The nutritive value of commonly Consumed processed and unprocessed Vegetables in South-Southern Nigeria.

ABSTRAC

Aim: The nutritive value, proximate, vitamin and mineral compositions of seven commonly consumed vegetables in South-Southern Nigeria were determined.

Methodology: Pods and leaves of vegetables were divided into two parts. One part was analyzed raw and the remaining part was cooked by boiling. The raw vegetable leaves and okro pods were separately washed and dried using a food dehydrator (40 ^{o}C) for 24hrs. After drying, it was milled into fine flour using an electric blender. The second part of the vegetables were processed by boiling using variable time, after boiling, they were separately drained and dried using a food dehydrator at a temperature of about 50^{o}C for 48hrs. Chemical analyses were carried out using standard laboratory methods. Means and standard deviations were calculated using the statistical package for social science. The least significant difference (LSD) was accepted at *P* = .05 significance.

Results: For the raw vegetables the results were as follows: Moisture 71.2 – 91.2%, ash 0.9- 2.9%, dietary fibre 9.2 – 13.1%, fat 0.3 -1.4%, protein 2.1 – 8.2%, available Carbohydrate 1.0 – 8.7%, phosphorus 8 -52 mg/100g, potassium 263- 1152mg/100g, sodium 3-23mg/100g, calcium 183-815mg/100g, magnesium 67-217 mg/100g, iron 0.26-1.27mg/100g, zinc 0.26-1.10mg, folate 3-13 mcg/100g. The results of the boiled vegetables were: moisture 80.9– 93.8%, protein 1.7 – 3.2%, fat 0.2 – 0.5%, ash 0.5– 1.1%, dietary fibre 3.9 – 9.3%, available carbohydrate 3.8 – 9.9%, phosphorus 7 – 35 mg/100g, Potassium 0.33 – 300mg/100g, sodium 0.3 – 20 mg/100g, magnesium 45 – 132mg/100g, calcium 82 – 200 mg/100g, iron 0.21 -0.60 mg/100g, zinc 0.13 – 0.30mg/100g. Folate 3 – 6 mcg/100g. The range of the percentage contributions of the vegetables that are consumed raw to the recommended nutrient intake or recommended dietary allowance of adults are as follows: protein 5-18%, fat 1-3%, carbohydrates 1-6%, dietary fibre 3-52%, iron 2-14%, zinc 6-36%, calcium 26 -116%, phosphorus 8-31%, sodium 0.3-1%, Potassium 8-32%, Magnesium 26-99%, Folate 3-4%.

Conclusion: Boiling significantly reduced most nutrient studied. Bitter leaves are more nutrient dense than other studied vegetable. Knowing the food compositions of these vegetables will promote their use.

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Keynote: Nutritive value, proximate, mineral and vitamin

1. INTRODUCTION

The persistence of malnutrition especially micronutrient deficiencies in developing countries call for the use of indigenous fruits and vegetables [1]. Vegetables are rich in some nutrient especially the micronutrients, although processing may destroy most of these nutrients [2]. The nutrients found in most vegetables are variable. The variability of nutrients in the same food materials from different sources can be attributed to time, geographical location, soil type among others [3,4]. Some vegetables are eaten raw while some need minimal processing to make them edible. Some of the studied vegetables like “utazi”,

bitter leaf and garden egg leaf can be eaten in their raw forms. Although, in south-southern Nigeria, they are mostly cooked for about 2- 5 minutes, while in the South- eastern part of Nigeria these vegetables are eaten in their raw forms. The vegetables that are eaten raw have little or no problem with loss of nutrient as a result of processing. Other vegetables studied like bitter leaf (bitter variety), okro leaf and pod and "afang leaf might need mild washing and/or cooking to improve their palatability.

Bitter leaf (*Vernonia amygdalina* and *Vernonia hymenolepsis*); These are green leafy vegetables which normally grow as shrub. Their leaves are petiole shaped. Their diameter is about 3-6mm. They adapt easily to the environment as they are resistant to drought [5]. They are used as fence or boundary indicator and are mostly home grown in rural areas of Nigeria especially in the South- eastern part. These bitter leaves irrespective of the variety can be eaten raw, washed mildly and eaten or cooked with minimal processing. They can be used for traditional soups or sauces. *Vernonia amygdalina* has a more bitter taste than *Vernonia hymenolepsis*. *Vernonia amygdalina* is mostly squeezed and washed thoroughly to reduce the bitter taste before use in preparing food. Vernonia hymenolepsis also called sweet variety can be eaten without further processing to reduce the bitter taste. They are known to have some medicinal potentials like anti-diabetic, antihelminthic and antimalarial properties [6]. They are cheap. Nutritionally, these vegetables are regarded as good sources of ϐ-carotene and vitamin C and some minerals [7].

Albemoschus esculentus (Okra) is one of the most popular vegetables in Nigeria. Okra pod is also called "Lady Finger". *Albemoschus esculentus* tree has a multipurpose advantage due to the various uses of the pods, fresh leaves, buds, flowers, stems, and seeds. Okra pods are best when not fully mature for ease in processing like slicing. These pods are consumed as vegetables. Okra leaves and pods are used fresh or dried. They can be milled into powder for ease in storage. The milled powder can be added to soups or sauces. They can be used as part of salad ingredient in some parts of the world, soups and stews in Africa especially Nigeria [8].

Solanum aethiopicum (Garden egg leaves) commonly called garden egg in Nigeria also have indigenous names like "Akwukwo Anara" in Igbo language, "Igba" in Yoruba language and "Gauta" in hausa language. They belong to the family of Solanaceae and genus Solanum. The species have very wide variations of about 1,000. The variations are evident in their colours (white, yellow, purple among others). There are about 25 species in Nigeria. The leaves and fruits of egg plants are eaten raw as vegetables or cooked for sauces or soups. they are also used in traditional medicine [9.10].

Gongronema latifolium commonly called "utazi" in the South-eastern part of Nigeria and "arokeke" in the South-western part is an herbaceous plant. It is from the family of *asclepiadaceae*. It has a bitter taste which is traditionally believed to be medicinal. This vegetable is commonly found in Africa and South American but sparsely found in Asia. In Nigeria, especially among the Igbo speaking people, ''Utazi'' is used to garnish several dishes like "Abacha" popularly called African salad. *Gongronema latifolium* is popularly eaten raw as a vegetable. It is also dried and milled into fine powder. The powder can be sprinkled on cooked pottage and other dishes. The fresh leaves are added to soups, yam/plantain pottage among others.

Gnetum africana belong to the family of *Gnetaceae*. In Nigeria, the people from cross River state commonly call it ''Afang'', the Igbos call it ''Okazi''. The plant is well adapted in humid forest. It is mostly grown in Cameroun. In Nigeria, *Gnetum africanum* is a local delicacy of immense importance in Cross River and Akwa- Ibom States. It is a popular vegetable for most soups in South-Southern and South Eastern parts of Nigerian [11] ''Afang'' leaves.

These vegetables are widely consumed in South – southern parts of Nigeria with little or no knowledge on their nutritive values especially as consumed. This study will, therefore, provide this information and enrich the food composition data base.

2. MATERIAL AND METHODS

2.1 Sample Collection

Seven leafy vegetables (okra pod, “utazi”, okra leaf, “afang” and two varieties of bitter leaf) were purchased from Watt market in Calabar except for garden egg leaves which was purchased from Akim market in Calabar, Cross River State.

Fresh bitter and sweet variety of the bitter leaves were separately washed till foaming ceased, after washing, about 100g of each variety was immersed in water (100ml) and allowed to boil for ten minutes. About 100g ‘’afang’’ leaves were washed and sliced. The sliced leaves were immersed in 50mls of water and allowed to boil for five minutes. About 100g Garden egg leaves were washed, sliced and boiled in 50mls of water for three minutes. 100g of Okro pods were washed, sliced and boiled in 50mls of water for ten minutes. About 100g of okro leaves were sliced and boiled in 50mls of water for five minutes. About 100g of ‘’utazi’’ leaves were sliced. After slicing, 50mls of water was added and it was boiled for three minutes. After boiling the vegetables, they were taken to the laboratory for moisture determination on wet weight basis.

2.2 Preparation of the samples for analysis

All the raw and boiled vegetables were dried at 40-50^{o}C using a food dehydrator for 24 and 48hrs hours respectively. After drying, they were milled into powder using an electric blender. The milled samples were separately stored in air-tight containers and labelled for chemical analysis.

2.3.1 Proximate Composition

The methods described by the Association of Official Analytical Chemist [12] were used in determining moisture, ash, total fat and crude protein content of the samples. Dietary fibre was carried out by Prosky, Asp, Furda, DeVries, Schweizer and Harland [13] method as described by AOAC Method 985.29. carbohydrate was determined by difference.

2.3.2 Determination of Moisture Content

Two grams of the sample was weighed into a previously weighed crucible. The crucible plus the sample was taken and transferred into the oven set at 100°C to dry to constant weight for 24 hours. The crucible plus the sample was removed from the oven, cooled for 10 minutes and reweighed. The sample in the crucible was returned into the oven for further drying. The drying, cooling and weighting were done at intervals of 4 hours until a constant weight was obtained. The moisture content was calculated as a percentage of the ratio of moisture loss to the weight of the samples analyzed. The expression represented below was used in the calculation:

$$\text{Moisture (\%)} = \frac{w_1 - w_2}{w_1} \times 100$$

where: W_1 = weight (g) of the sample before drying
W_2 = weight (g) of the sample after drying

2.3.3 Determination of Ash Content

Total ash content was determined as total inorganic matter by incineration of a sample at 600°C [12]. About 2g of the sample was weighed into a pre-weighed porcelain crucible and incinerated overnight in a muffle furnace at 600°C. The crucible was removed from the muffle furnace, cooled in desiccator and weighed. Ash content was calculated according to the following formula:

$$Ash\ (\%) = (\text{weight of ash})/(\text{Weight of sample}) \times 100\text{h}\ (\%) = \frac{\text{weight of ash}}{\text{Weight of sample}} \times 100$$

2.3.4 Dietary fibre

This was carried out by Prosky, Asp, Furda, DeVries, Schweizer and Harland [13] method as described by AOAC Method 985.29. After ashing, 5g of dried and defatted food samples were subjected to sequential enzymatic digestion by heat-stable bacterial α-amylase in harsh conditions (pH 8.2, 100ºC) to give gelatinization, hydrolysis and depolymerization of starch and protein for the enzymatic incubation step. The samples were precipitated following the addition of ethanol. The precipitated samples were filtered and weighed. Total dietary fibre was then determined by subtracting the weight of protein and ash from the weight of the precipitate.

2.3.5 Determination of Crude Fat

Crude fat was estimated by employing solvent extraction using a Soxhlet extraction unit [12] About 1g of the samples were weighed and placed in a thimble. Some 120ml petroleum ether was poured into a previously dried and weighed round bottom flask. The Soxhlet extractor apparatus was set up with the flask and the condenser. The extraction apparatus was set up with the flask sitting on the spaces provided on the hot plate. The hot plate was plugged and set to gentle heating, the other evaporated and as it condensed, it dropped into the thimble where it extracted the other soluble constituents (fat constituent) into the flask. The colour deepened as time increases. The thimble was then removed and dried in the oven. The petroleum ether in the flask was evaporated. The flask was then dried in an air circulating desiccator. The round bottom flask and the lipid extract were then weighed. The flask and its content were dried again to obtain constant weight. Amount of lipid was obtained from the difference between the weight of the flask before extraction and after extraction. Crude fat was calculated using the formula:

$$\% \text{ fat} = \frac{(\text{weight offlask} + \text{oil}) - (\text{weight of flask}) \times 100}{\text{Weight of sample}}$$

2.3.6 Determination of Crude Protein

The method used in the determination of the protein contents of the samples was the micro Kjeldahl method [12]. About 1g of the sample powder was weighed out into 50ml Kjeldahl digestion flask. Some 20ml concentrated H2SO4, 1 tablet of Kjeldahl catalyst and anti-bombing chips were added. The mixture was incinerated to gentle boiling on the digestion rack and then heated further for 3 hours. The digest was removed, cooled, quantitatively transferred to a 100ml volumetric flask and made up to mark. Erlenmeyer flask containing 10ml of the boric acid indicator solution was placed at the tip of the condenser extended below the surface of the solution. About 10ml of the sample digest was introduced into the sample tube and steam heated, 10ml of 40% NaOH solution was added to the digest and the digest was steamed and distilled into the boric acid-indicator solution, it changed to green. A blank determination was also carried out alongside that of the sample except that 1g sample was replaced with 1ml distilled water. The crude protein content was calculated as follows:

Protein (%) = (A-B) × N × 1.4007 × 6.25
Where
A= volume (ml) of 0.2 N HCl used sample titration
B = volume (ml) of 0.2 N HCl used in blank titration
N= Normality of HCl
W = weight (g) of sample
14.007 = atomic weight of nitrogen
6.25 = the protein-nitrogen conversation factor

2.3.7 Calculation of available carbohydrate Content

The available carbohydrate content of the samples was calculated by eliminating the percentage of the other food nutrients. Mathematically, Available Carbohydrate =

100 – (crude protein + lipid + ash + moisture+ dietary fibre).

2.4 Determination of Mineral Contents

The mineral elements were determined using wet-acid digestion method for multiple nutrients determination. The digest was used for the determination of Calcium (Ca) by the EDTA Versanate Complexometric titration method, Potassium (k) and Sodium (Na) by the flame photometry method, phosphorus (P) by the Vanadomolybdate yellow method, using the spectrometer and Magnesium (Mg) by the Atomic Absorption Spectrophotometry.

Calcium (Ca) was determined by the EDTA Versanate Complex metric titration method. About 10ml of the aliquot of the digest was pipetted into a conical flask, and then a pinch of potassium cyanide and potassium ferrocyanide were added to the digest to mask the interference of other ions during the determination.

Potassium (K) and Sodium (Na) were determined by the flame photometry method. Some 5ml of the sample digest was pipetted into a 50ml volumetric flask and diluted to 50ml with distilled water. A set of Potassium (K) and Sodium (Na) was prepared to contain 0ppm, 2ppm, 4ppm, 6ppm, 8pppm and 10ppm of the element in the solution. The flame photometer was placed on a sealed calibrator with 6ppm and adjusted to 60. The standard solution was tested, and their values recorded, the appropriate filter (photocell) was selected for each element. The atomizer of the instrument was dipped into the sample solution and the meter reading taken. The values obtained from the standard were used to plot the calibration curve for each test mineral element and the concentration of the sample element determined by extrapolating from the graph as ppm off the curve.

Phosphorus was determined using the vanado-molybdate spectrophotometric method. About 5ml of the extract was pipetted into a 500ml volumetric flask, while 10ml of distilled water was added initially to the 10ml of the vanado reagent. The sample was allowed for about 45 minutes for complete colour development and the absorbance (optical density) measured in a UNICAM UV/ULS spectrophotometer at 400nm wavelength. A set of phosphorus working standards was prepared in a 50ml volumetric flask which contains 0ppm, 2ppm, 4ppm, 6ppm, 8pppm and 10ppm of phosphorus. The same experiment as done for the samples were also carried out on the standards. The values obtained were used to plot standard curve for the extrapolation of the sample values as ppm.

2.5 Statistical Analysis

The statistical package for social sciences (SPSS) was used for the analysis. Analysis of variance (ANOVA) was used for the separation of means. Also, the least significant difference test (LSD) were computed and significant difference was judged at $p<0.05$.

3. RESULT AND DISCUSSION

Generally, the moisture contents of the vegetables were high and ranged from 71.2 % in raw bitter leaf to 93.8% in boiled okra pod. The moisture contents in the boiled samples were significantly (P = .05) higher than the contents in the raw samples (table 1). This observation is like the findings of Okeke *et al.,* [14]. The high moisture contents of these vegetables indicate that they will not keep for long, so good storage system will be needed to extend their shelf lives. Micro-organisms are known to strive in an environment with high moisture content [15]. The Protein contents of most of the vegetables decreased (*P=0.05*) with boiling. The protein content of raw 'utazi' leaves was very low (2.1%) when compared to other raw vegetables (2.8%- 8%). Despite the low protein in the raw sample, it was observed that boiling increased the protein contents of the leaves from 2.1 % in the raw vegetable to 2.8% in the boiled vegetable. Protein was highest in raw bitter leaves (8.2%), followed by raw okra leaves (7%). Boiled okra leaves and pods had the least protein values of 1.7%. Boiling also reduced the ash contents of the samples except in 'Utazi' and 'afang'. The ash contents of the raw and boiled samples were similar (0.9%) and (1%) respectively. This is not surprising as ash contents of a sample indicates the mineral contents, since most minerals are heat stable, boiling might not have much effect on them. The decline in the proximate

composition of the boiled samples might be attributed to their higher moisture contents. Boiling have been reported to reduce the proximate compositions of seeds (21). Dietary fibre value ranged from 6.0% in boiled garden egg leaves to 13.1% in raw 'utazi' leaves. The fat values decreased significantly with boiling and ranged from 0.2% in boiled okra leaves to 1.4% in raw okra leaves. Available carbohydrate values ranged from 1% in boiled okra leaves, raw ''afang'' and garden egg leaves to 8.7% in boiled garden egg leaves.

Table 1. Effect of processing on the proximate composition of seven leafy vegetables in Cross River State (%) wet weight basis

Samples	Moisture	ASH	Dietary Fibre	Fats	Crude Protein	CHO
Raw Okra pod	79.00±0.50[a]	1.6±0.07[a]	9.2±0.0[a]	0.7±0.69[a]	4.3±0.12[a]	7.2±0.72[a]
Boiled okra pod	93.8±0.22[b]	0.5±0.04[b]	7.7 ±0.02[b]	0.2 ±0.02[b]	1.7±0.01[b]	3.8±0.01[b]
Raw garden-egg leaves	78.0±0.50[a]	2.9±0.13[a]	11.4±0.00[a]	0.9±0.10[a]	5.9±0.13[a]	1.0±0.60[a]
Boiled garden-egg leaves	80.9±0.36[a]	1.0±0.03[b]	6.0±0.00[b]	0.3±0.03[b]	3.2±0.03[b]	8.7±0.10[b]
Raw ''Utazi'' leaves	91.2±0.35[a]	0.9±0.50[a]	13.1±0.01[a]	0.3±0.50[b]	2.1±0.05[a]	7.5± 0.30[a]
Boiled ''Utazi'' leaves	90.6±0.23[a]	0.9±0.03[a]	9.3±0.02[b]	0.4±0.03[a]	2.6±0.05[b]	3.7±0.10[b]
Raw Sweet-bitter leaves	77.4±0.27[b]	1.6±0.13[a]	12.2±0.01[a]	0.8±0.13[a]	6.0±0.13[a]	2.1±0.25[a]
Boiled Sweet bitter leaves	91.4±0.33[a]	0.7±0.02[b]	8.1±0.00[b]	0.3±0.05[b]	2.4±0.03[b]	2.9±0.04[b]
Raw Bitter leaves	71.2±0.27[a]	1.8±0.16[a]	11.6±0.01[d]	1.2±0.09[a]	8.2±0.16[a]	6.1±0.39[a]
Boiled bitter leaves	91.2±0.33[b]	0.5±0.00[b]	7.0±0.01[b]	0.3±0.03[b]	3.1±0.12[b]	2.1±0.12[b]
Raw ''Afang'' leaves	84.6±0.91[a]	1.0±0.80[a]	10.1±0.00[a]	0.7±0.08c[d]	2.8±0.08[a]	1.0±0.24[e]
Boiled ''Afang'' leaves	84.0±0.24[a]	1.1±0.05[a]	7.5±0.00[a]	0.5±0.30	2.6±0.04[b]	4.3±0.11
Raw Okra leaves	72.7±0.58[e]	2.1±0.16[b]	11.6±0.01[e]	1.4±0.16[a]	7.0±0.17[b]	5.2±0.21[b]
Boiled okra leaves	93.8±0.22[a]	0.5±0.04[a]	3.9±0.02[a]	0.2±0.02[a]	1.7±0.01[a]	1.0±0.01[a]

Values represent means of duplicate values ± standard deviation. The comparism is between raw and boiled similar vegetables. Means with the same superscripts in a column are not significantly different (P = .05)

The mineral composition (mg/100g), of seven leafy vegetables (Table 2) in Cross River State (Wet weight basis), was affected significantly by Boiling (P = .05). The reduction of the vegetable content was evident in all mineral evaluated but in different vegetables: phosphorus contents of few vegetables like okra pod (52mg/100g in raw to 17mg/100g in boiled), sweet bitter leaves (25mg/100g in raw to 11mg/100g in boiled), bitter leaves (30.9mg/100g in raw to 7mg/100g in boiled) and okra leaves (51mg/100g in the raw to 35mg/100g in boiled). The values ranged from 0.33mg/100g in boiled ''utazi' leaves to 1152mg/100g in the raw okra leaves. The reduction in the sodium contents of boiled ''utaz'i' leaves (19mg/100g in raw; 18mg/100g in boiled), ''afang'' leaves (2mg/100g in raw ; 1 mg/100g in boiled), okra leaves (3mg/100g in raw; 2mg/100g in boiled) were comparable (P = .05), while that in other boiled samples were significant (P = .05). The values ranged from 1 mg/100g in ''afang'' leaves to 23mg/100g in raw bitter leaf. The calcium contents of all the samples reduced significantly (P = .05) with boiling. The values ranged from 82mg/100g in boiled okra pods and leaves to 825mg/100g in raw okra leaves. Boiling significantly (P = .05) increased the magnesium contents of ''utazi' (67mg/100g in raw to 74mg/100g in boiled) and ''afang'' leaves (110 mg/100g in the raw to 132mg/100g in boiled). Generally, the magnesium contents of all the samples ranged from 45mg/100g in boiled okra pod and leaves to 277mg/100g in raw okra leaves.

Boiling reduced the iron contents of okra pods (0.77mg/100g in raw to 0.21mg/100g in boiled), garden egg (0.74 mg/100g in raw to 0.24mg/100g in boiled), sweet bitter leaf (0.95mg/100g in raw to 0.34 mg/100g in boiled sample). Boiling did not affect the zinc contents of ''utaz'i' leaves. The raw and boiled samples had similar values of 0.26mg/100g. Boiling had significant (P = .05) impact on the zinc values of other samples. The boiled samples had lower values from the raw. The values ranged from 0.13 mg/100g in boiled okra leaves to 1.10 mg/100g in raw 'afang' leaves

Table 2: Mineral composition (mg/100g) of seven leafy vegetables in Cross River State (Wet weight basis).

Samples	Phosphorus	Potassium	Sodium	Calcium	Magnesium	Iron	Zinc
Raw okro pod	52±2.40[a]	441±16.70[a]	3±4.9[a]	253±5.54[a]	146±8.65[a]	0.77±0.01[a]	0.83±0.01[a]
Boiled okro pod	17±0.71[b]	175±4.10[b]	2±4.94[b]	82±2.87[b]	45±2.56[a]	0.21±0.0[b]	0.13±0.01[b]
Raw garden egg leaves	22±2.50[a]	900.00±25.00[a]	4±1.20[a]	815±42.72[a]	165±18.03[a]	0.74±0.00[a]	0.94±0.01[a]
Boiled garden egg leaves	22±0.71[a]	344±12[b]	0.3±1.23[b]	173±2.83[b]	69±1.88[b]	0.43±0.11[b]	0.29±0.01[b]
Raw 'utazi' leaves	8±1.53[a]	263±15.28[a]	19±16.92[a]	183±3.06[a]	67±2.51[b]	0.37±0.00[a]	0.26±0.01[a]
Boiled 'utazi' leaves	9±0.60[a]	0.33±0.30[b]	18±16.00[a]	170±1.47[b]	74±64[a]	0.36±0.0[a]	0.26±0.01[a]
Raw sweet bitter leaf	25.0±2.50[a]	800.00±25.0[a]	18±0.00[b]	470.00±0.00[a]	113±6.29[a]	0.95±0.00[a]	0.66±0.01[a]
Boiled sweet bitter leaf	11±0.93[b]	334±9.30[b]	20±1.94[a]	144±4.55[b]	49±6.08[b]	0.34±0.0[b]	0.21±0.01[b]
Raw bitterleaf	31±1.85[a]	1131±18.48[a]	23±0.00[a]	608±32.00[a]	217±12.80[a]	1.27±0.01[a]	1.09±0.01[a]
Boiled bitterleaf	9.0±0.57[b]	116±19[b]	20±1.51[b]	149±1.10[b]	49±6.08[b]	0.34±0.01[a]	0.21±0.01[b]
Raw 'afang' leaves	9.07±0.92[a]	397.33±12.22[a]	2±0.00[a]	197.87±20.88[b]	110±10.65[b]	0.63±0.00[a]	1.10±0.00[a]
Boiled 'afang' leaves	7±1.77[b]	300±17.70[b]	1±4.09[a]	200±3.07[a]	132±4.45[a]	0.60±0.07[a]	0.30±0.01[b]
Raw okra leaves	51.2±3.20[a]	1152.00±32.0[a]	3±0.00[a]	825.60±23.08[a]	277.33±9.78[a]	1.03±0.06[a]	0.77±0.29[a]
Boiled okra leaves	35.0±0.77[b]	336±4.10[b]	2±4.04[a]	170±2.87[b]	48±2.56[b]	0.44±0.00[b]	0.22±0.01[b]

Values represent means of duplicate values ± standard deviation. The comparism is between raw and boiled similar vegetables. Means with the same superscripts in a column are not significantly different (P = .05)

Table 3: Effect of boiling on the folate composition of seven leafy vegetables in Cross River State

Sample	Folate (mcg/100g)
Raw Okra pods	8±0.01[a]
Boiled okra pods	3±0.14[b]
Raw garden egg leaves	7±0.04[a]
Boiled garden egg leaves	5±0.01[b]

Raw Utazi leaves	3 ±0.01[a]
Boiled 'utazi leaves'	4 ± 0.01[a]
Raw Sweet-bitter leaves	9 ± 0.01[a]
Boiled sweet bitter leaves	3 ± 0,01[b]
Raw Bitter leaves	13 ±0.04[a]
Boiled bitter leaves	3 ± 0.01[b]
Raw Afang leaves	5 ±0.09[b]
Boiled 'afang''	6 ± 0.04[b]
Raw Okra leaves	8 ± 0.01[a]
Boiled okra leaves	5 ± 0.01[b]

Values represent means of duplicate values ± standard deviation. The comparism is between raw and boiled similar vegetables. Means with the same superscripts in a column are not significantly different *(P* =.05)

According to the results summarized in table 3: The folate contents of the 'utazi' leaves were not affected by boiling. Rather there was an insignificant increase from 3mcg in the raw ''utazi leaves to 4 mcg in the boiled leaves. This observation might be attributed to the antioxidant potential of ''utazi'' leaves because folate degradation after processing is limited by the presence of antioxidant provided the resident time of the vegetables in water is not prolonged [19]. ''utazi'' leaves were boiled for three minutes while other leaves were boiled for at least five minutes, so, the boiling time might have contributed to the folate level. The folate contents of other samples significantly were (*P* = .05) reduced by boiling. This observation might be attributed to the boiling time. Although, boiling of vegetables have been reported to denature water soluble vitamin like vitamin C (20). The folate values of the vegetables affected negatively by boiling ranged from 3 mcg/100g in boiled okra pods and boiled bitter leaves to 9 mcg/100g in raw sweet bitter leaves.

Table 4: The percentage contribution of 100g of raw vegetables (as consumed) to the recommended nutrient intake (RNI) of adults

Nutrients	Required Nutrient intake	Bitter leaves	Sweet bitter leaves	'utazi' leaves	'garden egg leaves
Protein (g/day)	46	18	13	5	13
Fat (g/day)	65	2	1	3	2
Carbohydrate	130	5	2	6	1
Dietary fibre(g/day)					
Female	25	46	49	52	46
Male	38	31	32	34	30

Fe (mg/day)					
Males 18+	9.1	14	10	4	8
Females 18+	19.6	6	5	2	4
Zinc(mg/day)					
Female 19+	3.0	36	22	9	31
Males 19+	4.2	26	16	6	22
Ca (mg/day)	700	87	67	26	116
Phosphorus(mg/day)	550	31	25	8	22
Sodium (mg/day)	1600	1	1	1	0.3
Potassium (mg/day)	3500	32	23	8	26
Magnesium(mg/day)					
Male 19 -65yrs	260	83	43	26	63
Female 19-65yrs	220	99	51	30	75
Male 65+	224	83	50	30	74
Females 65+	190	114	59	35	87
Folate (mcg/day)	120	10	8	3	4

About 100g of ‘utazi’ leaves can contribute about 5% of protein to the recommended intakes of adults. The 18% contribution of 100g of bitter variant of the bitter leaves to the RNI/day is appreciable as a vegetable. The fat contents of the vegetables can be regarded as low as they are all below 3% [16]. About 100g of the vegetables consumed in their raw forms can be regarded as good sources of dietary fibre as their contributions to the RNI/day of adults are above 30%. The iron contribution of 100g of these vegetables to the RNI of females is below 10% and that of men below 15%, As such, these vegetables may not be regarded as good sources of iron. Although, when they are fewer alternative, the bitter variant of the bitter leaf can be a good choice. The 36% contribution of 100g of raw garden egg leaves to the RNI/day of zinc is appreciable, this might be useful in planning therapeutic diets. The vegetables eaten in their raw forms (bitter and sweet variants of the bitter leaves and garden eggs) are very good sources of calcium as they can contribute about 87%, 67% and 116% of calcium respectively to the RNI/day of adults. The vegetables can contribute below 32% of phosphorus to RNI/day of adults. The phosphorus contents are further reduced by boiling, care must be taken in preparing these vegetables when phosphorus is a key nutrient of interest. The vegetables except ‘utazi’ can be regarded as good sources of potassium because their potassium contents are above the potassium contents of banana [17]. The two variety of the bitter leaves, garden egg leaves and ‘’utazi’’ which are traditionally consumed in their raw forms had low sodium contents and a 100g of it can contribute about 1% to the RNI/day of sodium. As a result, the leaves can be good sources of vegetable when planning diets for hypertensive patients as low sodium content is

desirable in their meals [18]. About 100g of the bitter leaves (sweet and bitter varieties) and garden egg leaves when consumed in their raw forms can contribute between 43 to 114% of the RNI/day of magnesium for adults male and female. This is an important consideration in planning diets that require this nutrient. The vegetables except the bitter variant of the bitter leaves had less than 10% contribution to the RNI/day of folate for adult men and women., as such these vegetables might not be regarded as good sources of this nutrient.

Conclusion and recommendation.

The raw bitter variant of the bitter leaves was more abundant in nutrient especially calcium, phosphorus and dietary fibre. The potassium contents of all the vegetables except ''utazi'' can be regarded as high as they are higher than the potassium contents of banana. Since this vegetable is eaten raw after washing, its use should be encouraged. Despite the good attributes of the vegetables, boiling had significant negative effect on almost all of them. Among the affected nutrients, Calcium, magnesium potassium and sodium were most affected by boiling. Surprisingly, the folate contents of ''utazi'' leaves were not affected by boiling but rather was increased insignificantly (P=0.05). Aside folate, the decrease in the level of nutrients in the boiled 'utazi' was insignificant. This observation might be attributed to the boiling time. ''utazi'' was boiled for only 3 minutes. This increase calls for more research into the antioxidant compositions of this leaves. Care must be taken in cooking these vegetables in order to preserve the nutrients.

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