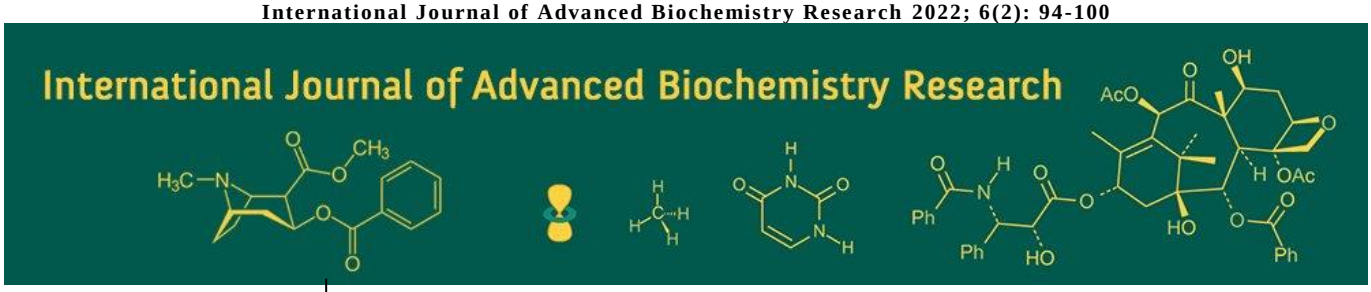

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2022; 6(2): 94-100
www.biochemjournal.com
Received: 05-04-2022
Accepted: 08-05-2022

AF Akinsola
Department of Chemistry, Faculty of Science, Ekiti State University, Ado-Ekiti, Nigeria

AG Oluwafemi
Department of Biochemistry, Faculty of Science, Ekiti State University, Ado- Ekiti, Nigeria

Corresponding Author:
AF Akinsola
Department of Chemistry, Faculty of Science, Ekiti State University, Ado-Ekiti, Nigeria

Phytochemical analysis, proximate composition and mineral profile of *cleome rutidosperma* found in Ado-Ekiti, Nigeria

AF Akinsola and AG Oluwafemi

DOI: https://doi.org/10.33545/26174693.2022.v6.i2b.141

Abstract
This study was carried out to determine the mineral profile, proximate composition, and qualitative and quantitative phytochemical constituents of *Cleome rutidosperma* found in Ado-Ekiti Nigeria, using different standard chemical analytical methods. Results of the proximate analysis showed that *Cleome rutidosperma* comprises 11.8±0.1% moisture, 10.4±0.0% ash, 22.8±0.1% crude protein, 5.10±0.0% fiber, 4.42±0.08% crude fat and 45.5±0.0% carbohydrate. The mineral with the highest concentration was calcium (787±1 mg/100g), followed by potassium (545±6 mg/100g) and phosphorus (289±0 mg/100g). Copper had the least concentration (8.17±8.17 mg/100g) among the mineral elements analyzed, however, lead was not detected. Qualitative phytochemical screening showed that alkaloids, tannins, flavonoids, phenols, saponins and terpenoids were present in the methanol extract of *C. rutidosperma*. Quantitative determination of the phytochemicals revealed 0.158± 0.008 mg/g; 6.25±0.01 mgTAE/g; 8.22± 0.03 mgQE/g; 0.082± 0.002 mg/g and 16.6 ± 0.3 mgTAE/g for alkaloids, total tannins, flavonoids, saponins and total phenolic content respectively. The findings of this investigation revealed that the powdered plant of *Cleome rutidosperma* was rich in macro minerals and phytochemicals. The plant also contained an appreciable amount of protein and carbohydrate. Therefore the plant might be a good food supplement and may be considered for production of drug

Keywords: Phytochemical, proximate, minerals, *cleome rutidosperma*

Introduction
Cleome rutidosperma DC (*C. rutidosperma*) usually referred to as fringed spider flower, is a flowering plant that is a member of the family of *Cleomaceae* [1, 2]. *C. rutidosperma* is an erect herb with a sparsely branched stem that can grow to a height of 50-100 cm. It was reported to originate from West Africa. In addition to Southeast Asia, it is also found in several tropical regions of America [3]. Although the plant generally grows as a weed, it is occasionally cultivated as a potherb in West Africa [4]. The leaves of C. rutidosperma are used in soups or consumed as a cooked vegetable [5, 6].
Traditionally, in Indian medicine, *C. rutidosperma* is used to treat paralysis, convulsions, epilepsy, pain, spasm and skin disease [7]. In DR Congo, Ghana and Gabon leaf sap of *C. rutidosperma* is used to treat deafness and earaches, while in Nigeria, the extract of the leaf is applied in the treatment of convulsion [4].
Some research studies have been able to isolate and identify some compounds in this plant but the information on the nutritional composition is still very insufficient. Therefore, this study found it essential to get more information on the nutritional composition by determining the phytochemical, mineral and proximate compositions of *C. rutidosperma*. This could be very helpful in discovering its medicinal value and edibility as well.

Collection and preparation of sample
Fresh *C. rutidosperma* plants were collected from Ado Ekiti, Ekiti State Nigeria. The sample was identified by Mr. Felix Omotayo, the curator at the Herbarium of the Department of Plant Science, Ekiti State University, Ado-Ekiti. Edible portion of the plant comprising the leaves and tender stems were removed from the whole plant, washed thoroughly with distilled water and air dried. The dried sample was ground into powder and stored in airtight container prior to subsequent examination.

Methods

Proximate analysis

The ash, moisture, fat, protein and crude fibre contents were determined using the methods of AOAC [8].

A dry, clean crucible was weighed for the purpose of determining the moisture content, and the weight was noted (W1). The sample was weighed at 3 g and added to the crucible (W2). The sample-containing crucible was oven dried for three hours at 105 ºC. The weight was recorded after the crucible was moved to the desiccator to cool. The procedure was repeated until the attainment of a constant weight (W3). The moisture content percentage was computed as the percentage loss in weight during drying (Equation 1).

$$\% \text{ Moisture} = \frac{Weight\ loss}{Weight\ of\ sample} X100 \quad (1)$$

A clean, dried, and previously weighed crucible with a lid was used to weigh 1 g of the sample in order to measure its ash content (W1). Following removal of the lid, the sample was lit on fire to char the organic material. The crucible was thereafter heated to a temperature of 550 ºC in a muffle furnace (lid removed). The ashing process was repeated until the ash was light grey or white. Crucible was then immediately placed into a desiccator, cooled, and weighed (W2). Equation 2 was used to determine the ash content percentage.

$$\text{Ash} = \frac{W_1 - W_2}{Weight\ of\ sample} \times 100 \quad (2)$$

Soxhlet extraction technique was used to estimate the crude fat content. A filter paper was filled with a sample weighing two grams (2 g). The filter paper containing the sample was neatly folded, and the sample was then put inside a dried-up thimble. The Soxhlet flask was filled with a thimble containing the sample. Diethyl ether was added to a boiling flask after it had been weighed (W1) and dried thoroughly. Diethyl ether boiling flask, Soxhlet flask with sample, and condenser were assembled. Six hours of reflux-induced extraction were carried out. The thimble was extracted, taken out of the extraction barrel, and dried. The solvent was removed by distillation, and then the boiling flask of fat was dried at a low temperature in the oven. The flask's weight plus the oil was measured and recorded (W2). The percentage fat content was then determined using fat extracted from a specified quantity of sample (Equation 3).

$$\% \text{ Fat} = \frac{W_2 - W_1}{Sample\ Weight} \times 100 \quad (3)$$

The method of micro Kjeldahl was used to calculate the sample's total nitrogen content. 20 ml of concentrated H_2SO_4 and a Kjeldahl digestion tablet were boiled with the sample (2 g) until a clear mixture was obtained in a Kjeldahl flask. The digest was filtered into a 250 ml volumetric flask, which was then ready for distillation by being properly topped off with distilled water. The digest, to which 50 ml of a 45 percent NaOH solution had been added, was steam-distilled to extract the ammonia. Methyl orange was utilized as an indicator, and 150 ml of the distillate were collected into a conical flask with 100 ml of 0.1 N HCl. Back titration against 2 M NaOH was used to quantify the percentage nitrogen (N) after the reaction between the ammonia and acid in the receiving flask. Equation 4 was used to determine the amount of nitrogen.

$$\text{Nitrogen} = \frac{(A-B)X\ 1.4007}{Weight\ of\ sample} \times 100 \quad (4)$$

Where:

A = volume (ml) of standard HCl x normality of standard HCl

B = volume (ml) of standard NaOH x normality of standard NaOH

The nitrogen value was multiplied by a factor of 6.25% to get the percentage of crude protein.

A Soxhlet apparatus was used to extract 2.5 g of the sample with diethyl ether to quantify the amount of crude fiber. The sample extracted was air dried, transferred to a dry, 1.25% sulphuric acid-filled 1 L conical flask, coupled to a water-cooled reflux condenser, and heated for exactly 30 minutes. The mixture was allowed to cool and then filtered through a clean white linen. It was thereafter washed with boiling water until the mixture were no longer acid to litmus. The residue was further boiled with 1.25% NaOH solution. The flask was immediately connected with the reflux condenser, and boiled for precisely 30 minutes. The filtering cloth was used to filter the flask's mixture through. The residue was then transferred to a Gooch crucible that had been preheated with a thin, compact layer of ignited asbestos after being thoroughly cleaned with boiling water. The residue was carefully cleaned with hot water before being treated with approximately 15 ml of ethyl alcohol. To attain consistent weight, the Gooch crucible and its contents were air oven dried at 105±2 °C. The dried crucible was cooled, then its contents were weighed. The Gooch crucible's contents were incinerated completely until only carbonaceous material remained in a muffle furnace. The resulting ash was dried in a desiccator, chilled, and weighed.

The crude fibre was estimated as:

$$\text{Crude Fibre\% by weight} = \frac{W_1 - W_2}{W} \times 100 \quad (5)$$

Where,

W_1 = Gooch crucible and its contents weight (grams) before ashing

W_2 = weight in grams of an asbestos- and ash-filled Gooch crucible

W = weight in grams of the dried test sample

Carbohydrate was determined by difference: {100 - (ash + moisture + crude protein + crude fibre + crude fat contents)}.

Calorific value (kcal/100g) of the sample was obtained by multiplying crude protein content by 4, carbohydrate content by 4 and crude fat value by 9.

Mineral content determination

Mineral constituents of *C rutidosperma* was determined by using the procedure of Oshodi [9] as reported by Omotoso and Adedire [10]. *C. rutidosperma* plant was ashed in a muffle furnace at 550 °C for sevral hours. To make up to 100 ml in a standard flask, distilled water was added after the sample ash had been dissolved in 10 percent HCl. Using an atomic absorption spectrophotometer, the sample's concentrations of iron, magnesium, calcium, manganese, copper, zinc, and lead were determined (Bulk Scientific East

Norwalk, CT, USA). Potassium and sodium concentrations were estimated with the use of a Corning, UK Model 405 flame photometer, while phosphorus concentrations were estimated using the vanadomolybdate technique.

Phytochemical analysis

Qualitative Phytochemical analysis

The powdered material was placed into a Soxhlet apparatus and extracted for 72 hours using methanol for the qualitative phytochemical screening analysis. The extract was dried out by concentration and the residue obtained was stored and later used for phytochemical screening. Phytochemical screening for alkaloids, phenols, saponins, flavonoids, and reducing sugar was conducted by the procedure reported by Tiwari *et al*. [11], tannins, terpenoids and steroids was by Edeoga *et al*. [12]. Cardiac glycosides and anthraquinones were determined by using the procedure reported by Aiyelaagbe and Osamudiamen [13].

Test for saponins

A 0.5 g extract and 2 milliliter of water were shaken. The presence of saponins was indicated by the persistence of foam produced for ten minutes.

Test for phenols (Ferric chloride test)

Three to four drops of a ferric chloride solution were added to the extract. Formation of bluish-black colour precipitate shows the presence of phenols in the extract.

Test for flavonoids (Lead acetate test)

Few drops of lead acetate solution were added to the extract for treatment. Formation of yellow colour precipitate shows the presence of flavonoids.

Test for alkaloids

The sample extract was filtered after it was dissolved in diluted hydrochloric acid. Wagner's reagent was applied to the filtrate (iodine in potassium iodide). Formation of brown/reddish precipitate shows the presence as alkaloids.

Test for reducing sugars

The extract was filtered after it was dissolved in 5 millilitre of distilled water. Filtrate was heated with Fehling's A & B solutions, neutralized with alkali, then hydrolysed with dilute HCl to undertake Fehling's test. The formation of a red precipitate shows the presence of reducing sugar.

Test for tannins

A test tube containing 0.5 g of dried powder was boiled with 20 ml of water and thereafter filtered. A few drops of 0.1 percent ferric chloride were added, and the coloration was checked for brownish green or a blue-black colour.

Test for terpenoids (Salkowski test)

Concentrated H_2SO_4 (3 ml) was added cautiously to yield a layer after 5 ml of the extract was softly mixed with 2 ml of chloroform. The formation of a reddish-brown coloration shows the presence of terpenoids.

Test for steroids

After mixing 0.5 g of the sample's ethanolic extract with 2 ml of H_2SO_4, 2 ml of acetic anhydride was added to the mixture. In some samples, the colour transitioned from violet to blue or green, signify the presence of steroids.

Test for cardiac glycosides (Keller-Killani's test)

One milliliter of glacial acetic acid with one drop of ferric chloride solution was used to dissolve about 100 mg of the extract. As an underlay, 1 cc of concentrated sulfuric acid was utilized. The existence of de-oxy sugar, a cardenolide characteristic, is shown by a brown ring at the interface.

Test for anthraquinone (Borntrager's test)

A dry test tube containing about 0.5g of the extract was filled with 5 ml of chloroform, which was then stirred vigorously for 5 minutes. The extract was filtered, and the filtrate was mixed with an equivalent volume of a solution containing 10% ammonia. The presence of anthraquinone is indicated by a violet, pink, or red colour in the ammoniacal layer.

Quantitative Phytochemical analysis

Determination of alkaloid

The Harborne method [14] was used to determine the alkaloid content. 200 ml of 10% acetic acid in ethanol and 5.0 g of the sample were put to a 250 ml beaker, capped, and left for 4 hours. The extract was filtered, then concentrated on a water bath to a quarter of its initial volume. Until the precipitation was completed, concentrated ammonium hydroxide was dropwisely added to the extract. The precipitate was collected, cleaned with weak ammonium hydroxide, and finally filtered. The residual was made up of dried and weighed Alkaloid.

Determination of saponin

To determine saponin, Obadoni and Ochuko's approach [15]. was applied. 100 cm^3 of 20 percent aqueous ethanol was added to the 20 g of ground-up sample in a conical flask. The sample was boiled at roughly 55 ^oC over a hot water bath for 4 hours while being continuously stirred. Filtering the mixture allowed the residue to be extracted again using 200 ml of 20 percent ethanol. Over a water bath heated to roughly 90^oC, the mixed extracts were reduced to 40 ml. The concentration was transferred into a 250 ml separatory funnel and 20 ml of diethyl ether was added. The mixture was thereafter rigorously shaken. While the ether layer was discarded, the aqueous layer was recovered. The purification procedure was repeated and N-butanol 60 ml was thereafter added. The mixed n-butanol extract was washed twice with 10 ml of 5% aqueous NaCl. The leftover solution was boiled in a water bath. After evaporation, the sample was dried to a fixed weight in an oven, and the amount of saponin was estimated.

Determination of Flavonoid

Flavonoid was identified according to Chandra *et al*. method [16]. The aluminium chloride colorimetric method was used to obtain the sample's total flavonoid content. Standard calibration curve for the research was created through Quercetin. In order to create the stock quercetin solution, 5.0 milligrams of quercetin were dissolved in 1.0 ml of methanol. The standard quercetin solutions were then created by serially adding methanol (5-200 g/ml) to the stock solution. Separately, 0.6 ml of diluted standard quercetin solutions or extracts were combined with 0.6 ml of aluminum chloride that was 2 percent. The mixture was then left to sit at room temperature for 60 minutes. Using a UV-Vis spectrophotometer, the reaction mixtures' absorbance

was estimated against a blank at 420 nm (Model 6306, Jenway, UK). The calibration plot y = 0.0284x + 0.0051 (R^2 = 0.9973) was employed to estimate the concentration of total flavonoid content in the test samples, which was then indicated as mg quercetin equivalent (QE)/g of dried plant material. All the determinations were carried out in triplicate.

Determination of total phenolics and total tannin content

The Folin-Ciocalteu procedure, which was described by Silva *et al*. in 2011 was employed to estimate the total phenolic and total tanmin contents [17]. Folin-Ciocalteu aqueous solution (5 ml, 10 percent, v/v), Na_2CO_3 (10 ml, 75 mg/l), and distilled water was combined with a diluted extract in methanol (2 ml, 0.5 mg/ml) to obtain the total phenolic content (84 ml). The mixture was left for 30 minutes in the dark. To calibrate the apparatus, distilled water was used to measure the absorbance at 760 nm. The extract (15 ml) was stirred for 3 hours with casein (1 g) and thereafter filtered and diluted with distilled water to 25 ml to estimate the residual phenolic content. The residual phenolic content was estimated from 5 ml of the filtrate with the use of the Folin-Ciocalteu technique. Duplicate runs of every process were made. The obtained total tannin content was the difference between the total and residual phenolic content. Tannic acid (0.1 to 6 g/mL) was used to create the correlation equation, which was y = 0.0152x + 0.0163 (R^2 = 0.9986). Milligrams of tannic acid equivalents (mg TAE/g) were used to indicte the total phenolic content and the total tannin content.

Results and Discussion

Results

Proximate composition of *C. rutidosperma*

Table 1 shows that *C. rutidosperma* contained 11.8 ±0.1% moisture, 10.4±0.0% ash, 22.8 ±0.1% crude protein, 5.10±0.0% crude fibre, 4.42±0.08% fat, 45.5±0.0% carbohydrate and 309 kcal/100g calorific value.

Table 1: Proximate composition (%) and calorific value (kcal/100g) of *C. rutidosperma*

Parameter	Results
Moisture	11.8±0.1
Ash	10.4±0.0
Protein	22.8±0.1
Crude fiber	5.10±0.0
Fat	4.42±0.08
Carbohydrate	45.5±0.0
Calorific value	309

Data presented as mean ± standard deviation of duplicate determinations

Phytochemical composition of *C. rutidosperma*

Table 2 below showed that alkaloids, tannins, flavonoids, phenols, saponins and terpenoids were present in the methanol extract of *C. rutidosperma*, while cardiac glycosides, steroids, anthraquinones and reducing sugar were absent.

Table 2: Qualitative phytochemical screening of *C. rutidosperma*

Phytochemicals	Observations
Alkaloids	+
Tannins	+
Phenols	++
Saponins	+
Flavonoids	++
Cardiac glycosides	-
Steroids	-
Terpenoids	+
Anthraquinones	-
Reducing Sugar	-

+ indicates present ++ indicates moderately present - indicates absent

Table 3 showed that *C. rutidosperma* contained 0.158±0.008 mg/g alkaloids, 0.082±0.002 mg/g saponins, 16.6±0.3 mgTAE/g total phenol, 6.25±0.01 mg TAE/g tannins and 8.22±0.03 mgQE/g flavonoids.

Quantitative phytochemical composition of *C. rutidosperma*

Table 3: Quantitative phytochemical composition of *C. rutidosperma*

Parameters	Value
Alkaloid (mg/g)	0.158±0.008
Saponin (mg/g)	0.082±0.002
Total Phenolics (mgTAE/g)	16.6±0.3
Total Tannins (mgTAE/g)	6.25±0.01
Flavonoids (mgQE/g)	8.22±0.03

Data presented as mean ± standard deviation of duplicate determinations

Mineral composition of *C. rutidosperma*

Table 4: Mineral composition of *C. rutidosperma*

Elements	Concentration (mg/100g)
Sodium (Na)	48.6±0.0
Potassium (K)	545±6
Manganese (Mn)	26.7±0.3
Magnesium (Mg)	85.4±0.2
Phosphorus (P)	289±0
Iron (Fe)	25.2±0.0
Calcium (Ca)	787±1
Zinc (Zn)	12.5±0.1
Copper (Cu)	8.17±0.04
Lead (Pb)	ND

Data presented as mean ± standard deviation of duplicate determinations

C. rutidosperma (Table 4) contained 48.6±0.0 sodium, 545±6 potassium, 26.7±0.3 manganese, 85.4±0.2 magnesium, 289±0 phosphorus, 25.2 ±0.0 iron, 787±1 calcium, 12.5±0.1 zinc and 8.17±0.04 copper while lead was absent.

Discussion

The result in Table 1 showed 11.8% moisture present in air-dried *C. rutidosperma*, a value comparable to the moisture level in *Hibiscus cannabinus* leaves (11.82%) [18]. Onimawo *et al*., [19] reported that plants with a moisture content higher than 15% is subjected to deterioration from mold growth, heat, insects' destruction and sprouting. Therefore, it can be speculated that *C. rutidosperma* could be kept for a long time in storage, because of its low moisture content. The ash content of *C. rutidosperma* (10.4%) was lesser than the value reported for the leaves of *A. viridus* (22.84%) [20] but greater than the values for *O. gratissimum* (5.11), *M. scandens* (7.73) and *L. guineensis* leaves (7.43) [21]. The ash content serve as an index of inorganic minerals present in the plant [22]. The crude protein content of *C. rutidosperma* (22.8%) was comparable to 21.95% recorded for the leaf of *T. occidentalis* [23] but comparatively higher than the range of values (14.67-21.28%) obtained by Nkamifaya *et al*., [24] for the leaves of 14 non-conventional leafy vegetables. *C. rutidosperma* could be regarded as a quality protein source because it can give more than 12% of calorific value from protein [25]. Based on the result obtained in this study, the crude fibre present in *C. rutidosperma* was 5.1%. Consuming fiber has been linked to a reduced risk of diverticulosis, heart disease, and some forms of cancer [26].

The crude fat value of *C. rutidosperma* was 4.42% which is moderately similar to the level found in *Amaranthus hybridus* (4.80%) [27]. Dietary fat enhances the flavor of food by absorbing and holding onto the flavor. Humans are considered to require a diet with 1.20% of their calories coming from fat, however excess fat has been linked to a number of cardiovascular problems [28]. *C. rutidosperma* contained higher percentage of carbohydrate (45.5%) when compared with the range of 7.50-30.55% reported by Mohammed and Mann [23] for the leaves of selected vegetables in Bida Nigeria. Moreover, the value obtained in the present study was within the range of carbohydrate contents of four lesser-known green leafy vegetables (43.78-47.23) [29]. A significant amount of carbohydrates could be obtained from *C. rutidosperma* and this can contribute to the energy needs of the body. Carbohydrates are a significant class of naturally occurring organic substances that support and sustain life in both plants and animals as well as serving as a source of raw materials for numerous industries [30]. The calorific value of *C. rutidosperma* was 309 kcal/100g, a value higher than 299.98 and 294.91 kcal/100g reported for *C. esculenta* and *I. batatas* [29]. The more calories a food has, the more energy it can provide for the body.

Table 2 and 3 show the results of qualitative and quantitative phytochemical analysis of *C. rutidosperma*. Alkaloids, phenols, tannins, flavonoids, terpenoids and saponins were present while cardiac glycosides, steroids, anthraquinone and reducing sugars were absent. A low level of alkaloid was found in *C. rutidosperma* (0.158±0.008 mg/g) in comparison with 27.36 mg/g and 13.9 mg/g alkaloid contents of *Cassia podocarpa* leaf and flower [31]. Alkaloids have strong anti-microbial properties because they impair the cytoplasm membrane's ability to function, which allows certain helpful metabolites to leak out and renders the bacterial enzymatic system inactive [32]. The tannin content of C. *rutidosperma* was found to be 6.25±0.01 mg TAE/g. According to reports, tannins increase the ability to absorb glucose and decrease adipogenesis, making them possible therapeutic agents for the management of non-insulin-dependent diabetic mellitus [33]. The plant sample in the present study had a higher total phenolic content (16.6±0.3 mgTAE/g) when compared with 10.13 and 9.13 mg/g w/v dry weight reported by Debnath *et al.* [34] for *Luffa actangula* and *Momordica Charantia* leaves respectively. The general effectiveness of plant phenolics as antioxidants and free radical scavengers is well recognized. Saponin which is slightly present in *C. rutidosperma* possesses some anti-inflammatory and anti-microbial activities as described in the literature [35]. It can also precipitate and coagulate red blood cells and thus it can serve as a haemolytic agent [36]. The flavonoid content of *C. rutidosperma* (8.22±0.03 mgQE/g) was within the range of 6.5 -14.35 mgQE/g dry weight of aeroponically and conventionally grown leafy vegetables [37]. Strong anticancer action, tumor growth inhibition, and prevention of oxidative cell damage are all characteristics of flavonoids, which are powerful water-soluble super antioxidants [38]. The presence of these bioactive compounds in *C. rutidosperma* is thus a significant finding of the present study, and it could be medicinal and useful for the development of therapeutic drugs.

Table 4 presents the results of the mineral composition of *C. rutidosperma*. The concentrations of the macronutrients investigated in the present study were 787, 545, 289, 85.4 and 48.6 (mg/100g) for calcium, potassium, phosphorus, magnesium and sodium respectively. The major mineral found in bone is calcium, which also aids in controlling the

contraction of the skeletal and cardiac muscles [39]. In addition, calcium is involved in a number of processes, including exocytosis, the release of neurotransmitters, and smooth muscle contraction. In maintaining cellular equilibrium, potassium and salt are critical nutrients [40]. The phosphorus found in the sample is a vital mineral for life; it aids in the development of bones and teeth; it functions as an enzyme cofactor; and it is a component of DNA, ATP, RNA and cell membrane [41]. Magnesium is essential for the replication, stability, and metabolic functions of lipid membranes [42]. All metabolic activities, including as glycolysis, the synthesis of cyclic AMP, energy-dependent membrane transport, and the transmission of the genetic code, depend on it as well [43]. Among the micronutrients, manganese had the highest value (26.7 mg/100g) followed by iron (25.2 mg/100g), zinc (12.5 mg/100g) and copper (8.17 mg/100g). Manganese which is present in *C. rutidosperma* is an essential human micronutrient which support brain function and reproduction and is also required for blood sugar regulation [44].

Humans can use iron for a range of vital processes, including the production of hemoglobin, growth, and sexual maturation [41]. The most significant mineral, zinc, is required for both enzyme catalysis and protein building [45]. Copper which is present in *C. rutidosperma* plant is an essential trace element (i.e. macro-nutrient) that is required for plants, animals and human health. It is also important as a cofactor for brain cells [46]. Minerals found in plants may have a significant impact on the control of numerous critical physiological processes in the bodies of animals that consume them, including the regulation of enzyme activity, skeletal development, neuromuscular irritability, and blood coagulation [47]. Chronic metabolic disorders can result from a lack of any one of the important minerals, which can also harm the health of the organism that is poor in them. Therefore, the presence of all these minerals in *C. rutidosperma* is an indication that it might be useful in treating some metabolic disorders and in maintaining good health.

Conclusion

Since *C. rutidosperma* is very rich in some phytochemicals, it shows its therapeutic physiological action potential on the human system, therefore, it could be a potential source of vital medicines. In addition, *C. rutidosperma* could contribute to meeting human nutritional needs and helps to fight diseases associated with malnutrition since it is very rich in protein, carbohydrate and other nutritional components.

References

1. Quattrocchi U. CRC world dictionary of medicinal and poisonous plants, common names, scientific names, eponyms, synonyms and etymology. Boca Raton, FL: CRC Press, 2012.
2. Archi F, Islam S, Babu Md, Ullah A, Azam S, Chowdhury A, *et al*. Potential evaluation of central nervous system anti-depressant activity of *Cleome rutidosperma* in mice. Biomedical Research and Therapy. 2016;3(10):889-901
3. Okoro I, Umar I, Atawodi SE, Anigo K. Antidiabetic effect of *Cleome rutidosperma* DC and senecio biafrae (Oliv. & Hiern) extracts in streptozotocin-induced diabetic rats. International Journal of Pharmaceutical Sciences and Research. 2014;6:2480.
4. Jansen, PCM. Cleome rutidosperma DC. [Internet] Record from PROTA4U. Grubben, G.J.H. & Denton, O.A. (Editors). PROTA (Plant Resources of Tropical Africa / Ressources végétales de l'Afrique tropicale), Wageningen, Netherlands, 2004. <http://www.prota4u.org/search.asp>. Accessed 18 July 2022.
5. Burkill HM. The useful plant of west tropical Africa. 2nd ed. Kew: Royal Botanical Gardens, 1985.
6. Khuntia A, Mohanty SK, Bose A: Pharmacognostical and preliminary phytochemical investigation of *Cleome rutidosperma* aerial parts. International Journal of Research in Pharmacy and Science. 2013;3(3):67-77.
7. Chakraborty AK, Roy HK. Evaluation of anti-arthritic activity of ethanolic extract of Cleome rutidosperma. Journal of Pharmaceutical Science and Technology. 2010;2(10):330-332.
8. AOAC. Official methods of analysis. (18th ed.). Association of Official Analytical Chemists, Washington DC, 2005.
9. Oshodi AA. Proximate composition, nutritionally valuable minerals and functional properties of *Adenopus breviflorus* benth seed flour and protein concentrate. Food Chemistry. 1992;**45**(2):79–83.
10. Omotoso OT, Adedire CO. Nutrient composition, mineral content and the solubility of the proteins of palm weevil, *Rhynchophorus phoenicis* f. (Coleoptera: Curculionidae). Journal of Zhejiang University Science. 2007;B8:318-322.
11. Tiwari P, Kumar B, Kaur M, Kaur G, Kaur H. Phytochemical screening and extraction: A review. Internationale Pharmaceutica Sciencia. 2011; 1:98-106.
12. Edeoga HO, Okwu DE and Mbaebie BO: Phytochemical constituents of some Nigerian medicinal plants. African Journal of Biotechnology. 2005;4(7):685-688
13. Aiyelaagbe OO, Osamudiamen PM. Phytochemical screening for active compounds in *Magnifera indica* leaves from Ibadan, Oyo State. Plant Sciences Research. 2009;2(1):1-13.
14. Harborne JB. Phytochemical methods. London: Chapman and Hall, Ltd., 1973, 49-188
15. Obadoni BO, Ochuko PO. Phytochemical studies and comparative efficacy of the crude extracts of some homostate plants in Edo and Delta States of Nigeria. Global J. Pure Appl Sci. 2001;8:203-208.
16. Chandra S, Khan S, Avula B, Lata H, Yang MH, Elsohly MA, *et al*. Assessment of total phenolic and flavonoid content, antioxidant properties, and yield of aeroponically and conventionally grown leafy vegetables and fruit crops: A comparative study. Evid. Based Complement Alternat Med, 2014, 253875.
17. Da Silva Raupp D, Rodrigues E, Rockenbach II, Carbonar A, de Campos PF, *et al*. Effect of processing on antioxidant potential and total phenolics content in beet (Beta vulgaris L.). Cienc Tecnol Aliment. 2011;31(3): 688-93.
18. Kubmarawa D, Andenyang IFH, Magomya AM. Proximate composition and amino acid profile of two non-conventional leafy vegetables (*Hibiscus cannabinus* and *Haematostaphis barteri*) African Journal of Food Science. 2009;3(9):233-236.

19. Onimawo IA, Nmerole EC, Idoko PI, Akubor PI. Effects of fermentation on nutrient content and some functional properties of pumpkin seed (*Telfaria occidentalis*). Plant Foods for Human Nutrition. 2003;58:1-9.
20. Pandey M, Abidi AB, Singh S, Singh RPI. Nutritional evaluation of leafy vegetables paratha. Journal Human Ecology. 2006;19(2):155:156
21. Fagbohun ED, Lawal OU, Ore ME. The proximate, mineral and phytochemical analysis of the leaves of *Ocimum gratissimum*, *Melanthera scandens* and *Leea guineensis* and their medicinal values. International Journal of Applied Biology and Pharmaceutical Technology. 2012;3(1):15-22.
22. Hassan LG, Umar KJ. Nutritional Value of Balsam Apple (*Momordica balsamina* L.) Leaves. Pakistan Journal of Nutrition. 2006;5:522-529.
23. Mohammed G, Mann A. Evaluation of the nutritional values of dry season Fadama vegetables in Bida, Nigeria. African Journal of Food Science. 2012;6(11):302-307.
24. Nkafamiya II, Osemeahon SA, Modibbo UU, Aminu A. Nutritional status of non-conventional leafy vegetables, *Ficus asperifolia* and *Ficus sycomorus*. African Journal of Food Science. 2010;4(3):104-108.
25. Ali A. Proximate and mineral composition of the marchubeh (*Asparagus officinalis*). World Dairy and Food Science. 2009;4(2):142-149.
26. Jalili T, Wildman REC, Medeiros DM. Nutraceutical roles ofdietary fibres. Journal of Nutraceutical, Functional and Medicinal Foods. 2000;2(4):19-34.
27. Akindahunsi AA, Salawu SO. Phytochemical screening and nutrient-antinutrient composition of selected tropical green leafy vegetables. African Journal of Biotechnology. 2005;4:497-501.
28. Antia BS, Akpan EJ, Okon PA, Umoren IU. Nutritive and antinutritive evaluation of sweet potatoes (Ipomoea batatas) leaves. Pakistan Journal of Nutrition. 2006;5:166-168
29. Inyang UE. Nutrient content of four lesser known green leafy vegetables consumed by Efik and Ibibio people in Nigeria. Nigerian Journal of Basic and Applied Sciences. 2016;24(1):1-5.
30. Oladele E, Oshodi A. Nutritional potential of berlandier nettle spurge (*Jatropha cathartica*) seed. Pakistan Journal of Nutrition. 2007;6(4):345-348.
31. Adewole E. Phytochemical Evaluation of Phytochemicals of *Cassia podocarpa*. Global Journal of Science Frontier Research: B Chemistry. 2015;15(4). Version 1.0, Global Journals Inc. (USA).
32. Harlina H, Prajitno A, Suprayitno E, Nursyam H. The identification of chemical compound and antibacterial activity test of kopasanda (*Chromolaena Odorata* L.) leaf extract against vibriosis-causing vibrio harveyi (MR 275 Rif) on tiger shrimp. Aquatic Science and Technology. 2013;1(2):2168-9148.
33. Shanmuganathan M, Anand S, Sangeetha KN, Jaiganesh S, Balakrishnan A, Lakshmi, BS. Tannins present in *Cichorium intybus* enhance glucose uptake and inhibit adipogenesis in 3T3-L1 adipocytes through PTP1B inhibition. Chemico-biological interactions. 2008;17:69-78.
34. Debnath B, Patari P, Das M, Maiti D, Manna K. Estimation of alkaloids and phenolics of five edible cucurbitaceous plants and their antibacterial activity Original Article. International Journal of Pharmacy and Pharmaceutical Sciences. 2015;7:223-227.
35. Sofowora, A medicinal plants and traditional medicine practice in Africa. Ibadan, Spectrum Books Limited.
36. Okwu DE, Phytochemicals and vitamin content of indigenous species of south eastern Nigeria. Journal of Sustainable Agricultural Environment. 2004;6(1):30-37.
37. Chandra S, Khan S, Avula B, Lata H, Yang M, Elsohly M, *et al*. Assessment of total phenolic and flavonoid content, antioxidant properties, and yield of aeroponically and conventionally grown leafy vegetables and fruit crops: A comparative study. Evidence-based complementary and alternative medicine: eCAM. 2014. 253875. 10.1155/2014/253875.
38. Okoli BJ, Okere OS. Antimicrobial activity of the phytochemical constituents of *Chrysophyllum albidum* G. Don_Holl. (African star apple) plant. Journal of Research of the National Institute of Standards and Technology. 2010;8:1-7.
39. Toyoshima C, Nakasako M, Nomura H, Ogawa H. Crystal structure of the calcium pump of sarcoplasmic reticulum at 2.6 A resolution. Nature. 2000;405:647-655.
40. Pohl H, Wheeler J, Murray H. Sodium and potassium in health and disease. Metal Ions in Life Sciences. 2013;13:29-47.
41. Uzoekwe NM, Mohammed JJ. Phytochemical, proximate and mineral contents of leaves and bark of *Ficus capensis*. J. Appl. Sci. Environ. Manage. 2015;19(4):633-637.
42. Payandeh J, Pfoh R, Pai EF. The structure and regulation of magnesium selective ion channels. Biochimica et Biophysica Acta. 2013;1828(11):2778-9.
43. Censani M, Gallagher MP, Chung WK, Oberfield SE. Endocrinology and metabolism. In: Polin RA, Spitzer AR, editors. Fetal and neonatal secrets. 3rd ed. Mosby, 2014, 155-180.
44. Vincente AR, Manganaris GA, Ortiz C, Sozzi G, Crisosto CH. Nutritional quality of fruits and vegetables. In: Florkowski WJ, Shewfelt RL, Brueckner B, Prussia SE, editors. Postharvest Handling: A Systems Approach, 3rd ed. Academic Press, 2014, 69-122.
45. Auld DS. Zinc coordination sphere in biochemical zinc sites. BioMetals. 2001;14(3-4):271-313.
46. Scheiber IF, Dringen R. Astrocyte functions in the copper homeostasis of the brain. Neurochem. Int. 2013;62(5):556-565.
47. Kalita P, Mukhopadhyay PK, Mukherjee AK. Evaluation of the nutritional quality of four unexplored aquatic weeds from northeast India for the formulation of cost effective fish feeds. Food Chem. 2007;103:204-209.