Original Research Article

NUTRITIVE COMPOSITION AND GC- MS ANALYSIS OF BIOACTIVE PHYTOCHEMICALS FROM THE METHANOLIC EXTRACTS OF THE STEM AND ROOT OF *Tephrosia vogelii*

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ABSTRACT

Aims: This study was aimed at investigating the nutritive composition and bioactive compounds in the methanol extracts of root and stem of *Tephoresiavogelii.*
Place and Duration of Study: Sample: Samples were collected in K- Vom community in Jos, Plateau state Nigeria between April and May 2023.
Methodology: Sample extractions were carried out using maceration method. phytochemical screening and nutritive composition were carried out using standard methods while the bioactive compounds were detected using GC-MS technique. Phytochemicals were ascertained based on molecular weights (m/z) acquired from GC-MS chromatograms. Phytocompounds were established through interpretation of spectral peaks and comparing data with stored databases from the National Institute Standard and Technique (NIST) library.
Results: The extracts had variable percentage yield with methanol root extract having the highest (3.80%). The results of the phytochemical screening showed the presence and absence of some phytochemicals while the proximate composition varied significantly (P=0.002). The moisture content was in the range of (6.75 to 9.50%), protein (8.99 to 11.56%), crude fiber (2.00 to 7.33%), fat content (47.33 to 51.06%), ash content (15.80 to 17.60%) and carbohydrate (8.33 to 13.84%) in the methanol extracts of the root and stem. Gas Chromatography-Mass Spectrometry, (GC-MS) determined some specific phytocompounds in the extracts, GC-MS analysis furnished a combined total of 61 phytocompounds in the two extracts with fatty acid esters and fatty acids being the major families detected.
Conclusion: The extracts upon analysis revealed high potential for a vast number of bioactive compounds which justifies its use for various ailments by traditional practitioners. Phytochemical components identified in this study advocate the presence of ethnomedical and phytopharmaceutical versality of each of the extracts which could be used in the therapeutic drug formulation studies.

KeywordsTephrosia vogelii, Gas Chromatography-Mass Spectrometry (GC-MS), nutritive composition, Phytocompounds, GC-MS chromatograms

1.0 Introduction

Native to West Africa, many ethnomedical uses have been advocated for *Tephrosia vogelii.* Around the middle belt area of Nigeria, it is cultivated on a commercial scale for killing fish and, to a lesser extent, as part of medicament for bone-setting.[1] Grounded leaves and stem bark are mixed with vegetable oil and rubbed on the skin around fractured limb; pieces of cut stem are used to hold broken limb in position roots are boiled in water and, when warm, feet with localized fungal infections are immersed therein for some minutes.[1] The sap is added to palm-wine to treat diarrhea.[2] In view of its great potential in the therapy and prophylaxis of disease, efforts have been made to identify and isolate the active compounds contained in the plant. Compounds isolated from *Tephrosia vogelii* include flavonoids, glycosides, steroids, tannins, and reducing sugars.[1] Elliptone and Tephrosin have been reported present by Sharma and Khanna [3] in the stem and root while Rotenone was also reported by Barnes and Fryere[4] in the same plant parts. Bioactive phytocompounds from diverse herbal plants are known regarding their ability to fight against pathogens causing human and animal diseases.[5][6] Notably, such ability possessions of the medicinal plants have attracted researchers to exploit their lead compounds for devising the synthesis of the modern pharmaceuticals. Henceforth, this may describe why more than 25% of the pharmaceutical drugs available in the pharmaceutical market today are derived from the medicinal plants.[6][7]Therefore, drug discovery from medicinal plants involves extensive studies to investigate and determine bioactive compounds from traditionally and locally-used medicinal plants.

2.0 Materials and Methods

2.1 Plant collection and authentication

The stem and root of *Tephrosia vogelii* was collected in K-Vom, Jos South Local Government Area of Plateau State, Nigeria. Authentication was by Mr. Sale Mohammed (a taxonomist) from the College of Animal Health and Production Technology, Vom, Plateau State, Nigeria.

2.2 Sample preparation and extraction

The stem and root of the plant was washed properly and dried separately at room temperature and pulverized using a pestle and mortar for extraction. The powdered stem and root of the plant was macerated separately in methanol in the ratio of 1:10 for 48hours at room temperature and filtered to obtain the filtrates. Filtrates were completely evaporated using a hot air oven at 45°C. The evaporation afforded the methanol extracts of the stem and root of the plant.

2.3 Phytochemical screening of the methanol and petroleum ether extracts of the stem and root of *Tephrosia vogelii*

The methanol and petroleum ether extracts of the stem and root of the plant was analyzed for their phytochemical using standard qualitative procedures as described by Dubey [8] Soni & Sosa, [9].

2.4 Nutritive Composition Determination

The nutritive composition of the methanol extracts of the stem and root of the plant was determined as described by [10][11].

2.5 GC-MS analysis of the methanol and petroleum ether extracts of the stem and root of *Tephrosia vogelii*

Standard method according to Konappa*et al*., [12] and Shalini *et al*., [13]was adopted using GC-MS QP 2010 Plus Shimadzu system and Gas chromatography interfaced to a mass spectrometer instrument.

2.6 Identification of phytocompounds

The identification of the compounds was based on the comparisons of their mass spectra with NIST Ver. 2.0 Year 2008 library WILEY8, FAME.

3.0 RESULTS AND DISCUSSION

3.1 Results

Table 1: Yield of the extraction of methanol and petroleum ether extracts of the root and stem of *Tephrosia vogelii*

Extract	Weight (g)	% Yield
Root methanol	5.7	3.8
Stem methanol	3.8	2.5

Table 2: Qualitative phytochemical composition of the methanol extracts of the root (MRE) and stem (MSE) of *Tephrosia vogelii*

Phytoconstituent	MRE	MSE
Tannins	+	+
Saponins	+	+
Reducing sugar	-	-
Alkaloids	+	+
Terpenoides	+	+
Flavonoids	+	+
Cardiac glycosides	+	+
Anthraquinones	+	+
Phenols	+	+
Steroids	+	+
Volatile oil	+	+
Glycosides	+	+
Calcones	+	-
Quinones	-	+

Keys: - = Absent; + = present

Table 3: Nutritive compositions of the methanol extracts of the root (MRE) and stem (MSE) of *Tephrosia vogelii*

Nutritive composition	MRE	MSE
%Moisture	6.75±0.21	9.50±0.21
%Fat	51.06±0.56	47.33±0.56
%Protein	8.99±0.18	11.56±0.18
%Ash	17.60±0.30	15.80±0.30
%Fibre	7.33±0.02	2.00±0.02
%Carbohydrate (Calculated)	8.33±0.12	13.84±0.12

Key: MRE = Methanol Root Extract; MSE = Methanol Stem Extract

GC-MS Analysis for the whole methanol root extract of *Tephrosia vogelii*

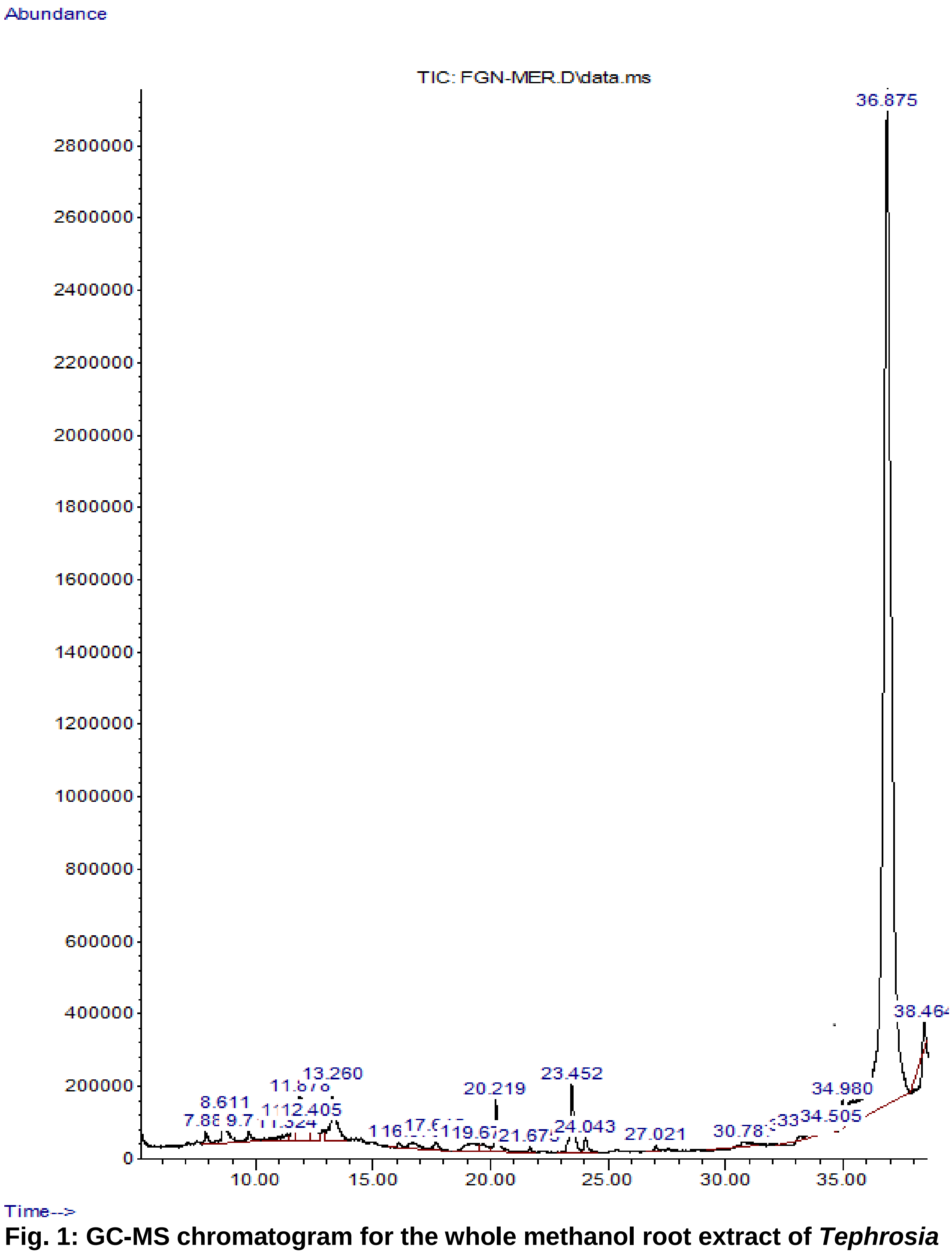

Fig. 1: GC-MS chromatogram for the whole methanol root extract of *Tephrosia vogelii*

Table 4 Bioactive compounds detected in methanol root extract of *Tephrosia vogelii*

Peak	Retention Time	% Peak Area	Compound	Ref	CAS	Quality
1	7.8827	0.4084	1,7-Dimethyl-4-(1-methylethyl) cyclodecane	74583	000645-10-3	49
2	8.6108	1.4874	5-Tetradecene, (E)-	61866	041446-66-6	93
3	9.7133	0.427	Cyclohexane, 1,1'-(1-methyl-1,2-ethanediyl) bis-	72750	041851-34-7	53
4	11.3243	0.4539	Eicosylpentafluoropropionate	255065	1000351-80-8	55
5	11.5744	0.6312	Dodecanoic acid, methyl ester	78067	000111-82-0	50
6	11.8782	3.6657	2,4-Di-tert-butylphenol	70634	000096-76-4	94
7	12.4047	0.9913	1H-Indene, 2,3,3a,4,7,7a-hexahydro-2,2,4,4,7,7-hexamethyl-	70784	061142-60-7	50
8	13.2602	2.826	Cetene	87833	000629-73-2	98
9	16.0711	0.1589	Tridecanoic acid, 12-methyl-, methyl ester	104333	005129-58-8	64
10	16.6735	0.6055	delta.-Lindane	148334	000319-86-8	72
11	17.645	0.5065	1-Tridecene	49686	002437-56-1	93
12	19.1525	1.0763	Dimethyl(ethenyl)silyloxycyclopentane	40659	1000278-80-8	43
13	19.675	0.5349	.beta.-d-Mannofuranoside, methyl	60078	026295-70-5	59
14	20.2193	1.9583	Hexadecanoic acid, methyl ester	130822	000112-39-0	98
15	21.6748	0.1398	1-Docosene	167463	001599-67-3	76
16	23.452	2.6794	10-Octadecenoic acid, methyl ester	155731	013481-95-3	99
17	24.0427	0.5587	Methyl stearate	157879	000112-61-8	98
18	27.0209	0.1007	Palmitoleic acid	115311	000373-49-9	58
19	30.7874	0.3117	9-(2',2'-Dimethylpropanoilhydrazono)-3,6-dichloro-2,7-bis-[2-(diethylamino)-ethoxy]fluorine	272195	1000111-04-6	14
20	33.2063	-0.1876	Benzene, 1-isothiocyanato-3-(trifluoromethyl)-	67718	001840-19-3	38
21	33.538	0.2506	Oleic Acid	142071	000112-80-1	53
22	34.5052	0.6814	Methyl 2-hydroxy-16-methyl-heptadecanoate	173327	1000336-40-8	55
23	34.98	0.717	Squalene	243221	000111-02-4	87
24	36.875	79.6913	Pyrazole-3-carboxylic acid, 1-(3-chloro-2-cyanophenyl)-5-methyl-, ethyl ester	148574	1000270-58-2	49
25	38.4637	-0.6743	Indole, 5-methyl-2-(4-pyridyl)-	72593	107919-92-6	76

GC-MS Analysis for the whole methanol stem extract of *Tephrosia vogelii*

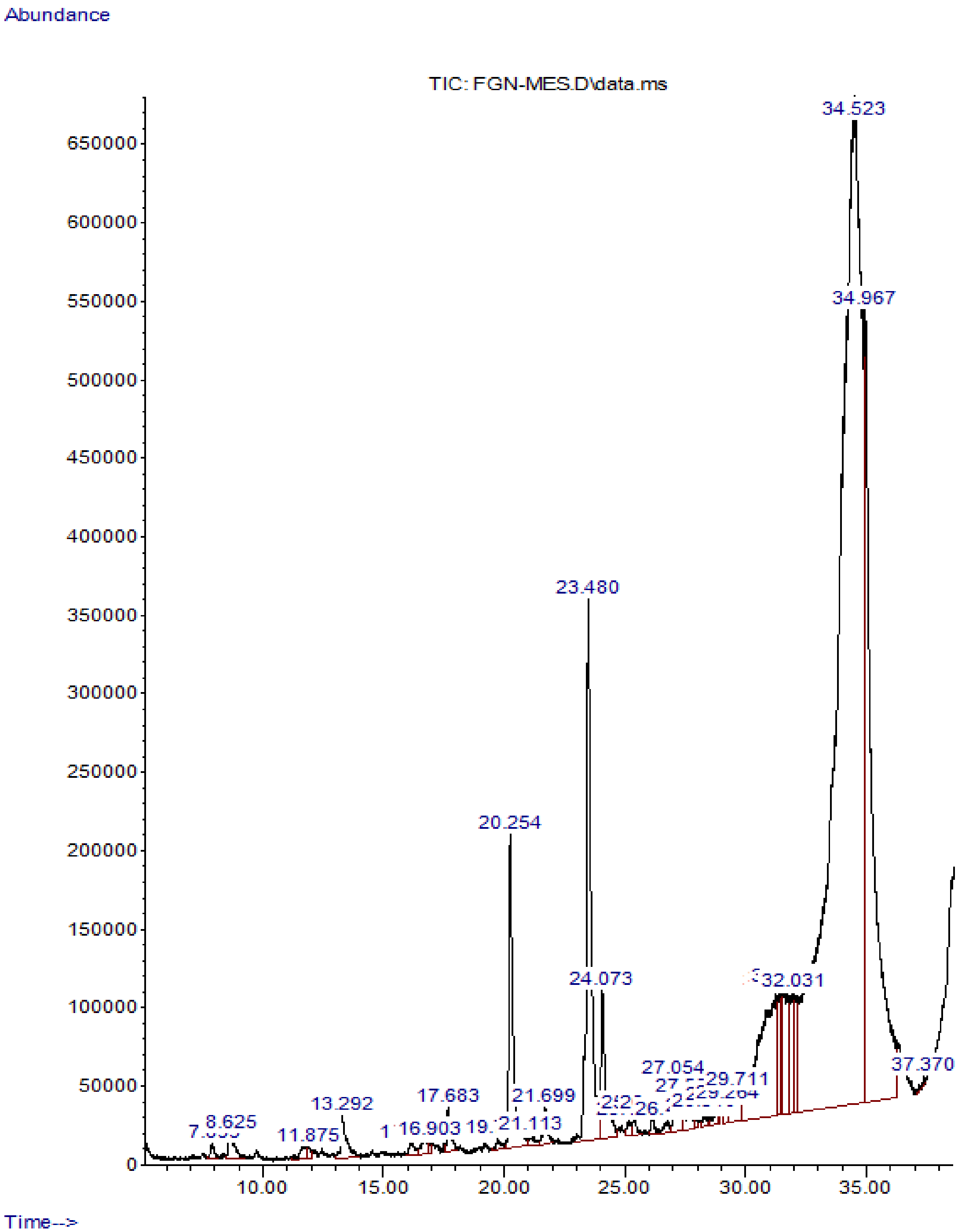

Fig 2: GC-MS chromatogram for the whole methanol stem extract of *Tephrosia vogelii*

Table 5: Bioactive compounds detected in methanol stem extract of *Tephrosia vogelii*

Peak	Retention Time	% Peak Area	Compound	Ref	CAS	Quality
1	7.8993	0.1228	Cyclooctanecarboxylic acid, 1-ethyl-, methyl ester	63357	007393-18-2	43
2	8.6247	0.3545	1-Dodecanol	53012	000112-53-8	91
3	11.7589	0.1897	Dodecanoic acid, methyl ester	78067	000111-82-0	38
4	11.8754	0.1073	Nonanoic acid, 9-oxo-, methyl ester	52517	001931-63-1	35
5	13.2919	0.5976	1-Octadecene	113634	000112-88-9	90
6	16.1298	0.1613	2-Acetoxytetradecane	117420	1000245-61-6	46
7	16.7454	0.2138	delta.-Lindane	148334	000319-86-8	53
8	16.9029	0.0421	delta.-Lindane	148334	000319-86-8	49
9	17.6829	0.3998	1-Nonadecene	126870	018435-45-5	91
10	19.7418	0.1219	9-Hexadecenoic acid, methyl ester, (Z)-	128698	001120-25-8	58
11	20.2536	3.079	Hexadecanoic acid, methyl ester	130813	000112-39-0	99
12	21.1133	0.1449	Cyclododecanemethanol	63535	001892-12-2	38
13	21.6988	0.3449	Trichloroacetic acid, tetradecyl ester	211617	074339-52-9	81
14	23.4805	5.9298	11-Octadecenoic acid, methyl ester	155737	052380-33-3	99
15	24.0726	1.566	Methyl stearate	157879	000112-61-8	99
16	25.1501	0.1522	9,12-Octadecadienoic acid (Z,Z)-, methyl ester	153891	000112-63-0	92
17	25.395	0.1453	Dichloroacetic acid, heptadecyl ester	217449	1000282-98-2	90
18	26.1229	0.1654	Adipic acid, isobutyl 2-methylpent-3-yl ester	146065	1000353-55-7	46
19	26.7367	0.1218	Heptadecanolide	128637	005637-97-8	49
20	27.0539	0.5638	cis-Methyl 11-eicosenoate	182558	002390-09-2	80
21	27.5939	0.3357	Eicosanoic acid, methyl ester	184598	001120-28-1	49
22	28.0024	0.0695	7-Hexadecenal, (Z)-	100566	056797-40-1	60
23	28.3096	0.0946	Propyl tetradecyl ether	117560	1000406-27-8	49
24	28.7935	0.1613	2- Chloropropionic acid, hexadecyl ester	190083	086711-81-1	64
25	28.8589	0.0676	i-Propyl 9-tetradecenoate	128647	1000336-60-7	52
26	29.2636	0.1606	1-Cyclohexylnonene	72732	114614-84-5	53
27	29.7105	0.5476	Indole, 6-methyl-2-(4-pyridyl)-	72594	107919-93-7	42
28	31.2562	5.4049	3,4-Dimethoxycinnamic acid	71974	002316-26-9	55
29	31.4014	0.8464	2-Vinylbenzophenone	72691	052095-42-8	45
30	31.477	0.5393	Oleic Acid	142070	000112-80-1	50
31	31.5704	1.63	6-Octadecenoic acid	142075	1000336-66-8	55
32	31.9379	1.0793	Octadec-9-enoic acid	142076	1000190-13-7	60
33	32.0309	0.9241	Butyl 9-tetradecenoate	142081	1000336-51-4	47
34	34.5228	58.869	.beta.-Sitosterol	245059	000083-46-5	90
35	34.967	14.722	Bicyclo[4.2.0]oct-2-ene, 3,7-dimethyl-7-(4-methyl-3-pentenyl)-8-(2,6,10-trimethyl-1,5,9-undecatrienyl)-, [1.alpha.,6.alpha.,7.beta.,8.alpha.(1E,5E)]-	242333	113681-03-1	60
36	37.37	0.0234	Oleic Acid	142070	000112-80-1	70

4.0 Discussion

4.1 Extraction

In the results of extraction (Table 1), the highest yield (3.80%) was in methanol root extract while the stem yielded lower with 2.53%. This yield for the root is in agreement with the 3.00% reported by Mlozi et al. [14] although slightly lower while the yield of the stem does not agree with the 0.40% reported by Tole and Neme [15]. This significant difference in yield may be due to difference in geographical area and climatic conditions.

4.2 Qualitative phytochemical screening of the extracts

The results of the qualitative phytochemical screening (Table 2), showed the presence of terpenoids, anthraquinones, Tannins, saponins, flavonoids, phenols, glycosides, Alkaloids, cardiac glycosides, steroid, volatile oils and calcones while quinones and reducing sugars are absent in the methanol root extract. The methanol stem extract revealed the presence of terpenoids, flavonoids, phenols, Tannins, alkaloids, cardiac glycosides, anthraquinones, steroids, Quinones, volatile oils and saponins while reducing sugars and calcones are absent. These findings do agree with the findings of Kabera*et al.*[16]and Mlozi*et al.*[14]who reported similar presence for the methanol leaves and root extracts of *Tephrosia Vogelii*.

4.3 Nutritive composition of the extracts

Table 3 showed the nutritive compositions of the root and stem extracts, one of these is the moisture content which has effect on the susceptibility of samples to spoilage by microbial actions.[17] This study revealed that the methanol stem extract and methanol roots extracts had a moisture content of 6.75and 9.50 % respectively whose difference is not statistically significant ($p \geq 0.05$). However, the amount of moisture in the methanol root and stem extracts are quite higher than 2.40% reported by Arukwe*et al*. [18] for Avocado seed. The results of this study also revealed that the ash contents of methanol root extract and methanol stem extract were 17.60% and 15.80% respectively. This clearly showed that methanol root and stem extract contain similar mineral contents. These results are not comparable to 1.31% reported by Gumte *et al*. [19]for mango kernel flour. Methanol root extract had the highest fat content (51.06%) than methanol stem extract (47.33%). The results for methanol root extract (MRE) and methanol stem extract (MSE) are higher than the 30.83% reported by Justina *et al*.[20]. The percentage crude fibre for MRE and MSE is 7.33% and 2.00% respectively showing significant difference in the amount of fibre in each extract. The MRE crude fibre values are quite higher than 3.96% reported by Kittiphoom,[21] for mango seed while that of MSE (2.00%) is much lower than it. The difference in values may largely be due to difference in plant and/or geographical location. In result of the protein content of the MRE and MSE (Table 3), the MSE (11.56%) had the highest value when compared to MRE (8.99%), although they do not agree with the higher 15.23% and 15.55% reported by Justina *et al*. [20] in avocado seed. The results of the Carbohydrate content (calculated) showed MSE (13.83%) and MRE (8.33%) respectively. These are although, quite lower than 48.11% reported by Arukwe*et al*. [18] for Avocado seed. Since carbohydrate generates energy, the findings are an indication that the sample could only fairly produce energy to power the cells and tissues of the body on consumption.

4.4 GC-MS Analysis

Table 6a: Compounds detected with their biological/medicinal activity in methanol root extract of *Tephoresiavogelii*

S/N	Compounds	Molecular formula	Molecular weight (g/mol)	Family of compounds	Medicinal/Biological activity
1	1,7-Dimethyl-4-(1-methylethyl) cyclodecane	$C_{15}H_{3}0$	210.40	Sesquiterpene	Antibacterial and antioxidant activities (Siqueira *et a*l.,2015)
2	5-Tetradecene, (E)-	$C_{14}H_{28}$	196.37	Unsaturated aliphatic hydrocarbon	Antibacterial, ant tuberculosis activities (kuppuswamy*et al*.,2013)
3	Cyclohexane, 1,1'-(1-methyl-1,2-ethanediyl)bis-	$C_{15}H_{28}$	208.38	Hydrocarbon	Not reported
4	Eicosylpentafluoropropionate	$C_{23}H_{41}F_{5}O_{2}$	444.56	Polyunsaturated fatty acid	Antimicrobial activity (Kumar & Sharma.,2021)
5	Dodecanoic acid, methyl ester	$C_{13}H_{26}O_{2}$	214.34	Fatty acid methyl esters	Antibacterial, antiviral, antifungal activities (ozcelik*et al*.,2005)
6	2,4-Di-tert-butylphenol	$C_{14}H_{22}O$	206.32	Phenol	Antioxidant, antibacterial and antifungal activities (Kontham*et al*.,2015)
7	1H-Indene, 2,3,3a,4,7,7a-hexahydro-2,2,4,4,7,7-hexamethyl-	$C_{15}H_{26}$	206.37	No record	Not reported
8	Cetene	$C_{16}H_{32}$	224.42	Unsaturated aliphatic hydrocarbon	Antimicrobial and antioxidant effect, also had highest value of antifungal activity (Edet *et al*.,2023)
9	Tridecanoic acid, 12-methyl-, methyl ester	$C_{15}H_{30}O_{2}$	242.39	Fatty acid methyl esters	Antifungal and antibacterial activities (Elaiyaraja *et al*.,2018)
10	.delta.-Lindane	$C_{6}H_{6}Cl_{6}$	290.83	Polychlorinated biphenyls	Insecticide and ovicidal activities (Brown., 2008)
11	1-Tridecene	$C_{13}H_{26}$	182.34	Unsaturated aliphatic hydrocarbon	Antibacterial activity (Kumar *et al*.,2011)
12	Dimethyl(ethenyl)silyloxycyclopentane	$C_{9}H_{18}OSi$	170.11	Alkane	Not reported
13	.beta.-d-Mannofuranoside, methyl	$C_{7}H_{14}O_{6}$	194.18	Monoterpenes	Antibacterial activity (Manilal *et al*., 2014)
14	Hexadecanoic acid, methyl ester	$C_{17}H_{34}O_{2}$	270.45	Fatty acid methyl esters	Antioxidant, decrease blood cholesterol, anti-inflammatory activities (Hema.,2011)

Table 6b: Compounds detected with their biological/medicinal activity in methanol root extract of *Tephoresiavogelii*

	S/N	Compounds	Molecular formula	Molecular weight (g/mol)	Family of compounds
15	1-Docosene	$C_{22}H_{44}$	308.58	Straight chain Hydrocarbon	Antibacterial, antifungal and anti-inflammatory activities (Subban *et al*.,2011)
16	10-Octadecenoic acid, methyl ester	$C_{19}H_{36}O_2$	296.48	Fatty acid ester	Antioxidant and antimicrobial activities (Elaiyaraja *et al*.,2018)
17	Methyl stearate	$C_{19}H_{38}O_2$	298.50	Fatty acid methyl esters	Anti-diarrheal, cytotoxic and anti-proliferative activities (Ayoola *et al*.,2020)
18	Palmitoleic acid	$C_{16}H_{30}O_2$	254.41	Fatty acid	Anti-inflammatory activity (Odiase-omoighe& Agoreyo.,2022)
19	9-(2',2'-Dimethylpropanoilhydrazono)-3,6-dichloro-2,7-bis-[2-(diethylamino)-ethoxy]fluorene	$C_{30}H_{42}Cl_2N_4O_3$	577.58	Polycyclic aromatic hydrocarbon	Antimicrobial, antioxidant and cytotoxic effect (Naine*et al*., 2015)
20	Benzene, 1-isothiocyanato-3-(trifluoromethyl)-	$C_8H_4F_3NS$	203.19	Isothiocyanates	Not reported
21	Oleic Acid	$C_{18}H_{34}O_2$	282.46	Long chain Fatty acid	Anti-cancer, anti-tumor, anti-inflammatory activities (subban*et al.,* 2011)
22	Methyl 2-hydroxy-16-methyl-heptadecanoate	$C_{19}H_{38}O_3$	214.50	Hydro fatty acids	Not reported
23	Squalene	$C_{30}H_{50}$	410.73	Triterpenoid	Antitumor, antioxidant, antistatic, antibacterial and anticancer activities (Amarowicz.,2009) and (Lozano.,2018)
24	Pyrazole-3-carboxylic acid, 1-(3-chloro-2-cyanophenyl)-5-methyl-, ethyl ester	$C_7H_{10}N_2O_2$	154.16	Pyrazoles and monocarboxylic acid	Anticancer, antibacterial, antifungal, antioxidant and anti-inflammatory (Kumar *et al*.,2013)
25	Indole, 5-methyl-2-(4-pyridyl)-	$C_{14}H_{14}N_2$	208.26	Alkaloids	Antitumor, antibacterial, antiviral, antifungal and anti-plasmodial activities (Umer *et al.*,2022)

Table 7a: Compounds detected with their biological/medicinal activity in methanol stem extract of *Tephoresiavogelii*

S/N	Compounds	Molecular formula	Molecular weight	Family of compounds	Medicinal/Biological activity
1	Cyclooctanecarboxylic acid, 1-ethyl-, methyl ester	$C_{12}H_{22}O_2$	198.30	Carboxylic acid esters	Not reported
2	1-Dodecanol	$C_{12}H_{26}O$	186.33	Fatty alcohol	Antibacterial activity (Farina *et al.*,2014)
3	Dodecanoic acid, methyl ester	$C_{13}H_{26}O_2$	214.34	Fatty acid esters	Antibacterial, antiviral and antifungal activities (Ozcelik B *et al*.,2005)
4	Nonanoic acid, 9-oxo-, methyl ester	$C_{10}H_{18}O_3$	186.24	Fatty aldehyde	Antifungal, antioxidant, antimicrobial and larvicidal (sen*et al*.,2017)
5	1-Octadecene	$C_{18}H_{36}$	252.28	Long chain hydrocarbon (alkene)	Antibacterial, antioxidant and anticancer (Lee *et al*.,2007)
6	2-Acetoxytetradecane	$C_{16}H_{32}O_2$	256.42	No record	Antibacterial activity (Kabouchz*et al*.,2013)
7	Delta -Lindane	$C_6H_6Cl_6$	290.83	Polychlorinated biphenyls	Insecticide and ovicidal activities (Brown 2008)
8	Delta -Lindane	$C_6H_6C_{l6}$	290.83	Polychlorinated biphenyls	Insecticide and ovicidal activities (Brown 2008)
9	1-Nonadecene	$C_{19}H_{38}$	266.50	Unbranched hydrocarbon (alkene)	Antituberculosis, anticancer, antioxidant, and antimicrobial activities (Rukachaisiriku*et al*.,2004)
10	9-Hexadecenoic acid, methyl ester, (Z)-	$C_{17}H_{32}O_2$	268.43	Fatty acid esters	Not reported
11	Hexadecanoic acid, methyl ester	$C_{17}H_{34}O_2$	270.45	Fatty acid esters	Antioxidant decrease blood cholesterol and anti-inflammatory activities (Hema 2011)
12	Cyclododecanemethanol	$C_{12}H_{26}O$	198.34	No record	Not reported
13	Trichloroacetic acid, tetradecyl ester	$C_{16}H_{29}Cl_3O_2$	359.75	Fatty acid ester	Precipitation agent , an ingredient agent, herbicide (Mary & Giri., 2018)
14	11-Octadecenoic acid, methyl ester	$C_{19}H_{36}O_2$	296.49	Fatty acid esters	Anti-cholesterolemic and anticancerogenic (Asghar *et al*.,2011)
15	Methyl stearate	$C_{19}H_{38}O_2$	298.50	Fatty acid methyl esters	Anti-diarrheal, cytotoxic and antiproliferative activities (Ayoola *et al*.,2020)
16	9,12-Octadecadienoic acid (Z,Z)-, methyl ester	$C_{19}H_{34}O_2$	294.47	Fatty acid methyl esters	Insecticidal (Christiana et al.,2019) anti-inflammatory and anticancer activities (Adeyemi *et al*.,2017)
17	Dichloroacetic acid, heptadecyl ester	$C_{19}H_{36}Cl_2O_2$	367.40	Fatty acid ester	Anti-inflammatory, antioxidant and hypocholesterolemia activities (Reddy *et al*.,2020)
18	Adipic acid, isobutyl 2-methylpent-3-yl ester	$C_{16}H_{30}O_4$	286.41	Ester	Not reported

Table 7b: Compounds detected with their biological/medicinal activity in methanol stem extract of *Tephoresiavogelii*

S/N	Compounds	Molecular formula	Molecular weight	Family of compounds	Medicinal/Biological activity
19	Heptadecanolide	$C_{17}H_{32}O_2$	268.43	Fatty acid	Flavoring agent, as perfume (Yakubu *et al*.,2017)
20	cis-Methyl 11-eicosenoate	$C_{21}H_{40}O_2$	324.54	Unsaturated fatty acid ester	Antioxidant, pesticide, flavor, antifibrinolytic, inhibitor, antialopecic activities (Ayoola *et al*.,2020)
21	Eicosanoic acid, methyl ester	$C_{21}H_{42}O_2$	326.55	Fatty acid methyl ester	Alpha-glucosidase inhibitors activity (Elaiyaraja *et al*.,2018)
22	7-Hexadecenal, (Z)-	$C_{16}H_{30}O$	238.40	Fatty aldehyde	Antiviral activity and organic fertilizer (Devakumar *et al* 2017)
23	Propyl tetradecyl ether	$C_{17}H_{36}O$	256.46	No record	Not reported
24	2- Chloropropionic acid, hexadecyl ester	$C_{19}H_{37}ClO_2$	332.95	Fatty acid ester	Acidifier, acidulant arachidonic acid inhibitor, uric acid production inhibitor and antifungal activities (Zainurin*et al* 2020)

Table 8a: Compounds detected with their biological/medicinal activity in methanol stem extract of *Tephoresiavogelii*

S/N	Compounds	Molecular formula	Molecular weight	Family of compounds	Medicinal/Biological activity
25	1-Propyl, 9-tetradecenoate	$C_{17}H_{32}O$	268.43	Fatty acid ester	Perfuming agent, binding agent, polar emollient used in cosmetics, antimicrobial, antioxidant and stimulants (Kadhim *et al.*,2016)
26	1-Cyclohexylnonene	$C_{15}H_{28}$	208.38	Unsaturated hydrocarbon	Antimicrobial activity (Waheed *et a*l.,2019)
27	Indole, 6-methyl-2-(4-pyridyl)-	$C_{14}H_{12}N_2$	208.26	Alkaloids	Antitumor, antibacterial, antifungal, antiviral and antiplasmodial activities (Umer *et a*l.,2023)
28	3,4-Dimethoxycinnamic acid	$C_{11}H_{12}O_4$	208.21	Phenol	Reduce risk of type 2 diabetes as well as colorectal cancer, antioxidant and anti-inflammatory activities (Farrell *et al*.,2012)
29	2-Vinylbenzophenone	$C_{15}H_{12}O$	208.26	Benzophenone (an aromatic ketone)	Antifungal, anti-HIV, antimicrobial, antioxidant, antiviral and cytotoxic activities (Shi-biaowu*et al*.,2014)
30	Oleic Acid	$C_{18}H_{34}O_2$	282.26	Long chain fatty acid	Anticancer, antitumor and anti-inflammatory activities (Subban *et al.*,2011)
31	6-Octadecenoic acid	$C_{18}H_{34}O_2$	282.26	Fatty acid	Antiandrogenic, anticancer and anti-inflammatory activities (Lutfi *et al.*,2021)
32	Octadec-9-enoic acid	$C_{18}H_{34}O_2$	282.26	Monounsaturated fatty acid	Antimicrobial, antioxidant, anticancer anemiagenic and anti-androgenic activities (Elaiyaraja *et al*.,2018)
33	Butyl 9-tetradecenoate	$C_{18}H_{34}O_2$	282.46	Fatty acid ester	Not reported
34	.beta.-Sitosterol	$C_{29}H_{50}O$	414.71	Steroid	Anti-cancer, antioxidant, anti-diabetic, antimicrobial, anti-inflammatory, anti-tuberculosis, anti-HIV, anti-arthritic and antipyretic activities (Khaled 2020)
35	Bicyclo[4.2.0]oct-2-ene, 3,7-dimethyl-7-(4-methyl-3-pentenyl)-8-(2,6,10-trimethyl-1,5,9-undecatrienyl)-, [1.alpha.,6.alpha.,7.beta.,8.alpha.(1E,5E)]-	$C_{30}H_{48}$	408.70	No record	Not reported
36	Oleic Acid	$C_{18}H_{34}O_2$	282.46	Long chain fatty acid	Anticancer, antitumor and anti-inflammatory activities (Subban *et al.*,2011)

The active principles in Table 5 and 6 detected 61 bioactive phytochemical compounds in the two extracts of *Tephrosiavogelii*. The major compounds detected in the MRE and MSE of *Tephrosia vogelii*are Pyrazole-3-carboxylic acid, 1-(3-chloro-2-cyanophenyl)-5-methyl-ethyl ester (79.69%) and 11-Octadecenoic acid, methyl ester (5.93%) respectively.

Table 7 and 8 (a-b) captures the bioactive compounds detected in MRE and MSE, molecular formula, molecular weight, family of compounds and their biological/medicinal activity. In the MRE, 25 compounds were detected (Table 5) while 36 compounds were detected in the MSE (Table 6). The family of compounds detected in the extracts are fatty acids esters, fatty acids, hydrocarbons, terpenoids, phenol, alkaloids, pyrazoles, Isothiaocyanotes, polychlorinated biphenyls, steroids, esters, benzophenones, fatty alcohols, fatty aldehydes, Heterocyclic, Pyrenes, naphthoquinone, phthalate esters and organobromide. Fatty acids have many unique and important biological properties such as antifungal, anti-inflammation, anticancer and antibacterial activity.[57] Heterocyclic Compounds have antifungal, anti-inflammatory, antioxidant, anticancer, herbicidal, antiallergic and antibacterial activities.[58] Fatty acids ester like methyl stearate are used as Flavor component in food, lubricant, used in the manufacture of pharmaceuticals, cosmetic and soap, surfactant and softening agents.[59] Benzophenone have antifungal, anti-HIV, antimicrobial, antioxidant, antiviral and cytotoxic activities.[54] Naphthoquinone exhibit Cytotoxic, antibacterial, antifungal, antiviral, insecticidal, anti-inflammatory and antipyretic properties.[60] Pyrazoles show anticancer, antibacterial, antifungal, antioxidant and anti-inflammatory activities.[37] Alkaloids shows several Pharmacological activities which include antitumor, antibacterial, antifungal, antiviral and antiplasmodial activities.[38] Terpenoids possessing lactone moieties are known for their cytotoxic, anti-inflammatory, antimicrobial, anticancer, and antimalarial activities.[61]Most of the pyrene are used to conduct research. Pyrene is used to make dyes, plastics and pesticides. It has also been used to make another pyrene called Benzo(a)pyrene.[62] Phthalic acid esters or phthalate esters have been widely used in numerous consumer products, including cosmetics, food packaging, building materials, medical supplies, home furnishings and also possess antimicrobial and insecticidal activity.[63]Phenolic compounds showed antioxidant activity and significant effects on chronic degenerative diseases, such as central neurodegenerative disorders, cataracts, macular degeneration (age-related), diabetes mellitus, cardiovascular Complication, and cancer. [29] Plant steroids possess many interesting medicinal, pharmaceutical and agrochemical activities like anti-tumor, immunosuppressive, hepatoprotective, antibacterial, plant growth hormone regulator, sex hormone, anti-helminthic, cytotoxic and cardiotonic activity.[64]

Esters such as Heptadecyl heptafluorobutyrate shows biological activity of antioxidant, antibacterial, antifungal, hepatopreservative, anticancer, anti-inflammatory agent.[65]Hydrocarbons such as Cetene shows antimicrobial and antioxidant effect, also had highest value of antifungal activity.[26] Fatty alcohols such as 1-dodecanol shows antibacterial activity and also used as chemical to remove flower buds and suckers from tobacco plants.[39] Polychlorinated biphenyls are used as coolants and lubricants in electrical equipment and are also used in hundreds of industrial and commercial applications including electrical, heat transfer, and hydraulic equipment; as plasticizers in paints, plastics, and rubber products; in pigments, dyes, and carbonless copy paper; and many other industrial applications such as insecticides.[66] Isothiocyanates possess strong anti-oxidant, anti-inflammatory activity, anti-microbial, neuroprotective, cardioprotective activity and potent anticancer activity against various forms of cancer and tumors.[67] Fatty aldehydes such as Nonanoic acid, 9-oxo-, methyl ester exhibit antifungal, antioxidant, antimicrobial and larvicidal activity.[40] Organobromides such as Tetrapentacontane, 1,54-dibromo- possess antioxidant activity.[68] These medicinal values and/or biological characteristics of the extracts points to the fact that MRE and MSE of *T.vogelii* could serve as alternative remedies in ethnopharmacology and also supports the use of the plant in traditional medicine in Nigeria.

4.6CONCLUSION

The many reports suggesting that *Tephrosiavogelii* are quite rich in useful metabolites are further strengthened by the findings of this study. The extracts have shown very high potential for a vast number of bioactive compounds which affirms why it is used for various ailments by traditional practitioners. Furthermore, it is safe to suggest that there much more possible therapeutic characteristics of the plant than already put into use.

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