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Phytochemical constituents of *Jasminum fluminense* Linnaeus (Oleaceae): An additional tool in the ecofriendly management of mosquitoes?

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Abstract
Plant based traditional knowledge has become an organized tool in search for new sources of drugs and neutraceuticals. Phytochemicals are primary and secondary compounds that occur naturally in plants. Phytoscience created from the integration of a range of disciplines, combine several different areas of chemistry, biochemistry, physiology, microbiology, medicine and agriculture. Researchers within the phytosciences work to elucidate and identify the bioactive components and define the best methods of extraction. Therefore, in the present study the phytochemical constituents were screened from the leaf and flower extracts of *Jasminum fluminense*.

Keywords: *Jasminum fluminense,* leaf and flower extracts, phytochemical constituents

1. Introduction
Plants are the basis of life on earth and are central to people's livelihoods. Tribals live in harmony with the nature and maintain a close link between man and environment. Indian subcontinent is being inhabited by over 53.8 million tribals in 5000 forest dominated villages of tribal community and comprising 15% of the total geographical area of Indian landmass, representing one of the greatest emporia of ethno-botanical wealth [1]. Traditional medical practices are an important part of the primary health care system in the developing world [2]. Plant based traditional knowledge has become an organized tool in search for new sources of drugs and neutraceuticals [3]. Phytochemicals are primary and secondary compounds that occur naturally in plants, vegetables and roots that have defense mechanism. Chlorophyll, proteins and common sugars are included in primary constituents and secondary compounds include terpenoids, alkaloids and phenolic compounds [4]. Despite the increasing use of herbal medicines, there is still a significant lack of research data in this field. Each medicinal plant and the specific plant part used as crude drug material contain active or major chemical constituents with a characteristic profile that can be used for chemical quality control and quality assurance. These constituents are described in the major chemical constituents. Today, the use of medicinal plants and their bioactive phytocompounds and the scientific knowledge about them comprises the modern field of phytosciences [5]. This is a science created from the integration of a range of disciplines that have never been linked before, combining several different areas of economic, social, and political fields, chemistry, biochemistry, physiology, microbiology, medicine and agriculture. Phytosciences differ from the other biomedical sciences wherein instead of testing a hypothesis, researchers try to determine whether plants commonly used in traditional medicine bring benefits for health and, if so, what are their mechanisms of action? Despite the common belief that bioactive phytocompounds are safe, they have inherent risks just like all active chemical compounds. Researchers within the phytosciences are working to elucidate the side-effects, calculate appropriate dosages, identify the bioactive components, and define the best methods of extraction and conservation [5]. In the present study, the phytochemical constituents were screened from the leaf and flower extracts of *Jasminum fluminense*.

2. Materials and methods
2.1 Preparation and screening of phytoextracts
Fresh healthy leaves and flowers of *Jasminum fluminense* were collected in and around of Walajah and Ponnai villages, Vellore district, Tamil Nadu, India.

Leaves were washed under running tap water to remove all traces of soil particles and other dirt. It was then shade dried for 10-15 days. The leaves were then powdered using an electric blender and sieved to obtain a fine powder. The powdered leaves were used for the extraction process. The leaf powder was extracted using a Soxhlet apparatus [6]. The plant material (1Kg) was soxhleted subsequently with 3L of solvents *viz*., chloroform and methanol each. The leaf extract was concentrated by evaporation [7]. The yield was used for further phytochemical analysis. Likewise, the same methodology was adopted for the flowers. The crude chloroform and methanolic leaf and flower extracts of *Jasminum fluminense* were screened for the presence of phytochemicals, *viz*., alkaloids, amino acids, carbohydrates, flavonoids, glycosides, phenols, proteins, saponins and tannins using standard tests.

2.2 Gas Chromatography-Mass Spectrometry (GC-MS)

GC-MS is a technique; consisting of two analytical procedures in sequence, namely a Gas Chromatography (GC) separation followed by Mass Spectroscopy (MS) detection. The purpose of the GC step is to separate multiple compounds in a sample so that they reach the MS detector one at the time. The GC uses a high-resolution fused silica capillary column housed in a temperature-controlled oven. The capillary column contains a stationary phase; a fine solid support coated with a nonvolatile liquid. The solid can itself be the stationary phase. Gas chromatography (GC) is a widely applied technique in many branches of science and technology. For over half a century, GC has played a fundamental role in determining how many components and in what proportion they exist in a mixture. However, the ability to establish the nature and chemical structure of these separated and quantified compounds is ambiguous and reduced, and requires a spectroscopic detection system. The most used, is the mass spectrometric detector (MSD), which allows obtaining the "fingerprint" of the molecule, i.e., its mass spectrum. Mass spectra provide information on the molecular weight, elemental composition, if a high resolution mass spectrometer is used, functional groups present, and, in some cases, the geometry and spatial isomerism of the molecule.

3. Results

The results of the screening for the presence of phytochemical constituents present in the chloroform and methanol extracts of *Jasminum fluminense* are presented in Table 1. Alkaloids, flavonoids, tannins and glycosides were present in all the screened phytoextracts. None of the phytoextracts showed presence of proteins and amino acids. The GC-MS of the chloroform and methanol leaf extract showed presence of six phytochemical constituents each (Figure 1 and 2; Table 2 and 3) whereas for the flower extract, it was 12 and 11 respectively (Figure 3 and 4; Table 4 and 5).

4. Discussion

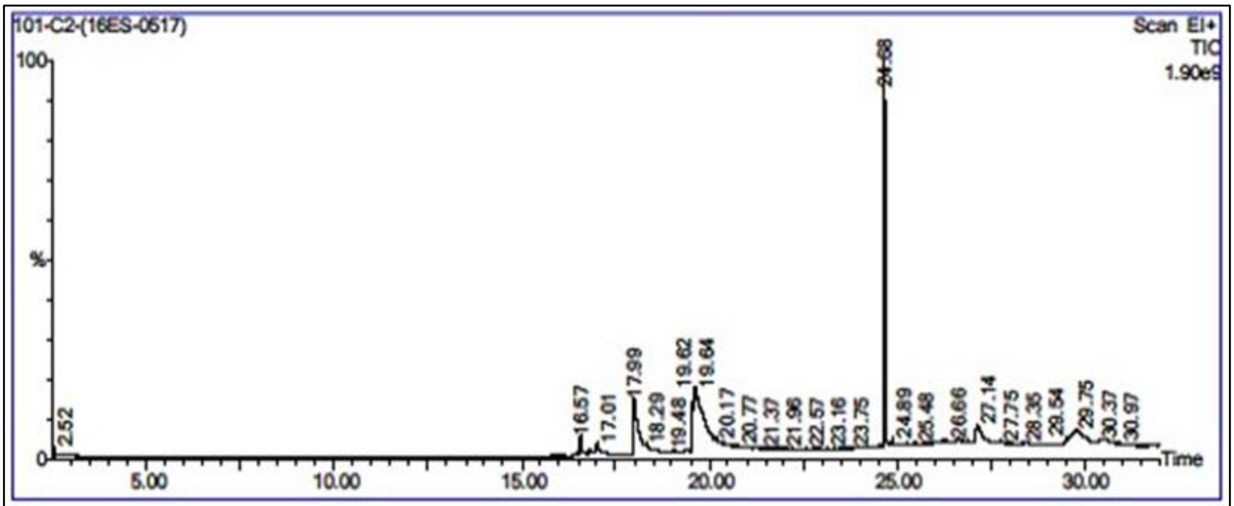
Plants are a rich source of secondary metabolites with interesting biological activities. In general, secondary metabolites are an important source with a variety of structural arrangements and properties. The World Health Organization estimates that plant extract or their active constituents are used as folk medicine in traditional therapies of 80% of the world's population. There is a growing awareness in correlating the phytochemical constituents of a medicinal plant with its pharmacological activity. Phytochemical constituents are known to exhibit medicinal as well as physiological activities. GC-MS analysis of chloroform and methanol leaf extract showed six major peaks indicating the presence of various phytochemical components whereas the flower extract exhibited twelve and eleven peaks respectively. Plants and plant derived products are rich in natural phytochemicals [8], which make them effective against different microbes and pests. Some of these chemicals have also been used successfully for controlling mosquito because of their larvicidal, ovicidal and skin repellent effects. Phytochemicals derived from plant sources act as insect larvicides, insect growth regulators, repellent, ovipositor attractant and have different activities as reported by many researchers [9]. The phytocompounds like phytol, squalene and tocopherol can be used as effective mosquitocides as earlier reports suggests that these above mentioned phytocompounds possessed mosquito larvicidal properties obtained from plants. Phytol present in the leaf extract of *Lantana camara* [10]; *Azadirachta indica* [11] and *Ocimum gratissimum* [12, 13] possessed larvicidal properties against *Aedes aegypti* and *Culex quinquefasciatus*; *Premna latifolia* against *Aedes albopictus* [14]; *Anthocephalus cadamba* against *Culex quinquefasciatus* [15]. Squalene present in the leaf extracts of *Heliotropium indicum* and *Mukia maderaspatana* exhibited larvicidal properties against *Aedes aegypti* [16]; *Acalypha indica* against *Aedes aegypti*, *Anopheles stephensi* and *Culex quinquefasciatus* [17]; and *Anthocephalus cadamba* against *Culex quinquefasciatus* [15]. Tocopherol present in the stem bark of *Casuarina equisetifolia* possessed larvicidal properties against *Aedes aegypti* and *Anopheles gambiae* [18]. Linolenic acid present in the seeds of *Millettia pinnata* exhibited larvicidal properties against *Culex pipiens*, *Aedes aegypti* and *Aedes albopictus*. The mechanism of larvicidal action might be due to interference with the octopaminergic system besides acting on both AChE and octopaminergic receptor [19]. The leaves of *Vitex altissima*, *Vitex negundo* and *Vitex trifolia* had presence of linolenic acid exhibiting larvicidal properties against *Culex quinquefasciatus* [20].

Hexadecanoic acid present in the leaf of *Feronia limonia* possessed larvicidal properties against *Aedes aegypti*, *Anopheles stephensi* and *Culex quinquefasciatus* [21]; in the leaf extracts of *Heliotropium indicum* and *Mukia maderaspatana* against *Aedes aegypti* [16]; in *Halophila ovalis* which causes repellent and adulticidal activity against *Culex quinquefasciatus*. They are natural insecticides and their mechanism of action might be due to inhibition of poly (ADP-ribose) polymerase enzyme which is involved in the DNA repair in adult mosquito, alterations in the siphon and toxicity of prothoracic glands in instar larvae [22]; *Anthocephalus cadamba* exhibiting larvicidal activity against *Culex quinquefasciatus* [15]; Hexadecanoic acid had larvicidal activity against *Aedes aegypti* [23], larvicidal and pupicidal activity against *Anopheles stephensi*, *Culex quinquefasciatus* and *Aedes aegypti* [24]; flowers of *Averrhoa bilimbi* exhibited larvicidal properties against *Anopheles barbirostris* [25]; in *Tarchonanthus camphoratus* against *Anopheles arabiensis* [26]. Eicosanoic acid present in *Leucas aspera* possessed larvicidal activity against *Aedes aegypti*, *Anopheles stephensi* and *Culex quinquefasciatus* [27]; in *Arachis hypogaea* against *Aedes aegypti* and *Anopheles stephensi* [28]. Hexatriacontane is present in leaves of *Coccinia grandis* and possesses larvicidal activity against *Aedes aegypti*, *Anopheles stephensi* and *Culex quinquefasciatus* [29]; in *Terminalia chebula* leaves against *Culex quinquefasciatus* [30]. Heptacosane in *Mukia maderaspatana* leaves possessed larvicidal activity against

Aedes aegypti [16]; in leaves of *Acalypha indica* [17] and *Vitex negundo* [31] against *Aedes aegypti*, *Anopheles stephensi* and *Culex quinquefasciatus* for larvicidal, oviposition deterrent and repellent properties. Hentriacontane present in flowers of *Tabebuia rosea* exhibited larvicidal activity against *Anopheles subpictus* and *Culex quinquefasciatus* [32]. Phenylethanolamine present in *Anthocephalus cadamba* possesses larvicidal activity against *Culex quinquefasciatus* [15]. Cinnamic acid obtained from *Piper alatabaccum* branches and *Piper tuberculatum* leaves possessed larvicidal activity against *Anopheles darlingi* [33]. They also showed strong properties against larvae of *Aedes aegypti* [34] when obtained from leaves of *Cinnamomum osmophloeum* and *Schinus terebinthifolius* [35]. Phytochemicals derived from plants act as general toxicants against adult as well as against larval stages of mosquitoes, while some act as growth inhibitors or as chemosterilants or act as repellents or attractants. Further, from the present study it can be suggested that the phytochemical constituents obtained from *Jasminum fluminense* when tested against mosquitoes can serve as an additional tool in the ecofriendly management of mosquitoes.

Table 1: Screening of *Jasminum fluminense* for presence of phytochemicals

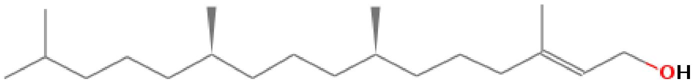
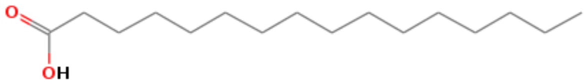
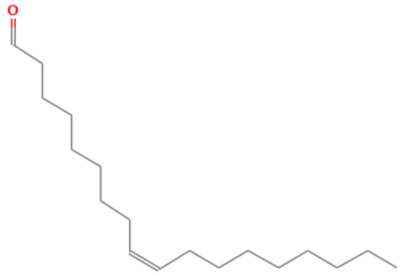
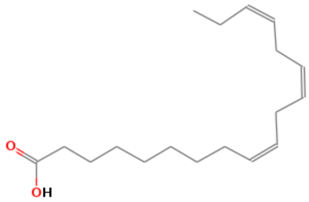
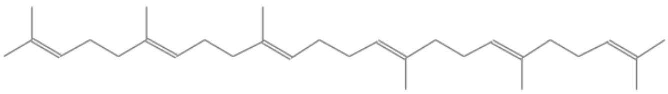
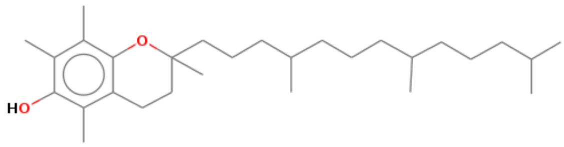
Phytochemicals	Test	Leaf extract		Flower extract	
		Chloroform	Methanol	Chloroform	Methanol
Alkaloids	Hager	+	+	+	+
Carbohydrates	Benedict	-	+	-	-
Saponins	Forth	-	+	-	-
Flavonoids	Alkaline reagent	+	+	+	+
Proteins and amino acids	Ninhydrin	-	-	-	-
Phenols	Ferric chloride	-	+	-	-
Tannins	Tannin	+	+	+	+
Glycosides	Glycoside	+	+	+	+
(+) indicates presence of particular phytocompound; (-) indicates absence of particular phytocompound					

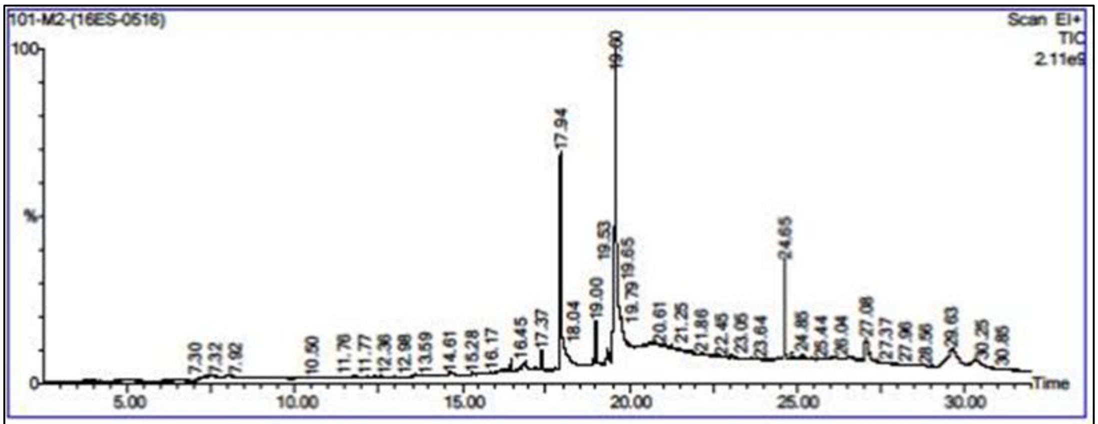


#	RT	Scan	Height	Area	Area %	Norm %
1	16.569	2813	88,642,552	4,693,794.0	2.046	4.87
2	17.995	3096	266,518,496	47,301,836.0	20.616	49.09
3	19.565	3412	233,968,416	10,911,084.0	4.756	11.32
4	19.655	3430	293,345,792	96,348,976.0	41.994	100.00
5	24.678	4434	1,834,022,656	56,885,104.0	24.793	59.04
6	27.169	4932	79,528,976	13,296,942.0	5.795	13.80

Fig 1: GC-MS analysis of *Jasminum fluminense* chloroform leaf extract

Table 2: Phytochemical constituents of *Jasminum fluminense* chloroform leaf extract

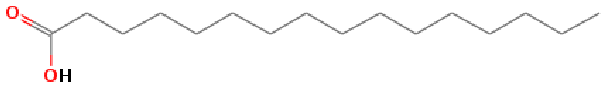
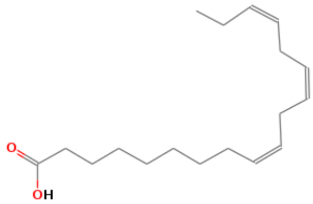
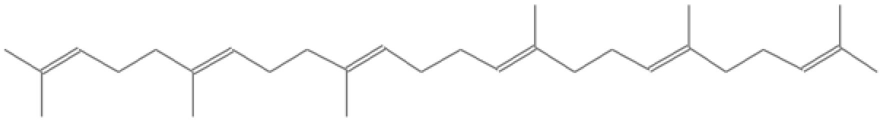
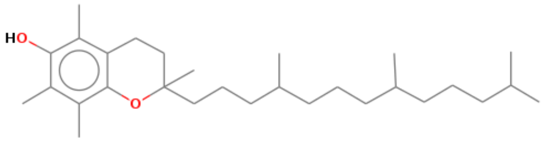
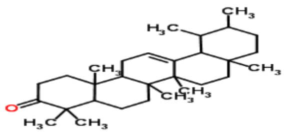
Phytochemical constituent	Molecular formula (Molecular weight)	Structure
Phytol	$C_{20}H_{40}O$ (296.531)	
Hexadecanoic acid	$C_{16}H_{32}O_2$ (256.424)	
Z-9-octadecenal	$C_{18}H_{34}O$ (266.462)	
Linolenic acid	$C_{18}H_{30}O_2$ (278.430)	
Squalene	$C_{30}H_{5}0$ (410.718)	
D-α-tocopherol	$C_{29}H_{50}O_2$ (430.706)	

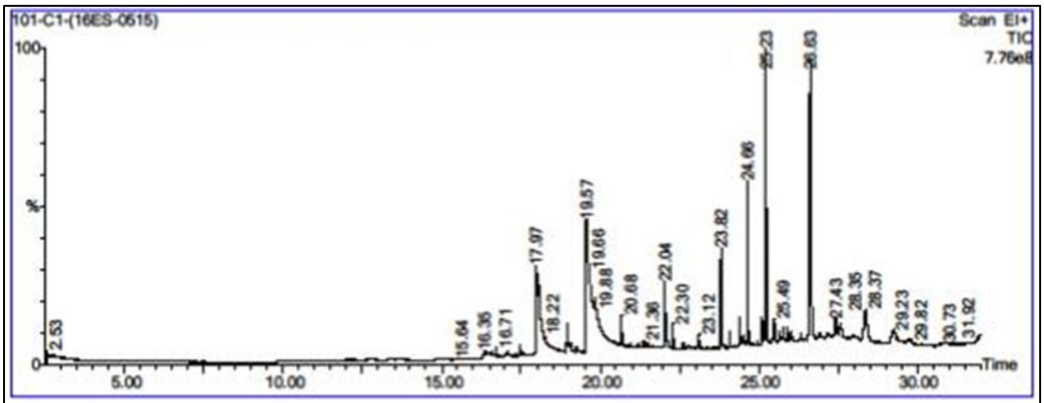


#	RT	Scan	Height	Area	Area %	Norm %
1	17.940	3087	1,359,673,600	78,621,312.0	23.817	46.73
2	19.000	3299	269,512,544	9,413,926.0	2.852	5.60
3	19.600	3419	1,926,520,192	168,247,472.0	50.967	100.00
4	24.652	4429	626,043,136	18,115,762.0	5.488	10.77
5	27.093	4917	143,062,560	18,224,478.0	5.521	10.83
6	29.654	5429	112,642,768	37,487,716.0	11.356	22.28

Fig 2: GC-MS analysis of *Jasminum fluminense* methanolic leaf extract

Table 3: Phytochemical constituents of *Jasminum fluminense* methanolic leaf extract

Phytochemical constituent	Molecular formula (Molecular weight)	Structure
Methyl linolenate	$C_{19}H_{32}O_2$ (292.456)	
Hexadecanoic acid	$C_{16}H_{32}O_2$ (256.424)	
Linolenic acid	$C_{18}H_{30}O_2$ (278.430)	
Squalene	$C_{30}H_{50}$ (410.718)	
D-α-tocopherol	$C_{29}H_{50}O_2$ (430.706)	
α-amyrone	$C_{30}H_{48}O$ (424.702)	



#	RT	Scan	Height	Area	Area %	Norm %
1	17.975	3094	215,230,032	18,927,426.0	8.498	34.54
2	18.080	3115	163,774,848	16,886,332.0	7.582	30.82
3	19.565	3412	323,961,248	54,795,520.0	24.603	100.00
4	19.835	3466	128,062,936	24,615,264.0	11.052	44.92
5	22.041	3907	161,339,744	7,667,799.5	3.443	13.99
6	23.817	4262	244,132,032	7,483,661.5	3.360	13.66
7	24.402	4379	70,985,440	2,836,973.0	1.274	5.18
8	24.657	4430	399,291,104	10,883,612.0	4.887	19.86
9	25.227	4544	718,370,560	24,119,074.0	10.829	44.02
10	26.628	4824	683,707,584	42,186,520.0	18.942	76.99
11	27.433	4985	44,791,808	3,523,797.0	1.582	6.43
12	28.374	5173	72,159,664	8,792,791.0	3.948	16.05

Fig 3: GC-MS analysis of *Jasminum fluminense* chloroform flower extract

Table 4: Phytochemical constituents of *Jasminum fluminense* chloroform flower extract

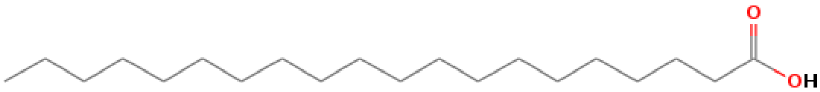
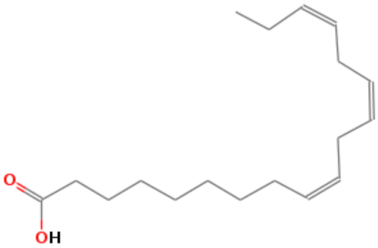
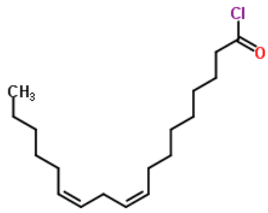
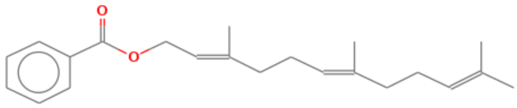
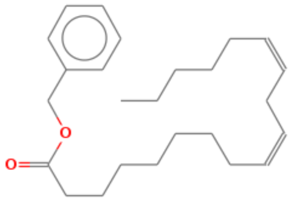
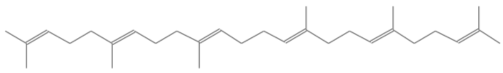
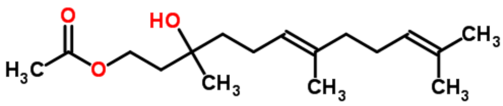
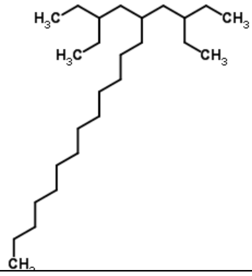
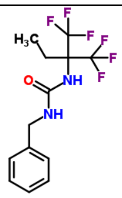
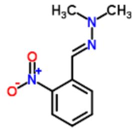
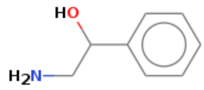
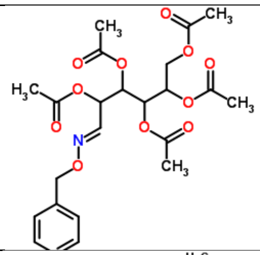
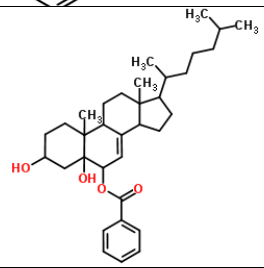
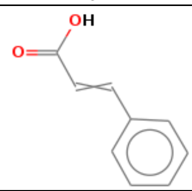
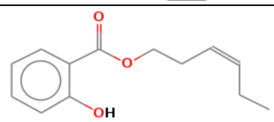
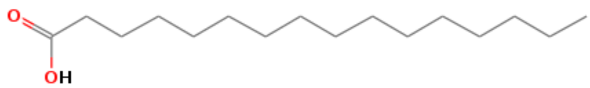
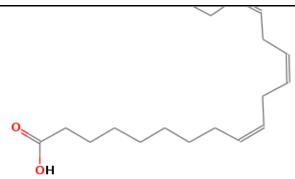
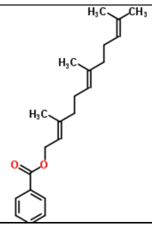
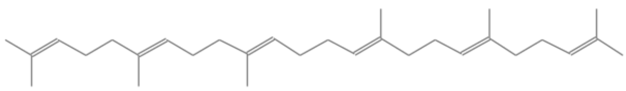
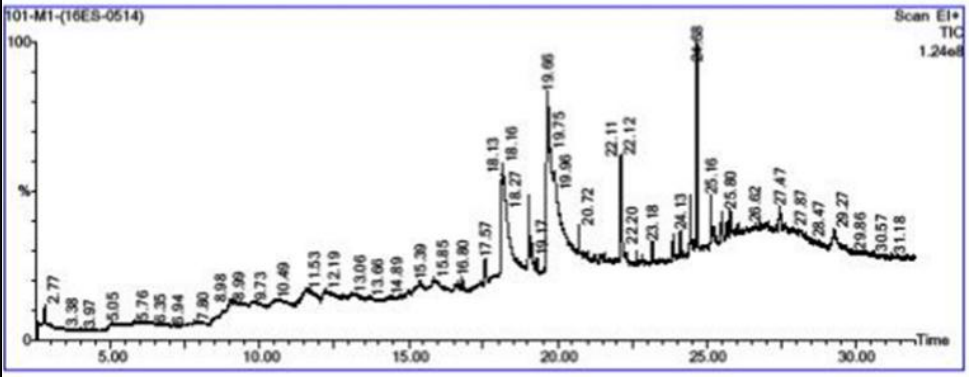
Phytochemical constituent	Molecular formula (Molecular weight)	Structure
Hexadecanoic acid	$C_{16}H_{32}O_2$ (256.424)	
Eicosanoic acid	$C_{20}H_{40}O_2$ (312.530)	
Linolenic acid	$C_{18}H_{32}O_2$ (280.430)	
Linoleoyl chloride	$C_{18}H_{31}OCl$ (298.891)	
(2E, 6E)-farnesyl benzoate	$C_{22}H_{30}O_2$ (326)	
Hexatriacontane	$C_{36}H_{74}$ (506.973)	
Benzyl linoleate	$C_{25}H_{38}O_2$ (370.568)	
Squalene	$C_{30}H_{50}$ (410.718)	
Heptacosane	$C_{27}H_{56}$ (380.733)	
Hentriacontane	$C_{31}H_{64}$ (436.840)	
3,7,11-trimethyl-3-hydroxy-6,10-dodecadien-1-yl acetate	$C_{17}H_{30}O_3$ (282.418)	
Octadecane, 3-ethyl-5-(2-ethylbutyl)-	$C_{26}H_5$ (366.707)	

Table 5: Phytochemical constituents of *Jasminum fluminense* methanolic flower extract

Phytochemical constituent	Molecular formula (Molecular weight)	Structure
1-Benzyl-3-[1,1,1-trifluoro-2-(trifluoromethyl)-2-butanyl]urea	$C_{13}H_{14}ON_2F_6$ (328.254)	
(2E)-1,1-Dimethyl-2-(2-nitrobenzylidene)hydrazine	$C_9H_{11}O_2N_3$ (193.202)	
Phenylethanolamine	$C_8H_{11}ON$ (137.179)	
Glucose benzyloxime pentaacetate	$C_{23}H_{29}O_{11}N$ (495.477)	
3,5-dihydroxycholest-7-en-6-yl benzoate	$C_{34}H_{50}O_4$ (522.758)	
Cinnamic acid	$C_9H_8O_2$ (148.159)	
cis-3-hexenyl salicylate	$C_{13}H_{16}O_3$ (220.264)	
Hexadecanoic acid	$C_{16}H_{32}O_2$ (256.424)	
Linolenic acid	$C_{18}H_{32}O_2$ (280.430)	
Benzoic acid, [(E,E)-3,7,11-trimethyl-2,6,10-dodecatrien-1-yl] ester	$C_{22}H_{30}O_2$ (326.472)	
Squalene	$C_{30}H_{50}$ (410.718)	



#	RT	Scan	Height	Area	Area %	Norm %
1	9.101	1320	8,629,297	6,771,457.0	11.154	27.93
2	9.816	1463	6,365,176	2,790,465.8	4.597	11.51
3	10.602	1620	5,234,670	3,244,129.2	5.344	13.38
4	11.577	1815	6,936,600	3,552,651.0	5.852	14.65
5	12.187	1937	4,981,442	1,616,202.5	2.662	6.67
6	15.369	2577	5,273,487	1,237,458.4	2.038	5.10
7	15.854	2670	5,025,780	1,438,933.4	2.370	5.94
8	18.160	3131	46,055,396	10,300,854.0	16.968	42.49
9	19.660	3431	74,749,896	24,242,906.0	39.935	100.00
10	22.121	3923	43,308,448	2,631,993.5	4.336	10.86
11	24.682	4435	86,835,984	2,879,020.2	4.743	11.88

Fig 4: GC-MS analysis of *Jasminum fluminense* methanolic flower extract

5. References

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