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Evaluation of Nutrient-supplying Potentials of Fluted Pumpkin (*Telfairia occidentalis,* Hook, F.) And Okra (*Abelmoschus esculentus*) (L.) Moench

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Abstract: This study analyzed fluted pumpkin (*Telfairia occidentalis* Hook, F.) leaves and seeds and okra (*Abelmoschus esculentus* (L.) 'Moench' leaves and pod/seeds for their proximate compositions and mineral element contents to assess their nutritive and energy values. Results show relatively high mean moisture contents for fluted pumpkin leaves (86.29 ± 1.77%) and seeds (74.29 ± 1.58%) and okra leaves (78.53 ± 3.4%) and pod/seeds (82.9 ± 0.75%), indicating that the bulk of the vegetables constitutes water. Mean concentrations of crude protein (29.58 ± 10 and 21.81 ± 2.10%), crude fat (22.86 ± 1.33 and 17.22 ± 0.66%), ash 12.83 ± 0.55 and 9.00 ± 1.18%) and energy value (1609.68 and 1613.78KJ) were higher in fluted pumpkin seeds and okra pod/seeds than in their leaves. In contrast, nitrogen free extract and crude fibre contents were higher in the leaves than seeds and pod/seeds. Mineral contents (potassium (K), phosphorus (P), iron (Fe), manganese (Mn), copper (Cu) and zinc (Zn) and vitamin C were relatively high, implying that both vegetables could be good supplements for these nutrients. However, only K, Fe and Mn could meet an RDA (Recommended Dietary Allowance) requirements.

Key words: Leafy and fruit/pod vegetables · Proximate composition · Nutritive value · Mineral element contents

INTRODUCTION

Vegetables are of great importance in the tropics and subtropics in a twofold sence: i) as food and ii) as commercial products [1]. In nutrition, vegetables are very good sources of most vitamins such as vitamins A, B and C and some organic acids like folic acid. Most minerals such as iron (Fe), calcium (Ca) and phosphorus are obtained from vegetables and sometimes vegetables are important sources of protein which is frequently in short supply in humid tropics.

Vegetables are often cooked and eaten in the form of soup, salad and in vegetable stew [2]. They are consumed as cooked complements to major stables such as cassava, cocoyam, guinea corn, maize (Zea mays), rice and plantain.

Vegetables are of interest economically from several points of view: where there are good opportunities for sale, they are among the most profitable agricultural products [1]. These vegetables range from leaves of annuals to shrubs of the families such as *Amarantheceae, Compositae, Portulacaceae, Curcurbitaceae* and *Solanaceae* and so on [3].

Vegetables contain indigestible fibre which can calm the irritable bowel and by triggering regular bowel movement prevent constipation. Consumption of vegetable can help prevent heart diseases, stroke, high blood pressure and accumulation of cholesterol [4]. Vegetables lower the chances of developing cardio-vascular diseases [5]. When consumed, the high water content and cellulose component of vegetables enhance food digestion and peristaltic movement; vitamin C supplied is essential for oxygen metabolism, building and maintenance of bone cartilage and connecting tissue.

The consumption of vegetables is far from being sufficient in almost all least developed countries. FAO [6] recommended an intake of 200g vegetable per person day^{-1} or 73kg $year^{-1}$ in order to ensure an adequate nutrient supply. This is presumed to provide balance diet needed by people in particular, in diet characterized by low inclusion of meat and other animal proteins.

Among the wide range of vegetables cultivated in Southeastern Nigeria, fluted pumpkin (*Telfairia occidentalis* Hook, F.) and okra (*Abelmoschus esculentus* (L.) 'Moench' are perhaps the most popular. Telfairia belongs to the family of Curcurbitaceae,

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which comprises a wide range of plants that have common characteristics of large leaves, creeping, or climbing stems usually with tendrils, flashy fruits with many seeds and more or less fibrous root system [7]. Okra belongs to the family of Malvaceae. It is a vegetable valued for many of its properties. The fruits are used as boiled or fried vegetable and added to soups and stews [8]. Mature pods of okra contain a mucilaginous substance; young shoots and leaves are edible. The mature seed contains about 20% of edible oil [9] while the fresh pod contains about 203mg ascorbic acid per 100g of fruits [10]. Babatola and Lawal [8] reported okra seed to be a potential source of high quality protein, a result of high lysine content while Al-wandari [11] recommended okra as a supplement to cereal-based diets.

Although these vegetables are regularly consumed for maintenance of good health and increasing productivity information on proximate composition, nutritive and energy value is scanty and limited, hence, this study was carried out to assess the nutrient-supplying power of fluted pumpkin leaves/seeds and okra leaves/pod and seeds, grown in soils formed on coastal plain sands parent materials.

MATERIALS AND METHOD

Sample Collection: Twenty fresh recently mature Telfairia and okra levaes, ten okra pods with seeds and two mature Telfairia fruits were harvested in the University of Uyo Teaching and Research Farm in February, 2009. The Telfairia fruits were split open to free the seeds. Each sample (TL – Telfairia leaf, TF – Telfairia fruit, OL – okra leave, OPS – okro pod/seed) was placed in a separate, large properly labeled envelop and taken to the laboratory for analysis. The samples were identified by a taxonomist in the Department of Crop Science, University of Uyo, Nigeria.

Sample Treatment: The plant samples were cleaned with 2% phosphate-free detergent solution and quickly washed with flowing distilled water, the residual moisture evaporated at room temperature; the samples were chopped and oven dried in paper envelopes to constant mass for moisture and dry matter determinations. The loss in mass was taken as percent moisture content. The dried samples were ground to fine powder using agate mortar and pestle, sieved to obtain particles less than 20 mesh sieve and stored in airtight containers for the following analyses:

Proximate Composition: The recommended methods of the Association of Official Analytical Chemists [12] were used for the determination of crude fibre (CF), crude fat (CFT), ash and total nitrogen contents. Crude protein (CP) was estimated by calculation: (CP = %total N x 6.25). Nitrogen free extract (NFE) was obtained by difference: NFE = 100 - $\sum$(%CP + %CF + %CFT + %ash) from dry mass sample (12). Vitamin A was determined by magnesium oxide chromatography while vitamin C was determined by 2, 6 – dichloroindophenol method using dye indicator. Energy value in KJ (kilojoule) was estimated by multiplying the percentages of CP, CFT and NFE (carbohydrate) by the recommended factors (10.25, 35.15 and 15) used in vegetable analysis [13].

Mineral Element Contents: One gram of fine powdered sample of each Telfairia leaf, fruit and okra leaf and pod was separately digested using a mixture of trioxonitrite (v), tetraoxochlorate (VII) and tetraoxosulphate (VI) acids (1:1:1) for the determination of calcium (Ca), magnesium (Mg), potassium (K), sodium (Na), zinc (Zn), iron (Fe), manganese (Mn) and copper (Cu). Sodium and K were measured by flame analyzer; phosphorus (P) was determined colorimetrically by vanadomolybdate procedure. Calcium, Mg, Fe, Mn, Zn and Cu concentrations were measured by atomic absorption spectrophotometer (Unicam 939/959 model).

Statistical Analysis: Means and standard deviations ($\bar{x} \pm$ SD) were calculated for three determinations. Means were tested with student t-test and significance accepted at $P \leq 0.05$ probability levels.

RESULTS AND DISCUSSION

Proximate Composition: Results of proximate analysis of fluted pumpkin (FP) and okra (OK) leaves (Table 1) show high mean moisture contents of 86.29 ± 1.77 and 78.53 ± 3.42% (wet mass) for FP and OK, respectively. These values are within the reported range (58 – 93%), in some leafy vegetables, for example, *amaranthus* (84.0%) and Talinum (90.8%) (3), consumed in Nigeria. In FP seeds, moisture content was lower (74.29 ± 1.58%), while in OK pod/seed, it was higher (82.9 ± 0.75%) than that of the leaves. These results imply that the bulk of FP leaves/seeds and OK leaves and pod/seeds constitute water, meaning that these vegetables have low storage capacity or are easily perishable, highlighting the problem of conservation in warm climatic condition. The high water content in vegetables can help enhance food digestion and peristaltic movement on consumption.

Table 1: Proximate composition of Telfairia and Okra leaves

Parameter	Telfairia leaves (%)	Okra leaves (%)
Moisture	86.29 ± 1.77a	78.53 ± 3.42b
Crude fibre	10.36 ± 2.01b	16.10 ± 1.86a
Crude fat	14.04 ± 1.13a	10.11 ± 0.14b
Ash	9.68 ± 0.73a	6.00 ± 2.10b
Crude protein	19.4 ± 1.29a	13.75 ± 1.14b
NFE*	46.52 ± 1.56b	54.14 ± 0.37a
Energy value (KJ)	1390.16	1308.41

*Nitrogen free extract. Each data is a mean and standard deviation (X ± SD) of three determinations. Figures followed by the same letter in the same row are not significantly different (P < 0.05)

Table 2: Proximate composition of Telfairia seed and Okra pod/seed

Parameter	Telfairia seed (%)	Okra pod/seed[1] (%)
Moisture	74.29 ± 1.58b	82.9 ± 0.75a
Crude fibre	1.2 ± 0.21b	4.3 ± 0.25a
Crude fat	22.86 ± 1.33a	17.22 ± 0.66b
Ash	12.83 ± 0.55a	9.00 ± 1.18b
Crude protein	29.83 ± 1.0a	21.81 ± 2.10b
NFE*	33.53 ± 2.28b	52.33 ± 3.00a
Vitamin A (mg/100g)	3.81b	12.00a
Vitamin C (mg/100g)	11.27b	28.00a
Energy value (KJ)	1609.68	1613.78

1. Okra pod and seed are eaten together.

*Nitrogen free extract. Each data is a mean and standard deviation (X ± SD) of three determinations. Figures followed by the same letter in the same row are not significantly different (P < 0.05)

The mean crude fibre (CF) contents of FP (10.36%/100g) leaves were high and compared favourably with those of *Lasianthera africana* (15.3 – 18.1% dry mass) [14] and *Heinsia crinata* (13 – 15% dry mass) [15] and values fall within the range (8.5 – 20.9%) reported for leafy vegetables by Ifon and Bassir [16]. However, CF content was low in FP seeds (1.2 ± 0.2%) and OK pod/seeds (4.3 ± 0.25%). With the dietary fibre for children being 19-25% (Recommended Dietary Allowance), a combination of FP and OK leaves could meet the requirement while individual leaf will provide only 55 (FP) and 85% (OK) of dietary fibre in human nutrition. Although intake of dietary fibre can lower the serum cholesterol level, risk of coronary heart disease, hypertension, diabetes and colon and breast cancer [17], the major problem associated with nutrition of vegetables by human is the high fibre content which can cause intestinal irritation and lower bioavailability [18].

Crude fat (CFT) contents of FP (14.04 ± 1.13%) and OK (10.11 ± 0.14%/100g dry mass) leaves were lower than those obtained for FP seeds (22.86 ± 1.33%) and OK pod/seeds (17.22 ± 0.66%), indicating that these vegetables are good sources of plant CFT and thus disadvantageous health wise as they could result in obesity if regularly consumed.

Ash contents (an index of mineral contents in biological mass), were relatively higher in FP seeds (12.83 ± 0.55%) and okra pod/seeds (9.00 ± 1.18%) than in FP (9.68 ± 0.73%) and OK (6.00 ± 2.10%) leaves. Though these values were slightly lower than those of *Veronia colorate* (bitter leaf) (15.86%) and *Moringa oleifera* (15.09%), fluted pumpkin and okra could however be good sources of mineral elements (Tables 3 and 4).

The leaves CP contents (19.4 ± 1.29%) and (13.75 ± 1.14%) and seeds (29.58 ± 1.00%) and pod/seeds (21.81 ± 2.10%/100g dry mass) for FP and OK were high and compared favourably with 24% in *Amaranthus vividis* (19), 20.72% in *Moringa oleifera* [20], 21.0% in *Lasianthera africana* and 15.0% in *Heinsia crinata* [15]. The results indicate that these vegetables can provide more than 12% of its energy from protein and are therefore considered good sources of protein [21]. Assuming complete adsorption, FP leaves/seeds and OK leaves and pod/seeds meet this requirement.

Table 3: Mineral composition of Telfairia and Okra leaves

Parameter	Telfairia leaves	Okra leaves
	(mg/100g^{-1})	
Calcium (mg/100g)	240.00 ± 1.00b	321.00 ± 0.88a
Magnesium (mg/100g)	67.92 ± 1.68b	180.00 ± 2.30a
Potassium (mg/100g)	714.53 ± 0.36b	1128.1 ± 2.19a
Sodium (mg/100g)	115.00 ± 0.76a	66.00 ± 0.36b
Phosphorus (mg/kg)	393.52 ± 0.10a	229.4 ± 3.22b
Iron (mg/kg)	91.09 ± 1.65b	110.31 ± 0.31a
Manganese (mg/kg)	34.55 ± 0.43a	19.19 ± 1.50b
Copper (mg/kg)	9.60 ± 2.00b	11.01 ± 0.91a
Zinc (mg/kg)	4.11 ± 0.13a	2.77 ± 1.75b
K/Na	6.21b	17.09a
Ca/P 0.61a	0.26b	

Each data is a mean and standard deviation (X ± SD) of three determinations. Figures followed by the same letter in the same row are not significantly different ($P < 0.05$)

Table 4: Mineral composition of Telfairia seed and Okra pod/seed

Parameter	Telfairia seed	Okra pod/seed
	(mg/100g^{-1})	
Calcium (mg/100g)	248.12 ± 0.38a	155 ± 0.49b
Magnesium (mg/100g)	72.81 ± 1.12a	52.2 ± 0.66b
Potassium (mg/100g)	1226.42 ± 0.21a	616.00 ± 2.82b
Sodium (mg/100g)	88.86 ± 0.48a	42.12 ± 0.24b
Phosphorus (mg/100g)	661.01 ± 1.22a	583.91 ± 1.72b
Iron (mg/100g)	121.00 ± 0.71a	76.20 ± 0.20b
Manganese (mg/100g)	36.62 ± 1.02a	21.77 ± 0.42b
Copper (mg/100g)	10.14 ± 0.38a	0.91 ± 0.03b
Zinc (mg/100g)	6.34 ± 1.71b	18.81 ± 1.16a
K/Na	13.8b	16.60a
Ca/P 0.4a	0.27b	

Each data is a mean and standard deviation (X ± SD) of three determinations. Figures followed by the same letter in the same row are not significantly different ($P < 0.05$)

Carbohydrate or nitrogen free extract (NFE) content in FP leaves (46.52 ± 1.56%) was significantly higher ($P \leq 0.05$) than that found for the seed (33.53 ± 2.26%) while in OK leaves and pod/seeds, NFE contents were almost the same with OK leaves having slightly higher value (54.14 ± 0.37%) than pod/seeds (52.33 ± 3.00%) per 100g dry mass. If the RDA value for children is 130g, FP and OK leaves can provide 36 and 42% while seeds and pod/seeds will supply 26 and 40% requirements when 100g dry mass of leaves/seeds and pod/seeds are consumed.

Energy (Caloric) Value: The values of energy calculated for 100g FP and OK leaves were low when compared to 10,000KJ daily energy expenditure, contributing only 14 and 13% of energy. Okra pod/seeds are most often cooked together and this could generate about 30% of daily energy requirement, if only 100g of each are consumed. Vitamins C (ascorbic acid) and vitamin A contents of the two vegetables were low (Table 2) compared to a range of 23 to 232mg/100g vitamin C in leafy vegetables obtained by Achivewhu *at al*., [22].

Mineral Composition: Tables 3 and 4 show the results of mineral concentrations of FP and OK leaves/seeds and pod/seeds. Although Ca (240.00±1.00 and 321.00±0.88mg/100g) and Mg (67.92±1.68 and 180.00±2.3mg/100g) levels (for FP and OK leaves) were high, though the values were still below the recommended dietary allowance (RDA) requirement of 800mg for Ca and 350mg for Mg [23], contributing only 30 and 40% and 19 and 51% of Ca and Mg if 100g of leaves are consumed. Values of Ca and Mg obtained from FP seeds and OK pod/seeds were lower than those found for leaves (Table 4).

These vegetables have sufficiently high levels of K and relatively low Na contents resulting in high K/Na ratios (17 and 6) in the leaves and 14 and 17 in the FP seeds and OK pod/seeds, respectively. These values are high compared to 3 – 4 considered most adequate for the normal retention of protein during growth stage [24]; and the high value could be reduced during cooking with addition of table salt (Nacl). Assuming complete adsorption, 150 and 200g of FP and OK, if consumed could contribute 72 and 85% to human diet. Calcium/P ratio of close to unity has been recommended for good Ca to P intestinal absorption, a requirement provided by FP leaves. Calcium and P are important in growth and maintenance of bones, teeth and muscles.

Fluted Pumpkin and OK Are Rich in Micronutrients: Fe – 91.09 ± 1.65 and 121.00 ± 0.71; Mn – 34.55 ± 0.43 and 36.62 ± 1.02; Cu – 9.60 ± 2.00 and 10.14 ± 0.38 mg/100g for FP leaves and seeds and Fe – 110.31 ± 0.31 and 76.20 ± 0.20; Mn – 19.19 ± 1.50 and 21.77 ± 0.42; Zn – 2.77 ± 1.75 and 18.81 ± 1.16mg/100g dry mass for OK leaves and pod/seeds. Zinc with concentrations of 4.11 for FP and 2.77mg/100g for OK were lower than an RDA requirement of 15mg.

Nutritional significance of FP and OK indicates that Fe and Mn will meet an RDA of 6 – 10 mg per day Fe and 2 – 5mg per day Mn for infants, children, pregnant and lactating mothers [25]. Only OK pod/seeds will satisfy 15mg/day Zn RDA requirement for adult males while Cu needs of 2 – 3mg/day will be met if 100g of FP seed is consumed daily.

CONCLUSION

This study presents chemical composition, nutritive and energy supplying potentials of Telfairia occidentalis leaves and seeds and Abelmoschus esculentus leaves and pod/seeds. Nutritionally, these leafy/pod and seed vegetables compared favourably with most vegetables consumed in Nigeria. On the basis of carbohydrate, CP, CFT, CF and mineral element contents, these vegetables are of high nutritional value and are therefore recommended for regular consumption as supplement for energy, K, Fe, Mn and P.

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