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Phytochemical Profile of *Cola pachycarpa* K. Schum. (Malvaceae) Leaf and Stem Ethanol Extracts

I. I. Johnny [a*], E. E. Ubengama [b], R. A. Umoh [a], O. I. Obasi [a], A. S. Udobre [c], A. M. Adefabi [d], N. A. Andy [a], E. J. Udofa [e], P. A. Iberi [a], E. E. Nyong [a], U. T. Nweke [a] and M. E. Bassey [f]

[a] Department of Pharmacognosy and Natural Medicine, Faculty of Pharmacy, University of Uyo, Akwa Ibom State, Nigeria.
[b] Department of Pharmacognosy and Natural Medicine, Faculty of Pharmacy, University of Calabar, Cross Rivers State, Nigeria.
[c] Department of Pharmaceutical and Medicinal Chemistry, Faculty of Pharmacy, University of Uyo, Akwa Ibom State, Nigeria.
[d] Department of Pharmacognosy, Faculty of Pharmacy, University of Ibadan, Oyo State, Nigeria.
[e] Department of Pharmaceutical Microbiology, Faculty of Pharmacy, University of Uyo, Akwa Ibom State, Nigeria.
[f] Department of Botany and Ecological Studies, Faculty of Sciences, University of Uyo, Akwa Ibom State, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Authors MEB and ASU supervised the author IIJ who carried out the bench work and wrote the first draft of the manuscript. Authors RAU, NAA, OIO, UTN, AMA, PEI, EJU, EEN and EEU managed the literature search. Author MEB perfected the final manuscript which was approved by all authors for publication.

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**Corresponding author: E-mail: imohjohnny@uniuyo.edu.ng, jonnyimoh@gmail.com;*

ABSTRACT

Background and Aim: *Cola pachycarpa* K. Schum. is a lesser-known member of the genus *Cola* called "Monkey kola" in the family Malvaceae. The leaf and fruit is used in the treatment and management of cancer in folklore medicine. The present study is carried out to explore the phytoconstituents present in the ethanolic extract of the leaf and stem of *Cola pachycarpa* by GC-MS analysis.

Methods: Leaf and stem were collected, identified, sliced, air-dried, pulverized, extracted with ethanol and concentrated using standard methods. The ethanolic extract of the extracts was used for the GC-MS analysis. QP2010SE Shimazu, Japan System GC-MS was used for the analysis. The compounds were identified by the gas chromatography coupled with the mass spectrometry. The molecular weight and structure of the compounds of test materials are ascertained by interpretation of the mass spectrum of GC-MS using the database of National Institute Standard and Technology (NIST).

Results: GC-MS analysis of the leaf and stem ethanol extracts of *C. pachycarpa* revealed the presence of 64 and 47 chemical constituents respectively which includes 1-propanol, 2-amino-2-methyl (31.34%), undecanal, 2-methyl (4.00%), phenol, 2,6-dimethoxy (4.18%), n-Hexadecanoic acid (3.35%) and vitamin E (5.15%) and the most abundant in the stem extract were: 1,4-Benzodioxin-6-sulfonamide,N-[2-(dimethylamino)ethyl- (30.10%), .alpha.D-Galactopyranoside, methyl (12.56%), Phenethylamine,.alpha.-ethyl- (10.96%), 4-Methylpiperazine-2-carboxylic acid (5.78%) and Guanosine (3.86%).

Conclusion: The presence of various bioactive compounds may be responsible for the application of *Cola pachycarpa* in the treatment and management of various ailments in folklore medicine. However, in vitro and in vitro studies, isolation of individual phytoconstituents and their mechanism of action may proceed to find a novel drug or lead compound for use as medicine.

Keywords: GC-MS analysis; phytochemical constituents and cola pachycarpa.

1. INTRODUCTION

Cola pachycarpa K. Schum. Family: Malvaceae. Is a Monkey Kola in the genus *Cola* with about 140 species (Burkill, 2000). It possesses non-edible seeds which are enclosed in an edible mesocarp. It is considered as valuable medicinal herb in folklore medicine. The white fleshy mesocarp is chewed for the management of cancer and the seeds are used in the eastern part of Nigeria as stimulants (Keay and Onochie, 1964).

Plants produce several chemical compounds that play significant roles in inducing biological activities including development of defense against insects, fungi and herbivorous mammals [1]. The mechanisms of action of herbal medicines do not vary greatly from those of the orthodox drugs because the chemical compounds present in plants causes their effect on human body via processes that are similar to those that are already understood for the chemical compounds in orthodox drugs [2,1]. These chemical compounds are a product of the plant's secondary metabolism (secondary metabolites) that can only be obtained from plants and are found in a range of plants that are employed as essential components of both human and animal diets including fruits, seeds, herbs and vegetables [3]. The study of these phytochemicals is important to understanding their essential roles in the human system such as protection and treatment of diseases and their possible adverse effects [4,5].

Johnny and Bassey [6] reported on the standardization of the taxa by evaluating the pharmacognostic and taxonomic parameters. No work has been analysed on the chemical constituents by gas chromatography-mass spectrometry (GC-MS). This work is the first-time report on the phytochemicals on the ethanolic leaf and stem extract of *C. pachycarpa.*

2. METHODS

2.1 Collection and Identification

The fresh samples of *C. pachycarpa* was collected from Osomba Hills in Osomba, Akankpa Local Government Area, Cross River State with the GPS reading as ±61m 5^{o} 27' 37.28N, 008^{0} 39'39.4E and preserved in Formalin Acetic Acid. The collected sample was authenticated by Prof. Margaret E. Bassey of the

department of Botany and Ecological Studies, Faculty of Science, University of Uyo and the herbarium number UUH4083 was allocated to the sample and the voucher specimen was deposited in the herbarium for reference purpose.

2.2 Preparation of Plant Material

The leaf and stem of the sample were washed under running tap water to remove soil particles and adhered debris and finally washed with sterile distilled water. The samples were chopped into pieces, dried under shade at room temperature. The dried samples were ground into powder. The powdered materials were stored in airtight containers until use. The leaf and stem powders of *C*. *pachycarpa* were extracted with 70% ethanol for 72 hours. It was filtered and the filtrate concentrated using the rotary evaporator.

2.3 GC-MS Analysis

GC-MS analysis of ethanol extract of the leaf and stem of *C. pachycarpa* was performed using QP2010SE Shimazu, Japan System and GCMS employed a fused silica capillary column packed with Elite-1(100% dimethyl polysiloxane, 30nm × 0.25nm ID × 1µm df). For GC/MS detection, an electron ionization system with ionizing energy of 70 ev was used. Helium gas (99.999%) was used as the carrier gas at constant flow rate 1mL/minute and an injection volume of 2 µL was employed [split ratio of 10.1) injector temperature was set at 250^{o} C; ion-sourced temperature was set at 230^{o}C. The oven temperature was programmed from 60^{o}C (isothermal for 2 minutes) with an increase at 10^{o}C/minutes to 240^{o}C, then 5^{o}C/minutes to 290^{o}C. Mass spectra were taken at 70 ev; a scan interval of 0.5seconds and fragments from 45 to 450Da. Total GC detection time was completed in 23 minutes. The relative percentage amount of each component was calculated by comparing its average peak area to the total areas.

2.4 Identification of Components

The interpretation of mass spectra of GC-MS was conducted using the database of National Institute of Standard and Technology (NIST) having more than 62, 000 patterns. The spectrum of the unknown component was compared with the spectrum of the known components stored in the NIST library. The name, molecular weight, molecular formular, % area and retention time were ascertained.

3. RESULTS AND DISCUSSION

Mass spectrometry becomes a vital tool in the hands of the organic chemists and biochemists because of its potential to supply the definitive, qualitative and quantitative information on molecules based on their structural compositions.

Spectrometer (GC-MS), enables mixture of small molecules mainly organic compounds of low molecular weight (<600) which can be analysed.

Johnny and Bassey [6] reported the presence of alkaloid, flavonoid, saponins, tannins, cardiac glycosides for the leaf while alkaloid, cardiac glycosides and anthraquinones were absent in the stem. Taxonomic characters were also reported for its identification.

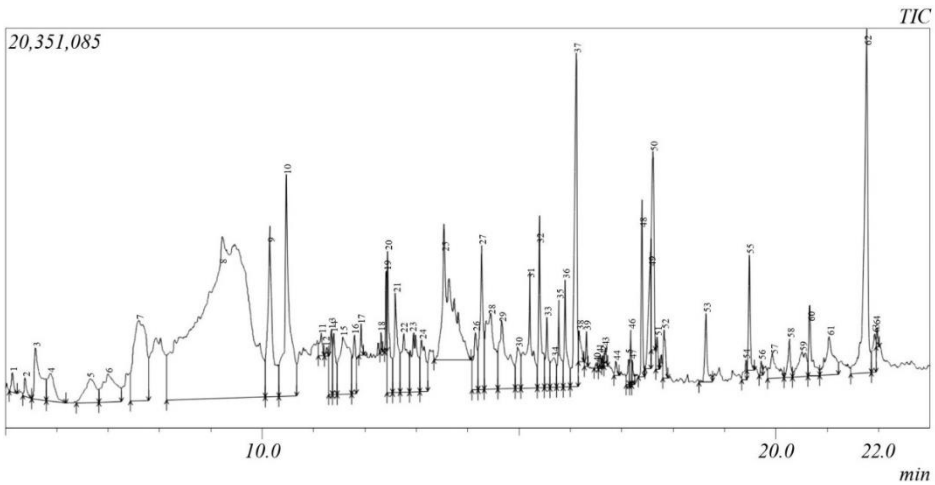


Fig. 1. Gas chromatography-mass spectrometry chromatogram of ethanol leaf extract of *C. pachycarpa*

Table 1. Phytochemical composition of ethanolic leaf extract of *Cola pachycarpa* by GC-MS analysis

S/N	Retention time	Compound name	Molecular formula	Molecular weight	Area %
1	5.140	1,1-Dimethylamino-1-butene	$C_6H_{13}N$	99	0.17
2	5.387	4-Oxopentyl formate	$C_6H_{10}O_3$	130	0.18
3	5.589	2-Propenamide, N-methyl-	C_4H_7NO	85	1.26
4	5.876	2-Methylcyclopropanecarboxylic acid	$C_5H_8O_2$	100	0.78
5	6.651	exo-Norborneol, methyl ether	$C_8H_{14}O$	126	1.07
6	7.001	Cycloheptanol, 2-chloro-, trans-	$C_7H_{13}ClO$	148	1.49
7	7.601	Undecanal, 2-methyl-	$C_{12}H_{24}O$	184	4.00
8	9.225	1-Propanol, 2-amino-2-methyl-	$C_4H_{11}NO$	89	31.34
9	10.155	2-Methoxy-4-vinylphenol	$C_9H_{10}O_2$	150	3.10
10	10.478	Phenol, 2,6-dimethoxy-	$C_8H_{10}O_3$	154	4.18
11	11.150	5-Octen-2-ol, 5-methyl-	$C_9H_{18}O$	142	0.22
12	11.256	5-Octen-2-ol, 5-methyl-	$C_9H_{18}O$	142	0.06
13	11.347	5-Octen-2-ol, 5-methyl-	$C_9H_{18}O$	142	0.66
14	11.398	cis-1,2-Cyclododecanediol	$C_{12}H_{24}O_2$	200	0.64
15	11.575	1H-Azepin-1-amine, hexahydro-	$C_6H_{14}N_2$	114	2.30
16	11.798	Bicyclo[2.2.1]heptane-2,3-diol,1,7,7-trimethyl-,(2-endo, 3-exo)	$ClOH_{18}O_2$	170	0.71
17	11.927	1-Naphthalenecarboxylic acid, decahydro-1,4a- dimethyl-6-methylene	$C_{21}H_{32}O_2$	316	0.19
18	12.319	2-Undecanone, 6,10-dimethyl-	$C_{13}H_{26}O$	198	0.09
19	12.419	12-Oxabicyclo[9.1.0]dodeca-3,7-diene,1,5,5,8-tetramethyl-	$C_{13}H_{22}O_3$	226	0.47
20	12.443	12-Oxabicyclo[9.1.0]dodeca-3,7-diene,1,5,5,8-tetramethyl-	$C_{15}H_{24}O$	220	1.15
21	12.602	3-tert-Butyl-4-hydroxyanisole	$C_{11}H_{16}O_2$	180	1.47
22	12.761	2,4,7,9-Tetramethyl-5-decyn-4,7-diol	$C_{14}H_{26}O_2$	226	1.39
23	12.953	5-Octen-2-ol, 5-methyl-	$C_9H_{18}O$	142	1.49
24	13.110	5-Octen-2-ol, 5-methyl-	$C_9H_{18}O$	142	1.05
25	13.544	Methyl-(2-hydoxy-3-ethoxy-benzyl)ether	$C_{10}H_{14}O_3$	182	4.79
26	14.151	Cyclohexanone, 2-(2-nitro-2-propenyl)-	$C_9H_{13}NO_3$	183	0.91
27	14.274	Phenol, 4-(3-hydroxy-1-propenyl)-2-methoxy-	$C_{10}H_{12}O_3$	180	1.72
28	14.458	5-Caranol, (1S,3R,5S,6R)-(-)-	$C_{10}H_{18}O$	154	2.63
29	14.674	1-Heptadec-1-ynyl-cyclopentanol	$C_{22}H_{40}O$	320	2.23
30	14.987	10-Undecen-1-al, 2-methyl-	$C_{12}H_{22}O$	182	0.69
31	15.214	3,7,11,15-Tetramethyl-2-hexadecen-1-ol	$C_{20}H_{40}O$	296	2.21
32	15.399	3,5-Dimethoxy-4-hydroxyphenethylamine	$C_{10}H_{15}NO_3$	197	1.63
33	15.544	3,7,11,15-Tetramethyl-2-hexadecen-1-ol	$C_{20}H_{40}O$	296	0.71
34	15.686	Cyclopentadecanone	$C_{15}H_{28}O$	224	0.59
35	15.776	Cyclopentanetridecanoic acid, methyl ester	$C_{19}H_{36}O_2$	296	0.82
36	15.901	1,2-Benzenedicarboxylic acid, butyl octyl ester	$C_{20}H_{30}O_4$	334	0.96
37	16.119	n-Hexadecanoic acid	$C_{16}H_{32}O_2$	256	3.35
38	16.175	[1,1'-Bicyclopropyl]-2-octanoic acid, 2'-hexyl-, methyl ester	$C_{21}H_{38}O_2$	322	0.30
39	16.314	Hexadecanoic acid, ethyl ester	$C_{18}H_{36}O_2$	284	0.17
40	16.503	5-Octen-2-ol, 5-methyl-	$C_9H_{18}O$	142	0.04
41	16.582	Tricyclo[4.3.1.1(2,5)]undec-3-en-10-ol, stereoisomer	$C_{11}H_{16}O$	164	0.07
42	16.630	4a,8a-Naphthalenediol, octahydro-, cis-	$C_{10}H_{18}O_2$	170	0.05
43	16.685	17-Octadecynoic acid	$C_{18}H_{32}O_2$	280	0.11

S/N	Retention time	Compound name	Molecular formula	Molecular weight	Area %
44	16.886	[1,1'-Bicyclopropyl]-2-octanoic acid, 2'-hexyl-, methyl ester	$C_{21}H_{38}O_2$	322	0.11
45	17.137	(R)-(-)-14-Methyl-8-hexadecyn-1-ol	$C_{17}H_{32}O$	252	0.18
46	17.176	9,12,15-Octadecatrienoic acid, methyl ester, (Z,Z,Z)-	$C_{19}H_{32}O_2$	292	0.31
47	17.208	Cyclopentadecanone	$C_{15}H_{28}O$	224	0.13
48	17.398	Phytol	$C_{20}H_{40}O$	296	0.98
49	17.575	9,12-Octadecadienoic acid (Z,Z)-	$C_{18}H_{32}O_2$	280	1.25
50	17.609	8,11,14-Eicosatrienoic acid, (Z,Z,Z)-	$C_{20}H_{34}O_2$	306	1.71
51	17.693	1,2-15,16-Diepoxyhexadecane	$C_{16}H_{30}O_2$	254	0.19
52	17.824	Dichloroacetic acid, tridec-2-ynyl ester	$C_{15}H_{24}Cl_2O_2$	306	0.44
53	18.642	cis-Vaccenic acid	$C_{18}H_{34}O_2$	282	0.62
54	19.419	Cyclohexanol,2-methyl-5-(1-methylethenyl)-, (1.alpha.,2.beta.,5.)	$ClOH_{18}O$	154	0.19
55	19.485	9-Octadecenamide, (Z)-	$C_{18}H_{35}NO$	281	0.73
56	19.717	cis-Verbenol	$C_{10}H_{16}O$	152	0.10
57	19.939	1-Heptatriacotanol	$C_{37}H_{76}O$	536	0.62
58	20.270	.beta.-Tocopherol	$C_{28}H_{48}O_2$	416	0.42
59	20.516	Pseudosmilagenin	$C_{27}H_{44}O_3$	416	0.81
60	20.675	Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester	$C_{19}H_{38}O_4$	330	0.81
61	21.045	cis-Z-.alpha.-Bisabolene epoxide	$C_{15}H_{24}O$	220	1.17
62	21.772	Vitamin E	$C_{29}H_{50}O_2$	430	5.16
63	21.925	4-Isopropenyl-4,7-dimethyl-1-oxaspiro[2.5]octane	$C_{12}H_{20}O$	180	0.48
64	21.973	1H-3a,7-Methanoazulen-5-ol,octahydro-3,8,8-trimethyl-6-methylene	$C_{15}H_{24}O$	220	0.11

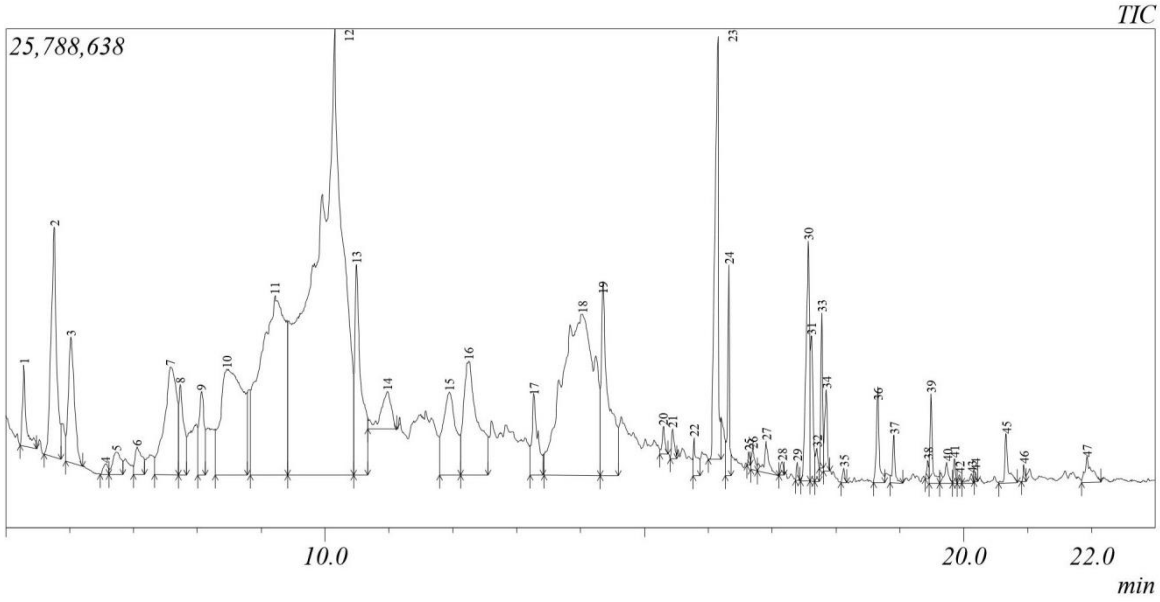


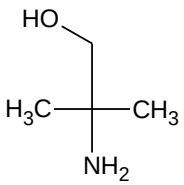
Fig. 2. Gas chromatography-mass spectrometry chromatogram of ethanol leaf extract of *C. pachycarpa*

Table 2. Phytochemical composition of ethanolic stem extract of *Cola pachycarpa* by GC-MS analysis

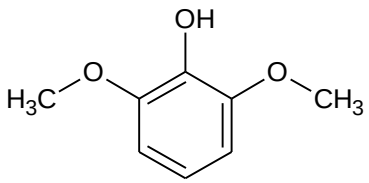
S/N	Retention time	Compound name	Molecular formula	Molecular weight	Area %
1	5.285	N-[Dimethylaminomethyl]aziridine	$C_5H_{12}N_2$	100	0.75
2	5.762	2(5H)-Furanone	$C_4H_4O_2$	84	3.07
3	6.016	6-Oxa-bicyclo[3.1.0]hexan-3-one	$C_5H_6O_2$	98	1.84
4	6.559	Cycloheptanol, 2-chloro-, trans-	$C_7H_{13}ClO$	148	0.13
5	6.734	Cycloheptanol, 2-chloro-, trans-	$C_7H_{13}ClO$	148	0.46
6	7.057	Cycloheptanol, 2-chloro-, trans-	$C_7H_{13}ClO$	148	0.48
7	7.577	3-Cyclohexen-1-carboxaldehyde, 3-methyl-	$C_8H_{12}O$	124	3.23
8	7.735	3-Cyclohexen-1-carboxaldehyde, 3-methyl-	$C_8H_{12}O$	124	1.10
9	8.063	10-Undecen-1-al, 2-methyl-	$C_{12}H_{22}O$	182	1.00
10	8.465	4-Methylpiperazine-2-carboxylic acid	$C_6H_{12}N_2O_2$	144	5.78
11	9.214	Phenethylamine, .alpha.-ethyl-	$C_{10}H_{15}N$	149	10.96
12	10.148	1,4-Benzodioxin-6-sulfonamide, N-[2-(dimethylamino)ethyl]-	$C_{12}H_{18}N_2O_4S$	286	30.10
13	10.488	Phenol, 2,6-dimethoxy-	$C_8H_{10}O_3$	154	3.19
14	10.974	2,2-Dimethyl-1-aza-spiro[2.4]heptane	$C_8H_{15}N$	125	0.95
15	11.952	Guanosine	$C_{10}H_{13}N_5O_5$	283	2.60
16	12.253	Guanosine	$C_{10}H_{13}N_5O_5$	283	3.86
17	13.274	Phenol, 3,4,5-trimethoxy-	$C_9H_{12}O_4$	184	1.13
18	14.030	.alpha.-D-Galactopyranoside, methyl	$C_7H_{14}O_6$	194	12.56
19	14.355	Phenol, 4-(3-hydroxy-1-propenyl)-2-methoxy-	$C_{10}H_{12}O_3$	180	3.36
20	15.296	Octadecanoic acid	$C_{18}H_{36}O_2$	284	0.19
21	15.440	4,4-Dimethyl-cyclohex-1-enecarboxylic acid, methyl ester	$C_{10}H_{16}O_2$	168	0.18
22	15.775	Cyclopentaneundecanoic acid, methyl ester	$C_{17}H_{32}O_2$	268	0.33
23	16.146	n-Hexadecanoic acid	$C_{16}H_{32}O_2$	256	3.69
24	16.317	Hexadecanoic acid, ethyl ester	$C_{18}H_{36}O_2$	284	0.91
25	16.633	4-Cyclooctene-1-carboxaldehyde	$C_9H_{14}O$	138	0.06
26	16.692	10-Undecen-1-al, 2-methyl-	$C_{12}H_{22}O$	182	0.16
27	16.901	Octadecanoic acid	$C_{18}H_{36}O_2$	284	0.37
28	17.151	1-Tetradecyne	$C_{14}H_{26}$	194	0.08
29	17.392	Cyclopentadecanone	$C_{15}H_{28}O$	224	0.07
30	17.568	9,12-Octadecadienoic acid (Z,Z)-	$C_{18}H_{32}O_2$	280	2.11
31	17.613	9,12-Octadecadienoic acid (Z,Z)-	$C_{18}H_{32}O_2$	280	0.89
32	17.697	13-Tetradecenal	$C_{14}H_{26}O$	210	0.22
33	17.777	9,12-Octadecadienoic acid (Z,Z)-	$C_{18}H_{32}O_2$	280	0.63
34	17.847	[1,1'-Bicyclopropyl]-2-octanoic acid, 2'-hexyl-, methyl ester	$C_{21}H_{38}O_2$	322	0.54
35	18.120	Nonanoic acid, 9-oxo-, ethyl ester	$C_{11}H_{20}O_3$	200	0.09
36	18.655	cis-Vaccenic acid	$C_{18}H_{34}O_2$	282	0.62
37	18.908	Ethyl 9-hexadecenoate	$C_{18}H_{34}O_2$	282	0.28
38	19.436	2-Pentyl-cyclohexane-1,4-diol	$C_{11}H_{22}O_2$	186	0.10
39	19.485	9-Octadecenamide, (Z)-	$C_{18}H_{35}NO$	281	0.50
40	19.736	17-Octadecynoic acid	$C_{18}H_{32}O_2$	280	0.23
41	19.854	Oxiraneoctanoic acid, 3-octyl-, cis-	$C_{18}H_{34}O_3$	298	0.10
42	19.931	Cyclopentadecanone	$C_{15}H_{28}O$	224	0.05
43	20.121	Cyclopentadecanone	$C_{15}H_{28}O$	224	0.08
44	20.183	Cyclopentadecanone	$C_{15}H_{28}O$	224	0.04
45	20.665	Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester	$C_{19}H_{38}O_4$	330	0.42
46	20.939	9-t-Butyltricyclo[4.2.1.1(2,5)]decane-9,10-diol	$C_{14}H_{24}O_2$	224	0.08
47	21.930	Propyleneglycol monoleate	$C_{21}H_{40}O_3$	340	0.43

Table 3. Biological activities of phytocomponents identified in the ethanol extract of leaf of *C. pachycarpa*

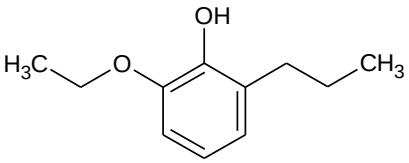
S/N	Retention time	Compound name	Molecular formula	Molecular weight	Area %	Compound nature	Activity	References
1	16.314	Hexadecanoic acid, ethyl ester	$C_{18}H_{36}O_2$	284	0.17	Palmitic acid ethyl ester	Antioxidant, Hypocholesterolemic Nematicide, Pesticide Lubricant, Antiandrogenic Flavor, Hemolytic	Balamurugan et al. [7]
	20.270	.beta.-Tocopherol	$C_{28}H_{48}O_2$	416	0.42	Vitamin E	Antiageing, Analgesic, Antidiabetic, Anti-inflammatory, Antioxidant, Antidermatitic, Antileukemic, Antitumor, Anticancer, Hepatoprotective, Hypocholesterolemic Antiulcerogenic, Vasodilator, Antispasmodic, Antibronchitic, Anticoronary	Balamurugan et al. [7]
	21.772	Vitamin E	$C_{29}H_{50}O_2$	430	5.16	Vitamin E	Antiageing, Analgesic, Antidiabetic, Anti-inflammatory, Antioxidant, Antidermatitic, Antileukemic, Antitumor, Anticancer, Hepatoprotective, Hypocholesterolemic Antiulcerogenic, Vasodilator, Antispasmodic, Antibronchitic, Anticoronary	Devi and Muthu [8]
	19.717	cis-Verbenol	$C_{10}H_{16}O$	152	0.10		antioxidative and anti-inflammatory	
	17.398	Phytol	$C_{20}H_{40}O$	296	0.98		Antioxidant	Balamurugan et al. [7]
	17.609	8,11,14-Eicosatrienoic acid, (Z,Z,Z)-	$C_{20}H_{34}O_2$	306	1.71		Cardio protective	Balamurugan et al. [7]
	16.119	n-Hexadecanoic acid	$C_{16}H_{32}O_2$	256	3.35	Palmitic acid	anti-inflammatory	Balamurugan et al. [7]
	16.685	17-Octadecynoic acid	$C_{18}H_{32}O_2$	280	0.11		antioxidant, nematicide, pesticide and vasoconstrictor	Jarez et al. (2011)
	17.176	9,12,15-Octadecatrienoic acid, methyl ester, (Z,Z,Z)-	$C_{19}H_{32}O_2$	292	0.31	Palmitic acid	antifungal, antibacterial, antioxidant, anti-inflammatory, hypocholesterolemic, anticancer, anticoronary, 5-alpha reductase inhibitor and antimicrobial	



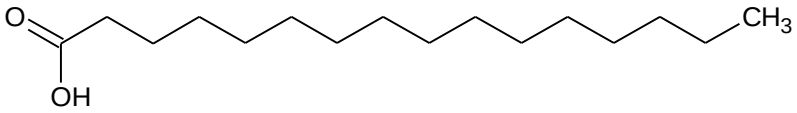
1-propanol,2-amino-2-methyl



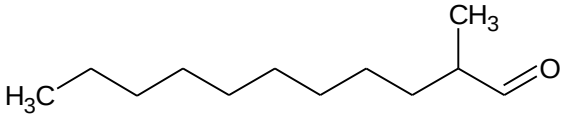
Phenol 2,6-dimethoxy



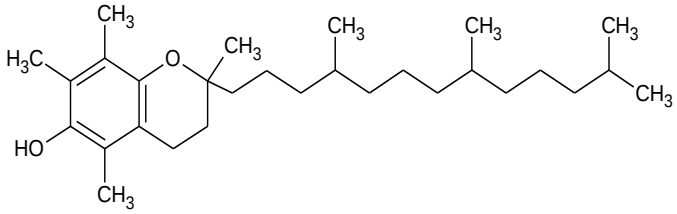
Methyl-(2-hydroxy-3-ethoxy-benzyl) ether



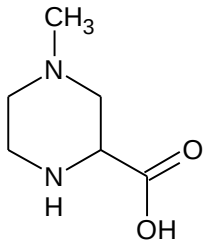
n-Hexadecanoic acid



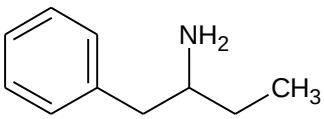
Undecanal,2-methyl



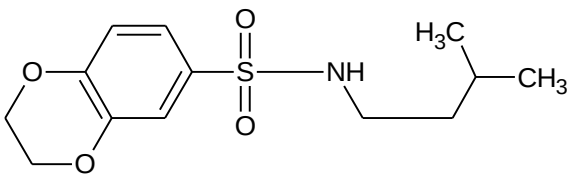
Vitamine E



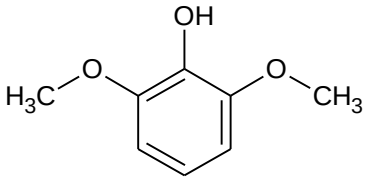
4-methylpiperazine-2-carboxuylic acid



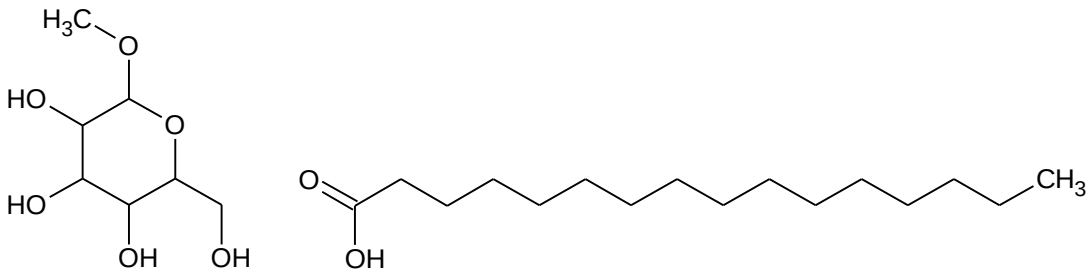
2-phenethylamine, .alpha-ethyl



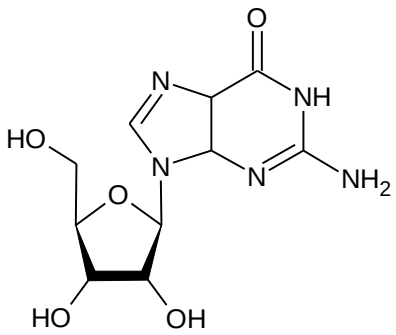
1,4-benzodioxin-6-sulphonamide, 2-N-[2-dimethylamino ethyl]



Phenol-2,6-dimethoxy



Alpha.-D-galactopyranoside, methyl n-Hexadecanoic acid



Guanosine

Fig. 3. Some chemical structures of compounds in the leaf and stem ethanol extract

GC-MS chromatogram analysis of the ethanolic leaf and stem extracts of *C. pachycarpa* [Figs. 1 and 2] predicted 64 and 47 peaks respectively, indicating the presence of 64 and 47 phytochemical constituents respectively. On comparison of the mass spectra of the constituents with the NIST library, the phytocompounds were characterized and identified [Tables 1 and 2] for the leaf and stem extracts respectively. The various phytochemicals which contribute to the medicinal activities of the plant were shown in Table 3. The chemical structures of the most abundant phytochemicals were presented in Fig. 3. Of the 64 compounds identified in the leaf extract, the most prevailing compounds were: 1-propanol, 2-amino-2-methyl (31.34%), undecanal, 2-methyl (4.00%), phenol, 2,6-dimethoxy (4.18%), n-Hexadecanoic acid (3.35%), 3,7,11,15-Tetramethyl-2-hexadecen-1-ol (2.21%), 9,12-Octadecadienoic acid (Z,Z) (1.25%), vitamin E (5.15%), methyl-(2-hydroxy-3-ethoxy-benzyl)ether (4.79%),5-caranol, (1S,3R,5S,6R) (2.63%), 2-methoxy-4-vinylphenol (3.10%), 1H-Azepin-1-amine, hexahydro (2.30%), 1-Heptadec-1-ynyl-cyclopentanol (2.23%) and 5-Octen-2-ol, 5-methyl (1.49%), while the most abundant in the stem ethanol extracts were: 2(5H)-Furanone (3.07%), 3-Cyclohexen-1-carboxaldehyde, 3-methyl (3.23%), 4-Methylpiperazine-2-carboxylic acid (5.78%), Phenethylamine .alpha.-ethyl- (10.96%), 1,4-Benzodioxin-6-sulfonamide,N-[2-(dimethylamino)ethyl- (30.10%), Phenol,2,6-dimethoxy-(3.19%), Guanosine (3.86%), .alpha.D-Galactopyranoside, methyl (12.56%), Phenol,4-(3-hydroxy-1-propenyl)-2-methoxy- (3.36%), n-Hexadecanoic acid (3.69%) and 9,12-Octadecadienoic acid (Z,Z)- (2.11%) amongst others.

In the study by Johnny et al. [9], the presence of 9, 12, 15-octadecatrienoic acid (10.05 %), hexadecanoic acid (6.58 %), n-hexadecanoic acid (1.71%) for the leaf of *Cola millenii* while the stem had n-hexadecaoic acid (0.81 %) and 9,12-octadecadienoic acid (0.35%). *C. pachycarpa* and *C. millenii* both belong to the same genus *Cola* and with the common name “Monkey Kola” also possess these phytochemicals as well.

Guanosine was recorded in the stem of *C. pachycarpa* being a heavy molecule. Guanosine has been reported to play a role in neuropathologies [10]. The available literature in Table 3 supports that the identified phytochemical constituents in the ethanol leaf and stem extracts of *C. pachycarpa* may confirm

its folklore uses in disease treatment and management.

4. CONCLUSION

The results of the study clearly indicate the presence of active principles with the pharmacological activities in the ethanolic extract of *Cola pachycarpa* K. Schum. So, this may justify its uses in the treatment and management of ailments like cancer, diabetis mellitus, arthritis and inflammation in folkore medicine. The identification of these bioactive phytochemicals is just the initial step. Further studies on *in vitro* and *in vivo* studies should be carried out on various partition fractions and the isolates obtained from this important medicinal plant may be studied further using clinical trials, to assess the efficacy and safety of the extract for specific diseases.

CONSENT AND ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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