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Research Article

GC-MS based metabolite profiling and antioxidant activity of solvent extracts of *Allium chinense* G Don leaves

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Abstract

Allium chinense, a main source of "Xiebai" drug in Chinese traditional medicine and commonly known as *Ganoderma lucidum* belongs to the family Amaryllidaceae. The main focus of this research was to quantify the secondary metabolites, antioxidant potential and study the GC- MS based metabolite profile of different solvent leaf extracts of *A. chinense*. The reports on the bioactive compounds of *A. chinense* leaves are still insufficient compared to the bulb; hence this study was carried out to understand the bioactive compounds present in *A. chinense* leaves using different solvents of varying polarity. Our investigation showed that the ethanol extract contained the highest saponin, flavonoid, phenol, and DPPH scavenging activity. Further, metabolite profiling revealed a total of forty-eight compounds, indicating a diverse range of phytochemicals present in the four extracts. The highest number of compounds were observed in ethanol extract (15) followed by chloroform extract (13), petroleum ether extract (11) and methanol extract (9). Some of the major compounds identified in the four solvents are octacosane (27.11%), heptadecane (19.66%), eicosane (18.51%), ethyl palmitate (18.50%), phytol (17.68%) and phytol acetate (17.30%). In conclusion, this study highlights that *A. chinense* leaf extracts contain high saponins, terpenes and alkanes which could be a potential source of a new beneficial drug.

Keywords: *Allium chinense*; bioactive compounds; metabolite profile; scavenging activity

Introduction

Medicinal herbs are a rich source of a bioactive compound and considered to play a beneficial role in traditional and modern health care delivery systems. The bioactive compounds synthesized from these plants provide the raw material for the cosmetic and pharmaceutical industries (Kretovich, 2005). *Allium chinense* G Don, is a medicinal herb from the Amaryllidaceae family, commonly known as the oriental onion or *Ganoderma lucidum* in vegetables. The plant is widely distributed in India's North-East states and grows well in 15-30 °C temperature with moderate fertile soils (Lim *et al.*, 2015). It has a strong onion-like odor and known for its rich organo-sulfur (Pino *et al.*, 2001; Liu *et al.*, 2014) and saponin (Sobolewska *et al.*, 2020) content and is also the original source of the famous Chinese medicine "Xiebai", as it functions like a tonic to the digestive system (Yao *et al.*, 2016). Saponins from edible plants have been reported to have diverse biological

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functions, including antitumor effects (Wang *et al.*, 2019). The essential oil of *A. chinense* bulb and leaf has been reported to have sulfide containing compounds (Pino *et al.* 2001; Liu *et al.*, 2014) which are the main components for odour and it is effective in breaking seed and bud dormancy (Hosoki *et al.*, 1986; Kubota *et al.*, 2000). However, there is no report on quantification, GC-MS based metabolite profiling, and antioxidant potential of different solvents extracts of *A. chinense* leaves. The investigation on bioactive compounds of *A. chinense* leaves is still inadequate compared to the research findings on the bulb. Hence, the present study aimed to identify and characterize biomolecules by GC-MS analysis and to determine the antioxidant potential of *A. chinense* leaf in different solvent extracts.

Materials and Methods

Plant material collection and preparation of extracts

A. chinense plants were collected from agriculture fields in Viswema village (25.5615 °N, 94.1450 °E), Kohima, Nagaland, India, and was identified and authenticated by Dr. V. Rama Rao, Regional Ayurvedic Research Institute for Metabolic Disorders (Central Council for Research in Ayurvedic Sciences, Ministry of AYUSH, Govt. of India) Bengaluru-560109. The voucher specimen RRCBI-mus 244 was preserved and deposited in Botany Department, Bangalore University, Bangalore. The leaves were carefully washed with distilled water and shade-dried till all the moisture contents were removed. The dried leaves were ground using a mixer to a fine powder and extracted using Soxhlet extractor (Merculieff *et al.*, 2014) with different solvents viz, ethanol, methanol, chloroform, and petroleum ether. The extracts were concentrated using a rotary evaporator at 30-40 °C for petroleum ether and chloroform and 40-50 °C for methanol and ethanol stored in a bottle in a cool (4 °C), dark environment for further use.

Quantitative analysis

Determination of total phenols

The total phenols in different solvent extracts of *A. chinense* leaf were evaluated using FC (Folin-Ciocalteu) spectrophotometric method (Khan and Bhat, 2018). The standard curve was plotted using gallic acid at 1-100 µg/ml concentrations. Plant extracts at 1mg/ml were mixed with 5 ml of FC (1:10) and 4 ml of sodium bicarbonate (7.5%) and the mixture was incubated for half an hour in the dark at 20 °C to allow the reaction to take place. The absorbance was measured at a wavelength of 765 nm against blank.

Estimation of total alkaloids

The total alkaloids were quantified using atropine as a reference standard at 200-1000 µg/ml concentration to obtain the calibration curve (Tan, 2018). The extracts (1 mg/ml) were mixed with 2 ml of 2N HCl and washed with 5 ml of chloroform. The solution was vortexed and layers were separated using a micropipette. Later, the separated layer was taken in a test-tube and 5 ml of BCG (Bromocresol Green) solution and phosphate buffer (pH 4.7) was added and vortexed. A yellow color complex observed at the bottom was carefully removed by using pipette and absorbance was measured at a wavelength of 470 nm.

Estimation of total flavonoids

The quantification of total flavonoids content in different solvent extracts was determined using the $AlCl_3$ (Aluminum trichloride) method. Catechin was used as a standard (Aryal *et al.*, 2019) at 20-100 µg/ml concentration to plot the standard calibration graph. Plant extracts (0.5 ml) with 1 mg/ml concentration was suspended in distilled water (2 ml) in a test tube, 0.15 ml of 5% $NaNO_2$ was added to it and incubated for 6 minutes. Thereafter, 0.15 ml of 10% $AlCl_3$ was added and incubated again for 6 minutes. Later, 2 ml of 10% NaOH was added to it and the final volume was made up to 5 ml using distilled water. The solution was then incubated at room temperature for 15 minutes and the absorbance of the solution was read at 510 nm.

Estimation of saponins

The saponin content of the extracts was estimated using the method described by Le *et al.* (2018). The Plant extract at 1mg/ml concentration was taken in a test tube and 500 µL of 8% vanillin and 72% sulphuric acid was added and incubated for 10 minutes at 60 °C in a water bath. After incubation, it was allowed to cool to room temperature and absorbance was measured at 544 nm. Quillaia (200-1000 µg/ml) was used as a standard to generate the standard calibration curve.

DPPH free radical scavenging assay

A. chinense leaf's ability in different solvent extracts to scavenge free radicals was evaluated (Vasundhara *et al.*, 2017) using ascorbic acid as the standard and all the tests were performed in triplicate. One ml of varying plant extract and ascorbic acid with 1-100 µg/ml concentrations were mixed with 3.0 ml of DPPH (0.06 mM) and incubated in dark for 15 minutes at room temperature for reaction to occur. The absorbance was measured at a wavelength of 517 nm using a UV-Vis spectrophotometer. The percentage of inhibition of the extracts and ascorbic acid was calculated using the given formula:

DPPH radical scavenging activity (%) = $[(A_1 - A_2) / A_1] \times 100$

Where A_1 – Absorbance of control (DPPH), A_2 – Absorbance of extracts

The calibration curve was generated and 50% inhibition concentration (IC_{50}) values were calculated.

GC-MS analysis and identification of compounds

To obtain the complete chemical profile of *A. chinense* leaf, GC-MS analysis was performed using SHIMADZU QP2010S GC-MS system. The operating condition was set up as follows: and oven temperature was programmed at 70.0°C; the ion source temperature was set at 200.00 °C sample was injection mode was split less and sampling time 2.00 min equipped with Rxi-5Sil MS column; length: 30 meters, the carrier gas was helium (99.99%) at a flow of 1.00 mL/min; start time 7.00 min; End time 35.75 min; event time 0.50 sec; scan range 50-500 m/z. The chemical compounds were identified based on the peaks observed at different mass-to-charge ratios. Further identification was made by comparing with the standard spectrum existing in the database mass spectral library of the National Institute of Standards and Technology NIST-11 and WILEY 8 library.

Statistical analysis

The data were analysed using a one-way method of Analysis of variance (ANOVA) at a 5% probability (P,0.005) by using Prism V. 5.00 (Graphpad Inc. USA). The total phenol, alkaloid, flavonoids and saponin content was estimated using the linear regression equation obtained from the standard graph. All the analysis was carried out in triplicates and expressed as mean ± SE.

Results and Discussion

Quantitative analysis

In recent years, plant metabolites have played an important role in alleviating several ailments and multiple health benefits, the knowledge on phyto components is important to obtain active principles for its highest pharmacological significance. The different solvent extract has a significant difference in the concentration of total phenols, alkaloid, flavonoid, and saponin (Table 1).

Table 1. Quantitative analysis of phenol, alkaloid, flavonoid, and saponin content in *A. chinense* leaf extracts

S No.	Sample	Alkaloids (mg/g)	Flavonoids (mg/g)	Phenol (mg/g)	Saponin (mg/g)
	Linear regresion equation for standard	Y=0.0003X+0.0009 R^2=0.9996 (Atropine)	Y=0.0029X+0.0031 R^2=0.9992 (Quercetin)	Y=0.0127X+0.0252 R^2=0.9991 (Gallic acid)	Y=0.0002x+0.003 R^2=0.999 (Quillaia)
1	Ethanol	49.080 ± 0.481	38.241 ± 0.398	35.575 ± 0.227	515.000 ± 0.578
2	Chloroform	200.750 ± 0.254	12.034 ± 0.783	22.859 ± 0.205	322.500 ± 0.289
3	Petroleum ether	184.920 ± 0.918	15.483 ± 0.199	17.819 ± 0.068	351.250 ± 0.144
4	Methanol	64.500 ± 0.770	20.138 ± 0.542	25.260 ± 0.273	496.250 ± 0.722

Values are mean ± SE (n=3) ($p<0.05$)

The highest concentration of saponins was recorded in ethanol extract, followed by methanol extract, petroleum ether extract and chloroform extract. Quantitative analysis in leaf extract showed a moderately high concentration of alkaloid in chloroform and petroleum ether extract; however, in methanol and ethanol the concentration was moderate. In quantitative estimation, low phenol and flavonoid content was observed in leaf extract; ethanol extract showed higher phenolic and flavonoid content than the other extracts.

Saponin are widely distributed in monocotyledonous families (Sobolewska *et al.*, 2020), and several studies have confirmed that they have an extensive range of pharmacological activities. Steroidal saponins vernoniamyoside A, B, and B_2, possess cytotoxicity activity against BT-549 (Wang *et al.*, 2018), steroidal sapogenin 25-*R*-spirosta-3, 5-dien-12β-ol showed cytotoxicity on 5-8F cells a human nasopharyngeal carcinoma cell line (Chu *et al.*, 2018). Saponin subsides coronary heart disease (Yang *et al.*, 2018) and acts as cytotoxic towards the human glioblastoma U87MG and U251 cell lines (Liu *et al.*, 2018). Saponins like diosgenin have great value in the pharma industry and used as substrates in drug and steroid hormone production (Sobolewska *et al.*, 2020). The presence of a high saponin amount might have contributed to the significant use of this plant in traditional medicine and drug discovery. Quantitative analysis of leaf extract showed a moderately high concentration of alkaloid. Plant alkaloids possess anti-inflammatory, anti-depressive, antioxidant, anti-convulsing, anti-amyloid efficacy, antiviral, antifungal, anticancer and antibacterial activity (Hussain *et al.*, 2018; Thawabteh *et al.*, 2019). The analysis showed a moderate concentration of phenol and flavonoid content in the leaf extract. Phenols possess high antioxidant activity (Safari and Ahmady-Asbchin, 2019) and contribute hydrogen and react with nitrogen and reactive oxygen compounds acting as an antioxidant (Pereira *et al.*, 2009). Medicinal plants have a copious amount of flavonoids and are considered potential nutraceuticals, They also regulate numerous pathways for diseases like diabetes, neuro-disease, cancers, and other transmittable diseases (Qiu *et al.*, 2018).

Antioxidant assay

The free radical scavenging activity was determined in all the four solvent extracts of *A. chinense* leaf viz ethanol, methanol, chloroform, and petroleum ether by the DPPH method. Scavenging activity against free radicals from leaf extracts is shown in (Figure 1, Table 2).

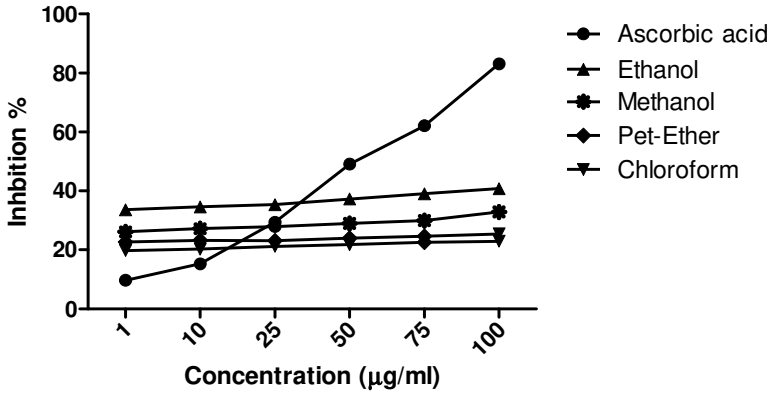


Figure 1. Scavenging activity of ascorbic acid, ethanol, methanol, petroleum ether, and chloroform extract of *A. chinense* leaf

Table 2. Antioxidant activity measured by DPPH scavenging method

Conc. (µg/ml)	Ascorbic acid	Ethanol	Chloroform	Petroleum ether	Methanol
1	9.720 ± 0.498	33.586 ± 0.141	22.747 ± 0.162	19.769 ± 0.289	26.091 ± 0.576
10	15.324 ± 0.382	34.637 ± 0.240	23.257 ± 0.180	20.329 ± 0.232	27.167 ± 0.622
25	29.411 ± 0.214	35.340 ± 0.184	23.086 ± 0.238	21.247 ± 0.140	27.928 ± 0.042
50	49.132 ± 0.526	37.253 ± 0.139	23.963 ± 0.299	21.781 ± 0.468	28.990 ± 0.083
75	62.159 ± 0.574	39.012 ± 0.281	24.623 ± 0.099	22.596 ± 0.554	29.954 ± 0.591
100	83.157 ± 0.417	40.833 ± 0.412	25.432 ± 0.585	22.969 ± 0.587	32.915 ± 0.582
IC_{50}	55.096	228.156	1045.287	947.025	391.529

Values are mean ± SE (n=3) ($p<0.05$)

The *A. chinense* leaf extracts showed moderate scavenging activity in all the four solvents compared to standard ascorbic acid (IC_{50}=55.096 µg/ml) with a significant difference ($p<0.05$). Ethanol extract with IC_{50} value of 228.156 µg/ml was found to exhibit the highest free radical scavenging activity when compared to other solvent extracts, followed by methanol with IC_{50} value of 391.529 µg/ml, petroleum ether with IC_{50} of 947.025 µg/ml, and chloroform extract with IC_{50} value of 1045.287 µg/ml.

Free radicals are unstable molecules that cause oxidative stress, triggering cell damage, antioxidants are substances that may prevent or delay cell deterioration, vegetables and fruits are a rich source of antioxidants (Lobo *et al.*, 2010). The percentage of free radical scavenging activity was found to be significantly low, which may be due to a lower concentration of phenol (Wang *et al.*, 2018) and flavonoids in the present study (Liu *et al.*, 2018). Lin *et al.* (2016) observed mild antioxidant activity in the essential oil of *A. chinense* bulb which supports the present findings.

GC-MS analysis

Identifying plant's chemical constituents is important for finding new therapeutic agents and GC-MS is the key technology for secondary metabolites profiling in plants. Bioactive compounds identified by GC-MS analysis showed that the leaf extracts have a complex combination of numerous compounds; some of which were present in trace quantities. The GC-MS analysis of methanol, ethanol, chloroform, and petroleum ether extracts of *A. chinense* leaf revealed a total of 48 peaks. The highest number of peaks was observed in ethanol extract. Fifteen compounds were identified in ethanol extract with a run time of 50 min. (Figure 2, Table 3). In the chloroform extract, thirteen peaks were observed with a run time of 45 min. (Figure 3, Table 4). The petroleum ether extract was run for 49 min. (Figure 4, Table 5) where eleven peaks were recorded. A total of

nine peaks were detected in the chromatogram of methanol leaf extract with a run time of 49 min. (Figure 5, Table 6). The peaks indicated the number of compounds and the active compounds was confirmed based on retention time, molecular weight, molecular formula, and molecular structure. Among the various phytochemicals identified, phytol and phytol acetate were the most common chemical compounds found in all four extracts.

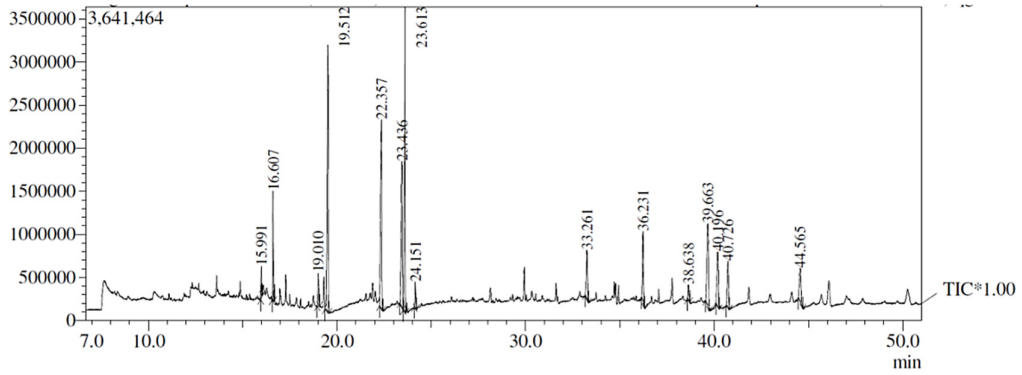


Figure 2. GC-MS chromatogram of ethanol extract of *A. chinense* leaf

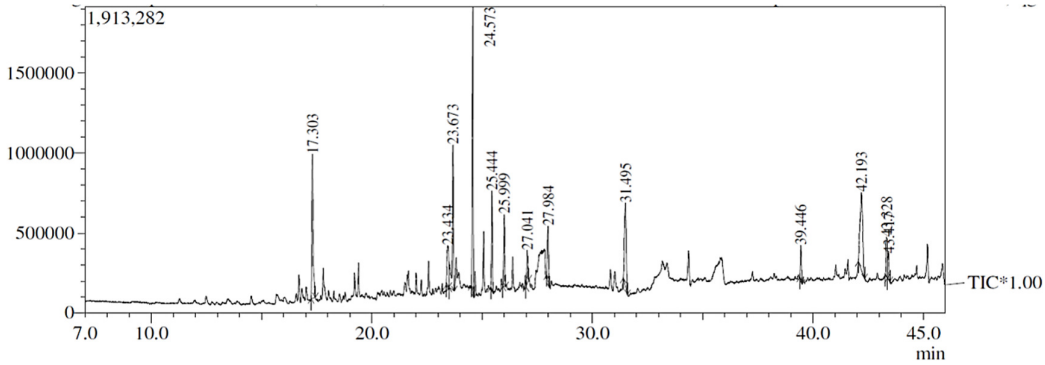


Figure 3. GC-MS chromatogram of chloroform extract of *A. chinense* leaf

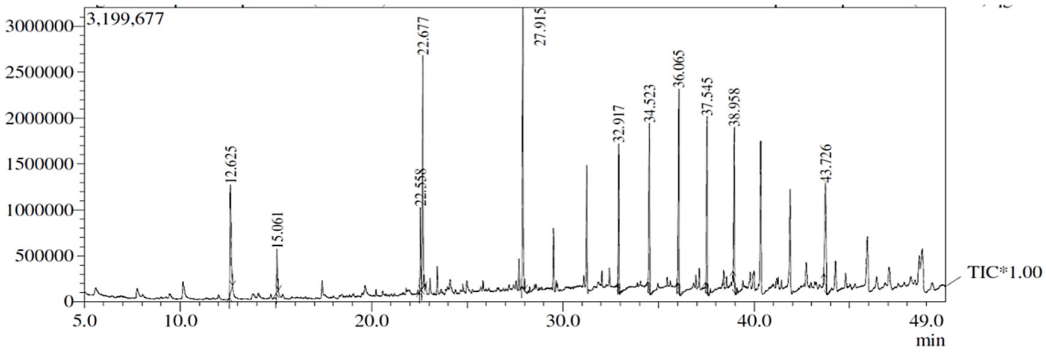


Figure 4. GC-MS chromatogram of petroleum ether extract of *A. chinense* leaf

Table 3. Phytocompounds identified in the ethanol leaf extract of *A. chinense* by GC-MS analysis

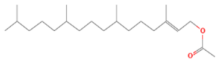
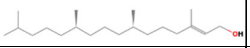
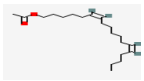
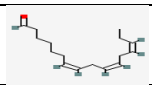
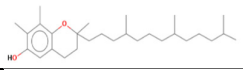
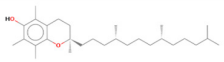
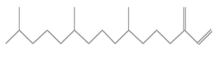
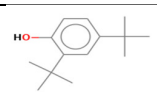
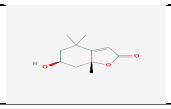
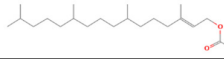
RT	Name of the compound	Peak area %	Mol. formula	Mol. wt.	Structure	Nature
15.991	Ethyl pentadecanoate	1.11	$C_{17}H_{34}O_2$	270		Fatty acid esters
16.607	Phytol acetate	3.95	$C_{22}H_{42}O_2$	338		Diterpene alcohol
19.010	Ethyl 9-hexadecenoate	1.79	$C_{18}H_{34}O_2$	282		Fatty acid esters
19.512	Ethyl palmitate	18.50	$C_{18}H_{36}O_2$	284		Fatty acid ethyl ester
22.357	Phytol	15.94	$C_{20}H_{40}O$	296		Diterpene
23.436	Z,Z-6,13-octadecadien-1-ol acetate	11.97	$C_{20}H_{36}O_2$	308		Fatty alcohol
23.613	cis,cis,cis-7,10,13-Hexadecatrienal	15.34	$C_{16}H_{26}O$	234		Aldehydes
24.151	Ethyl nonadecanoate	1.23	$C_{21}H_{42}O_2$	326		Ester
33.261	1-Hexacosanol	3.61	$C_{26}H_{54}O$	382		Primary fatty alcohol
36.231	Hexatriacontane	4.57	$C_{36}H_{74}$	506		Alkane
38.638	.gamma.-Tocopherol	1.00	$C_{28}H_{48}O_2$	416		Vitamin E
39.663	Octacosane	8.69	$C_{28}H_{58}$	394		Fatty acid
40.196	dl-.alpha.-Tocopherol	4.94	$C_{29}H_{50}O_2$	430		Vitamin E
40.726	Neophytadiene	3.89	$C_{20}H_{38}$	278		Sesquiterpenoids
44.565	Tetratetracontane	3.47	$C_{44}H_{90}$	619		Alkane

Table 4. Phytocompounds identified in the chloroform leaf extract of *A. chinense* by GC-MS analysis

RT	Name of the compound	Peak area %	Mol. formula	Mol. wt.	Structure	Nature
17.303	2,4-Ditert-butylphenol	13.80	$C_{14}H_{22}O$	206		Phenols
23.434	Calendin	5.80	$C_{11}H_{16}O_3$	196		Tetraterpenoids
23.673	1-Nonadecene	12.09	$C_{19}H_{38}O$	266		Alkene
24.573	Phytol acetate	17.30	$C_{22}H_{42}O_2$	338		Diterpene alcohol

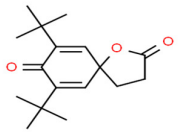
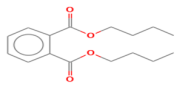
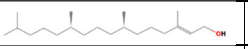
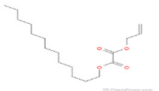
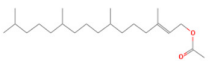
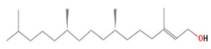
25.444	3,7,11.15-Tetramethyl-2-hexadecen-1-ol	6.16	$C_{20}H_{40}O$	296		Diterpene
25.999	7,9-Ditert-butyl-1-oxaspiro[4.5]deca-6,9-diene-2,8-dione	4.74	$C_{17}H_{24}O_3$			Oxaspiro
27.041	Dibutyl phthalate	2.56	$C_{16}H_{22}O_4$	278		Plastilizer
27.984	5-Octadecene, (E)	4.29	$C_{18}H_{36}$	252		Hydrocarbon alkene
31.495	Phytol	10.06	$C_{20}H_{40}O$	296		Diterpenoid
39.446	1-Hexacosanol	2.59	$C_{26}H_{54}O$	382		Primary fatty alcohol
42.193	Oxalic acid, allyl tridecyl ester	15.14	$C_{18}H_{32}O_4$	312		Ester
43.328	5-Eicosene, (E)	3.41	$C_{20}H_{40}$	280		Alkene
43.417	Tetradecane	2.05	$C_{14}H_{30}$	198		Alkane

Table 5. Phytocompounds identified in the petroleum ether leaf extract of *A. chinense* by GC-MS analysis

RT	Name of the Compound	Peak area %	Mol. formula	Mol. Wt.	Mol. structure	Nature
12.625	Heptadecane	8.17	$C_{17}H_{36}$	240		Alkane
15.061	Pentadecane	2.63	$C_{15}H_{32}$	212		Alkane
22.558	Phytol acetate	3.97	$C_{22}H_{42}O_2$	338		Diterpene alcohol
22.677	Hexahydrofarnesylacetone	11.79	$C_{18}H_{36}O$	268		Ketone
27.915	Phytol	15.53	$C_{20}H_{40}O$	296		Diterpene
32.917	Eicosane	7.52	$C_{20}H_{42}$	282		Acyclic alkanes
34.523	Hexadecane	9.53	$C_{16}H_{34}$	226		Alkane hydrocarbon
36.065	Heptadecane	11.49	$C_{17}H_{36}$	240		Alkane
37.545	Eicosane	10.99	$C_{20}H_{42}$	282		Acyclic alkanes
38.958	Octacosane	8.27	$C_{28}H_{58}$	394		Fatty acid
43.726	Tetracosane	10.11	$C_{24}H_{50}$	338		Alkane

The most versatile compounds in ethanol leaf extract were ethyl palmitate (18.50%) which is a long-chain fatty acid ethyl ester with has nematicide, antioxidant, anti-androgenic, hemolytic, flavor, and hypocholesterolemic (Tyagi and Agarwal, 2017) activity followed by phytol (15.94%) a diterpene mostly used as a fragrance in the pharmacological and biotechnological industry has autophagy, antioxidant, anxiolytic, immune-modulating, anti-inflammatory, cytotoxic, metabolism-modulating, apoptosis-inducing, antinociceptive, antimicrobial effects nematicidal, antibacterial, anti-inflammatory and pesticidal activities (Islam *et al.*, 2018; Adnan *et al.*, 2019). No activity has been reported in cis, cis, cis-7,10,13-hexadecatrienal (15.34%), and Z, Z-6,13-octadecadien-1-ol acetate (11.97%).

The major compounds found in chloroform leaf extract were phytol acetate (17.30%) which is acyclic diterpene alcohol has anti-inflammatory, anti-leishmanial activity (Godara *et al.*, 2019). Oxalic acid, allyl tridecyl ester (15.14%), an ester compound, 2,4-ditert-butylphenol (13.80%) a phenol has antifungal, antioxidant (Varsha *et al.*, 2015), 1-nonadecene (12.09%) an unbranched nineteen-carbon alkene has antimicrobial, antioxidant property (Nandhini *et al.*, 2015).

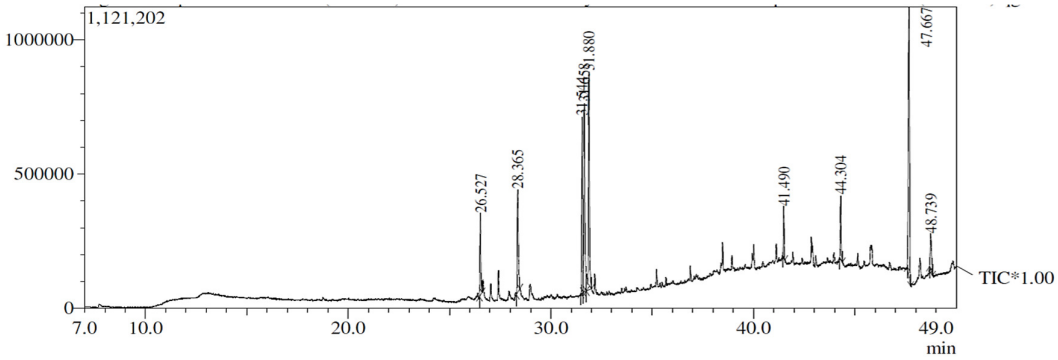


Figure 5. GC-MS chromatogram of methanol extract of *A. chinense* leaf

Table 6. Phytocompounds identified in the methanol leaf extract of *A. chinense* by GC-MS analysis

RT	Name of the compounds	Peak area %	Mol. formula	Mol. Wt.	Structure	Nature
26.527	Phytol acetate	5.58	$C_{22}H_{42}O_2$	338		Diterpene alcohol
28.365	Methyl isohexadecanoate	9.70	$C_{17}H_{34}O_2$	270		Fatty acid methyl ester
31.544	Methyl 9,12-octadecadienoate	12.79	$C_{19}H_{34}O_2$	294		Fatty acid methyl ester
31.658	Linolenic acid, methyl ester	16.14	$C_{19}H_{32}O_2$	292		Linoleic acid
31.880	Phytol	17.68	$C_{20}H_{40}O$	296		Diterpene
41.490	Pentatriacontane	3.10	$C_{35}H_{72}$	492		Alkane
44.304	Tetratetracontane	4.45	$C_{44}H_{90}$	619		Alkane
47.667	Octacosane	27.11	$C_{28}H_{58}$	394		Alkane
48.739	Neophytadiene	3.45	$C_{20}H_{38}$	278		Sesquiterpenoids

It was observed that in the petroleum ether leaf extract the most predominant compounds identified were heptadecane (19.66%) a straight-chain alkane has anti-inflammatory , antioxidant, anti-fungal (Kim *et al.,* 2013; Abubacker *et al*., 2015), eicosane (18.51%) an acyclic alkane has antioxidant, antibacterial, antifungal (Lin *et al*., 2016; Chuah *et al*., 2018), hexahydrofarnesylacetone (11.79%) a ketone is a pheromone found in numerous plants, frequently as a part of the floral odor, and in some insect species (Schulz *et al*., 2011) and tetracosane (10.11%) a straight-chain alkane that has anti-cancer, cytotoxic property (Paudel *et al*., 2019).

The most prevailing compounds were octacosane (27.11%) a straight-chain alkane that has antioxidant and anti-inflammatory activity Bakr *et al*., 2017) and phytol (17.68%) an acyclic diterpene which is also identified in ethanol (15.94%) and chloroform (10.06%) extracts were reported to have anti-diuretic, antimicrobial, anticancer, anti-diabetic, anti-inflammatory, and immunostimulatory (U.S. Department of Agriculture, Agricultural Research Service, 1992-2016, Dr. Duke Phytochemical and Ethnobotanical databases,). The compound linolenic acid, methyl ester (16.14%) has properties like anticandidal and antibacterial activity (Mujeeb *et al*., 2014) and methyl 9,12-octadecadienoate (12.79%) has antihistaminic, antieczemic, hepatoprotective, hypocholesterolemic, nematicide, antiandrogenic, antiacne, 5 α reductase inhibitor, anticoronary, insectifuge, and antiarthritic (Gnanavel and Saral, 2013; Ghazali and Abdullah, 2014).

All the four extracts of the *A. chinense* leaf exerted a very high amount of saponin content. The ethanol extract had the highest concentration of saponins, flavonoid, and phenol. The GC-MS report showed a high content of terpenoids and alkanes. The metabolite profile reported from the different solvent extracts of the present study varies from the essential oil extracted from both *A. chinense* leaves and bulbs (Pino *et al*., 2001; Liu *et al*., 2014). The difference in results may be due to the extraction method, climatic conditions, soil pH, seasonal variation and many other environmental factors.

Conclusions

To the best of our knowledge, this is the first GC-MS report from India on the metabolite profile of *A. chinense* leaf extracts using methanol, ethanol, petroleum ether, and chloroform solvent. The extracts of *A. chinense* are rich in saponins, terpenes and alkanes representing an important step to understand the phytochemicals constituent of the leaf extracts which could facilitate further use in the pharmaceutical and food industry considering its availability since it is non-toxic and edible. The present results may recommend the use of *A. chinense* leaf to treat various ailments where this plant may be a natural source of a new drug to the scientific and biomedical communities.

Authors' Contributions

TR; Performed all the experiments and drafted the manuscript. RMS; Participated in carrying out the analysis. SR; Participated in interpretation of the data. SV; Participated in design and critical revision of the manuscript. All authors read and approved the final manuscript.

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Conflict of Interests

The authors declare that there are no conflicts of interest related to this article.

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