PHYTOCHEMICAL PROFILING AND GC-MS ANALYSIS OF *HENCKELIA INCANA* AND *H. HUMBOLDTIANA* WHOLE PLANTS (GESNERIACEAE)

R. Senthil Kumar[1], A. Rajesh[2], C. Mullai Nathan[3], P.S. Tresina[4] V.R. Mohan[5]*

Abstract:
To investigate the possible bioactive compounds in the ethanol extracts of whole plants of *Henckelia incana* and *Henckelia humboldtiana*. This is doneusing GC-MS methods. GC-MS analysis of the plant extracts were completed by employing a Perkin-Elmer GC Clarus 500 system and mass spectra of the compounds found in the extracts were matched with the data in the library of National Institute of Standards and Technology (NIST). Phytochemical screening of the diverse solvent extracts of the *H. incana* and *H. humboldtiana* disclosed the presence of alkaloids, quinones, catechins, flavonoids, phenols, saponins, steroids, tannins, terpenoids, sugars, glycosides and xanthoproteins. In the whole plants studied, forty and thirty five phytocompounds were regulated to be present in the GC-MS analysis. The active principles with their retaining time, molecular formula, molecular weight, peak area and their structure were envisaged. The most prevailing compounds were 6-nonadecyltetrahydro-2H-pyran-2-one, carbonic acid, but-2-yn-1-yl eicosylestaer, octadecane-3-ethyl-5 (2-ethyl butyl); n-hexadecanoic acid, stigmasta-5, 20(22)-dien-3-ol, dotriacontane, propane, 2, 2-diethoxy, propanoic acid, ethyl ester and oleic acid. The occurrence of numerous bioactive compounds justifies the use of this plant for treating various ailments by traditional practitioners.

Keywords: *Henckelia*, Phytochemical, GC-MS, Ethanol extract, n-Hexadecanoic acid.

[1,3]Department of Botany, Annamalai University, Chidambaram, Tamilnadu.
[2]Department of Medicinal Botany, Govt. Siddha Medical College, Palayamkottai, Tamilnadu.
[4, 5]*Ethnopharmacology Unit, Research Department of Botany, V.O. Chidambaram College, Thoothukudi, Tamilnadu.

* **Corresponding author: -** V.R. Mohan
*Ethnopharmacology Unit, Research Department of Botany, V.O. Chidambaram College, Thoothukudi, Tamilnadu, E-mail: vrmohanvoc@gmail.com, ORCID ID: 0000:0003-0464-9969

DOI: - 10.48047/ecb/2023.12.si5a.063

Introduction

Medicinal plants are known to be the chief source of drug therapy in traditional medicine. Medicinal plants are valued gift of nature for mankind and they are the source of aassortment of phytochemicals which are employed for human and animal diets also. It is adept of synthesizing an overwhelming multiplicity of low molecular weight organic compounds called secondary metabolites, typically with unique and complex structures. The medicinal actions of plants exceptional to particular plant species or groups are dependable with the concept that the combination of secondary products in a specific plant is taxonomically distinct [1, 2]. About 80% of the world population depends on plant based medicines as a source of primary health care in rural areas of both developing and developed countries. Here modern medicines are mainly used [3]. Studies on phytochemical constituents of medicinal plant and its pharmacological activities have received wide attention [4-6] in recent decades. Phytochemicals are energetic in pharmaceutical industry for growth of new drugs and preparation of therapeutic agents [7]. The development of new drugs starts with identification of active principles from the natural sources. The screening of plant extracts is a novel approach to find therapeutically active compounds in numerous plant species [8, 9]. Gas chromatography – mass spectroscopy (GC – MS) is a chained analytical technique recycled to determine and identity compounds existing in a plant sample. GC – MS plays acrucial role in the phytochemical analysis and chemotaxonomic studies of medicinal plantscovering biologically active components [4].

Genus *Henckelia* comprises roughly 180 species, belongs to the family Gesneriaceae. A few uses of traditional medicines are known for roots and leaves of *Henckelia* in South-East Asia as a shielding medicine after childbirth, as a bandage of wounds, to treat itch and rash and to treat dysentery, cough and colic. Research on phytochemistry and pharmacological properties is wanted to establish value of genus *Henckelia* as a

medicinal plant, which appears to be marginally as yet [10]. Hence, the present study is planned to investigate the phytochemical and GC – MS analysis of the whole plants of *Henckelia incana* and *H. humboldtiana*.

Materials and methods

Collection of plant samples

The whole plants of *Henckelia incana* (Vahl) Spreng and *Henckelia humboldtiana* (Gardner) A. Weber & B.L. Burtt were gathered from Valparai, Anamalai Tiger Reserve Coimbatore District, Tamil Nadu. With the local flora and authenticated by Botanical Survey of India, Southern Circle, Coimbatore the specimens collected were identified. The collected plants samples were cleaned, dried, powdered separately and stored for additional studies.

Preparation of extracts

Coarse powder samples (100 g) of *H. incana* and *H. humboldtiana* were removed separately with solvents like petroleum ether, methanol, benzene, ethyl acetate, ethanol and aqueous successively. 250 mL volume of each solvent was used. The extraction was carried out by employing a Soxhlet apparatus, the duration being 24 h for each solvent. Through Whatman No. 41 filter paper all the extracts were filtered and subjected to qualitative tests for the identification of several phytochemical constituents as per standard procedures [11-13]. The ethanol extracts hence obtained were concentrated in a rotary evaporator. Further it was subjected to GC – MS.

Gas chromatography – mass spectrometry

The GC – MS analysis of ethanolic extracts was performed. This was done by using a Perkin-Elmer GC Clarus 500 system and gas chromatograph interfaced to a mass spectrometer (GC – MS) equipped with Elite – I, fused silica capillary column (30 × 0.25 mm 1 D × 1 μM df, composed of 100 % dimethyl polysiloxane). For GC – MS detection, an electron ionization system with ionizing energy of 70 eV was employed. At a constant flow rate 1 mL/min Helium (99.999 %) was used as the carrier gas, and an injection volume of 2 μL (split ratio of 10:1), with the injector temperature being 250°C and ion-source temperature 280°C. The oven temperature was programmed from 110°C (isothermal for 2 min). This is done with an increase of 10°C/min, to 200°C, then 5°C/min to 280°C, closing with a 9-min isothermal at 280°C. Mass spectra were involved at 70 eV: a scan interval of 0.5 s and portions from 45 to 450 Da. 36 min was the entire GC running time. The relative percentage of each component was found. This was done by comparing its regular peak area to the total area. Turbo mass was the software accepted to handle mass spectra and chromatograms.

Identification of compounds

The interpretation of mass spectrum of GC – MS was conducted. This was done by using the database of National Institute of Standard and Technology (NIST) having more than 62,000 patterns. The spectra of the unknown components were compared with those stored in the NIST library. The molecular weight, name and structure of the compounds were defined.

Results and discussion

Preliminary study of the methanol and ethanol extracts of *H. incana* and *H. humboldtiana* exhibited the presence of quinones, saponins, alkaloids, catechins, flavonoids, phenols, steroids, tannins, terpenoids, sugars, glycosides and xanthoproteins (Table 1).

Table 1. Preliminary phytochemical screening of *H. incana* and *H. humboldtiana*

Phytochemical constituents	Petroleum ether		Benzene		Ethyl acetate		Methanol		Ethanol		Aqueous	
	Hi	Hh	Hi	Hh	Hi	Hh	Hi	Hh	Hi	Hh	Hi	Hh
Alkaloids	–	–	–	–	+	+	+	+	+	+	–	–
Anthraquinones	–	–	–	–	–	–	–	–	–	–	–	–
Catechins	+	+	–	–	+	+	+	+	+	+	+	+
Coumarins	–	–	+	+	–	–	–	–	–	–	–	–
Flavonoids	–	–	+	+	+	+	+	+	+	+	+	+
Phenols	+	+	+	+	+	+	+	+	+	+	+	+
Quinones	–	–	–	–	+	+	+	+	+	+	–	–
Saponins	–	–	+	+	+	+	+	+	+	+	+	+
Steroids	+	+			+	+	+	+	+	+	–	–
Tannins	–	–	+	+	+	+	+	+	+	+	+	+
Terpenoids	–	–	+	+	+	+	+	+	+	+	+	+
Sugars	+	+	+	+	+	+	+	+	+	+	+	+
Glycosides	+	+	+	+	+	+	+	+	+	+	–	–
Xanthoproteins	+	+	+	+	+	+	+	+	+	+	+	+
Fixed oil	+	+	–	–	+	+	–	–	–	–	+	–

+ present – absent Hi – *Henckelia incana*, Hh – *Henckelia humboldtiana*

By using GC – MS analysis the phytochemical constituents of ethanol extracts of *H. incana* and *H. humboldtiana* were detected. The chromatograms are presentedin Figures 1 and 2. The phytocompounds recorded, with their retention time (RT) peak area (%) molecular formula, molecular weight and along with their structures are tabulated in Tables 2 and 3. Forty compounds were noticed in the ethanol extract of *H. incana*. Based on the RT and peak area (%) of individual phytocompounds, the predominant compounds were octadecane-3-ethyl-5-(2-ethylbutyl) (11.99%), carbonic acid, but-2-yn-1-yl eicosyl ester (6.08%), stigmasta – 5, 20 (22)-dien-3.01 (5.44 %), 4-stilbenol, 4- (benzyloxy) – alpha, alpha, diethyl (3.89 %), 6 nonadecyltetrahydro-2H-pyran-2-one (16.93 %), dotriacontane (8.65 %) n-hexadecanoic acid (6.16 %), 5, 7 – dimethoxy – 2 – phenyl – (3.32 %), oleic acid (2.46 %) 2, 6, 10 – trimethyl, 14–ethylene – 14 – pentade (2.19%), propanoic acid, ethyl ester (2.17 %) and squalene (2.13%).

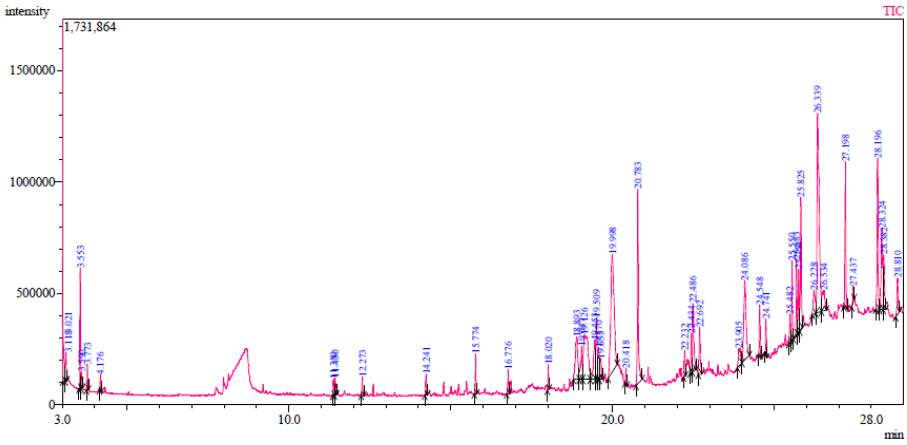


Fig. 1: GC-MS chromatogram of *H. incana*

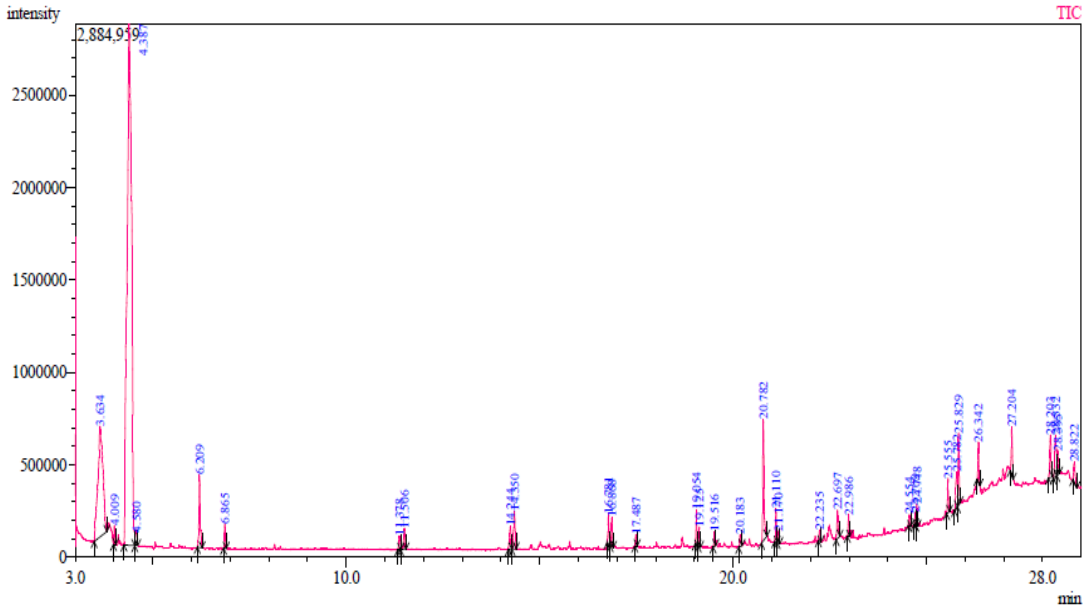


Fig. 2: GC-MS chromatogram of *H. humboldtiana*

Thirty five phytocompounds were detected in the ethanol extract of *H. humboldtiana*, the chief compounds were propane, 20 (22) – dien – 3 – 01 (4.88 %), phthalic acid, butyl undecyl ester (3.78 %) oleic acid (2. 78 %), 2, 2 – diethoxy – (45.32 %), propanoic acid, ethyl ester (13.68 %), n-hexadecanoic acid (5.24 %) stigmasta – 5, 1-butanol, 3-methyl-acetate (2.10 %), 4-stilbenol, 4-(benzyloxy)-alpha, alpha-diethyl-(1.88 %) and 4H-1-benzopyran – 4 – one, 5, 7 – dimethoxy – 2 – phenyl.

The usage of medicinal plants in the treatment of several human ailments depends on their phytochemical constituents. In the current study, the phytochemical screening of different solvent extracts of *H. incana* and *H. humboldtiana* revealed the presence of various phytocompounds.

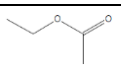
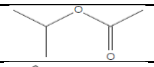
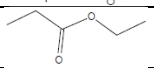
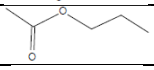
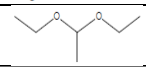
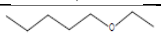
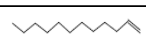
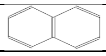
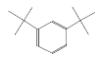
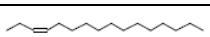
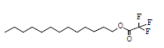
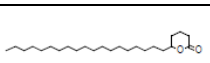
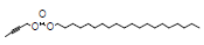
Alkaloids play an indispensable role in both human medicine and in an organismsnatural defense. Alkaloids make up about 20 % of the known secondary metabolites found in plants. Therapeutically, alkaloids are mainly well known as anaesthetics, cardioprotective and antiinflammatory agents [14]. Catechins have been found to have numerous beneficial effects on the human body and protect it from the damaging effects of UV-radiation. The antimicrobial, antioxidant, antiinflammatory antiviral, antiallergenic and anticancer properties of catechins have been recorded [15].

The biological and oxidative properties of flavonoids are responsible for their antiallergic, antidiabetic, antiinflammatory, cardioprotective, antioxidative activity and free radical scavenging capacity [16, 17] Flavonoids have been reported to display anticancer activity [18]. Saponins have many medicinal uses counting antimicrobial, antitumor, antiinsect, hepatoprotective, hemolytic and antiinflammatory activities. They also decrease the blood cholesterol level and may be employed as adjuvant in vaccines [19]

Tannins have been reported to have antioxidant antibacterial, antiinflammatory, antiviral, antiparasitic and antidiarrheal activity [20]. Terpenoids have a wide range of medicinal uses like antiinflammatory, antioxidant, anticancer, antiseptic, antiplasmodial, astringent, digestive, diuretic and many other properties [21]. The presence of these numerous phytocompounds in dissimilar solvent extracts of *H. incana* and *H. humboldtiana* indicates the numerous medicinal properties of these plants.

Our preliminary search of the presence of various active constituents in petroleum ether, ethanol, benzene, ethyl acetate, methanol and aqueous extracts indicated that ethanol extracted the most phytochemicals from the plants. Hence, in the presentinvestigation, only the ethanol extract for the GC – MS study was used.

Table 2. Phytocompounds detected in the ethanol extract of *H.incana*

Peak	R-Time	Peak Area %	Molecular formula	Molecular Weight	Name of the compound	Structure
1	3.021	1.65	$C_4H_8O_2$	88	Aceticacidethylester	
2	3.118	0.78	$C_5H_{10}O_2$	102	Aceticacid,1-methylethylester	
3	3.553	2.17	$C_5H_{10}O_2$	102	Propanoicacid, ethylester	
4	3.590	0.26	$C_5H_{10}O_2$	102	Aceticacid,propylester	
5	3.773	0.43	$C_6H_{14}O_2$	118	Ethane,1,1-diethoxy-	
6	4.176	0.30	$C_7H_{16}O$	116	Pentane,1-ethoxy-	
7	11.380	0.36	$C_{12}H_{24}$	168	1-Dodecene	
8	11.430	0.42	$C_{10}H_8$	128	Naphthalene	
9	12.273	0.46	$C_{14}H_{22}$	190	Benzene,1,3-bis(1,1-dimethylethyl)-	
10	14.241	0.49	$C_{16}H_{32}$	224	3-Hexadecene,(Z)-	
11	15.774	0.91	$C_{14}H_{22}O$	206	2,4-Di-tert-butylphenol	
12	16.776	0.57	$C_6H_{27}F_3O_2$	296	Trifluoroaceticacid,n-tridecylester	
13	18.020	0.52	$C_{17}H_{36}$	240	Heptadecane	
14	18.893	2.99	$C_{24}H_{46}O_2$	366	6-Nonadecyltetrahydro-2H-pyran-2-one	
15	19.047	1.42	$C_{16}H_{34}O$	242	1-Hexadecanol	
16	19.126	6.08	$C_{25}H_{46}O_3$	394	Carbonicacid,but-2-yn-1-yleicosylester	

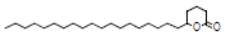
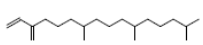
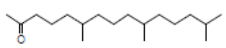
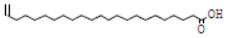
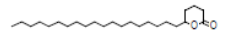
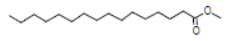
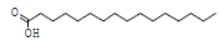
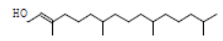
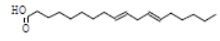
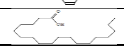
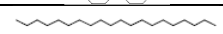
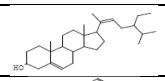
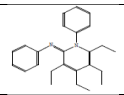
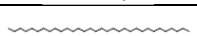
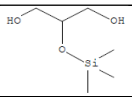
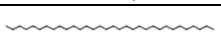
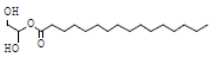
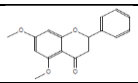
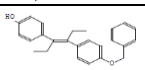
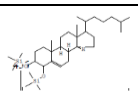
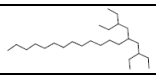
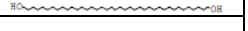
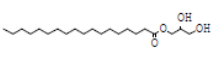
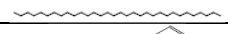
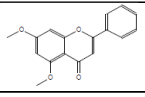
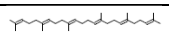
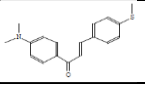
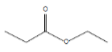
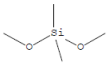
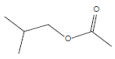
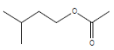
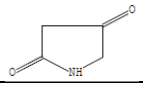
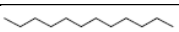
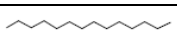
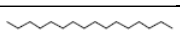
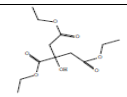
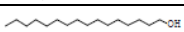
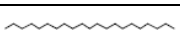
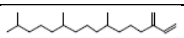
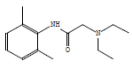
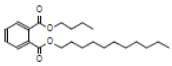
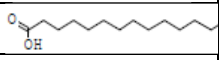
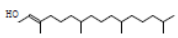
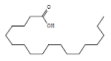
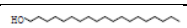
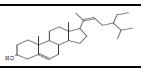
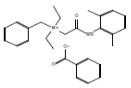
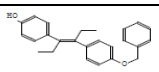
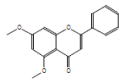
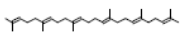
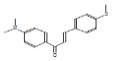
Peak	R-Time	Peak Area %	Molecular formula	Molecular Weight	Name of the compound	Structure
17	19.453	2.47	$C_{25}H_{46}O_2$	366	6-Nonadecyltetrahydro-2H-pyran-2-one	
18	19.509	2.19	$C_{25}H_{38}$	278	2,6,10-Trimethyl,14-ethylene-14-pentade	
19	19.570	0.96	$C_{18}H_{36}O$	268	2-Pentadecanone,6,10,14-trimethyl-	
20	19.635	1.12	$C_{23}H_{44}O_2$	352	22-Tricosenoicacid	
21	19.998	11.47	$C_{24}H_{46}O_2$	366	6-Nonadecyltetrahydro-2H-pyran-2-one	
22	20.418	0.36	$C_{17}H_{34}O_2$	270	Hexadecanoicacid, methylester	
23	20.783	6.16	$C_{16}H_{32}O_2$	256	n-Hexadecanoic acid	
24	22.232	0.65	$C_{20}H_{40}O$	296	2-hexadecen-1-ol,3,7,11,15-tetramethyl-	
25	22.434	1.04	$C_{18}H_{32}O_2$	280	9,12-octadecadienoicacid (Z,Z)-	
26	22.486	2.46	$C_{18}H_{34}O_2$	282	OleicAcid	
27	22.692	1.44	$C_{18}H_{36}O_2$	284	Octadecanoicacid	
28	23.905	1.18	$C_{20}H_{42}$	282	Eicosane	
29	24.086	5.44	$C_{29}H_{48}O$	412	Stigmasta-5,20(22)-dien-3-ol	
30	24.548	1.21	$C_{25}H_{30}N_2$	358	Benzenamine,N-(3,4,5,6-tetraethyl-1-phenyl-2(1H)-py	
31	24.741	0.72	$C_{32}H_{66}$	450	Dotriacontane	
32	25.482	0.78	$C_6H_{16}O_3$ Si	164	Glycerol,2-TMS-	
33	25.550	1.80	$C_{32}H_{66}$	450	Dotriacontane	
34	25.683	1.99	$C_{19}H_{38}O_4$	330	Hexadecanoicacid,2-hydroxy-1-(hydroxymethyl)ethy	
35	25.754	1.96	$C_{17}H_{16}O_4$	284	4H-1-Benzopyran-4-one,2,3-dihydro-5,7-dimethoxy-2	
36	25.825	3.89	$C_{25}H_{26}O_2$	358	4-Stilbenol,4'-(benzyloxy)-.alpha.,.alpha.'-diethyl-	
37	26.228	1.32	$C_{33}H_{62}O_2Si_2$	546	3.Beta.,4.beta.-bis(trimethylsiloxy)cholest-5-ene	
38	26.339	11.99	$C_{26}H_{54}$	366	Octadecane,3-ethyl-5-(2-ethylbutyl)-	
39	26.534	1.64	$C_{40}H_{82}O_2$	594	Tetracontane-1,40-diol	
40	27.198	3.83	$C_{32}H_{66}$	450	Dotriacontane	
41	27.437	0.46	$C_{21}H_{42}O_4$	358	Octadecanoicacid,2,3-dihydroxypropylester	
42	28.196	4.82	$C_{32}H_{66}$	450	Dotriacontane	
43	28.324	3.32	$C_{17}H_{14}O_4$	282	4H-1-Benzopyran-4-one,5,7-dimethoxy-2-phenyl-	
44	28.382	2.13	$C_{17}H_{50}$	410	Squalene	
45	28.810	1.41	$C_{17}H_{19}NOS$	297	trans-4'-Dimethylamino-4-(methylthio)chalcone	

Table 3. Phytocompounds detected in the ethanol extract of *H.humboldtiana*

Peak	R-Time	Peak Area %	Molecular formula	Molecular Weight	Name of the compound	Structure
1	3.634	13.68	$C_5H_{10}O_2$	102	Propanoicacid,ethylester	
2	4.009	0.32	$C_4H_{12}O_2Si$	120	Silane,dimethoxydimethyl-	
3	4.387	45.32	$C_7H_{16}O_2$	132	Propane,2,2-diethoxy-	
4	4.580	0.64	$C_6H_{12}O_2$	116	Aceticacid,2-methylpropylester	
5	6.209	2.10	$C_7H_{14}O_2$	130	1-Butanol,3-methyl-,acetate	
6	6.865	0.49	$C_7H_{12}O_3$	144	Pyrrolidine-2,4-dione	
7	11.378	0.45	$C_{14}H_{28}$	196	3-Tetradecene,(e)-	
8	11.506	0.79	$C_{12}H_{26}$	170	Dodecane	
9	14.244	0.77	$C_{13}H_{28}O$	200	1-Tridecanol	
10	14.350	1.27	$C_{14}H_{30}$	198	Tetradecane	
11	16.781	0.74	$C_{16}H_{34}O$	242	1-Hexadecanol	
12	16.868	0.75	$C_{16}H_{34}$	226	Hexadecane	
13	17.487	0.24	$C_{12}H_{20}O_7$	276	1,2,3-Propanetricarboxylicacid,2-hydr	
14	19.054	0.74	$C_{16}H_{34}O$	242	1-Hexadecanol	
15	19.125	0.40	$C_{21}H_{44}$	296	Heneicosane	
16	19.516	0.31	$C_{20}H_{38}$	278	Neophytadiene	
17	20.183	0.34	$C_{14}H_{22}N_2O$	234	Acetamide,2-(diethylamino)-N-(2,6-dimet	
18	20.782	3.78	$C_{23}H_{36}O_4$	376	Phthalicacid,butylundecylester	
19	20.786	5.24	$C_{16}H_{32}O_2$	256	n-Hexadecanoicacid	
20	21.110	0.70	$C_{22}H_{46}O$	326	Behenicalcohol	
21	21.170	0.27	$C_{21}H_{44}$	296	Heneicosane	
22	22.235	0.26	$C_{20}H_{40}O$	296	Phytol	
23	22.426	2.78	$C_{18}H_{34}O_2$	282	OleicAcid	
24	22.697	0.81	$C_{18}H_{36}O_2$	284	Octadecanoicacid	
25	22.986	0.43	$C_{20}H_{42}O$	298	1-Eicosanol	
26	24.076	4.88	$C_{29}H_{48}O$	412	Stigmasta-5,20(22)-dien-3-ol	
27	24.554	0.24	$C_{25}H_{30}N_2$	358	Benzenamine,N-(3,4,5,6-tetraethyl-1-phenyl-2(1H)-py	
28	24.709	0.24	$C_{25}H_{46}$	346	Cyclopentane,1,1'-[4-(3-cyclopentylpropyl)-1,7-hepta	
29	24.748	0.44	$C_{20}H_{42}$	282	Eicosane	
30	25.555	0.77	$C_{32}H_{66}$	450	Dotriacontane	
31	25.782	1.30	$C_{28}H_{34}N_2O_3$	446	Benzyldiethyl-(2,6-xylylcarbamoylmethyl)-ammonium	
32	25.829	1.88	$C_{25}H_{26}O_2$	358	4-Stilbenol,4'-(benzyloxy)-	

Peak	R-Time	Peak Area %	Molecular formula	Molecular Weight	Name of the compound	Structure
					.alpha.,.alpha.'-diethyl-	
33	26.342	0.84	$C_{32}H_{66}$	450	Dotriacontane	
34	27.204	1.20	$C_{36}H_{74}$	506	Hexatriacontane	
35	28.203	1.38	$C_{54}H_{110}$	758	Tetrapentacontane	
36	28.332	1.71	$C_{17}H_{14}O_4$	282	4H-1-Benzopyran-4-one,5,7-dimethoxy-2-phenyl-	
37	28.395	0.76	$C_{30}H_{50}$	410	Squalene	
38	28.822	0.77	$C_{18}H_{19}NOS$	297	trans-4'-Dimethylamino-4-(methylthio)chalcone	

Among the identified bioactive compounds, hexatriacontanehas antioxidant, hypocholesterolemic, flavor, hemolytic, nematicide, Lubricant antiandrogenic and 5-alpha reductase inhibitor [22] Naphthalene has antimicrobial, antiprotozoal, antioxidant, cytotoxic, anti-inflammatory and antiplatelet potential [23]. Carbonic acid, but-2-yn-1-yl eicosyl ester has acidifier, hinder production of uric acid, urinary-acidulant and urine – acidifier [24], Tetrapentacontane has cytotoxic, antioxidant, antitumoral and antimutagenic activity [25], Tetradecane has cytotoxicity, antipyretic, anthelmintic, antimicrobial activity and treat bronchitis, asthma, tuberculosis, dyspepsia, constipation and anemia[26]. Phthalic acid butyl undecyl ester has urine – acidifier, antiviral, antibacterial and antifungus activity [27] n-Hexadecanoic acid has hypocholesterolemic, nematicide, pesticide, antioxidant, lubricant, hemolytic andantiandrogenic[2]. 6-Nonadecyltetrahydro-2H-pyran,-2-one has anti-HIV integrase and hematonic[24], 2, 6, 10 – Trimethyl, 14-ethylene -14- pentade has antioxidant action[28].Octadecane, 3-ethyl-5 (2-ethylbutyl) has antimicrobial and antifungal action[29]. Dotriacontane has antimicrobial, antioxidant and antispasmodic activity [22], 4H-1. Benzopyran-4-one, 5, 7-dimethoxy-2-phenyl has hematonic, hemagglutinator and antiinflammatory activity. [24, 30] and trans-4, dimethylamino-4-(methythio) chalcone has glucosyl-transferase inhibitor and reverse-transcriptase inhibitor [24].

Using GC – MS analysis, forty and thirty five compounds were identified from the ethanol extracts of *H. incana* and *H. humboldtiana* whole plants respectively. The presence of numerous bioactive compounds justifies the use of the whole plants for treating numerous ailments by traditional medicine practitioners.Some of the bioactive phytocompounds identified may become commercially significant phytopharmaceuticals. As GC – MS is the first step towards understanding the nature of active principles, further study in this species is recommended for the development of novel drugs.

Conflict of Interests

The authors declare that they have no conflict of interests regarding the publication of this paper.

Acknowledgements

The authors acknowledge the Periyar University, Salem for providing GC – MS analysis facility.

References

1. Briskin DP. Medicinal plants and phytomedicines linking plant biochemistry and physiology to human health Plant phy. 2000,124:507-514.
2. Karthika K, Paulsamy S. Phytochemical profiling of leaf, stem and tuber parts of Solenaam plexicaulis (Lam.) Gandhi using GC – MS. Int. Sch. Res Not., 2014doi: 10.1155/2014/567409.
3. Sath SD, Sharma B. Medicinal Plants in India. Indian J. Med Res., 2004, 120:9-11
4. Olivia NU, Goodness UC, Obinna UM. Phytochemical profiling and GC – MS analysis of aqueous methanol fraction of Hibiscus asper leaves. Fut. J. Pharmaceu. sci.2021,7,59, doi:10.1186/s43094-021-00208-4
5. Mishra D, Patnaik S. GC – MS analyzed phytochemicals and antibacterial activity of Withania somnifera (L.) Dunal extract in the context of treatment to liver cirrhosis. Biomed Pharmacol. J., 2020,13, doi:10.13005/bpj/1862.
6. Akubugwo EI; Emmanuel O, Ekweogu CN, Ugbogu, OC, Onuorah TR; Egeduzu OG, Ugbogu EA. GC – MS analysis of the phytochemical constituents, safety assessment, wound healing and antiinflammatory activities

of Cucurbita pepo leaf extracts in rats. Sci. Pharm. 2022, 90, 64 doi: 10.3390/scipharm 90040064.
7. Nisha K, Darshana M, Madhu G, Bhupendra MK. GC – MS analysis and antimicrobial activity of Psidiumguajava(leaves) grown in Malva region of India. Int. J. Drug. Dev. Res, 2011,3: 237-245.
8. Gopalakrishnan K and Udayakumar R. GC – MS analysis of phytocompounds of leaf and stem of Marsilea quadrifolia (L.) Int. J. Biochem. Res. Rev.,2014,4: 517-526.
9. Starlin T, Prabha PS, Thayakumar BKA, Gopalakrishnan VK. Screening and GC-MS profiling of ethanolic extract of Tylophora paciflora Biomed Inform., 2019, 15:425-429.
10. Rachman E, Kiew R. HenckeliaSprengel. In: Plant Resources of South – East Asia No. 12 (3): Medicinal and Poisonous Plants 3 (Eds) Lemmens RHMJ; Bunyapraphatsara N. Prosea Foundation. Bogor, Indonesia, 2003.
11. Saraf A. Phytochemical and antibacterial studies of medicinal plant Costus specious. Koer. E. J. Chem, 2020, 7: 5405-5413.
12. Shajeela PS, Kalpanadevi V, Mohan VR. Potential antidiabetic, hyperlipidemic and antioxidant effects of Nymphaea pubescens extract in alloxan induced diabetic rats. J. Appl. Pharmaceu Sci., 2012,2:83-88.
13. Murugan M, Mohan VR, Evaluation of phytochemical analysis and antibacterial activity of Bauhinia purpurea L and Hiptage benghalensis (C.) Kurz. J. Appl. Pharmacu. Sci., 2011,1:157-160.
14. Heinrich M, Mah J, Amirkia V, Alkaloids used as medicines: structural phytochemistry meets biodiversity – an update and forward look. Molecules,2021, doi:10.3390/molecules 26071836.
15. Bae J, Akim N, Shin Y, Kim SY, Kim YJ Activity catechins and their applications, Biomed Dermat, 2020, 4, 8, doi: 10.1186/34/702-020-0057-8.
16. Egert S, Rimbach G, Which sources of flavonoids: complex diets or dietary supplements? Am.Soc Nut Adv Nut, 2011,28-14 doi: 10.3945/an.110.0000268
17. Tiwari CS, Husain N, Biological activities and role of flavonoids in human health – are view. Indian J. Sci. Res., 2017,12.193-196.
18. Kozlowska A, Szostak – Wegierek D, Flavonoids, - Lod sources and health benefits. Rocz Panstw Zakl, 2014, High 65: 79-85.
19. Barbosa ADP, An overview on the biological and pharmacological activities of saponins. Int. J. Pharm Pharm Sci., 2014, 6: 47-50.
20. Tong Z, He, W, Fan X, Guo A, Biological function of plant tannin and its application in animal health. Front Vet. Sci:2022, doi:10.3389/Fvests 2021.803657.
21. Joshee N, Dhekney SA, Parajuli P. Therapeutic and medicinal uses of terpenes. Med plant, 2019, 12:333-359.
22. Soosairaj S, Dons T. Bioactive compounds analysis and characterization in ethanolic plant extracts of Justicia tranquebariensis L (Acanthaceae) – using GC – MS Int. J. Chem Tech Res. 2016, 9: 260-265.
23. Abozeid MA, El-Sawi AA, Abdelmoteleb M, Awad H, Abdel – Aziz MM, Abdul – Rahman ARH, El – Desoky ESI. Synthesis of novel naphthalene – heterocycle hybrids with potent antitumor, antiinflammatory and antituberculosis activity. RSC. Adv., 2020, 10: 42998-43009.
24. Duke. Phytochemical and Ethnobotanical Databases. U.S. Department of Agriculture; Agricultural Research Service (1992-2016), 2017, http://phytochem.nal.usde.gov/.accessed 16 Mar 2017.
25. Gollo AL, Tanobe VO, de Melo Pereira GV, Marin O, Bonatto SJR, Silva S, de Barros IR, Soccol CR. Phytochemical analysis and biological activities of in vitro cultured Nidularium procerum, a bromeliad vulnerable to extinction Sci. Rep., 2020,10:1-13.
26. Banakar P, Jayaraj M. GC – MS analysis of bioactive compound from ethanolic leaf extract of Waltheria indica Linn and their pharmacological activities. Int. J. Pharm Sci. Res. 2018, 9:2005-2010.
27. Al-Gara NI, Abu-Sera NA, Shaheed KAA, Al-Bahadly ZK. Analysis of bioactive phyto-chemical compound of Cyperus alternifolius L. by using gas chromatography – mass spectrometry. In: IOP Conference Series: Materials Science and Engineering. 2019, (Vol. 571, No. 1, P. 012047) IOP Publishing.
28. Naik B, Maurya VK, Kumar V, Kumar U, Upadhyay S, Gupta S. Phytochemical analysis of Diplazium esculentum reveals the presence of medically important components. Curr Nut Food Sci., 2021, 17:210-215.
29. Diep CN, Tan Binh N, Ha Lam PV. Bioactive compounds from marine fungus Penicillium citrinum strain ND7c by gas chromatography – mass spectrometry. Pharm Chem J., 2018, 5: 211-224.
30. Kadhim MJ. In vitro antifungal potential of Acinetobacter baumannii and determination of its chemical composition by gas chromate-

graphy – mass spectrometry, Der Pharma Chem, 2016, 8: 657-665.