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Research Article

FTIR and GC-MS spectral analysis of *Gmelina asiatica* L. Leaves

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Abstract

The present study is aimed to identify the functional groups and phytoconstituents present in *Gmelina asiatica* leaf through FTIR and GC-MS spectroscopy. FTIR method was performed by using Perkin Elmer Spectrophotometer and the characteristic peaks were detected. The phytochemical constituents screened by GC-MS method and the compound detection employed the NIST Ver. 2.0 year 2005 library. The FTIR spectroscopic studies revealed the presence of alcohols, phenols, alkanes, alkynes, alkyl halides, aldehydes, carboxylic acids, aromatics, nitro compounds and amines. The results of the GC-MS analysis provide different peaks determining the presence of 50 phytochemical compounds in the extracts. The major phytoconstituents are Ethyl α-D-glucopyranoside (21.86%); 2-Hexadecen-1-OL, 3,7,11,15- Tetramethyl-, [R-(R*,R*-(E)] (14.96%); 9,12,15-Octadecatrienoic acid (14.96%); Pentadecanoic acid (10.71%); Ethyl (9Z, 12Z) -9,12-Octadecadienoate (7.12%). The results of the present study generated the FTIR and GC-MS spectrum profile for the medicinally important plant *Gmelina asiatica* leaf extract having various bioactive compounds and used to cure various ailments by traditional practitioners.

INTRODUCTION

Phytochemicals are bioactive substances of plants that have been associated in the protection of human health against chronic degenerative diseases (Fukumoto and Mazza, 2000; Florence *et al*., 2014 & 2015) which are do not act alone but most of the time it is in a combination of complexes (Cowan, 1999). FT-IR Spectroscopy has demonstrated to be a reliable and sensitive method for finding out the functional groups present in plant samples were determined with the help of IR region in the range of 400-4000cm^{-1}. For most common plant compounds, the spectrum of an unknown compound can be identified by comparison to a library of known compounds (Griffiths and Haseth, 1986). Gas Chromatography Mass Spectroscopy is a very compatible and one of the best methods to identify the pure compounds present at less than 1ng biological specimen and quantification purpose. The unknown organic compounds in a complex mixture can be determined by interpretation and also by matching the spectra with reference spectra (Hites, 1997). Within a decade there were a number of dramatic advances in analytical techniques, including FT-IR and GC-MS that were powerful tools for identification and determination of phytochemicals is of increasing interest among researchers (Roberts and Xia, 1995; Alagammal *et al*., 2011; Bharathi *et al*., 2012; Sumathi and Uthayakumari, 2014; Asha *et al*., 2014; Nithyadevi and Sivakumar, 2015).

Gmelina asiatica L. (Syn: *Gmelina parvifolia* Roxb.), is a deciduous large sized bush or shrub, commonly growing to about 4m to 8m tall and much branched. It is commonly called "Asiatic

Bush Beech" and "Nilakumil" in Tamil (Dassanayake, 1983; Brintha *et al*., 2015). The leaves, aerial parts and roots are used in traditional medicine for the treatment of jaundice, rheumatism, syphilis, gonorrhea, burning sensation of eyes, catarrh of the bladder, fever, dysuria, wounds, dandruff, diabetes, hepatic diseases and also to reduce body heat (Apparanantham *et al*., 1982; Parekh *et al*., 2005; Parekh and Chanda, 2007; Vikneshwaran *et al*., 2008; Kusuma and Joshi, 2010; Bakkiyaraj and Pandiyaraj, 2011). Hence the present investigation was aimed to identify the functional groups present in crude powder and phyto components present in ethanol extract of *G. asiatica* leaf with the aid of FT-IR and GC-MS analytical techniques, which may provide an insight in its use of traditional medicine.

MATERIALS AND METHODS

Collection and processing of plant material

Leaves of the plant *G. asiatica* collected from Scott Christian College Campus, Nagercoil, Kanyakumari District, South Tamilnadu, India and identified by using taxonomic keys (Gamble and Fischer, 1935). The healthy and mature leaves were freshly collected and thoroughly washed with distilled water and kept in shade at room temperature for about two weeks to dry. They were made into powder with the help of a mechanical grinder and sieved. Dried and powdered samples were soxhlet extracted with ethanol until the solvent was colorless. The extracts were filtered and concentrated under reduced pressure in a rotary evaporator. The dried extracts were kept in the refrigerator at 4^{o}C until use.

Fourier Transform Infrared Spectroscopic Analysis (FT-IR)

Oven-dried leaf samples (60˚C) were ground into fine powder using a mortar and pestle. Two milligrams of the sample was mixed with 100 mg KBr (FT-IR grade) and then compressed to prepare a salt-disc (3 mm diameter). The disc was immediately kept in the sample holder and FT-IR spectra were recorded in the absorption range between 400 and 4000 cm^{-1}. All investigations were carried out with a Shimadzu FT-IR spectrometer.

Gas Chromatography-Mass Spectrometry analysis (GC-MS)

Ethanolic extract of leaves of *G. asiatica* were subjected to GC-MS analysis. Extracts were dissolved in high-performance liquid chromatography (HPLC)-grade ethanol and subjected to JEOL GCMATE II GC-MS (Agilent Technologies 6890N Network GC system for gas chromatography). Helium was used as the carrier gas at a flow rate of 1mL/min. The temperature was programmed at 80˚C for 5 min then increased to 300˚C at the rate of 15˚C/min. The temperatures of injector and EI detector (70 eV) were 280 and 300˚C respectively; 2 µL of plant extract was injected with a Hamilton syringe into the GC/MS manually.

Identification of functional groups

The FTIR spectrum was used to identify the functional groups of the active components present in plant sample based on the peaks values in the region of IR radiation. When the plant extract was passed into FTIR, the functional groups of the components were separated based on its peaks ratio.

Identification of Components

Interpretation of mass spectrum obtained from GC-MS was conducted using the database of National Institute Standard and Technology (NIST) having more than 82,000 patterns. The spectrum of the unknown component was compared with the spectra of the known components stored in the NIST library. The name, molecular weight, molecular formula and structure of the components of the test materials were ascertained.

RESULTS

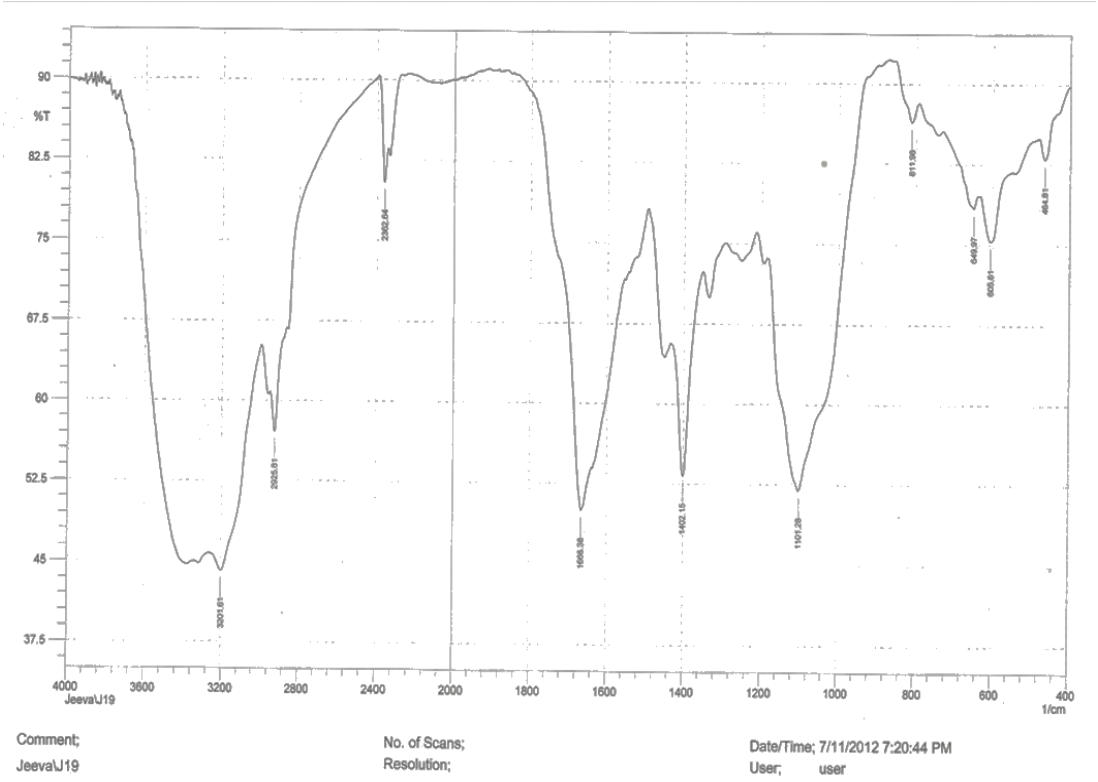
FT-IR Spectrum analysis

The results of FT-IR spectroscopic analysis revealed the presence of alcohols, phenols, alkanes, alkynes, alkyl halides, aldehydes, carboxylic acids, aromatics, nitro compounds and amines (Fig-1 and Table-1). The absorption at 3201cm^{-1} is due to the OH stretching of Normal "polymeric" group that present in the extract. The band at 2925cm^{-1} is due to C-H stretching of Methylene asym./sym.; the band at 1666cm^{-1} showed Alkenyl C=C stretch;band at 1402cm^{-1} showed Phenol or tertiary alcohol, OH bend; the band at 1101cm^{-1} showed Aromatic C-H in plane bend; the band at 811cm^{-1} showed 1,4-Disubstitution (Para); the band at 649cm^{-1} showed Alkyne C-H bend; the band at 605cm^{-1} showed Aliphatic bromo compounds; the band at 464cm^{-1} showed Aryl disulfides (S-S stretch).

Table 1: FT-IR peak values and functional groups of *Gmelinaasiatica* leaf

Peak No.	Group frequency (cm^{-1})	Origin	Functional groups
1	3201.61	O-H	Normal " polymeric" OH stretch
2	2925.81	C-H	Methylene C-H asym./sym. stretch
3	2362.64		Unknown
4	1666.38	C=C	Alkenyl C=C stretch
5	1402.15	O-H	Phenol or tertiary alcohol, OH bend
6	1101.28	C-H	Aromatic C-H in plane bend
7	811. 98	C-H	1,4- Disubstitution (Para)
8	649.97	C-H	Alkyne C-H bend
9	605.61	C-Br	Aliphatic bromo compounds
10	464.81	S-S	Aryl disulfides (S-S stretch)

Fig. 1: FT-IR Spectrum for ethanolic leaf extract of *Gmelinaasiatica*



Gas Chromatography-Mass Spectrometry analysis

Gas Chromatography-Mass Spectrometry analysis (GC-MS) is one of the best methods to identify the bioactive compounds of non polar components and volatile essential oil, fatty acids and lipids. Fifty compounds were identified from the ethanolic extract of *G. asiatica* leaves. The identification of the phytochemical compounds was confirmed based on the peak area, retention time and molecular formula were presented in Table 2.

The GC-MS analysis of *G. asiatica* leaf extract revealed the presence of phytochemicals represented 2,3-Dihydroxy propanal (2.04%), Benzoic acid (1.67%); 2,3-Dihydro-Benzofuran (0.29%); 2-Amino-9-(3,4-dihydroxy-5-hydroxymethyl-Tetrahydro-furan-2-yl)-3,9-dihydro-purin-6-one(0.48%); 3-Ethoxy-4-Hydroxy-Benzaldehyde (0.38%); Bicyclo(10.1.0) Tridec-1-ene (0.12%); Dodecanoic acid (0.23 %); 1,2-Benzenedicarboxylic acid, Diethyl ester (0.94%);

Ethyl α-D-glucopyranoside (21.86%); 4-(2-Hydroxy-2,6,6-Trimethyl-Cyclohexyl)-3-Buten (0.66 %); 2,3-Pentanediol, 2-Methyl-5-(2,6,6-Trimethyl-1-Cyclohexen-1 (0.20%); Tetradecanoic acid (1.23%); 2(4H)-Benzofuranose, 5,6,7,7A- Tetrahydro-6-Hydro-6-Hydroxy-4,4,7A-Trimethyl, (6S-Cis (0.28%); Pluchidiol (0.32%); 2,6,10-Trimethyl, 14-Ethylene-14-Pentadecene (0.34%); Oleic acid (0.17%); Pentadecanoic acid (10.71%); Hexadecanoic acid, ethyl ether (3.41%); Octahydro-1H-Indene (0.29%); 4,6,6,7,8,8-hexamethyl-1,3,4,6,7,8 Hedrocyclopenta {G} Isochromene (0.32%); Ethanone,1-(5,6,7,8-tetrahydro-3,5,5,6,8,8-Hexamethyl-2-naphthalenyl)(0.20%); 3-Hexen-1-ol benzoate (0.21%); 4-(1,3,3-Trimethyl-7-Oxabicyclo(4.1.0) Hept-2-Yl (0.22%); Dimethoxyphenylpropanoic acid (0.25%); Ethylene brassylate (1.14%); Tridecanoic acid, ethyl ester (0.29%); Heptadecenoic acid (0.15%); 2-Hexadecen-1-OL, 3,7,11,15- Tetramethyl-, [R-(R*,R*-(E)] (14.96%); 9,12,15-Octadecatrienoic acid (14.96%); Ethyl (9Z, 12Z) -9,12-Octadecadienoate (7.12%); Octadecanoic acid, ethyl ester (1.64%); Eicosanoic acid (0.17%); Heptadecanoic acid, ethyl ester (0.30%); Tritetracontane (0.25%); 1,2-Benzenedicarboxylic acid (0.14%); Ethyl Nonadecanoate (0.13; Tetratetracontate (0.39%); Ethyl Docosanoate (0.26%); 2,6,10,14,18,22-Tetracosahexaene, 2,6,10,15,19,23-hexamethyl (0.49%); 3-(1-Methoxy-1-Methylethoxy)-2-Methylpropyl Benzoate (0.49%); Heneicosane (0.33%); γ–Tocopherol (0.25%); Vitamin E (1.08%); Octadecanol (0.53%); Stigmasta-5,22-Dien-3-OL (1.07%); 17-Pentatriacontene (1.08%); Chondrillasterol (1.53%); Methyl Commated (1.51%); 35.98618-Oleanene (0.36%) and Lup-20(29)-en-3-yl acetate (2.46%).

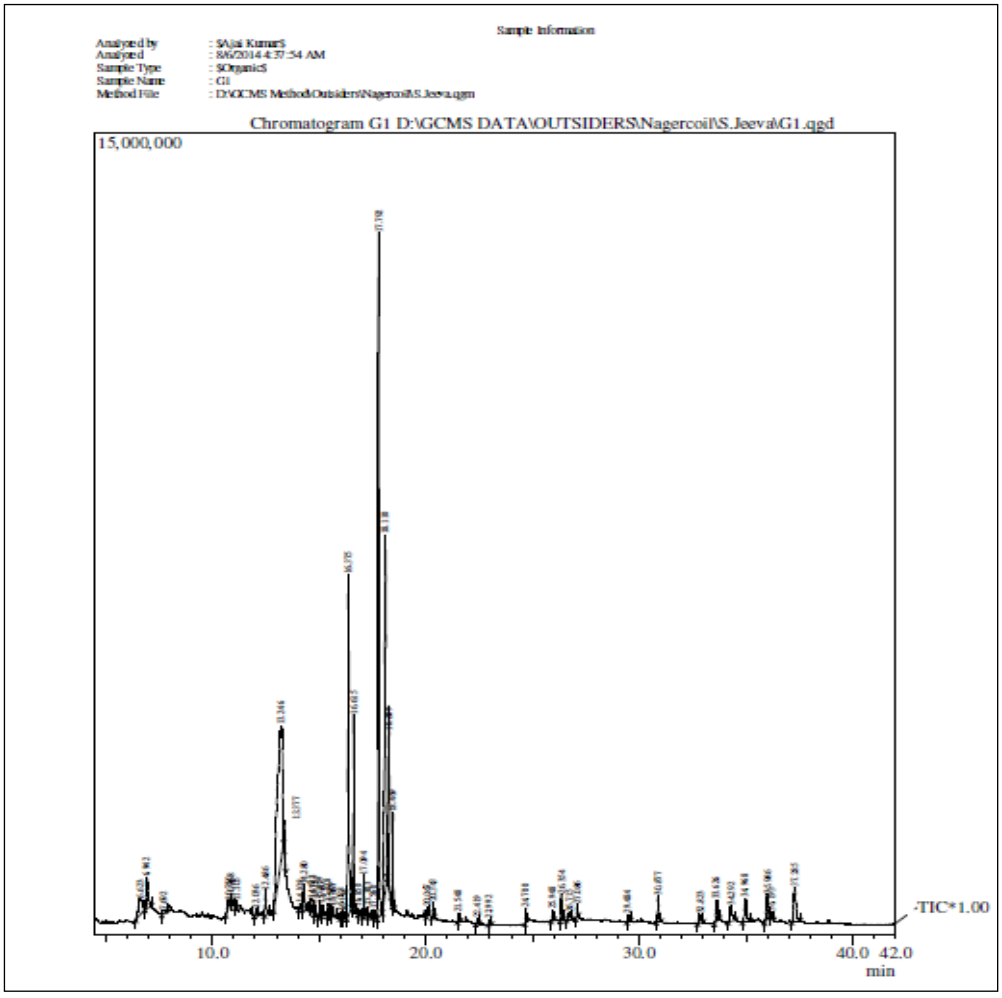
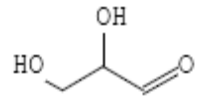
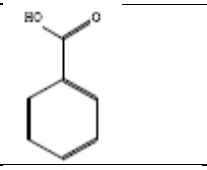
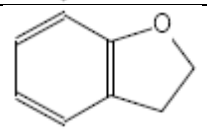
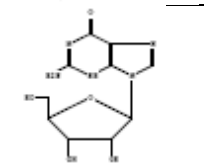
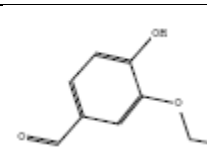
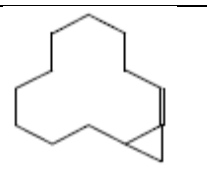
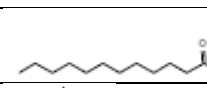
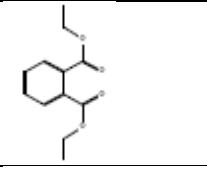
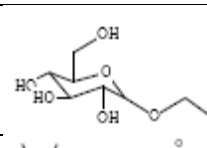
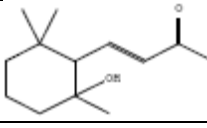
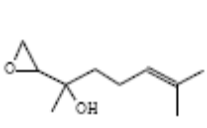
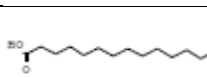
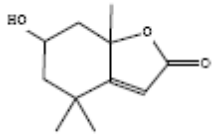
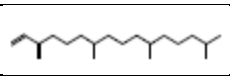
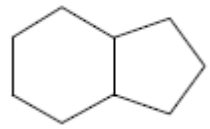
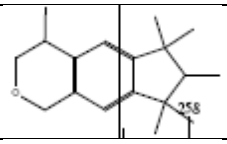
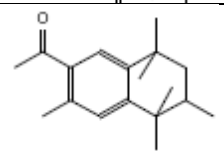
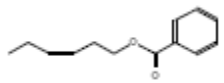
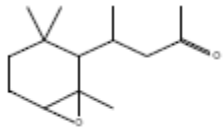
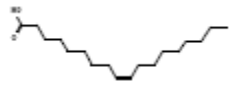
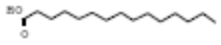
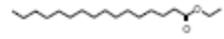
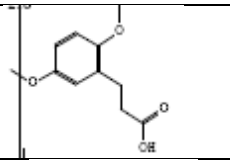
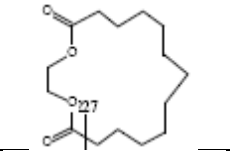
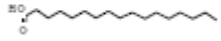
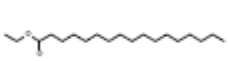
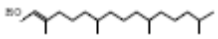
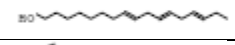
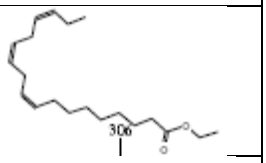
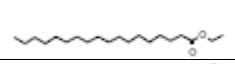
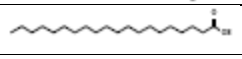
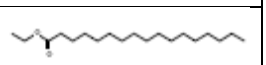
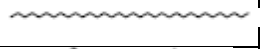
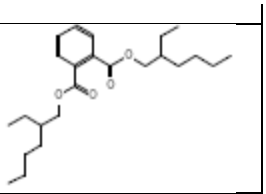
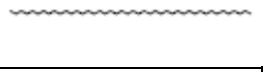
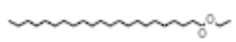
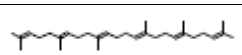
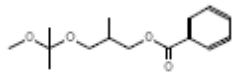
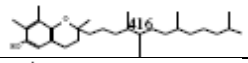
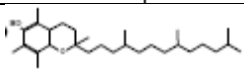
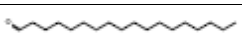
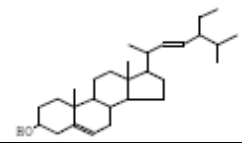


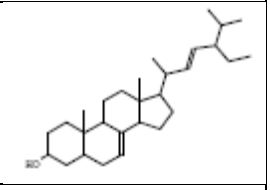
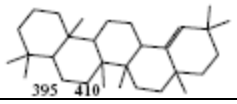
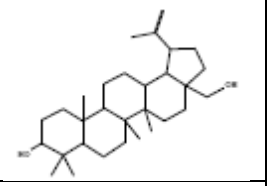
Fig. 2: GC-MS Chromatogram of ethanolic extract from*Gmelinaasiatica* leaf

Table 2: Phytoconstituents identified in the ethanolic leaf extract of *Gmelinaasiatica*by GC-MS analysis

No	Name of the compounds	R. time	Area %	M. weight	M. Formula	Structure
1	2,3-dihydroxy Propanal	6.623	2.04	90	$C_3H_6O_3$	
2	Benzoic acid	6.942	1.67	122	$C_7H_6O_2$	
3	2,3-dihydro-Benzofuran	7.692	0.29	120	C_8H_8O	
4	2-Amino-9-(3,4-dihydroxy-5-hydroxymethyl-Tetrahydro-furan-2-yl)-3,9-dihydro-purin-6-one	10.750	0.48	283	$C_{10}H_{13}N_5O_5$	
5	3-Ethoxy-4-Hydroxy-Benzaldehyde	10.868	0.38	166	$C_9H_{10}O_3$	
6	Bicyclo(10.1.0) Tridec-1-ene	11.105	0.12	178	$C_{13}H_{22}$	
7	Dodecanoic acid	12.036	0.23	200	$C_9H_{10}O_3$	
8	1,2-Benzenedicarboxylic acid, Diethyl ester	12.486	0.94	222	$C_{12}H_{14}O_4$	
9	Ethyl. α-d-glucopyranoside	13.246	21.86	208	$C_8H_{16}O_6$	
10	4-(2-Hydroxy-2,6,6-Trimethyl-Cyclohexyl)- 3-Buten	13.377	0.66	210	$C_{13}H_{22}O_2$	
11	2,3-Pentanediol, 2-Methyl-5-(2,6,6-Trimethyl-1-Cyclohexen-1	14.108	0.20	240	$C_{15}H_{28}O_2$	
12	Tetradecanoic acid	14.280	1.23	228	$C_{14}H_{28}O_2$	

No	Name of the compounds	R. time	Area %	M. weight	M. Formula	Structure
13	2(4H)-Benzofuranose, 5,6,7,7A-Tetrahydro-6-Hydro-6-Hydroxy-4,4,7A-Trimethyl,(6S-Cis)	14.622	0.28	196	$C_{11}H_{16}O_3$	
14	Pluchidiol	14.793	0.32	208	$C_{13}H_{20}O_2$	
15	2,6,10-Trimethyl, 14-Ethylene-14-Pentadecene	15.059	0.34	278	$C_{20}H_{38}$	
16	Octahydro -1H-Indene,	15.147	0.29	124	C_9H_6	
17	4,6,6,7,8,8-hexamethyl- 1,3,4,6,7,8-Hedrocyclopenta{G}Isochromene	15.428	0.32	258	$C_{18}H_{26}O$	
18	Ethanone,1-(5,6,7,8-tetrahydro-3,5,5,6,8,8- Hexamethyl-2-naphthalenyl)	15.549	0.20	258	$C_{18}H_{26}O$	
19	3-Hexen-1-ol benzoate	15.667	0.21	204	$C_{13}H_{16}O_2$	
20	4-(1,3,3-Trimethyl-7-Oxabicyclo(4.1.0) Hept-2-Yl	16.028	0.22	224	$C_{14}H_{24}O_2$	
21	Oleic acid	16.174	0.17	282	$C_{18}H_{34}O_2$	
22	Pentadecanoic acid	16.375	10.71	242	$C_{15}H_{30}O_2$	
23	Hexadecanoic acid, ethyl ether	16.615	3.41	284	$C_{18}H_{36}O_2$	
24	Benzene, (2,5-dimethoxyphenyl) propanoic acid	16.850	0.25	210	$C_{11}H_{14}O_4$	
25	Ethylene brassylate	17.094	1.14	270	$C_{15}H_{26}O_4$	
26	Heptadecanoic acid	17.303	0.29	270	$C_{17}H_{34}O_2$	
27	Heptadecanoic acid, ethyl ester	17.560	0.15	298	$C_{19}H_{38}O_2$	

No	Name of the compounds	R. time	Area %	M. weight	M. Formula	Structure
28	2-Hexadecen-1-OL, 3,7,11,15-Tetramethyl-, [R-(R^*,R^*-(E)]	17.792	14.96	296	$C_{20}H_{40}O$	
29	9,12,15-Octadecatrienoic acid	18.110	14.96	292	$C_{19}H_{32}O_2$	
30	9,12-Octadecadienoate, ethyl (9Z, 12Z)	18.289	7.12	308	$C_{20}H_{36}O_2$	
31	Octadecanoic acid, ethyl ester	18.469	1.64	312	$C_{20}H_{40}O_2$	
32	Eicosanoic acid	20.067	0.17	312	$C_{20}H_{40}O_2$	
33	Heptadecanoic acid, ethyl ester	20.343	0.30	298	$C_{19}H_{38}O_2$	
34	Tritetracontane	21.548	0.25	604	$C_{43}H_{88}$	
35	1,2-Benzenedicarboxylic acid	22.419	0.14	390	$C_{24}H_{38}O_4$	
36	Ethyl Nonadocosanoate	22.992	0.13	368	$C_{24}H_{48}O_2$	
37	Tetratetracontate	24.700	0.39	618	$C_{44}H_{90}$	
38	Ethyl Docosanoate	25.948	0.26	368	$C_{24}H_{48}O_2$	
39	2,6,10,14,18,22- Tetracosahexaene, 2,6,10,15, 19, 23-hexamethyl	26.715	0.49	410	$C_{30}H_{50}$	
40	3-(1-Methoxy-1-Methylethoxy)-2-Methylpropyl Benzoate	26.715	0.49	266	$C_{15}H_{22}O_4$	
41	Heneicosane	27.086	0.33	296	$C_{21}H_{44}$	
42	γ –Tocopherol	29.484	0.25	416	$C_{28}H_{48}O_2$	
43	Vitamin E	30.877	1.08	430	$C_{29}H_{50}O_2$	
44	Octadecanol	32.823	0.53	268	$C_{18}H_{36}O$	
45	Stigmasta-5,22-Dien-3-OL	33.626	1.07	412	$C_{29}H_{48}O$	
46	17-Pentatriacontene	34.292	1.08	490	$C_{35}H_{70}$	

No	Name of the compounds	R. time	Area %	M. weight	M. Formula	Structure
47	Chondrillasterol	34.968	1.53	412	$C_{29}H_{48}O$	
48	Methyl Commated	35.986	1.51	486	$C_{31}H_{50}O_4$	
49	18-Oleanene	36.193	0.36	410	$C_{30}H_{50}$	
50	Lup-20(29)-en-3-yl acetate	37.285	2.46	468	$C_{32}H_{52}O_2$	
			100.00			

DISCUSSION

FT-IR spectral analysis was useful for compound identification, when run under IR region in the range of 400-4000 cm^{-1} there was a variation in the peaks of plant samples (Thenmozhi *et al*., 2011; Kalaiselvi *et al*., 2012). IR is used for the identification of functional groups like hydroxyl groups, amines, carboxylic acids, aromatic compounds, aliphatic bromo compounds, aryl disulfides, alkenyl groups and nitro compounds in the molecules. Such functional groups can be identified by their absorption bands (Manfred *et al*., 1997).

In the present analysis, the crude ethanolic extract of *G. asiatica* leaf was subjected to FT-IR analysis, the functional groups of the components were separated based on its peak ratio and chemical compounds were identified. Presence of carboxylic acids, aromatics, alkenes, phenols or tertiary alcohols, alkanes, aliphatic bromo compounds and alkynes were noticed. The FT-IR spectrum at 1101.28cm^{-1} is due to the vibration stretching for (C-H) bond of aromatic compound contains phenol, carbonyl and ether group (Silverstein and Webster, 1997). The peak at 2923.95-2926.37cm^{-1} assigned to the C-H stretching which means that some alkane compounds existed in rare medicinal plants (Starlin *et al*., 2012). The bands between 3000 and 2800 cm^{-1} represent C-H stretching vibrations that are mainly generated by lipids (Wolkers and Koekstra, 1995; Wei *et al*., 2009). FTIR spectroscopy is used proved to be a reliable and sensitive method for detection of bimolecular composition (Kumar and Prasad, 2011). Similarly, Sathish*et al*. (2012) estimated that the ethanolic extract of *Vitex altissima* leaves showed all functional groups are similar to the present study except nitro compounds and amines. But the present results collaborate with those of Shankar *et al*. (2009) which possesses phenolic compounds such as phenols (C=C stretch); aromatics and alkanes (C–H stretch) and aryl alcohols. Based on the functional group analysis, it can be confirmed that carboxylic acids, aldehydes, aromatics, alkenes, phenols or tertiary alcohols, alkanes, aliphatic bromo compounds and alkynes might be responsible for the various medicinal properties of *G. asiatica*.

GC-MS is a valuable tool for reliable identification of bioactive compounds and also can identify pure compounds present at less than 1ng in biological specimens (Liebler *et al*., 1996; Johnson *et al*., 2011). In the last few years, GC-MS has become confidently established as a key technological platform for secondary metabolites profiling in plant species (Merlin *et al*., 2009; Janakiraman *et al*., 2012). This study demonstrated the usefulness of GC-MS, not only for the determination of drugs of abuse in biological samples, for their clinical or forensic purposes, but also for physiological evaluations and development of toxicological models (Cardano *et al*., 2006; Yang *et al*., 2006; Valente *et al*., 2011).

In the present work, fifty compounds were isolated from the ethanolic extract of *G. asiatica* leaf. According to Duke's ethnobotanical and phytochemistry database (Duke's, 1998) the identified compounds possess many biological properties.

Among the identified phytochemicals hexadecanoic acid is suggested to be a fatty acid ester and it may employed as antioxidant, antimicrobial, flavor, hypocholesterolemic agent and larvicidal activities (Bodoprost and Rosemeyer, 2007; Falodun *et al*., 2009). 1, 2-benzenedicarboxylic acid, diisooctyl ester is a plasticizer compound and acts as antimicrobial and antifouling agent. α-tocopherol has antioxidant properties and reduce the risk of prostate cancer in smokers (Heinonen *et al*., 1998). The compound n-dodecanoic acid acts as an antioxidant, cancer preventive, nematicide and lubricating agent. 9,12,15-octadecatrienoic acid is unsaturated fatty acid and have the property of antimicrobial, antioxidant, hypocholesterolemic, anti-inflammatory, cancer preventive, hepatoprotective, anti-arthritic, anti-histimic, anti-enzemic and anti-coronary. Methyl octadecanoate exhibits antifungal and anti-cancer activities (Gross and Shah, 2009). The compound 9,12-octadecadienoic acid (Z,Z)-ethyl, is a fatty acid ester and it may be employed as antioxidant, antimicrobial, flavor, hypocholesterolemic agent and larvicidal activities. Stigmasterol is a steroidal compound used as the precursor of vitamin D3 and it may be employed as antimicrobial, anticancer, anti-arthritic, antiasthma, diuretic and anti-inflammatory and also useful in prevention of certain cancers, including ovarian, prostate, breast and colon cancers (Kametani and Furuyama, 1987). It also exhibits potent antioxidant, hypoglycemic and thyroid inhibiting properties (Panda *et al*., 2009) as well as inhibits several pro-inflammatory and matrix degradation mediators typically involved in osteoarthritis-induced cartilage degradation (Gabay *et al*., 2010). Dodecanoic acid and tetradecanoic acid are alcoholic compounds and it may used as antimicrobial agent, antiviral, candidicide and hypocholesterolemic agent (Saravana, 2013). Oleic acid is suggested to be a monounsaturated fatty acid, and it may be employed as anti-inflammatory, anti-androgenic, cancer preventive, dermatitigenic, hypocholesterolemic, anemiagenic, flavor, 5-alpha reductase inhibitor and insectifige. Vitamin E is suggested to be a vitamin compound and it may be employed as analgesic, anti-diabetic, anti-inflammatory, antioxidant, anti-dermatitic, anti-leukemic, antitumor, anticancer, hepatoprotective, anti-ageing, anti-ulcerogenic, vasodilator, antispasmodic, anti-bronchitic, anti-coronary, hypocholesterolemic and antispasmodic.

Similar results were also observed in the leaves of *Gmelina asiatica* which showed Pregnane – 3,11, 12,14,20 – pentol, 3,12, 20, triacetate 11 (hydroxyacetate), (3a, 11a, 12a, 14a), Tridecanoic acid, methyl ester, 10-Octadecanoic acid, methyl ester, 16-Octadecanoic acid, methyl ester, 2,7-Diphenyl-1,6-dioxopyridazino (4,5:2,3) pyrrolo (4,5,-d) pyridazine, spiro (androstane-3,2-thiazolidine), were anthelminthic, Anti-Inflammatory and Anti microbial activities and anti cancerous activity of the leaf extract (Azhagumurugan and Rajan, 2014). Similarly Merlin *et al*. (2009) identified twenty-two chemical compounds from the chloroform extract of *G. asiatica* aerial parts, of which six compounds were similar to that of the results obtained in the present study. The compounds were 1, 2 benzene dicarboxylic acid, diisooctyl ester, benzoic acid, 2-hydroxy, phenyl ester; n-hexadecanic acid; octadecanol, 2-bromo; octadecanoic acid and nonadecane. There are variations in the composition of chloroform and ethanol extracts in comparison to the crude extracts of other places or countries. These differences seem to depend on climatic changes and conditions, solvent types and methods of extraction (Arokiyaraj *et al*., 2009; Stojkovic *et al*., 2011) therefore; there are essential differences between the compounds of plants that have been previously reported with this plant.

Chemical components including hexadecanoic acid, 9, 12-octadecanoic acid, octadecanoic acid, 9-octadecenoic acid, eicosanoic acid, benzoic acid, and stigmasterol were reported from the different parts of *G. arborea* (Vijay *et al*., 2011; Mahadkar *et al*., 2013)whereas,oleic acid and linoleic acid are noticedin *G. arborea* stem (Ukkinen, 1982) andoctacosanolin *G. arborea* root (Joshi and Singh, 1980).

Compounds like n-hexadecanoic acid, 12-octadecanoic acid, dodecanoic acid, tetradecanoic acid, 1, 2-benzene dicarboxylic acid, butyl octyl ester, hexadecanoic acid, ethyl ester and 9,12-octadecadienoic acid (Z,Z) were identified in the ethanolic leaf extract of *Vitex altissima*, a Verbenaceae member (Sathish *et al*., 2012). Likewise, hexadecane, dodecanoic acid, nonadecane, eicosane, tetradecanoic acid, oleic acid, heptacosane, 9,12- octadecenoic acid, ethyl ester; n-hexadecanoic acid; 1,2-benzenedicarboxylic acid and 9-octadecenoic acid (Z)-ethyl ester were reported in *Clerodendrum inerme* and *C. phlomidis* leaves (Anandhi and Ushadevi, 2013; Balaji and Kilimozhi, 2014). The investigation concluded that

the stronger extraction capacity of ethanol could have produced a number of active constituents healthy environment (Daffodil *et al*., 2012; ThangaKrishnaKumari *et al*., 2012; Sheela and Uthayakumari, 2013).

Conclusion

In the present study the FTIR and GC-MS spectral analysis of *G. asiatica* leaf extract composed of various functional groups and variety of fatty acids which are responsible for many biological activities. Thus this type of spectral analyses is the first step towards understanding the nature of active principles in this medicinal plant which will be helpful for further detailed study.

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