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STUDY OF BIOACTIVE COMPONENTS OF N-BUTANOL BY GAS CHROMATOGRAPHY–MASS SPECTROMETRY (GC-MS) IN LEAVES OF *GREWIA TENAX* GROWING IN KACHCHH DISTRICT

[1]*Vijay R. Ram, [1]Mital K. Aadesariya and [2]Suhas J. Vyas

[1]Department of Chemistry, KSKV Kachchh University, Bhuj, Kachchh- 370001.

[2]Department of Life Sciences, Bhakta Kavi Narsinh Mehta University, Junagadh – Gujarat.

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***Corresponding Author**
Dr. Vijay R. Ram
Department of Chemistry,
KSKV Kachchh University,
Bhuj, Kachchh- 370001.

ABSTRACT

Grewia tenax (GT) is the mutual name of Guddaim or Gangeti, a treasured plant species in Kachchh region.Leaves of *G. tenax* are a significant part of the traditional remedy for the use of treatment against tonsillitis infections, trachoma and are used as a compress against inflammation. *Grewia's* extracts are also useful in remedial hepatitis and another such type of diseases. Plant containshigh therapeutic standards. It has been used to treatseveral diseases such as dysentery, fever, rheumatism, diarrhea, anemia, osteoporosis, body weakness nausea, bone fractures, bone strengthening etc. Present study has been carried out on thequalitative and quantitative analysis of the major bioactive components of therapeutically significant plant *Grewia tenax* (GT) leaves by the use of GC-MS, whereas the mass fragment spectra of the compounds was compare with the National Institute of Standards and Technology(NIST) library. The soxhlet extraction of sample was done by use of continuous hot percolation method using n-Butanol as a solvent. After extraction, it was concentrated by using distillation method. Crude n-Butanol extracts were introduced in GC/MS instrument for isolation and identification of valuable phytochemicals. GC-MS analysis hasrevealed the existence of 27 compounds.The result exhibited that there are very significant phytochemicals found in n-Butanol leaves extract of *G. tenax*likeFatty acid, Hydrocarbons, Carbohydrate, Diterpenoid, Diterpenes, Triterpen, Phytosterol, Vitamin E and Steroid compounds.

KEYWORDS: *Grewia tenax*, GC/MS, Phytochemicals, n-Butanol extract, Soxhlet extraction.

1.0 INTRODUCTION

The plant as a medicine are use the most ancient form of therapeutic agent.[1] The ancientuniversal medical systems like Ayurveda, Siddha, Homeopathy etc., are used to treat various diseases.[2] As per the study of WHO, above 85% of the world's population rely on ancient herbaltreatments for their prime healthcare requirements.[3]

Grewia genus belonging to the family *Teliaceae*.[4] *Grewia tenax* (Forssk.) Fiori (GT) known as of Guddaim or Gangeti, a treasured plant species in Kachchh region, adult in the African and Southeast Asian regions.[5,6] *Grewia tenax* is used as a remedy totreatseveral diseases, including jaundice and hepatic disorders.[7] *G. tenax* leaves are useful against of tonsillitis infections, trachoma and as a poultice to treat inflammation.

This work will help to identify the therapeutic value of butanol extract of *G. tenax* leavesby use of GC-MS. Gas chromatography with Mass Spectrum (GC/MS) has been widely usefulunequivocally to recognize the structures of various Phytoconstituents from plant extracts with great achievement.TheGC-MS analysis is a mutualvalidationexperiment. It splits all the parts in an extract and provides a descriptivemass spectra. Through the injection port the extract is inserted into of the GC device, convert to vaporized form. That could travel according to their mass by charge ratio andexaminesby mass spectra.

Everyconstituentelectronically produces on a paper chart. The time intervened between injection and elution is called the "retention time." It can help to distinguish among some composites. [3]

2.0 MATERIALS AND METHODS

Plant material was collected from the Punitvan Bhuj- Kachchh. Leaves were washed with tap & distilled water and dried. Using electric grinder it has been converted into the fine powder and prepared to use for further study.

2.1 Preparation of Plant Extraction

15 gm of leaves powder was extracted with 2-3 litre of n-Butanol (117.6º C) for 12 hours using plant tissue homogenization method. After extraction, it was filtered and the exclusion of solvent was done under pressure by distillation process to afforded extract. Extracts were collected in air tight glass tube.[8]

2.2 GCMS Data Analysis Study

Shimadzu made GC-MS QP2010 instrument was used forGC-MSanalysis. The composition of the volatile constituents was established by GCMS analysis. It was performed on a Shimadzu GCMS-QP2010 system in EI mode prepared with a split/split less injector (300.00°C), at a split ratio of 1/10 using SGE make BPX5WCOT (Wall coated open tubular) capillary column (30m,0.25mm i.d.,0.25µm film thickness). Helium was used as a carrier gas at a flow rate of 2.5ml/min and Hold Time was 2.00 min. The injection volume of each sample was 3µl Column Oven Temperature was maintained at 70.0°C to 300.0°C. The flow rate of Career gas was 1.47 ml/min. The chromatogram is shown in Figure 2 and identified by Comparison with NIST and Wiley compound library which is presented in Table 1.

2.3 Identification of Phytocomponents

The identification of bio-component in n-butanol extract of (*G. tenax*) was done by Mass Spectroscopy comparing retention indices and mass spectra fragmentation patterns with the computer library of NIST08s and Wiley Registry of Mass Spectral Data's, New York (Wiley 8) have been usedto identify compound in above extract.

3.0 RESULT AND DISCUSSION

In present study, nine different types of bioactive chemical constituents were identified in the *G. tenax* leaves with important chemical properties. It has been described below in table 1 & 2 and mass spectra of that bioactive compound have been shown in figure 1.

Table 1: Bioactive compound detected from n-butanol extract of G. tenax.

Sr No.	Name	Synonyms	Formula	RT	CAS ID	M.W	% of Peak area	Library
1	Tetradecanoic acid	Myristic acid	$C_{14}H_{28}O_2$	8.615	544-63-8	228	1.70	WILEY
2	Tricosane	n-Tricosan	$C_{23}H_{48}$	8.855	638-67-5	324	2.43	WILEY
3	Octacosane	n-Octacosane	$C_{28}H_{58}$	8.856	630-02-4	394	2.43	WILEY
4	Heneicosane	n-Heneicosane	$C_{21}H_{44}$	8.857	629-94-7	296	2.43	WILEY
5	Docasane	n-Docosane	$C_{22}H_{46}$	8.858	629-97-0	310	2.43	WILEY
6	Neophytadiene	2,6,10-trimethyl,14-ethylene-14-pentadecne	$C_{20}H_{38}$	9.020	0-00-0	278	12.68	WILEY
7	(E)-(7R,11R)-3,7,11,15-tetramethyl-2-hexadecen-1-ol	Phytol	$C_{20}H_{40}O$	9.021	150-86-7	296	12.56	WILEY
8	3-Eicosyne	3-Eicosyne	$C_{20}H_{38}$	9.120	61886-66-6	278	1.89	WILEY

9	9-Eicosyne	9-Eicosyne	$C_{20}H_{38}$	9.200	71899-38-2	278	4.30	WILEY
10	Hexatriacontane	n-Hexatriacontane	$C_{36}H_{74}$	9.280	630-06-8	507	2.84	WILEY
11	Dotriacontane	Bicetyl	$C_{32}H_{66}$	9.282	544-85-4	451	2.84	WILEY
12	Pentacosane	n-Pentacosane	$C_{25}H_{52}$	9.284	629-99-2	352	2.84	WILEY
13	Nonacosane	Celidoniol, deoxy-	$C_{29}H_{60}$	9.285	630-03-5	408	2.84	WILEY
14	n-Hexadecanoic acid	Palmitic acid	$C_{16}H_{32}O_2$	9.480	57-10-3	256	24.55	WILEY
15	9-Octadecenoic acid	Oleic acid	$C_{18}H_{34}O_2$	9.482	112-80-1	282	24.55	WILEY
16	Triacontane	n-Triacontane	$C_{30}H_{62}$	9.680	638-68-6	422	2.40	WILEY
17	Eicosane	n-Eicosane	$C_{20}H_{42}$	10.065	112-95-8	282	2.46	WILEY
18	Heptacosane	n-Heptacosane	$C_{27}H_{56}$	10.067	593-49-7	380	2.46	WILEY
19	Nonadecane	n-Nonadecane	$C_{19}H_{40}$	10.069	629-92-5	268	2.46	WILEY
20	Dihomo γ-linolenic acid	8,11,14-Eicosatrienoic acid,	$C_{20}H_{34}O_2$	10.160	1783-84-2	306	2.21	WILEY
21	9,12,15-Octadecatrienoic acid	Methyl linolenate	$C_{19}H_{32}O_2$	10.162	301-00-8	292	2.21	WILEY
22	2,6,10-trimethyl dodecane	Farnesane	$C_{15}H_{32}$	10.435	3891-98-3	212	17.44	WILEY
23	Farnesol	2,6,10-Dodecatrien-1-ol, 3,7,11-trimethyl-, (E,E)-	$C_{15}H_{26}O$	12.740	106-28-5	222	1.84	WILEY
24	Squalene	2,6,10,14,18,22-Tetracosahexaene, 2,6,10,15,19,23-hexamethyl-, (all-E)-	$C_{30}H_{50}$	14.555	111-02-4	410	9.39	WILEY
25	2H-1-Benzopyran-6-ol, 3,4-dihydro-2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)-, [2R-[2R*(4R*,8R*)]]-	α-Tocopherol, Vitamin E	$C_{29}H_{50}O_2$	14.550	59-02-9	430	30.44	WILEY
26	Spiro[androst-5-ene-17,1'-cyclobutan]-2'-one,3-hydroxy-,(3á,17á)-	Spiro[androst-5-ene-17,1'-cyclobutan]-2'-one,3-hydroxy-,(3á,17á)	$C_{22}H_{32}O_2$	16.385	60534-16-9	318	10.44	WILEY
27	Stigmasta-5,22-dien-3-ol	Stigmasterol	$C_{29}H_{48}O$	16.387	83-48-7	412	10.44	WILEY

The chemical compoundsin then-butanol leaf extract of *G. tenax*were found to be in theorder ofα-Tocopherol (30.44%), n-Hexadecanoic acid (24.55%), 9-Octadecenoic acid

(24.55%),2,6,10-trimethyl dodecane (17.44%), Neophytadiene (12.68%), Phytol (12.56%),Spiro[androst-5-ene-17,1'- cyclobutan]-2'-one,3-hydroxy-,(3á,17á) (10.44%) Stigmasterol (10.44%), Squalene (9.39%), were obtained at very high concentration. All this major component (described in table 2) have higher biological activity like anticancer, antimicrobial, antiarthritic, antidiabatic, antioxidant, anti-inflammatory, antihypertensive, anti-atherogenic and antitumor activitiesetc.[9] The leaves n-butanol extract also possesstricosane, pentacosane, heptacosane, octacosane, nonacosane, docasane, n-heneicosaneeicosane, triacontane, dotriacontane, nonadecane, hexatriacontane types of carbohydrates as well as hydrocarbons which aregoodexhibited antibacterial, antiviraland antioxidant activity.[10,11]

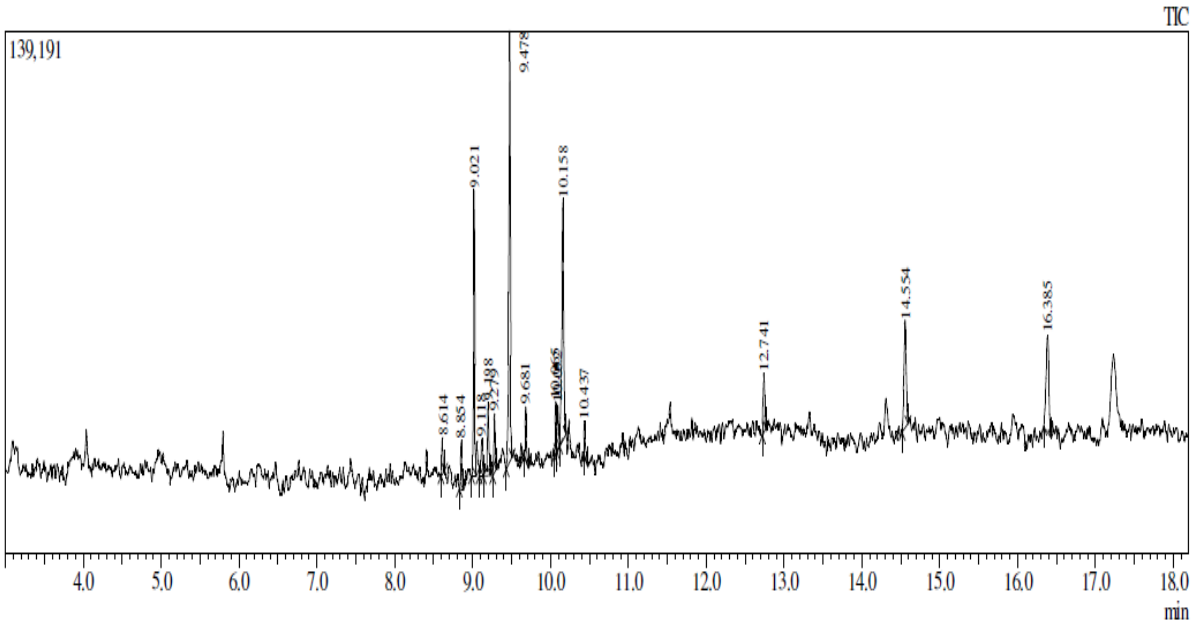
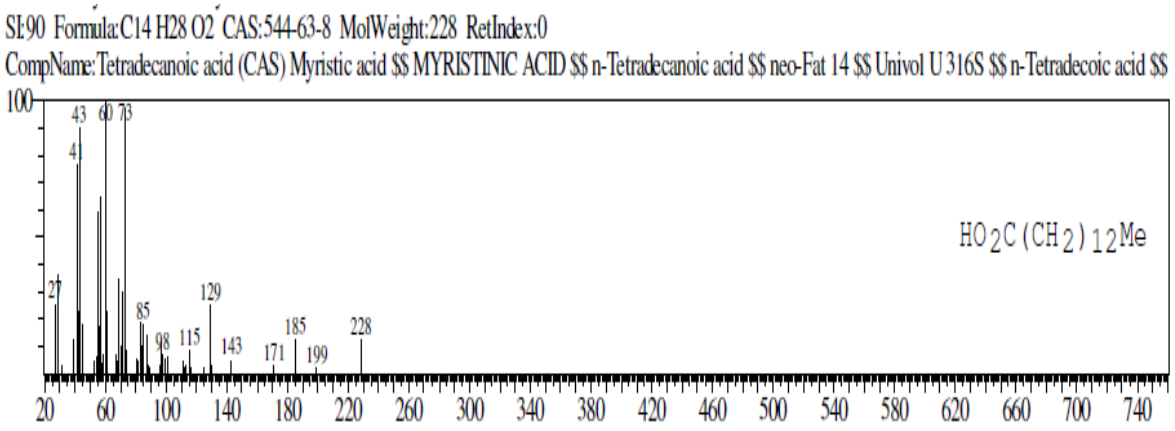
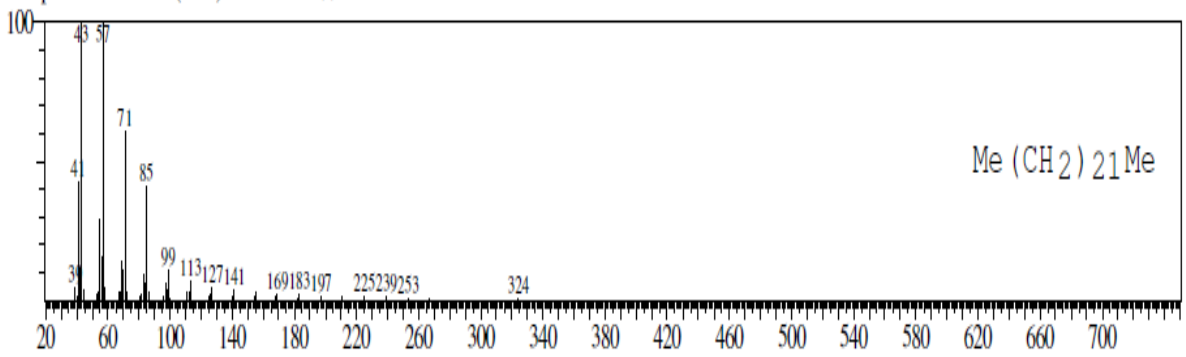


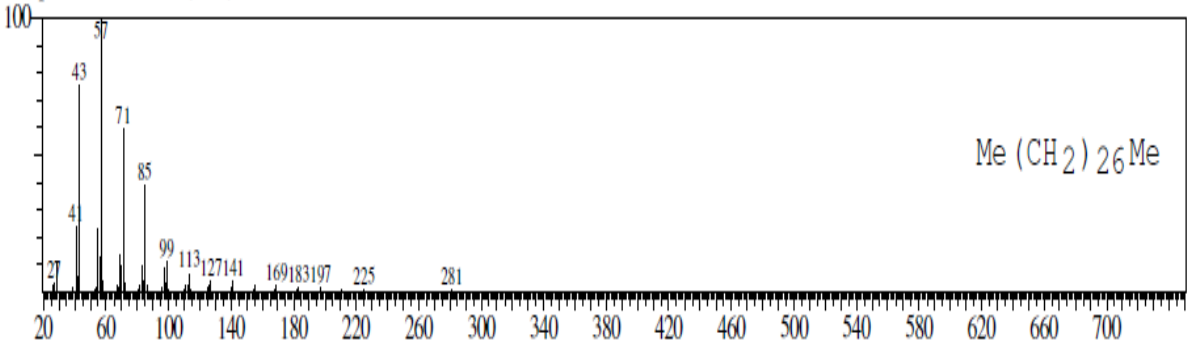
Figure 1: GC-MS chromatogram of n-butanol extract of leaves of G. tenax.



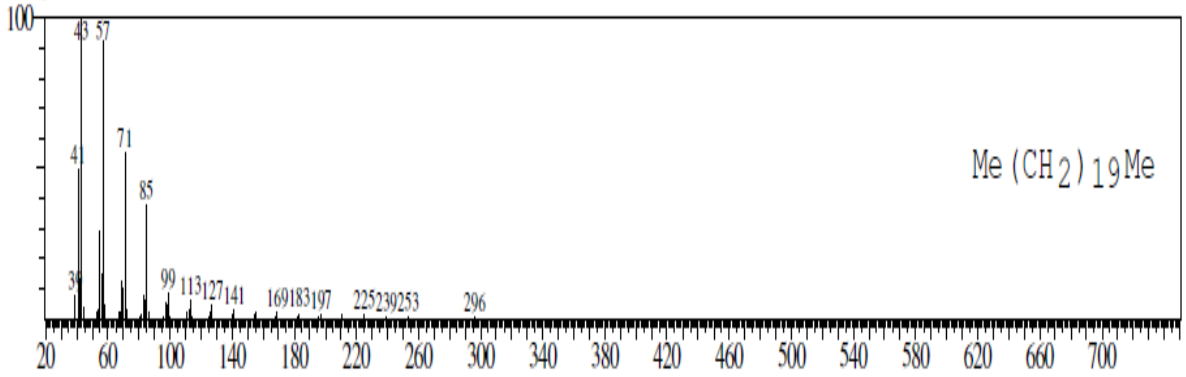
CompName:Tricosane (CAS) n-Tricosane $$



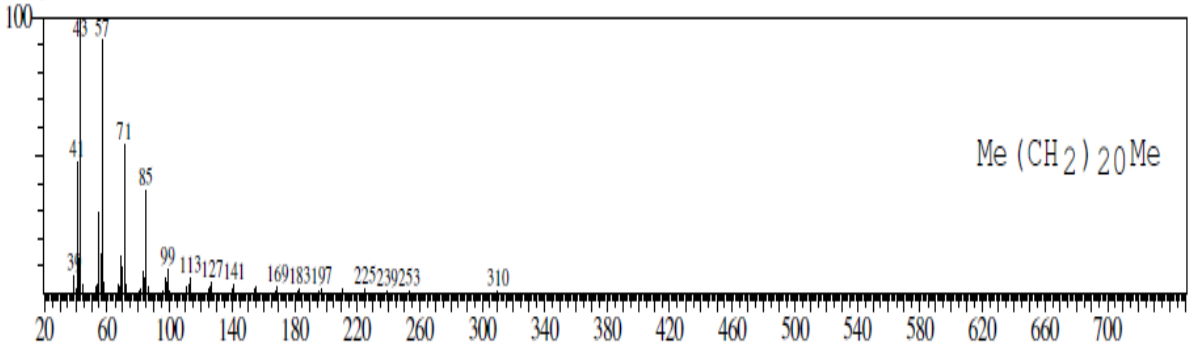
CompName:Octacosane (CAS) n-Octacosane $$



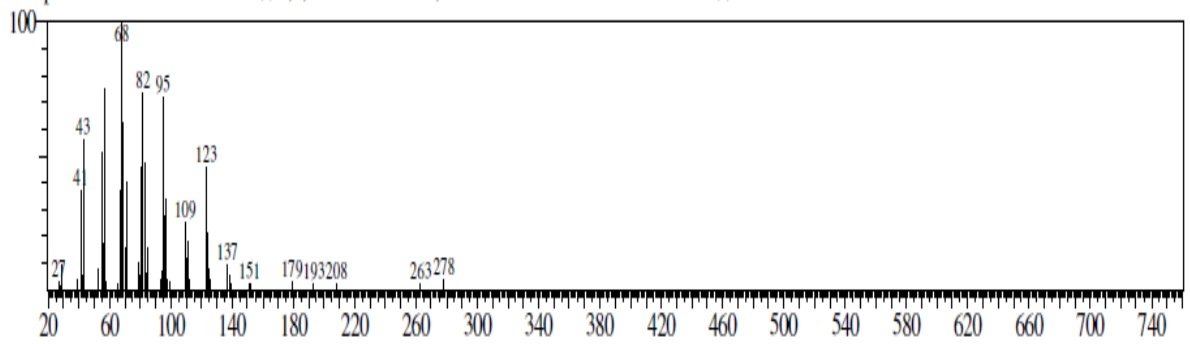
CompName:Heneicosane (CAS) n-Heneicosane $$



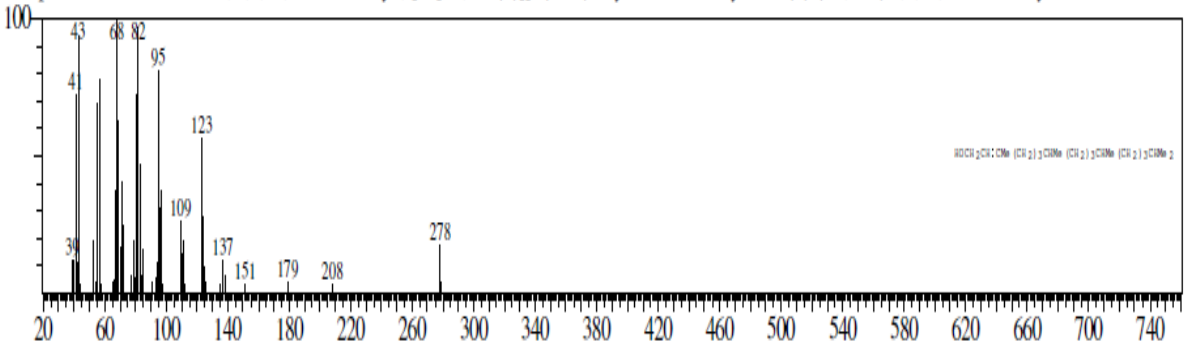
CompName:Docosane (CAS) n-Docosane $$ C22H46 STANDARD $$ Normal-docosane $$



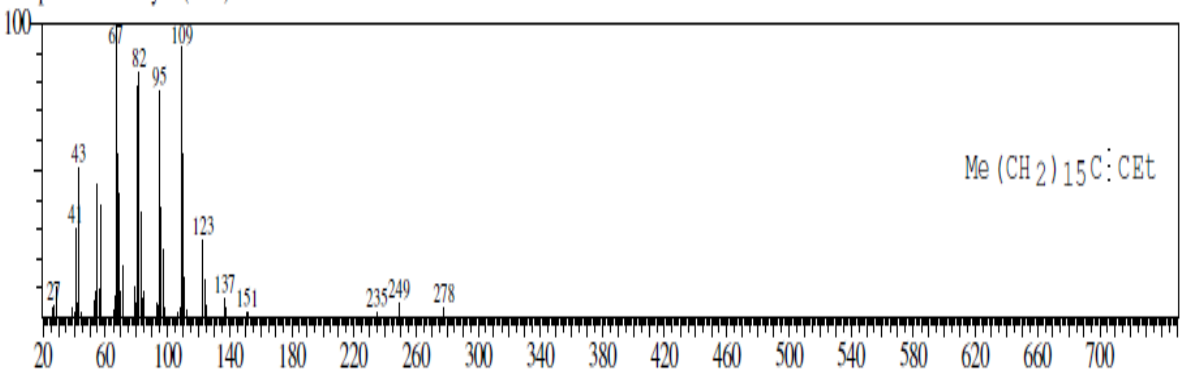
CompName:NEOPHYTADIENE $$ 2,6,10-TRIMETHYL,14-ETHYLENE-14-PENTADECNE $$



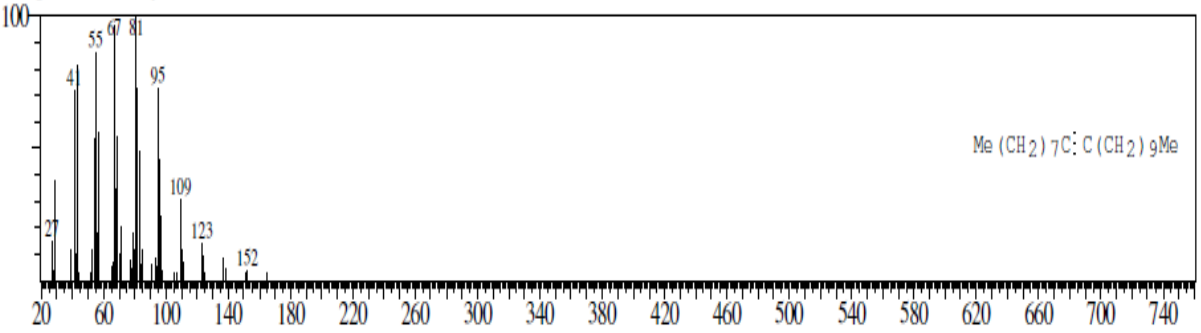
CompName:2-Hexadecen-1-ol, 3,7,11,15-tetramethyl-, [R-[R*,R*-(E)]]- (CAS) Phytol $$ trans-Phytol $$ (E)-(7R,11R)-3,7,11,15-tetramethyl-2-hexadecen-1-ol



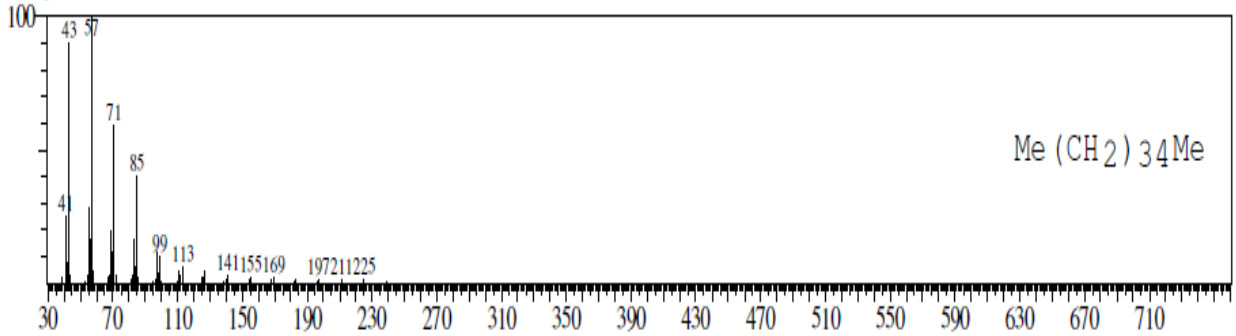
CompName:3-Eicosyne (CAS)



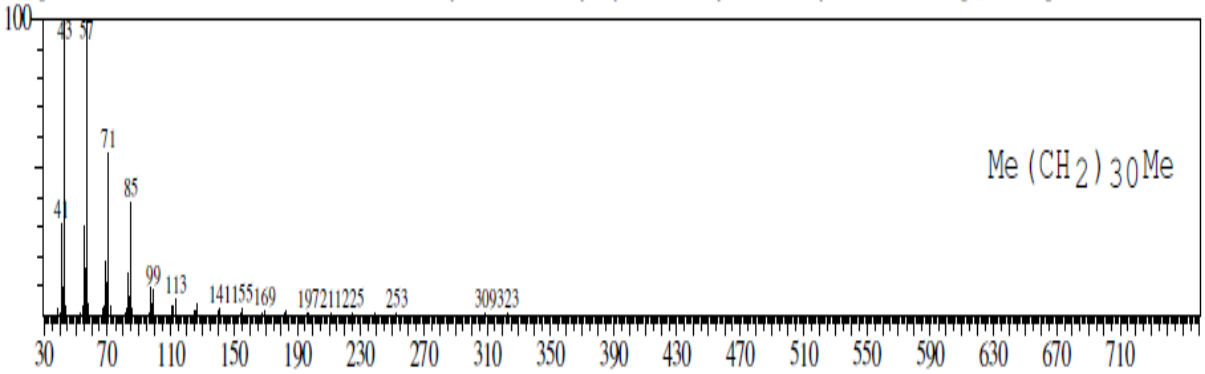
CompName:9-Eicosyne (CAS)



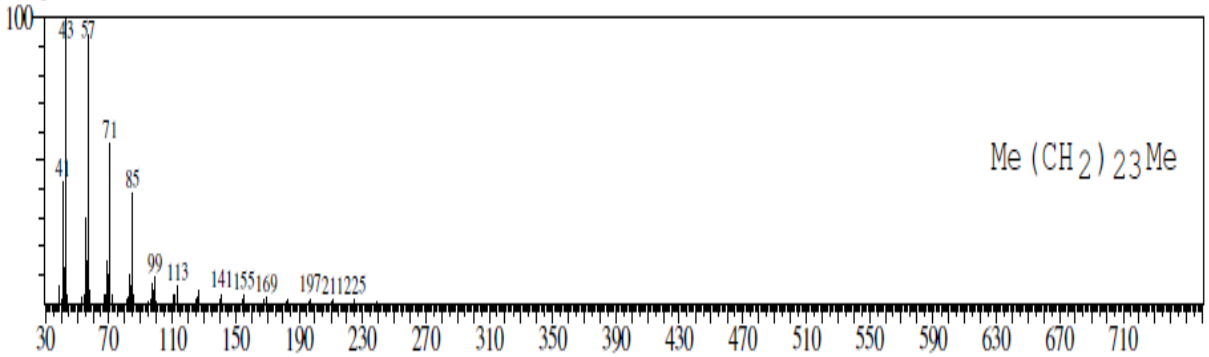
CompName:Hexatriacontane (CAS) n-Hexatriacontane $$ NOR-HEXATRIACONTANE $$



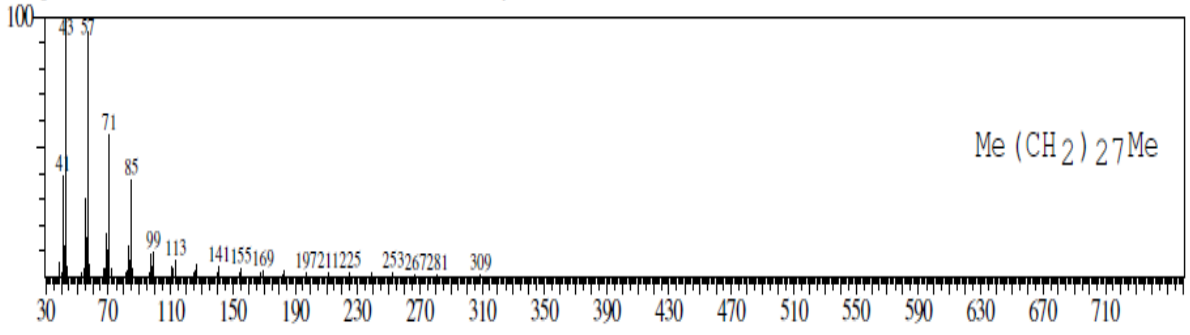
CompName:Dotriacontane (CAS) n-Dotriacontane $$ Bicetyl $$ Tris(trimethylsilyl)ether, methyl ester of ethyl anthranilate azo pigment(.alpha.z) of bilivubin-1



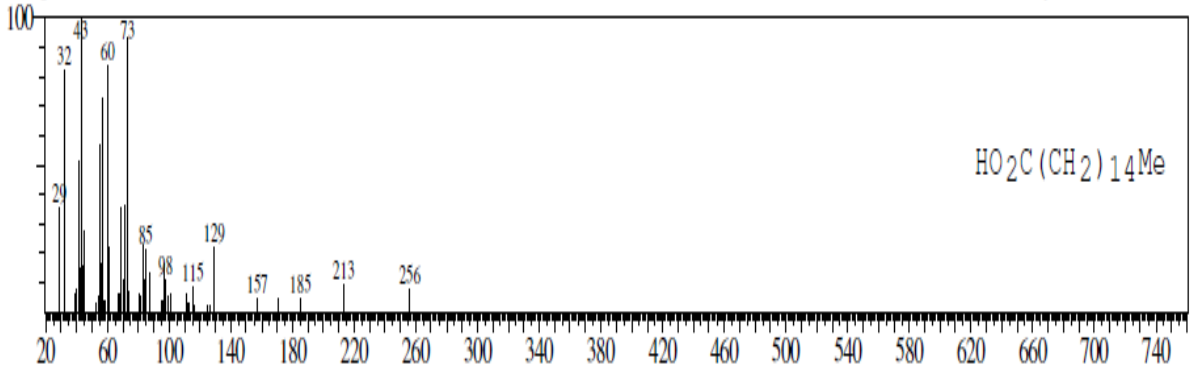
CompName:Pentacosane (CAS) n-Pentacosane $$



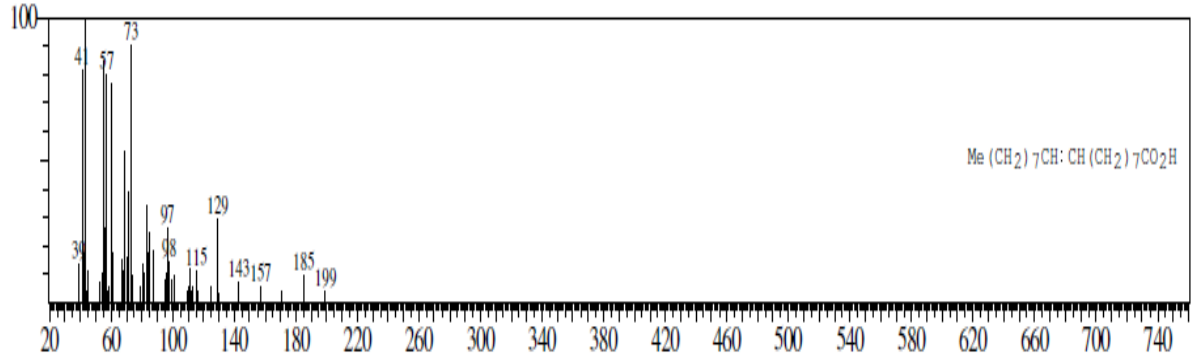
CompName:Nonacosane (CAS) n-Nonacosane $$ Celidoniol, deoxy- (CAS)



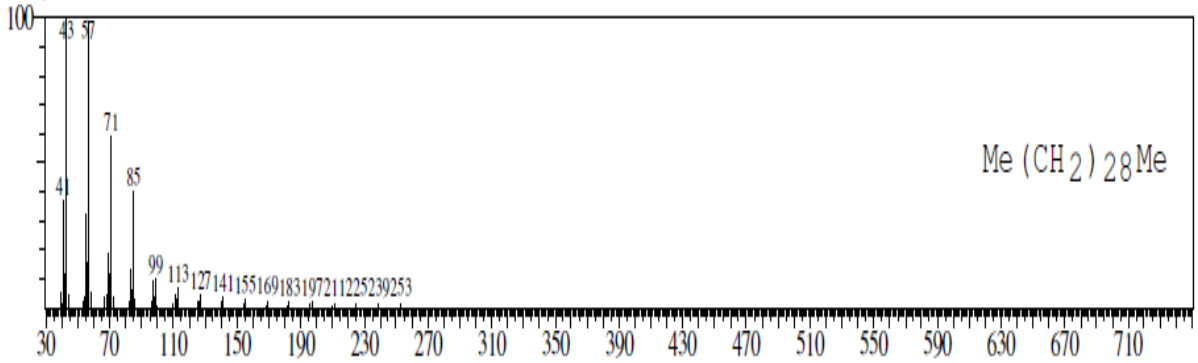
CompName:Hexadecanoic acid (CAS) Palmitic acid $$ Palmitinic acid $$ n-Hexadecoic acid $$ n-Hexadecanoic acid $$ Pentadecanecarboxylic acid $$ 1-Penta



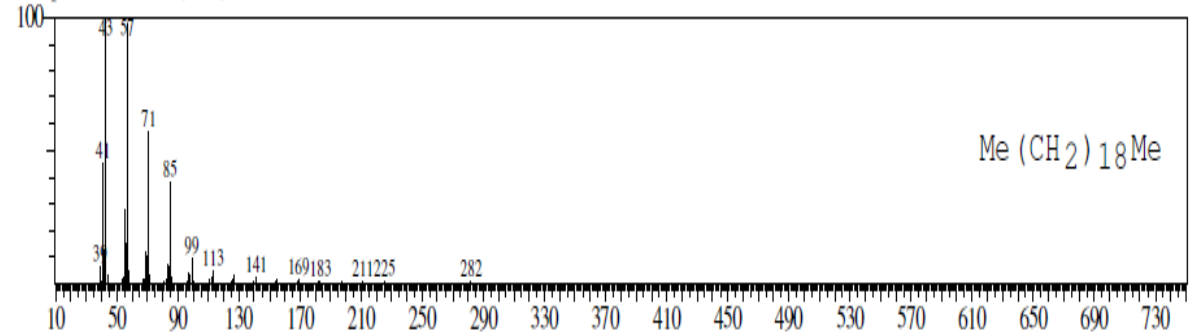
CompName:9-Octadecenoic acid (Z)- (CAS) Oleic acid $$ Red oil $$ Oelsauere $$ Oleine 7503 $$ Pamolyn 100 $$ Emersol 211 $$ Vopcolene 27 $$ cis-Oleic



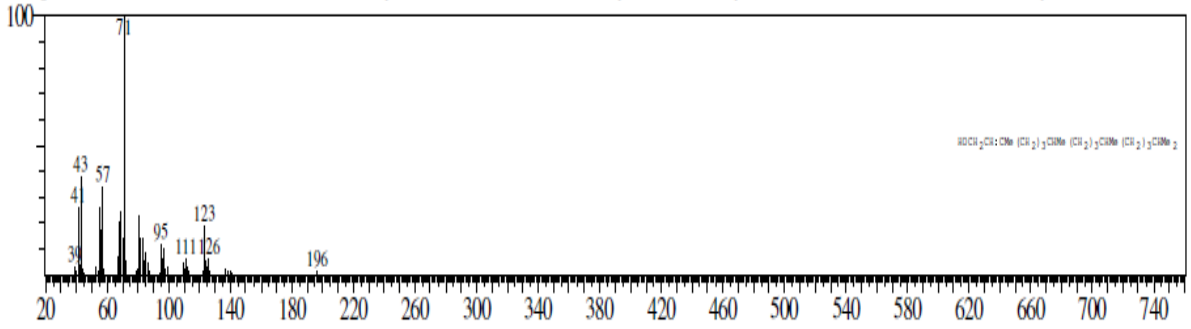
CompName:Triacontane (CAS) n-Triacontane $$



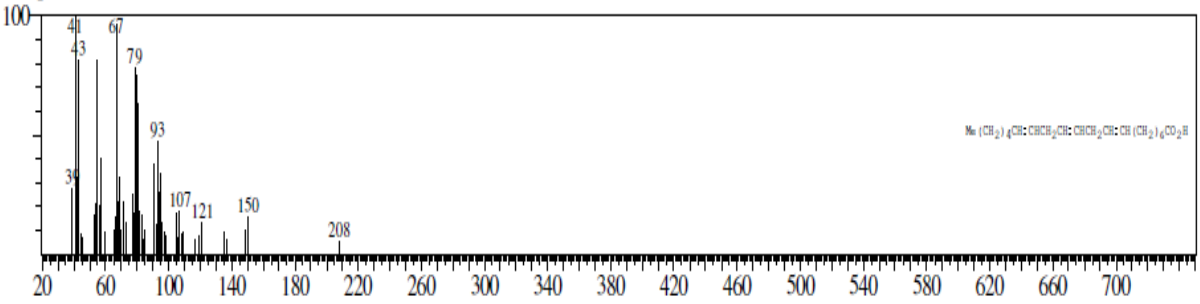
CompName:Eicosane (CAS) n-Eicosane $$



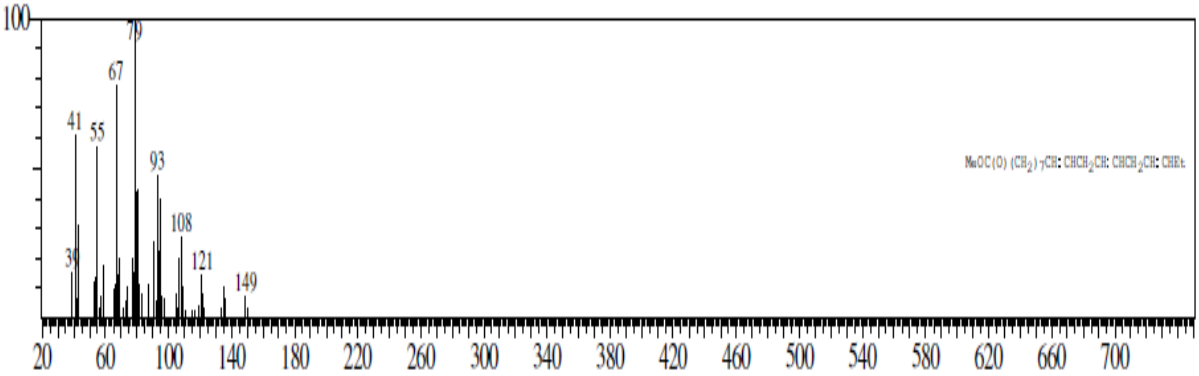
CompName:2-Hexadecen-1-ol, 3,7,11,15-tetramethyl-, [R-[R*,R*-(E)]]- (CAS) Phytol $$ trans-Phytol $$ (E)-(7R,11R)-3,7,11,15-tetramethyl-2-hexadecen-1-ol



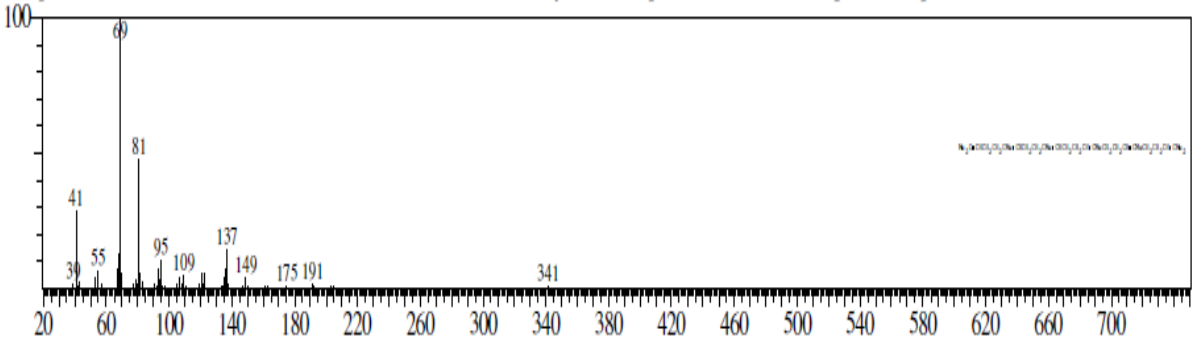
CompName:8,11,14-Eicosatrienoic acid, (Z,Z,Z)- (CAS) CIS,CIS,CIS-8,11,14-EICOSATRIENOIC ACID $$ Dihomo-.gamma.-linolenic acid $$ cis-8,11,14-Ei



CompName:9,12,15-Octadecatrienoic acid, methyl ester, (Z,Z,Z)- (CAS) Methyl linolenate $$ Linolenic acid methyl ester $$ Linolenic acid, methyl ester $$ Me



CompName:2,6,10,14,18,22-Tetracosahexaene, 2,6,10,15,19,23-hexamethyl- (CAS) Squalene $$ Skvalen $$ Supraene $$ Spinacene $$ 2,6,10,15,19,23-HEXAI



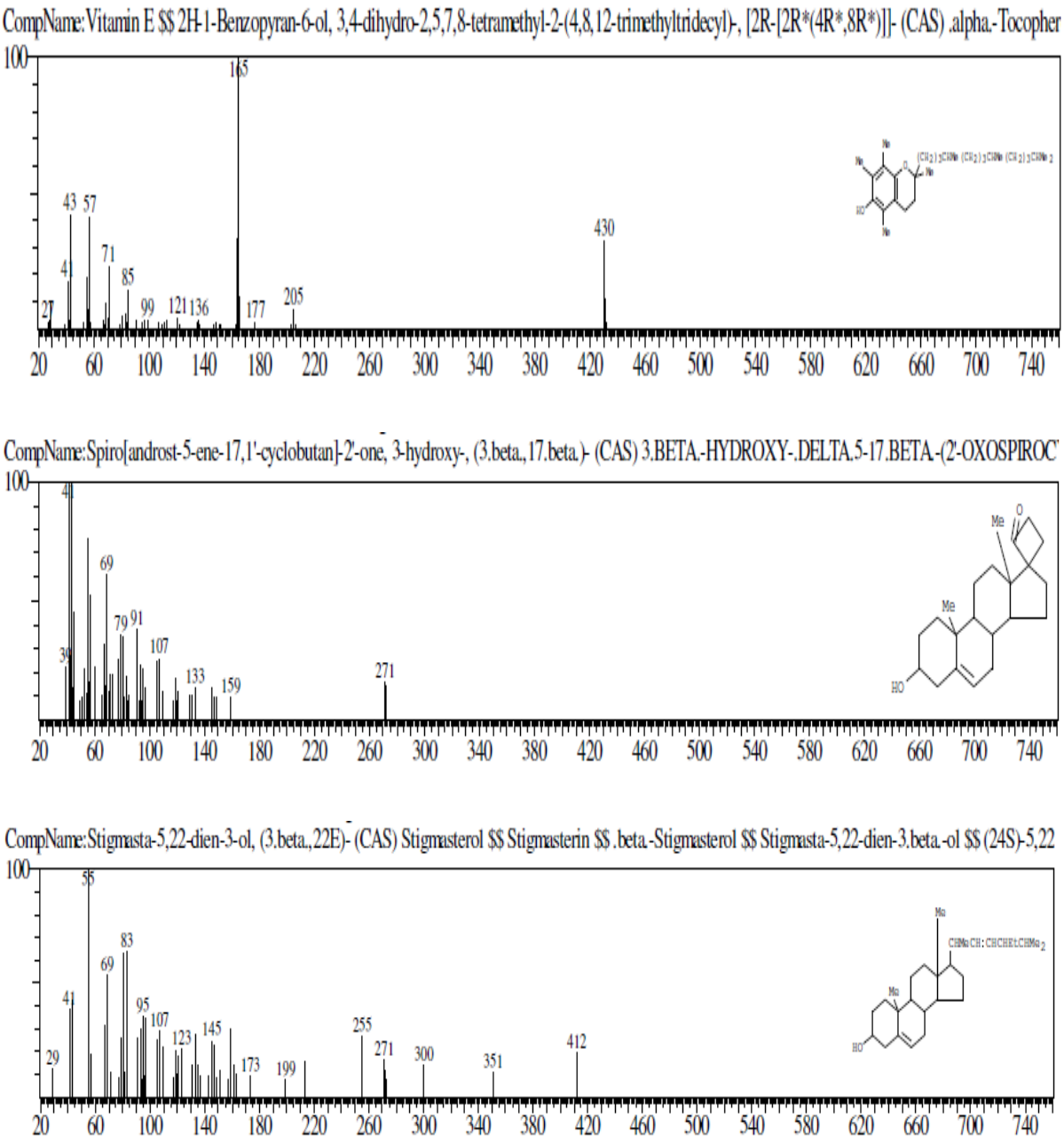
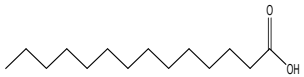
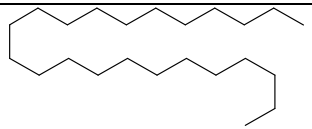
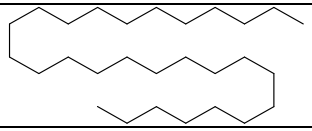
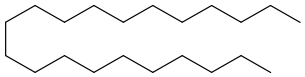
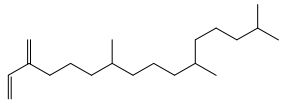
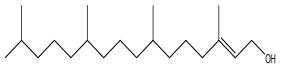
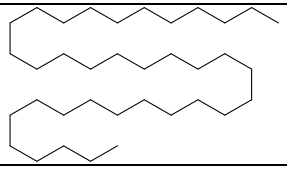
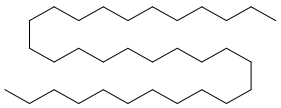
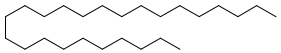
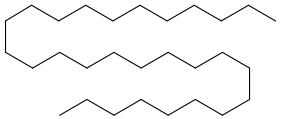
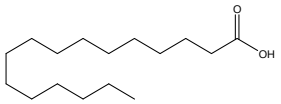
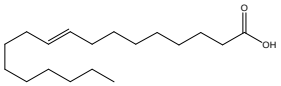
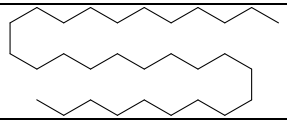
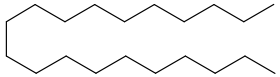
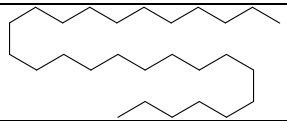
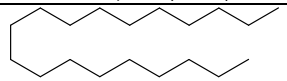
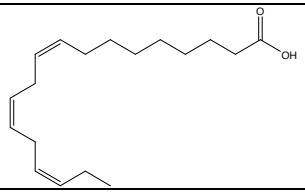
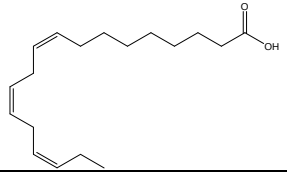
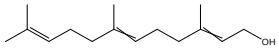


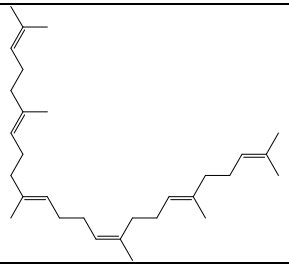
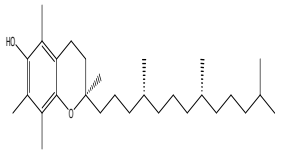
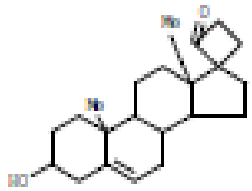
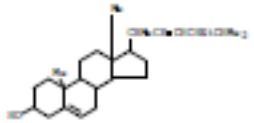
Figure 2: Mass spectra of the bioactive compound of n-butanol extract of *g. tenax* leaves sample.

Table 2: Components Identified and it's Activity/Uses in n-butanol Extracts of *Grewia tenax* by GC-MS.

Sr. No.	Fatty acid name	Structure	Nature	Importance	Reference
1	Tetradecanoic acid		Fatty acid	Larvicidal and repellent activity, it is used in cosmetic and topical medicinal preparations,also acts as a lipid anchor in bio-membrane, it is also used in antioxidant, cancer-preventive, lubricant, hypercholesterolemi, flavoring agent	8, 11, 12
2	Tricosane		Carbohydrate/Hydrocarbon	Antibacterial	10
3	Octacosane		Carbohydrate s/Hydrocarbon	Act as good phase change materials	13, 14
4	Heneicosane		Carbohydrate	Antibacterial, Inhibit larva growth	15
5	Docasane	$CH_3\,(CH_2)_{20}\,CH_3$	Carbohydrate	To inspect commercially obtainable waxes in the form of thin disc as possible diffraction intensity standards for macromolecular crystallography synchrotron beam lines	16
6	Neophytadiene		Diterpenoid	Strong bactericidal, anti-inflammatory, antifungal compounds	17

7	(E)-(7R,11R)-3,7,11,15-tetramethyl-2-hexadecen-1-ol		Diterpene	Diuretic Fragrance compound Antimicrobial Anti-inflammatory Anticancer, anti – inflammatory,	18,
8	3-Eicosyne	$CH_3\ (CH_2)_{15}C\ CEt$	Hydrocarbon	Antimicrobial	19
9	9-Eicosyne	$CH_3\ (CH_2)_7C\ C(CH_2)_9\ CH_3$	Saturated aliphatic hydrocarbon	Antimicrobial	20
10	Hexatriacontane		Terpene alcohol	Antioxidant activity	21
11	Dotriacontane		Hydrocarbon	Antimicrobial, antioxidant, antispasmodic, antibacterial, and antiviral	22
12	Pentacosane		Aliphatic hydrocarbon	Antibacterial	10
13	Nonacosane		Straight chain hydrocarbon	Antibacterial Antihypertensive, Vasodilator, Angiotensin AT-II receptor antagonist and Saluretic activity	11,23
14	n-Hexadecanoic acid		Fatty acid	Anti-inflammatory, Antioxidant, antipsychotic, hypocholesterolemicnematicide, pesticide, anti androgenicflavor, hemolytic, 5-Alpha reductase inhibitor, potent mosquito larvicide.	24, 25, 26
15	9-Octadecenoic acid		Fatty acid	Antihypertensive, Increase HDL and decrease LDL Cholesterol	25, 27

16	Triacontane		Hydrocarbon	Antibacterial, antidiabetic, and antitumor activity	28
17	Eicosane		Hydrocarbon	it has been used as a thermal-regulating functional phase change material for clothing application	29
18	Heptacosane		Hydrocarbon	Antibacterial	20
19	Nonadecane		Hydrocarbon	Antioxidant	30
20	Dihomo γ-linolenic acid		Fatty acid	Anti-inflammatory responses	31
21	9,12,15-Octadecatrienoic acid		Fatty acid	Anti-inflammatory and anti-atherogenic properties	32
22	2,6,10-trimethyl dodecane	$(CH_3)_2CH(CH_2)_3CHMe(CH_2)_3CH\ CH_3CH_2\ CH_3$	Hydrocarbon	fuel component	33
23	Farnesol		Terpenol	Antibacterial, antioxidant, antifungal anti-cancer agent, and chemoprotective effects	34

24	Squalene		Triterpene	Antibacterial, Chemo preventive, immunostimulant, anti-tumor, antioxidant, anticancer, lipooxygenase-inhibitor, perfumery, pesticide, sunscreen	35, 37
25	2H-1-Benzopyran-6-ol, 3,4-dihydro-2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)-, [2R-[2R*(4R*,8R*)]]-		Vitamin E	Anticancer, antitumor, antioxidant, antiinfertility, anti-stroke, anti-t	36
26	Spiro[androst-5-ene-17,1'-cyclobutan]-2'-one,3-hydroxy-,(3á,17á)-		Steroid Compound	Antiarthritic, Hepatoprotective, Antiasthma, Diuretic, Anti-inflammatory, Cancer preventive	35, 38
27	Stigmasta-5,22-dien-3-ol	Stigmasterol 	phytosterols	Stoppage of certain cancers like ovarian, prostate, breast, and colon cancers. It also holds potent antioxidant, hypoglycemic and thyroid inhibiting properties	39

CONCLUSION

The present study has been carried out on thequalitative and quantitative analysis of the major bioactive components of therapeutically significant plant *G. tenax* leaves by use of GC-MS. Totalnine different types of bio-compounds were identified from the *G. tenax* leaves extracts by using n-butanol solvent. The biological activities of each of the identified phytocomponentsrange from anticancer, antimicrobial, antiarthritic, antioxidant, Anti-inflammatory, antihypertensive, anti-atherogenic and antitumoral activities. These findings have provided the scientific basis for the therapeutic usage of the plant. Though, isolation of theseparate phytochemical components subject to biologicalactivity and toxicity profile will give fruitful results.

REFERENCE

1. Ahmedull M., Nayar M. P., Red data book for Indian plants. Botanical Survey of India, 1999; 4.
2. Dhanalakshmi R., Manavalan R., "Bioactive Compounds in Leaves of Corchorustrilocularis L. BY GCMS Analysis", *International Journal of Pharm Tech Research*, 2014; 6(7): 1991-1998.
3. Shree Devi M. et al., "GC-MS, FT-IR Analysis and Antibacterial Study of Bioactive Compounds of Chundaivattral Chooranam - A Siddha Poly Herbal Formulation", *International Journal of Pharm Tech Research*, 2015; 8(10); 204-209.
4. Gebauer J., Patzelt A., Hammer K. and Buerkert A., "First record of *Grewia tenax* (Forssk.) Fiori in northern Oman, a valuable fruit producing shrub", *Gene. Res. Crop Evolut.*, 2007; 54: 1153-1158.
5. Aboagarib E.A., Yang R. and Hua X., "Physicochemical, nutritional and functional characteristics of seeds, peel and pulp of Grewia tenax (Forssk) Fiori fruits", *Trop. J. Pharmaceut. Res.*, 2016; 14(12): 2247-2254.
6. Khemiss F., Ghoul-Mazgar S., Moshtaghie A. and Saidane D., "Study of the effect of aqueous extract of *Grewia tenax* fruit on iron absorption by everted gut sac", *J. Ethnopharmacol*., 2006; 103: 90-98.
7. Mukherjee K.S., Bhattacharya M.K. and Ghosh P.K., "Phytochemical examination of *Grewia tenax", J. Indian Chem. Soc*., 1981; 58(8): 818.
8. AadesariyaM. K., RamV. R. and DaveP. N., "Evaluation of Antioxidant Activities by use of Various Extracts from *Abutilon Pannosum* and *Grewia Tenax* in the Kachchh Region", *MOJ Food Process. Technol.*, 2017; 5(1): 13.

9. Yogeswari S., Ramalakshmi S., Neelavathy R., Muthumary J., "Identification and Comparative Studies of Different Volatile Fractions from Monochaetiakansensis by GCMS", *Global J Pharm*, 2012; 6(2): 65-71.
10. Mihailovi V. et al., "Studies on the antimicrobial activity and chemical composition of the essential oils and alcoholicextracts of Gentianaasclepiadea L.", *J Med Plant Res*, 2011; 5(7): 1164-1174.
11. Sivakumar R., Jebanesan A., Govindarajan M., Rajasekar P., "Larvicidal and repellent activity of tetradecanoic acid against Aedesaegypti (Linn.) and Culexquinquefasciatus (Say.) (Diptera: Culicidae)", *Asian Pac. J. Trop. Med.*, 2011; 4: 706–710.
12. Mancini A. *et al.*, "Biological and nutritional properties of palm oil and palmitic acid: Effects on health", *Molecules*, 2015; 20(9): 17339–17361.
13. Sari A., Alkan C., Karaipekli A., and Uzun O., "Microencapsulated n-octacosane as phase change material for thermal energy storage", *Sol. Energy*, 2009; 83(10): 1757–1763.
14. Reverchon E., RussoP. and Stassi A., "Solubilities of Solid Octacosane and Triacontane in Supercritical Carbon Dioxide," *J. Chem. Eng. Data*, 1993; 38(3): 458–460.
15. BhutiaY. D.*et al.*, "Acute and sub-acute toxicity of an insect pheromone, N-heneicosane and combination with insect growth regulator, diflubenzuron, for establishing no observed adverse effect level (NOAEL)", *Indian J. Exp. Biol.*, 2010; 48(7): 744–751.
16. Majeed H., Bokhari T. Z., and SherwaniS. K., "An Overview of Biological, Phytochemical and Pharmacological Values of Abiespindrow", 2013; 2(4): 182–187.
17. Venkata RamanB. *et al.*, "Antibacterial, antioxidant activity and GC-MS analysis of Eupatorium odoratum", *Asian J. Pharm. Clin. Res.*, 2012; 5(2): 99–106.
18. MeenakshiS. A. and Kalavathy, S. "Analysis of Bioactive Compounds in Antiinfertility Formulation Using Gc Ms and Ftir Techniques," *Int. J. Res. Biochem. Biophys.*, 2015; 5(2): 20–24.
19. De MoraesJ.*et al.*, "Phytol, a Diterpene Alcohol from Chlorophyll, as a Drug against Neglected Tropical Disease SchistosomiasisMansoni," *PLoSNegl. Trop. Dis.*, 2014; 8(1): 51.
20. Aimen I., Hatem K., Mohamed K., "Supercritical fluid extraction of triterpenes and aliphatic hydrocarbons from olive tree derivatives", *Arabian Journal of Chemistry*, 2017; 10: S3967–S3973.
21. Igwe O. U. and OffiongS. P., Chemistry of Semi chemicals Used as Trail Pheromones in Tropical Fire Ant (Solenopsisgeminata), 2015, 7: 35–40.

22. Nithya T.G., Jayanthi J. and Raghunathan M.G., "Phytochemical, Antibacterial and GC MS analysis of a floating fern Salviniamolesta D. S. Mitchell", *International Journal of Pharm Tech Research*, 2015; 8(9): 85-90.
23. Elango V. et al., "Identification of bioactive components and its biological activities of Evolvulusalsinoideslinn.-A GC-MS study", 2015; 3(1): 41–44.
24. SalahA. I., AliH. A. M., ImadH. H., "Spectral analysis and anti-bacterial activity of methanolic fruit extract of Citrulluscolocynthis using gas chromatography-mass spectrometry", *African J. Biotechnol.*, 2015; 14(46): 3131–3158.
25. Kapoor R. and Huang Y. S., "Gamma linolenic acid: an antiinflammatory omega-6 fatty acid", *Curr. Pharm. Biotechnol.*, 2006; 7(6): 531–534.
26. SoosairajS. And Dons T., "Bio-active compounds analysis and characterization in Ethanolic plant extracts of Justiciatranquebariensis L. (Acanthaceae) using GC-MS", 2016; 9(7): 260–265.
27. Journal A., "Phytochemical analysis of ruelliapatula using gas chromatography - mass spectrometry", *Asian Journal of Pharmaceutical and Clinical Research*, 2016; 25–28.
28. IlicA., "Biological activities of selected Mono- and sesquiterpenes: Possible uses in medicine", 2013; 1–93.
29. Uddin M. et al., "Synthesis of a Novel Nanoencapsulated n-Eicosane Phase Change Material with Inorganic Silica Shell Material for Enhanced Thermal Properties through Sol-Gel Route", *J. Text. Sci. Eng.*, 2017; 7(2).
30. Verma R., Tapwal A., Puri S., Plant A., "Phytochemical Profiling and GCMS Study of Adhatodavasica Nees., an Ethnomedicinal Plant of North Western Himalaya, 2016; 8(2): 268–273.
31. Rustan A. C. and Drevon C. A., "Fatty Acids: Structures and Properties," *Encycl. Life Sci.*, 2005; 1–7.
32. SivakumarR. and Dhivya A., "GC-MS Analysis of Bioactive Compounds on Ethyl Acetate Extract of Cordia Monoica Roxb. Leaves," *Int. J. Res. Dev. Pharm. Life Sci.*, 2015; 4 (1): 1328–1333.
33. Konovalova O., Gergel E., and Herhel V., "GC-MS analysis of bioactive components of Shepherdiaargentea (Pursh.) Nutt. from Ukrainian flora",*Sect. Title Pharm. Anal.*, 2013; 2(6): 7–12.
34. Radhamani T., BrittoS. J., "GC-MS analysis of Polygala arillata Buch. Ham Ex D. Don", 2013; 4(11): 70–75.

35. PierreL. L., MosesM. N., "Isolation and Characterisation of Stigmasterol and B - Sitosterol from OdontonemaStrictum (Acanthaceae)," *J. Innov. Pharm. Biol. Sci.*, 2015; 2: 88–95.
36. Kumari TK, Muthukumarasamy S, Mohan VR. GC-MS analysis of ethanol extract of *Sarcostemmasecamone* L. Bennet (Asclepiadaceae). *Sci Res Rep*, 2012; 2: 187-91.
37. Gopalakrishnan S. Saroja K. Elizabeth JD. GC-MS analysis of the methanolic extract of the leaves of *Dipteracanthuspatulus* (Jacq.) Nees. *Res J Chem Pharm*, 2011; 3: 477-80.
38. Won S. H. *et al.*, "The combustion properties of 2, 6, 10-trimethyl dodecane and a chemical functional group analysis", *Combust. Flame*, 2014; 161(3): 826–834.
39. Panda S., Jafri M., Kar A., Meheta B. K., "Thyroid inhibitory, antiperoxidative and hypoglycemic effects of stigmasterol isolated from Buteamonosperma," *Fitoterapia*, 2009; 80(2): 123–126.