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Phytochemical Composition, Antioxidant and Antimicrobial Potentials of some Indigenous Plants in Umudike, Abia State, Nigeria

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ABSTRACT: Twenty four ethanol leaf and stem bark extracts of 17 indigenous plants were examined for their phytochemical composition, antimicrobial and antioxidant properties. Phytochemical compositions were analysed with GC-MS while antimicrobial activities on *Staphylococcus aureus* and *Pseudomonas aeruginosa* were investigated by the agar well diffusion method. The antioxidant activities were determined with Ferric reducing antioxidant power (FRAP), total phenolic content (TPC) and 2, 2,-dihenyl-1-picryhydazyl (DPPH) radical scavenging assays. The antibacterial activity was more towards the gram positive *S. aureus* than the gram negative *P. aeruginosa* for all the plant extracts. A wide range of phenolic concentrations among the aqueous plant extracts which varied from 28.04 to 500.26mg GAE per gram were observed. Inhibition percentages of DPPH ranged from 19.13 to 95.77% showing effectiveness in radical scavenging. GC-MS characterization of the plant extracts showed a total of 18 components including alkaloids, flavonoids, phenols, saponins, terpenoids, steroids and glycosides. *Irvingia gabonensis* leaf (IGL) extract and Tamarind stem bark (TSB) exhibited excellent ferric reducing abilities of 2.11 and 1.56 respectively while *Voucanga Africana* leaf (VCA) extract indicated the lowest ferric reducing power of 0.50. Extracts of IGL and TSB exhibited the highest antioxidant capacities and therefore could be the main sources of natural antioxidant. An important relationship between total phenolic content was observed showing that the major contributor to the antioxidant properties were phenolic compounds.

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Antioxidants are secondary metabolities that fight against oxidative damage caused by free radicals (Shen *et al.*, 2012; Subhasree *et al.*, 2009). Free radicals are known to display essential activity in the development of tissue damage in many human diseases such as neurodegenerative disorders, cancer, cardiovascular diseases and pathological events in living organism. They rapidly inactivate enzymes, destroy membranes, and damage cell organelles by inducing degradation of nucleic acids and proteins lipids (Giweli *et al.*, 2013; Tuo *et al.*, 2015; Khalaf *et al.*, 2008). Free radicals include reactive nitrogen species (RNS), reactive oxygen species (ROS), and reactive chlorine species (RCS). The human anatomy possesses innate defence mechanisms, such as uric acid, glutathione peroxides, superoxide dismutase, glutathione, catalase, and ubiquinone which counteract free radicals in the form of endogenous antioxidants (Spiegel *et al.*, 2020; Fernandes *et al.*, 2015; Udem *et al.*, 2018). However, the quantities of these body generated defenders seem to be inadequate, most likely under oxidative stress conditions or

inflammation during which the quantity of free radicals produced is increased (Ahn and Je, 2011; Gutteridge, 1994). Antioxidants plays important roles in preventing most of these diseases induced by free radicals by preventing or inhibiting the oxidation of oxidizable materials, decreasing oxidative stress and scavenging free radicals (Lim *et al.*, 2009). Plants contain large numbers of biologically active compounds that can act as antioxidants. Under high environmental stress, plants contain non-enzymatic and enzymatic antioxidants. The enzymatic antioxidants are peroxidase (POX), superoxide dismutase (SOD), ascorbate peroxidase (APX) and catalase (CAT) while non-enzymatic antioxidants include α-tocopherol, anthocyanins, polyphenolic, ascorbic acid, catechins, lignans, β-carotene, coumarins, and flavonoid compounds. Furthermore, the most synthetic antioxidants commonly used in cosmetic and food industries are propyl gallate (PG) butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT) and butylated hydroquinone (BHQ) (Duracková, 2010). However, these synthetic antioxidants are known to be promoters of carcinogenesis. This necessitates the search for natural antioxidants that have little or no side effects for use in the cosmetic and food industries and also as a material in medicine to displace the synthetic antioxidants. Plants that have curative uses are the main sources of antioxidants like phenolic compounds such as flavonoids, tannins, lignin, phenolic acids and stilbenes. They are also rich sources of vitamins such as E, C and A (Karuppanapandian *et al.*, 2011; Erdemoglu *et al.*, 2006). They also exhibit antibacterial, anticancer, immune stimulating, antiviral and anti-inflammatory activities (Reuter *et al.*, 2010). Many studies have shown that plants exhibit important health benefits such as antimicrobial and antioxidants properties and this has led to the development of products for scavenging of free radicals (Kaur *et al.*, 2009). However, a large number of plants are still unexplored as potential sources of antioxidants for use in food, cosmetic and drug industries. This study was designed to investigate the phytochemicals composition, antimicrobial and antioxidant activities of 24 leaf and stem bark extracts from 17 plants namely, *Starchytarpheta indica*, *Axonopus compressus*, *Mangifera indica*, *Irvingia gabonensis*, *Dacryodes edulis*, *Anacardium occidentale*, *Azadirachta indica*, *Dalium guinenses*, *Voucanga Africana*, *Funtumia africana*, *Tetrapleura tetraplera*, *Detarium senegalense*, *Newbouldia laevis*, *Khayaiv orensis*, *Nauclea latitolia*, *Abutilon mauritianum* and *Artocarpus altilis*

MATERIALS AND METHODS

Collection and identification of leaf and stem bark samples: The leaf and stem bark samples were collected within and around Michael Okpara University of Agriculture, Umudike. They were tightly packed into plastic bags and transferred to the laboratory..

Table 1. Names of Plant Samples Collected

SN	Scientific Name	Common/local (Igbo) Name	Part of Plant	Sample ID
1	*Stachytarpheta indica* (Linn) Vahl	Snakeweed/Ogwuiba	L	SNPT
2	*Axonopus compressus*	Carpet grass	L	CPG
3	*Mangifera indica*	Mango/Mangoro	L	MGL
4	*Mangifera indica*	Mango/Mangoro	SB	MGSB
5	*Irvingia gabonensis*	Bush Mango/Ogbono	L	IGL
6	*Dacryodes edulis*	African Pear/Ube	L	DEDL
7	*Dacryodes edulis*	African Pear/Ube	SB	DESB
8	*Anacardium occidentale*	Cashew/Kashu	SB	CSB
9	*Azadirachta indica*	Neem/Dogonyaro	L	NML
10	*Azadirachta indica*	Neem/Dogonyaro	SB	NMSB
11	*Dalium guinenses*	Tamarind/Icheku	L	TML
12	*Dalium guinenses*	Tamarind/Icheku	SB	TSB
13	*Voucanga Africana* Stapf	Milk bush/Pete pete	L	VCA
14	*Funtumia africana* (Benth.) Stapf	Silk Rubber/Mba-miri	L	FTAL
15	*Tetrapleura tetraptera*(Schum&Thonn)Taub	Aidan fruit or Gum Tree/Osakirisa or Oshosho	L	TTL
16	*Tetrapleura tetraptera*(Schum&Thonn)Taub	Aidan fruit or Gum Tree/Osakirisa or Oshosho	SB	TTSB
17	*Detarium senegalense* J.F. Gmelin	Detar Tree/Ofo	L	DSGL
18	*Newbouldia laevis* (P. Beauv) seem. ex Bureau	Boundary tree/Ogirisi	L	NBL
19	*Newbouldia laevis* (P. Beauv) seem. ex Bureau	Boundary tree/Ogirisi	SB	NSB
20	*Khayaiv orensis* A. Chev	African mahogany/Utu-eyi or Ono	L	KYIV
21	*Nauclea latifolia*(Afzelexsobine)	African peach/Ubuluinu	L	NCLF
22	*Abutilon mauritianum* (Jacq) Mediv	Bush or Country mallow	L	AMT
23	*Artocarpus altilis*	Breadfruit	L	SCL
24	*Artocarpus altilis*	Breadfruit	SB	SCSB

L = leaf; SB = stem bark

They were identified by Mr. Sylvester Ibe of the Forestry Department of the University while voucher specimens were deposited in the herbarium of the Plant Science and Biotechnology (PBS) Department of the same University. Details of the plants collected are shown in Table 1

Pre-treatment of Samples: The samples were washed thoroughly thrice with double distilled water and were shade dried for 14 days.

Extraction: This was achieved based on the procedure reported by Azwanida (2015) with little modification. The dry samples were mechanically pulverized into powder with wooden mortar and pestle. The plant powder (40 g) was soaked in 200 mL of absolute ethanol for 20 h followed by filtration under applied vacuum through Whatman no 1 filter paper spread on a fitting Buchner funnel. The filtrate (extract) was then concentrated using a rotary evaporator to 2 ml. The extracts for DPPH, total phenolic and FRAP assays were left overnight for complete evaporation of the ethanol and the resulting solid residue was used for these analyses. The extract for GC-MS analysis was transferred into a labelled Teflon screw-cap vial and was cleaned up with 3 g of anhydrous sodium sulphate in a well packed column before analysis.

2, 2-Diphenyl-1-Picrylhydrazyl (DPPH) photometric assay: The free radical scavenging activity of the extract was investigated by the DPPH assay according to the method described by Mensor *et al*. (2001) using a Bio-base double beam scanning UV–VIS spectrophotometer (model BK-D 590). The crude extract at concentrations (25, 50, 100, 200 and 400) µg/mL each was mixed with 1 mL of 0.5 mM DPPH (in methanol) in a cuvette. The absorbance at 517 nm was taken after 30 min of incubation in the dark at room temperature. The experiment was done in triplicate. The percentage antioxidant activities were calculated as follows.

$$\%\ AA = 100 - \frac{(\text{ABS sample} - \text{ABS blank}) \times 100\}}{\text{ABS control}}$$

Where AA = antioxidant activity

Methanol (1 mL) plus 2.0 mL of the test extract was used as the blank while 1.0 mL of the 0.5 mM DPPH solution plus 2.0 mL of methanol was used as the negative control. Ascorbic acid (vitamin C) was used as the reference standard (Iwalewa *et al.*, 2008; Nurhaslina *et al.*, 2019). The half maximal inhibitory concentrations (IC_{50}) of the plant extracts were calculated from the plot of mean percentage DPPH inhibitory activity versus the equivalents of the tested samples concentrations in linear regression.

Total Phenolic Content Assay: Total phenol content (TPC) of each extract was determined using the Folin–Ciocalteau (FC) method described by Do *et al*. (2014) with minor modifications. The dried extract was dissolved in distilled water to a concentration of 50µg/mL. The calibration curve was established using gallic acid (0–60 µg/mL). The diluted extract or gallic acid (1.6 mL) was added to 0.2 mL FC reagent (5-fold diluted with distilled water) and mixed thoroughly for 3 min. Sodium carbonate (0.2 mL, 10% w/v) was added to the mixture and the mixture was allowed to stand for 30 min at room temperature. The absorbance of the mixture was measured at 760 nm using a Bio-base double beam scanning UV–VIS spectrophotometer (model BK-D 590). TPC was expressed as milligram gallic acid equivalent per gram of extract (mg GAE/g extract).

Ferric Reducing Antioxidant Potential Assay: The ferric reducing antioxidant potential assay is a procedure for determining the reducing power of substances that are electron donors. This was determined according to the method described by Duh *et al.* (1999). Different concentrations (15–240 µg/mL) of the solvent fractions and the standard (gallic acid) were mixed with 2.5 mL of phosphate buffer (0.2 mol/L, pH 6.6) and 2.5 mL of 1% w/v potassium ferricyanide. The mixture was incubated for 20 min at 50°C. 2.5 mL of 10% trichloroacetic acid was added to acidify the mixture. Thereafter, 1 mL of the acidified mixture was mixed with 1 mL of distilled water and 0.5 ml of 0.1% $FeCl_3$. The absorbance of the resulting solution was measured at 700 nm. The antioxidant power of the plant fractions was expressed as:

$$\text{FRAP}\ \% = \frac{\text{Absorbance of sample x 100}}{\text{Absorbance of gallic acid}}$$

Where FRAP = ferric reducing antioxidant power

GC/MS Analysis: An agilent 6890N gas chromatography equipped with an auto sampler connected to an Agilent Mass Spectrophotometric Detector was used. 1 µL of sample (extract) was injected in the pulsed spitless mode onto a 30 m x 0.25 mm ID DB 5MS coated fused silica column with a film thickness of 0.15 µL. Helium gas was used as a carrier gas and the column head pressure was maintained at 20 psi to give a constant of 1 ml/min. Other operating conditions were preset. The column temperature was initially held at 55 °C for 0.4 min, increased to 200 °C at a rate of 25 °C/min, then to 280 °C at a rate of 8

°C/min and to a final temperature of 300 °C at a rate of 25 °C/min, held for 2 min. The identification was based on retention time. Components with lower retention times eluted first before the ones of higher retention times.

The relative percentage amount of each component was calculated by comparing the average peak area to the total areas. The software adapted to handle mass spectra and chromatograms was chemstation. Interpretation of the mass spectrum of GCMS was conducted using the database of National Instrument of Standard and Technology (NIST) having more than 63,000 patterns. Unknown components were compared to the known ones using the NIST library. Molecular weights and structures of the components of the test materials were ascertained. The spectrum profile of GC-MS confirms the presence of the main components with their retention times. The height of the peak aligned with the concentration of the components in the extracts.

Antimicrobial assay: The antimicrobial screening tests were carried out using the agar well cup-plate diffusion method described by Oforkansi *et al.* (2013), Irawan *et al*. (2014) and Ike *et al*. (2021) with slight modification. One species each of the gram positive *S. aureus* and the gram negative *P. aeruginoso* were used as the test organisms. Sterile Mueller agar plates were seeded with 0.1 of standardized broth culture of the microorganism. A 6 mm diameter well in the solid agar was made by the use of sterile cork borer for each of the microbial isolate. Solutions of ciprofloxacin were added into separate agar wells as positive control and DMSO or methanol as negative control. The remaining wells were filled with the respective test agents. For proper diffusion all the plates were left for 1 h at room temperature. Thereafter, they were incubated at 37 ˚C for 24 h. Inhibition Zones around the wells were measured in millimeter. The investigation was carried out in triplicate and the average values calculated for antimicrobial assay.

RESULTS AND DISCUSSION

Antioxidant activity (DPPH): The antioxidant activities of various indigenous plant extracts were evaluated by DPPH radical scavenging mechanism which has been widely used to examine the free radical scavenging abilities of numerous plant extracts Durga *et al.*, 2020). The results are shown in Table 2 and are expressed as the relative activities against standard ascorbic acid.

All the plant extracts showed dose-dependent antioxidant assay, that is, increase in the concentration of the crude extract increases the percentage inhibition. A Similar result was reported by Donga *et al.* (2020) and Jimoh *et al.* (2019). Nevertheless, inhibition percentages of DPPH range from 19.13 to 95.77%. In comparison to the various plant extracts, NML indicated the least inhibition percentage with 19.13% showing less effectiveness in radical scavenging, followed by NSB with 30.96%, NCLF, 33.18%, VCA, 47.03%, NBL, 55.56% and CPG, 57.59%. TSB, FTAL and MGL possess the highest DPPH activity among the studied plants with 95.77%, 95.14% and 95.03% respectively. Therefore, the percentage of radical scavenging activity inhibition can be arranged in the following order; TSB > FTAL> MGL > AMT > DESB > NMSB > TML.TTL > IGL > KYIV > CSB > SNPT > MGSB etc. IC_{50} values give an indication of the concentrations of the samples at which 50% of DPPH free radicals that have been scavenged Vijendren *et al.* (2015). The lower the IC_{50} the stronger the antioxidant activity. IGL has the lowest IC_{50} value and hence the strongest antioxidant activity.

Table 2. DPPH Radical Scavenging Activity of the extracts

Plant Extract	DPPH (mean)	SD	IC_{50}
MGSB	85.52	0.067209	429.339
MGL	95.03	0.067209	118.304
NSB	30.96	0.308001	699.84
NBL	55.56	0.641159	345.86
TTSB	91.54	0.242336	262.72
TTL	94.68	0.067209	84,352.89
KYIV	93.79	0.292969	534.56
IGSB	87.50	0.067215	32.657
SNPT	88.44	2.311741	346.88
DESB	94.80	0.155198	18.9131
FTAL	95.14	0.067215	29.01
NCLF	33.18	0.292969	17,942,381.04
SCSB	78.19	0.559588	46.98
DSGL	90.03	0.155203	19.607
CSB	90.68	0.116415	54.862
VCA	47.03	0.067215	86,233.89
AMT	94.96	0.067209	44.891
TML	94.72	0.134424	54.54
IGL	93.99	0.682127	14.836
NML	19.13	0.597391	41,219.24
SCL	85.25	0.308001	25.55
CPG	57.59	0.134419	647,083.02
NMSB	94.76	0.335719	19.968
TSB	95.77	0.136022	151.45
Ascorbic Acid	97.33	0.085140	6.1

Total Phenolic Content (TPC): Tables 3 shows that the values of the total phenolic content of the 24 indigenous plant extracts varied from 28.04 to 500.26 mg GAE/g of sample calculated by the Folin-Ciocalteu method (Lu *et al.*, 2011; Abdel-Hameed, 2009). This indicated a wide range of phenolic concentration among the various aqueous plant extracts. Three extracts showed very high phenolic contents (greater than 300 mg GAE/g) namely, TSB,

DEDL and CSB with values of 500.26, 411.66 and 370.54 respectively. Seven other plant extracts such as DESB, NMSB, MGL, TML, TTSB, IGSB and KYIV also exhibited high phenolic contents of 285.12, 281.47, 277, 239.41, 232.93 227.03 and 216.2 mg GAE/g respectively. Among the considered plant extracts, NML exhibited a very low phenolic content of 28.04 mg GAE/g.

Table 3. Total phenolic content (TPC) of the ethanolic extracts of the Plants

Samples	Average/mg g^{-1} Gallic Acid Equivalents	SD
DSGL	169.54	3.8123
AMT	194.87	3.5405
TML	239.41	11.623
TSB	500.26	6.5641
TTSB	232.93	3.4087
TTL	127.48	4.127
VCA	46.42	2.4826
NCLF	47.01	4.5126
IGL	121.47	1.2413
NMSB	281.47	1.7791
CSB	370.54	7.4673
NBL	46.54	7.212
KYIV	216.2	4.9019
NSB	55.38	4.0967
NML	28.04	2.6529
DESB	285.12	2.9432
SCL	87.31	6.6031
FTAL	155.17	3.724
SCSB	53.14	1.779
MGL	277	5.681
DEDL	411.66	4.9018
SNPT	129.25	7.0189
MGSB	110.63	1.7673
CPG	43.48	2.8055

Ferric Reducing Antioxidant Power (FRAP): The result obtained for the ferric reducing power is shown in Table 4. The abilities of the various extracts to reduce Fe^{3+} to Fe^{2+} ranges from 0.50 to 2.11. IGL and TSB extracts showed excellent ferric reducing ability compared to other extracts, with 2.11 and 1.56 respectively. VCA extract indicated the lowest ferric reducing power with 0.50 followed by CPG and NML extracts with 0.54 and 0.56 respectively. The total antioxidant capacities from both FRAP and DPPH assays varied significantly and could be attributed to the different structure of phenolic compounds Kumaran and Karunakaran (2007).

Table 4: Ferric Reducing Potentials

Plant Extract	**FRAP (mean values)**	**SD**
MGSB	1.02	0.005657
MGL	1.01	0.16617
NSB	0.84	0.005657
NBL	0.92	0.004243
TTSB	1.03	0.011314
TTL	0.61	0.005657
KYIV	0.98	0.004243
SNPT	0.88	0.008485
DESB	1.05	0.003536
FTAL	1.15	0.010607
NCLF	0.47	0.002828
SCSB	1.19	0.00495
DSGL	1.28	0.002828
IGSB	1.13	0.049497
CSB	1.12	0.001414
VCA	0.50	0.015556
AMT	1.14	0.00495
TML	1.04	0.084146
IGL	2.11	0.002121
NML	0.56	0.001414
SCL	1.18	0.005657
CPG	0.54	0.002828
NMSB	1.41	0.03677
TSB	1.56	0.51442
Ascorbic Acid mg/mL	2.124	0.005657
Gallic Acid mg/mL	1.9315	0.00495

Phytochemical Composition: The GC-MS of the plant extracts showed a total of 18 components including alkaloids, flavonoids, phenols, saponins, terpenoids, steroids and glycosides. These results are itemized in Table 5.

Table 5. Phytochemical Compositions of the Plant Extracts

Sample ID	**Scientific Name**	**Major Bioactive Compounds**
PS1	*Stachytarpheta indica* L	Mannosamine;dl-Allo-cystathionine; piperidine-1-thiocarboxamide; phosphorothioic acid-ester; d-arabino-Hexose, 2-deoxy-, cyclic 1,2-ethanediyl mercaptal, tetraacetate; S-[2-aminoethyl]-dl-cysteine
PS 2	*Axonopus compressus* L	2-thioxo-imidazolidin-4-one-5-ethanoic acid; pentaborane(9); S-carboxymethyl-L-cysteine; 5-hydroxy pentanamide; Piperazine, 2-methyl-; 2-methyl-, 3-Piperidinol, 1,6-dimethyl-;reserpiline
PS 3	*Mangifera indica* L	1,4-oxathian-2-one, 6-methyl-, 3,3,3-trifluoro-N-[2-(phenylcarbamoyl)phenyl]-2-(trifluoromethyl)propionamide;ethanol, 2,2'-(nitrosoimino)bis-; cycloheptanone, oxime;Imidazole, 2-amino-5-[(2-carboxy)vinyl]-
PS 4	*Mangifera indica* \ \SB	Cycloheptanol, 2-chloro-, trans-; 1,2-cyclopentanediol, trans-; pentanoic acid, 2-(aminooxy)-; acetic acid, (2,4,5-trichlorophenoxy)-, 2-butoxypropyl ester;sparsomycin; gentamicin a
PS 5	*Irvingia gabonensis* L	5-Hexen-3-yn-2-ol;methyl 1-trimethylsilyl-2-methyl-cyclopropene-3-carboxylate;pentadecafluorooctanoic acidester;1-phenyl-3,5,6-trimethyl-7-oxo-6,7(8H)-dihydropyrazolo(3,4-b)(1,4)diazepine; 4H-1-benzopyran-4-one; N-methyl-2-(triphenylphosphoranylidene) amino-benzamide;

PS 6	*Dacryodes edulis* L	Ethanone; 1,1'-biphenyl, 2,3,4,4'-tetramethoxy-5-methyl-6'-; 1,1'-Biphenyl, 2,3,4,4'-tetramethoxy-5-methyl-6'-diethylaminomethyl-; pregnan-20-one;gamabufotalin; chloropropylate; ellagic acid; benzofuran-2-carboxylic acid; levodopa; resveratrol;carbazochrome; benzoic acid, 4-hydroxy-
PS 7	*Dacryodes edulis* SB	1-(2-Nitroanilino)-1-deoxy-.alpa.-d-ribofuranose; guanosine;mannosamine;1,2,3-triazole-4-carbohydrazide; N2-(4-hydroxybenzylidene)-5-chloro-; pyrimidin-2,4-dione;cystine; 1-(2-chlorophenylsulfonyl)-2-(3-hydroxypropyl)urea
PS 8	*Anacardium occidentale* L	α-dl-Lyxo-hexopyranoside; hexyl 6-(acetylamino)-4,6-dideoxy-1-thio-;furan-2-one;imidazole; 2-amino-5-[(2-carboxy)vinyl]-; 1-(β-d-Ribofuranosyl)-4-difluoromethyl-5-bromouracil; pterin-6-carboxylic acid; sparsomycin; l-4-hydroxylysine; Pyrazole[4,5-b]imidazole, 1-formyl-3-ethyl-6-β-d-ribofuranosyl-
PS 9	*Azadirachta indica* L	cystine; pterin-6-carboxylic acid; α-N-normethadol; levodopa;mannosamine, deoxyspergualin, alanine, 3-(3,4-dihydroxyphenyl)-, methyl ester,L-, morphinan-3,14-diol, 4,5-epoxy-, (5α)-
PS 10	*Azadirachta indica* SB	3-Quinolinol; trans-8-Hydroxy-bicyclo(4,3,0)non-3-ene; propenoic acid, 3-(4-hydroxy-3-methoxyphenyl)-;ellagic acid;benzoic acid, 3,4-dihydroxy-, methyl ester; aurin; alanine, 3-(3,4-dihydroxyphenyl)-, methyl ester, L-
PS 11	*Dalium guinenses* L	N-methyl-N-[4-[4-fluoro-1-hexahydropyridyl]-2-butynyl]-;desulphosinigrin;dl-allo-cystathionine, 2,4-hexadien-1-ol; methanone (2,4-dihydroxyphenyl)phenyl-
PS 12	*Dalium guinenses*SB	12,15-octadecadiynoic acid, methyl ester; 4-hydroxyhistamine; 2H-Benzoxathiol-2-one, 5-hydroxy-6-nitro-;1,2-propanediol, 3-(butylthio)-;cyclopropanepropionic acid; R-limonene; dl-cystathionine; D-streptamine;dl-Citrulline; α-D-Galactopyranose; 1,2-benzenediol; 2,4,6,8-tetraazabicyclo[3.3.0]octan-3-one; 9-oxabicyclo[3.3.1]nonane-2,6-diol
PS 13	*Voucanga Africana* L	2-hydroxy-3-nitropyridine;dimethirimol; 1-(4-Hydroxy-3-methoxyphenyl)-1-ethoxyacetic acid ethyl ester, O-trimethylsilyl; acetic acid, butyl ester;benzeneethanol;2β,3β,14α-Trihydroxy-27-nor-5α-cholest-7-en-6-one; 3-O-acetyl-exo-1,2-O-ethylidene-α-d-erythrofuranose; 3-(2-furyl)-3-methyl-1,2-diphenylcyclopropene; 2-(1-Hydroxyethyl)-2-methyl-1,3-oxathiolane
PS 14	*Funtumia Africana* L	Phenol, 1,6-di-t-butyl-4-[2-[N,N-dimethylamino]ethyl]-;Benzoic acid, 2-methyl-, (2-methylphenyl)methyl ester; quercetagetin; resveratrol, ellagic acid;levodopa; 2-propenoic acid,3-(4-hydroxy-3-methoxyphenyl)-; benzofuran-2-carboxylic acid; Acetic acid, phenyl ester;
PS 15	*Tetrapleura tetraptera* L	D-streptamine;dammar-22-en-3-ol, 20,24-epoxy-24-methyl-; 2,8-bornanediol; 2,6-diazaspiro(4,4)nonane-3,7-dione; formic acid;oxybenzone, 3-hexyn-1-ol; Imidazole, 2-amino-5-[(2-carboxy)vinyl]-;dinoseb acetate
PS 16	*Tetrapleura tetraptera* SB	Mannosamine; dl-allo-cystathionine;dithiocarbamate, S-methyl-,N-(2-methyl-3-oxobutyl)-;butanoic acid, 2-amino-4-(methylsulfinyl)-; gala-l-ido-octose; 5-nitroimidazole-4-propionic acid
PS 17	*Detarium senegalense* L	2,7-Bis-pyrrol2-[2-(2-hydroxy-ethoxy)-ethoxy]-ethoxymorpho-fluoren-9-one;isonipecotic acid, N-(3-methylbenzoyl) pentadecyl ester; benzoic acid ester; β,ε-carotene; succinic acid, phenethyl 2-chloroethyl ester
PS 18	*Newbouldia laevis* L	12-Hydroxystearic acid, phenacyl ester; d:a-friedooleanan-1-one, 3,24-dihydroxy-;glutaric acid, heptyltetrahydrofurfuryl ester;2-(N-methylacetamido)-4-phenyl-6-methyl-8-benzylidene-5,6,7,8(4H)-tetrahydropyrido(4,3-d)(1,3)thiazine;tetrabromo-O-sulfobenzoic anhydride
PS 19	*Newbouldia laevis* SB	S-[2-[2-Hydroxy-3-isopropoxypropylamino]ethyl]thiophosphate; D-fructose, diethyl mercaptal; pentaacetate; L-glucose; 9-oxabicyclo[6.1.0]nonan-4-ol; D-streptamine, 5-thio-D-glucose
PS 20	*Khaya ivorensis* L	Pregan-20-one, 2-hydroxy-5,6-epoxy-15-methyl-; morphinan-3,14-diol, 4,5-epoxy-;, R-limonene;aAndrostan-3-one, cyclic 1,2-ethanediyl mercaptole, (5α)-;furan-2-one, 3,4-dihydroxy-5-[1-hydroxy-2-fluoroethyl]-;pyrazole[4,5-b]imidazole, 1-formyl-3-ethyl-6-β-d-ribofuranosyl-; D-streptamine; Phosphorothioic acid, S-ester with trimethylenediiminodipropanethiol (2:1)
PS 21	*Nauclea latitolia* L	Cystine; D-streptamine; pyrrolizin-1,7-dione-6-carboxylic acid, methyl(ester); mannosamine, 6H-1,2,5-Oxadiazolo[3,4-E]indole-6,8a-diol, 4,5,5a,7,8,8a-hexahydro-, 3-oxide; Pyrazole[4,5-b]imidazole, 1-formyl-3-ethyl-6-β-d-ribofuranosyl-; d-Glycero-d-ido-heptose
PS 22	*Abutilon mauritianum* L	dl-allo-cystathionine; 6H-1,2,5-oxadiazolo[3,4-E]indole-6,8a-diol, 4,5,5a,7,8,8a-hexahydro-, 3-oxide; l-gala-l-ido-octose; 4,4-ethylenedioxy-pentanenitrile; 2-aminoquinoline-4-carboxylic acid;furan-2-one, 3,4-dihydroxy-5-[1-hydroxy-2-fluoroethyl]-;chlorozotocin; 4-cyclopropylcarbonyloxytridecane; 1-(3-hydroxypropyl)-2-piperidinone,
PS 23	*Artocarpus altilis* L	D-arabino-hexose, 2-deoxy-, cyclic 1,2-ethanediyl mercaptal, tetraacetate; pentanol, 5-amino-; imidazole-4-carboxylic acid, 2-fluoro-1-methoxymethyl-, ethyl ester, valine, 3-[sulfothio]-
PS 24	*Artocarpus altilis*SB	Gentamicin a; Pyridine-3-carboxamide, 1,2-dihydro-4,6-dimethyl-2-thioxo-;sparsomycin, : l-gala-l-ido-octose;pentanoic acid, 3,3-dimethyl-4-semicarbazono-

L = leaf; SB = stem bark

Antimicrobial Activity: The result of the antimicrobial screening of the plant extracts are shown in Figures 1 – 3. It can be observed that the extracts showed degrees of inhibition on the microorganism investigated. All the plant extracts exhibited higher inhibition zone towards the gram positive *S. aureus* than the gram negative *P. aeruginoso*. The microorganisms were sensitive to MGL, SNPT, NCLF and TTSB which can be attributed to the presence of secondary metabolites including steroids, flavonoid, alkaloids, terpenoids, glycosides (Cai *et al.* (2004). Metabolites like flavonoids can complex with microbial cells and soluble proteins. Alkaloids have biological activities such as anti-plasmodic, analgesic and the ability to intercalate between DNA strands Ofokansi *et al.* (2013).

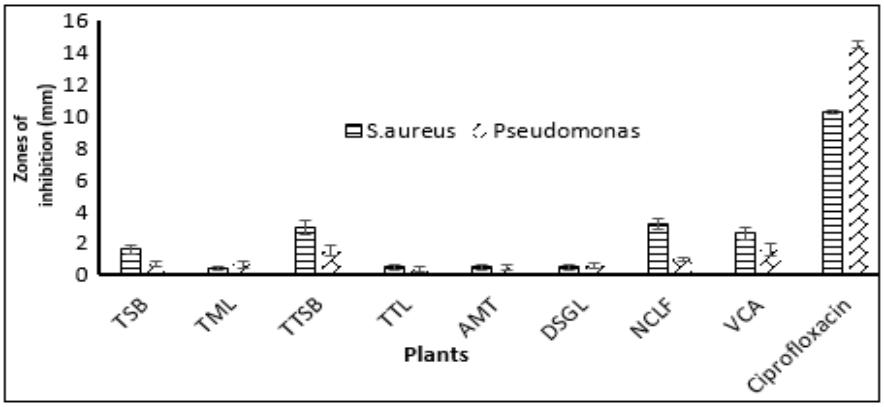

Fig. 1. Antibacterial activities of TSB-VCA extracts against *S. aureus* and *pseudomonas* strains

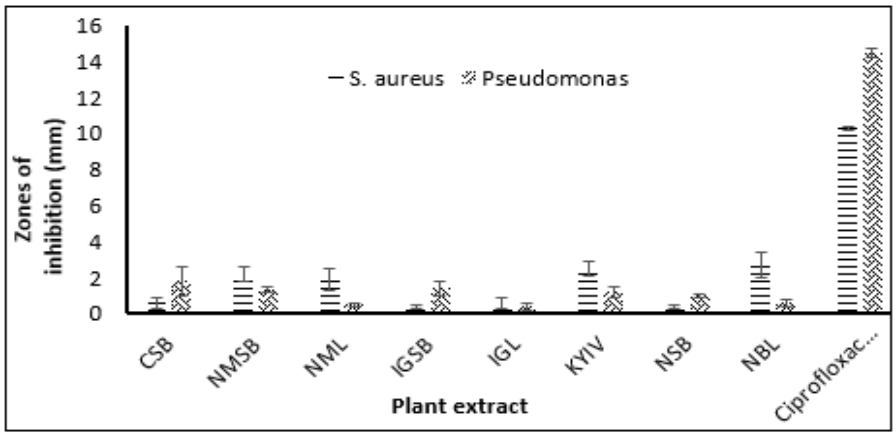

Fig. 2: Antibacterial activities of CSB-NBL extracts against *S. aureus* and *pseudomonas* strains

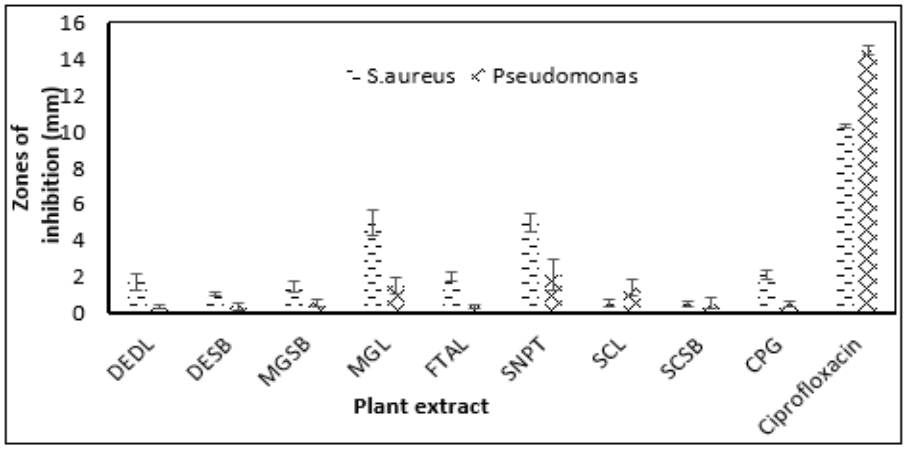

Fig. 3: Antibacterial activities of DEDL-CPG extracts against *S. aureus* and *pseudomonas* strains

Conclusion: The FRAP and DPPH assays show *Irvingia gabonensis* leaf (IGL) and Tamarind stem bark (TSB) extracts had the highest contents of phenolic compounds and the highest antioxidant activities compared to other plant extracts. Therefore, the extracts could be considered as natural sources of antioxidants for treatment of diseases caused by free radicals. The finding also suggest that these plant extracts could be effective and efficient materials for the treatment of bacteria caused by *Staphylococcus aureus*.

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