American Journal of Food and Nutrition, 2017, Vol. 5, No. 2, 51-57
Available online at http://pubs.sciepub.com/ajfn/5/2/1
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DOI:10.12691/ajfn-5-2-1

Mineral and Vitamin Composition of Some Lesser Known Leafy Vegetables Consumed in Northern Senatorial District of Cross River State, Nigeria

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Abstract Seven leafy vegetables (*Albizia zygia, Basella alba, Ficus glumosa, Hibiscus cannabinus, Pterocarpus santalinoides, Solanum nigrum and Vitex doniana*) grown in the Northern Senatorial District of Cross River State, Nigeria, were authenticated and evaluated for their vitamin and mineral contents using standard methods of analysis. The fresh leafy vegetables were collected from local farms around Obudu, Bekwarra and Obanliku LGA of Cross River State, Nigeria. The results of mineral analysis revealed that at $P<0.05$, *Basella alba* had the highest potassium (146.03±1.14mg/100g) and phosphorus (36.83±0.09mg/100g) content, *Hibiscus cannabinus* had the highest content of magnesium (168.30±0.12mg/100g) while *Ficus glumosa* had a relatively high sodium content (16.43±0.12mg/100g). *Vitex doniana* had the highest content of calcium (67.47±0.12mg/100g). The heavy metals, cadmium, lead and mercury were not detected. *Ficus glumosa* had the highest content of Beta carotene (5.07±0.33mg/100g) and ascorbic acid (68.50±0.12mg/100g) while *Vitex doniana* had the highest content of vitamin E (6.23±0.06mg/100g). *Solanum nigrum* had the highest concentration of vitamin B_2 (0.85±0.06mg/100g) and vitamin B_6 (18.43±0.18mg/100g). The results suggest that the seven leafy vegetables contain appreciable amounts of minerals and vitamins, thus may be included in diets to supplement daily dietary allowances needed by the body, hence, improving nutritional status and curbing the problem of micronutrient deficiency.

Keywords: *mineral, vitamin, vegetables, micronutrients, micronutrient deficiency*

Cite This Article: Agiang Margaret Akpana, Mgbang John Edward, Peters Henry, and Akuirene Joseph, "Mineral and Vitamin Composition of Some Lesser Known Leafy Vegetables Consumed in Northern Senatorial District of Cross River State, Nigeria." *American Journal of Food and Nutrition*, vol. 5, no. 2 (2017): 51-57. doi: 10.12691/ajfn-5-2-1.

1. Introduction

The term vegetable may be defined as the fresh portion of herbaceous plants that may be eaten either raw or cooked [1]. According to Misra and Misra [2] and Igile *et al.* [3], they are sometimes accompanied by tender petioles and shoots and are a valuable part of the dietary regimen of Africans, providing essential minerals and vitamins needed for growth, development and maintenance of optimal health. However, wild edible plants have also been shown to have very high nutritional potentials so much so that their nutritional value can be considered greater than that of some cultivated green-leafy vegetables. The wild edible plants have been reported to contain vitamins, minerals, fiber, pigments as well as a host of secondary metabolites like polyphenolics, alkaloids, gums, resins and essential fatty acids that enhance dietary taste and colour [1], hence they have become a necessary and complimentary source of nutrients in most homes. They are easily collected by rural dwellers from the environment and thus inexpensive, used as regular ingredients in dietary regimen of tribal people of Northern Cross River State of Nigeria, and may provide good amount of nutrients in comparison with other fruit and seed plants. These wild edible vegetables are often prepared into vegetable sauce or soups and eaten with boiled yam or pounded yam, cassava 'garri' meal, or cassava 'fufu'. Cooking (or blanching before use) of these vegetables, as it is often practiced by the rural dwellers and all who consume this vegetables, is bound to cause nutrient losses, though it may help to reduce the amount of anti-nutrients in the vegetables. These vegetables form part of the regular meals of the rural dwellers just as other conventional vegetables do and can be eaten 3 to 4 times a week particularly in the season of abundance.

When dietary intake of vegetables and fruits is insufficient, micronutrient malnutrition occurs and this is reported to be responsible for about 2.7 million deaths worldwide annually, thus ranking it among the top ten risk factors that contribute to mortality rates observed around the world [4]. There are about 907 million undernourished people in developing countries alone, of which Africa represents the larger proportion [5]. On a global scale, it is estimated that about 10.6 million children below five years of age die on an annual basis and malnutrition is seen as the underlying cause of about 50% of these deaths.

It is also reported that sub-Saharan African nations which constitutes about 10% of the world's population, carries about 41% of the global mortality burden of children under the age of five [6].

Consequently, this study seeks to explore the possible contribution of lesser known wild green-leafy vegetables to solving the problem of micronutrient malnutrition, particularly amongst the low-income earners as well as create more variety in the food menu of the Nigerian populace. In Cross River State, Nigeria for instance, the search for these wild green-leafy vegetables has become very necessary because cultivated vegetables are becoming too expensive for low income families [7]. Among these wild green-leafy vegetables are *Albizia zygia, Vitex doniana, Ficus glumosa, Solanum nigrum, Pterocarpus santalinoides* and *Hibiscus cannabinus*. A study by Agiang *et al.* [8] on the proximate and phytochemical composition of these seven leafy vegetables indicated that they may possess some nutritional and ethno-medicinal attributes. Detail description of these vegetables was provided in that study. Their results showed appreciable amount of ash (4.73 – 13.47%) indicative of the mineral content of the vegetables, high protein content (43.87 - 55.60%), and significantly ($p<0.05$) low fat content (3.33 – 6.43%) on dry matter basis.

2. Material and Methods

2.1. Sample Collection and Treatment

Albizia zygia, Vitex doniana, Solanum nigrum, Ficus glumosa, Hibiscus cannabinus, Pterocarpus santalinoides, Basella alba were collected from farms in Obudu, Obanliku and Bekwarra Local Government areas of the Northern senatorial district of Cross River State, Nigeri. The vegetables were identified and authenticated and voucher specimens (BCH/VC/75, 305, 110, 97, 87, 207, and 400) were deposited in the Herbarium of the Department of Botany, University of Calabar, Nigeria. The samples were properly washed under tap water, oven-dried in an air circulating over at 50°C, ground into powder using a manual grinder and preserved in tightly sealed plastic containers for mineral and vitamin analyses.

2.2. Mineral Analysis

The analysis of mineral composition of the seven leafy vegetables was carried out according to the methods of Association of Official Analytical Chemists AOAC [9].

A portion (1g) of each sample was measured into a digestion flask, 20mls of acid mixture (650mls of conc. HNO_3; 80ml PCA; 20ml conc. H_2SO_4) was then added and the flask was heated until a clear digest was obtained. The digest was diluted with distilled water to the 500ml mark. Appropriate dilution was then made for each element.

2.2.1. Determination of Calcium Content

For determination of calcium, $SrCl_2$ solution, containing 10,000mg/ml to yield a 1,500mg/ml of Sr^{2+} in the final solution, was added. A calibration curve was prepared for each element using standard solution [10].

2.2.2. Determination of Potassium and Sodium Content

Each sample digest (5mls) was pipette into separate test tubes in duplicates, 2mls of cobaltnitrite was then added, shaken vigorously and allowed to stand for 45 minutes then centrifuged for 15 minutes a 3000rpm. The supernatant was drained-off and 2mls of ethanol was added to the residues. The individual solution was shaken vigorously and centrifuged for another 15 minutes. The supernatants were drained off and 2mls of distilled water was added to the residue. The individual solution was boiled for 10 minutes with frequent shaking to dissolve the precipitate, 1ml of 1% choline hydrochloride and 1ml of 2% sodium ferric cyanide was added. Then 2mls of distilled water was also added and the solutions were shaken to mix well. The absorbance was taken at 620nm against the blank [9].

2.2.3. Determination of Magnesium Content

Five millilitres (5mls) of each sample digest was pipetted into a test tube in duplicate, 1ml of 0.67N sulphuric acid (H2SO4) and 1ml of 0.05% titan yellow was added. Then 1ml of 0.01% gum acacia and 2mls of 10% sodium hydroxide (NaOH) was also added. The solution was mixed and the absorbance was taken at 520nm against the blank [9].

2.2.4. Determination of Phosphorus Content

The molybdate colorimetric method was used to determine phosphorus. 2 ml of dry ash extract was mixed with equal volume of Vanodo-molybdate colour reagent. The mixture was then diluted with 50 ml distilled water. A standard phosphorus solution was also prepared. The absorbances of the standard and sample were measured at 660nm after fifteen minutes [9].

2.3. Vitamin Analysis

2.3.1. Determination of Vitamin C Content

The vitamin C content was determined by the method of AOAC [9]. A measured volume (20mls) of 1% acetic acid and 20mls of 1% oxalic acid were added to about 2g of each dried samples. The mixture was allowed to stand for two hours before it was filtered. Then, 10mls of the filtrate was pipetted into a conical flask and titrated with 2, 4-dinitrophenol-hydrazine and the volume noted. A portion of 10mls standard ascorbic acid of analytical grade was also titrated with indophenol dye solution. The weight of ascorbic acid oxidized by 1ml of the dye was calculated in mg. A blank titration was also done in the same manner without the sample. The value obtained was used to calculate vitamin C concentration using the formula:

$$\text{Vitamin C}\ (\text{mg}/100\ \text{g}) = \frac{100 \text{ x } V_T (V_1 - V_2)}{W - V_3 (V_T - V_o)}$$

Where,
W = weight of sample
V_1 = value for standard ascorbic acid
V_2 = value for sample
V_o = value for blank
V_3 = volume of extract and for titration
V_T = total extract.

2.3.2. Determination of Beta Carotene Content

Beta carotene content was determined using spectrophotometric method described by Kirk and Sawyer [11]. Each sample was weighed (2g) into a flat bottom reflux. Distilled water (10ml) was added and shaken carefully to form a paste; 25ml of alcoholic KOH solution was added and a reflux condenser attached. The mixture was heated in boiling water bath for one hour with frequent shaking, cooled rapidly and 30 ml of distilled water was added. The hydrolyzed product obtained was transferred into a separator funnel and the solution was extracted three times with 20 ml of ether; 20g of anhydrous Na_2SO_4 was added to the extract to remove any traces of water. The mixture was then filtered into a 100 ml volumetric flask and made up to mark with ether. A standard solution of β-carotene of range 0-50μg/ml was dissolved in 100ml of ether. The gradients of different standard solutions were determined with reference to their absorbance from which the average gradient was taken to calculate β-carotene in μg/100g. Absorbance of sample and standards was read on a spectrophotometer (Metrohn Spectronic 21D Models) at a wavelength of 328nm. Calculations to determine actual beta carotene content was done using the formular,

$$\text{Vitamin A}\left(\text{mg}/100\text{g}\right) = \frac{\text{Absorbance of sample}\times\text{Dilution Factor}\times\text{Gradient Factor}}{\text{Weight of sample}}.$$

2.3.3. Determination of Vitamin E Content

Beta carotene content was determined using spectrophotometric method described by AOAC [9]. One gramme (1g) of each sample was weighed into a 250ml conical flask, 10mls of absolute alcohol and 20mls of 1M alcoholic sulphuric acid were added. The condenser and flask were wrapped in aluminum foil and refluxed for 45 minutes and then cooled for 15 minutes. A volume of 50mls distilled water was added to the mixture and transferred to a 250ml separating funnel covered with aluminum foil. The unsaponifiable matter in the mixture was extracted with 30mls of dimethyl ether. The combined extracts were washed free of acid and dry-evaporated at a low temperature and the residues obtained, immediately dissolved in 10mls of absolute alcohol. Aliquots of solutions of each sample and standards (0.3-3.0mg vitamin E) were transferred into a 20ml volumetric flask and 5ml absolute alcohol added, followed by a careful addition of 1ml concentrated HNO_3. The flask was placed on a water bath and temperature set at 90°C for 3 minutes. The flask was allowed to cool rapidly under running water and volume was adjusted with absolute alcohol.Absorbance was measured at 470 nm against a blank solution containing 5ml absolute alcohol and 1ml concentrated HNO3 treated in a similar manner. Vitamin content was then calculated using the formular:

$$\text{Vitamin E}\left(\text{mg}/100\text{g}\right) = \frac{\text{Absorbance of gradient}\times\text{Gradient factor}\times\text{Dilution factor}}{\text{Weight of sample}}.$$

2.3.4. Determination of Vitamin B_6

Vitamin B_6 was determined according to the method described by AOAC [12]. A weighed (2g) portion of sample was placed in 25 mL of H_2SO_4 (0.1 N) solution and incubated for 30 minutes at 121°C. Then, the contents were cooled and adjusted to pH 4.5 with 2.5 M sodium acetate, and 50 mg Takadiastase was added. The preparation was stored at 35°C overnight. The mixture was then filtered through a Whatman No. 4 filter, and the filtrate was diluted with 50 mL of pure water and filtered again through a micropore filter (0.45 μm). Twenty microliters (20 μl) of the filtrate were injected into the HPLC system. Quantification of vitamin B_6 content was accomplished by comparison to vitamin B_6 standards. Standard stock solutions for pyridoxine was prepared as reported previously [13,14]. Chromatographic separation was achieved on a reversed phase (RP) HPLC column (Agilent ZORBAX Eclipse Plus C18; 250 × 4.6 mm i.d., 5 μm) through the isocratic delivery mobile phase (A/B 33/67; A: MeOH, B: 0.023 M H3PO4, pH = 3.54) at a flow rate of 0.5 mL/min. Ultraviolet (UV) absorbance was recorded at 270 nm at room temperature [15].

3. Results and Discussion

3.1. Mineral Analysis

Mineral analysis was carried out on selected vegetables: *A. zygia*, *B. alba*, *F. glumosa*, *H. cannabinus*, *P. santalinoides*, *S. nigrum and V. doniana.* The data obtained is presented in Table 1. The potassium content ranged from 18.53±0.12 to 146.03± 1.14. Potassium was least in *Vitex doniana* (20.40±0.14 mg/100g) but significantly higher in *Basella alba* (146.03±0.13 mg/100g) compared to other vegetables analyzed. Results indicated high potassium content which ranged from 18.53 to 146.03 mg/100g.*B. alba* and *S. nigrum* both had the highest potassium content. These values were very high when compared with data obtained by Igile *et al. [3]* for *Vernonia calvaona* (2.46%), Iheanacho and Udebuani [16] for *Amaranthus hybridus*, *Curcubita pepo* and *Gnetum africanum* (8.65, 4.64 and 4.10mg/100g respectively). Potassium is the major cation in intracellular fluid and functions in the maintenance of weight [3], regulation of acid-base balance, conduction of nerve impulse, muscular contraction (especially of the cardiac muscle), correct functioning of the cell membrane, regulation of the sodium-potassium adenosine triphosphatase (ATPase) system and the maintenance of fluid volume [17]. It also plays a vital role in the transfer of phosphate from adenosine triphosphate to pyruvic acid. The metabolism of potassium is regulated by the hormone, aldosterone. Vegetables, fruits and nuts tend to contain many times more potassium than sodium and the results of this study provide proof of this. According to Institute of Medicine [18], the RDA for potassium for both normal healthy males and non-pregnant females between the ages of 19 and 50 years is 4700mg/day. The range of potassium content reported in this study shows that the vegetables may be a poor source, capable of providing about 0.39% to 3.1% of RDA for healthy living.

The result of sodium content ranged from 8.10mg/100g to 16.43mg/100g. This range of values is low compared to the range of values obtained by Iheanacho and Udebuani

[16] for *Amaranthus hybridus* and *Curcubita pepo* (17.50 and 24.80mg/100g respectively). The sodium content for all seven vegetables was higher than the 1.08g/100g obtained by Igile *et al.* [3] for *Vernonia calvaona.* Sodium plays a key role in the maintenance of body fluid composition, especially water content. Its interaction with potassium is important for the maintenance of proper acid-base balance as well as in the transmission of nerve impulses. Variation of sodium and potassium is of significant importance to a hypertensive patient as it enhances blood pressure [19]. This blood pressure enhancement leads to the development of hypertension [3]. The RDA requirement for sodium is 1500mg and 2300mg/day for normal healthy male adults aged 19 to 50 years and female non-pregnant adults aged 19-50 years respectively [18]. The low sodium content reported for the vegetables in this study show that they can be consumed by hypertensive patients as they can keep body sodium levels low.

The result of calcium content of the seven leafy vegetables analyzed is relatively high when compared to the range of values (10.7mg/100g to 48.2mg/100g) obtained by Agbaire and Emoyan [20] for some local vegetables in Delta State, Nigeria. The calcium content of *Solanum nigrum* in this study is relatively higher than the value (17.33mg/100g) obtained by Akubugwo *et al.* [21]. However, values for calcium in this study are much lower when compared with data obtained by Nkafamiya *et al.* [7] for *F. asperifolia* and *Ficus Sycomorus* (428.65 and 390.78mg/100g respectively). According to Osse [22], leaves have high calcium concentration which goes to support the findings of this study. Calcium plays a vital role in the development and sustenance of strong bones and teeth (especially in fetuses, infants, children, and the elderly), regulation of muscular contraction and relaxation, regulation of nerve function and absorption of cyanocobalamin (vitamin B_{12}) [23]. Calcium may therefore be useful in the prevention of osteoporosis in the elderly [24]. It also plays a key role in the coagulation of blood as it activates the process leading to the conversion of prothrombin to thrombin.

The result of phosphorus content ranged from 19.57 to 36.83mg/100g. This range of values is very high when compared with the range of values obtained by Agbaire, [17] for some local vegetables (0.20 to 9.20mg/100g). However, phosphorus content of *P. santalinoides* and *A. zygia* were very similar compared with data obtained by Agbaire and Emoyan [20] for *Ocimum gratissimum* (28.20mg/100g). Phosphorus is concerned with many metabolic processes including those involving body fluid buffers, maintenance of normal kidney function as well as in the transfer of nerve impulses [25]. Just like calcium, phosphorus also plays a key role in strengthening bones and teeth and in the maintenance of muscle growth [26]. According to Vunchi *et al.* [27], for good calcium absorption to occur, calcium-phosphorus ratio must be 1:1. The average calcium-phosphorus ratio for the leaves of all seven vegetables analyzed in this study is about 2:1 which indicates that diets containing these vegetables may need to be supplemented with other phosphorus sources. This is backed up by the fact that RDA requirement for phosphorus in both adult males and non-pregnant females is 700mg/day [18].

Result of magnesium content ranged from 42.30 mg/100g to 168.30 mg/100g. The magnesium content of *V. doniana* was very similar to the value obtained by Achikanu *et al.* [28] for *Solanum nigrum,* though, the value for *Solanum nigrum* in this study differed from values obtained by these researchers for the same vegetable species. This may be due to harvesting stage, seasonal variations, soil differences and differences in methods used in analysis [29]. However, values obtained for *H. cannabinus* (168.30 mg/100g) in this study was similar to that obtained by Adnan *et al.* [30] for *V. officinalis* (183.0 mg/100g). The magnesium status of the body is greatly influenced by the health of both the digestive and renal systems. Any disorder of the gastro-intestinal tract that impair absorption processes, such as Crohn's disease, can limit magnesium absorption by the body leading to depletion in body magnesium stores which could, in extreme cases, lead to chronic magnesium deficiency which may include symptoms like erythemia, hyperaemia, neuromuscular hyper-irritability which increases if the deficiency is unchecked and may be accompanied by cardiac arrhythmia and generalized tremours [25]. Magnesium deficiency can be prevented by consumption of magnesium rich diets as well as supplementation of diets with magnesium if these diets are poor in magnesium content.

Results of the concentrations of heavy metals, such as cadmium, lead and mercury tested in this study, showed that they were not detected in significant amount indicating that the soils in which these vegetables grow are not contaminated by these substances.

Table 1. Mineral composition of some lesser known vegetables (mg/100g)

Sample	Potassium	Sodium	Calcium	Phosphorus	Magnesium	Cadmiu m	Lead	Mercury
P. Santalinoides	28.77 ± 0.09^{a}	9.17 ± 0.07^{a}	52.73 ± 0.20^{a}	26.43 ± 1.8^{a}	52.63 ± 0.07^{a}	ND	ND	ND
V. doniana	20.40 ± 0.14^{b}	8.63 ± 0.09^{b}	67.47 ± 0.12^{b}	32.33 ± 0.15^{b}	42.30 ± 0.90^{b}	ND	ND	ND
B. alba	146.03 ± 1.14^{c}	12.17 ± 0.07^{c}	50.83 ± 0.20^{c}	36.83 ± 0.09^{c}	54.10 ± 0.56^{c}	ND	ND	ND
A. zygia	18.53 ± 0.12^{d}	11.17 ± 0.09^{d}	48.77 ± 0.07^{d}	28.30 ± 0.20^{d}	124.20 ± 0.10^{d}	ND	ND	ND
F. glumosa	30.87 ± 0.20^{e}	16.43 ± 0.12^{e}	49.70 ± 0.21^{e}	27.17 ± 1.47^{a}	89.20 ± 0.45^{e}	ND	ND	ND
S. nigrum	121.57 ± 0.13^{f}	$8.23\pm 0.07^{b,f}$	$49.53\pm 0.03^{d,e}$	19.57 ± 0.09^{e}	91.40 ± 0.12^{f}	ND	ND	ND
H. cannabinus	27.20 ± 1.45^{g}	$8.10\pm 0.10^{b,f}$	46.50 ± 0.12^{f}	21.47 ± 0.09^{f}	168.30 ± 0.12^{g}	ND	ND	ND

Values are expressed as the mean ± SEM of triplicate experiments. Mean values carrying different superscripts vary at 95% confidence ($P<0.05$). ND = Not detected.

Table 2. Vitamin Analysis of some selected lesser known vegetables (mg/100g)

Sample	Beta carotene	Vitamin E	Vitamin B_6	Vitamin C
P. santalinoides	4.04± 0.01[a]	5.75± 0.16[a]	15.70± 0.12[a]	59.03± 0.55[a]
V. doniana	3.44± 0.31[b]	6.23± 0.06[b]	8.67± 0.15[b]	48.87± 0.17[b]
B. alba	2.77±0.01[c]	3.89±0.08[c]	4.27±0.09[c]	51.47±0.03[c]
A. Zygia	3.42± 0.01[b]	2.06±0.04[d]	4.17± 0.30[c]	45.83±0.38[d]
F. glumosa	5.07± 0.33[d]	3.09± 0.10[d]	10.57± 0.12[d]	68.50± 0.12[a]
S. nigrum	4.440.02[a]	4.91± 0.08[a]	18.43±0.18[a]	62.97±0.82[f]
H. cannabinus	3.53± 0.02[b]	3.88± 0.12[c]	12.67± 0.09[f]	56.23± 0.44[g]

Values are expressed as the mean ± SEM of triplicate experiments. Mean values carrying different superscripts vary at 95% confidence (P<0.05).

3.2. Vitamin Analysis

The results of vitamin analysis are presented in Table 2.

The beta carotene content of the vegetables analyzed ranged from 2.77±0.01 to 5.07± 0.33 mg/100g. Beta carotene content of *F. glumosa*, *B. alba* and *H. cannabinus in this study* was similar to values obtained by Otitoju *et al.* [23]) for *Ficus capensis* (6.25mg/100g), *Ficus thonnigii* (1.82mg/100g), *Myrianthus arboreus* (1.06mg/100mg),and *Mucuna pruriens* (2.47mg/100g). Recorded values in this study were however higher than values obtained by Igile *et al.* [3] for *Vernonia calvoana* (0.61mg/100g). Values for *Solanum nigrum* was very similar to the value obtained by Akubugwo *et al.* [21] for *the* same vegetable (4.66mg/100g). Beta carotene is invaluable for the promotion of growth of cells and tissues, resistance to diseases and for delaying the ageing process. It is also important for the maintenance of eye, skin, nails and hair health. The RDA requirement for Beta carotene for a normal healthy, active adult man and non-pregnant woman is 0.3mg/day and 0.27mg/day respectively [31]. Based on comparison between RDA requirement and range of values reported for beta carotene content for vegetables in this study suggests that the vegetables may be capable of providing adequate levels of beta carotene for healthy living.

Vitamin E content ranged from 2.06mg/100g to 6.23mg/100g. This range was similar to that obtained by Achikanu *et al.* [28] for some leafy vegetables which ranged from 3.39mg/100ml (*Ficus capensis*) to 7.34mg/100ml (*Solanum aethiopicum*). The overall vitamin E content for the vegetables analyzed in this study was significantly high when compared to values for *Vernonia calvaona* (0.99mg/100g) obtained by Igile *et al.* [3]. According to FAO [32], the RDA requirement for vitamin E is 10mg/day for normal healthy adult men between the ages of 19-65 years while that of adult non-pregnant women within same age range is 7.5mg/day. Vitamin E is a very potent antioxidant that helps to protect body cells from damage due to reactive oxygen species. It is very important for the formation and normal function of erythrocytes and muscles [28].

The vitamin B_6 (pyridoxine) content of the vegetables ranged from 4.17mg/100g (*A. zygia*) to 18.43mg/100g (*S. nigrum). These* values were high when compared with values obtained by Igile *et al.* [3] for the leafy vegetable *Vernonia calvaona* (0.56 mg/100g), Akah and Onweluzo [33] for edible shoot of elephant grass (2.40 mg/100g), Hasan *et al.* [34] for *Lagennaria vulgaris* (0.755 mg/100g) and *Amaranthus viridis* (0.07 mg/100g) respectively. The level of vitamin B_6 in the vegetables in this study provides more than the 1.3 mg/day RDA requirement for both adult men and women between 19 and 50 years respectively. Vitamin B_6 is one of the essential amino acids that the body cannot synthesize and its availability in the diet is necessary to meet with the body's daily needs. It promotes the metabolism of protides (which are side chains of amino acids) and unsaturated fatty acids [3]. Based on the RDA and the level of vitamin B_6 observed in the vegetable samples analyzed in this study, these vegetables, therefore, may be considered good sources of vitamin B_6.

Results showed that vitamin C content ranged from 45.83 mg/100g to 68.50 mg/100g, which is high when compared to values for vitamin C obtained by Blessing *et al.* [35] for pumpkin accessions (3.47 to 4.39 mg/100g), Misra and Misra [2] for *Moringa oleifera* and *Ipommea aquatic* (2.17 mg/100g and 0.34 mg/100g respectively) and by Igile *et al.* [3] for *Vernonia calvoana* (11.33 mg/100g). These results were, however, relatively low when compared to the vitamin C content reported by Acikgoz [36] for kale (98.30 mg/100g) in its first harvest. This relatively high vitamin C content reported make these indigenous vegetables potentially good sources of vitamin C. Vitamin C is a potent antioxidant that facilitates non-haeme iron transport and uptake at the intestinal mucosa, the reduction of intermediates of folic acid as well as the synthesis of cortisol. It also aids in the purification of blood [3]. From the result, these vegetables appear to be good sources of vitamin C that could provide adequate amounts of vitamin C to ensure that the recommended daily allowance is reached especially for vulnerable groups such as children and pregnant women as well as in times of food shortage where micronutrient deficiencies become apparent. The recommended daily requirement for Vitamin C according to FAO [31] is between 45.83 mg/day to 68.50 mg/day for both male and female adults between the ages of 19 to 65 years. Furthermore, the availability of reasonable amounts of vitamin C in the vegetables in this study provides a new source of antioxidants required for the maintenance of health and the prevention of conditions such as stress and prostate cancer [3]. Since the wild vegetables in this study are often consumed in their cooked forms, losses of micronutrients such as vitamins may occur. Loss of vitamins due to cooking may depend largely on cooking time, temperature and cooking method. Some vitamins are quite heat stable while others are heat labile [37]. For example, fat soluble vitamins such as vitamins A and E are relatively heat stable while water soluble vitamins such as vitamin C and B_6 are heat labile and so are susceptible to loss on exposure to heat [37].

The sensitivity of water soluble vitamins such as thiamine and pyridoxine to heat is the reason why they are commonly used as indicators of water-soluble vitamin losses in fruit and vegetables [38]. Generally, the greater the surface: weight ratio of a given vegetable, the lower the retention of micronutrients will be [39]. It has been suggested that loss of vitamins and minerals from vegetables is mainly because of extraction into the cooking liquid rather than their destruction [40].

4. Conclusion

Mineral and vitamin content of the vegetables analyzed in this study showed that the vegetables contained appreciable amounts of macro-minerals like magnesium, calcium, potassium and phosphorus, which work synergistically to maintain optimal health by keeping the body and tissue fluids from being either too acidic or too alkaline; allowing for exchange of nutrients between body cells. The observed low sodium make these plants healthy alternative dietary components in the management and prevention of hypertension. All the vegetables were observed to be, relatively, good sources of vitamin B_6 and ascorbic acid as they can provide the recommended dietary allowance for daily healthy living. However, since vegetables like *B. alba, A. zygia, F. glumosa, H. cannabinus* were observed to be poor sources of beta-carotene and vitamin E, this study has further showed that no single plant food could provide all required nutrients in recommended amounts and so there is the need to consume these vegetables in combination with other dietary sources of nutrients to ensure an adequate nutritional status, thus reducing the problem of micronutrient deficiencies within the Northern senatorial district of Cross River State, Nigeria and beyond.

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