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Chemical fingerprint of essential oil components from fresh leaves of *Glycosmis pentaphylla* (Retz.) Correa

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Abstract
The present research was undertaken to characterize the promising bioactive constituents of *Glycosmis pentaphylla* leaves. The volatile oil was obtained by hydrodistillation and the components present were analyzed by gas chromatography-mass spectrometry. Elucidation on mass spectrum GC-MS was conducted using the database of National Institute of Standard and technology (NIST). The GC-MS analysis of essential oil of *Glycosmis pentaphylla* leaves resolved into sixty seven compounds representing 99.71% of essential oil. The active principles with their retention time, peak area, molecular formula, molecular weight, structure and category of the compound were predicted. Phytol (28.03%) was the dominant compound in the oil. From the present study, it is revealed that the oil present in leaf is very rich in diverse phytochemicals. Most of the identified compounds are basically biological important. The results are in conformity with the tribal conviction for which they use as traditional medicine for diverse bioactivities and curing of ailments.

Keywords: *Glycosmis pentaphylla*, essential oil, GC-MS, Phytol, sesquiterpenes.

1. Introduction
The therapeutic use of plants against critical human illnesses predates recorded history and represents the most significant direct antecedent to modern medicine [1]. Scientific research has allowed discovering a wide range of active constituents, of which the most important as far as health is concerned are essential oils, alkaloids, glycosides or heterosides, mucilage and gums, and tannins. The active constituents specific to a particular species are characterized as chemical markers. Use of chemical markers is an effective tool to resolve problems in standardization of botanicals, using chemical fingerprinting and in chromatographic finger printing of botanicals to demarcate them on the basis of their chemotypes and geographical origin [2].

Glycosmis pentaphylla, belonging to the Rutaceae family, is a shrub or small (1.5–5 m) tree, widely distributed, spanning from India, Malaysia and Southern China to the Philippine Islands where it occurs in tropical forests at low altitudes. It has been used as folk medicine for the treatment of fever, liver complaints, jaundice, cough, eczema, anaemia, diarrhoea, and rheumatism [3, 4]. Phytochemically speaking, *Glycosmis pentaphylla* were investigated on a few occasions. Most of the phytochemical work realized in this field resulted in the isolation of hydrophobic alkaloids acridone, carbazoles, quinolones and quinazolones [5-8]. Studies showed the extracts of *G. pentaphylla* having potent anthelmintic, antipyretic, hepatoprotective, antibacterial, antioxidant, antidiabetic and antinociceptive properties [9, 10]. Regarding the phytochemistry of essential oil of *G. pentaphylla*, the composition of essential oil was shown, and aliphatic ketones 2- tridecanone 6,10,14- trimethyl-2-pentadecanone were the major components identified [11]. Review of literature divulges that the essential oil composition within the species may vary significantly and such differences in the composition of their essential oil could be due to natural chemical variation called chemotype, which occur in the secondary metabolism of plants and could possibly due to organ of the plant studied and also induced by environmental factors such as soil type, altitude, sun exposure, rain and seasonal variation besides the method of oil isolation [12]. As far the literature investigation could ascertain, the fresh leaves of *Glycosmis pentaphylla* were never examined regarding their volatile oil composition. Hence, the aim of the present study is to provide the first detail GC-MS analysis of the volatile components of the fresh leaves of *Glycosmis pentaphylla*.

2. Materials and Methods

2.1 Plant material

Fresh leaves of *Glycosmis pentaphylla* were collected from its natural habitat from district of Thiruvananthapuram (Latitude- 8.54ºN and Longitude- 76.91ºE), Kerala, India, in January 2014. The titled plant was botanically identified by Curator, department of Botany, University of Kerala and a voucher specimen (KUBH 5858) has been deposited at the herbarium of Botany department, University of Kerala, India.

2.2 Extraction of essential oil

The leaves were slightly washed to remove dust and other physical contaminants. The leaves were then reduced to a suitable size using electric blender and loaded them in the extraction flask. The essential oil was extracted by hydrodistillation for 8 h (60 g of sample in 500 mL of distilled water) using Clevenger apparatus [13]. The essential oil obtained was separated from aqueous phase and stored in sealed glass vial protected from the light at 4 ºC until analysis. The oil sample was subsequently analysed by GC-MS.

2.3 GC-MS analysis

The analysis of the oil was performed using GC-MS (Model: GCMS- QP 2010, Shimadzu, Tokyo, Japan) equipped with a VF 5 ms fused silica capillary column of 30 m length, 0.25 mm diameter and 0.25 mm film thickness. For GC-MS detection, electron ionization energy of 70 eV was used. The carrier gas was Helium (99.99%) used ata constant flow rate of 1.51 ml/min. Injector and mass transfer line temperature were set at 2000 C and 2400 C respectively. The oven temperature was set from 70 to 2200 C at 100 C/min. Two µL of sample was injected in a split mode with a scan range of 40-1000 m/z. The total running time of GC-MS was 31 min. The relative percentage of the extract was expressed as percentage with peak area normalization.

2.4 Identification of the compounds

Elucidation on mass spectrum GC-MS was conducted using the database of National Institute of Standard and technology (NIST). The spectrum of the unknown components was compared with the spectrum of the known components stored in the NIST08 library source [14]. The name, molecular weight and molecular mass of the identified compounds were further confirmed by comparison of their retention indices with literature data. For quantitative analysis, compounds concentrations (as % content) were calculated by integrating their corresponding chromatographic peak areas.

3. Results

The essential oil of fresh leaves of *Glycosmis pentaphylla* was obtained by conventional hydro- distillation method using a Clevenger apparatus. The hydrodistillation gave characteristic odour, golden yellow oil. In this study GC-MS fingerprinting of essential oil of fresh leaves of *Glycosmis pentaphylla* revealed several peaks. The gas chromatogram shows the relative concentrations of various compounds getting eluted as a function of retention time (Figure 1). Identification of the compounds was accomplished by comparing their mass spectra and retention indices with those given in the literature and those authentic samples. The active principles with their retention time (RT), molecular formula, molecular weight (MW) and concentration (%) are presented in Table 1. They are listed by their order of retention times. The heights of the peak indicate the relative concentrations of the compounds present in essential oil of *Glycosmis pentaphylla* leaves. Sixty seven compounds were identified representing about 99.71% of the total oil's compounds.

The most prevailing major compounds were Phytol (28.03%), Bicyclo[5.2.0]nonane, 2-methylene-4,8,8-trimethyl-4-vinyl (10.93%), 1,19-Eicosadiene (9.84%), 1,6-Cyclodecadiene, 1-methyl-5-methylene-8-(1-methylethyl)-,[S(E,E)]- (4.63%), Caryophyllene oxide (4.32%), (-)-Spathulenol (3.92%) and Bicyclogermacrene (3.55%)., and the minor compounds were Bicyclo[4.4.0]dec-1-ene, 2-isopropyl-5-methyl-9-methylene- (2.11%), Epiglobulol (1.75%), (-)-Globulol (1.59%), Naphthalene,1,2,3,5,6,8a-hexahydro-4,7-dimethyl-1-(1-methylethyl)-(1S-cis)-(1.53%), 1H Indene, (1.33%), Ledol (1.33%), Cyclohexane ,1-ethenyl -1-methyl -2,4-bis (1-methylethenyl)-, [1S-(1.alpha.,2.beta.,4.beta.)]- (1.23%), Santolina triene (1.23%), Toluene (1.20%), Humulene (1.20%), gamma.-Elemene (1.18%), 2-Pyrrolidinone (1.10%) and Cyclohexane, 1-ethenyl-1-methyl-2-(1-methyethenyl)-4-(1-methylethylidene)- (1.05%). The remaining compounds were present in less than 1%.

Chemical class of the detected volatile compounds are displayed in Table 2. The compounds were separated into monoterpenes, sesquiterpenes, diterpenes, alkanes and alkenes, fatty acids and others. The most representative compounds were sesquiterpenes (46.39%) followed by diterpenes (28.58%), fatty acids (10.61%), monoterpenes (5.81%) and alkane and alkene (3.83%). Major phytocompounds and its biological activities obtained through the GC-MS study of leaves of *Glycosmis pentaphylla* are presented in Table 3. The biological activities listed are based on Dr. Duke's phytochemical and ethnobotanical online databases by Dr. Jim Duke of Agricultural Research Service/ USDA.

4. Discussion

The chemical and chromatographic fingerprints provide adequate information about the safety and credibility, with evidence for the product. A chemical profile of sixty seven compounds was identified representing about 99.71% of the total oil's compounds. Usually the major compounds mirror the biological activities of the essential oil from which it is extracted. Essential oil of *G. pentaphylla* composed mainly of terpenes (monoterpenes, sesquiterpene and diterpene) and its biological activity may be attributed to its high concentration. However, the activity of major components may be modulated by other minor components present in the oil.

Among the identified compounds, the diterpene alcohol, Phytol, which is at hand in highest with 28.09% , is vital in the dispensation of glucose and can trigger enzymes within the body that have strong positive effects on insulin level. This means that Phytol in the human diet could perhaps help reinstate the metabolic activities of those with type-2 diabetes. Phytol confirmed a strong antioxidant effect *in vitro* in its capacity to remove hydroxyl radicals and nitric oxide as well as to prevent the formation of thiobarbituric acid reactive substances (TBARS) [15]. Sesquiterpene biosynthesis seems to be complex since the formation *via* either pathway (mevalonic or methylerythrytol) or a combination of both has been reported [16]. Nevertheless, these appear to be ubiquitous in plant taxa and some insects, and are associated to the cytosol–mitochondria. Sesquiterpenes were reported to have anti-hyperlipidemic activity.

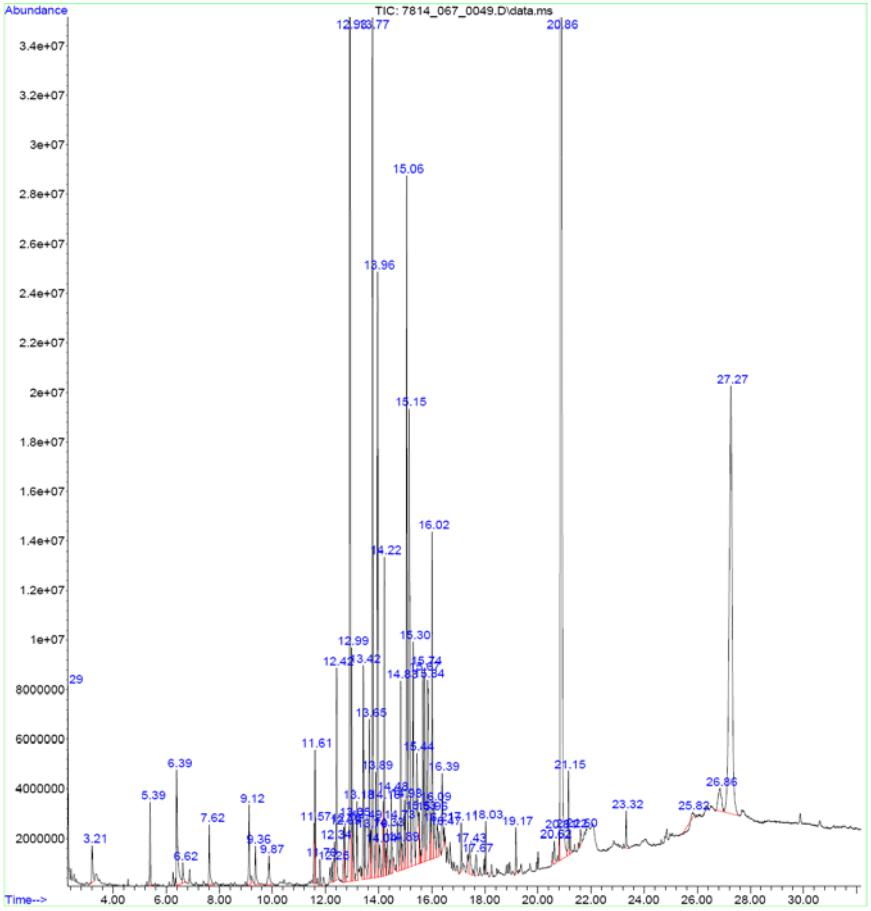

Fig 1: GC-MS Chromatogram of essential oil of *Glycosmis pentaphylla* leaves

Table 1: Phytocompounds identified in the essential oil of *Glycosmis pentaphylla* leaf by GC-MS.

Peak no	Name of the compound	RT	Molecular formula	Molecular weight (g/mol)	Area %
1	Toluene	2.29	C_7H_8	92.13	1.2
2	3- Hexen-1-ol, (Z)	3.21	$C_6H_{12}O$	100.15	0.3
3	.beta. – Pinene	5.39	$C_{10}H_{16}$	136.23	0.45
4	2-Pyrrolidinone, 1-methyl-	6.39	C_4H_7NO	85.1	1.1
5	.beta.-Ocimene	6.62	$C_{10}H_{16}$	136.23	0.17
6	1,6- Octadien-3-ol, 3,7-dimethyl-	7.61	$C_{11}H_{18}O_2$	182.25	0.41
7	Terpinen-4-ol	9.11	$C_{10}H_{18}O$	154.24	0.53
8	.alpha.-Terpineol	9.36	$C_{10}H_{18}O$	154.24	0.3
9	cis-3-Hexenyl isovalerate	9.86	$C_9H_{16}O_2$	156.23	0.28
10	1,5,5-Trimethyl-6-methylene-cyclohexene	11.56	$C_{10}H_{16}$	136.23	0.29
11	2-Carene	11.6	$C_{10}H_{16}$	136.23	0.7
12	.alpha.-Cubebene	11.79	$C_{15}H_{24}$	204.35	0.13
13	.alfa.-Copaene		$C_{15}H_{24}$	204.35	0.11
14	5-Amino-1-phenylpyrazole	12.33	$C_9H_9N_3$	159.19	0.27
15	Cyclohexane, 1-ethenyl-1-methyl-2,4-bis(1-methylethenyl)-,[1S-(1.alpha.,2.beta.,4.beta.)]-	12.42	$C_{15}H_{24}$	204.35	1.23
16	Caryophyllene	12.69	$C_{15}H_{24}$	204.35	0.3
17	1H-Cyclopro[e]azulene, 1a,2,3,4,4a,5,6,7b-octahydro-1,1,4,7-tetramethyl-,[1arR-(1a.alpha.,4.alpha.,4a.beta.,7b.alpha.)]-	12.72	$C_{15}H_{24}$	204.35	0.34
18	Bicyclo[5.2.0]nonane, 2-methylene-4,8,8-trimethyl-4-vinyl-	12.92	$C_{15}H_{24}$	204.35	10.93
19	.gamma.-Elemene	12.98	$C_{15}H_{24}$	204.35	1.18
20	.beta.-copaene	13.04	$C_{15}H_{24}$	204.35	0.37
21	Aromadendrene	13.18	$C_{15}H_{24}$	204.35	0.47
22	Humulene	13.42	$C_{15}H_{24}$	204.35	1.2

23	Alloaromadendrene	13.49	$C_{15}H_{24}$	204.35	0.42
24	.gamma.-Muurolene	13.64	$C_{15}H_{24}$	204.35	0.97
25	Naphthalene, 1,2,4a,5,6,8a-hexahydro-4,7-dimethyl-1-(-1-methylethyl)-	13.7	$C_{15}H_{24}$	204.35	0.31
26	1,6-Cyclodecadiene, 1-methyl-5-methylene-8-(1-methylethyl)-, [S(E,E)]-	13.76	$C_{15}H_{24}$	204.35	4.63
27	Naphthalene, 1,2,3,5,6,7,8,8a-octahydro-1,8a-dimethyl-7-(1-methylethylene)-,[1R-(1.alpha.,alpha.,7.beta.,8a.alpha.)]-	13.89	$C_{15}H_{24}$	204.35	0.61
28	Bicyclogermacrene	13.96	$C_{15}H_{24}$	204.35	3.55
29	1H-Cycloprop[e]azulene, decahydro 1,1,7-trimethyl-4-methylene-	14.03	$C_{15}H_{24}$	204.35	0.29
30	.gamma.-Muurolene	14.17	$C_{15}H_{24}$	204.35	0.41
31	Naphthalene, 1,2,3,5,6,8a-hexahydro-4,7-dimethyl-1-(1-methylethyl)-(1S-cis)-	14.21	$C_{15}H_{24}$	204.35	1.53
32	Hotrienol	14.32	$C_{10}H_{16}O$	152.23	0.32
33	Aromandendrene	14.48	$C_{15}H_{24}$	204.35	0.57
34	Caryophyllene oxide	14.72	$C_{15}H_{24}O$	220.35	0.51
35	Cyclohexane, 1-ethenyl-1-methyl-2-(1-methyethenyl)-4-(1-methylethylidene)-	14.83	C_6H_{12}	84.16	1.05
36	3-Hexen-1-ol, benzoate, (Z)	14.89	$C_{13}H_{16}O_2$	204.26	0.2
37	4,7-Methanoazulene, 1,2,3,4,5,6,7,8-octahydro-1,4,9,9-tetramethyl-[1S-(1.alpha.,4.alpha.,7.alpha.)]-	14.97	$C_{15}H_{24}$	204.35	0.49
38	(-)-Spathulenol	15.05	$C_{15}H_{24}O$	220.35	3.92
39	Caryophyllene oxide	15.15	$C_{15}H_{24}O$	220.35	4.32
40	(-)-Globulol	15.29	$C_{15}H_{26}O$	222.36	1.59
41	1 H Indene, 1-ethylideneoctahydro-7a-methyl-(1E, 3a.alpha.,7a.beta.)	15.44	C9H8	116.16	1.33
42	cis-Thujopsene	15.52	$C_{15}H_{24}$	204.35	0.35
43	Ledol	15.67	$C_{15}H_{26}O$	222.36	1.33
44	Santolina triene	15.73	$C_{10}H_{16}$	136.23	1.23
45	Bicyclo[4.4.0]dec-1-ene, 2-isopropyl-5-methyl-9-methylene-	15.84	$C_{15}H_{24}$	204.35	2.11
46	Alloaromadendrene	15.96	$C_{15}H_{24}$	204.35	0.31
47	Epiglobulol	16.01	$C_{15}H_{26}O$	222.36	1.75
48	.beta.-Humulene	16.09	$C_{15}H_{24}$	204.35	0.45
49	Isoaromadendrene epoxide	16.2	$C_{15}H_{24}O$	220.35	0.35
50	trans-Z-.alpha.-Bisabolene epoxide	16.39	$C_{15}H_{24}O$	220.35	0.52
51	1H-Cycloprop[e]azulene	16.47	$C_{15}H_{24}$	204.35	0.07
52	Benzoic acid, heptadecyl ester	17.11	$C_{23}H_{28}N_2O_3$	380.48	0.29
53	trans-.beta.-Ionone	17.43	$C_{13}H_{20}O$	192.29	0.39
54	Isoshyobunone	17.67	$C_{15}H_{24}O$	220.35	0.25
55	2-Pentadecanone, 6,10,14-trimethyl	18.03	$C_{18}H_{36}O$	268.47	0.26
56	Isophytol	19.16	$C_{20}H_{40}O$	296.53	0.23
57	Phytol	20.61	$C_{20}H_{40}O$	296.53	0.2
58	.alpha.-Pyrrolidone, 5-[3-hydroxybutyl]-	20.8	$C_8H_{15}NO_2$	157.21	0.13
59	Phytol	20.86	$C_{20}H_{40}O$	296.53	28.03
60	Cyclopentane, 1,2,3,4,5-pentamethyl-	21.15	C10H20	140.26	0.51
61	3-Eicosene, (E)-	21.21	$C_{20}H_{40}$	280.53	0.15
62	trans-Geranylgeraniol	21.6	$C_{20}H_{34}O$	290.48	0.12
63	Fumaric acid, cis-hex-3-enyl tetra decyl ester	23.32	$C_4H_4O_4$	116.07	0.23
64	Cyclopentane,1,1,3-trimethyl-	25.82	C5H10	70.13	-0.1
65	9-Undecen-2-one, 6,10-dimethyl	26.85	$C_{13}H_{24}O$	196.33	0.57
66	1,19- Eicosadiene	27.26	$C_{20}H_{38}$	278.51	9.84
67	1,4-Bis(trimethylsilyl)benzene	33.84	$C_{12}H_{22}Si_2$	222.47	0.89
	Grouped components				
1	Monoterpenes				5.81
2	Sesquiterpenes				46.39
2	Diterpenes				28.58
4	Alkane and Alkene				3.83
5	Fatty acids				10.61
4	Others				4.49
	Total identified components				99.71

RT: Retention time

Area %: relative percentage obtained from peak area

Table 2: Nature of the compound

Peak no	Name of the compound	Nature of compound
1	Toluene	Aromatic hydrocarbon
2	3- Hexen-1-ol, (Z)	Alcohol
3	.beta. – Pinene	Monoterpene
4	2-Pyrrolidinone,1-methyl-	Pyrrolidines (aliphatic heteromonocyclic compounds)
5	.beta.-Ocimene	Monoterpene
6	1,6- Octadien-3-ol, 3,7-dimethyl-	Monoterpene
7	Terpinen-4-ol	Monoterpene
8	.alpha.-Terpineol	Monoterpene alcohol
9	cis-3-Hexenyl isovalerate	Fatty acid
10	1,5,5-Trimethyl-6-methylene-cyclohexene	Monoterpene
11	2-Carene	Monoterpene
12	.alpha.-Cubebene	Sesquiterpene
13	.alpha.-Copaene	Sesquiterpene
14	5-Amino-1-phenylpyrazole	Azoles
15	Cyclohexane, 1-ethenyl-1-methyl-2, 4-bis(1-methylethenyl)-,[1S-(1.alpha.,2.beta.,4.beta.)]-	Cycloalkane
16	Caryophyllene	Bicyclic sesquiterpene
17	1H-Cyclopro[e]azulene, 1a,2,3,4,4a,5,6,7b-octahydro-1,1,4,7-tetramethyl-,[1arR-(1a.alpha.,4.alpha.,4a.beta.,7b.alpha.)]-	Tricyclic sesquiterpene
18	Bicyclo[5.2.0]nonane, 2-methylene-4,8,8-trimethyl-4-vinyl-	Sesquiterpene
19	.gamma.-Elemene	Monocyclic sesquiterpene
20	.beta.-copaene	Tricyclic sesquiterpene
21	Aromandendrene	Tricyclic sesquiterpene
22	Humulene	Monocyclic sesquiterpene
23	Alloarmadendrene	Tricyclic sesquiterpene
24	.gamma.-Muurolene	Oxygenated sesquiterpene
25	Naphthalene, 1,2,4a,5,6,8a-hexahydro-4,7-dimethyl-1-(-1-methylethyl)-	Hydrocarbon sesquiterpene
26	1,6-Cyclodecadiene, 1-methyl-5-methylene-8-(1-methylethyl)-,[S(E,E)]-	Sesquiterpene
27	Naphthalene, 1,2,3,5,6,7,8,8a-octahydro-1,8a-dimethyl-7-(1-methylethylene)-,[1R-(1.alpha.,alpha.,7.beta.,8a.alpha.)]-	Hydrocarbon sesquiterpene
28	Bicyclogermacrene	Monocyclic sesquiterpene
29	1H-Cycloprop[e]azulene, decahydro 1,1,7-trimethyl-4-methylene-	Tricyclic sesquiterpene
30	.gamma.-Muurolene	Oxygenated sesquiterpene
31	Naphthalene, 1,2,3,5,6,8a-hexahydro-4,7-dimethyl-1-(1-methylethyl)-(1S-cis)-	Hydrocarbon sesquiterpene
32	Hotrienol	Monoterpene
33	Aromandendrene	Tricyclic sesquiterpene
34	Caryophyllene oxide	Bicyclic sesquiterpene
35	Cyclohexane, 1-ethenyl-1-methyl-2-(1-methyethenyl)-4-(1-methylethylidene)-	Cycloalkane
36	3-Hexen-1-ol, benzoate, (Z)	Monoterpene
37	4,7-Methanoazulene, 1,2,3,4,5,6,7,8-octahydro-1,4,9,9-tetramethyl-[1S-(1.alpha.,4.alpha.,7.alpha.)]-	Sesquiterpene
38	(-)-Spathulenol	Oxygenated sesquiterpene
39	Caryophyllene oxide	Bicyclic sesquiterpene
40	(-)-Globulol	Tricyclic hydroazulene sesquiterpene
41	1H Indene, 1-ethylideneoctahydro-7a-methyl-, (1E,3a.alpha.,7a.beta.)	Bicyclic aromatic compound
42	cis-Thujopsene	Sesquiterpene
43	Ledol	Crystalline sesquiterpene
44	Santolina triene	Oxygenated monoterpene
45	Bicyclo[4.4.0]dec-1-ene, 2-isopropyl-5-methyl-9-methylene-	Hydrocarbon sesquiterpene
46	Alloaromadendrene	Tricyclic sesquiterpene
47	Epiglobulol	Oxygenated sesquiterpene
48	.beta.-Humulene	Monocyclic sesquiterpene
49	Isoaromadendrene epoxide	Tricyclic sesquiterpene

50	trans-Z-.alpha.-Bisabolene epoxide	Oxygenated sesquiterpene
51	1H-Cycloprop[e]azulene	Tricyclic sesquiterpene
52	Benzoic acid, heptadecyl ester	Aromatic carboxylic acid
53	trans-.beta.-Ionone	Monocyclic monoterpene
54	Isoshyobunone	Monocyclic monoterpene
55	2-Pentadecanone, 6,10,14-trimethyl	Fatty acid ketone
56	Isophytol	Acyclic diterpene
57	Phytol	Acyclic diterpene alcohol
58	.alpha.-Pyrrolidone, 5-[3-hydroxybutyl]-	Pyrrolidines
59	Phytol	Acyclic diterpene alcohol
60	Cyclopentane, 1,2,3,4,5-pentamethyl-	Cycloalkane
61	3-Eicosene, (E)-	Acyclic alkene
62	trans-Geranylgeraniol	Diterpene alcohol
63	Fumaric acid, cis-hex-3-enyl tetra decyl ester	Unsaturated fatty acid
64	Cyclopentane, 1,1,3-trimethyl-	Cycloalkane
65	9-Undecen-2-one, 6,10-dimethyl	Acyclic monoterpene
66	1,19- Eicosadiene	Aliphatic fatty acid
67	1,4-Bis(trimethylsilyl)benzene	Cycloalkane

Table 3: Biological activities of major compounds

Name of the compound	Peak area %	Biological activity*	Nature of compound
Bicyclogermacrene	3.55	Antimicrobial, anti-inflammatory , anticancer, antiplasmodial, antifeedant, phytotoxic, inhibitor of tumour necrosis and interleukin-6	Sesquiterpene
(-)-Spathulenol	3.92	Immunomodulatory effects, mosquito repellant activity, antimicrobial, anti-inflammatory	Oxygenated Sesquiterpene
Caryophyllene oxide	4.32	Trypanocidal activity,antiedemic, antifeedant, anti-inflammatory, antitumor, calcium antagonist, fungicide, insecticide, pesticide	Oxygenated Sesquiterpene
1,6-Cyclodecadiene, 1-methyl-5-methylene-8-(1-methylethyl)-, [S(E,E)]-	4.63	Antimicrobial, antioxidant, deterrent effects against herbivores, insecticidal activity against mosquitoes, antibacterial	Sesquiterpene
1,19- Eicosadiene	9.84	No activity reported	Fatty acid
Bicyclo[5.2.0]nonane, 2-methylene-4,8,8-trimethyl-4-vinyl-	10.93	Antimicrobial, anti-inflammatory, antihyperlipidemic, antioxidant	Sesquiterpene
Phytol	28.03	Cytotoxic, antinociceptive, antioxidant, antimicrobial, anti-inflammatory, anticancer, diuretic	Diterpene

*Biological Activity: Dr. Duke's Phytochemical and Ethnobotanical Database.

Some sesquiterpene hydrocarbons present in this oil have been reported to exhibit antibacterial activity such as Bicyclo[5.2.0]nonane, 2-methylene-4,8,8-, (-)-Spathulenol, Bicyclogermacrene and 1,6-Cyclodecadiene, 1-methyl-5-methylene-8-(1-methylethyl)-, [S(E,E)]-. The compound Caryophyllene oxide is an oxygenated sesquiterpene, and it has been suggested to function as trypanocidal acivity [17]. It also has biological properties of antiedemic, antifeedant, anti-inflammatory, antitumor etc. Immunomodulatory effects of Spathulenol have been reported. Bicyclo [5.2.0]nonane, 2-methylene-4,8,8-trimethyl-4-vinyl- is a sesquiterpene, is known to possess anti-inflammatory, antihyperlipidemic properties. Monoterpenes, have shown sound effects on mevalonate metabolism, linked to the maintenance of cell membrane, which could add to terpene tumor suppressive action. Thus, the presence of monoterpenes in the selected active fractions explains their antiproliferative actions against some tumor cell lines. Studies indicated that the activity of the essential oil may be due to the synergistic effects of the active compounds. The reports on the chemical composition of the essential oils of *G. pentaphylla* leaves are few in the literature. An assessment with literature data showed that the compounds identified in the present study showed variation in the chemical composition pattern to those reported for the same species growing in another geographical region [18]. It is noteworthy to point out that the constituents of the plants essential oils are normally influenced by several factors such as geographical, climatic, seasonal and experimental conditions.

5. Conclusion

This is the first report on the chemical composition of essential oil of fresh leaves of *Glycosmis pentaphylla*. The result reveals the existence of various bioactive compounds and validates the earlier reports of therapeutic importance of the plant. It is strongly recommended that this medicinal plant needs further research in many-sided field of natural products to isolate, typify and explicate the structure of bioactive molecules to endure the clinical trials to develop a safety and effectual plant-based natural drug for various ailments in the point of health security.

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