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# Proximate Composition, Mineral and Phytochemical Contents of Some Leafy Vegetables Native to Igala Kingdom Kogi State Nigeria

**Opega Justina Ladi[1*], Orishagbebmi Cornelius Ojo[1], Yusufu Peter Awodi[1] and Ishaka Nurudeen Alfa[1]**

*[1]Department of Food, Nutrition and Home Sciences, Faculty of Agriculture, Kogi State University, Anyigba, Kogi State, Nigeria.*

***Authors' contributions***

*This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

The proximate composition, minerals and phytochemical contents of some leafy vegetables native to Igala land were determined. It was designed to establish the nutritional value and inclusion in food composition table for use by nutritionists and dieticians. Fresh vegetable samples (cocoyam, eggplant leaf, sweet potato leaf, fluted pumpkins, camwood, spinach, drum stick, jute mallow, basil plant leaf and bitter leaf) were obtained from gardens and vegetable shops of Igalas at Anyigba. They were washed and dried and standard methods were used for the analysis. Triplicate values were obtained in each case and expressed on dry weight basis. All data obtained were analyzed statistically using SPSS version 17.0 package. Means and standard deviation were calculated at significant level of $p \leq 0.001$. Among the vegetable samples, crude fibre contents ranged from (26.7 to 8.0%), Ash (15.2 to 5.1%), moisture (5.3 to 1.52±0.02%), fat 4.1 to 1.3%, protein (25.1 to 9.2%) and carbohydrates, (67.2 to 8.04%). Phytochemical contents (mg/100 g) included Phenolic

**Corresponding author: E-mail: opega.jl@ksu.edu.ng, ladiopega2011@yahoo.com;*

acid (312.6 to 10.1) flavonoid was (420.7 to 2.6) alkaloid (9.7 to 2.6), oxalate (0.9 to 0.003). Tannin (36.20 to 0.03), Saponin was (5.20 to 0.0), Phytates (2.02 to 0.06) and Cyanides was (0.5 to 0.05). Mineral contents mg / 2 g included: sodium (0.08 to 0.001), potassium content included (0.3 to 0.002), calcium (0.06 to 0.02), magnesium (0.06 to 0.00) and phosphorus was (0.06 to 0.02). Drumstick contained the highest crude fibre, protein, potassium, magnesium and phytate contents while ash contents were higher in fluted pumpkins. All the leafy vegetables considered, phytochemical contents were within an allowable level for safety.

*Keywords: Chemical analysis; proximate; phytochemicals; minerals; leafy vegetables.*

## 1. INTRODUCTION

Leafy vegetables are low in fat and high in protein and dietary fibre and they are rich sources of minerals (calcium, potassium and magnesium) and vitamins and high in phytochemicals [1]. Vegetables contain bioactive compounds which protect the body from nutritional deficiency diseases [2] and free radicals that cause oxidative damage to cells. Vegetables are important foods both from economic and nutritional stand points. Their nutritive significance is the richness in minerals which is very essential in the maintenance of human health [3], they are important component of healthy diet, if consumed daily in sufficient amounts, could help to prevent major diseases such as cardiovascular diseases and certain cancers [4]. Vegetables are at their best when tender or succulent. Many of them can easily be grown in home gardens thus, provide economic, easy access and handy sources of fresh, unprocessed vegetables with active enzymes and nutrients [5]. In Nigeria; vegetables are used in dishes for soups (melon or egusi, ogbono (*Trvingia gabonensis*) and vegetable soups for the consumption of the main dishes (fufu, pounded yam, garri and akpu) and others.

Most of the vegetables available in Igala land are potent bioactive compounds found in medicinal plant parts that can be used for therapeutic purpose or as precursors for the synthesis of useful drugs [6].

The feeling of fullness produced by intake of vegetables helps in controlling overweight and obesity since they are low in calories and high in fibres. From the economic point of view, vegetables quench hunger due to their satiety factor [7]. Some of the green leafy vegetables native to Igala land are cocoyam leaf (*Colocacial esculentus*), egg plant leaf (*Solanum incamum*), bitter leaf (*Vernonia amygdalina),* sweet potato leaf (*Ipomoea batatas*), fluted pumpkin leaf (*Telferia occidentalis*). Others include camwood leaf (*Pterocaptus soyanxii*), spinach (*Amaranthus chlosostachys*), drumstick (*Moringa oleifera*) jute mallow (*Cochorus olitoius*), and basil plant leaf (*Occimum bacilicum*) [8]. Therefore, this work aimed at establishing the quantitative nutrient contents, phytochemical and minerals in the leafy vegetables available in Igala land.

## 2. MATERIALS AND METHODS

### 2.1 Sample Collection

Ten leafy vegetable were harvested and purchased from gardens and shops of Igalas, drum sticks, sweet potato leaf, basil plant leaf, cocoyam leaf and jute mallow were harvested from gardens adjacent to various homes of Igalas while (eggplant, camwood, spinach, fluted pumpkins, and bitter leaf) were procured from only Igala vegetable shops. Both harvested and purchased samples were identified by experts.

### 2.2 Preparation of Samples

Samples were trimmed, washed and drained as described by [9] and air dried to prevent loss in nutrients and color. Each sample was milled into fine powder using type 8 k 31 Kenwood blender and packaged in plastic bags to prevent moisture absorption, contamination and also labeled for easy identification and kept refrigerated at 10±2 for not longer than two weeks prior to proximate, phytochemical and minerals analyses using standard methods. Triplicate values were obtained for each sample.

### 2.3 Ash Content Determination

Ash content was determined; using incineration at 600℃ in a muffle furnace, according to the method described by [10]. Two grams of each sample was weighed into a weighed and ignited tarred crucible ($w_1$). The crucible and weighed sample were placed on a hot plate inside a fume cupboard to prevent smoke accumulation, the remaining residue was transferred to a preheated

muffle furnace and maintained at 600℃ for 6 hours to ash until the sample was reduced to a light ash, the crucible was removed, placed in the desiccators, cooled and weighed ($w_2$) and the ash content was calculated:

$$\% \text{ Ash (on dry basis)} = \frac{`N_2\text{-}w_1 \times 100}{2.0 \text{ g}}$$

## 2.4 Fat Content Determination

Fat content was estimated using Soxhlet extraction method according to [11]. Two grams of the sample was weighed into a thimble ($w_1$), dried and cooled boiling flask was weighed, filled with 300 mL petroleum ether ($w_2$) and boiled at 60℃ with the extraction thimble in soxhlet apparatus which was allowed to reflux for 6 hours. The thimble was carefully removed, while the extracted oil in the petroleum ether flask was dried between 105-110℃ for 1 hour. It was then transferred from the oven to the desiccators, cooled, weighed and calculated as below;

$$\% \text{ fat} = \frac{w_2 - w_1 \times 100}{\text{Weight of sample (2.0 g)}}$$

## 2.5 Crude Protein Determination

The crude protein of the sample was determined using the micro–Kjeldahl method described by [12]. Two grams was weighed along with 20 mL of distilled water into a micro – Kjeldahl digestion flask. It was shaken and allowed to stand for some times. One tablet of selenium catalyst and 20 mL tetra oxo sulphate (vi) acids were added. The flask was heated on the digestion block at 100℃ for 4 hours until the digest became clear. The flask was removed from the block and allowed to cool and the content was transferred into 50 mL volumetric flask and diluted to the mark with water.

An aliquot of the digest (10 mL) was transferred into another micro-Kjeldahl flask along with 20 mL of distilled water, placed in the distilling outlet of the micro – Kjeldahl distillation unit. A conical flask containing 20 mL of boric acid indicator was placed under the condenser outlet and sodium hydroxide solution of 20 mL was added to the content in the Kjeldahl flask by opening the funnel stopcock. The distillation started and the heat supplied was regulated to avoid sucking back. Distillate was collected in 4% boric acid and the distillation was stopped. Nitrogen in the distillate was determined by titrating with 0.014 M of $H_2SO_4$; the end point was obtained when the color of the distillate changed from green to pink.

Calculation;

% Crude protein = % N x 6.25 (conversion factor)

The nitrogen content of the sample is given by the formula below.

% N = TV x Na x 0.014 x V1 x 100 x G x V2

Where

TV = Titre value of acid ($cm^3$)
Na = Normality of acid
V1 = Volume of distilled water used for distilling the digest (50 mL).
V2 = Volume of aliquot used for distillation (10 mL)
G = Original weight of sample grams

## 2.6 Determination of Moisture Contents

Moisture content of each sample was determined as described by [13] using vacuum oven method. Two grams of the sample was rapidly weighed into a pre-weighed dried dish ($w_1$) and weighed with the dish ($W_2$) It was dried to a constant weight at 100℃ at a pressure that was not exceeding 100 $mH_g$ for 5 hours. When the drying procedures were completed, the dish was placed in the desiccators to cool and reweighed ($W_3$) and the recorded loss in weight, was the moisture. The percentage moisture was calculated as below;

$$\% \text{ moisture} = \frac{w_2\text{-}w_1 \times 100}{W_3\text{-}w_1}$$

Where;

$W_1$ = Initial weight of the empty crucible
$W_2$ = Weight of the crucible plus (+) the sample before drying
$W_3$ = Final weight of crucible + sample after drying

% total solid (dry matter) = 100 % moisture.

## 2.7 Crude Fiber Determination

A non-enzymatic method of [14] was used to determine crude fiber content. Two grams of the dried sample was defatted with petroleum ether and boiled under reflux for 30 minutes with 200

mL of solution containing 1.5 g of $H_2SO_4$ /100 mL of the solution. The solution was filtered through linen on a fluted funnel and washed with boiling water until the washing was no longer acidic. The residue was transferred to a beaker and boiled for 30 minutes in 200 mL of solution containing 1.25 g of carbonate-free NaOH per 100 mL. Final residue was filtered through a thin but closed pad of washed and ignited asbestos in porcelain crucible. It was dried in electric oven, weighed, incinerated, cooled and reweighed;

The loss in the weight after incineration x 100 was calculated as the percentage (%) of the crude fiber.

$$\% \text{ crude fiber} = \frac{\text{Loss in weight (g) x 100}}{\text{Original mass (2.0)}}$$

## 2.8 Carbohydrate Content Determination

Carbohydrate content was determined by difference as described [15] where the total proportion of carbohydrate in the sample was obtained by calculation, using the percentage weight method by subtracting the % sum of food nutrients: (% protein, % crude fiber, fat % and % ash %) from 100%. Where, percentage (%) of carbohydrates (=) (CF + CP + F + A + M – 100 %) where; CF = Crude Fibre, CP= Crude Protein, M = Moisture, F = Fat and A = Ash.

Note: Triplicate values were obtained for each sample.

## 2.9 Phytochemical Analysis Procedures

### 2.9.1 Phytic acid determination

Phytic acid was determined using the procedures described by [11]. Two gram of each sample was weighed into 250 mL conical flask. One hundred mills of 2% concentrated hydrochloric acid was used to soak the sample in the conical flask for 3 hours. It was filtered through a double layer of hardened filter papers. Fifty milliliters of each filtrate was placed in 250 mL beaker and 107 ml of distilled water was added in each case to give proper acidity. Ten milliliters of 0.3% Ammonium thiocyanate solution indicator was added. It was titrated with standard iron chloride solution, which contained 0.00195 g iron/mL. The end point was slightly brownish-yellow and persisted for 5 minutes. The percentage (%) phytic acid was calculated using the following formula;

% phytic acid =.r. x 1.19 x 100 where x = titer value x 0.00195 g

## 2.10 Oxalate Estimation

Oxalate determination was carried out using methods described by [11]. Two grams of each sample was boiled in 40 ml distilled water for 30 minutes in a reflux condenser. A total of 10 ml of 20% $Na_2CO_3$ was added and boiled for another 30 minutes. The resulting mixture was filtered and the residue was washed repeatedly with hot water until neutral $p^H$ is achieved. The filtrates were concentrated to a small volume and cooled with constant stirring. Hydrochloric acid (HCl) was added, (1:1) dropwise until the final acid concentration after neutralization was 1%. The precipitate was allowed to flocculate and the extract carefully filtered into a 250 mL flask and made-up to mark. It was kept overnight and supernatant liquid was filtered through a dry filter paper in a dry beaker. An aliquot of this filtrate was taken into a 400 mL beaker, diluted with water to 200 mL and made just ammonia cal to re-acidify with acetic acid. In the cold medium, 10 mL of 10% calcium chloride solution was added and stirred well to induce calcium oxalate precipitate to appear, it was allowed to stay overnight. The clear supernatant liquid was decanted off through whatman No. 42 and the precipitate was dissolved in HCl acid (1:1). Oxalic acid was re-precipitated by adjusting the $p^H$ with ammonia hydroxide solution. Content was boiled and allowed to settle overnight. Oxalic acid was determined by titrating against 0.05N$KMnO_4$, solution.

**Calculation;**

1 ml of 0.05N $KMn0_4$ = 0.00225 g anhydrous oxalic acid.

$$\% \text{ Oxalic acid} = \frac{\text{itre value x 0.00225}}{2} = \text{T.V x 0.1125.}$$

Where, T.V= Titre value

## 2.11Tannic Acid Determination

The total tannin content was determined according to method described by [16]. This involved the use of butanol /HCl reagent (95.5 w/v and 37% HCl) and ferric reagent (2% ferric ammonia sulphate in $NH_4Cl$) where 0.5 mL of extract was diluted with 70% acetone to make absorbance not to exceed 0.6 in a tube of 30 mL. and incubated at 97-100℃ for 60 minutes. The tube was cooled and read absorbance at A550 nm using unheated suitable blank and condensed tannin (96% of dry matter) and

calculated using; A55onm x 78.26 x dilution factor.

Where; 1 cm, 550 nm of leuccocyanidin = 406. (The formula assumed that 1 cm, 550 nm of leucocyanidin is equal to 460) and A = absorbance

## 2.12 Flavonoid Determination

Flavonoid was determined using spectrophotometer (Aluminum chloride method) as described by [17]. Nine milliliter of the sample was weighed and treated with ethyl acetate and mixed with 1 mL of Aluminum chloride ($AlCl_3$) and methanolic solution (2% w/v) incubated at a room temperature for 15 minutes, the absorbance was read at 430 nm. The amount of the TFC (total flavonoid contents) was estimated from the standard calibration curve of 10 - 100 µg/ mL – 1 quercetin.

## 2.13 Saponin Contents Determination

Saponin content was determined as described by [18]. Five grams of each sample was dispersed in 50 mL of 20% ethanol. The suspension was heated over a hot water bath for 4 hours with continuous stirring at 55℃. The mixture was filtered and the residue re- extracted with another 200 ml of ethanol prepared in distilled water (20% v/v). The combined extracts were reduced to 40 mL over water bath at 90℃ and the concentrate was transferred into 250 ml separator funnel, 20 mL of diethyl ether was added and shaken vigorously. The aqueous layer was recovered while the ether layer was discarded. The purification process was repeated and 60 mL of n-butanol was added and the mixture was washed twice with 10 mL of 5% aqueous sodium chloride. The remaining solution was heated in a water bath at 90℃. Samples were dried in an oven at 100℃ until a constant weight was obtained and Saponin content was calculated in percentage.

$$(\%)\ \text{Saponin} = \frac{\text{absorbance of sample x gradient factor x Dilution factor}}{\text{Wt of sample x 10,000}}$$

## 2.14 Determination of Phenolic Acid

Total phenol contents was determined using the procedures described by [19] 1 mL aliquot of the extracts were taken into 10 mL glass tube and made up to a volume of 3 mL with distilled water, 5 mL of Folin Ciocalteau reagent (1:1) with water and 2 mL. 20% of $Na_2CO_3$ were added sequentially in each tube. Blue color was developed in each tube because the phenols undergo a complex redox-reaction with phosphomolibdic acid in Folin Ciocalteau reagent in alkaline medium resulted in blue colored complex molybdenum blue. The test solutions were warmed for 1 minute, cooled and absorbance was measured at 650 nm against the reagent, used as blank. A standard calibration plot was generated at 650 nm using a concentration of catechol. The concentration of phenol in the test samples were calculated from the calibration plot and expressed as mg catechol equivalent of phenol/100 g of sample.

## 2.15 Alkaloid Determination

Alkaloid was determined using gravimetric method, [20], 2.0 g of sample was weighed ($w_1$) and dispensed into 50 ml of 10% acetic acid solution in ethanol. The mixture was well shaken and allowed to stand for 4 hours and filtered. The filtrate was evaporated to ¼ of its original volume. Concentrated $NH_4OH$ was added and alkaloid precipitated. The filter paper was weighed ($w_2$) and the precipitate was scrapped off and washed with 1% $NH_4OH$ solution. This was weighed with filter paper ($w_3$); the precipitate was dried in a filter paper in the oven at 60℃ for 30 minutes and reweighed ($w_4$). By weight difference, the weight of the alkaloid was determined and expressed as a percentage of sample weight analyzed, given by formula

$$\%\ \text{Alkaloid} = \frac{W_1 - W_2\ X\ 100}{W_3.w_4}$$

Where

$W_1$ = Weight of sample
$W_2$ = Weight of empty filter paper
$W_3$ = Weight of filter paper+ precipitate before drying.
$W_4$ = weight of filter paper+ precipitate after drying

Triplicate values were obtained for each sample

## 2.16 Cyanide Determination

Total cyanide was determined by the pH-differential method as described by [21] two buffer system:

1. Potassium chloride buffer pH 1.0 M and sodium acetate buffer $p^H$ 4.5 M. 0.4 ml of the extract was mixed with 3.6 ml of corresponding buffers and read against a blank at 510 nm and 700 nm, Absorbance (A) was calculated as follows;

A = (510 – A700) $p^H$ 1.0 – (510 – A700) pH 4.5 Cyanide (mg/l) = A x MW x DF x 1000 (Mn x 1.0)

Where,

A = absorbance
MW = molecular formula (449.2)
DF = dilution factor
MA = molecular absorptive (26, 900)

## 2.17 Mineral Analysis

Sodium, Potassium, Calcium and Magnesium Mineral contents of the samples were determined using triple acid digestion method of [22]. 2.0 g of the samples were weighed into a micro-Kjeldahl digestion flask to which 24 mL of mixture of concentrated $HNO^3$, $H_2SO_4$, and 60% $HclO_4$ (9:2:1 v/v) were added. The flask was put on the heating block and digested to a clear solution, cooled and the content was transferred into 50 mL volumetric flask and made-up to the volume mark with water.

## 2.18 Phosphorus Determination

Phosphorous was determined using [23] methods. Digested supernatant solution (2 mL) was placed into 50 $cm^3$ volumetric flask, 2 mL of sample and 2 $cm^3$ of ammonium molybdate solution were added with distilled water to make-up to 48 mL, the content was mixed and 1 mL of diluted stannous chloride solution was added and mixed, then 1 mL of distilled water was added to make-up to 50 mL marked and left to stand for 5 minutes. The % absorbance on spectrophotometer at 660 nm wavelength was used to determine the concentration of phosphorus.

Triplicate values were obtained for each sample.

## 2.19 Statistical Analysis

All data obtained were analyzed statistically, using SPSS version 17.0 package. Means were separated using [24] multiple comparison test at $P < 0.05$.

## 3. RESULTS

Table 1 represents the proximate composition of ten (10) leafy vegetables native to Igala kingdom Kogi state. Ash contents ranged between (15.2 to 5.1%), Crude fiber contents (26.7 g to 8.0%), moisture (5.3 to 1.52%), fat (4.1 to 1.3%), proteins (25.1 to 9.2%) and carbohydrates, (69.49 to 40.2.04%).

Table 2 represents the phytochemical contents of ten (10) leafy vegetables obtained; Phenolic acid (312.6 to 10.1 mg), flavonoid was (420.7 to 2.6 mg), alkaloid (9.7 to 2.6 mg) oxalate (0.9 to 0.003 mg). Tannin included (36.20 to 0.03 mg), Saponin (5.20 to 0. 0 mg), Phytates [2.02 to 0.06 mg] and Cyanides was (0.5 to 0.05 mg).

## 3.1 Mineral Contents of Leafy Vegetables Common in Igala Land

Table 3 represents the mineral contents of ten (10) leafy vegetables native to Igala kingdom Kogi state: sodium (0.08 to 0.01 mg) potassium (0.3 to 0.002 mg) calcium (0.06 to 0.02 mg) magnesium (0.06 to 0.002 mg), phosphorus (0.06 to 0.02 mg).

**Table 1. Proximate composition of ten vegetables native to Igala land (%) dry basis**

| Sample code | Moisture | Ash | Crude fiber | Fats | Protein | Cabohydrate |
|---|---|---|---|---|---|---|
| 212 | 2.7±0.03[a] | 5.1±0.01[a] | 8.05 ± 0.05 [a] | 2.2±0.17 [b] | 9.2±o.1 b | 69.48±0.08[a] |
| 213 | 5.3±0.2 [a] | 12.1 ± 0.2 [a] | 11..2 ± 0.8 [b] | 2.1 ± 0.0 [b] | 20.1 ± 1.0 [b] | 49.2 ± 0.11 [a] |
| 214 | 1.8±0.04 [a] | 9.2±0.11[a] | 12.1 ± 0.08[b] | 2.1±0.06 [b] | 20.10±5.00[b] | 54.5±0.3 [a] |
| 215 | 2.7±0.17 | 6.7±0.2 [b] | 15.1 ± o.1[a] | 1.9±1.6 [b] | 9.11±0.1 [b] | 64.1±0.3 [a] |
| 216 | [a]1.52±0.0[b] | 3.4±1.05 [a] | 26.7±0.2 [a] | 3.02±0.0 [a] | 25.1±1.1 [b] | 40.2±0.9 [a] |
| 217 | *1.77±0.3* [a] | 7.2±0.3 [a] | 12. 18±0.2[a] | 1.5±0.07 [b] | 10.10±0.2 [b] | 67.3±0.1 [a] |
| 218 | 2.5 ± 0.01[a] | 15.2±0.1[a] | 12.2±0.06 [a] | 1.80±0.07[b] | 14.5±0.2 [b] | 53.70±0.05[a] |
| 219 | 4.6±0.01[a] | 7.5±.0.03 [b] | 18.1±0.04 [a] | 4.1±0.0 [a] | 11.30 ± 0.2 [b] | 54.1±0.2 [a] |
| 220 | 5.1±0.1[a] | 5.9±0.1[c] | 11.8±0.9 [b] | 1.3±0.09 [b] | 13.4±0.01 [b] | 62.5±0.02 [a] |
| 221 | 1.6±0.04[b] | 11.2±0.05 [a] | 11.6±0.3 [b] | 1.9±1.59 [b] | 23.4±0.06 [b] | 50.1±0.2 [a] |

*Values represent means of triplicate values ± sd (standard deviation)*
*Sample means with the same superscripts in a Column are not significantly different p≥0.05*

***Sample code*** ***Sample code*** ***Sample code***

*212 = (BASIL PLANT LEAF)*
*218 = (FLUTED PUMPKINS)* *a = (significant ≥0.01)*
*213 = (BITTER LEAF)* *219 = (JUTE MALLOW)* *b = (not significant ≥0.05)*
*214 = (CAMWOOD PLANT LEAF)* *220 = (SPINACH)* *c = weak significant*
*215 = (COCOYAM LEAF)* *221 = (SWEET POTATO LEAF)* *± = Data expressed as mean ±*
*216 = (DRUMSTICK)*
*217 = (EGG PLANT LEAF).*

**Table 2. Phytochemical contents of ten leafy vegetables common in Igala land (mg/100) powdered sample**

| Sample code | Cyanide | Saponin | Tannin | Phytate | Oxalate | Flavonoid | Phenol | Alkaloids |
|---|---|---|---|---|---|---|---|---|
| 212 | 0.14 ± 0.03$^{a}$ | 1.03±0.04 $^{b}$ | 1.1±0.01$^{b}$ | 1.3 ± 0.05$^{b}$ | 0.08 ±0.01$^{b}$ | 6.2 ± 0.1$^{c}$ | 247.4±1.20 $^{a}$ | 5.0 ± 0.01$^{b}$ |
| 213 | 0.1 ± 0.05$^{a}$ | 5.20 ± 0.91$^{a}$ | 36.2±0.1$^{b}$ | 1.06 ± 0.06$^{a}$ | 0.06 ± 0.01$^{b}$ | 420.7 ± 0.1$^{a}$ | 15.2 ± 1.5 $^{a}$ | 4.20± 0.1$^{b}$ |
| 214 | 0.1 ± 0.02$^{a}$ | 1.2±0.15 $^{b}$ | 3.08±0.07 $^{b}$ | 1.0±0.01$^{a}$ | 0.9 ± 0.02$^{b}$ | 6.7±0.02 $^{b}$ | 200.38±0.01$^{a}$ | 2.6±0.17$^{a}$ |
| 215 | 0.2 1 ±0.3$^{a}$ | 0. 00 $^{a}$ | 1.28±0.1$^{b}$ | 1.19±0.1$^{a}$ | 0.07 ± 0.07$^{b}$ | 2.9±0.07 $^{a}$ | 230.4±0.9$^{a}$ | 9.6±0.3$^{a}$ |
| 216 | 0.1 ± 0.01$^{a}$ | 1.07±0.05$^{b}$ | 0.85 ± 0.0 $^{b}$ | 11.4 6± 0.05$^{b}$ | 0.08 ± 0.03$^{b}$ | 8.9 ± 0.5$^{c}$ | 312.6 ± 0.1$^{a}$ | 4.6 ± 0.2$^{a}$ |
| 217 | 0.5 ± 0.9 $^{a}$ | 1.07 ± 0.02$^{a}$ | 1.4 ± 1.4$^{b}$ | 1.5 ± 0.05$^{a}$ | 0.07 ± 0.01$^{b}$ | 7.5 ± 0.4$^{a}$ | 226.4 ± 1$^{a}$ | 4.2 ± 0.2$^{b}$ |
| 218 | 0.3 ± 0.03$^{c}$ | 0.00 $^{a}$ | 1.28 ±. 0.3$^{b}$ | 2.02 ±0.01$^{a}$ | 0.05±0.26$^{b}$ | 5.3±0.02$^{a}$ | 134.2±0.26$^{a}$ | 4.40±0. 01$^{b}$ |
| 219 | 0.05± 0.01$^{a}$ | 1.5±0.4 $^{b}$ | 0.4±0.01$^{b}$ | 0.4±0.0 $^{a}$ | 0.007 ±0. 01$^{b}$ | 2.6±0.4$^{a}$ | 175.3±0.01$^{a}$ | 4.4±10.1$^{b}$. |
| 220 | 0.07 ± 0.02$^{a}$ | 1.5 ± 0.01$^{b}$ | 0.25 ± 0.01$^{b}$ | 0.06 ± 0.06$^{a}$ | 0.003 ±0.004$^{b}$ | 346.5±.0.3$^{a}$ | 10.1±0.3 $^{a}$ | 9.7±0.03$^{a}$ |
| 221 | 0.2 ± 0.02 $^{a}$ | 2.2±0.04 $^{a}$ | 0.03 ± 0.02$^{b}$ | 0.15 ± .04$^{a}$ | 0.2±0.013$^{b}$ | 350.6±0.4$^{a}$ | 16.7±0.55$^{a}$ | 5.6±1.7$^{b}$ |

*Values represent means of triplicate values ± sd (standard deviation)*
*Sample means with the same superscripts in a Column are not significantly different p≥0.05*

| ***Sample code*** | ***Sample code*** | ***Sample code*** |
|---|---|---|
| *212 = (BASIL PLANT LEAF)* | *218 = (FLUTED PUMPKINS)* | *a = (significant ≥0.01)* |
| *213 = (BITTER LEAF)* | *219 = (JUTE MALLOW)* | *b = (not significant ≥0.05)* |
| *214 = (CAMWOOD PLANT LEAF)* | *220 = (SPINACH)* | *c = weak significant* |
| *215 = (COCOYAM LEAF)* | *221 = (SWEET POTATO LEAF)* | *± = Data expressed as mean ±* |
| *216 = (DRUMSTICK)* | | |
| *217 = (EGG PLANT LEAF).* | | |

**Table 3. Mineral contents of ten vegetables common in Igala land (mg/20) powdered sample**

| Sample code | Sodium (mg/20) | Potassium (mg/20) | Calcium (mg/20) | Magnesium (mg/20) | Phosphorous (mg/20) |
|---|---|---|---|---|---|
| 212 | 0.02±0.005 $^{b}$ | 0.1±0.01$^{b}$ | 0.06±0.01$^{c}$ | 0.04±0.30 $^{b}$ | 0.043±0.03 $^{a}$ |
| 213 | 0.006±0.03$^{b}$ | 0.06±0.02$^{b}$ | 0.02±0.006$^{b}$ | 0.03±0.006 $^{b}$ | 0.02±0.01 $^{b}$ |
| 214 | 0.002±0.04$^{b}$ | 0.02±0.03$^{b}$ | 0.02±0.003$^{b}$ | 0.002±0.03 $^{b}$ | 0.04±0.015$^{a}$ |
| 215 | 0.080±0.01$^{b}$ | 0.08±0.015$^{b}$ | 0.02±0.003$^{c}$ | 0.02±0.006 $^{b}$ | 0.03±0.01$^{b}$ |
| 216 | 0.009±0.01$^{b}$ | 0.27±0.11$^{b}$ | 0.02±0.005$^{c}$ | 0.06±0.02 $^{b}$ | 0.03±0.20 $^{b}$ |
| 217 | 0.001±0.003$^{b}$ | 0.3±0.06$^{b}$ | 0.05±0.005$^{b}$ | 0.05±0.0005 $^{b}$ | 0.03±0.005$^{b}$ |
| 218 | 0.001±0.003 $^{b}$ | 0.08±0.06$^{b}$ | 0.02±0.006$^{c}$ | 0.02±0.01 $^{b}$ | 0.30±0.06 $^{a}$ |
| 219 | 0.01±0.04$^{b}$ | 0.07±0.01 $^{b}$ | 0.03±0.07$^{b}$ | 0.04±0.02 $^{b}$ | 0.03±0.01 $^{a}$ |
| 220 | 0.002±0.005 $^{b}$ | 0.1±0.01 $^{b}$ | 0.02±0.01$^{c}$ | 0.02±0.005 $^{b}$ | 0.06±0.01$^{b}$ |
| 221 | 0.003±0.01$^{b}$ | 0.1±0.01 $^{b}$ | 0.02±0.003 $^{b}$ | 0.04±0.05 $^{b}$ | 0.02±0.01$^{a}$ |

Values represent means of triplicate value± sd (standard deviation)
Sample means with the same superscripts in a Column are not significantly different p≥0.05

| ***Sample code*** | ***Sample code*** | ***Sample code*** |
|---|---|---|
| *212 = (BASIL PLANT LEAF)* | *218 = (FLUTED PUMPKINS)* | *a = (significant ≥0.01)* |
| *213 = (BITTER LEAF)* | *219 = (JUTE MALLOW)* | *b = (not significant ≥0.05)* |
| *214 = (CAMWOOD PLANT LEAF)* | *220 = (SPINACH)* | *c = weak significant* |
| *215 = (COCOYAM LEAF)* | *221 = (SWEET POTATO LEAF)* | *± = Data expressed as mean ±* |
| *216 = (DRUMSTICK)* | | |
| *217 = (EGG PLANT LEAF).* | | |

## 4. DISCUSSION

### 4.1 Proximate Composition of Leafy Vegetable Common in Igala Land

Proximate composition of ten (10) studied leafy vegetables (%) on dry basis, showed drumstick [coded sample 216] contained highest amount of crude fiber with (26.7 ± 0.2%) and protein [25.1±1.1%] values respectively. The fiber content signified that the leaves of drumstick can be used to reduce incidence of duodenal ulcer. The finding agrees with the results of [25] in a study where intake of high fiber diet of 28.2 g/day for 6 months lowered incidence of duodenal ulcer recurrence. Also, [26] reported that high crude fibre in jute mallow decreased blood sugar level and cardiovascular diseases. [27] Reported that a total dietary fibre of 20 g to 25 g/day can prevent obesity, diabetes and cancers, the findings in this study showed that drumstick contained the highest amount of crude fiber therefore, it could be suitable for prevention of duodenal ulcer, hyperglycemia, obesity, diabetes, cancers and other related disorders. The significant difference at p≤0.001 for fibre content at various levels indicated that the samples are good source of vegetable exchange list that can be used in cases of allergy.

The Recommended Dietary Allowance (RDA) for protein is in the range of 28-65 g for children, lactating mothers, pregnant women and adults [28] also [29] reported that high protein of 1.8 g / kg is required in postoperative nutrition, the protein content of [25.1±1.1%] in drumstick in this current study is reasonably high and adequate. Therefore, it could be referenced for use in disease condition and for management of other nutritional related diseases. Fluted pumpkin has the highest amount of Ash [15.2%] and drumstick [3.4±1.05%] the least. The highest moisture content occurred in bitter leaf [5.3±0.2%] and lowest in drumstick (1.52±0.02%). Vegetable studied generally have low moisture which is an index of extended shelf life also according to [30] and [31] Low moisture content after dehydration provides concentrated nutrients while high moisture enhances water activities that can increase spoilage therefore; the low moisture content of the leafy vegetables studied can encourage the keeping quality through prevention of the growth of microorganisms, and conservation of nutrients that can prevent/ reverse nutritional related diseases. Fat contents for all vegetable samples were all low; jute mallow contained the highest amount [4.1±0.0%] and least in spinach (1.3±0.09%). The low fat content of the vegetables revealed in this study can be referenced in prevention of chronic diseases such as liver cirrhosis, diabetes and cardiovascular diseases [32] and [33]. Carbohydrates in basil [sample coded 212] is [69.48±0.008%], which is reasonably high and could be suitable for active man of 36-40 years with total intake of 2,800 kcl /day. The findings in this study is evidenced and also in agreement with [34].

### 4.2 Phytochemical Contents of Leafy Vegetables Common in Igala Land

Phytochemical contents of ten leafy vegetables showed that flavonoid in bitter leaf [420.7 ± 0.1 mg] was high but, the least compared to camwood, phenolic acid was the highest in drumstick [312.6] but, lower compared to spinach while values for all the vegetables were extremely significant at p ≤ 0.01. Alkaloid in spinach [9.7±0.03 mg] was found to be the highest but camwood leaf the least. However, there existed significant difference at p≥0.01. Oxalate [0.9 ± 0.02 mg] was highest in camwood but, lowest in spinach. The result also showed that tannin was high in bitter leaf [36.20±0.1 mg] with the least amount in sweet potato but, were not significantly different at p ≤ 0.05, Saponin [5.20 ± 0.91 mg] was higher in bitter leaf while both cocoyam and fluted pumpkins were the lowest, with 0.00 value each though significant at p≤0.001. Drumstick contained highest amount of Phytate [2.02 ±0.01 mg] of which sweet potato was the least; cyanide was [0.5 ± 0.9 mg], highest in eggplant and least amount was found in jute mallow. The contents of phytochemical indicated the presence of high anti-nutrients at various concentrations which could be harmful to human if consumed raw but, could be reduced to safety level through processing of the vegetables by various blanching and abrasion [35]. According to [36] in the study of effect of processing methods, on the nutritional contents of bitter leaf it was reported that boiling, cooking and other heat processing techniques reduced anti-nutrient (Saponin, tannin, Phytates and alkaloids, oxalate and cyanide) in vegetables. This study showed that other phytochemical with minimal amount are negligible and could not course any harmful effects if consumed by humans. Hypoglycemic effect of bitter leaf on experimental broilers at various levels (5%, 10% and 15%) for 28 days was observed [37]. Sample studied, showed that flavonoid in bitter leaf, sweet potato and spinach high amount of

346.5±.03 and 350.6±0.4 which could be referenced to reduce the occurrence of diabetes. Consumption of purple sweet potato leaf of 200 g/day (902 mg) of phenol compound for 7 and 14 days decreased lipid peroxidation and DNA damage in human [38]. In this study, high amount of phenol in drumsticks, basil, fluted pumpkins, cocoyam leaf and egg plant leaf was observed therefore; they are good source of dietary antioxidant defense and can decrease oxidative stress in human.

### 4.3 Mineral Contents of the Leafy Vegetables to Igala Land

Table 3 showed mineral contents of the common leafy vegetables in Igala land. Sodium ranged from [0.08 - 0.001 mg] of which drumstick contained the highest value, potassium (0.3±0.06 mg) with eggplant leaf having the largest amount, calcium (0.06±0.01 mg), basil (0.06±0.01 mg) with the largest contents and spinach (0.02±0.01 mg) was the least. While drumstick has the highest magnesium contents (0.06±0.02 mg), comwood plant leaf (0.002±0.03 mg) the least, phosphorus in spinach was (0.06±0.0.01 mg) with highest amount in bitter leaf (0.02±0.01) and sweet potato (0.02±0.01 mg) samples had least values. [39] Reported that reduced sodium intake has a reduced risk ratio on cardiovascular diseases, coronary diseases and stroke. The result of this study produced a low sodium content (0.08/100 mg) at $p \leq 0.001$ if compared to [40] recommended dietary allowance of ≤ 2 g /day (1.3 g) therefore, the result in this current study are recommendable for low/ sodium restricted diets, hypertension and for composition table and in vegetable exchange list. [41] Found that the major component of bitter leaf include calcium, potassium and sodium and these are the major factors sustaining strong bones and therefore, reduces the risk of arthritis. High amount of micronutrients in this study are recommendable in building strong healthy bones and teeth that could reduce and prevent arthritis.

## 5. CONCLUSION

The study revealed that most of the vegetables available in Igala kingdom especially drumstick, jute mallow, cocoyam, eggplant leaf, fluted pumpkin leaf are good sources of crude fiber, phytochemical, minerals and macronutrients which could prevent metabolic and chronic nutritional deficiency disorders and for alleviation of risk factors of chronic diseases.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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