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Proximate, Mineral Composition and Phyto-Constituents of Some Medicinal Plants/Herbs in India

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Abstract

This study was conducted to assess the proximate, mineral content, and phyto-constituents of several therapeutic plants and herbs found in India. The medicinal properties of herbs are attributable to the existence of several complex chemical substances known as secondary metabolites, which are exclusively accumulated in diverse sections of the plant such as leaves, stems, roots, and flowers. These secondary metabolites or phytochemicals contain saponins, alkaloids, flavonoids, triterpenoids, diterpenoids, tannins, and steroids, which are considered a valuable source of nutrition and also possess pharmacological properties such as antimicrobial, anfungal, antiviral, antihelminthic, antioxidant, hepato-protective, antibacterial, immunostimulatory, hypolipidemic, anti-rheumatic, antidiarrheal, anti-pyretic, antimalarial, anticancer, and anti-allergic properties, among others. Medicinal plant extracts have traditionally been used to treat diseases and inhibit the activities of pathogenic organisms such as Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa, Enterococcus faecalis, Staphylococcus aureus, Bacillus subtilis, Penicillium notatum, and Candida albicans. It was determined that all medicinal plants investigated had varied chemical compositions, which might be ascribed to the plant's age, specie, extraction procedure or processing, storage, geographical location, and other factors. This study will also provide information on emerging phyto-constituents, which can help to lower the growing incidence of antimicrobial resistance and bridge the gap between animal production and food safety.

Key words: medicinal plants; phytochemicals; toxicity; treatment; antimicrobial; resistance

Introduction

Medicinal or herbal plants have nutritional, pharmacological, or therapeutic characteristics because they contain phytochemicals (Singh et al., 2002). They've been used to treat a variety of ailments for thousands of years. The use of terrestrial plants as medicines has been reported in Egypt, China, India and Greece from ancient times, and an astounding number of modern pharmaceuticals have been produced from them (Singh et al., 2002). Plants' natural ingredients or phytochemicals can be obtained from their stem barks, leaves, flowers, roots, fruits, and seeds (Wojcikowski et al., 2004; Singh et al., 2021).In 1999, the World Health Organization (WHO) reported that 80% of the world's population used medicinal plants to heal ailments. In recent years, medicinal plants have become a primary health supply for the pharmaceutical business (Phillipson, 1991).

Medicinal plants are currently gaining acceptance among literates in urban settlements, most likely due to the increasing inefficacy of many modern drugs used to control many infections, as well as the increase in resistance by several bacteria to various antibiotics and the rising cost of prescription drugs for personal health maintenance (Smolinski et al., 2003; Tzortzakis and Economakis, 2007). Current issues with antibiotic use, as well as the rising incidence of multiple-drug resistance strains of a variety of harmful bacteria, have reignited interest in plants having antimicrobial capabilities (Voravuthikunchai and Kitpipit, 2003).Antimicrobial resistance endangers the population by making infections difficult to cure and raising morbidity and mortality rates. It also raises the expense of disease treatment and management (Zhang et al., 2013; Winkel, 2015).

Secondary metabolites are the active ingredients in many plant-derived medications. Plant extracts' antibacterial properties may be attributed to a range of components, including aldehydes and phenolic chemicals (Yadav et al., 2010; Valgas et al., 2007). According to the World Health Organization (2001), there are over 100,000 medicinal plant species worldwide, many of which have yet to be identified. They perform multiple biological activities such as: antimicrobial (Daniel and Alagbe, 2023; Musa et al., 2021), antioxidant, anti-inflammatory (Demain and Fang, 2000), anti-helminthic, anticancer, antimalarial, anti-rheumatic (Daglia, 2012; WHO, 2000), anti-diuretic, anticonvulsant, antidiarrheal, antiviral (Ayanwuyi et al., 2010), hepato-protective, immuno-stimulatory, anti-fungal, dermato-protective, hypolipidemic

Infusions of any or extracts from plant parts have also been used traditionally for the treatment of various diseases and infections such as cough, chest, pain, waist pain, irregular menstruation, internal pile, malarial, quick ejaculation, headache, hypertension, dysentery, premature aging, memory improvement, blood cleansing, chronic venous, insufficiency, mental function, minor burns, scars, scieroderma, skin ulcers, varicose veins, wound healing, rheumatism, blood disease, congestive heart failure, urinary tract infections, venereal disease, hepatitis and high blood pressure phlebitis, leg cramps, gastro intestinal diseases, amongst others (Trentin et al., 2011; Singh et al., 2008). They have also been shown to suppress the activity of Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa, Enterococcus faecalis, Staphylococcus aureus, Bacillus subtilis, Penicillium notatum, and Candida albicans, among others (Trentin et al., 2011; Yasunaka et al., 2005). However, factors such as species, age of medicinal plants, and geographical location may impact plant nutritional and phytochemical composition (Alagbe et al., 2021). Given the pharmacological or therapeutic activity associated with various phytochemicals in medicinal plants, it is necessary to identify their chemical components or phyto-constituents, as this could lead to the discovery of novel drugs while also providing information on their harmful effects.

Materials and methods

Experimental Location

The experiment was carried out at Sumitra Research Laboratory Gujarat, India located between 23º 13' N and 72º 41' E. All laboratory kit/machines were operated according to their manufacturer's recommendation.

The collection, identification, and verification of medicinal plants

Fresh leaves from 16 medicinal plants were picked from various strands of trees at the Sumitra Research Institute research farm in Gujarat, India. Collected samples were delivered to the institute's Crop Protection Department for proper identification and authentication, with each sample allocated a voucher specimen number. Following that, they were air dried separately for 14 days, ground into powder with an electric blender, and placed in a marked polythene bag for easy identification. The samples were transported to the Sumitra Biological Laboratory for additional analysis.

Reagents (analytical grade) used for analysis

Sodium hydroxide, copper sulphate, sulphuric acid, Folin-Ciocalteu reagent, aluminium chloride, sodium carbonate solution, sodium nitrate, isobutyl alcohol, ferric chloride solution, trioxonitrate (v) acid, boric acid, potassium ferricyanide solution, zinc acetate solution, petroleum ether, potassium hydroxide, sodium sulphate, aqueous ammonia solution, chloroform, folin-Denis reagent, hydrochloric acid,

Liebermann Buchard reagent, sodium nitroprusside, sodium bicarbonate, bromocresol and pyridine.

Machines/kit used for analysis

Mineral analysis of medicinal plants

Samples of medicinal plants were analyzed using Skyray instrument (Model: AAS 9000, USA) integrated with atomic absorption spectrometer combining both flame and atomic graphite. To achieve accurate result, 100 g of each sample was passed through the sample thin chamber. Prior to the analysis, 7 lamps in the kit were preheated simultaneously before it was set at a wavelength coverage, repeatability and accuracy of 900nm, ± 0.25nm and <0.10nm respectively and a heating rate of 3000°C/s, static stability of 0.003 Abs according to the manufacturers recommendation before generating results via the visual display unit in less than 120 seconds.

Gas chromatography and mass spectrophotometer (GC/MS)

Analysis of phyto-constituents in medicinal plants was carried out using Ultrospec® 7500, United Kingdom. Samples was injected through the sample chamber which contains two silicon photodiodes and Xenon flash lamp before it was adjusted at a spectral band width (<2nm), wavelength range (190 – 1100 nm), photometric accuracy and reproducibility of 0.5 % and photometric range of -3.000 – 3.000 A.

Proximate analysis of medicinal plants

Proximate analysis of medicinal plant was carried out using Phoenix 5000 near infra-red (NIR) analyzer. Kit was calibrated using specific reagents according to the manufacturers recommendation. 100 g of each sample was placed in a sample cap and the machine was set at a wavelength range, reproducibility and accuracy of 1100 – 2500 nm, <0.002nm and 0.3 nm, photometric noise (< 15 µAu) before results were generated on the monitor in less than 60 seconds.

Quantification of phyto-constituents in medicinal plants by GC/MS

Total flavonoid content estimation

Total flavonoid content was measured by aluminium chloride colorimetric assay outlined by Tolari *et al*. (2012). 100 grams of each samples were added to 10 ml volumetric flask containing 4 ml of distilled water. To the above mixture, 0.3 ml of 5 percentage sodium nitrate was added followed by aluminium chloride after 30 minutes. Mixture was set in an Ultrospec® 7500 and measured at an optical density of 450 nm.

Quantification of total phenols

The total phenols in the sample was carried out according to methods described by of Makkar *et al.* (1997). 100 grams of each samples were transferred into a test tube followed by the addition of 1 ml of Folin-Ciocalteu reagent and 1 ml of sodium carbonate solution after 30-minute interval before the mixture was set in an Ultrospec® 7500 and measured at an optical density of 550 nm.

Saponin estimation

100 g of the grinded dried sample was weighed into a beaker followed by the addition of isobutyl alcohol after 2 minutes. The mixture was shaken and kept in a dark. Thereafter, the mixture was filtered through a filter paper into a beaker containing magnesium carbonate. The solution was mixed well and the absorbance was measured against the prepared reagent blank at 380 nm in an Ultrospec® 7500.

Total alkaloid analysis

100 g of grinded sample was weighed into a beaker containing absolute alcohol. Thereafter, the mixture was transferred to a 100 ml flask followed by the addition of 0.5 g magnesium oxide. The mixture was digested in a boiling water bath for an hour and was filtered while hot through a Buchner funnel. After 30 minutes, 2 drops of alcohol, hydrogen chloride, zinc acetate solution, potassium ferricyanide solution were thoroughly mixed to give a homogenous mixture. Mixture was set in an Ultrospec® 7500 and measured at an optical density of 660 nm.

Total tannins estimation

100 g of sample was measured into a conical flask followed by the addition of methanol and placed in a water bath for 30 minutes. The mixture was shaken. 1.5 mL of Folin-Denis reagent was added with 0.5 mL of sodium bicarbonate before it was filtered into a volumetric flask. The mixture was made up to mark with water mixed well and allowed to stand for 30 minutes. Mixture was set in an Ultrospec® 7500 and measured at an optical density of 350 nm.

Total glycosides analysis

100 g of the sample were measured into 100 mL of conical flask followed by the addition of 5 ml of chloroform, 2 ml of pyridine and sodium nitroprusside shaken thoroughly for 20 minutes before 3 ml of sodium hydroxide was added. Mixture was set in an Ultrospec® 7500 and measured at an optical density of 600 nm.

Total steroid analysis

100 g of each sample were weighed into a conical flask followed by 5ml of chloroform to dissolve the extract and it was kept for 10 minutes. Potassium hydroxide was also added at 2 ml to obtain a homogenous mixture and set in a water bath at 40˚C for 60 minutes. Thereafter, 10 ml of petroleum ether and Liebermann Buchard reagent before it was evaporated to dryness. Mixture was set in an Ultrospec® 7500 and measured at an optical density of 720 nm.

Statistical analysis

All the tests were carried out in triplicates outcomes were expressed as the mean value ± standard deviation.

Results

Proximate composition of some sixteen medicinal plants found in India (expressed in %) is presented in Table 1. The crude protein values obtained in this study varied from 7.31 – 17.1 %, moisture (8.13 – 11.7 %), crude fat (1.29 – 2.61 %), crude fibre (10.9 – 18.4 %), ash (7.55 – 9.87 %) and carbohydrates (40.9 – 55.6 %). *Centella asiatica* had the highest crude protein value while *Tribulus terrestris* had the lowest value. Higher moisture content was recorded for *Tinospora cordifolia* while *Symplocos racemose* had the lowest value. Result on crude fibe, crude fat, ash and carbohydrate revealed that *Tribulus terrestris*, *Glycyrrhiza glabra*, *Bauhinia variegate* and *Centella asiatica* had a higher value compared to *Crateva nurvala*, *Tribulus terrestris*, *Symplocos racemose* and *Psoralea corylifolia* which had a lower value respectively.

As presented in Table 2, mineral composition of some medicinal plants found in India (expressed in mg/100g). Result revealed that calcium level varied from 155.7 – 211.6 mg/100g, phosphorus (78.9 – 114.2 mg/100g), potassium (398.7 – 831.1 mg/100g), magnesium (47.2 – 96.0 mg/100g), manganese (10.5 – 31.9 mg/100g), zinc (29.1 – 48.0 mg/100g), iron (5.12 – 13.2 mg/100g), selenium (0.43 – 3.11 mg/100g), copper (1.83 – 8.67 mg/100g) and sodium (101 – 132 mg/100g).

As presented in Table 3, phytochemical evaluation of some medicinal plants found in India (expressed in mg/g). Result showed that the concentrations of alkaloids, saponins, flavonoids, tannins, glycosides, steroids and phenols were greater in *Terminalia bellerica* (40.6 mg/g), *Centella asiatica* (45.8 mg/g), *Bauhinia variegate* (70.5 mg/g), *Eclipta alba* (29.5 mg/g), *Andrographis paniculata* (7.12 mg/g), *Bauhinia variegate* (6.17 mg/g) and *Terminalia bellerica* (92.5 mg/g) compared to those of *Psoralea corylifolia* (21.3 mg/g), *Symplocos racemose* (22.0 mg/g), *Withania somnifera* (37.0 mg/g), *Plumbago zeylanica* (16.3 mg/g), *Tinospora cordifolia* (2.06 mg/g), *Psoralea corylifolia* (2.67 mg/g) and *Barleria prionites* (51.4 mg/g) respectively.

Medicinal plants (leaves)	[1]MC	[2]CP	[3]CF	[4]CFF	[5]CHO	ASH
Eclipta alba	9.87 ± 0.88	11.4 ± 0.35	16.7 ± 1.46	2.11 ± 0.02	49.8 ± 0.80	7.55 ± 0.19
Andrographis paniculata	10.2 ± 0.65	10.9 ± 0.66	14.5 ± 0.97	1.95 ± 0.01	51.4 ± 0.76	8.04 ± 0.11
Barleria prionites	9.11 ± 0.30	12.6 ± 0.25	16.2 ± 0.88	2.59 ± 0.00	45.6 ± 0.00	8.15 ± 0.04
Withania somnifera	11.4 ± 0.18	14.1 ± 0.17	15.1 ± 0.62	2.03 ± 0.05	42.8 ± 0.11	7.87 ± 0.12
Glycyrrhiza glabra	10.6 ± 0.40	13.6 ± 0.11	16.8 ± 0.85	2.61 ± 0.08	44.0 ± 0.85	9.00 ± 0.06
Tinospora cordifolia	12.8 ± 0.57	15.2 ± 0.70	15.9 ± 0.51	2.55 ± 0.02	53.4 ± 0.73	8.51 ± 0.08
Holarrhena antidysenterica	11.7 ± 0.35	14.3 ± 0.88	17.8 ± 0.70	2.49 ± 0.01	51.2 ± 0.70	8.00 ± 0.00
Plumbago zeylanica	10.6 ± 0.60	16.8 ± 0.40	13.6 ± 0.81	2.00 ± 0.00	49.8 ± 0.69	7.64 ± 0.31
Symplocos racemose	8.13 ± 0.26	7.49 ± 0.10	16.8 ± 1.12	1.96 ± 0.06	46.7 ± 0.85	6.07 ± 0.20
Psoralea corylifolia	10.1 ± 0.11	10.8 ± 0.12	17.2 ± 1.88	1.72 ± 0.04	40.9 ± 0.90	6.42 ± 0.15
Tribulus terrestris	11.0 ± 0.45	7.31 ± 0.06	18.4 ± 0.31	1.50 ± 0.01	55.6 ± 1.00	6.55 ± 0.12
Terminalia arjuna	9.50 ± 0.40	16.2 ± 0.90	16.1 ± 0.82	1.87 ± 0.05	51.2 ± 1.20	6.60 ± 0.05
Crateva nurvala	8.33 ± 0.31	9.04 ± 0.11	10.9 ± 0.46	2.04 ± 0.02	54.0 ± 1.06	8.11 ± 0.12
Terminalia bellerica	9.28 ± 0.12	13.2 ± 0.85	11.5 ± 0.50	1.51 ± 0.04	49.6 ± 0.97	9.26 ± 0.15
Centella asiatica	10.5 ± 0.50	17.0 ± 0.80	12.3 ± 0.11	1.29 ± 0.02	54.7 ± 1.88	9.10 ± 0.04
Bauhinia variegate	10.0 ± 0.61	17.1 ± 0.12	11.6 ± 0.18	1.87 ± 0.12	45.1 ± 1.22	9.87 ± 0.03

[1]Moisture content; [2] Crude protein; [3]Crude fibre; [4]Crude fat; [5]Carbohydrates

Table 1: Proximate composition of some medicinal plants found in India (expressed in %)

Table 2: Mineral composition of some medicinal plants found in India (expressed in mg/100g)

Medicinal plants	[1]Ca	[2]Phos	[3]K	[4]Mg	[5]Mn	[6]Zn	[7]Fe	[8]Se	[9]Cu	[10]Na
Eclipta alba	211.6 ± 0.03	108.1± 0.10	812.4±0.09	95.3±0.00	15.1±0.11	48.0±0.11	10.4±0.02	0.61±0.001	4.12±0.02	121±1.4
Andrographis paniculata	194.8 ± 0.00	100.5±0.04	706.1±0.06	81.2±0.19	10.5±0.07	44.6±0.10	7.12±0.00	0.43±0.001	3.61±0.01	109±0.81
Barleria prionites	206.8 ± 0.07	114.2±0.16	800.6±0.04	94.1±0.04	17.3±0.12	31.2±0.40	9.33±0.02	0.45±0.000	3.06±0.06	118±4.87
Withania somnifera	188.5±0.21	106.3±0.10	658.2±0.23	82.6±0.00	21.0±0.90	29.5±0.10	8.56±0.05	0.87±0.002	3.11±0.05	105±3.11
Glycyrrhiza glabra	203.1 ±0.23	100.2±0.06	811.5±0.15	96.0±0.03	26.4±0.19	30.6±0.04	10.4±0.07	0.68±0.003	2.41±0.03	109±2.86
Tinospora cordifolia	174.9±0.12	98.5 ±0.12	604.7±0.00	71.0±0.16	23.9±0.06	29.1±0.00	8.55±0.02	0.59±0.006	2.06±0.06	114±3.11
Holarrhena antidysenterica	185.4 ±0.07	75.9 ±0.01	516.2±0.90	69.4±0.24	16.5±0.02	31.4±0.56	9.00±0.01	0.74±0.005	2.33±0.05	112±2.00
Plumbago zeylanica	200.1 ±0.00	93.6±0.00	831.1±0.06	94.2±0.16	20.9±0.01	33.8±0.09	8.60±0.03	0.69±0.004	2.60±0.01	116±3.26
Symplocos racemose	161.0 ±0.01	88.7±0.09	502.8±0.53	56.9±0.04	24.7±0.02	30.7±0.51	6.06±0.06	0.57±0.001	1.83±0.02	101±1.69
Psoralea corylifolia	196.1 ±0.14	90.4±0.15	489.3±0.06	52.1±0.16	12.9±0.00	27.6±0.05	5.67±0.08	0.82±0.000	2.94±0.09	115±1.22
Tribulus terrestris	172.5 ±0.10	81.6±0.40	420.7±0.18	48.4±0.03	18.7±0.09	31.2±0.09	5.12±1.00	0.67±0.009	3.71±0.01	104±1.34
Terminalia arjuna	182.9 ±0.08	78.9 ±0.43	400.6±0.04	50.6±0.31	16.5±0.04	30.4±0.01	6.08±1.22	0.93±0.006	3.03±0.03	112±1.63
Crateva nurvala	155.7 ±0.11	70.2±0.18	398.7±0.12	47.2±0.47	18.4±0.31	32.0±0.07	6.77±1.50	0.67±0.001	5.48±0.00	105±1.24
Terminalia bellerica	194.8 ±0.12	84.1±0.43	408.5±0.08	60.8±0.21	31.2±0.12	38.4±0.12	12.6±1.88	3.11±0.007	7.91±0.00	132±1.34
Centella asiatica	205.1±0.03	93.5±0.12	800.6±0.12	78.9±0.23	30.9±0.18	39.8±0.03	13.8±1.24	2.51±0.005	8.06±0.06	130±2.98
Bauhinia variegate	211.4 ±0.12	95.7±0.00	815.0±0.00	82.6±0.09	31.9±0.04	36.5±0.00	13.2±1.45	2.33±0.001	8.67±0.05	131±2.55

[1]Calcium; [2]Phosphorus; [3]Potassium; [4]Magnesium;[5]Manganese; [6]Zinc; [7]Iron; [8]Selenium;[9]Coppe

Table 3: Phytochemical evaluation of some medicinal plants found in India (expressed in mg/g)

Medicinal plants (leaves)	Alkaloids	Saponins	Flavonoids	Tannins	Glycosides	Steroids	Phenols
Eclipta alba	27.1±0.09	34.0±0.01	51.8±2.06	29.5±1.22	5.40±0.03	5.66±0.00	56.4±1.45
Andrographis paniculata	25.4±0.06	35.1±0.00	45.6±1.21	25.0±0.33	7.12±0.00	4.09±0.01	53.0±1.00
Barleria prionites	23.1±0.01	37.5±0.07	40.9±1.34	26.2±1.43	5.77±0.01	6.60±0.02	51.4±1.13
Withania somnifera	21.9±0.05	38.9±0.06	37.0±1.61	24.9±1.00	6.06±0.03	2.56±0.03	50.9±1.31
Glycyrrhiza glabra	20.6±0.03	31.5±0.02	45.7±0.95	22.0±0.42	4.42±0.05	3.07±0.01	55.6±1.09
Tinospora cordifolia	25.1±0.01	33.8±0.08	48.5±1.12	22.3±0.21	2.06±0.01	4.12±0.02	65.7±1.46
Holarrhena antidysenterica	23.6±0.05	34.0±0.11	42.3±0.45	23.7±0.53	4.11±0.00	5.06±0.00	62.1±1.00
Plumbago zeylanica	26.7±0.00	31.3±0.17	47.6±1.21	16.3±0.41	5.67±0.03	6.31±0.01	60.9±1.70
Symplocos racemose	26.8±0.02	22.0±0.06	47.0±0.46	26.2±0.34	6.07±0.02	6.09±0.03	56.0±2.56
Psoralea corylifolia	21.3±0.21	31.6±0.02	45.1±0.33	21.0±0.25	4.61±0.01	2.67±0.02	55.1±2.21
Tribulus terrestris	22.0±0.12	31.0±0.08	43.8±1.35	21.2±0.00	5.78±0.18	5.31±0.01	56.7±1.21
Terminalia arjuna	24.6±0.01	31.0±0.01	45.6±1.41	24.5±0.16	6.90±0.80	5.00±0.01	59.4±1.00
Crateva nurvala	21.5±0.83	32.7±0.03	47.9±1.04	22.3±0.18	4.33±0.93	5.32±0.03	67.3±0.09
Terminalia bellerica	40.6±0.07	42.0±0.04	67.1±0.06	27.0±0.33	3.94±0.90	5.08±0.01	92.5±0.00
Centella asiatica	38.7±0.01	45.8±0.31	65.6±0.04	26.2±0.12	3.40±0.16	6.00±0.03	90.6±0.02
Bauhinia variegate	32.8±0.04	40.9±0.32	70.5±0.51	28.3±0.34	4.52±0.70	6.17±0.01	91.5±0.15

Discussion

According to Alagbe (2019a, 2019b), a plant's chemical makeup can be influenced by factors such as age, geographical location, and species. The crude protein range (7.31 - 17.1%) in this study was consistent with Huskie et al.'s (2010) established values for leafy vegetables (8.00 - 30.0%). The findings imply that these therapeutic plants provide both nutritional and pharmacological benefits, making them suitable for inclusion in animal diets. Andrew et al. (2023) reported protein concentrations for Dysphania ambrosoides (15.99%) and Crassocephalum crepidiodes leaves (17.11%) that are consistent with the investigation. Alagbe et al. (2024) found a lower value of 7.60% for Pterocarpus erinaceus leaves, 5.11% for Pterocarpus erinaceus stem bark, and 4.33% for the root. Mohammad et al. (2020) recorded a higher crude protein of 28.20 % for *Vernonia amygdalina* leaves. Protein are needed for the growth and maintenance of animals, they also play an integral part in the immune system and enzyme production in the body (Ojediran et al., 2024). The range of moisture content 8.13 – 11.7 % was within the standard range of 6 – 15 % reported for vegetables (Rishi et al., 2012). Therefore, high moisture content in the samples are advantageous because inhibits the growth of microbes on a sample (Adewale et al., 2022). The difference in moisture content between different plants is directly dependent on climatic changes (Goss, 1980). This result corresponds to the reported values by Adewale et al. (2022) for Pterocarpus carpus leaves (11.46 %) and stem bark (13.18 %) and lower when compare with the report of Alagbe et al. (2022) for Piliostigma thonningii leaves (7.23 %). The results on the crude fibre suggests that *Tribulus terrestris* had the highest concentration (18.4 %). Availability of such high contents in the diets of livestock's helps to prevent gastrointestinal disorders and coronary heart disease (Ibironke, 2003). The crude fibre range (10.4 – 18.9 %) were within the range reported by Abiodun et al. (2017) for Chenopodium ambrosoides leaves (13.40 %) and Morinda lucida leaves (15.06 %) but lower than values recorded for Parquetin nigrescen leaves (22.05 %), Oscium gratissimum (22.02 %) and Magnifera indica (19.01 %) by the same author. Ash content of medicinal plants can be used to evaluate its mineral content (Daniel et al., 2023; Alagbe, 2022). The ash content range reported in this study 7.55 – 9.87 % showed that *Bauhinia variegate* had the highest mineral content suggesting that it can promote construction of muscles, blood cells, internal organs and enzymes in animals (Singh et al., 2022). Therefore, animals with a deficiency of minerals will never develop properly and are more susceptible to diseases (Alagbe, 2024). The mineral content of medicinal plants is in consonance with the reports of Amabye (2015) for Rhamnus prinoides leaves (9.50 %) and lower when compared with the reports of Raimi et al. (2014) for Sida acuta leaves (6.33 %). Crude fat content range of 1.29 – 2.61 % recorded for the medicinal plants indicated that *Terminalia arjuna* had the lowest value. This result suggests that they are able to maintain good health by preventing the incidence of cardiovascular diseases as a result of excessive fat consumption (Sodamade, 2013). Carbohydrate values (40.9 – 55.6 %) corresponds with the values of Abiodun et al. (2017) on Oscium gratissimum (50.06 %) and lower when compared with the report of the same author for Parquetin nigrescen leaves (36.03 %), Chenopodium ambrosiodes (4.36 %) and Magnifera indica (43.76 %). Availability of high carbohydrate content in a sample is helpful in providing energy and excess of it can be stored as fat which is stored in the adipose tissues of animals (Alagbe et al., 2023).

Calcium, phosphorus, potassium, magnesium, manganese, zinc, iron, selenium, copper and manganese in *Eclipta alba* (211.6 mg/100g), *Barleria prionites* (114.2 mg/100g), *Plumbago zeylanica* (831.1 mg/100g), *Glycyrrhiza glabra* (96.0 mg/100g), *Terminalia bellerica* (31.2 mg/100g), *Terminalia bellerica* (3.11 mg/100g), *Bauhinia variegate* (8.67 mg/100g) and *Terminalia bellerica* (132.0 mg/100g) compared to those of *Crateva nurvala* (155.7 mg/100g), *Crateva nurvala* (70.2 mg/100g), *Crateva nurvala* (398.7 mg/100g), *Crateva nurvala* (47.2 mg/100g), *Andrographis paniculata* (10.5 mg/100g), *Psoralea corylifolia* (27.6 mg/100g), *Tribulus terrestris* (5.12 mg/100g), *Andrographis paniculata* (0.43 mg/100g), *Symplocos racemose* (1.83 mg/100g) and *Symplocos racemose* (101 mg/100g) which had lower values. The variation in their compositions may be due to differences in geographical location and species of plants (Alagbe, 2021a). The result obtained showed that the medicinal plants contains appreciable quantities of minerals which are needed for the activation of enzymatic reaction in the body of animals (Ojediran et al., 2024; Alagbe, 2021b). Deficiency of minerals are known to affect the performance and health in both humans and animals (Thomas and Krishnakumari, 2015). Calcium and phosphorus are essential components of the skeleton and are necessary for the synthesis of structural proteins (Alagbe, 2021a). The calcium and phosphorus levels are within the standard range reported by Obazelu et al. (2021) for Combretum platypterum leaves (266.4 mg/100g) but lower than values reported for *Ficus capensis* leaves 186.0 mg/100g and 160 mg/100 respectively by Ngozi et al. (2017).Magnesium activates enzyme systems that maintain electrical potential in nerves, whereas potassium influences osmotic pressure and contributes to normal acid-base balance (Thomas and Krishnakumari, 2015). Iron is essential in mammalian diet to prevent anemia, and it is a component of hemoglobin and myoglobulin molecules that transport oxygen to and within cells. Zinc creates metalloproteinase and enzyme complexes that cannot be separated without losing activity (Alagbe et al., 2021; Adewale et al., 2021). They also help cells replicate and differentiate (Robert et al., 2003).

Phytochemicals are basically divided into two groups that are primary and secondary metabolites. Primary metabolites comprise common sugar, amino acids, proteins and chlorophyll while secondary metabolites consist of alkaloids, flavonoids, tannins etc., (Kumar et al., 2009). Phytochemicals like flavonoids and phenols are powerful antioxidants and have an important role in the health care system (Ojediran et al., 2024). The values of alkaloids, saponins, flavonoids, tannins, glycosides, steroids and tannins which varied from 20.6 – 40.6 mg/g, 22.0 – 42.0 mg/g, 37.0 – 70.5 mg/g, 16.3 – 29.5 mg/g, 2.06 – 7.12 mg/g, 2.56 – 6.60 mg/g and 50.9 – 92.5 mg/g respectively. Alkaloid, saponin, tannin and flavonoid concentrations were within the range reported by Aliyu et al. (2008) for the leaves of Anchomanes difformis (23.6 mg/g), Anisopus mannii (41.6 mg/g), Pavetta crassipes (39.6 mg/g), Stachytarpheta augustifolia (40.8 mg/g) and Vernonia blumeoides (38.2 mg/g) but lower than values recorded by Obazelu et al. (2021) for Combretum platypterum (3.52 mg/g). The role of medicinal plants in disease prevention or control has been attributed to antioxidant properties of their active constituents (Ivanova et al., 2005). Medicinal plants have been shown to function as free radical scavengers through anti-oxidative mechanisms mediated by polyphenols, flavonoids, ascorbic acid, and terpenoids, which have the ability to protect cell organelles from damage caused by free radical-induced oxidative stress by inhibiting the initiation or propagation of oxidative chain reactions (Ghaffar and El-Elaimy, 2012; Shittu and Alagbe, 2020). Alkaloids have been shown to act as painkillers as well as having antimalarial and antibacterial activities (Alagbe et al., 2024; Alagbe et al., 2020).Melaleuca Alternifolia (Cox et al., 2000), Cassia Occidentalis (Chukwujekwu et al., 2006), Rhamnus Californica, and Umbellularia Californica leaves have all been found to contain alkaloids and saponins (Carranza et al., 2015). Tannins are employed as antiseptics due to the presence of phenolic groups, and they have also been linked to antibacterial and antioxidant characteristics (Alagbe and Ushie, 2021). Saponins are also useful therapeutically because they have been proven to have hypolipidemic and anticancer properties (Carranza et al., 2015). Glycosides have a bitter taste and have been employed as flavoring ingredients in numerous pharmacological products (Sarker and Nahar, 2007).These natural metabolites are significant as prospective antibacterial crude drugs and a source of natural chemicals as new anti-infection agents (Dwivedi et al., 2011).

Conclusion

Medicinal plants are thought to be safe and free of adverse effects when used to improve animal performance. Herbs can be used as feed additives because they are suitable and preferred, have a minimal risk of toxicity, pose few health risks, are environmentally friendly, and are less expensive to produce. Differences in processing processes, species, geographical regions, plant age, and storage, among other factors, can all have an impact on the chemical composition of medicinal plants. Phytochemicals are natural substances that are easily digested by animals. They can also assist to slow the rise in antimicrobial resistance and improve food safety. They can boost feed intake and digestibility in animals while causing no negative effects or withdrawal periods, enhancing farmer profits.

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