

# PROXIMATE COMPOSITION, MINERAL AND PHYTOCHEMICAL CONTENTS OF SOME LEAFY VEGETABLES NATIVE TO IGALA KINDOM KOGI STATE NIGERIA.

## ABSTRACT

The proximate composition, minerals and phytochemical contents of some leafy vegetables native to Igala land were determined. It was designed to establish their nutritional value and inclusion in food composition table for use by nutritionists and dieticians. Fresh vegetable samples (cocoyam, egg plant 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 at Anyigba and prepared separately into dry sample for analysis, using standard methods. Triplicate values were obtained in each case, expressed on dry weight basis. All data obtained were analyzed statistically using SPSS version 17.0 package. Means and standard deviation were calculated at a significant level of  $p \leq 0.001$ . Among the vegetable samples, **crude fiber** contents ranged from (26.7 to 8.0%). **Ash** (15.2 to 5.1%), **moisture** (5.3 to  $1.52 \pm 0.02\%$ ), **fat** 4.1 to 1.3%, **protein** ( $25.1 \pm 1.1$  to 9.2%) and **carbohydrates**, (67.2 to 8.04, **Phytochemical contents (mg/100g)** included; **Phenol** (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** (5.20 to 0.0), **Phytates** (2.02 to 0.06). Cyanides 0.5 to 0.05. **Mineral contents mg/100g** included: **sodium** (0.08 to 0.001) **potassium** (0.3 to 0.002) **calcium** (0.06 to 0.02) **magnesium** (0.06 to 0.00) and **phosphorus** (0.06 to 0.02). Drum stick contained highest crude fiber, in protein, Potassium, Magnesium and Phytate contents while Ash content was higher in fluted pumpkins. For all the leafy vegetables considered, they contain Phytochemicals within allowable level for safety.

**KEY WORDS:** chemical analysis, proximate phytochemical, minerals, leafy vegetables.

## INTRODUCTION

Leafy vegetables are low in calories, low in fat and high in protein and dietary fibers and are rich source of minerals (Calcium, Potassium and Magnesium) and high in Phytochemicals [1]. They are agricultural products that are highly perishable, but important sources of vitamins, minerals and roughages which are complex carbohydrates known as dietary fibers [2]. Vegetables contain bioactive compounds that protect the body from nutritional deficiency diseases [3]. Vegetables also protect the body from free radicals that cause oxidative damage to cells because of Phytochemicals they contain. They are low in energy and packed with vitamins, minerals and fibers. They contain mixtures of Phytochemicals which act as powerful antioxidants [4]. Green leafy vegetables are highly valued because of the mineral, Phytochemical and vitamin contents; Vegetables are important food both from economic and nutritional stand points. Their nutritive significance is their richness in minerals which is very essential in the maintenance of human health [5], **vegetables are an important component of healthy diet if consumed daily in sufficient amounts, could help prevent major diseases such as cardiovascular diseases and certain cancers** [6]. They are at their best when tender or succulent, many of them can easily be grown in home gardens and thus provide economic access and convenient sources of fresh, unprocessed vegetables with active nutrients [7]. 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). Other main dishes include; white rice, bean, corn meal, yam porridge, semolina and others.

Most of these are potent bioactive compounds found in medicinal plant parts that can be used for therapeutic purpose or which are precursors for the synthesis of useful drugs [8]

The feeling of fullness produced by intake of vegetables helps in controlling overweight and obesity since they are low in calories and high in fibers. From the economic point of view, vegetables quench hunger due to their satiety factor [9]. Some of the green leafy vegetables native to Igala land are

cocoyam leaf (*Colocasia esculenta*), egg plant leaf (*Solanum incanum*), bitter leaf (*Vernonia amygdalina*), sweet potato leaf (*Ipomoea batatas*), fluted Pumpkin leaf (*Telferia occidentalis*) others include; camwood leaf (*Pterocarpus soyanxii*), +spinach (*Amaranthus chlosostachys*), drumstick (*Moringa oleifera*) jute mallow (*Cochorus olitoides*) and basil plant leaf (*Occimum bacilicum*) [2]. Therefore, this work aimed at establishing the quantitative nutrient contents, Phytochemical and minerals in the leafy vegetables available in Igala land, some of which are often neglected. The result will be suitable for inclusion in food composition table, a veritable tool for nutritionists in diet planning, dieticians for counseling of the malnourished, medical personnel for prescription of diets for treatment of nutrient related diseases also researchers, lecturers and students of related field of study can benefit from using it as references for vegetable exchange list and nutrient calculation.

## Materials and methods

### Sources of vegetables

Ten leafy vegetable samples were harvested from gardens adjacent to various homes at Anyigba and some were procured from only Igala vegetable shops. They included basil plant leaf, bitter leaf, egg plant leaf, camwood leaf, cocoyam leaf, Jute mallow, drumstick leaf, fluted pumpkin leaf, spinach and sweet potato leaf which were identified by experts.

### Preparation of samples

Samples were trimmed, washed, drained and shade dried to prevent loss in nutrients and color as described by [10]. Each was milled into fine powder using type 8k 31 Kenwood blender and packaged in plastic bags to prevent moisture absorption, contamination and also labeled for easy identification and kept refrigerated ( $10 \pm 2^\circ\text{C}$ ) for not longer than two weeks prior to proximate, Phytochemical and minerals analysis, using standard methods and instruments.

### Analytical methods:

#### Proximate composition analyses

##### Ash content determination

Ash content of the finely sieved sample was determined by incineration at  $600^\circ\text{C}$  in muffle furnace as described by [11]. Triplicate values were obtained for each sample, two grams (2.0g) 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 pre - heated muffle furnace and maintained at  $600^\circ\text{C}$  for 6hrs 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:

$$\% \text{ Ash (on dry basis)} = \frac{W_2 - w_1 \times 100}{2.0\text{g}}$$

##### Fat content Determination

Fat content was estimated using soxhlet extraction method, according to [12] two (2.0g) of sample was weighed into a thimble ( $w_1$ ). Dried and cooled boiling flask was weighed, filled with 300 mL ( $w_2$ ) petroleum ether and boiled at  $60^\circ\text{C}$  with the extraction thimble in soxhlet apparatus which was allowed to reflux for 6hrs. The thimble was carefully removed, while the extracted oil in the petroleum ether flask was dried at  $105\text{--}110^\circ\text{C}$  for 1hr. It was then transferred from the oven to the desiccators, cooled, weighed and calculated as below;

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

##### Crude Protein Determination

The crude protein of the sample was determined using the micro – Kjeldahl method described by [13] two grams (2g) was weighed along with 20cm<sup>3</sup> of distilled water into a micro – Kjeldahl digestion flask. It was shaken and allowed to stand for some time. One tablet of selenium catalyst and 20cm<sup>3</sup> concentrated sulphuric acids were added. The flask was heated on the digestion block at  $100^\circ\text{C}$  for 4

hours until the digest became clear. The flask was removed from the block and allowed to cool. Content was transferred into 50cm<sup>3</sup> volumetric flask and diluted to the mark with water. An aliquot of the digest (10cm<sup>3</sup>) was transferred into another micro-Kjeldahl flask along with 20cm<sup>3</sup> of distilled water, placed in the distilling outlet of the micro – Kjeldahl distillation unit. A conical flask containing 20cm<sup>3</sup> of boric acid indicator was placed under the condenser outlet. Sodium hydroxide solution (20cm<sup>3</sup>, 40%) 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 20cm<sup>3</sup> boric acid and the distillation was stopped. Nitrogen in the distillate was determined by titrating with 0.014M of H<sub>2</sub>SO<sub>4</sub>; 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 =  $\frac{TV \times Na \times 0.014 \times V1 \times 100}{G \times V2}$

Where TV = Titre value of acid (cm<sup>3</sup>)

Na = Normality of acid

V1 = Volume of distilled water used for distilling the digest (50cm<sup>3</sup>).

V2 = Volume of aliquot used for distillation (10cm<sup>3</sup>)

G = Original weight of sample used, g

#### Determination of moisture contents

Moisture content of each sample was determined as described by [14] using vacuum oven method; 2.0g of the sample was rapidly weighed into a pre-weighed dried dish (w<sub>1</sub>), and weighed with the dish (W<sub>2</sub>) It was dried to a constant weight at 95-100°C at a pressure that was not exceeding 100mHg for 5hrs when the drying procedures was completed, the dish was placed in the desiccators to cool and re-weighed (W<sub>3</sub>) and the recorded loss in weight, was the moisture. The percentage moisture was calculated as below;

% moisture =  $\frac{W_2 - W_1 \times 100}{W_3 - W_1}$

Where; W<sub>1</sub>= initial weight of the empty crucible

W<sub>2</sub> = weight of the crucible plus (+) the sample before drying.

W<sub>3</sub> = final weight of crucible + sample after drying

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

#### Crude Fiber Determination

A non-enzymatic method of A.O.A.C [15] was used to determine crude fiber content, 2.0g of the dried sample was defatted with petroleum ether and boiled under reflux for 30 minutes with 200mL of solution containing 1.5g of H<sub>2</sub>SO<sub>4</sub> per 100mL 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 30minutes in 200mL of solution containing 1.25g of carbonate-free NaOH per 100mL. Final residue was filtered through a thin but closed pad of washed and ignited asbestos in a gooch crucible. It was dried in electric oven, weighed, incinerated, cooled and re-weighed;

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

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

#### Carbohydrate content determination

Carbohydrate content was determined by difference as described [10] where the total proportion of carbohydrate in the leaves 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 fiber, CP= Crude Protein, M = Moisture, F = Fat and A = Ash.

Note: Triplicate values were obtained for each sample.

# **Phytochemical analysis procedures**

## **Phytic acid Determination**

Phytic Acid was determined using the procedures described by [12]. 2.0g of each sample was weighed into 250 mL conical flask. 100mL of 2% concentrated hydrochloric acid was used to soak the sample in the conical flask for 3hrs. It was filtered through a double layer of hardened filter papers. 50 mL of each filtrate was placed in 250 mL beaker and 107 mL of distilled water was added in each case to give proper acidity. 10ml of 0.3% Ammonium thiocyanate solution indicator was added. It was titrated with standard iron chloride solution, which contained 0.00195g iron per mL; the end point was slightly brownish-yellow, this persisted for 5 minutes. The percentage (%) phytic acid was calculated using the formula;

% phytic acid =  $\frac{r}{t} \times 1.19 \times 100$  where x = titer value x 0.00195g.

## **Oxalate Estimation.**

Oxalate determination was carried out using methods described by [12] 2.0g of each sample was boiled in 40mL distilled water for 30 minutes in a reflux condenser. A total of 10 mL of 20%  $\text{Na}_2\text{CO}_3$  was added and boiled for another 30 min. The liquid was extracted and the residue was washed with hot water until the wash water stopped showing any alkaline reaction. The combination of wash water and filtrate were concentrated to a small volume and cooled with constant stirring. Hydrochloric acid (HCL) was added, (1:1) drop wise until the final acid concentration after neutralization was 1%. The precipitate was allowed to flocculate and the extract carefully filtered into a 250mL 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 400mL beaker, diluted with water to 200mL and made just ammonia cal to re-acidify with acetic acid. In the cold medium, 10mL 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 filter paper; the precipitate was dissolved in HCL acid (1:1). Oxalic acid was re-precipitated by adjusting the  $\text{P}^{\text{H}}$  with ammonia hydroxide solution. Content was boiled and allowed to settle overnight. Oxalic acid was determined by titrating against 0.05N  $\text{KMnO}_4$  solution.

## **Calculation;**

1ml of 0.05N  $\text{KMnO}_4$  = 0.00225g anhydrous oxalic acid.

% Oxalic acid =  $\frac{\text{Titer value} \times 0.00225}{\text{T.U} \times 0.1125} \times 100$

2

Where, T. U = titer unit

## **Tannic 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  $\text{NH}_4\text{Cl}$ ) where 0.5mL of extract was diluted with 70% acetone to make absorbance not to exceed 0.6 in a tube of 30mL. and incubated at 97-100°C for 60 minutes. The tube was cooled and read absorbance at 550ppm using unheated suitable blank and condensed tannin (96% of dry matter) and calculated using;  $A_{550\text{nm}} \times 78.26 \times \text{dilution factor}$ .

Where; 1cm, (550ppm) of leuccocyanidin = 406.

## **Flavonoid determination**

Flavonoid was determined using spectrophotometer (Aluminum chloride method) as described by [17], 9 mL of the sample was weighed and treated with ethyl acetate and mixed with 1 mL of Aluminum chloride ( $\text{AlCl}_3$ ) 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<sup>-1</sup> quercetin.

#### **Saponin Contents Determination**

Saponin content was determined as described by [18]. five(5g) of each sample was dispersed in 50 mL of 20% ethanol. The suspension was heated over a hot water bath for 4hrs with continuous stirring at 55°C. 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 °C 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°C. Samples were dried in an oven at 100<sup>0</sup> C until a constant weight was obtained and Saponin content was calculated in percentage.

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

#### **Determination of phenol**

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, 5mL of folin ciocalteau reagent (1:1) with water and 2 mL. (20%) of Na<sub>2</sub>CO<sub>3</sub> 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, which 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 650nm 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/100g of sample.

#### **Alkaloid Determination**

Alkaloid was determined using gravimetric method, [20], 2.0g of sample was weighed (w<sub>1</sub>) and dispensed into 50ml of 10% acetic acid solution in ethanol. The mixture was well shaken and allowed to stand for 4hr and filtered. The filtrate was evaporated to ¼ of its original volume. Concentrated NH<sub>4</sub>OH was added and alkaloid precipitated. The filter paper was weighed (w<sub>2</sub>) and the precipitate was scrapped off and washed with 1% NH<sub>4</sub>OH solution. This was weighed with filter paper (w<sub>3</sub>); the precipitate was dried in a filter paper in the oven at 60°C for 30 min and reweighed (w<sub>4</sub>). By weight difference, the weight of the alkaloid was determined and expressed as a percentage of sample weight analyzed, given by formula

$$\% \text{ Alkaloid} = \frac{W_1 - W_2 \times 100}{W_3 - W_4}$$

Where; W<sub>1</sub> = Weight of sample

W<sub>2</sub> = Weight of empty filter paper

W<sub>3</sub> = Weight of filter paper+ precipitate before drying.

W<sub>4</sub> = weight of filter paper+ precipitate after drying

Triplicate values were obtained for each sample

#### **Cyanide determination**

Total cyanide was determined by the pH-differential method as described by [21] two buffer system: potassium chloride buffer pH 1.0M and sodium acetate buffer pH 4.5 M . 0.4 ML of the extract was mixed with 3.6 mL of corresponding buffers and read against a blank at 510nm and 700nm, Absorbance (A) was calculated as follows; A = (510 – A700) pH 1.0 – (510 – A700) pH 4.5 Cyanide (mg/l) = A x MW x DF x 1000 (Mn x 1.0).

Where, A = absorbance

239 MW = molecular formula (449.2)  
 240 DF = dilution factor  
 241 MA = molecular absorptive (26, 900)

## 242 Mineral Analysis;

243 **Sodium, Potassium, Calcium and Magnesium** Mineral contents of the samples were determined using  
 244 triple acid digestion method of [22]. 2.0g of the samples were weighed into a micro-Kjeldahl digestion  
 245 flask to which 24cm<sup>3</sup> of mixture of concentrated HNO<sup>3</sup>, H<sub>2</sub>SO<sub>4</sub>, and 60% HClO<sub>4</sub> ( 9 : 2 : 1 v/v) were added.  
 246 The flask was put on the heating block and digested to a clear solution, cooled and the content was  
 247 transferred into 50cm<sup>3</sup> volumetric flask and made-up to the volume mark with water.

## 248 Phosphorus Determination

249 Phosphorous was determined using [23] methods. Digested supernatant solution (2cm<sup>3</sup>) was placed into  
 250 50cm<sup>3</sup> volumetric flask, 2cm<sup>3</sup> of sample and 2cm<sup>3</sup> of ammonium molybdate solution were added with  
 251 distilled water to make-up to 48cm<sup>3</sup>, the content was mixed and 1cm<sup>3</sup> of diluted stannous chloride  
 252 solution was added and mixed, then 1cm<sup>3</sup> of distilled water was added to make-up to 50cm<sup>3</sup> marked and  
 253 left to stand for 5mins. The % absorbance on spectrophotometer at 660nm wavelength was used to  
 254 determine the concentration of phosphorus.

255 Triplicate values were obtained for each sample

## 256 Statistical analysis

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

## 259 Results

260 **Proximate composition of leafy vegetables**, Table 1 represents the proximate composition (moisture,  
 261 ash, crude fiber, protein and carbohydrates) contents of ten (10) leafy vegetables native to Igala  
 262 kingdom Kogi state. Ash contents (15.2 to 5.1%), Crude fiber contents (26.7g to 8.0%), moisture (5.3 to  
 263 1.52±0.02%), fat (4.1±0.0 to 1.3±0.09%), proteins (25.1±1.1 to 9.2±0.1%) and carbohydrates,  
 264 (69.49±0.008 to 40.2.04±0.9g)

265 **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 <sup>a</sup>   | 5.1±0.01 <sup>a</sup>   | 8.05± 0.05 <sup>a</sup>  | 2.2±0.17 b  | 9.2±0.1 b                | 69.48±0.008 <sup>a</sup> |
| 213         | 5.3±0.2 <sup>a</sup>    | 12.1 ± 0.2 <sup>a</sup> | 11..2 ± 0.8 <sup>b</sup> | 2.1 ± 0.0 b | 20.1 ± 1.0 <sup>b</sup>  | 49.2 ± 0.11 <sup>a</sup> |
| 214         | 1.8±0.04 <sup>a</sup>   | 9.2±0.11 <sup>a</sup>   | 12.1±0.08 <sup>b</sup>   | 2.1±0.06 b  | 20.10± 5.00 <sup>b</sup> | 54.5±0.3 <sup>a</sup>    |
| 215         | 2.7±0.17 <sup>a</sup>   | 6.7±0.2 <sup>b</sup>    | 15.1 ± 0.1 <sup>a</sup>  | 1.9±1.6 b   | 9.11±0.1 <sup>b</sup>    | 64.1±0.3 <sup>a</sup>    |
| 216         | 1.52±0.02 <sup>b</sup>  | 3.4±1.05 <sup>a</sup>   | 26.7±0.2 <sup>a</sup>    | 3.02±0.0 a  | 25.1±1.1 <sup>b</sup>    | 40.2±0.9 <sup>a</sup>    |
| 217         | 1.77±0.3 <sup>a</sup>   | 7.2±0.3 <sup>a</sup>    | 12.18±0.2 <sup>a</sup>   | 1.5±0.07 b  | 10.10±0.2 <sup>b</sup>   | 67.3±0.1 <sup>a</sup>    |
| 218         | 2.5 ± 0.01 <sup>a</sup> | 15.2±0.1 <sup>a</sup>   | 12.2±0.06 <sup>a</sup>   | 1.80±0.07 b | 14.5±0.2 <sup>b</sup>    | 53.70±0.05 <sup>a</sup>  |
| 219         | 4.6±0.01 <sup>a</sup>   | 7.5±0.03 <sup>b</sup>   | 18.1±0.04 <sup>a</sup>   | 4.1±0.0 a   | 11.30 ± 0.2 <sup>b</sup> | 54.1±0.2 <sup>a</sup>    |
| 220         | 5.1±0.1 <sup>a</sup>    | 5.9±0.1 <sup>c</sup>    | 11.8±0.9 <sup>b</sup>    | 1.3±0.09 b  | 13.4±0.01 <sup>b</sup>   | 62.5±0.02 <sup>a</sup>   |
| 221         | 1.6±0.04 <sup>b</sup>   | 11.2±0.05 <sup>a</sup>  | 11.6±0.3 <sup>b</sup>    | 1.9±1.59 b  | 23.4±0.06 <sup>b</sup>   | 50.1±0.2 <sup>a</sup>    |

266 **Values represent means of triplicate values ± sd (standard deviation)**

267 Sample means with the same superscripts in a Colum are not significantly different p≥0.05

| SAMPLE CODE                | SAMPLE CODE                 | SAMPLE CODE                  |
|----------------------------|-----------------------------|------------------------------|
| 212= (BASIL PLANT LEAF)    | 218= (FLUCTED 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 POTATOE PLEAF) |                              |
| 216 =(DRUMSTICK)           |                             |                              |
| 217= (EGG PLANT LEAF).     |                             |                              |

275 **Phytochemicals of leafy vegetables**; table 2, represents the Phytochemical contents of the ten (10) leafy  
 276 vegetables obtained; cyanide, Saponin, tannin, phytate, oxalate flavonoid, phenol and alkaloid. Phenol

(312.6 ± 0.1 to 10.1±0.3) flavonoid was (420.7 ± 0.1 to 2.6±0.4), alkaloid (9.7±0.03 to 2.6±0.17) oxalate (0.9 ± 0.02 to 0.003 ±0.004). Tannin (36.20±0.1 to 0.03 ± 0.02), Saponin (5.20 ± 0.91 to 0. 0), Phytates [2.02 to 0.06]. Cyanides (0.5 to 0.05).

**Table 2: Phytochemical contents of ten vegetables common in Igala land (mg/100) powdered samples**

| Sample code | Cyanide                  | Saponin                  | Tannin                   | phytate                   | oxalate                   | Flavonoid                | phenol                   | Alkaloids               |
|-------------|--------------------------|--------------------------|--------------------------|---------------------------|---------------------------|--------------------------|--------------------------|-------------------------|
| 212         | 0.14 ± 0.03 <sup>a</sup> | 1.03±0.04 <sup>b</sup>   | 1.1±0.01 <sup>b</sup>    | 1.3 ± 0.05 <sup>b</sup>   | 0.08 ±0.01 <sup>b</sup>   | 6.2 ± 0.1 <sup>c</sup>   | 247.4±1.20 <sup>a</sup>  | 5.0 ± 0.01 <sup>b</sup> |
| 213         | 0.1 ± 0.05 <sup>a</sup>  | 5.20 ± 0.91 <sup>a</sup> | 36.20±0.1 <sup>b</sup>   | 1.06 ± 0.06 <sup>a</sup>  | 0.06 ± 0.01 <sup>b</sup>  | 420.7 ± 0.1 <sup>a</sup> | 15.2 ± 1.5 <sup>a</sup>  | 4.20± 0.1 <sup>b</sup>  |
| 214         | 0.1 ± 0.02 <sup>a</sup>  | 1.2±0.15 <sup>b</sup>    | 3.08±0.07 <sup>b</sup>   | 1.0±0.01 <sup>a</sup>     | 0.9 ± 0.02 <sup>b</sup>   | 6.7±0.02 <sup>b</sup>    | 200.38±0.01 <sup>a</sup> | 2.6±0.17 <sup>a</sup>   |
| 215         | 0.2 1 ±0.3 <sup>a</sup>  | 0.00 <sup>a</sup>        | 1.28±0.1 <sup>b</sup>    | 1.19±0.1 <sup>a</sup>     | 0.07 ± 0.07 <sup>b</sup>  | 2.9±0.07 <sup>a</sup>    | 230.4±0.9 <sup>a</sup>   | 9.6±0.3 <sup>a</sup>    |
| 216         | 0.1 ± 0.01 <sup>a</sup>  | 1.07±0.05 <sup>b</sup>   | 0.85 ± 0.0 <sup>b</sup>  | 11.4 6± 0.05 <sup>b</sup> | 0.08 ± 0.03 <sup>b</sup>  | 8.9 ± 0.5 <sup>c</sup>   | 312.6 ± 0.1 <sup>a</sup> | 4.6 ± 0.2 <sup>a</sup>  |
| 217         | 0.5 ± 0.9 <sup>a</sup>   | 1.07 ± 0.02 <sup>a</sup> | 1.4 ± 1.4 <sup>b</sup>   | 1.5 ± 0.05 <sup>a</sup>   | 0.07 ± 0.01 <sup>b</sup>  | 7.5 ± 0.4 <sup>a</sup>   | 226.4 ± 1 <sup>a</sup>   | 4.2 ± 0.2 <sup>b</sup>  |
| 218         | 0.3 ± 0.03 <sup>c</sup>  | 0.00 <sup>a</sup>        | 1.28 ± 0.3 <sup>b</sup>  | 2.02 ±0.01 <sup>a</sup>   | 0.05±0.26 <sup>b</sup>    | 5.3±0.02 <sup>a</sup>    | 134.2±0.26 <sup>a</sup>  | 4.40±0.01 <sup>b</sup>  |
| 219         | 0.05± 0.01 <sup>a</sup>  | 1.5±0.4 <sup>b</sup>     | 0.4±0.01 <sup>b</sup>    | 0.4±0.0 <sup>a</sup>      | 0.007 ±0. 01 <sup>b</sup> | 2.6±0.4 <sup>a</sup>     | 175.3±0.01 <sup>a</sup>  | 4.4±10.1 <sup>b</sup>   |
| 220         | 0.07 ± 0.02 <sup>a</sup> | 1.5 ± 0.01 <sup>b</sup>  | 0.25 ± 0.01 <sup>b</sup> | 0.06 ± 0.06 <sup>a</sup>  | 0.003 ±0.004 <sup>b</sup> | 346.5±0.3 <sup>a</sup>   | 10.1±0.3 <sup>a</sup>    | 9.7±0.03 <sup>a</sup>   |
| 221         | 0.2 ± 0.02 <sup>a</sup>  | 2.2±0.04 <sup>a</sup>    | 0.03 ± 0.02 <sup>b</sup> | 0.15 ± .04 <sup>a</sup>   | 0.2±0.013 <sup>b</sup>    | 350.6±0.4 <sup>a</sup>   | 16.7±0.55 <sup>a</sup>   | 5.6±1.7 <sup>b</sup>    |

**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 CODES             | SAMPLE CODES               | SAMPLE CODES               |
|--------------------------|----------------------------|----------------------------|
| 212 (BASIL PLANT LEAF)   | 218= (FLUCTED 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 POTATOE PLEAF) |                            |
| 216 (DRUMSTICK)          |                            |                            |
| 217 (EGG PLANT LEAF).    |                            |                            |

**Mineral contents of leafy vegetables common in Igala land. The mineral contents of leafy vegetables in table 3 included: sodium (0.08 to 0.01) potassium (0.3±0.06 to 0.002±0.03) calcium (0.06±0.01 to 0.02±0.01) magnesium (0.06 to 0.002), phosphorus (0.06±0.0.01 to 0.02±0.01).**

**Table 3: some Mineral contents of 10 vegetables common in Igala land (mg/100) dry sample**

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

**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 CODES             | SAMPLE CODES               | SAMPLE CODES                 |
|--------------------------|----------------------------|------------------------------|
| 212= (BASIL PLANT LEAF)  | 218=(FLUCTED 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 POTATOE PLEAF) |                              |
| 216= (DRUMSTICK)         |                            |                              |
| 217=(EGG PLANT LEAF).    |                            |                              |

## Discussion

### Proximate composition of leafy vegetable samples

Table 1, proximate composition of ten (10) samples of leafy vegetables (%) dry basis, showed drumstick [coded sample 216] contained highest amount of crude fiber and protein, with (26.7 ±0.2) and [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 findings agree with the results of [25] in a study where intake

of high fiber diet of 28.2g/day for 6 months lowered incidence of duodenal ulcer recurrence. Also, [26] reported that high crude fiber in jute mallow decreased blood sugar level and cardiovascular diseases. [27] Reported that a total dietary fibre of 20g to 25g/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  $p \leq 0.001$  for fiber 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 28-65g for children, lactating mothers, pregnant women and adults [28] also [29] reported that high protein of 1.8g / kg is required in postoperative nutrition, the protein content of  $[25.1 \pm 1.1]$  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  $[3.4 \pm 1.05]$  the least. The highest moisture content occurred in bitter leaf  $[5.3 \pm 0.2]$  and lowest in drumstick  $(1.52 \pm 0.02)$ . 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 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  $[4.1 \pm 0.0\%]$  and least in spinach  $(1.3 \pm 0.09\%)$ . The low fat content of the vegetables revealed in this study can be referenced in prevention of chronic diseases such as liver cirrhosis, diabetes cardiovascular diseases [32] and [33]. Carbohydrates in basil [sample coded 212] is  $[69.48 \pm 0.008\%]$  which is reasonably high and could be suitable for active man of 36-40years with total intake of 2,800Kcal/day, the findings in this study is evidenced and also in line with [34].

Phytochemical contents of leafy vegetables;

Table 2, showed the Phytochemical contents of ten vegetables, bitter leaf has the highest amount of flavonoid  $[420.7 \pm 0.1]$  but lowest in camwood, phenol in drumstick was the highest [312.6] with spinach being the least while values for all the vegetables were extremely significant at  $p \geq 0.01$ . Alkaloid in spinach  $[9.7 \pm 0.03]$  was found to be the highest and camwood leaf the least. However, there existed significant difference at  $p \geq 0.01$ . Oxalate  $[0.9 \pm 0.02]$  was highest in camwood but, lowest in spinach. The result showed that tannin was highest in bitter leaf  $[36.20 \pm 0.1]$  with the least amount in sweet potato but, were not significantly different at  $p \leq 0.05$ , Saponin  $[5.20 \pm 0.91]$  was high in bitter leaf while both cocoyam and fluted pumpkins were the lowest, with 0.00 value though significant at  $p \leq 0.001$ . Drumstick contained highest amount of Phytate  $[2.02 \pm 0.01]$  of which sweet potato was the least; cyanide was  $[0.5 \pm 0.9]$  highest in egg plant and least amount was found in jute mallow. The contents of Phytochemicals 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 cause 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  $346.5 \pm 0.3$  and  $350.6 \pm 0.4$  which could be referenced to reduce the occurrence of diabetes. Consumption of purple sweet potato leaf of 200g/day (902mg) of phenol compound for 7 and 14 days decreased lipid per-oxidation 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.

Mineral contents of the leafy vegetables

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

## CONCLUSION

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

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