RESEARCH ARTICLE

Sokoto Journal of Veterinary Sciences

(P-ISSN 1595-093X: E-ISSN 2315-6201)

http://dx.doi.org/10.4314/sokjvs.v22i3.9

Salihu *et al.*/*Sokoto Journal of Veterinary Sciences*, **22**(3): 202 - 213.

Phytochemical, elemental and proximate analysis of methanolic root extract of *Fadogia andasonii* Robyn

SI Salihu[1]*, D Sani[2], A Abba[3], M Mamman[2], ZS Abubakar[4], KP Gadzama[1] & OM Olowomeye[5]

1. *Department of Veterinary Pharmacology and Toxicology, University of Maiduguri, Nigeria*
2. *Department of Veterinary Pharmacology and Toxicology, Ahmadu Bello University, Zaria, Nigeria*
3. *Veterinary Teaching Hospital, University of Maiduguri, Nigeria*
4. *Department of Physiology, Faculty of Basic Medical Sciences, Yusuf Maitama Sule University Kano, Nigeria*
5. *Department of Human Physiology, Faculty of Basic Medical Sciences, Ahmadu Bello University, Zaria, Nigeria*

*Correspondence: Tel.: +2348096532445; E-mail: sabosalihu83@gmail.com

Publication History:
Received: 06-06-2024
Revised: 05-07-2024
Accepted: 19-07-2024

Abstract

The presence of numerous bioactive phytoconstituents in plants is widely accepted for its therapeutic relevance in curing several diseases. *Fadogia andersonii* (*F. andersonii*) is an ethnomedicinal plant used to manage many diseases in Africa with limited information on its bioactive constituents. Therefore, this study was designed to determine the phytochemical constituents, elemental, and proximate analysis of *F. andersonii root*. This was carried out using standard procedures of Gas chromatography-mass spectrometer (GC-MS), fourier transform infrared (FTIR), Atomic absorption spectrophotometer (AAS), and proximate analysis of phytochemical constituents, functional groups, elemental, and proximate contents respectively. The GC-MS analysis reveals the presence of 40 different phytochemical constituents each with proven pharmacological activity. The FTIR analysis indicates the presence of hydroxyl, alkyl, alkene, carboxyl, and carbonyl functional groups. The AAS analysis for Fe, K, Mn, Zn, Ca, Na, and Cu in part per million (ppm) were 4.336, 38.00, 12.151, 17.388, 3.860, 18.00, and 0.020. Proximate analysis of *F. andersonii* root indicated the presence of Moisture (5.65 %), ash (4.33 %), lipid (6.19 %), fibre (35.23 %), and carbohydrate (45.10 %). This part of the plant contains essential nutrients, and has potential health benefits.

Keywords: *Fadogia andersonnii*, Elemental analysis, Phytochemical analysis, Proximate analysis

Introduction

Ethnomedicine is one of the most reliable methods of identifying natural and semi-synthetic drugs (Reddy *et al.*, 2023). Humans have been using plants as a source of medicines from time immemorial to treat and prevent many diseases (Jaradat and Zaid, 2019). This type of medicine has played an essential role in healthcare systems in both developed and developing countries, particularly in rural areas (Sofowora *et al.*, 2013; Hosseinzadeh *et al.*, 2015). Herbs do not usually have "drug" actions or side effects, even though they are commonly used and thought to be harmless; yet, they can be hazardous (Karimi *et al.*, 2015). The evaluation of medicinal plants has a long-standing history, especially in assessing their quality. At first, organoleptic methods were used, relying on the senses of taste, smell, and appearance (Ray, 2021). As time went on, more advanced and sophisticated techniques were created (Fitzgerald *et al.*, 2020).

Recently, there has been a rise in the development of functional foods and pharmaceutical products using medicinal and food plants, which have improved various aspects of life (Galanakis, 2021). The utilization of multivariable analytic tools for data processing has improved the field of metabolomics, therefore augmenting our comprehension of the many chemical changes found in medicinal plants. (Fitzgerald *et al.*, 2020). This has increased our certainty regarding the quality of the plants and medicines as well as their appropriateness for clinical investigation. Technology advancements have made it possible to analyze and classify plants more effectively, as well as to detect pollutants and adulterants that are present at extremely low levels. Gas chromatography-mass spectrometry (GC-MS) is a combined analytical technique used to identify and quantify various classes of phytochemicals, such as alkaloids, flavonoids, terpenoids, and phenolic compounds, in a plant sample (Olivia *et al.*, 2021). Fourier Transform Infrared (FTIR) spectroscopy is also a widely used analytical technique in various fields, including pharmaceuticals, biomedicine, and clinical research, for identifying unknown compounds or confirming the identity of known compounds (Fahelelbom *et al.*, 2022). *Fadogia andersonii* (*F. andersonii*) is an ethnomedicinal plant that belongs to the *Rubiaceae* family. It grows in humid climates and is commonly used in Africa to cure and manage a variety of ailments. *Fadogia* has been used as a herbal remedy for aphrodisiacs, diuretics, toothaches, fever, kidney pain, diarrhoea, stomachaches, and blennorrhea (Yakubu *et al.*, 2005; Suleimana *et al.*, 2014; Gotep *et al.*, 2021). *F. andersonii*, also known as Black aphrodisiac in English, Gagai in Hausa (Muhammad *et al*., 2020), has been utilized in northern Nigeria to boost male fertility by stimulating copulatory behavior (Yakubu *et al.*, 2005). This study aims to evaluate the phytochemical, elemental, and proximate constituents of *F. andersonii* Robyn root extract using GC- MS, FTIR, AAS, and proximate analysis following standard protocols.

Materials and Methods

Study location

The study was conducted at the Department of Veterinary Pharmacology and Toxicology, Ahmadu Bello University, Zaria, Kaduna State Nigeria.

Plant collection and identification

The plant was sourced from the Fufa forest, Forsum District, Jos East Local Area, Plateau State, Nigeria. The plant was harvested in August during the rainy season, well packaged, and transported under standard conditions to Zaria, Kaduna State for identification at the Department of Botany Faculty of Life Sciences, Ahmadu Bello University, Zaria. The plant was identified as *Fadogia andersonii* with Voucher Number ABU05888, and was stored at the herbarium of the Department.

Preparation of plant extract

The root of the *F. andersonii* plant was harvested from the wild, washed, and separated from the aerial part, chopped into small sizes, and allowed to dry under the shed. The dried roots were macerated using a wooden pestle and mortar into powder. The powder was collected into a dry polythene bag sealed and stored at room temperature until required for use. The powder of *F. andersonii* root was extracted at the Department of Pharmacognosy research laboratory, Faculty of Pharmaceutical Science, Ahmadu Bello University Zaria using the method described by Youn *et al.* (2003). The outlet of the macerating bottle was packed with cotton wool and rubber cork fixed to obliterate the outlet of the macerating bottle. Five hundred grams (500 g) of the powdered *F. andersonii* were weighed with a digital weighing scale and transferred into the macerating bottle through the inlet. A measuring cylinder was used to measure 1,500 millilitres (1,000 ml) of analytical-grade methanol (BDH), which was then transferred into the macerating bottle using a funnel that was placed into the bottle's intake. A rubber cork was used to seal the macerating bottle's inlet, and the contents were then carefully agitated to ensure appropriate mixing. For 48 hours at room temperature, the macerating bottle was left undisturbed. The extract was filtered into a collecting tube after 48 hours of extraction. Two-thirds of the initial volume of methanol (which amounted to 1000 ml) were then measured and transferred into the macerating bottle and allowed to stand undisturbed for 24 hours at room temperature. The extract was filtered after 24 hours of extraction. The extracts collected on different days were pooled together and gently poured into a stainless steel bowl and left open to stand undisturbed at room temperature for the methanol used for extraction to evaporate. After the methanol had evaporated from the filtrate, the extract was weighed to determine the total extract recovered from 500 g of the powdered *F. andersonii*

root, and the percentage extract yield was determined (Anand, 2020).

Phytochemical analysis of F. andersonii methanol root extract using gas chromatography-mass spectrometer (GC- MS)

The *F. andersonii* root extract (1.0 g) was dissolved in an analytical grade methanol (10 mL), in the ratio of 1:10 v/v, then filtered with micro filter Nylon 0.45µm and transferred into a sample vial of about 2µL of the sample. GC- MS machine (GC7890B 5977A MSD Agilent Technologies, USA) was used for the analysis. The sample was then injected at 250 $^{\theta}$ C in the injection port and splitters at a rate of 5:1 before reaching the Gas Chromatographic column which was conditioned in an oven set initially at 70 $^{\theta}$C hold for 1 min at a rate of 30 $^{\theta}$C/min-raised to 250 $^{\theta}$C hold at 0 min, then at a rate of 5 $^{\theta}$ C/min to 300$^{\theta}$ C and finally hold for 9 min. The sample was volatilized and separated into various components of ions of mass to charge ratio m/z, then transferred to the mass selective detector. The resulting mass spectrum of the component was identified and qualified standard reference Library in the data analysis software which gives the compound names with respect to its quality comparison in percentage.

Results

The results for the phytochemical, FITR, elemental, and proximate analysis of *F. andersonii* methanol root extract are presented in Tables 1, 2, 3, and 4 respectively.

The percentage extract yield of the *F. andersonii* root was calculated using the formula

$$\text{The percentage extract yield} = \frac{\text{Weight of } F.andersonii \text{ extract recovered in g}}{\text{Weight of Powdered } F.andersonii} \times 100$$

Weight of *F. andersonii* extract recovered= 86.0g

Weight of *F. andersonii* powder= 500 g

Percentage extract yield = 86.0 g× 100/500 g

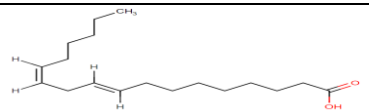
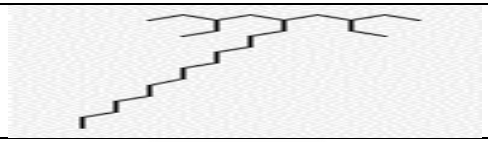
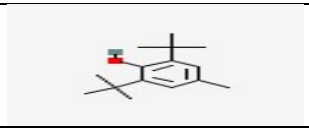
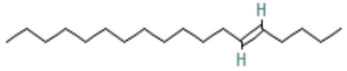
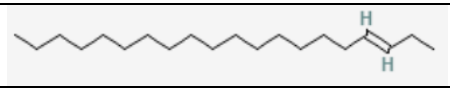
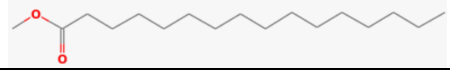
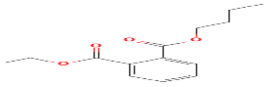
= 17.2 %

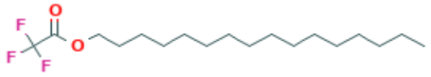
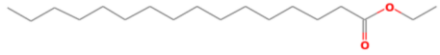
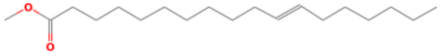
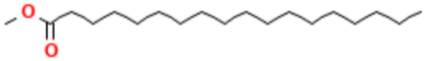
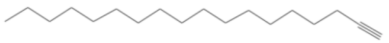
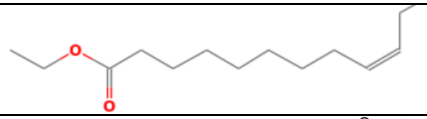
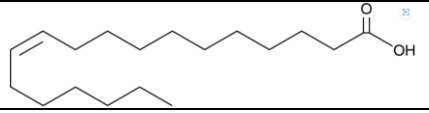
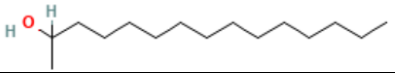
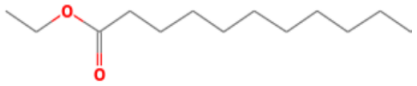
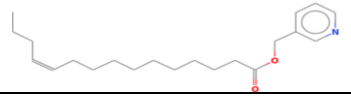
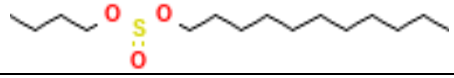
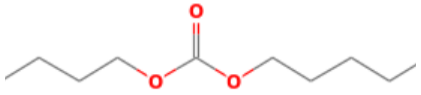
Discussion

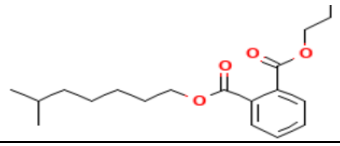
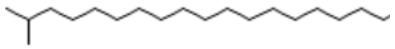
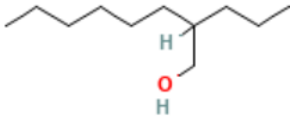
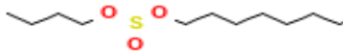
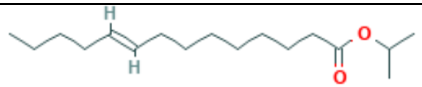
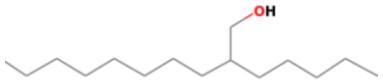
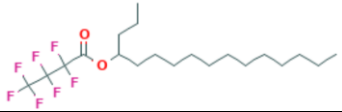
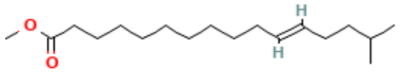
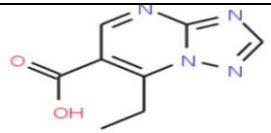
GC-MS has become widely recognized as a key analytical platform for profiling secondary metabolites such as phenolics, steroids, alkaloids, sugars, amino acids, and fatty acids in plant and non-plant sources (Rohloff, 2015). In this study, the phytochemical screening of *F. andersonii* methanol root extract using GC-MS identified 40 phyto-compounds with documented pharmacological activities. The phytochemicals 9,12-octadecadienoic acid (Z, Z), also known as Linoleic acid and 1,2-benzenedicarboxylic acid had been reported to have inhibitory effects against bacterial organisms such *Escherichia coli, Klebsiella pneumoniae, Proteus vulgaris, Staphylococcus aureus, Staphylococcus epidermidis, Bacillus subtilis* and fungi such *Candida albicans, Aspergillus niger and some Macrophomia species*. (Rajkumar and Jebanesan, 2004; Rahman and Anwar, 2006; Kapoor *et al.*, 2014). Phthalic acid, specifically Octadecane 3-ethyl-5-(2-ethylbutyl), has shown potential in managing obesity and diabetes. The compound demonstrated significant activity against α-glucosidase (IC 50 value of 10.28 ± 0.015 µg/mL) and moderate inhibitory activity against pancreatic lipase (IC 50 value of 24.43 ± 0.096 µg/mL) (Anyanwu *et al.*, 2019). Octacosane is an endogenous metabolite that exhibits antibacterial, anticancer and larvicidal activity. It has been reported to be effective against murine melanoma B16F10-Nex2 cells and *Culex quinquefasciatus* mosquitoes with an LC_{50} concentration of 7.2 mg (Rajkumar and Jebanesan, 2004; Figueiredo *et al.*, 2014). Butylhydroxytoluene which can be synthesized as a vitamin E analogue has antioxidant activity on the cryoprotective effect of human spermatozoa by preserving DNA integrity, reducing reactive oxygen species (ROS) production and viral effect in semen (Merino *et al.*, 2014). According to an experimental study by Aimola *et al.* (2016), cis-vaccenic acid shows potential as a treatment for sickle cell anaemia and beta-thalassemia. It was found to up-regulate γ-globin gene expression in JK-1 and transgenic mice bone marrow erythroid progenitor stem cells (TMbmEPSCs) and induced differentiation of K562, JK1, and transgenic mice primary bone marrow hematopoietic progenitor stem cells.

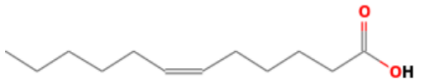
The FTIR analysis of *F. andersonii* methanol root extract in this study has revealed the presence of 5 functional groups with different wave number and transmittance. Hydroxyl groups are simple structures comprising an oxygen atom bonded to a hydrogen atom which participates in chemical reactions, forming chains of sugars or fatty acids (Klecker and Nair, 2017). According to Cramer *et al.* (2019), the ChEMBL database shows that 37% of marketed drugs contain hydroxyl groups, while 69% and 23 % are of natural and synthetic origin respectively. The hydroxy group has a dual effect (pharmacokinetic and pharmacodynamics) on the drug according to El-Haj *et al.* (2018). Firstly, it enhances the water solubility and facilitates the elimination of the metabolite, leading to the termination of the drug's action. Secondly, it interacts with the receptor site of a parent drug, which can either enhance, retain,

Table 1: GC- MS analysis of *F. andersonii* Robyn methanol root extract

S/No.	RT	Peak area (%)	Name of compound	Molecular formula	Molecular weight g/mol	Structure	CAS	Quality (%)
1.	5.1521	40.1204	9,12-Octadecadienoic acid (Z,Z)-	$C_{18}H_{32}O_2$	280.4		000060-33-3	95
2.	14.4416	0.485	Octadecane, 3-ethyl-5-(2-ethylbutyl)-	$C_{26}H_{54}$	366.7		055282-12-7	50
3.	14.5955	0.4716	Hexadecane	$C_{16}H_{34}$	226.44		000544-76-3	78
4.	15.0794	2.3946	Butylated Hydroxytoluene	$C_{15}H_{24}O$	220.35		000128-37-0	98
5.	16.8474	0.7024	5-Octadecene, (E)-	$C_{18}H_{36}$	252.5		007206-21-5	90
6.	17.0058	0.8979	Octacosane	$C_{28}H_{58}$	394.8		000630-02-4	80
7.	19.3306	0.3179	Heptacosane, 1-chloro-	$C_{27}H_{55}Cl$	415.179		062016-79-9	72
8.	21.4197	1.1273	3-Eicosene, (E)-	$C_{20}H_{40}$	280.5		074685-33-9	87
9.	21.5471	0.6955	Octadecane, 1-chloro-	$C_{18}H_{37}Cl$	288.9		003386-33-2	80
10	23.2346	0.5455	1-Methylcycloheptanol	$C_8H_{16}O$	128.21		003761-94-2	35
11	24.3144	5.5966	Hexadecanoic acid, methyl ester	$C_{17}H_{34}O_2$	270.45		000112-39-0	98
12	25.181	4.1927	1,2-Benzenedicarboxylic acid, butyl octyl ester	$C_{20}H_{30}O_4$	334.45		000084-78-6	90

13	25.6004	0.702	Trifluoroacetoxy hexadecane	• $C_{18}H_{33}F_3O_2$	338.40		006222-03-3	91
14	25.6882	3.6939	Hexadecanoic acid, ethyl ester	$C_{18}H_{36}O_2$	284.48		000628-97-7	92
15	27.5437	0.7738	Propyl tetrazolyl ether	$C_{27}H_{56}O$	396.70		1000406-28-3	72
16	27.6522	6.3415	9,12-Octadecadienoic acid, methyl ester	$C_{19}H_{34}O_2$	294.47		002462-85-3	99
17	27.7719	13.35	11-Octadecenoic acid, methyl ester	$C_{19}H_{36}O$	296.4879		052380-33-3	99
18	28.2681	3.0745	Methyl stearate	$C_{19}H_{38}O_2$	298.5		000112-61-8	97
19	28.9072	0.5731	1-Octadecyne	$C_{18}H_{34}$	250.4626		000629-89-0	47
20	29.0092	4.4807	(E)-9-Octadecenoic acid ethyl ester	$C_{20}H_{40}O_2$	312.5		006114-18-7	99
21	29.1421	1.1763	cis-Vaccenic acid	$C_{18}H_{34}O_2$	282.5		000506-17-2	70
22	29.4436	0.4246	2-Pentadecanol	$C_{15}H_{32}O$	228.41		001653-34-5	72
23	29.5083	1.7865	Octadecanoic acid, ethyl ester	$C_{20}H_{40}O_2$	312.5304		000111-61-5	76
24	30.7516	0.1811	cis-Vaccenic acid	• $C_{24}H_{39}NO_2$	373.572		000506-17-2	70
25	33.0155	0.3314	Sulfurous acid, butyl hexadecyl ester	$C_{21}H_{44}O_3S$	376.6		1000309-18-4	72
26	34.6568	0.4495	Carbonic acid, decyl tetradecyl ester	$C_{25}H_{50}O_3$	398.662		1000383-16-3	68

27	35.5929	1.9741	Diisooctyl phthalate	$(C_8H_{17}COO)_2C_6H_4$	390.6		000131-20-4	91
28	36.2503	0.6707	2-Methyltetracosane	$C_{25}H_{52}$	352.7		001560-78-7	64
29	37.5486	0.3584	1-Decanol, 2-hexyl-	$C_{16}H_{34}O$	242.44		002425-77-6	11
30	37.7378	0.7525	Sulfurous acid, butyl octadecyl ester	$C_{22}H_{46}O_3S$	390.7		1000309-18-5	64
31	38.0585	0.1389	Tetrapentacontane, 1,54-dibromo-	$C_{54}H_{108}Br_2$	917.2		1000156-09-4	50
32	38.0964	0.0779	1-Hentetracontanol	$C_{41}H_{84}O$	593.10		040710-42-7	49
33	38.1431	0.0693	i-Propyl 9-tetradecenoate	$C_{17}H_{32}O_2$	268.40		1000336-60-7	46
34	38.1926	0.0562	Octadecane, 1-(ethenyloxy)-	$C_{20}H_{40}O$	296.53		000930-02-9	43
35	38.2255	0.0326	1-Decanol, 2-hexyl-	$C_{16}H_{34}O$	242.44		002425-77-6	42
36	38.2987	0.3881	4-Heptafluorobutyryloxyhexadecane	$C_{20}H_{33}F_7O_2$	438.5		1000282-97-2	49
37	38.367	0.0691	11-Hexadecenoic acid, 15-methyl-, methyl ester	$C_{18}H_{34}O_2$	282.5		055044-54-7	41
38	38.4339	0.0966	[1,2,4]Triazolo[1,5-a]pyrimidine-6-carboxylic acid, 7-amino-, ethyl ester	$C_8H_8N_4O_2$	192.17		1000316-75-8	30

39	38.4625	0.075	6-Octadecenoic acid, (Z)-	$C_{18}H_{34}O_2$	282.46		000593-39-5	47
40	38.6051	0.3543	Hexadecane, 1-(ethenyloxy)-	$C_{18}H_{36}O$	268.485		000822-28-6	43

Key: RT- Retention time, CAS- Chemical Abstracts Service Registry Number

Table 2: Wave numbers and transmittance obtained from the FTIR spectrum of *F. andersonii* methanol root extract matched with the corresponding groups, class of compounds, and likely source of the functional groups

S/N	Wavenumber (cm^{-1})	Transmittance	*Group*	Compound *Class*	Likely Source
1.	3186.9	49.241	O – H	Hydroxyl	Alcohol and Phenol
2.	2928.7	59.994	C- H	Alkyl	Natural gas, fats, oils, wax and petroleum
3.	1595.3	47.063	C = C	Alkene	Terpenes, Ethylene, Dehydrogenation of alkyl halides
4.	1509.6	59.129	C = C	Alkene	
5.	1405.2	50.834	C = C	Alkene	
6.	1263.6	53.311	C-O-H	Carboxylic	Vinegar, Valerian plant, Palm oil, Coconut, Milk fat
7.	1021.3	24.917	C= O	Carbonyl	Acetic acid, Methyl n-propyl ketone, formic acid, mesityl oxide
8.	931.8	45.540	C- H	Alkyl	Vinyl, trans-aromatic

Table 3: Elemental analysis of *F. andersonii* root extracts

Element	Concentration (ppm)	
	F. andersonii	Standard
Iron	4.336	0.5- 50
Potassium	38.00	0.10- 1.00
Manganese	12.151	10- 20
Zinc	17.388	15- 20
Calcium	3.860	360- 800
Sodium	18.00	4.00- 5.00
Copper	0.020	1.00- 3.00

Standard - Auwal *et al.* (2014)

Table 4: Proximate Composition (percentage) of *F. andersonii* Robyn root

Test Parameter	Composition (%)
Moisture	5.65
Ash	4.33
Lipid	6.19
Crude Protein	3.50
Crude Fibre	35.23
Carbohydrate	45.10

attenuate, or reduce the activity of the metabolite in comparison to the parent drug. Some hydroxyl-containing drugs include Esmolol, Tramadol, Betaxolol, Isoetharine, Metoprolol, and Atenolo (DrugBank, 2023). Alkyl groups are alkanes with one hydrogen atom missing (Chalk, 1997). In medicinal chemistry, alkyl chains are added to increase lipophilicity and enhance the antimicrobial activity of flavanones and chalcones (Mallavadhani *et al.*, 2014). Alkenes are a family of organic molecules commonly found in medicinal agents that contain a carbon-carbon double bond, which makes them more reactive than alkanes. Examples of drugs containing alkenes include 17-α-acetylenic estrogen, which acts as an estrogen receptor antagonist, cyclophosphamide, used as an antineoplastic, and spironolactone, indicated as antihypertensive (Zhong, 2017; Patibandla *et al.*, 2023). A carboxyl group is a functional group in organic chemistry, consisting of a carbon atom double-bonded to an oxygen atom and single-bonded to a hydroxyl group. The carboxylic acid general formula is R−COOH or R−CO2H, where R represents an alkyl, alkenyl, aryl, or other group. Compounds containing the carboxyl group are polar due to the electronegativity of the oxygen atom, have high melting and boiling points due to the formation of hydrogen bonds in the solid and liquid states, and are also weak acids (BYJUS, 2023). Examples of drugs containing the carboxylic group are non-steroidal anti-inflammatory drugs (NSAIDs) such as aspirin ibuprofen, naproxen, indomethacin, diclofenac, and celecoxib (Lou and Zhu, 2016). A carbonyl group is an organic functional group with a carbon atom double-bonded to an oxygen atom. It includes aldehydes and ketones, which are found in many aromatic compounds and contribute to taste and smell. Carbonyl compounds are polar and have higher boiling points than most hydrocarbons, while higher-order carbonyl compounds are generally insoluble, and weaker ones are easily soluble (Testbook, 2023). Mehta *et al.* (2009) report that carbonyl-scavenging drugs containing thiol or amine functional groups can prevent protein carbonylation by trapping dicarbonyls glyoxal and methylglyoxal to form non-toxic adducts.

Minerals are vital micronutrients of inorganic origin, playing a significant role in cellular processes (Arigony *et al.*, 2013). The concentrations of copper and calcium are below the permissible limit, while those of sodium and potassium exceed it as observed in this study. Iron (Fe), manganese (Mn) and Zinc (Zn) are the only trace elements found within the permissible limit. The findings in our study differ from the report of Imam *et al.* (2022) on *Fadogia andersonii* leaf and Muhammad *et al.* (2019) on *Fadogia agrestis* root. The variation in the mineral concentration may be associated with differences in the parts of the plant under study, species, location, time of the harvest, and method of analysis. Iron is essential for the synthesis and operation of several enzymes, hormones, and cells, particularly in the brain and muscles (Abbaspour *et al.*, 2014). It is also a key component of haemoglobin, a protein found in red blood cells that transports oxygen from the lungs to every part of the body (Ha & Bhagavan, 2023). Manganese is essential for synthesizing enzymes, metabolism of glucose and lipids, and scavenging reactive oxygen species via MnSOD during oxidative stress in mitochondria (Li and Yang, 2018). Scaccaglia *et al.* (2024) describe the synthesis of manganese-based complexes using combinatorial chemistry. These complexes exhibit high and broad-spectrum activity against Gram-positive bacteria, are low in toxicity against human cells, and have a therapeutic index of >100. Zinc is an essential trace element necessary for the growth and development of microorganisms, plants, and animals (Chasapis *et al.*, 2011). Studies have reported valuable effects of zinc supplementation in childhood acute diarrhoea, chronic hepatitis, and common colds (Abd El-Ghaffar *et al*., 2022). Potassium and sodium are cations that control the electric potential of the body's nerves (Adeyeye and Aye, 2005). Potassium is one of the seven macrominerals that are required (Farag *et al.*, 2023). It protects the proper functioning of the kidneys, heart, muscles, neurological system, and body's ability to maintain appropriate fluid balance along with sodium (Sica *et al.*, 2002; Alli, 2009; Roumelioti *et al.*, 2018; Wieërs *et al.*, 2022).

The proximate composition of *F. andersonii* root was elucidated in this present study. It was noted that various percentages of moisture content, ash, fat, crude protein, fibre, and carbohydrates were present. The moisture content of a sample is the mass percentage of the sample that evaporates overnight at 115 °C using suitable drying equipment (Thangaraj, 2016). The moisture content, which was found to be 5.65%, falls within the optimal range which inhibits both fungal and bacterial growth (Sumbul *et al.*, 2012). Ash is the measure of the quantity of minerals present in plant products. Although some of these plant products may be nutritionally beneficial, the study found that they also indicate how well the products are digested and how physically stable they are, with a determination of 4.33%. Although less than *Datura innoxia* root 25.71 % (Ayuba *et al.*, 2011)

but higher than *Fadogia cienkowskii* leaves 1.4 % (Bruce and Onyegbule, 2019). The lipid content of *F. andersonii* was determined to be 6.9 %. Lipids, which are either fatty acids or derivatives, are used in cosmetics to lubricate and moisturize the skin and also have anti-inflammatory properties (Erhan, 2005; Mumtaz *et al.*, 2020). *F. andersonii* root is determined to be a good source of crude fibre (35. 25 %). The value obtained was higher when compared to *Amaranthus hybridus* (8.61%) and *Vernonia calvaona* (7.63%) (Akubugwo *et al.*, 2007; Ayoola and Adeyeye, 2010). Dietary fibre consists of cellulose, non-cellulosic polysaccharides, and lignin, which are components of plant material in the diet that resist enzymatic digestion. Dietary fibre has numerous benefits, including speeding up the passage of food through the digestive system, reducing the risk of heart disease, maintaining balanced intestinal pH, and stimulating intestinal fermentation production of short-chain fatty acids to lower the risk of colo-rectal cancers (Kochhar *et al.*, 2006). It also helps maintain lower variance in blood sugar levels (Dhingra *et al.*, 2012). The *F. andersonii* plant's root contains a significant amount of carbohydrates (45.10%), which is higher than the carbohydrate content found in the leaves of *Parquetin nigrescen* (36.03%) *and Magnifera indica* (40.23%), but lower than the leaves of *Oscium gratissimum* (50.06%) and *Morinda lucida* (51.66%) (Aborisade *et al.*, 2017). Carbohydrates are the primary source of energy for the human body and also play a crucial role in the structure and function of organs and nerve cells (Asif *et al.*, 2011). Carbohydrate-based therapeutics are used for cardiovascular and haematological treatments, including inflammatory diseases, anti-thrombotic treatments, and wound healing (Kilcoyne and Joshi, 2007).

In conclusion, phytochemical, elemental, and proximate analyses are important for understanding the medicinal and nutritional compositions, as well as the factors that influence the stability and genuineness of different plant parts. This study showed that the methanol root extract of *F. andersonii* contains 40 phytochemicals, each with proven pharmacological activities and five functional groups. The elemental analysis indicates that most elements are either above or below the permissible limit, with Fe, Mn, and Zn falling within it. Based on the proximate analysis, the root of *F. anderonii* has a low moisture, ash, lipid, and protein content, but high crude fibre and carbohydrate content. This part of the plant is proven safe for consumption, contains essential nutrients, and has potential health benefits.

Funding
No funding was received.

Conflict of Interest
The authors declare that there is no conflict of interest.

References

Abbaspour N, Hurrell R & Kelishadi R (2014). Review on iron and its importance for human health. *Journal of Research in Medical Science,* **19**(2): 164-174.

Abd El-Ghaffar YS, Shouman AE, Hakim SA, El- Gendy YGA & Wahdan MMM (2022). Effect of zinc supplementation in children less than 5 years on diarrhea attacks: A randomized controlled trial. *Global Pediatric Health*, doi.10.1177/2333794x221099266.

Aborisade A, Adetutu A & Owoade O (2017). Phytochemical and proximate analysis of some medicinal leaves. *Clinical Medicine Research*, doi.10.11648/j.cmr.20170606.16.

Adeyeye EI & Aye PA (2005). Chemical composition and the effect of salts on the food properties of *Triticum durum* whole meal flour. *Pakistan Journal of Nutrition,* doi.10.3923/pjn.2005.187.196

Aimola IA, Inuwa HM, Nok AJ, Mamman AI & Bieker JJ (2016). Cis-vaccenic acid induces differentiation and up-regulates gamma globin synthesis in K562, JK1 and transgenic mice erythroid progenitor stem cells. *European Journal of Pharmacology,* doi.10.1016/j.ejphar.2016.02.041.

Akubugwo IE, Obasi NA, Chinyere G & Ugbogu AE (2007). Nutritional and chemical value of *Amaranthus hybridus* L. leaves from Afikpo, Nigeria. *African Journal of Biotechnology,* doi.10.5897/AJB2007.000-2452.

Alli SYR (2009). Determination of chemical composition of *Senna siamea* (Cassia Leaves). *Pakistan Journal of Nutrition,* doi.10.3923/pjn.2005.187.196

Anand A (2020). Calculations involved in solvent extraction. https://www.researchgate.net/publication/340264398_Calculations_involved_in_solvent_extraction, retrieved 03-03-2024.

Anyanwu G, Onyeneke E, Okoli B, Johannes M, Rehman S, Zaib S & Rauf K (2019). Pharmacological activities of a novel phthalic acid ester and iridoid glycoside isolated from

the root bark of *Anthocleista vogelii* Planch. *Tropical biomedicine,* **36**(1): 35-43.

Arigony AL, de Oliveira IM, Machado M, Bordin DL, Bergter L, Prá D & Henriques JA (2013). The influence of micronutrients in cell culture: a reflection on viability and genomic stability. *Biomedical Research International,* doi.10.1155/2013/597282.

Asif M, Akram M, Saeed T, Khan I, Naveed A, Ur Rehman M, Ali SDS, Ahmad K & Shaheen D (2011). Review Paper Carbohydrates 1. *International Research Journal of Biochemistry and Bioinformatics,* **1**(1): 001-005.

Auwal MS, Saka S, Mairiga IA, Sanda KA, Shuaibu A & Ibrahim A (2014). Preliminary phytochemical and elemental analysis of aqueous and fractionated pod extracts of *Acacia nilotica* (*Thorn mimosa*). *Veterinary Research Forum,* **5**(2): 95–100.

Ayoola BP & Adeyeye A (2010). Phytochemical and nutrient evaluation of *Carica papaya* leaves. *International Journal of Research Review and Applied Science*, **5**(3): 325–328.

Ayuba VO, Ojobe TO & Ayuba SA (2011). Phytochemical and proximate composition of *Datura inn*oxia leaf, seed, stem, pod and root. *Journal of Medicinal Plants Research,* 5(14): 2952-2955.

Bruce S & Onyegbule F (2019). Pharmacognostic, physicochemical and phytochemical evaluation of the leaves of *Fadogia cienkowski* Schweinf (Rubiaceae). *Journal of Pharmacognosy and Phytotherapy.* doi.10.5897/JPP2019.0552.

BYJUS (2023). Carboxylic Group; Formula, Structure, Properties and Source/Chemistry. https://byjus.com/chemistry/carboxyl-group/, retrieved 03-11-2023.

Chalk SJ. (1997). *The Gold Book.* Second edition, Blackwell Scientific Publications, Oxford. Pp 206- 211

Chasapis C, Loutsidou A, Spiliopoulou C & Stefanidou M (2011). Zinc and human health: An update. *Archives of Toxicology*. doi.10.1007/s00204-011-0775-1.

Cramer J, Sager C & Ernst B (2019). Hydroxyl Groups in Synthetic and Natural Product Derived Therapeutics – A Perspective on a Common Functional Group. *Journal of Medicinal Chemistry,* doi.10.1021/acs.jmedchem.9b00179.

Dhingra D, Michael M, Rajput H & Patil RT (2012). Dietary fibre in foods: A review. *Journal of Food Science & Technology,* doi.10.1007/s13197-011-0365-5.

DrugBank (2023). Alcohols. https://go.drugbank.com/categories/DBCAT000272, retrieved 01- 11-2023.

El-Haj BM, Ahmed SBM, Garawi MA & Ali HS (2018). Linking aromatic hydroxy metabolic functionalization of drug molecules to structure and pharmacologic activity. *Molecules,* **23**(9): 2119.

Erhan SZ (2005). *Industrial Uses of Vegetable Oil*: AOCS publishing. New York. doi.10.4324/9781003040248.

Fahelelbom KM, Saleh A, Al-Tabakha MMA & Ashames AA (2022). Recent applications of quantitative analytical FTIR spectroscopy in pharmaceutical, biomedical, and clinical fields: A brief review. *Reviews in Analytical Chemistry,* doi.10.1515/revac-2022-0030.

Farag MA, Abib B, Qin Z, Ze X & Ali SE (2023). Dietary macrominerals: Updated review of their role and orchestration in human nutrition throughout the life cycle with sex differences. *Current Research in Food Science,* doi.10.1016/j.crfs.2023.100450.

Figueiredo CR, Matsuo AL, Pereira FV, Rabaça AN, Farias CF, Girola N, Massaoka MH, Azevedo RA, Scutti JA, Arruda DC, Silva LP, Rodrigues EG, Lago JH, Travassos LR & Silva RM (2014). *Pyrostegia venusta* heptane extract containing saturated aliphatic hydrocarbons induces apoptosis on B16F10-Nex2 melanoma cells and displays antitumor activity *in vivo*. *Pharmacognosy Magazine,* doi.10.4103/0973-1296.133284.

Fitzgerald M, Heinrich M & Booker A (2020). Medicinal plant analysis: A historical and regional discussion of emergent complex techniques. *Frontier Pharmacology,* doi.10.3389/fphar.2019.01480.

Galanakis CM (2021). Functionality of food components and emerging technologies. *Foods,* doi.10.3390/foods10010128.

Gotep JG, Sabo SY, Makama S, Uguru MO & Okwuasaba FK. (2021). Aphrodisiac activity of ethanol extract and fractions of *Fadogia cienkowskii* Shweinf. *Rubiaceae* roots in albino rats. *Journal of Medicinal Plant Research*. doi.10.5897/JMPR2020.7070

Ha CE & Bhagavan NV (2023). *Essentials of Medical Biochemistry (Third edition)*, Academic Press, San Diego. Pp 573-611.

Hosseinzadeh S, Jafarikukhdan A, Hosseini A & Armand R (2015). The application of medicinal plants in traditional and modern medicine: a review of *Thymus vulgaris*. *International Journal of Clinical Medicine,* **6**(09): 635-642.

Imam KI, Ahmed A & Ambi AA (2022). Pharmacognostic and physicochemical analysis of the leaves of *Fadogia andersonii* Robyns (*Rubiaceae*). *Journal of Pharmacy and Bioresources,* **19**(2): 66- 75.

Jaradat N & Zaid AN (2019). Herbal remedies used for the treatment of infertility in males and females by traditional healers in the rural areas of the West Bank/Palestine. *Journal of Alternative and Complementary Medicine,* doi.10.1186/s12906-019-2617-2.

Kapoor A, Mishra D & Narasimhan B (2014). Antibacterial and antifungal evaluation of synthesized 9,12-octadecadienoic acid derivatives. *Der Pharmacia Lettre,* **6**(5): 246-251.

Karimi A, Majlesi M & Rafieian-kopaei M (2015). Herbal versus synthetic drugs; beliefs and facts. *Journal of Nephropharmacology,* **4**(1): 27-30.

Kilcoyne M & Joshi L (2007). Carbohydrates in therapeutics. *Cardiovascular and Hematological Agents in Medicinal Chemistry,* doi.10.2174/187152507781058663.

Klecker C & Nair LS (2017). *Biology and Engineering of Stem Cell Niches*, Academic Press, Boston. Pp 195-213.

Kochhar A, Nagi M & Sachdeva R (2006). Proximate composition, available carbohydrates, dietary fibre and anti nutritional factors of selected traditional medicinal plants. *Journal of Human Ecology,* **19**(3): 195-199.

Li L & Yang X (2018). The essential element manganese, oxidative stress, and metabolic diseases: Links and interactions. *Oxidative Medicine and Cellular Longevity,* doi.10.1155/2018/7580707.

Lou Y & Zhu J (2016). *Bioactive Carboxylic Compound Classes,* doi.10.1002/9783527693931.

Mallavadhani UV, Sahoo L, Kumar KP & and Murty US (2014). Synthesis and antimicrobial screening of some novel chalcones and flavanones substituted with higher alkyl chains. *Medical Chemistry Research,* doi.10.1007/s00044-013-0876-x.

Mehta R, Wong L & O'Brien PJ (2009). Cytoprotective mechanisms of carbonyl scavenging drugs in isolated rat hepatocytes. *Chemico-Biological Interactions,* doi.org/10.1016/j.cbi.2008.10.026.

Merino O, Aguagüiña GW, Esponda P, Risopatron J, Isachenko E, Isachenko V & Sanchez R (2014). Protective effect of butylated hydroxytoluene on sperm function in human spermatozoa cryopreserved by vitrification technique. *Andrologia,* doi. 10.1111/and.12246.

Muhammad MN, Sunusi U, Muttaka A, Sanusi H & Mukhtar YU (2020). Pharmacognostic, Elemental and Acute Toxicity Study of *Fadogia agrestis* root. *Bayero Journal of Pure and Applied Sciences,* **12**(2): 1-11.

Mumtaz F, Zubair M, Khan F & Niaz K (2020). *Recent Advances in Natural Products Analysis* Elsevier Inc. doi.10.1016/B978-0-12-816455-6.00022-6.

Olivia NU, Goodness UC & Obinna OM (2021). Phytochemical profiling and GC-MS analysis of aqueous methanol fraction of *Hibiscus asper* leaves. *Future Journal of Pharmaceutical Science,* doi.10.1186/s43094-021-00208-4.

Patibandla S, Heaton J & Kyaw H (2023). Spironolactone. https://www.ncbi.nlm.nih.gov/books/NBK554421/, Retrieved 16-07-2023.

Rahman M & Anwar MN (2006). Fungitoxic and cytotoxic activity of a novel compound 1,2-benzenedicarboxylic acid, diisooctyl ester of *Plumbago zeylanica* linn. *Asian Journal of Microbiology, Biotechnology and Environmental Science,* **8**(3): 461-464.

Rajkumar S & Jebanesan A (2004). Mosquitocidal activities of octacosane from *Moschosma polystachyum* Linn (lamiaceae). *Journal of Ethnopharmacology,* doi.10.1016/j.jep.2003.09.030.

Ray S (2021). *Techniques to Measure Food Safety and Quality: Microbial, Chemical, and Sensory*,Cham, Springer International Publishing, Switzerland. Pp 345-381.

Reddy S, Subedi B & Guite N (2023). *Ethnomedicine and Tribal Healing Practices in India: Challenges and Possibilities of Recognition and Integration*,Singapore, Springer Nature, Singapore. Pp 1-31.

Rohloff J (2015). Analysis of phenolic and cyclic compounds in plants using derivatization techniques in combination with GC-MS-based metabolite profiling. *Molecules,* doi.10.3390/molecules20023431.

Roumelioti ME, Glew RH, Khitan ZJ, Rondon-Berrios H, Argyropoulos CP, Malhotra D, Raj DS, Agaba EI, Rohrscheib M, Murata GH, Shapiro JI & Tzamaloukas AH (2018). Fluid balance concepts in medicine: Principles and practice. *World Journal of Nephrology,* doi.10.5527/wjn.v7.i1.1.

Scaccaglia M, Birbaumer MP, Pinelli S, Pelosi G & Frei A (2024). Discovery of antibacterial manganese(i) tricarbonyl complexes through combinatorial chemistry. *Chemical Science,* doi.10.1039/D3SC05326A.

Sica DA, Struthers AD, Cushman WC, Wood M, Banas JS & Epstein M (2002). Importance of potassium in cardiovascular disease. *Journal of Clinical Hypertension (Greenwich),* **4**(3): 198-206.

Sofowora A, Ogunbodede E & Onayade A (2013). The role and place of medicinal plants in the strategies for disease prevention. *African Journal of Traditional and Complementary Alternative Medicine,* **10**(5): 210-229.

Suleimana I, Mabroukb MA & Alhassana AW (2014). Effect of aqueous root extract of *Fadogia andersonii* on sperm count and motility in adult male Wistar rats. *Annals of Biological Science,* **2**(4): 33-36.

Sumbul S, Ahmad MA, Asif M, Akhtar M & Saud I (2012). Physicochemical and phytochemical standardization of berries of *Myrtus communis* Linn. *Journal of Pharmacy and Bioallied Sciences,* doi.10.4103/0975-7406.103266.

Testbook (2023). Carbonyl Compounds - Learn their types, properties, reactions, and importance. https://testbook.com/chemistry/carbonyl-compounds#:~:text=Properties%20of%20Carbonyl%20Compounds%201%20Most%20of%20the,have%20a%20higher%20boiling%20point%20than%20most%20hydrocarbons, retrieved 02-11-2023.

Thangaraj P (2016). *Pharmacological Assays of Plant-Based Natural Products*, Cham, Springer International Publishing. doi.10.1007/978-3-319-26811-8.

Wieërs MLAJ, Mulder J, Rotmans JI & Hoorn EJ (2022). Potassium and the kidney: a reciprocal relationship with clinical relevance. *Pediatric Nephrology,* doi.10.1007/s00467-022-05494-5.

Yakubu MT, Akanji MA & Oladiji AT (2005). Aphrodisiac potentials of the aqueous extract of *Fadogia agrestis* (Schweinf. Ex Hiern) stem in male albino rats. *Asian Journal of Andrology,* doi.10.1111/j.1745-7262.2005.00052.x

Youn HJ, Lakritz J, Kim DY, Rothingars GE & Marsh AE (2003). Antiprotozoan efficacy of medicinal herb extracts against *Toxoplasma gondii* and *Neospora caninum. Veterinary Parasitology,* **11**(6): 7- 14.

Zhong HA (2017). *Drug Design: Principles and Applications*, Springer, Singapore. Pp 113-133.