield

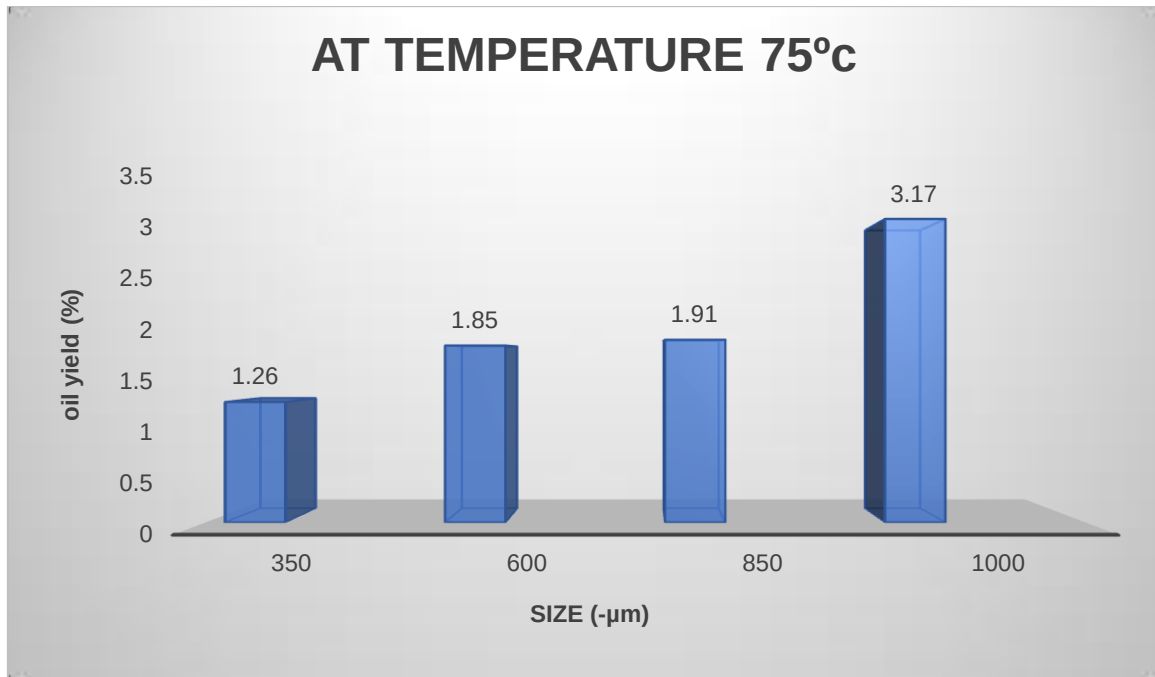


Fig 5.2. Size variation versus oil yield

CALCULATION OF OIL YIELD USING 75°C

(i) The yield of the oil extracted around 75°C (-350µm) using Soxhlet apparatus was calculated using this below equation,

$$\begin{aligned}\% \text{ yield} &= \frac{\text{weight of the oil extracted}}{\text{weight of the sample feed}} \times 100 \\ &= \frac{1.26}{10} \times 100\end{aligned}$$

$$\text{Oil yield} = 12.6\%$$

(ii) The yield of the oil extracted around 75°C (-600µm) using Soxhlet apparatus was calculated using this below equation,

$$\begin{aligned}\% \text{ yield} &= \frac{\text{weight of the oil extracted}}{\text{weight of the sample feed}} \times 100 \\ &= \frac{1.85}{10} \times 100\end{aligned}$$

$$\text{Oil yield} = 18.5 \%$$

(iii) The yield of the oil extracted around 75°C (-850µm) using Soxhlet apparatus was calculated using this below equation,

$$\begin{aligned}\% \text{ yield} &= \frac{\text{weight of the oil extracted}}{\text{weight of the sample feed}} \times 100 \\ &= \frac{1.91}{10} \times 100\end{aligned}$$

Oil yield =19.1 %

(iv) The yield of the oil extracted around 75°C (-1mm) using Soxhlet apparatus was calculated using this below equation,

$$\begin{aligned}\% \text{ yield} &= \frac{\text{weight of the oil extracted}}{\text{weight of the sample feed}} \times 100 \\ &= \frac{3.17}{10} \times 100\end{aligned}$$

Oil yield =31.7 %

Results obtained from the above analysis shows that the increase in temperature and time generally favours an increase in the oil yield. This phenomenon is due to the fact that oils are generally more soluble at elevated temperatures (Sen et al.1992). At higher temperatures, the viscosity of the solvent is reduced while the diffusivity, as well as the evaporation rate is increased. This increases the contact time between the solvent and the oil-bearing material (Ayoola et al.2014). From the above result, Soxhlet extraction using solvent as n-hexane with different particle size (-350µm, -600µm, -850µm and -1mm) using two set of temperature are 70°C and 75°C has obtained the yield.

5.3. RESULTS OF GC-MS

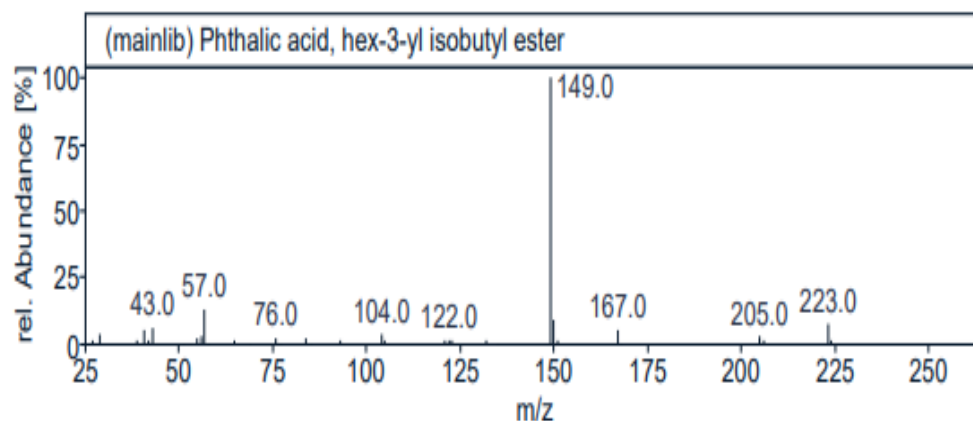
Gas chromatography mass spectrometry (GC-MS) is an instrumental technique, comprising a gas chromatograph (GC) coupled to a mass spectrometer (MS), that is carried out by which complex mixtures of chemicals may be separated, identified and quantified. This makes it ideal for the analysis of the hundreds of relatively low molecular weight compounds found in environmental materials. In order for a compound to be analysed by GC-MS it must be sufficiently volatile and thermally stable. In addition, functionalised compounds may require

chemical modification (derivatization), prior to analysis, to eliminate undesirable adsorption effects that would otherwise affect the quality of the data obtained. Samples are usually analysed as organic solutions consequently materials of interest (e.g.: soils, sediments, tissues etc.) need to be solvent extracted and the extract subjected to various 'wet chemical' techniques before GC-MS analysis is possible.

The sample solution is injected into the GC inlet where it is vaporized and swept onto a chromatographic column by the carrier gas (usually helium). The sample flows through the column and the compounds comprising the mixture of interest are separated by virtue of their relative interaction with the coating of the column (stationary phase) and the carrier gas (mobile phase). The latter part of the column passes through a heated transfer line and ends at the entrance to ion source where compounds eluting from the column are converted to ions.

The GC-MS results of the extracted oil is observed from the below graphs. The retention time is observed and peak area is calculated. X-axis denotes the retention time and Y-axis denotes the intensity.

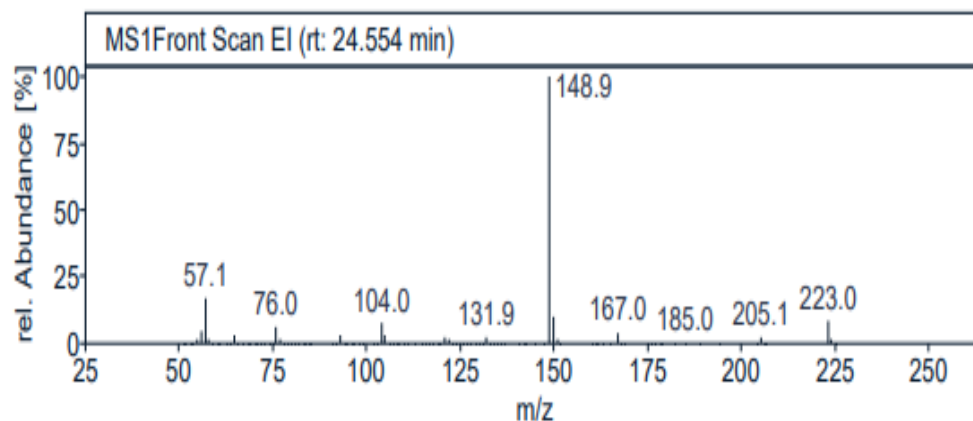
Peak @ 24.556 Area 2714468.309 Area % 0.78



Ion Table

149.0 999 • 57.0 131 • 150.0 91 • 223.0 76 • 43.0 56 • 167.0 49

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
Phthalic acid, hex-3-yl isobutyl ester	910	938	8.04	mainlib		150432



Ion Table

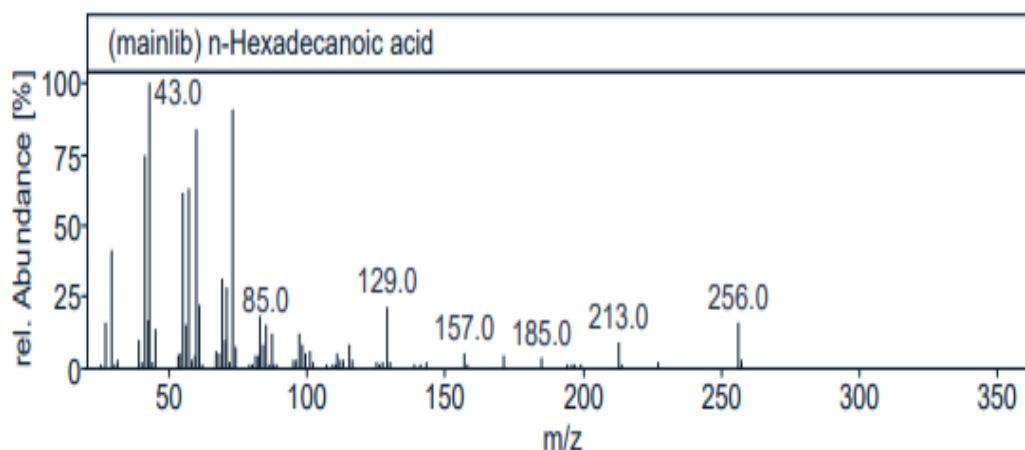
148.9 999 • 57.1 164 • 150.0 95 • 223.0 78 • 104.0 74 • 76.0 56

Summary Hit Table

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
Phthalic acid, hex-3-yl isobutyl ester	910	938	8.04	mainlib		150432

Fig.5.3. Represents Phthalic acid, hex-3-yl isobutyl ester

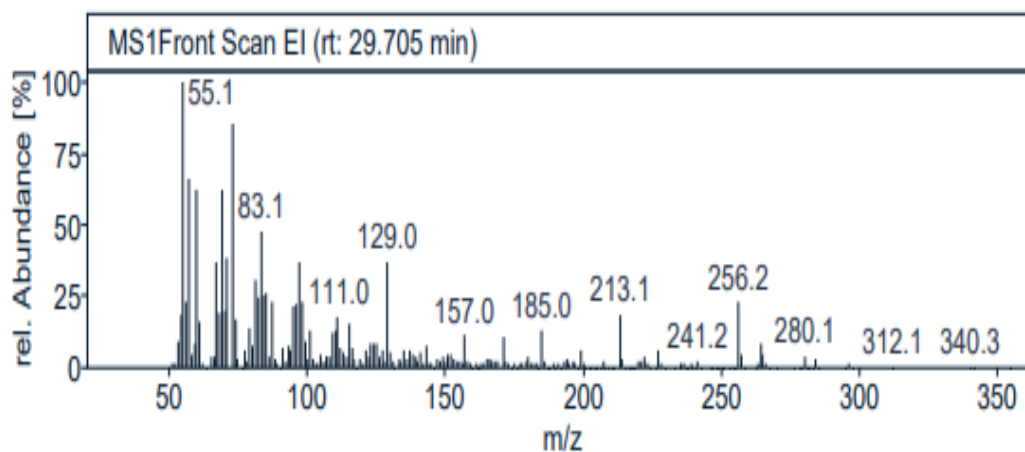
Peak @ 29.701 Area 16886208.333 Area % 4.87



Ion Table

43.0 999 • 73.0 905 • 60.0 838 • 41.0 749 • 57.0 634 • 55.0 616

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
n-Hexadecanoic acid	775	844	13.14	mainlib	57-10-3	9946



Ion Table

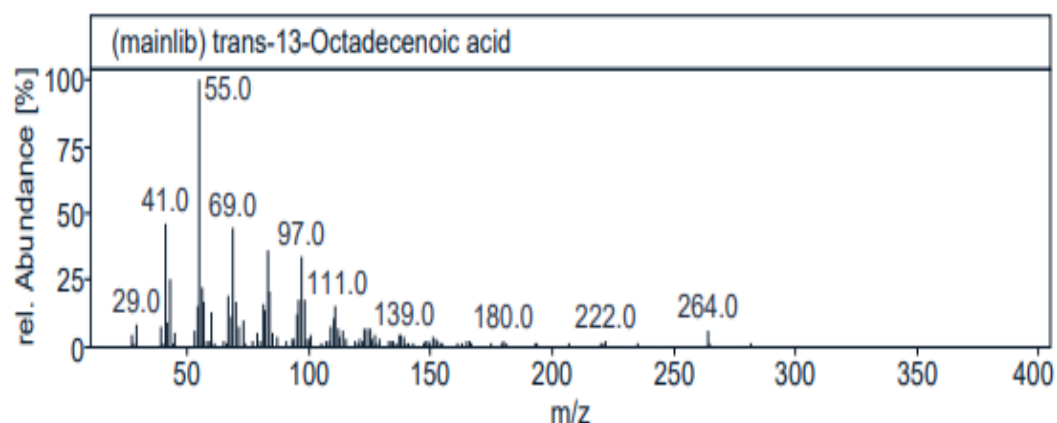
55.1 999 • 73.0 858 • 57.1 659 • 60.0 624 • 69.1 619 • 83.1 475

Summary Hit Table

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
n-Hexadecanoic acid	775	844	13.14	mainlib	57-10-3	9946

Fig.5.4. Represents n-Hexadecanoic acid

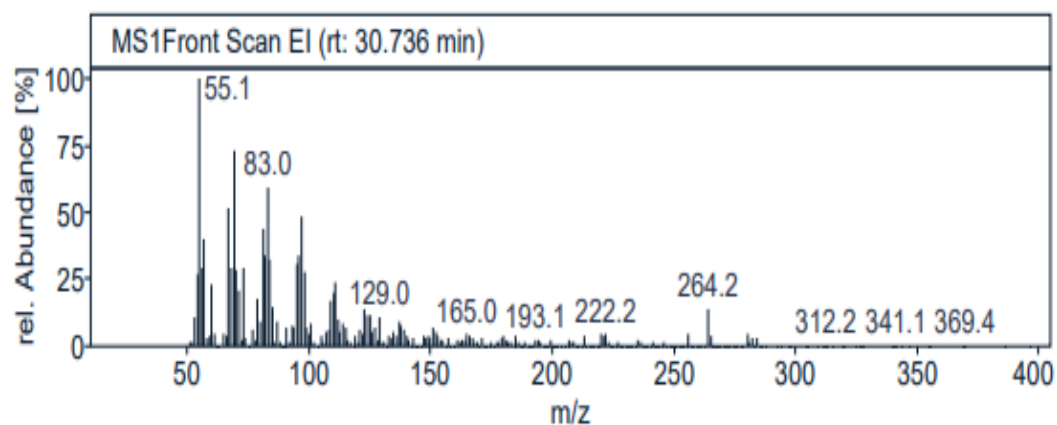
Peak @ 30.732 Area 190163838.132 Area % 54.82



Ion Table

55.0 999 • 41.0 463 • 69.0 448 • 83.0 362 • 97.0 333 • 43.0 248

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
trans-13-Octadecenoic acid	892	901	18.36	mainlib	693-71-0	20916



Ion Table

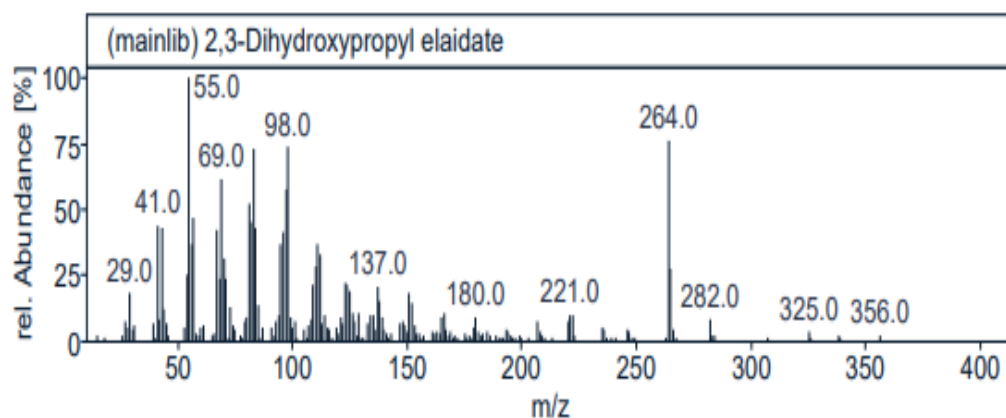
55.1 999 • 69.1 729 • 83.0 594 • 67.0 514 • 97.1 485 • 81.0 438

Summary Hit Table

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
trans-13-Octadecenoic acid	892	901	18.36	mainlib	693-71-0	20916

Fig.5.5. Represents trans-13-Octadecenoic acid

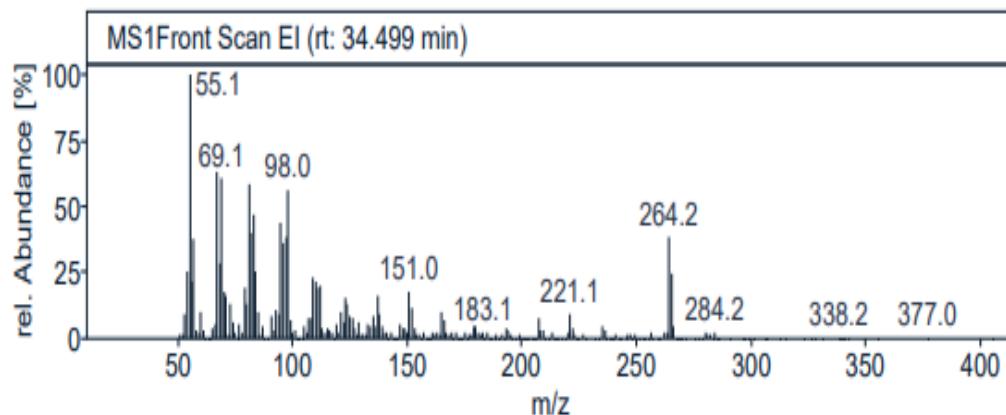
Peak @ 34.504 Area 3428265.991 Area % 0.99



Ion Table

55.0 999 • 264.0 761 • 98.0 738 • 83.0 728 • 69.0 611 • 97.0 573

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
2,3-Dihydroxypropyl elaidate	868	871	13.94	mainlib	2716-53-2	23542



Ion Table

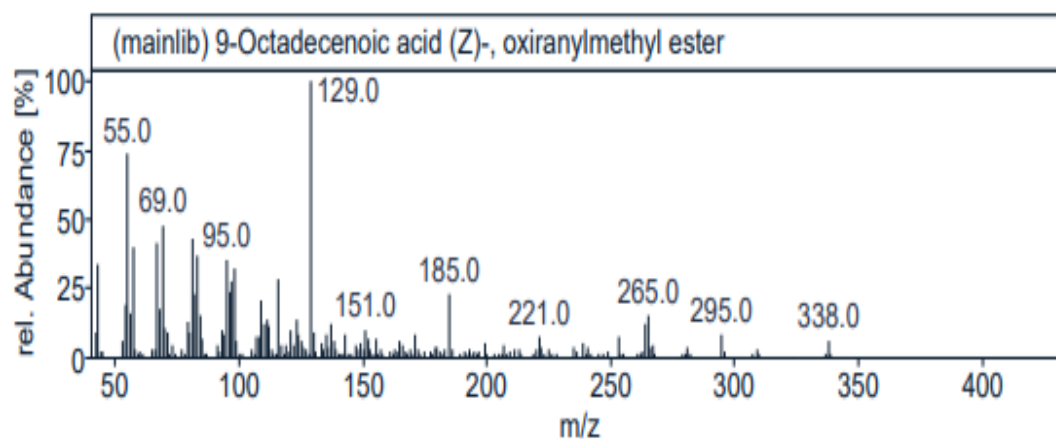
55.1 999 • 67.0 629 • 69.1 611 • 81.0 582 • 98.0 560 • 83.0 470

Summary Hit Table

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
2,3-Dihydroxypropyl elaidate	868	871	13.94	mainlib	2716-53-2	23542

Fig.5.6. Represents 2,3-Dihydroxypropyl elaidate

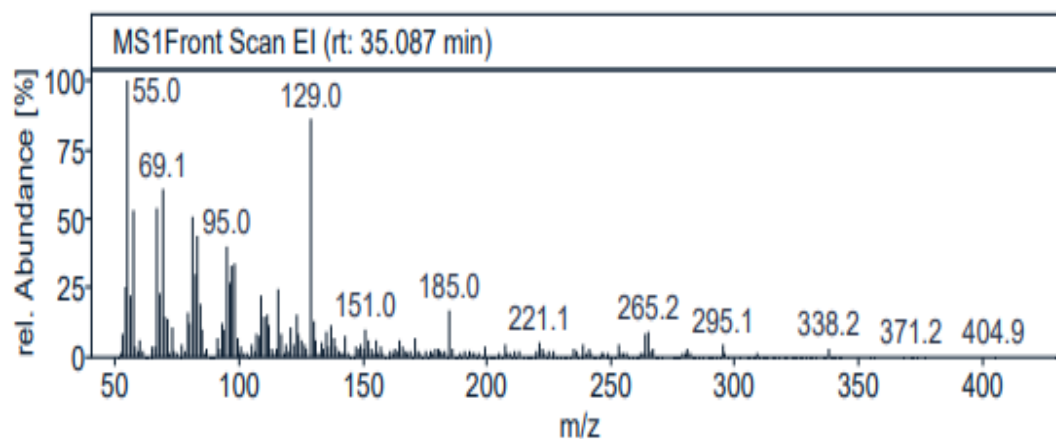
Peak @ 35.090 Area 9011893.615 Area % 2.60



Ion Table

129.0 999 • 55.0 741 • 69.0 473 • 81.0 426 • 67.0 414 • 57.0 399

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
9-Octadecenoic acid (Z)-, oxiranylmethyl ester	926	940	79	mainlib	5431-33-4	123490



Ion Table

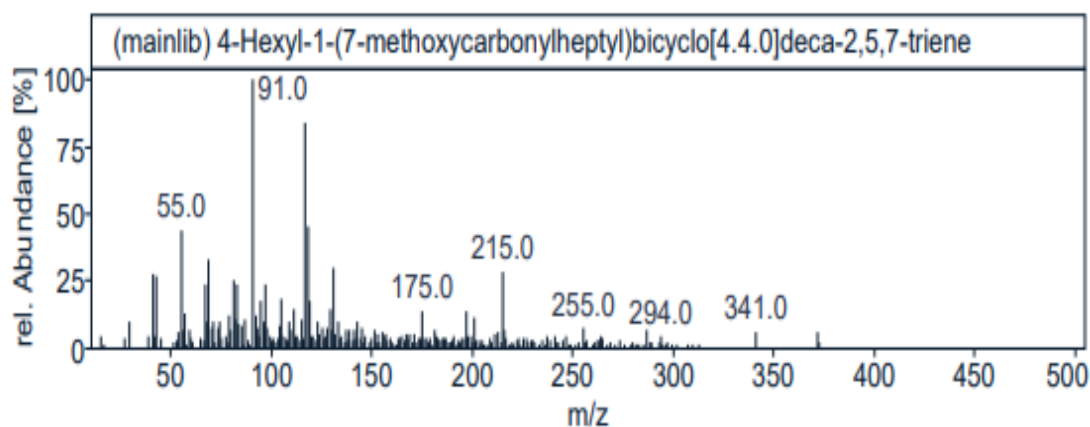
55.0 999 • 129.0 863 • 69.1 611 • 67.0 541 • 57.1 526 • 81.0 509

Summary Hit Table

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
9-Octadecenoic acid (Z)-, oxiranylmethyl ester	926	940	79	mainlib	5431-33-4	123490

Fig.5.7. Represents 9-Octadecenoic acid (Z)-, oxiranylmethyl ester

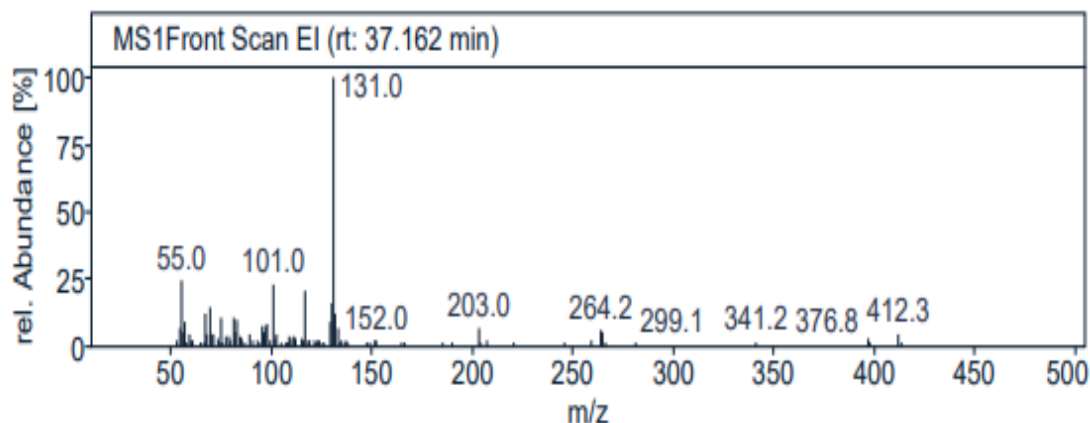
Peak @ 37.165 Area 3999875.537 Area % 1.15



Ion Table

91.0 999 • 117.0 836 • 118.0 449 • 55.0 437 • 69.0 325 • 131.0 300

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
4-Hexyl-1-(7-methoxycarbonylheptyl)bicyclo[4.4.0]deca-2,5,7	618	648	24.53	mainlib		66959



Ion Table

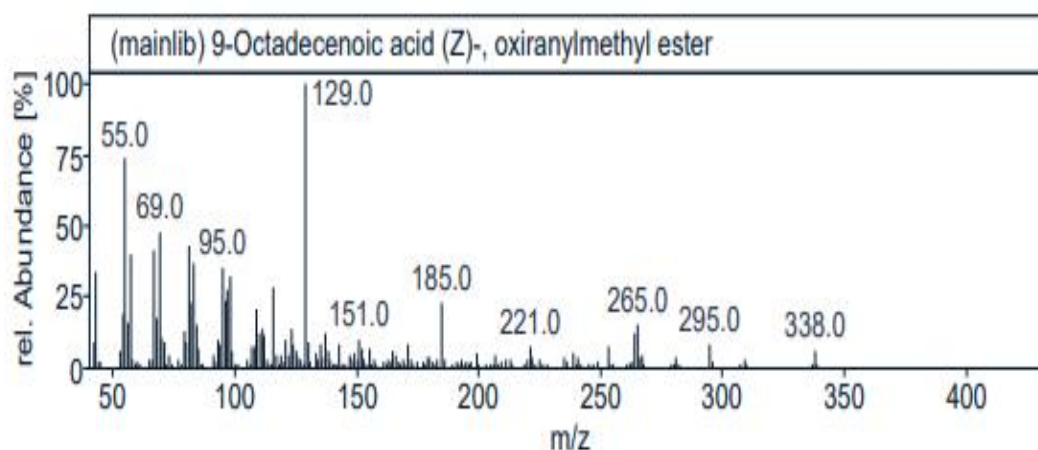
131.0 999 • 55.0 244 • 101.0 224 • 117.0 209 • 130.0 161 • 69.1 147

Summary Hit Table

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
4-Hexyl-1-(7-methoxycarbonylheptyl)bicyclo[4.4.0]deca-2,5,7	618	648	24.53	mainlib		66959

Fig.5.8. Represents 4-Hexyl-1-(7-methoxycarbonylheptyl)bicyclo[4.4.0]deca-2,5,7-triene

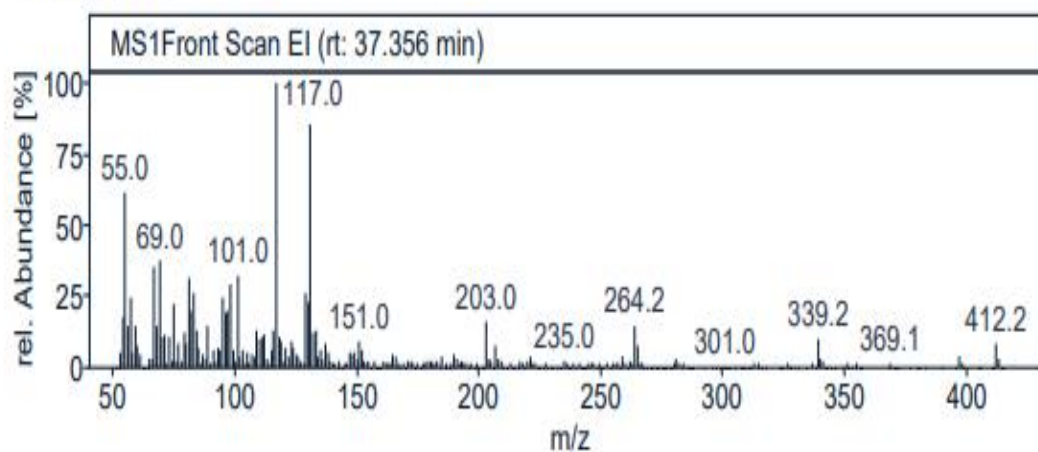
Peak @ 37.355 Area 4589509.652 Area % 1.32



Ion Table

129.0 999 • 55.0 741 • 69.0 473 • 81.0 426 • 67.0 414 • 57.0 399

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
9-Octadecenoic acid (Z)-, oxiranylmethyl ester	697	758	19.3	mainlib	5431-33-4	123490



Ion Table

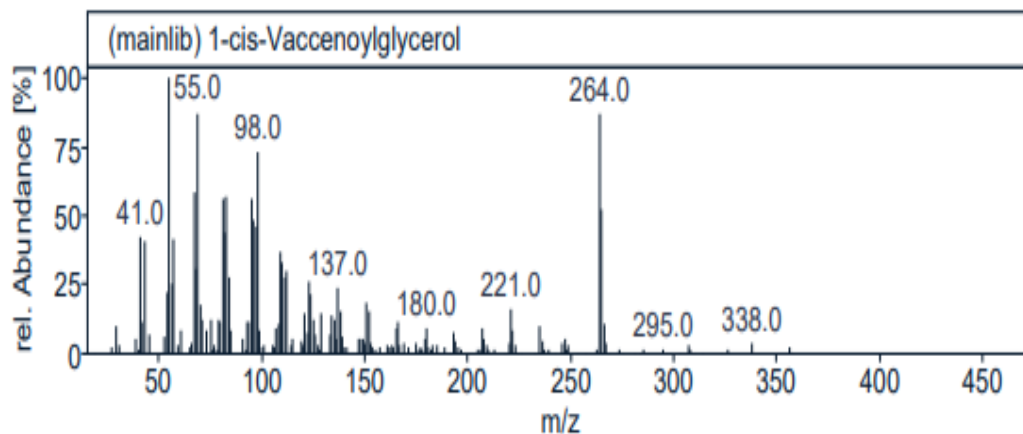
117.0 999 • 131.0 852 • 55.0 614 • 69.0 372 • 67.0 350 • 101.0 324

Summary Hit Table

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
9-Octadecenoic acid (Z)-, oxiranylmethyl ester	697	758	19.3	mainlib	5431-33-4	123490

Fig.5.9. Represents 9-Octadecenoic acid (Z)-, oxiranylmethyl ester

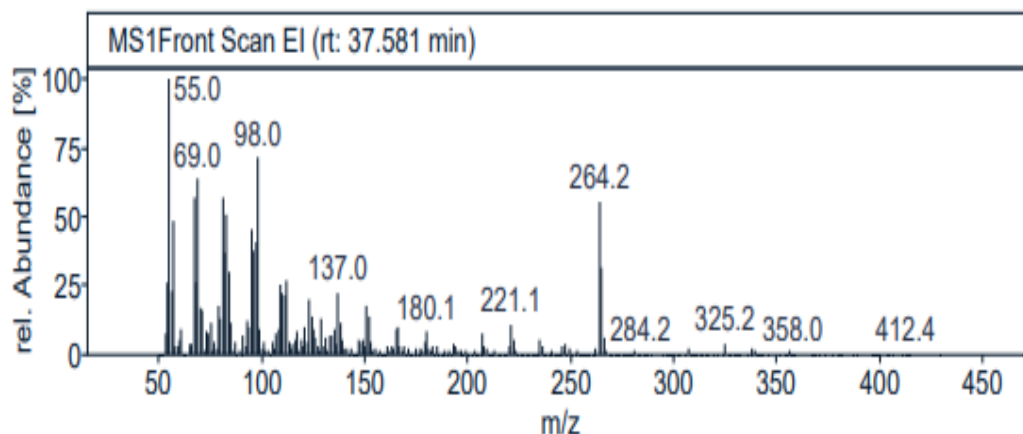
Peak @ 37.579 Area 24316170.431 Area % 7.01



Ion Table

55.0 999 • 69.0 872 • 264.0 872 • 98.0 734 • 67.0 582 • 83.0 568

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
1-cis-Vaccenoylglycerol	890	930	22.59	mainlib	20379-67-3	21959



Ion Table

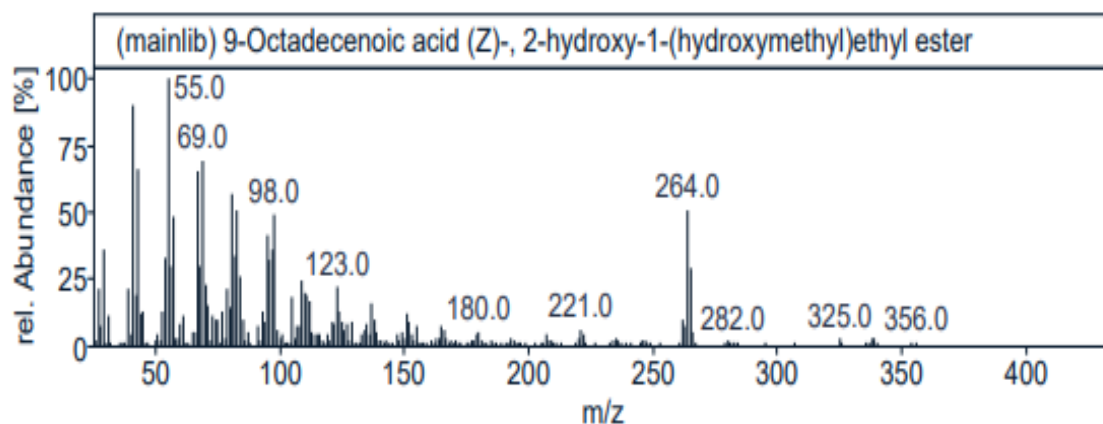
55.0 999 • 98.0 719 • 69.0 642 • 67.0 569 • 81.0 568 • 264.2 556

Summary Hit Table

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
1-cis-Vaccenoylglycerol	890	930	22.59	mainlib	20379-67-3	21959

Fig.5.10. Represents 1-cis-Vaccenoylglycerol

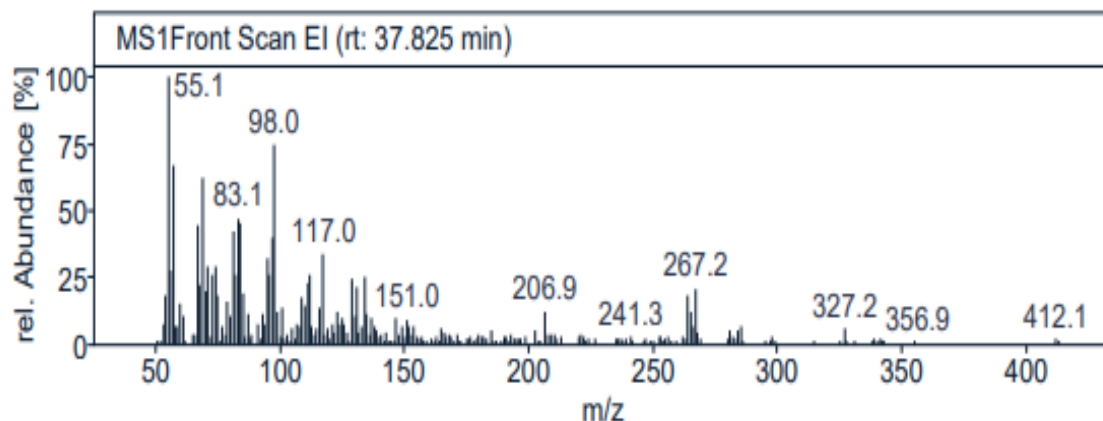
Peak @ 37.825 Area 2898434.661 Area % 0.84



Ion Table

55.0 999 • 41.0 900 • 69.0 690 • 43.0 660 • 67.0 650 • 81.0 570

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
9-Octadecenoic acid (Z)-, 2-hydroxy-1-(hydroxymethyl)ethyl	774	830	16.68	mainlib	3443-84-3	20887



Ion Table

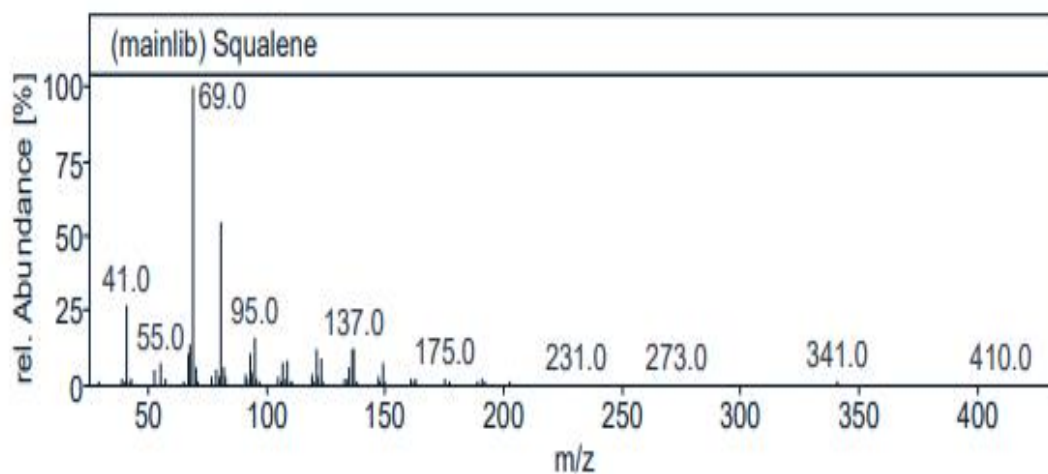
55.1 999 • 98.0 748 • 57.0 670 • 69.0 624 • 83.1 464 • 84.0 449

Summary Hit Table

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
9-Octadecenoic acid (Z)-, 2-hydroxy-1-(hydroxymethyl)ethyl	774	830	16.68	mainlib	3443-84-3	20887

Fig.5.11. Represents 9-Octadecenoic acid (Z)-, 2-hydroxy-1-(hydroxymethyl)ethyl ester

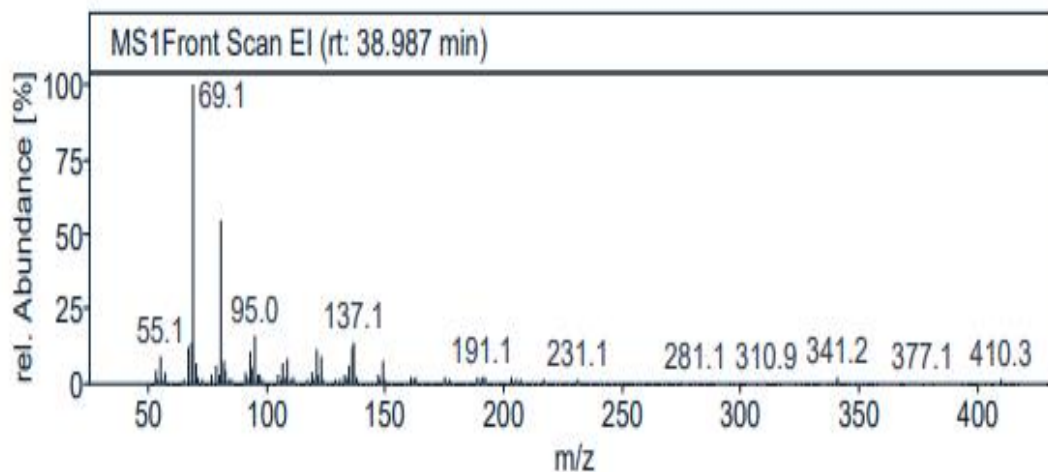
Peak @ 38.986 Area 5421085.161 Area % 1.56



Ion Table

69.0 999 • 81.0 545 • 41.0 264 • 95.0 155 • 68.0 134 • 121.0 121

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
Squalene	900	929	52.41	mainlib	111-02-4	38134



Ion Table

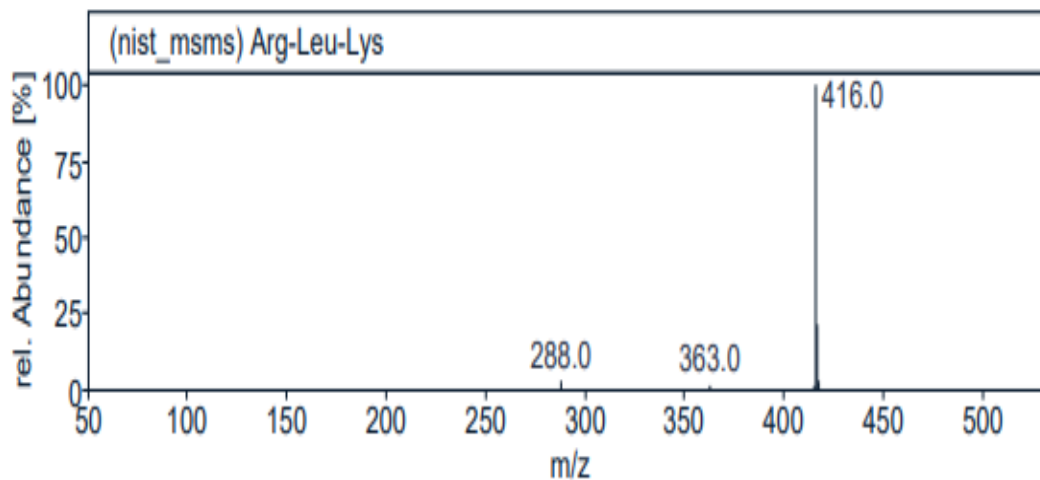
69.1 999 • 81.0 545 • 95.0 161 • 68.1 136 • 137.1 132 • 67.0 120

Summary Hit Table

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
Squalene	900	929	52.41	mainlib	111-02-4	38134

Fig.5.12. Represents Squalene

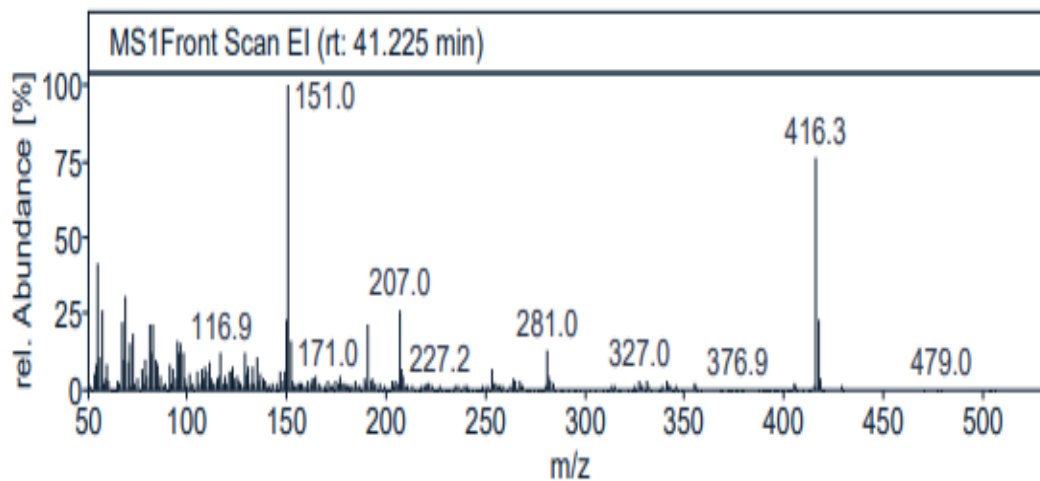
Peak @ 41.223 Area 824544.790 Area % 0.24



Ion Table

416.0 999 • 417.0 209 • 288.0 29 • 418.0 24 • 415.0 11 • 363.0 10

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
Arg-Leu-Lys	738	926	27.66	nist_msms		55844



Ion Table

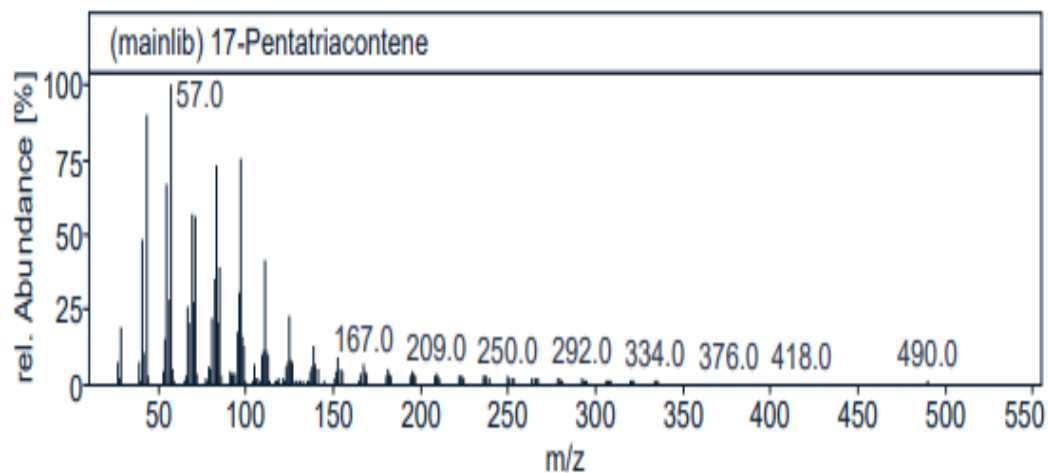
151.0 999 • 416.3 758 • 55.0 417 • 69.1 306 • 207.0 260 • 57.1 259

Summary Hit Table

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
Arg-Leu-Lys	738	926	27.66	nist_msms		55844

Fig.5.13. Represents Arg-Leu-Lys

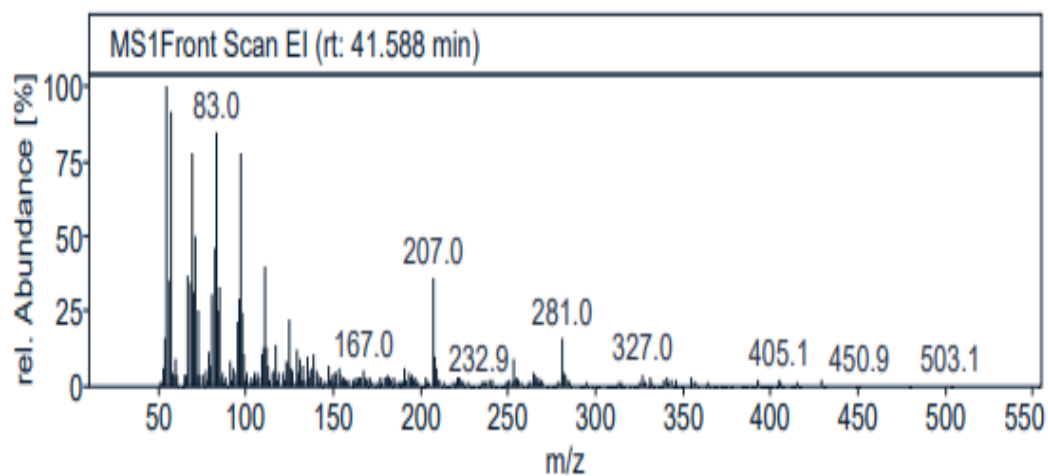
Peak @ 41.588 Area 1324957.093 Area % 0.38



Ion Table

57.0 999 • 43.0 904 • 97.0 751 • 83.0 727 • 55.0 666 • 69.0 569

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
17-Pentatriacontene	749	773	13.68	mainlib	6971-40-0	26388



Ion Table

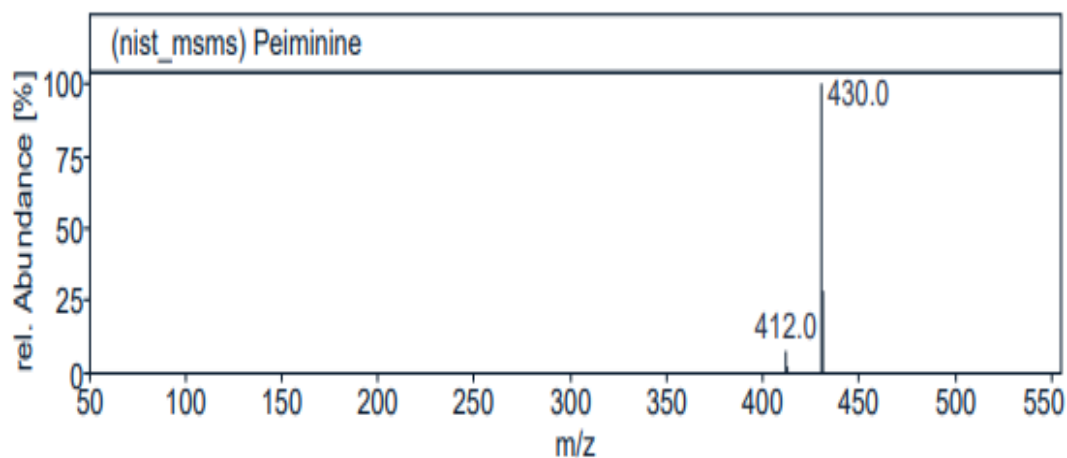
55.0 999 • 57.1 915 • 83.0 847 • 69.1 780 • 97.0 775 • 71.0 502

Summary Hit Table

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
17-Pentatriacontene	749	773	13.68	mainlib	6971-40-0	26388

Fig.5.14. Represents 17-Pentatriacontene

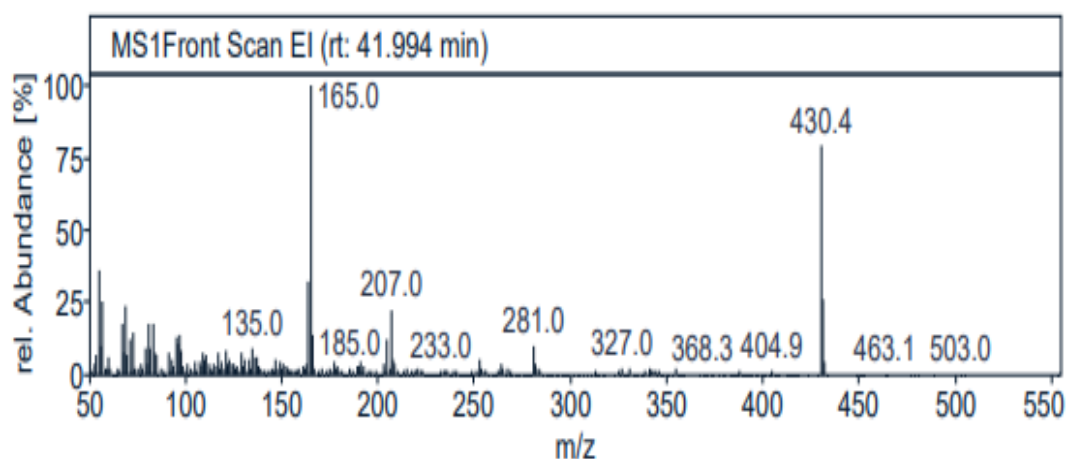
Peak @ 41.993 Area 1313949.972 Area % 0.38



Ion Table

430.0 999 • 431.0 285 • 412.0 77 • 413.0 21 • 432.0 3

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
Peiminine	786	813	72.34	nist_msms	18059-10-4	219010



Ion Table

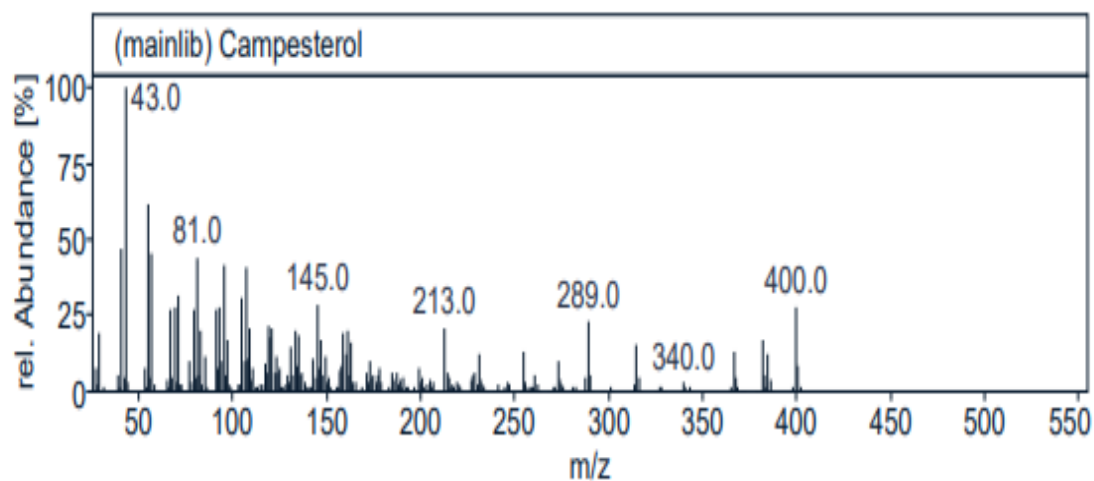
165.0 999 • 430.4 794 • 55.0 361 • 164.0 319 • 431.4 259 • 57.1 250

Summary Hit Table

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
Peiminine	786	813	72.34	nist_msms	18059-10-4	219010

Fig.5.15. Represents Peiminine

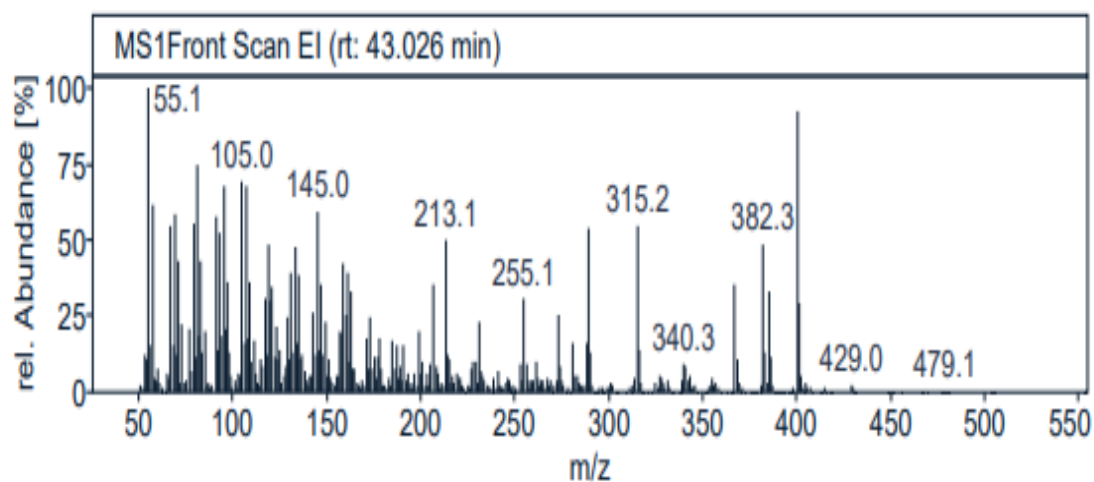
Peak @ 43.024 Area 9154520.253 Area % 2.64



Ion Table

43.0 999 • 55.0 617 • 41.0 470 • 57.0 452 • 81.0 436 • 95.0 414

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
Campesterol	890	909	62.45	mainlib	474-62-4	7617



Ion Table

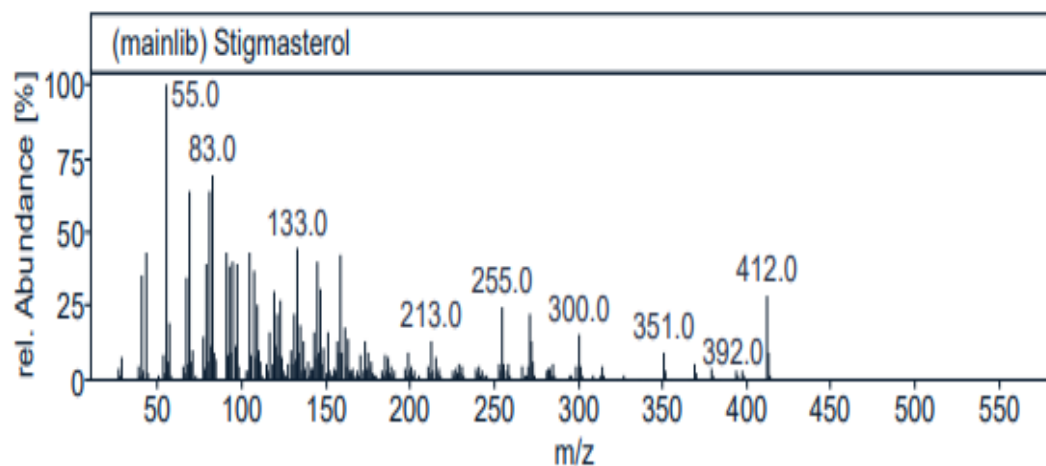
55.1 999 • 400.3 924 • 81.0 742 • 105.0 690 • 95.1 677 • 107.0 676

Summary Hit Table

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
Campesterol	890	909	62.45	mainlib	474-62-4	7617

Fig.5.16. Represents Campesterol

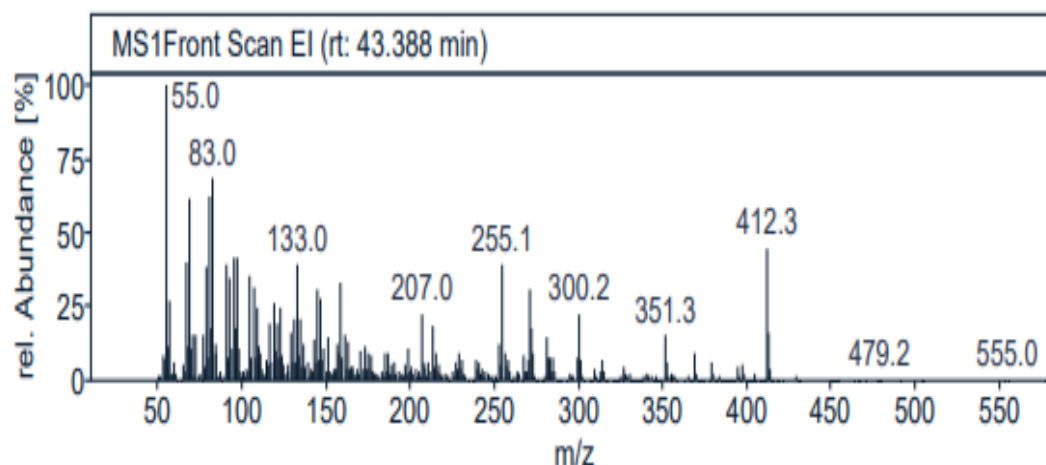
Peak @ 43.386 Area 7411297.391 Area % 2.14



Ion Table

55.0 999 • 83.0 692 • 81.0 638 • 69.0 636 • 133.0 444 • 43.0 431

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
Stigmasterol	882	915	75.83	mainlib	83-48-7	22487



Ion Table

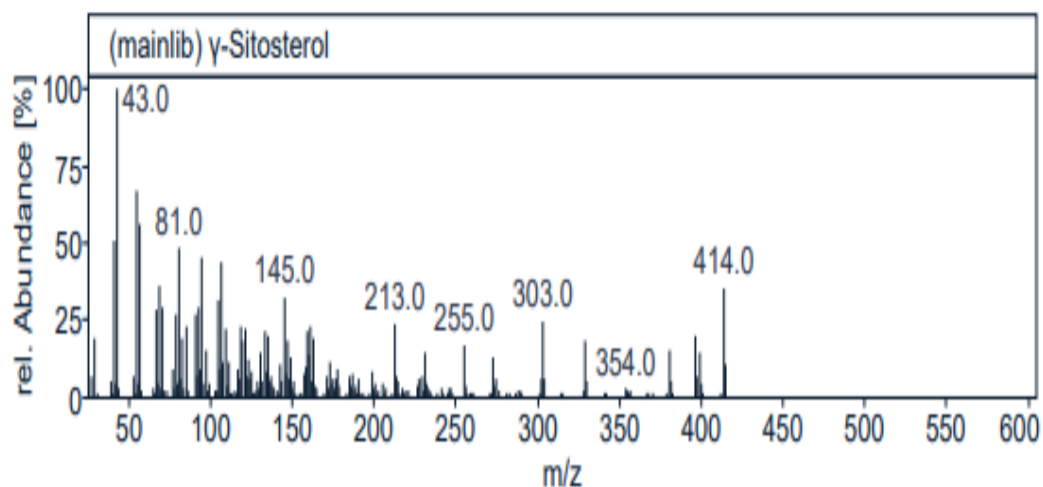
55.0 999 • 83.0 683 • 81.0 621 • 69.0 616 • 412.3 442 • 95.1 411

Summary Hit Table

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
Stigmasterol	882	915	75.83	mainlib	83-48-7	22487

Fig.5.17. Represents Stigmasterol

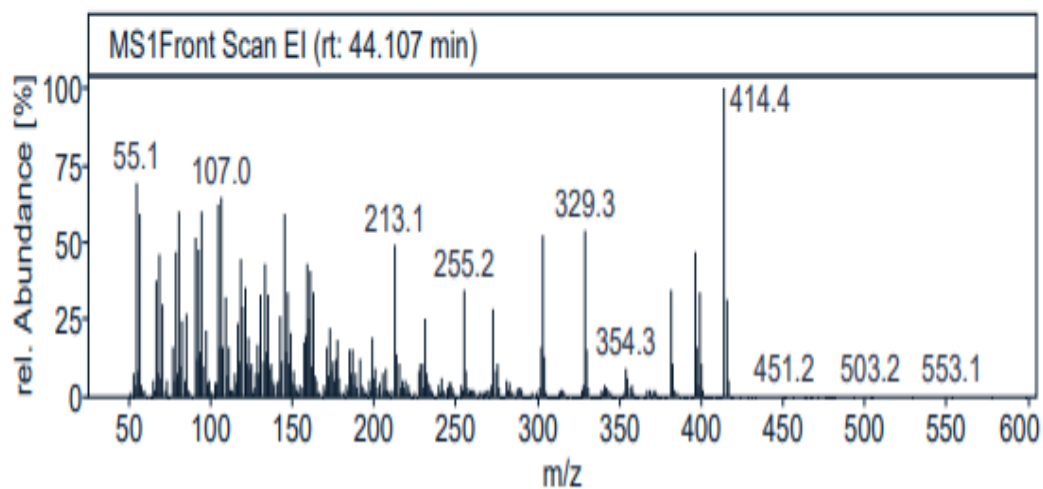
Peak @ 44.105 Area 36152178.347 Area % 10.42



Ion Table

43.0 999 • 55.0 667 • 57.0 563 • 41.0 507 • 81.0 481 • 95.0 449

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
γ -Sitosterol	927	933	75.45	mainlib	83-47-6	7753



Ion Table

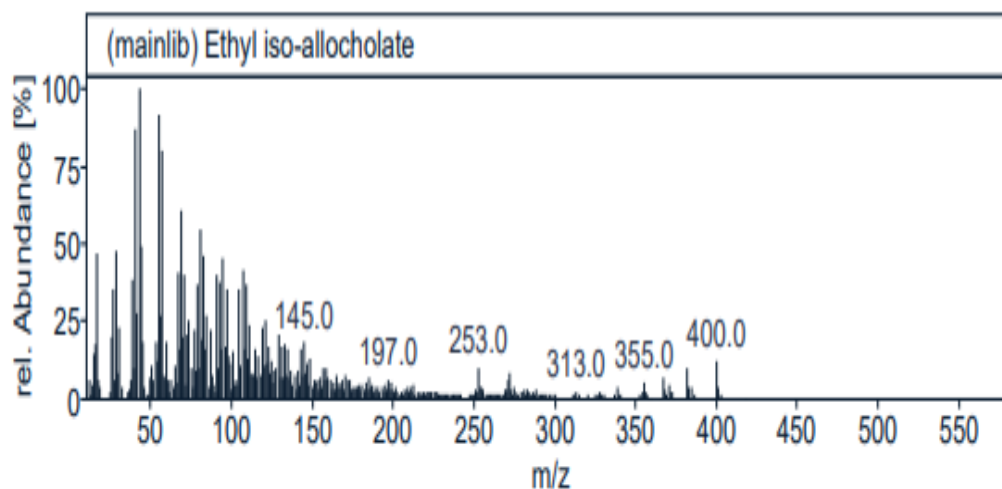
414.4 999 • 55.1 692 • 107.0 643 • 105.0 626 • 95.1 601 • 81.0 599

Summary Hit Table

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
γ -Sitosterol	927	933	75.45	mainlib	83-47-6	7753

Fig.5.18. Represents γ -Sitosterol

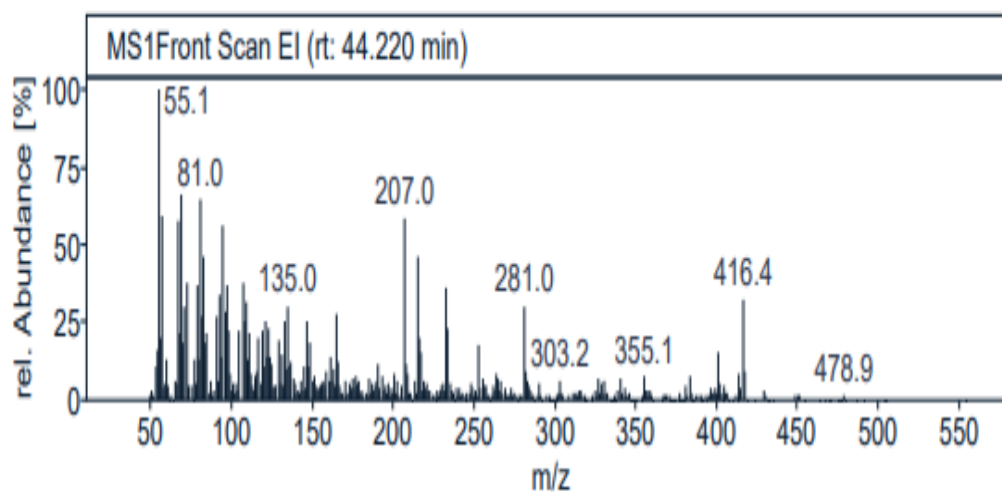
Peak @ 44.219 Area 1448042.367 Area % 0.42



Ion Table

43.0 999 • 55.0 914 • 41.0 867 • 57.0 797 • 69.0 609 • 81.0 547

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
Ethyl iso-allocholate	728	772	18.18	mainlib		7555



Ion Table

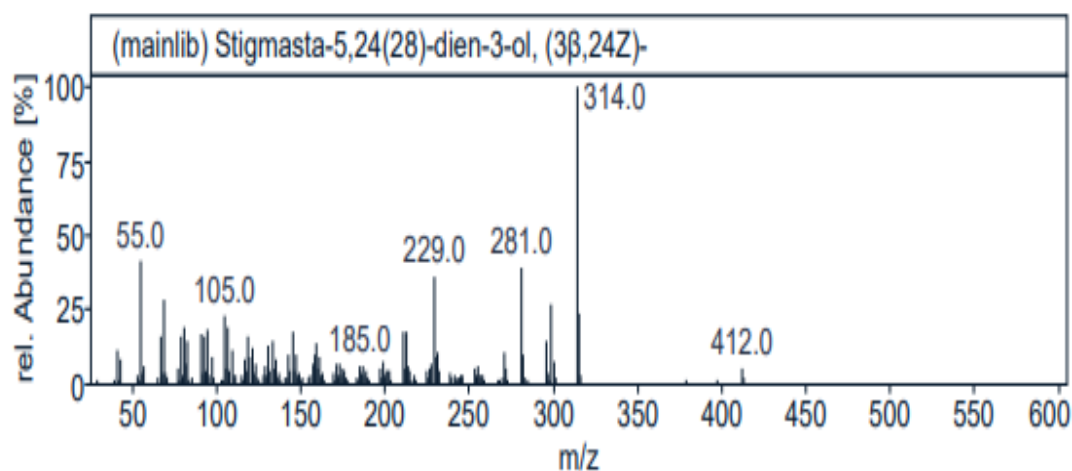
55.1 999 • 69.1 664 • 81.0 643 • 57.1 593 • 207.0 587 • 67.0 579

Summary Hit Table

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
Ethyl iso-allocholate	728	772	18.18	mainlib		7555

Fig.5.19. Represents Ethyl iso-allocholate

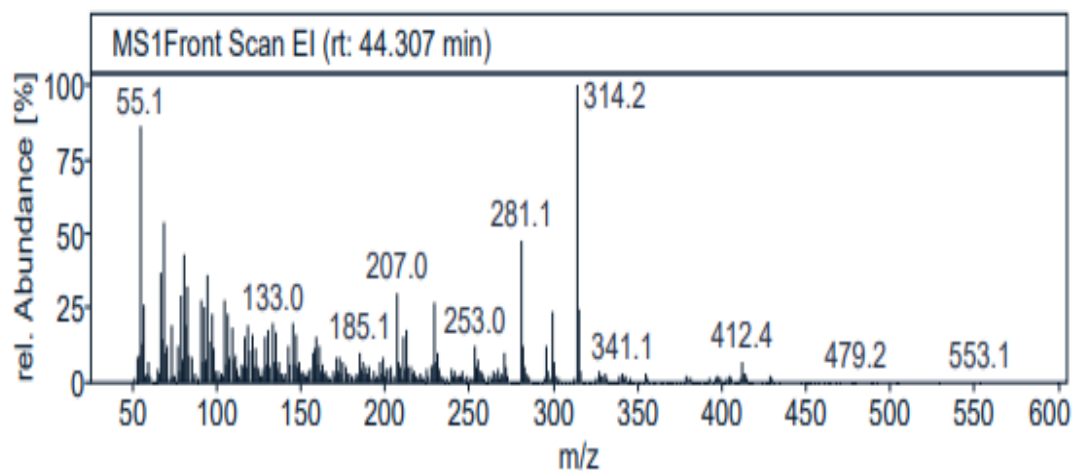
Peak @ 44.302 Area 4297763.231 Area % 1.24



Ion Table

314.0 999 • 55.0 416 • 281.0 388 • 229.0 361 • 69.0 284 • 299.0 268

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
Stigmasta-5,24(28)-dien-3-ol, (3 β ,24Z)-	827	913	32.66	mainlib	481-14-1	251023



Ion Table

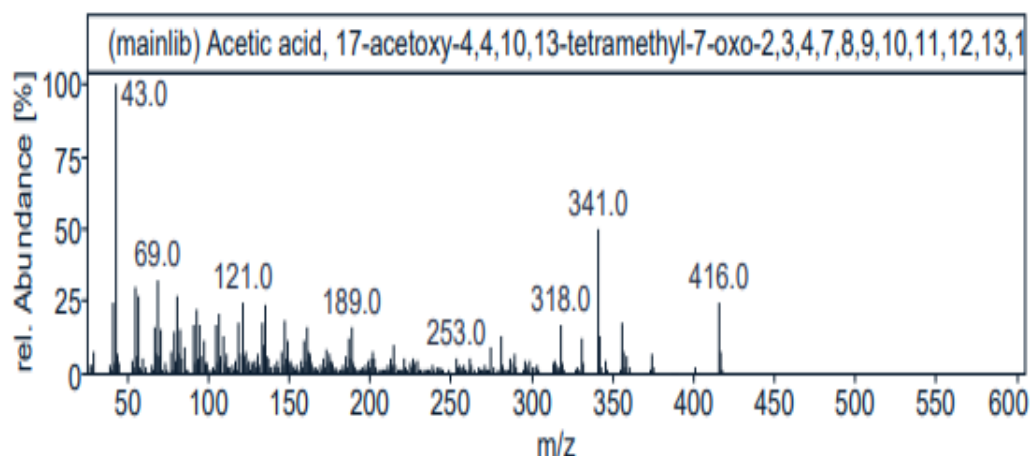
314.2 999 • 55.1 860 • 69.0 535 • 281.1 473 • 81.0 432 • 67.0 370

Summary Hit Table

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
Stigmasta-5,24(28)-dien-3-ol, (3 β ,24Z)-	827	913	32.66	mainlib	481-14-1	251023

Fig.5.20. Represents Stigmasta-5,24(28)-dien-3-ol, (3 β ,24Z)-

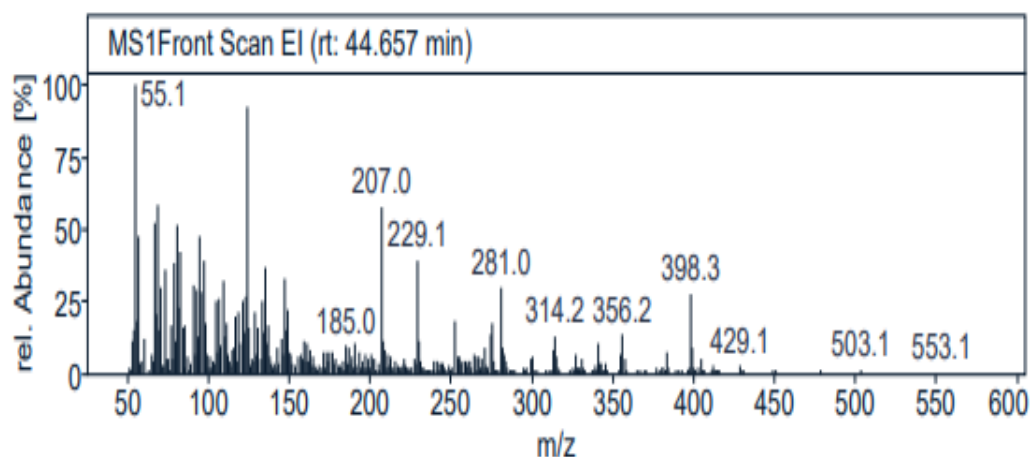
Peak @ 44.653 Area 2218798.365 Area % 0.64



Ion Table

43.0 999 • 341.0 495 • 69.0 319 • 55.0 299 • 57.0 265 • 81.0 265

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
Acetic acid, 17-acetoxy-4,4,10,13-tetramethyl-7-oxo-2,3,4,7	701	743	19.66	mainlib		15934



Ion Table

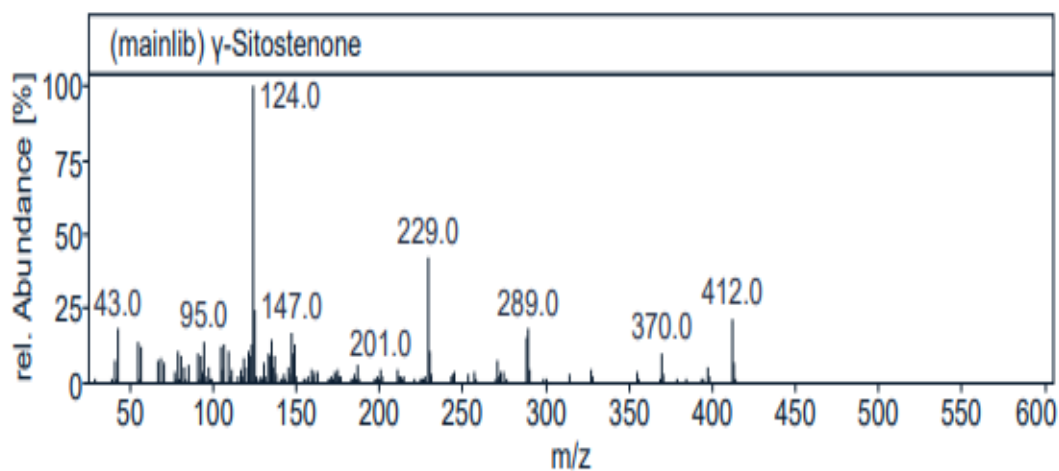
55.1 999 • 124.0 923 • 69.0 581 • 207.0 578 • 67.0 520 • 81.0 517

Summary Hit Table

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
Acetic acid, 17-acetoxy-4,4,10,13-tetramethyl-7-oxo-2,3,4,7	701	743	19.66	mainlib		15934

Fig.5.21. Represents Acetic acid, 17-acetoxy-4,4,10,13-tetramethyl-7-oxo-2,3,4,7,8,9,10,11,12,13,14,15,16,17

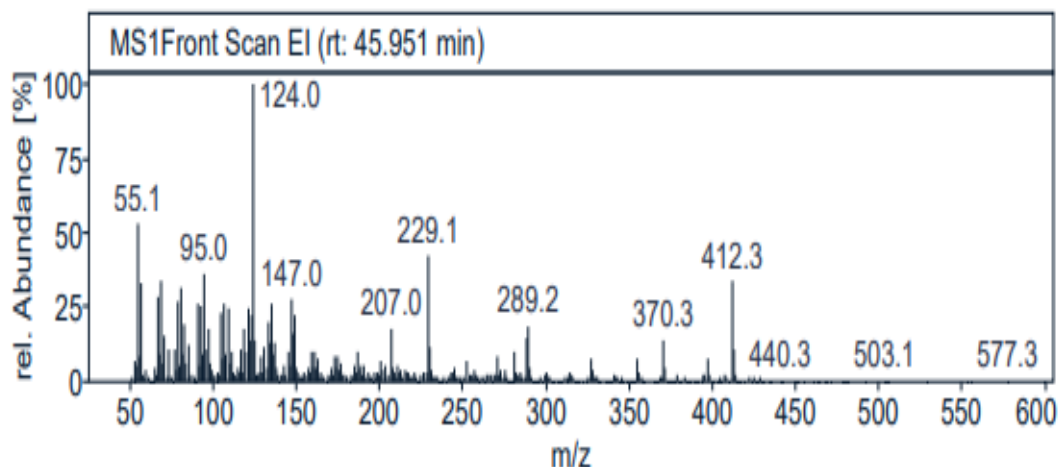
Peak @ 45.954 Area 9616250.648 Area % 2.77



Ion Table

124.0 999 • 229.0 422 • 125.0 243 • 412.0 215 • 289.0 182 • 43.0 181

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
γ -Sitostenone	812	927	62.58	mainlib	84924-96-9	118906



Ion Table

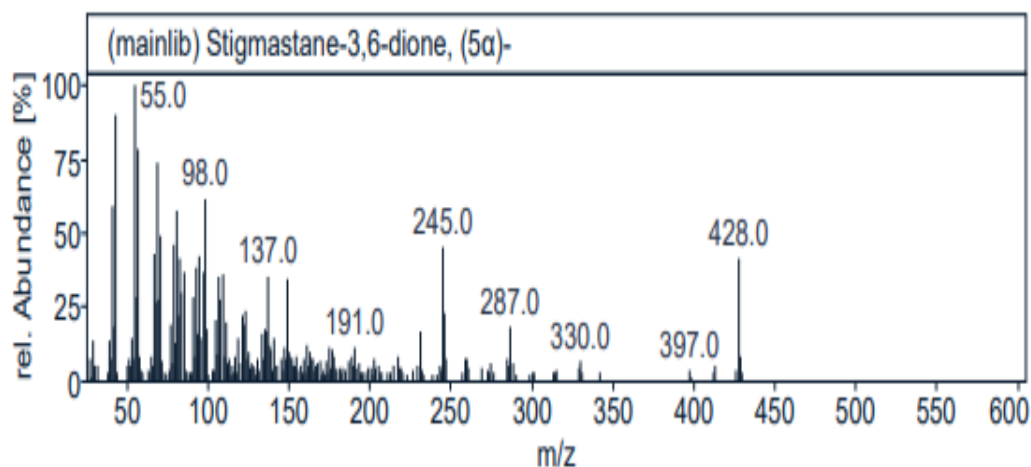
124.0 999 • 55.1 529 • 229.1 423 • 95.0 358 • 412.3 339 • 69.1 339

Summary Hit Table

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
γ -Sitostenone	812	927	62.58	mainlib	84924-96-9	118906

Fig.5.22. Represents γ -Sitostenone

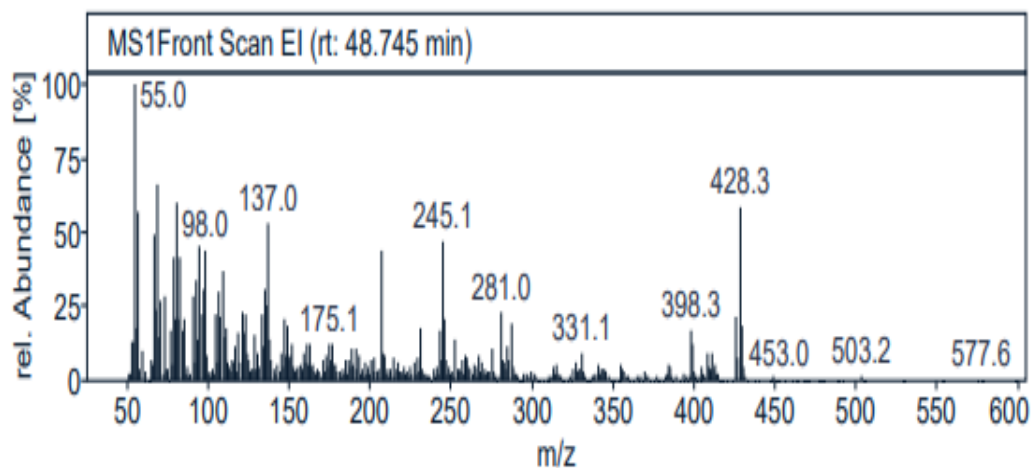
Peak @ 40.740 Area 9690570.930 Area % 2.79



Ion Table

55.0 999 • 43.0 902 • 57.0 786 • 69.0 740 • 98.0 615 • 41.0 594

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
Stigmastane-3,6-dione, (5 α)-	743	878	30.33	mainlib	22149-69-5	21290



Ion Table

55.0 999 • 69.1 660 • 81.0 597 • 428.3 587 • 57.1 569 • 137.0 533

Summary Hit Table

Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
Stigmastane-3,6-dione, (5 α)-	743	878	30.33	mainlib	22149-69-5	21290

Fig.5.23. Represents Stigmastane-3,6-dione, (5 α)-

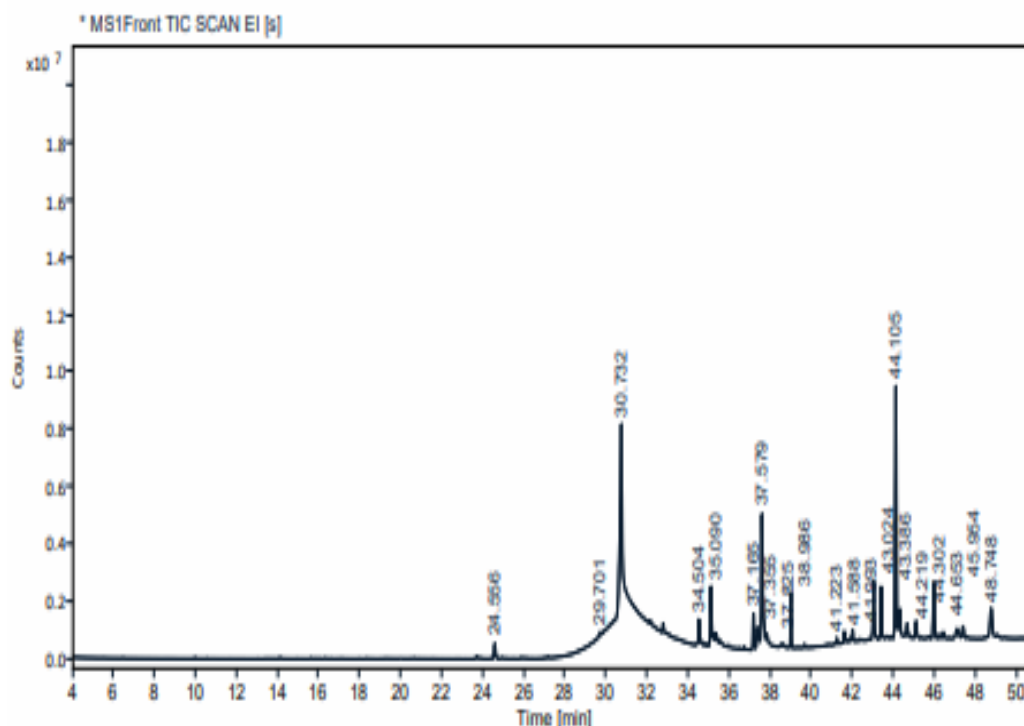


Fig. 5.24. GC-MS analysis of carica papaya

S: No	Retention time	Name of the compound	Molecular weight	Molecular formula	Peak area	%
01	24.554	Phthalic acid, hex-3-yl isobutyl ester	320.4	C ₁₉ H ₂₈ O ₄	2714468	0.78
02	29.705	n-Hexadecanoic acid	256.42	C ₁₆ H ₃₂ O	16886208	4.87
03	30.736	trans-13-Octadecenoic acid	282.5	C ₁₈ H ₃₄ O ₂	19016388	54.82
04	34.499	2,3-Dihydroxypropyl elaidate	356.5	C ₂₁ H ₄₀ O ₄	3428265	0.99
05	35.087	9-Octadecenoic acid (Z)-,	338.5	C ₂₁ H ₃₈ O ₃	9011893	2.60

		oxiranylmethyl ester				
06	37.162	4-Hexyl-1-(7-methoxy carbonylheptyl) bicyclo[4.4.0]deca-2,5,7-triene	372.6	C ₂₅ H ₄₀ O ₂	3999875	1.15
07	37.356	9-Octadecenoic acid (Z)-, oxiranylmethyl ester	338.5	C ₂₁ H ₃₈ O ₃	4589509	1.32
08	37.581	1-cis-Vaccenoylglycero	356.5	C ₂₁ H ₄₀ O ₄	2431617 0	7.01
09	37.825	9-Octadecenoic acid (Z)-, 2-hydroxy-1-(hydroxymethyl)ethyl ester	356.5	C ₂₁ H ₄₀ O ₄	2898434	0.84
10	38.987	Squalene	410.7	C ₃₀ H ₅₀	5421085	1.56
11	41.225	Arg-Leu-Lys	415.5	C ₁₈ H ₃₇ N ₇ O 4	824544	0.24
12	41.588	17-Pentatriacontene	490.9	C ₃₅ H ₇₀	1324957	0.38
13	41.994	Peiminine	429.6	C ₂₇ H ₄₃ NO ₃	1313949	0.38
14	43.026	Campesterol	400.7	C ₂₈ H ₄₈ O	9154520	2.64
15	43.388	Stigmasterol	412.7	C ₂₉ H ₄₈ O	7411297	2.14
16	44.107	γ-Sitosterol	414.7	C ₂₉ H ₅₀ O	3615217 8	10.42
17	44.220	Ethyl iso-allocholate	436.6	C ₂₆ H ₄₄ O ₅	1448042	0.42
18	44.307	Stigmasta-5,24(28)-dien-3-ol, (3β,24Z)-	412.6	C ₂₉ H ₄₈ O	4297763	1.24
19	44.657	Acetic acid, 17-acetoxy-4,4,10,13-tetramethyl-7-oxo-2,3,4,7,8,9,10,11,12,13,14,15,16,17	416.6	C ₂₅ H ₃₆ O ₅	2218798	0.64
20	45.951	γ-Sitostenone	412.6	C ₂₉ H ₄₈ O	9616250	2.77

21	48.745	Stigmastane-3,6-dione, (5 α)-	428.7	C ₂₉ H ₄₈ O ₂	9690570	2.79
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Table 5.4. List of fatty acids present in the given sample

From the Table 5.4. The retention time, molecular weight, molecular formula, peak area and its percentage was observed. Since the percentage of the oleic acid was absorbed more this has been used as an application for mineral processing as a reagent.

5.4. FTIR RESULTS

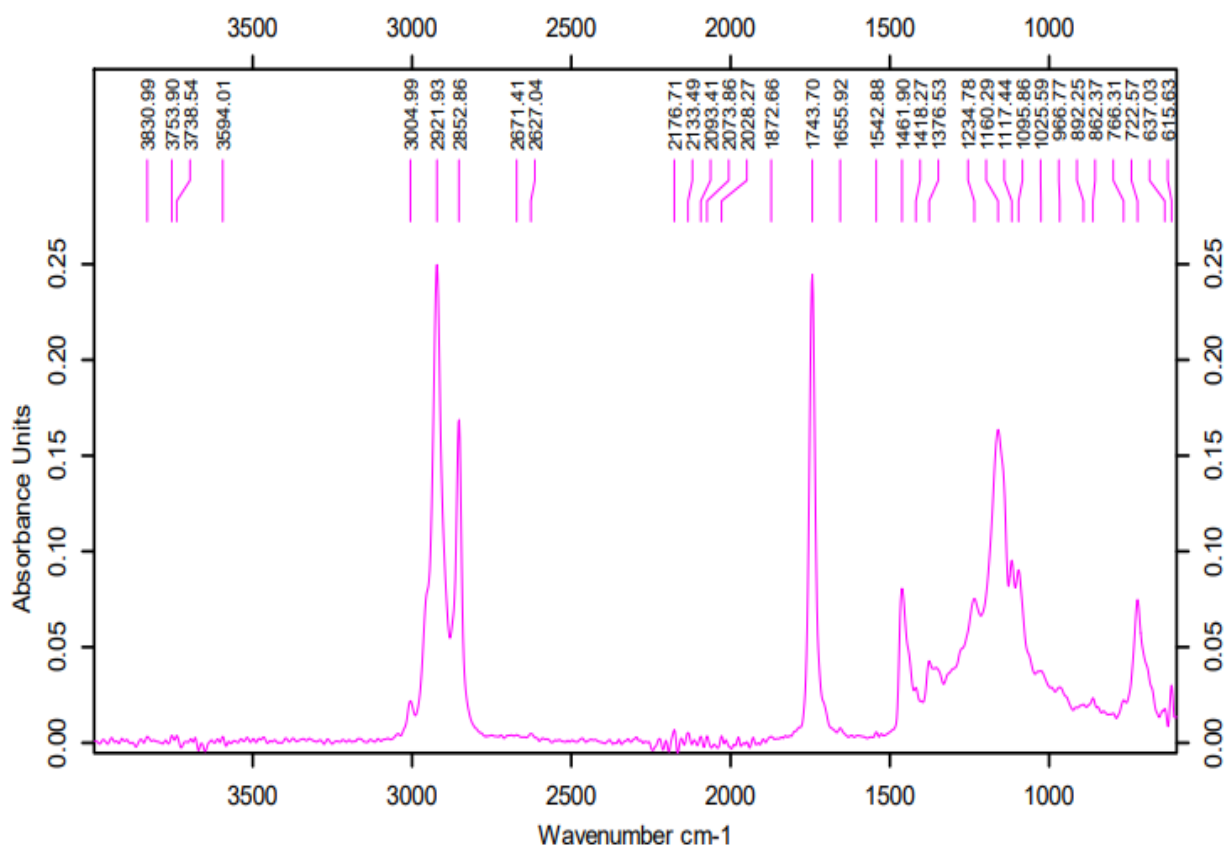


Fig.5.25. Graphical representation of FTIR

The extracted oil sample was subjected for Fourier Transform Infrared Spectroscopy (FTIR) spectrum ranging from 4000 cm⁻¹ to 500 cm⁻¹ to find the functional groups presents in it. The results of the study are given in the figure. It

may be seen that the broad band at 2921 cm^{-1} is due to the stretching mode of the $\text{sp}^3\text{-C-H}$ groups in hydrocarbon. The peak at 2852 cm^{-1} is due to the stretching mode of $\text{sp}^2\text{-C-H}$ groups in hydrocarbon. The peaks at 1743 denotes stretching mode of C=O in amino acids. The peak 1160 cm^{-1} denotes C-O stretching vibration. The peak 722 cm^{-1} denotes methylene group of CH_2 rocking vibration. these are the compound present in the given oil. X-axis denotes the wavenumber (cm^{-1}) and Y-axis denotes the absorbance unit.

5.5. NMR RESULTS

From the ^1H NMR spectra, it can be concluded that the chemical shift value at 0.89 is due to the primary proton, the chemical shift value at 1.25 is due to the secondary proton and the chemical shift value at 1.5 is due to the 3° proton. The chemical shift value at 2.53 is due to the carboxyl group and the chemical shift value at 3.5 is due to the ester/ether linkage and the chemical shift value at 5.35 is due to the vinylic carbon (C=C-H).

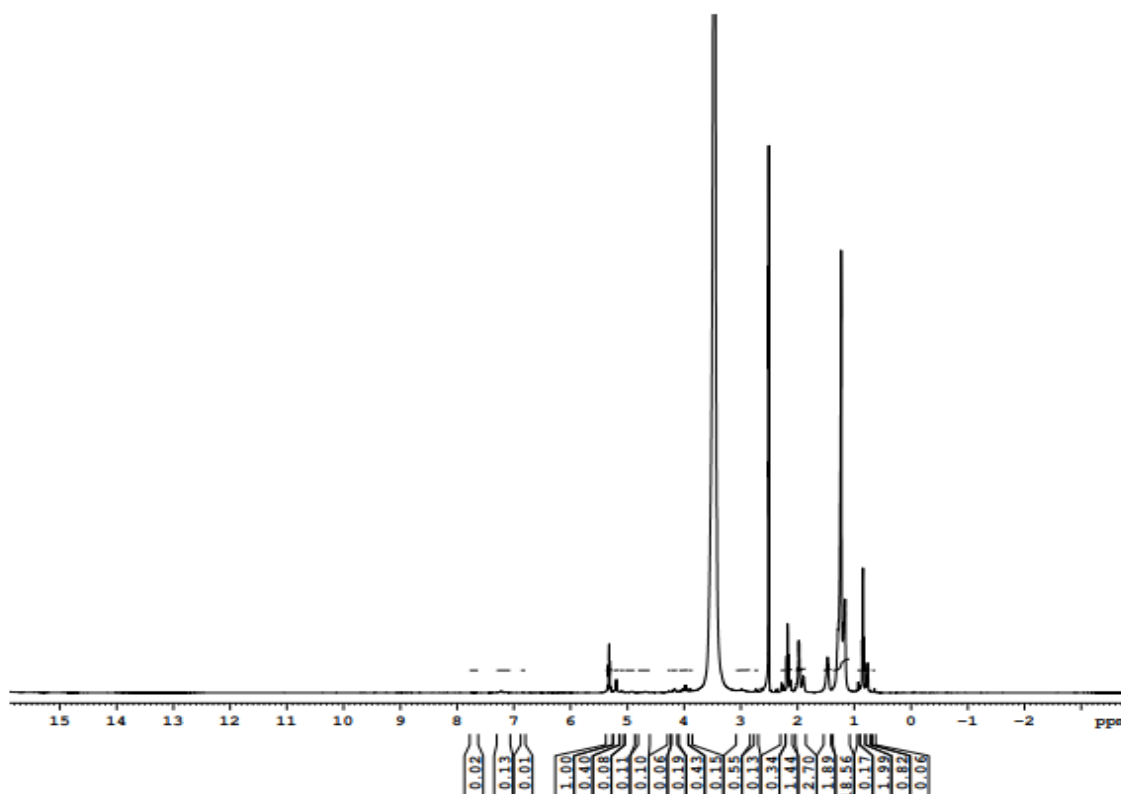


Fig.5.26. Graphical representation of NMR

S.no	Product	While grinding		While flotation		Weight %	Ash %	Ash distribution%
		Time (mins)	Sodium silicate (1%)	Dispersant (Sodium silicate 1%)	Collector (extracted oil)			
1	F	3	37.5	37.5	0.5	48.82	15.03	23.15
2	NF	3	37.5	37.5	0.5	51.17	47.63	76.86
						Head calculated		23.15

Table 5.5. Results for coal flotation

CHAPTER – 6

SUMMARY AND CONCLUSION

The results obtained from the extraction and characterization of the essential oil from aromatic plant have shown the maximum yield of essential oil using Soxhlet extraction method by varying the parameters such as temperature, time and particle size. Soxhlet extraction gave the maximum yield that was achieved at a lesser temperature (75°C) which was capable of giving oil of better quality. Not only the temperature but also the particle size played an important role in exhibiting the maximum yield. At same temperature (75°C), the particle size at - 1mm it gave the highest yield of about 31.7%.

The experimental design and data analysis carried out on Soxhlet extraction method was to represent the extraction process with significance and a reasonable value.

It was also shown by the analysis of variance of the developed model that temperature, time and particle size are the very significant factors on the yield of the oil extraction. The physical and chemical properties values that are obtained from the characterization of the oil revealed that it could be used in different industrial process for the production of other valuable products.

As the large amount of the raw material, which was not used frequently would be required for the large-scale extraction of the oil, thus making this process an advantage for the environmental and waste management sectors of the community.

In the effect of particle size, since the highest yield was at 75°C, in this case the size of the particle was varied by maintaining at 75°C constant. From this the highest yield (31.7%) was at -1mm. This is because as the size is decreased the surface area becomes high, resulting in the highest oil yield.

As the percentage of the oleic acid was absorbed more in GC-MS, this has been used as an application for mineral processing as a reagent. The extracted oil was used as a collector for low grade graphite ore flotation. From GC-MS and

FTIR studies the peaks that contains hydrocarbons, fatty acid and other compounds are well resolved and well aggregated.

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GEO TAGGED IMAGE



This project was done at CSIR-NML and the Geo tagged location is attached above.