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GC-MS analysis of aqueous and ethanolic extract in different plant parts of *Alternanthera philoxeroides* (Mart.) Griseb

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Abstract
Alternanthera philoxeroides is considered to be one of the worst aquatic weeds in the world. The aquatic form of the plant is a serious threat to waterways, agriculture and the environment. Due to a situation of changing climate, this alligator weed has recently become a dominating invasive weed all over the world. Recent studies have looked into the possibility of a plant producing possible allelocompounds. It is crucial to extract these bioactive chemicals using specific solvents. Hence the present study was on use of different solvent viz. water and ethanol to extract potential compounds using GC-MS was studied. The GC-MS analysis shows different peaks with low and high molecular weight determining the presence of many bioactive compounds. The phytoconstituents in the ethanolic extract and aqueous extracts different plant parts of *A. philoxeroides* have been screened by using GC-MS analysis. Aqueous extracts show higher phytoconstituents than the ethanol extracts. This study helps to explore the potential compounds and the presence of these compounds may proceed to find out various allelochemicals present the plant.

Keywords: *Alternanthera philoxeroides*, aqueous extract, ethanol extract, GC-MS analysis, phytoconstituents

Introduction
After receiving a great deal of scrutiny for several decades, allelopathy has received attention because of its potential to find out solution of various crop production and therapeutic activities. Several plants are known to produce allelochemicals one such field explored to extract allelopathy potential by an invasive weed. Among the various invasive weeds *Alternanthera philoxeroides* pose serious threat to aquatic ecosystem. It has proved to be second most invasive weed in the world after parthenium. An investigation is made to study the allelopathic effects of *A. philoxeroides* because of its invasive nature, the ability of this weed to persist in terrestrial, semiaquatic and aquatic environment, the ability to rapidly take root along water way banks and the ability to propagate via vegetative fragmentation and waterborne dispersal of vegetative propagules contribute to its success as an invasive species. (ISSG, 2016) [3]

Alternanthera philoxeroides (Alligator wed) belonging to family amaranthaceae commonly known as joy weed has many allelochemicals. The chemical released from plamts and imposing allelopathic influences are allelochemicals or allelochemics. Chemicals with allelopathic potential are present in almost all plant and these chemicals under specific condition are released in to the environment and can positively or negatively affect on growth and development of vegetation (Nasar and Shariati 2005) [5]

Allelopathic compounds interfere with physiological processes and allelopathic inhibition is complex and can involve in the interaction of different classes of chemicals like phenolic compounds, flavonoids, terpenoids, alkaloids, steroids, carbohydrates and amino acids with mixtures of different compounds. Sometimes having a greater allelopathic effect than individual compounds alone. Allelochemicals may be more biodegradable than traditional herbicides but may also have undesirable effects on non-target species, necessitating the ecological studies before wide spread use.

Alternanthera philoxeroides is a promising species in the search for new molecules with biological effects. Recently, biological agents and allelopathic effects to control weeds have been added to integrated weed management strategies. Allelopathy as a tool, can be importantly used to combat the challenges of environmental pollution and herbicide resistance development. (Rice 1974) [9].

This alligator weed have been found to possess interesting biological activities and find application such as pharmaceuticals, insecticides, bio herbicides, dyes, flavors and fragrances. The modern methods for describing the identification and quantification of active constituents in plant material may be useful for proper standardization and formulations. *A. philoxeroides* is one of the invasive weeds known to have various allelochemicals and has shown phyto-inhibitory effects.

The preliminary phytochemical analysis showed the presence of alkaloids, carbohydrates, saponins, phenols, flavonoids, amino acids, diterpenes, tannin, terpenoids, protein, steroid, oxalate, coumarin and quinone but again the amount of allelochemicals extracted depends upon the type of the solvents are determined to extract the allelochemicals the most précised quantifiable solvent or extract has to be determined (Pamilia and Karpagam (2017a) [6]. Hence the main objective of the experiment was determining the most precise method of solvent to extract and identify phytochemical constituents present in the *A. philoxeroides* plant part extract with this background aqueous extract and ethanol extracts of stem, root, leaf and wholeplant part of *A. philoxeroides* were examined through gas chromatography and mass spectrometry (GC-MS) method.

Materials and Methods

Collection of sample materials

The alligator weed plant *Alternanthera philoxeroides* was bought from Hebbal lake which is located at Bengaluru. The botanical identification and confirmation were achieved by AICRP Weed Management, University of Agricultural Sciences GKVK Bangalore. The fresh healthy plant was thoroughly washed with three to four times with running tap water then finally with sterile water. The plant parts leaf, root, stem and whole plant of *A. philoxeroides* was separated and dissected in small pieces and dried under shades inside the laboratory benches at ambient temperature for 20-30 days to ensure it is dried completely and powdered by using plant sample grinder and stored in dark bags to protect from humidity and light, prior to analysis.

Aqueous extracts of *Alternanthera philoxeroides*

Aliquots (50 mL) containing the 8g of different plant part extracts of *A. philoxeroides* were transferred to a Soxhlet apparatus. The solution was extracted with 50 mL of ethyl acetate at a ratio of 1:1 (v/v). Then the extract was concentrated to a final volume of 1 mL using a rotary evaporator at 55 ºC and the samples were immediately analyzed by GC-MS using an Agilent 6890 GC-5973 MSD (Agilent Technologies, Santa Clara, CA) fitted with an RTX-5 ms capillary column (Restek Corporation, Bellefonte, PA), 30 m × 0.25 mm i.d., 0.25 µm.

The optimized conditions for the analysis of the different plant parts of aqueous extracts of *A. philoxeroides* using the column configuration were as follows: helium was used as the carrier gas at a flow rate of 1.5 mL min^{-1}; the injection temperature was 260 ºC, injection volume 1 µL and operated in split mode (1: 100); the temperature program was 40 ºC (held for 2 min) to 250 ºC (held for 5 min) at 10 ºC min^{-1}. Electron ionization for the mass spectrometry detection experiments used temperatures of 200 and 250 ºC for the ion source and interface, respectively. The scan range of the mass-to charge ratio (*m/z*) of ions was 40-700, the scanning interval was 0.5 s, and the scan rate 1.5 scans s^{-1}. Compounds were tentatively identified (p<0.05) on the basis of the National Institute of Standards and Technology (NIST) Mass Spectral Library.

Preparation of Ethanol extract

The 10 g of sample was taken and soaked for 24h in 30ml of ethanol. The extract was filtered using Whatman filter paper No. 1, evaporated to dryness and re-dissolved in DMSO (Dimethyl Sulphoxide). The extracts were preserved in airtight container and kept at 4-50 °C for further use. Gas Chromatography-Mass spectrometry (GC-MS) analysis

The GC-MS was performed by using PerkinElmer Clarus 500 Model and the software used is Turbomass ver 5.2. The fused silica column was packed with Elite -5 MS (5% Phenyl 95%dimethylpolysiloxane, 30m x 250 µm). The oven temperature was set up from 50 ºC with an increase of 8 ºC/minto 220 ºC for 5 min and 7 ºC /min to 280 ºC for 15 mins. Helium gas (99.999%) was used as the carrier gas at constant flow rate of 1 ml/min. An aliquot of 2µl of sample was injected into the column with the injector temperature at 280 ºC and the Split ratio of 10:1. The ionizing energy of 70 eV was used and the electron ionization is involved. The mass range is 40-600amu. The inlet line temperature was 200 ºC and source temperature was 150 ºC. Total GC running time was 50 minutes. The compounds were identified referring to NIST 2005 library.

Identification of compounds

Interpretation of mass spectrum of GC-MS was conducted using the database of National Institute Standard and Technique (NIST Version-Year 2005) having more than 62,000 patterns. The name, molecular weight, molecular formula and structure of the components of the test material were determined.

Results and Discussion

GC-MS is one of the most precise methods to identify various secondary metabolites present in the plant extract (Deshpande and Kadam., 2013; Payum., 2016) [2, 8]. The components present in the aqueous and ethanol extract of different parts of *A. philoxeroides* were identified by GC-MS and the type of the compounds identified by different extractant in different plant part of *A. philoxeroides as* presented in table 1 to 8 (Figure 1 to 8).

The number of chemicals detected are 24, 25, 25 and 32 chemicals and 15, 16, 17, and 16 chemicals in stem, root, leaf and whole plant by aqueous and ethanol extracts respectively. The peak names with their molecular formula, molecular weight (MW), retention time (RT) and peak area percentage are exhibited in Tables 1 and 8.

In the present study, the GC-MS analysis in aqueous and ethanol extracts of different plant parts of *A. philoxeroides* showed the presence of various phytochemicals with allelopathy activities, which may help in deriving the most allelopathic potential of plant part of *A. philoxeroides.* Among that nine compounds are present in all the parts of the plant they are Eucalyptol, 1, 2, 3-Propanetriol, 1-acetate, (+)-2-Bornanone, 1-Tridecene, 1-Tetradecene, 1-Heptadecene, 1-Nonadecene, n-Hexadecanoic acid and Phytol. The whole plant of aqueous extract shows the highest phytoconstituents than other plant parts. The number of common compounds found in both (aqueous and ethanol) the extracts of root was eight chemical compounds. similarly, five chemical compounds are commonly found in leaf and whole plant extracts. There were no common compounds were identified or determined in stem extracts of aqueous and ethanol extract

similarly results were observed by Pamilia and Karpagam (2017b) [7]

Where as in the GC-MS analysis of ethanolic extract of different plant parts of *A. philoxeroides* showed the presence of many phytoconstituents .they are eleven compounds are present in all the parts of the plant and they are Neophytadiene, 2-Pentadecanone, 6,10,14-trimethyl- Hexadecanoic acid, methyl ester, Dibutyl phthalate, n-Hexadecanoic acid, 9,12-Octadecadienoic acid (Z,Z)-, methyl ester, Hexadecanoic acid, ethyl ester, 8-Octadecenoic acid, methyl ester, 12(Z)-Conjugated linoleic acid, (Z)- 9-Octadecenoic acid, methyl ester10(E)-, Phthalic acid, and butyl 2-pentyl ester. The ethanolic leaf extracts of *A. philoxeroides* shows the highest phytoconstituents than other plant parts in ethanol extract.

Among the identified phytochemicals the number of phytochemicals extracted by aqueous was more than ethanol extracts. Zuo *et.al* (2012) [11] reported that *A. philoxeroides* grown in aquatic ecotype showed stronger allelopathic potential due to higher level of antioxidant compounds (protein and flavonoids) and higher activity of protective enzymes (superoxidase, dismutase, peroxidases and catalases). Similar observation was made by Abbas, *et al* (2016) [1] and Mandal and Mondal (2011) [4] concluded in their study that *A. philoxeroides* has ability to produce several allelochemicals which has inhibitory chemicals effect of some plants on germination growth and development. In their study the stem and root extracts were found to exhibit maximum allelopathic potential ability causing a decrease in spore germination percentage in *Ampelopteris prolifera* than of leaf extracts. The increased filamentous growth and decrease rhizoidal growth has been attributed to the presence of alkaloids and phenols in the extracts of *A. philoxeroides*. It has been found that these toxic substances are synthesized in the leaf but gradually they are translocated to the various plant parts like stem and roots.

Table 1: Chemical composition of aqueous extract of Root of *Alternanthera philoxeroides*

Sl.no	Ret. time	Name of compounds	Molecular formula	M. W (g/mol)	Peak area %
1	8.375	Eucalyptol	$C_{10}H_{18}O$	154.24	1.32
2	9.365	1,2,3-Propanetriol, 1-acetate	$C_5H_{10}O_4$	134.13	5.58
3	10.174	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl	$C_6H_8O_4$	144.12	0.79
4	10.274	(+)-2-Bornanone	$C_{10}H_{16}O$	152.23	2.21
5	10.538	Octanoic acid	$C_8H_{16}O_2$	144.21	0.40
6	10.879	1-Tridecene	$C_{13}H_{26}$	182.34	1.47
7	11.209	Bicyclo[3.1.1]hept-3-en-2-one, 4,6,6-trimethyl-	$C_{10}H_{14}O$	150.21	0.72
8	11.401	5-Hydroxymethylfurfural	$C_6H_6O_3$	126.11	5.88
9	13.312	1,2,3-Propanetriol, 1-acetate	$C_5H_{10}O_4$	134.130	0.39
10	13.721	1-Tetradecene	$C_{14}H_{28}$	196.37	3.40
11	15.111	Pentadecane	$C_{15}H_{32}$	212.42	0.98
12	16.239	1-Heptadecene	$C_{17}H_{34}$	238.45	7.54
13	16.327	Heptadecane	$C_{17}H_{36}$	240.47	1.94
14	18.500	1-Nonadecene	$C_{19}H_{38}$	266.5	6.33
15	19.011	2-Pentadecanone, 6,10,14-trimethyl-	$C_{18}H_{36}O$	268.47	0.94
16	19.214	1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester	$C_{16}H_{22}O$	278.34	1.00
17	19.858	Hexadecanoic acid, methyl ester	$C_{17}H_{34}O_2$	270.45	1.40
18	20.228	n-Hexadecanoic acid	$C_{16}H_{32}O_2$	256.4	47.09
19	21.420	n-Nonadecanol-1	$C_{19}H_{40}O$	284.52	1.42
20	21.493	9,12-Octadecadienoic acid (Z, Z)-, methyl ester	$C_{19}H_{34}O_3$	310.5	1.48
21	21.555	9-Octadecenoic acid, methyl ester, (E)-	$C_{19}H_{36}O_2$	296.5	2.78
22	21.654	Phytol	$C_{20}H_{40}O$	296.53	2.05
23	21.791	Methyl stearate	$C_{19}H_{38}O_2$	298.50	0.41
24	22.418	Eicosyl trifluoroacetate	$C_{22}H_{41}F_3O$	394.55	2.47

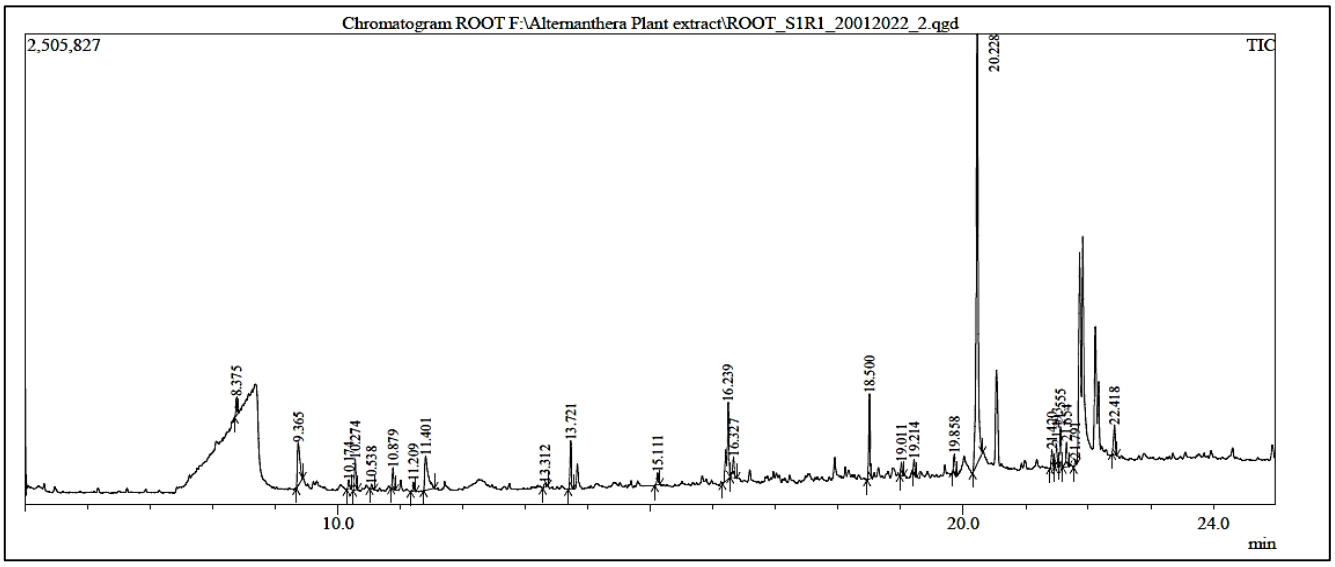

Fig 1: GC-MS analysis of phytochemicals identified from Aqueous extract of Root of *Alternanthera philoxeroides.*

Table 2: Chemical composition of aqueous extract of Stem of *Alternanthera philoxeroides*

Sl.no	Ret. time	Name of compounds	Molecular formula	M. W (g/mol)	Peak area %
1	7.628	1-Decene	$C_{10}H_{20}$	140.26	0.29
2	8.379	Eucalyptol	$C_{10}H_{18}O$	154.24	0.71
3	9.364	1,2,3-Propanetriol, 1-acetate	$C_5H_{10}O_4$	134.13	3.99
4	10.176	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl	$C_6H_8O_4$	144.12	0.48
5	10.276	(+)-2-Bornanone	$C_{10}H_{16}O$	152.23	1.30
6	10.881	1-Tridecene	$C_{13}H_{26}$	182.34	2.08
7	11.009	Dodecane	$C_{12}H_{26}$	170.33	0.62
8	11.211	Bicyclo[3.1.1]hept-3-en-2-one, 4,6,6-trimethyl-, (1S)-	$C_{10}H_{14}O$	150.21	0.33
9	11.396	5-Hydroxymethylfurfural	$C_6H_6O_3$	126.11	2.73
10	13.722	1-Tetradecene	$C_{14}H_{28}$	196.37	4.48
11	14.691	2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)-	$C_{14}H_{20}O$	220.30	0.41
12	15.115	Pentadecane	$C_{15}H_{32}$	212.42	0.54
13	15.216	2,4-Di-tert-butylphenol	$C_{14}H_{22}O$	206.32	1.23
14	16.241	1-Heptadecene	$C_{17}H_{34}$	238.45	7.83
15	16.328	Octadecane	$CH_3(CH_2)_{16}CH_3$.	254.49	0.88
16	16.592	Oxirane, tetradecyl-	$C_{16}H_{32}O$	240.42	0.66
17	18.116	Tetradecanoic acid	$C_{14}H_{28}O_2$	228.37	0.65
18	18.503	1-Nonadecene	$C_{19}H_{38}$	266.50	6.56
19	20.238	n-Hexadecanoic acid	$C_{16}H_{32}O_2$	256.40	31.37
20	20.935	Oxirane, hexadecyl	$C_{18}H_{36}O$	268.47	0.45
21	21.421	Behenic alcohol	$C_{22}H_{46}O$	326.61	1.52
22	21.658	Phytol	$C_{20}H_{40}O$	296.53	1.59
23	21.868	9(E),11(E)-Conjugated linoleic acid	$C_{18}H_{32}O_2$	280.5	25.74
24	22.421	Eicosyl trifluoroacetate	$C_{22}H_{41}F_3O$	394.55	2.78
25	24.312	1-Hexacosanol	$C_{26}H_{54}O$	382.71	0.78

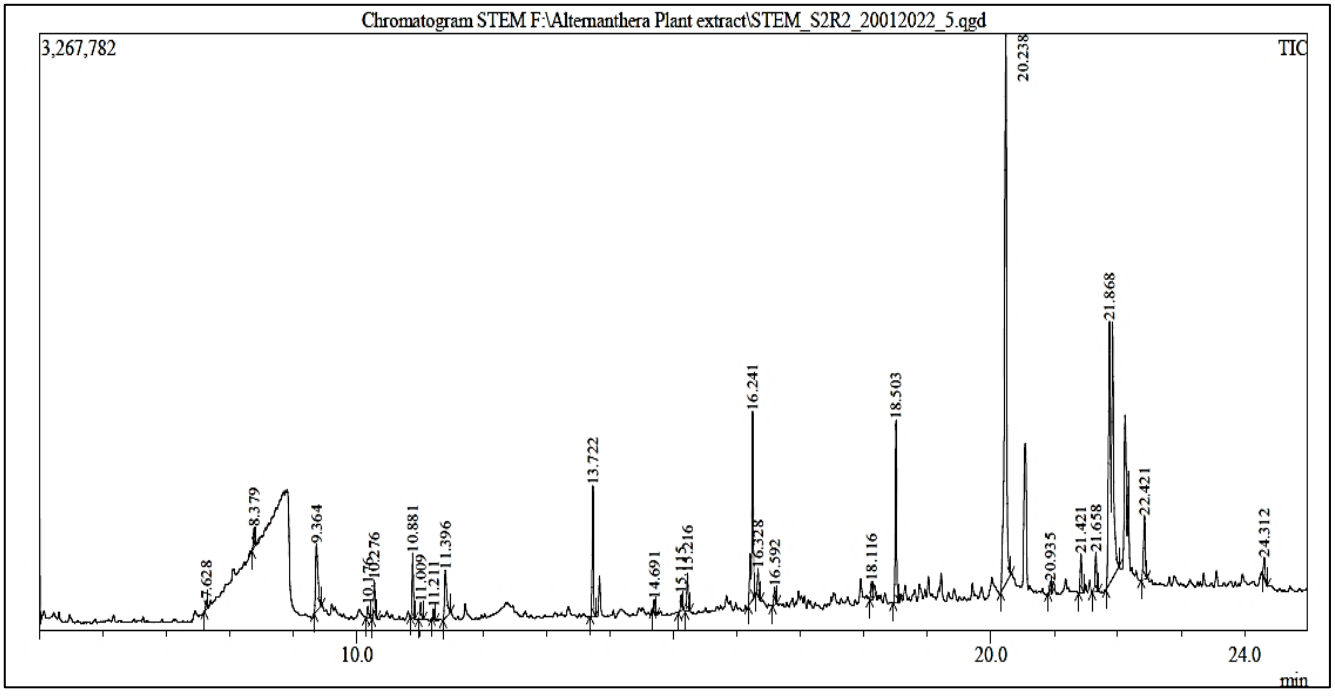

Fig 2: GC-MS analysis of phytochemicals identified from Aqueous extract of Stem of *Alternanthera philoxeroides.*

Table 3: Chemical composition of aqueous extract of Leaf of *Alternanthera philoxeroides.*

Sl.no	Ret. time	Name of compounds	Molecular formula	M. W (g/mol)	Peak area %
1	7.631	1-Decene	$C_{10}H_{20}$	140.26	0.30
2	8.382	Eucalyptol	$C_{10}H_{18}O$	154.24	0.18
3	9.356	1,2,3-Propanetriol, 1-acetate	$C_5H_{10}O_4$	134.13	4.67
4	10.280	(+)-2-Bornanone	$C_{10}H_{16}O$	152.23	0.30
5	10.481	Benzoic acid	$C_7H_6O_2$	122.12	0.32
6	10.883	1-Tridecene	$C_{13}H_{26}$	182.34	1.48
7	13.723	1-Tetradecene	$C_{14}H_{28}$	196.37	3.95
8	15.218	2,4-Di-tert-butylphenol	$C_{14}H_{22}O$	206.32	1.52
9	15.607	2(4H)-Benzofuranone, 5,6,7,7a-tetrahydro-4,4,7a-trimethyl-, (R)-	$C_{11}H_{16}O$	180.24	0.27
10	16.243	1-Heptadecene	$C_{17}H_{34}$	238.45	4.32
11	17.176	7-Oxabicyclo [4.1.0] heptan-3-ol, 6-(3-hydroxy-1-butenyl)-1,5,5-trimethyl-	$C_{13}H_{22}O$	226.31	0.29
12	18.329	6-Hydroxy-4,4,7a-trimethyl-5,6,7,7a-tetrahydrobenzofuran-2(4H)-one	$C_{11}H_{16}O\cdot$	196.24	0.33
13	18.501	1-Nonadecene	$C_{19}H_{38}$	266.5	4.76
14	18.804	Pentadecanoic acid	$C_{15}H_{30}O_2$	242.39	0.82
15	18.887	l-(+)-Ascorbic acid 2,6-dihexadecanoate	$C_{38}H_{68}O_8$	176.12.	0.82
16	18.964	Neophytadiene	$C_{20}H$	278.51	0.31
17	19.014	2-Pentadecanone, 6,10,14-trimethyl	$C_{18}H_{36}O$	268.47	0.91
18	19.837	n-Hexadecanoic acid	$C_{16}H_{32}O_2$	256.4	0.49
19	20.535	Hexadecanoic acid, ethyl ester	$C_{18}H_{36}O_2$	284.47	4.72
20	21.422	Behenic alcohol	$C_{22}H_{46}O$	326.61	0.81
21	21.663	Phytol	$C_{20}H_{40}O$	296.53	36.81
22	22.168	9,12,15-Octadecatrienoic acid, ethyl ester, (Z, Z,Z)-	C20H34O	306.48	9.36
23	22.420	Eicosyl trifluoroacetate	$C_{22}H_{41}F_3O$	394.55	1.61
24	22.579	3,7,11,15-Tetramethylhexadec-2-en-1-yl acetate	$C_{22}H_{42}O_2$	338.56	0.56
25	24.717	Eicosanal-	$C_{20}H_{40}O$	296.5	0.32

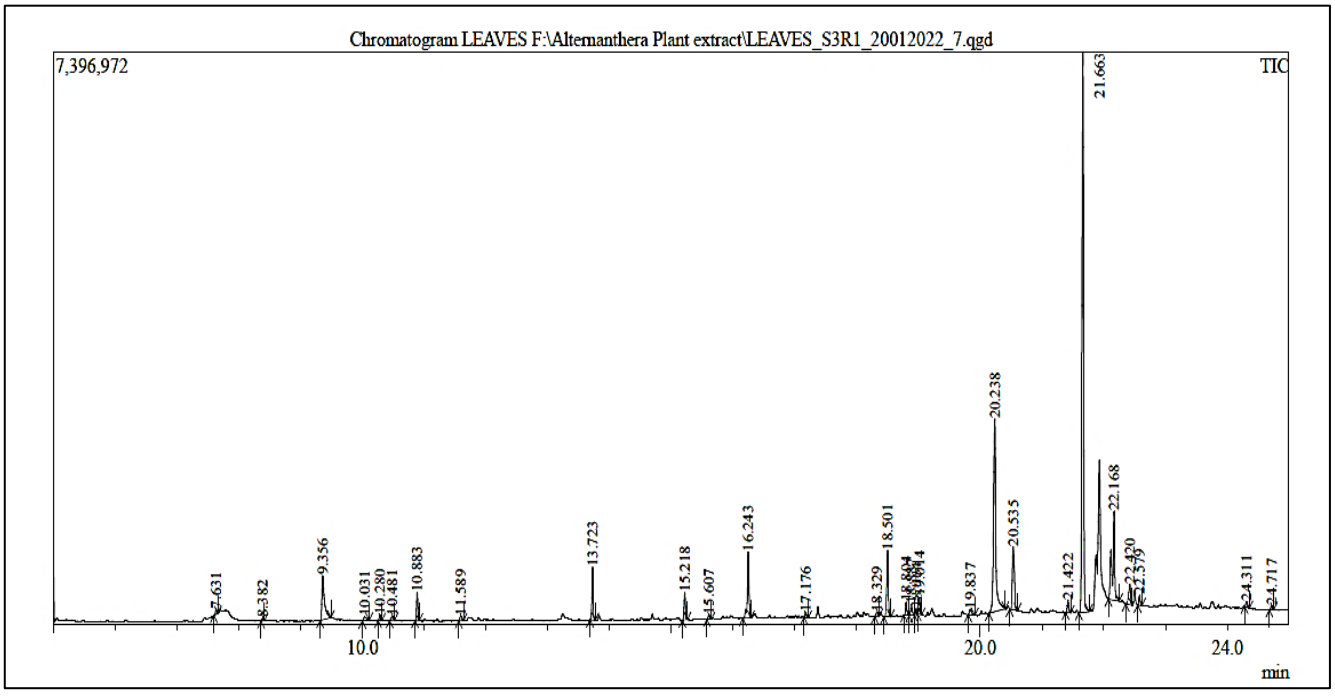

Fig 3: GC-MS analysis of phytochemicals identified from aqueous extract of Leaf of *Alternanthera philoxeroides.*

Table 4: Chemical composition of aqueous extract of whole plant of *Alternanthera philoxeroides*

Sl.no	Ret. time	Name of compounds	Molecular formula	M. W (g/mol)	Peak area %
1	7.630	1-Decene	$C_{10}H_{20}$	140.26	0.30
2	7.693	Benzene, 1-ethyl-2-methyl-	C_9H	120.19	0.35
3	8.057	1H-Pyrrole-2-carboxaldehyde	C_5H_5NO	95.10	0.41
4	8.380	Eucalyptol	$C_{10}H_{18}O$	154.24	0.66
5	9.378	1,2,3-Propanetriol, 1-acetate	$C_5H_{10}O_4$	134.13	6.28
6	10.279	(+)-2-Bornanone	$C_{10}H_{16}O$	152.23	1.17
7	10.515	Benzoic acid	$C_7H_6O_2$	122.12	0.35
8	10.884	1-Tridecene	$C_{13}H_{26}$	182.34	3.09
9	11.214	Bicyclo[3.1.1]hept-3-en-2-one, 4,6,6-trimethyl-	$C_{10}H_{14}O$	150.21	0.38
10	11.403	5-Hydroxymethylfurfural	$C_6H_6O_3$	126.11	0.97
11	13.724	1-Tetradecene	$C_{14}H_{28}$	196.37	6.07
12	14.051	Oxirane, decyl-	$C_{12}H_{24}O$	184.31	0.15
13	14.693	2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)-	$C_{14}H_{20}O$	220.30	0.52
14	15.115	Pentadecane	$C_{15}H_{32}$	212.42	0.44
15	15.221	2,4-Di-tert-butylphenol	$C_{14}H_{22}O$	206.32	2.98
16	16.244	1-Heptadecene	$C_{17}H_{34}$	238.45	8.73
17	16.330	Octadecane	$CH_3(CH_2)_{16}CH_3$.	254.49	0.39
18	16.595	Oxirane, tetradecyl-	$C_{16}H_{32}O$	240.42	0.49
19	18.125	Tetradecanoic acid	$C_{14}H_{28}O_2$	228.37	0.24
20	18.505	1-Nonadecene	$C_{19}H_{38}$	266.5	7.51
21	18.647	Hexadecane, 2,6,10,14-tetramethyl	$C_{20}H$	282.54	0.33
22	18.875	Oxirane, hexadecyl-	C18H36O	268.47	0.54
23	18.962	Neophytadiene	$C_{20}H$	278.51	0.74
24	19.016	2-Pentadecanone, 6,10,14-trimethyl-	$C_{18}H_{36}O$	268.47	0.71
25	19.837	n-Hexadecanoic acid	$C_{16}H_{32}O_2$	256.4	0.49
26	20.535	Hexadecanoic acid, ethyl ester	$C_{18}H_{36}O_2$	284.47	4.72
27	20.935	Oxirane, hexadecyl-	$C_{18}H_{36}O$	268.47	0.36
28	21.558	6-Octadecenoic acid, methyl ester, (Z)-	$C_{19}H_{36}O$ ·	296.48	0.33
29	21.659	Phytol	$C_{20}H_{40}O$	296.53	9.18
30	22.421	n-Tetracosanol-1	$C_{24}H_{50}O$	354.65	3.78
31	24.310	1-Hexacosanol	$C_{26}H_{54}O$	382.71	0.78
32	24.420	Tetracontane	$C_{40}H_{82}$	563.1	1.45

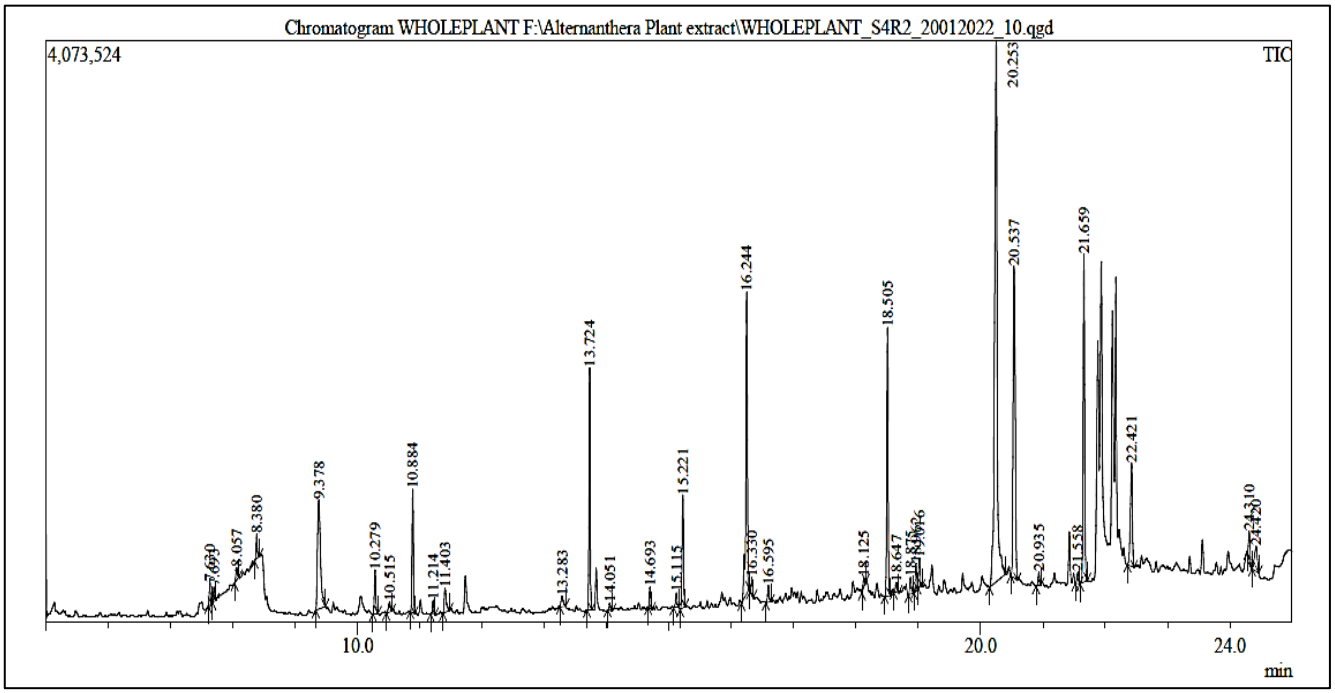

Fig 4: GC-MS analysis of phytochemicals identified from Aqueous extract of whole plant of *Alternanthera philoxeroides*

Table 5: Chemical composition of Ethanolic extract of Root of *Alternanthera philoxeroides.*

Sl.no	Ret. time	Name of compounds	Molecular formula	M. W (g/mol)	Peak area %
1	19.165	Neophytadiene	$C_{20}H$	278.51	0.67
2	19.226	2-Pentadecanone, 6,10,14-trimethyl-	$C_{18}H_{36}O$	268.47	0.92
3	19.462	1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester	$C_{16}H_{22}O$	278.34	3.70
4	20.065	1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester	$C_{16}H_{22}O$	278.34	1.00
5	20.281	Hexadecanoic acid, methyl ester	$C_{17}H_{34}O$	270.45	2.55
6	20.664	Dibutyl phthalate	$C_{16}H_{22}O_4$	278.34	3.61
7	20.739	n-Hexadecanoic acid	$C_{16}H_{32}O$	256.42	49.97
8	20.883	Phthalic acid, butyl 2-pentyl ester	$C_{18}H_{26}O_4$	306.4	0.84
9	21.117	Hexadecanoic acid, ethyl ester	$C_{18}H_{36}O$	284.47	2.73
10	22.436	9,12-Octadecadienoic acid (Z, Z)-, methyl ester	$C_{19}H_{34}O$	294.47	1.61
11	22.536	9-Octadecenoic acid, methyl ester, (E)-	$C_{19}H_{36}O$	296.48	4.46
12	22.697	Phytol	$C_{20}H_{40}O$	296.53	0.83
13	22.937	Methyl stearate	$C_{19}H_{38}O_2$	298.5	0.91
14	23.030	9,12-Octadecadienoic acid (Z,Z)-	$C_{18}H_{32}O$	280.44	14.77
15	23.128	6-Octadecenoic acid, (Z)-	$C_{18}H_{34}O$	282.46	11.42

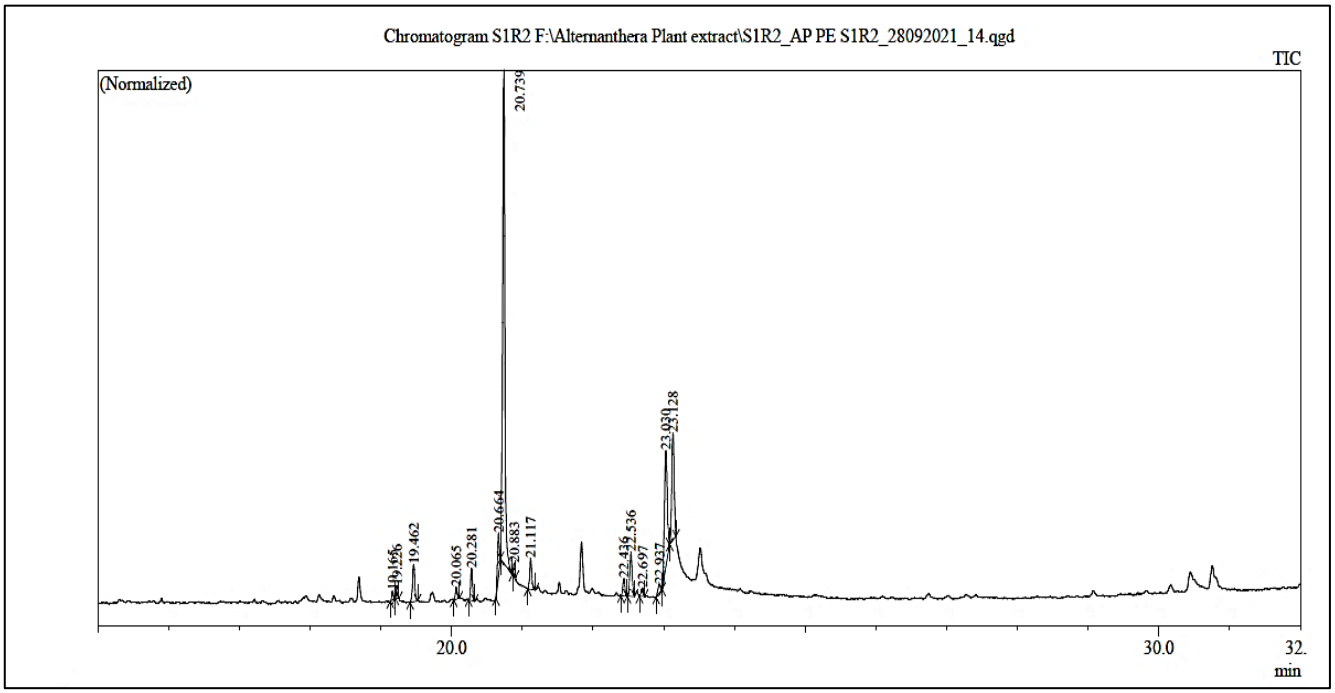

Fig 5: GC-MS analysis of phytochemicals identified from Ethanolic extract of Root of *Alternanthera philoxeroides.*

Table 6: Chemical composition of Ethanolic extract of Stem of *Alternanthera philoxeroides*

Sl.no	Ret. time	Name of compounds	Molecular formula	M. W (g/mol)	Peak area %
1	19.163	Neophytadiene	$C_{20}H$	278.51	1.40
2	19.226	2-Pentadecanone, 6,10,14-trimethyl-	$C_{18}H_{36}O$	268.47	1.85
3	19.459	Phthalic acid, decyl isobutyl ester	$C_{16}H_{22}O$	278.34	2.85
5	20.279	Hexadecanoic acid, methyl ester	$C_{17}H_{34}O$	270.45	1.28
6	20.660	Phthalic acid, butyl tridecyl ester	$C_{26}H_{42}O_4$	418.6	2.78
7	20.748	n-Hexadecanoic acid	$C_{16}H_{32}O$	256.42	44.75
8	20.881	Phthalic acid, butyl 2-pentyl ester	$C_{18}H_{26}O_4$	306.4	0.55
	21.115	Hexadecanoic acid, ethyl ester	$C_{18}H_{36}O$	284.47	2.21
9	22.531	9-Octadecenoic acid, methyl ester, (E)-	$C_{19}H_{36}O$	296.48	2.11
10	22.689	9,12-Octadecadienoic acid (Z, Z)-, methyl ester	$C_{19}H_{34}O_2$	294.47	1.61
11	22.689	Phytol	$C_{20}H_{40}O$	296.53	3.35
12	22.929	Methyl stearate	$C_{19}H_{38}O_2$	298.5	0.81
13	23.032	9,12-Octadecadienoic acid (Z, Z)-	$C_{18}H_{32}O$	280.44	14.46
14	23.131	6-Octadecenoic acid, (Z)-	$C_{18}H_{34}O$	282.46	11.29
15	23.517	Octadecanoic acid	$C_{18}H_{36}O_2$.	284.47	6.29
16	30.424	Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester	$C_{19}H_{38}O_4$	330.5	3.92

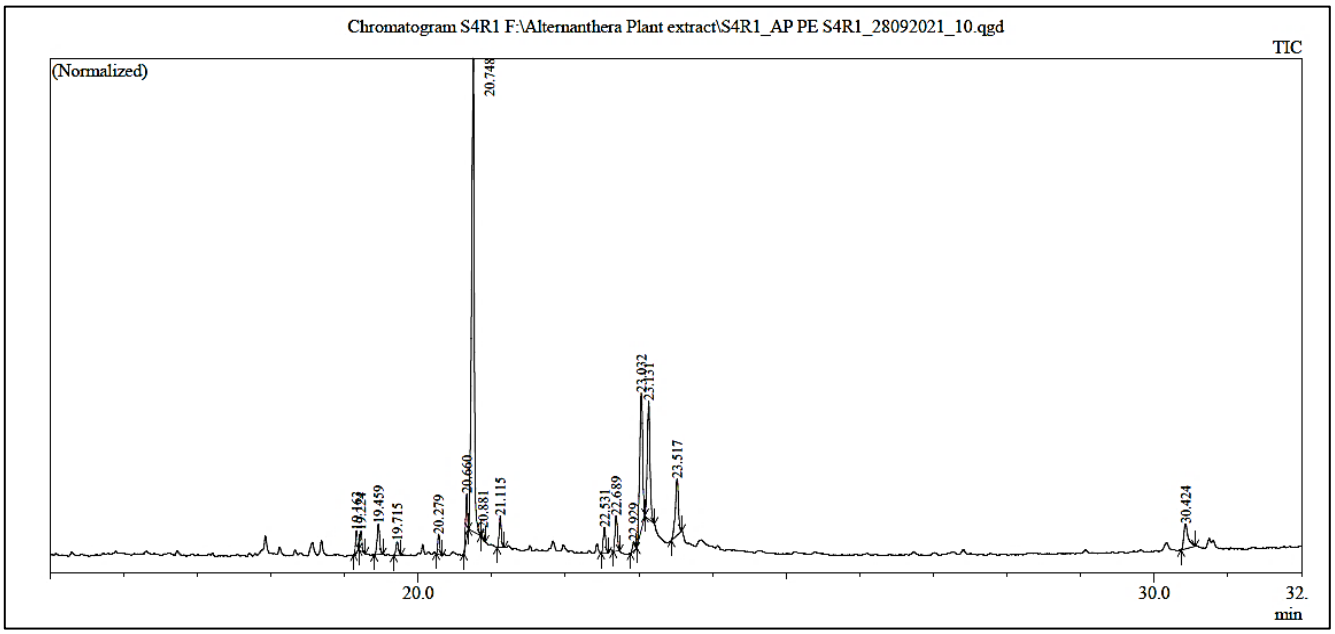

Fig 6: GC-MS analysis of phytochemicals identified from Ethanolic extract of stem of *Alternanthera philoxeroides*

Table 7: Chemical composition of Ethanolic extract leaf of *Alternanthera philoxeroides*

Sl.no	Ret. time	Name of compounds	Molecular formula	M. W (g/mol)	Peak area %
1	19.164	Neophytadiene	$C_{20}H$	278.51	1.64
2	19.225	2-Pentadecanone, 6,10,14-trimethyl-	$C_{18}H_{36}O$	268.47	2.17
3	20.217	Phytol	$C_{20}H_{40}O$	296.53	0.89
4	20.280	Hexadecanoic acid, methyl ester	$C_{17}H_{34}O$	270.45	4.48
5	20.659	Dibutyl phthalate	$C_{16}H_{22}O_4$	278.34	1.65
6	20.758	n-Hexadecanoic acid	$C_{16}H_{32}O$	256.42	32.03
7	20.879	Phthalic acid, butyl 2-pentyl ester	$C_{18}H_{26}O_4$	306.4	0.28
8	21.117	Hexadecanoic acid, ethyl ester	$C_{18}H_{36}O$	284.47	3.12
9	22.436	9,12-Octadecadienoic acid (Z, Z)-, methyl ester	$C_{19}H_{34}O_2$	294.47	1.61
10	22.429	9-Octadecenoic acid, methyl ester, (E)-	$C_{19}H_{36}O$	296.48	1.28
11	22.535	8-Octadecenoic acid, methyl ester	$C_{19}H_{36}O_2$	296.5	5.74
12	22.694	Phytol	$C_{20}H_{40}O$	296.53	20.98
13	22.935	Methyl stearate	$C_{19}H_{38}O_2$	298.5	1.72
14	23.032	9,12-Octadecadienoic acid (Z, Z)-	$C_{18}H_{32}O$	280.44	5.73
15	23.523	Octadecanoic acid	$C_{18}H_{36}O_2$.	284.47	3.03
16	23.826	Phenol, 4,4'-(1-methylethylidene) bis-	$C_{15}H_{16}O$	228.28	12.04
17	30.423	Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester	$C_{19}H_{38}O_4$	330.5	1.48

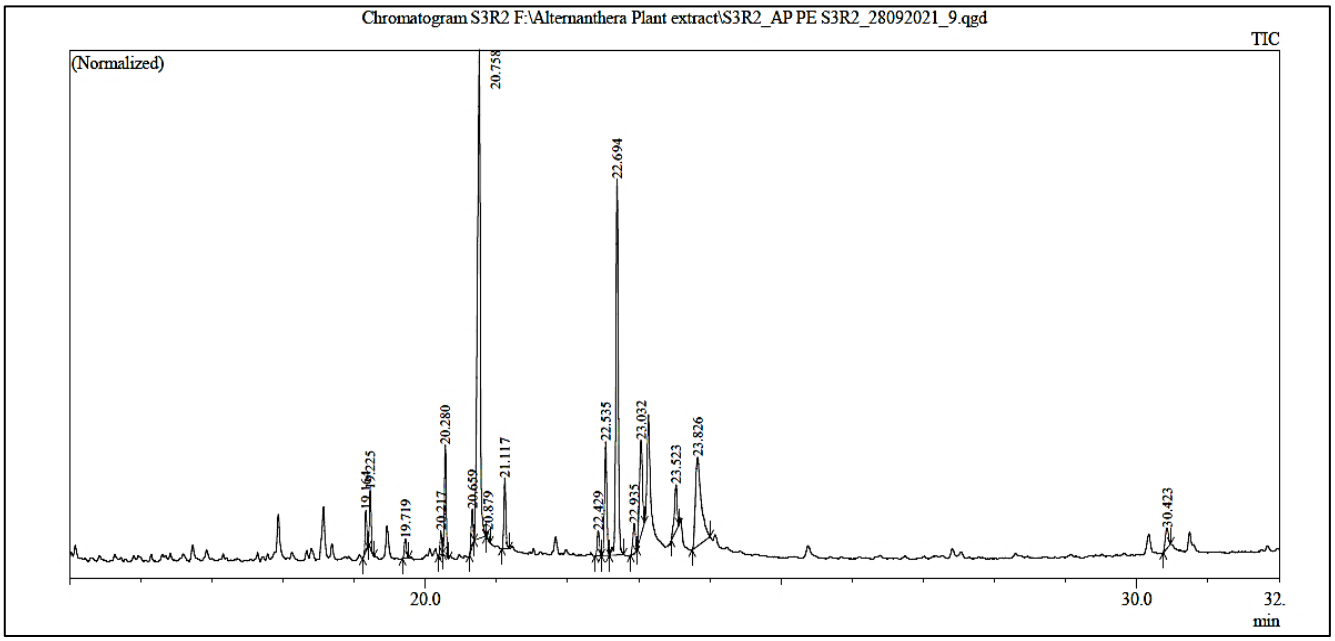

Fig 7: GC-MS analysis of phytochemicals identified from Ethanolic extract of Leaf of *Alternanthera philoxeroides.*

Table 8: Chemical composition of Ethanol extract of whole plant of *Alternanthera philoxeroides*

Sl.no	Ret. time	Name of compounds	Molecular formula	M. W (g/mol)	Peak area %
1	18.698	Squalene	$C_{30}H_{50}$	410.73	2.51
2	19.174	Neophytadiene	$C_{20}H$	278.51	1.73
3	19.234	2-Pentadecanone, 6,10,14-trimethyl-	$C_{18}H_{36}O$	268.47	0.86
4	20.289	Hexadecanoic acid, methyl ester	$C_{17}H_{34}O$	270.45	2.02
5	20.673	Dibutyl phthalate	$C_{16}H_{22}O_4$	278.34	1.93
6	20.746	n-Hexadecanoic acid	$C_{16}H_{32}O$	256.42	26.07
7	20.890	Phthalic acid, butyl 2-pentyl ester	$C_{18}H_{26}O_4$	306.4	0.64
8	21.125	Hexadecanoic acid, ethyl ester	$C_{18}H_{36}O$	284.47	6.13
9	22.443	9,12-Octadecadienoic acid (Z, Z)-, methyl ester	$C_{19}H_{34}O_2$	294.5	1.21
10	22.542	9-Octadecenoic acid, methyl ester, (E)-	$C_{19}H_{36}O$	296.48	2.88
11	22.704	Phytol	$C_{20}H_{40}O$	296.53	33.07
12	23.042	10(E),12(Z)-Conjugated linoleic acid	$C_{18}H_{32}O_2$	280.5	3.97
13	23.139	6-Octadecenoic acid, (Z)-	$C_{18}H_{34}O_2$	282.46	5.40
14	23.495	Linoleic acid ethyl ester	$C_{20}H_{36}O$	308.5	7.43
15	24.089	Octadecanoic acid, ethyl ester	$C_{20}H_{40}O$	312.53	2.11
16	30.443	Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester	$C_{19}H_{38}O_4$	330.5	2.61

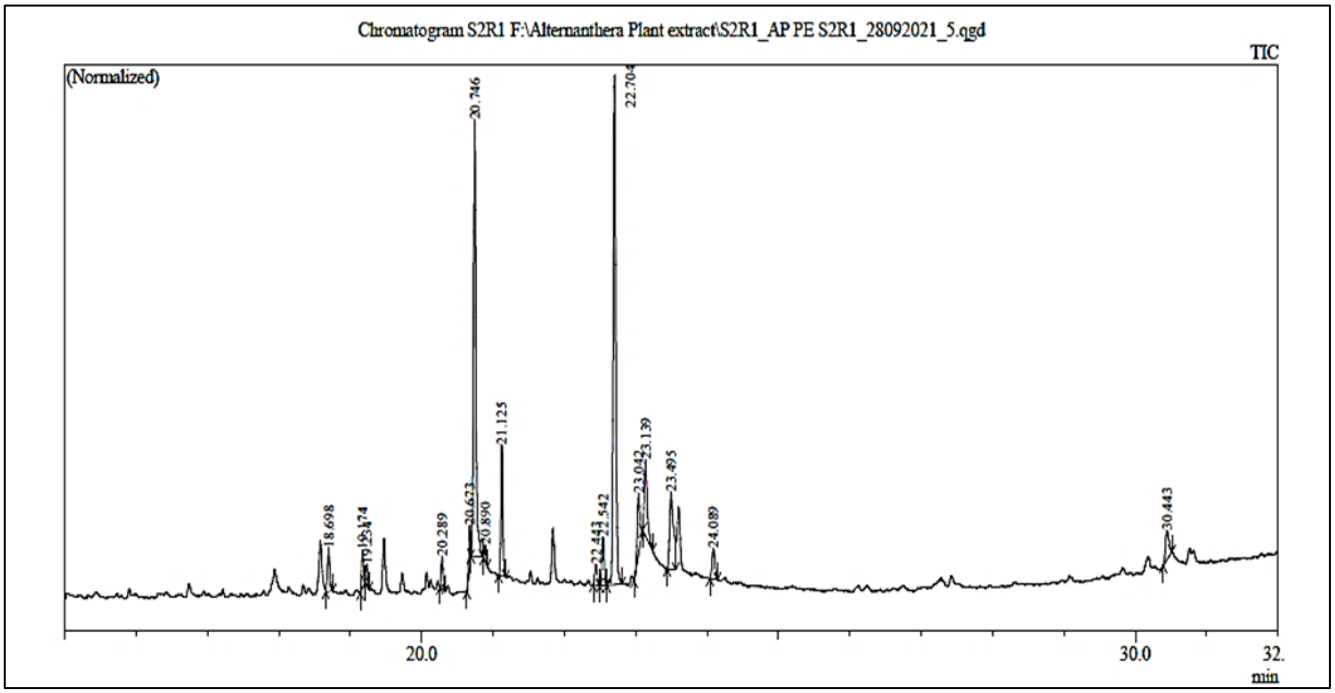

Fig 8: GC-MS analysis of phytochemicals identified from Ethanolic extract of Whole plant of *Alternanthera philoxeroides*

Conclusion

In the present study that *A. philoxeroides* of aqueous extracts showed higher phytoconstituents when compared to ethanol extracts. The presence of these phytoconstituents justified the use of these plant for inhibitory or stimulatory of growth and development of crop or weeds in agroecosystem.

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