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Full Length Research Paper

Evaluation of the nutritional values of dry season Fadama vegetables in Bida, Nigeria

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The proximate and mineral analysis of the some vegetables: *Telfaria occidentalis* Hook. F., *Ocimum gratissimum* L., *Hyptis suaveolens* Poit., *Talinum triangulare* (Jacq.) Willd, *Amaranthus hybridus* L., and *Corchorus olitorius* L., were carried out to evaluate their nutritional value. Results showed high mean moisture contents ranging from 45.47 to 84.00%, low ash content ranging from 1.10 to 10.10%, and protein content ranging from 3.20 to 21.95%. Elemental analysis in mg/100 g indicated that the leaves and stem of the vegetable crops showed that they are rich sources of sodium, calcium, and potassium. There was complete absence of iron and magnesium in the vegetable crops. This result revealed that these vegetables are rich sources of nutrients and minerals essential for human growth and development.

Key words: Elemental analysis, vegetables, nutritional value.

INTRODUCTION

In common, parlance vegetable refers to fresh edible parts of herbaceous plants (roots, stem, leaves, fruits, and flowers) eaten fresh or prepared in a variety of ways (Fayemi, 1999; Dhellot et al., 2006). Vegetables are important sources of macro and micro nutrients which are highly important for the maintenance of good health and prevention of diseases (Sheela et al., 2004; Nnamani et al., 2007). Most people in developing countries depend on starch-based foods as the main staple food for the supply of both energy and protein. This accounts in part for protein deficiency which prevails among the populace (Ladeji et al., 1995). In Nigeria, as in most other tropical countries of Africa, where the daily diet is dominated by starchy staple foods, vegetables are the cheapest and most readily available sources of important proteins, vitamins, minerals, and essential amino acids (Okafor, 1983). Most of the commonly eaten vegetables are the succulent leaves of plants; they are eaten as supplementary foods, side dishes or in soup as condiments, or eaten with other main dishes (Van et al., 1968).

Vegetables are of several values to man, which include maintenance of alkaline reserve of the body (Chioyedua et al., 2009); high carbohydrate, vitamins, and mineral content (Robinson, 1990). *Corchorus olitorius* is usually recommended for pregnant women and nursing mothers (Oyedele et al., 2006), because it is the cheapest and most readily available sources of important proteins, minerals, and essential amino acids (Okafor, 1983; Thompson and Kelly, 1999). It also act as buffering agents for acidic substances produced during the digestion process (Thompson and Kelly, 1999). These vegetables are rich sources of carotene, ascorbic acid, riboflavin, folic acid, and minerals like calcium, iron and phosphorous (Nnamani et al., 2007) and potassium; some of which are good in the control of diuretic and hypertensive complications, because it lowers arterial blood pressure (George, 2003); their fibre content contributes to the feeling of satisfaction and prevents constipation (Noonan and Savage, 1999). It is against this background that the current study examined the nutritive value of selected vegetables commonly cultivated in Bida.

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Table 1. Dry season Fadama vegetables selected for the study.

Botanical name	Common name	Nupe name
Telfaria occidentalis Hook. F.	Fluted pumpkin	-
Ocimum gratissimum L	Scent leaf plant	Tanmotswangi - wawagi
Hyptis suaveolens Poit.	Curry leaf	Tanmotswangi-eba
T. triangulare (Jacq.) Willd	Water leaf	Eningi
A.hybridus L	African spinach	Alayefa
C.olitorius Linn.	Jute plant	Ayoyo

MATERIALS AND METHODS

Sample collection

Vegetable samples were obtained from the two locations of Fadama farms in Bida (Landzun and Bangaie areas) (Table 1). All samples were collected the same day and kept in labeled polythene bags.

Preparation of standard

Stock solutions of iron, potassium, calcium, sodium, and magnesium were prepared in accordance with standard methods (Association of Official Analytical Chemistry (AOAC, 1995).

Sample analysis

The freshly collected plants were washed to ensure that they are free from dirts, such as soil and other contaminations. Each vegetable sample was separated into the roots, stems, and leaves components. All were cut into small pieces. The samples were thoroughly mixed to ensure accuracy of result for each portion taken for analysis. Immediately, each part of the samples was taken separately for the determination of moisture content and ash content. The remaining samples separated into different crucibles according to their stems, leaves, and roots were taken to the oven for drying at 105°C. The oven-dried parts of each sample were grounded in a mortar using pestle and were passed through a 1.5 mm sieve. The samples were then kept in a sealed container in cupboard awaiting further analysis.

The moisture content was determined by air-oven method as described by AOAC (1995) using 2 g of each part of the samples, that is, roots, stems, and leaves until constant weights were obtained. The ash content was determined using procedure outlined in AOAC (1995) utilizing 2 g of each part of the plant samples and the result expressed as percentage.

Carbohydrate content was determined as outlined in AOAC (1995). This was calculated by carbohydrate difference: the sum total of the moisture, fat, protein, and ash content of each part of the samples were subtracted from 100 as follows:

Carbohydrate content = 100 – (protein (%) + moisture (%) + fat (%) + ash (%)).

The sample calorific value was estimated (in kcal) by multiplying the percentage crude protein, crude lipid, and carbohydrate by the recommended factor (2.44, 8.37, and 3.57, respectively) used in vegetable analysis (Asibey-Berko and Tayie, 1999). Protein value was estimated by determining the nitrogen value according to improved Kjeldahl method as described by AOAC (1995) and multiplying by a factor of 6.25. Crude fibre content was determined as outlined in AOAC (1995) using Gallenkhamp muffle furnace at 550°C and the result was expressed in percentage. Crude fat was determined using oven-dried samples from moisture content determination. This was extracted with petroleum ether (boiling point (BP) 40 to 60°C) for 6 h with soxhlet extractor. After evaporation of ether, drying to constant weight, and cooling, the result was expressed in percentage.

The mineral elements comprising sodium, calcium, potassium magnesium, and iron were determined using 2 g of each part of the processed samples weighed and were subjected to dry ashing in a well-cleaned porcelain crucible at 550°C in a Gallenkhamp muffle furnace. The resultant ash was dissolved in 5 ml of $HNO_3/HCl/H_2O$ (1:2:3) and was heated gently on a hot plate until brown fumes disappeared. To the remaining material in the crucible, 5 ml of de-ionized water was added and heated until a colourless solution was obtained. The mineral solution in each crucible was transferred into a 100 ml volumetric flask by filtration through Whatman Grade No. 42 filter paper and the volume was made to the mark with de-ionized water. This solution was used for elemental analysis by atomic absorption spectrophotometer (AAS). A 10 cm long cell was used and the concentration of each element in the sample was calculated in the percentage of dry matter, that is, mg/100 g sample.

RESULTS AND DISCUSSION

The results of the proximate and chemical compositions of the various parts of the selected vegetables showing the main moisture content, ash content, crude protein, crude lipid, crude fibre, available carbohydrate, and energy values is shown in Table 2. Moisture content varies from the highest in water leaf plant root (84.00%) to the lowest in African spinach root (29.90%). This is within the reported range (0.83 to 90.30%) for Nigeria green leafy vegetables (Akubugwo et al., 2007), but higher than those reported by Chionyedua et al. (2009) in *Amaranthus cruentus* (23.57%), *Celosia argenta* (15.58%), and *C. olitorius* (30.90%) or leaves of *Manihot esulentum* (0.90%), *Piper guineeses* (0.83%), and *Chromolena odorata* (1.01%) (Taiga et al., 2008) and *Zanthoxylum zanthoxyloides* (9.60%), *Vitex doniana* (10.20%), and *Adenia cissamploides* (10.80%) (Nnamani et al., 2009). George (2003) reported that high moisture content is important in maintaining the protoplasmic content of the cells, but it makes the vegetables perishable and susceptible to spoilage by micro-organisms during storage. The reason for the high moisture content could be due to high water content of the Fadama lands, where they are grown.

Table 2. Results of proximate analysis of various parts of the selected vegetables.

Name of plant	Plant parts	Moisture content (%DW)	Ash content (%DW)	Crude protein (%DW)	Crude lipid (%DW)	Crude fibre (%DW)	Carbohydrate (%DW)	Energy value (Kcal/100 g)
	Leaf	62.53	3.27	12.62	3.75	1.25	16.60	121.40
A. hybridus	Stem	45.47	3.59	8.05	3.25	1.25	38.40	183.93
	Root	29.90	4.00	7.63	2.50	1.50	7.48	66.66
	Leaf	55.60	6.75	8.25	1.75	1.75	25.90	127.40
C. olitorius	Stem	53.85	4.42	5.75	1.25	1.50	34.74	148.51
	Root	57.50	4.42	3.20	1.25	1.75	31.89	132.12
	Leaf	56.96	6.35	7.75	2.25	2.50	16.12	95.29
O. gratissimum	Stem	70.70	4.57	4.57	2.00	2.00	15.80	84.61
	Root	60.43	3.91	3.91	1.75	1.75	17.45	87.92
	Leaf	60.45	10.01	4.25	2.50	1.75	30.55	140.36
H. suaveolens	Stem	66.50	1.42	17.25	2.25	1.50	21.09	136.21
	Root	58.25	1.35	10.10	2.25	1.25	26.80	139.25
	Leaf	72.25	3.75	21.95	3.75	2.00	7.50	113.07
T. occidentalis	Stem	66.50	1.42	17.25	2.25	1.50	21.09	136.21
	Root	58.25	1.35	10.10	2.25	1.25	26.80	139.25
	Leaf	63.92	1.42	7.65	2.00	1.25	23.77	120.26
T. triangulare	Stem	61.00	1.60	10.75	2.25	1.00	23.40	128.60
	Root	84.00	1.10	4.50	1.00	1.25	5.15	37.73

All values of proximate analysis parameters are mean concentration of the duplicate of the different parts of different vegetables obtained from the two locations of Fadama farms in Bida.

The results of the mean ash content revealed that the curry plant leaf has the highest (10.01%), and the lowest is the root of water leaf (1.10%). The ash content of any sample is the measure of the mineral content of the food (Nnamani et al., 2009). This result is compared favourably with the results of Taiga et al. (2008) who reported 2.21% in *M. esulentum*, *P. guineeses* (1.38%), *C. odorata* (1.86%), *Solanum melanogaster* (1.02%), *Telfaria occidentalis* (1.88%) and *Z. zanthoxyloides* (8.10%), *V. doniana* (6.30%), and *A. cissamploides* (7.20%) (Nnamani et al., 2009). The results of the mean fibre content showed that the leaf of scent leaf plant recorded the highest (2.50%) and the stem of water leaf recorded the lowest (1.00%). This is lower than those of *C. olitorius* (6.60%), *A. cruentus* (7.83%), and *C. argenta* (11.70%) (Chionyedua et al., 2009); *Ipomoea batatas* (7.20%), *Talinum triangulare* (6.20%), *P. guineeses* (6.40%), *C. olitorius* (7.00%), and *Vernonia amagydalina* (6.50%) (Akindahunsi and Salawu, 2005; Antia et al., 2006). These results compared favourably with those reported in *T. occidentalis* (1.7%) *T. triangulare* (2.00%), and *C. argenta* (1.80%) (Akachukwu and Fawusi, 1995). This indicates that the fibre (roughages) content of these plants is low and could promote digestion and prevent constipation when consumed. Adequate intake of dietary fibre can lower the serum cholesterol level, risk of coronary heart disease, hypertension, constipation, diabetes, colon, and breast cancer (Ishida et al., 2000).

The results of the crude protein content revealed that it was the highest in the leaf of *T. occidentalis* (21.95%), and the lowest in the root of *C. olitorius* (3.20%). Pearson (1976) reported that plant food that contains more than 12% of its calorific value from protein is considered good source of protein. Therefore, the results of Fluted pumpkin, African spinach leaf, and curry stem meet these requirements. Roger et al. (2005) reported that protein level of green leafy vegetables range from 20.48 to 41.66% dry weight (DW). The results of the crude protein compared favourably with those of *T. occidentalis* (13.33%) *S. melanogaster* (2.50%), *P. guineeses* (10.50%) and *V. subteranea* (3.30%) (Taiga et al., 2008); *Momordica foecide* (4.60%) (Ogle and Grivetti, 1985; Isong et al., 1999; Hassan and Umar, 2006), *I. batatas* (24.85%), *Amaranthus candatus* (20.50%), (Etuk et al., 1998; Akindahunsi and Salawu, 2005; Antia et al., 2006), *Gnetum africana* (17.50%) and *Leptadenia hastata*

19.10%) (Sena et al., 1998; Ekpo, 2007).

Furthermore, adults, children, pregnant and lactating mothers require 34 to 50, 13 to 19, and 17 to 71 g of protein daily, respectively (FND, 2002). It has been reported that protein (calories malnutrition deficiencies) is a major factor responsible in nutritional pathology (Roger et al., 2005). The results therefore showed that African spinach leaf and curry leaf stem and root may be able to supply 27 g of protein daily which satisfies the recommended daily allowance of protein for children (FAO, 1986).

The results of the lipid content revealed that the leaves of African spinach and Fluted pumpkin have the highest values (3.75%) each, while the root of water leaf has the lowest value (1.00%). This shows that vegetables are poor sources of lipid. The crude lipid contents are low as compared to reported values (8.30 to 27.00%) in some vegetables consumed in West Africa (Ifon and Bassir, 1980; Sena et al., 1998). However, the results are higher than those reported for *A. cruentus* (0.45%), *C. argenta* (0.21%), and *C. olitorius* (0.32%) (Chionyedua *et al*., 2009); *T. occidentalis* (0.68%), *M. esulentum* (0.69%), *P. guineeses* (0.28%), *C. odorata* (0.96%) and *Voandzeia subteranea* (0.63%) (Taiga et al., 2008); *Celosia argenta* (1.25%) as reported by Okafor (1998). The results compared favourably with 2.90% reported for *S. melanogaster* (Taiga et al., 2008), and *A. cissamploides* (3.50%), and *V. doniana* (2.10%) (Nnamani et al., 2009).

The results of the available carbohydrate showed that the stem of African spinach has the highest value (38.40%), while the lowest value was recorded at the root of water leaf (5.15%). These results are low when compared with those of the carbohydrate content of various parts of vegetables with those reported for *T. occidentalis* (63.64%), *M. esulentum* (58.79%), *S. melanogaster* (87.57%) and *P. guineeses* (77.175) by Taiga et al. (2008); *Amaranthus hybridus* (52.18%) (Akubugwo et al., 2007); *Momordica balsamina* (39.05%) (Faruq et al., 2002; Hassan and Umar, 2006), *Corchorus tridens* (75.00% DW) and sweet potatoes leaves (82.80%) (Asibey-Berko and Tayie, 1999) and *A. cissamploides* (66.20%) (Nnamani et al., 2009). The results are high when compared to the carbohydrate content level of 8.0 g in *T. occidentalis* (FAO, 1986). The results are high when compared with those of *Senna obtusfolia* (20.00%) and *Amaranthus incurvatus* leaves (23.70%), respectively (Faruq et al., 2002; Hassan and Umar, 2006). This indicates that the indigenous vegetables can act as a better food supplement in providing carbohydrate (Nnamani et al., 2009). The recommended carbohydrate dietary allowance values for children, adults, pregnant, and lactating mothers are 130, 130, 175, and 210 g, respectively (FND, 2002).

The energy values of the vegetables showed that it was highest in the stem of African spinach (183.93 kcal/100 g) and lowest in the root of water leaf plant (37.73 kcal/100 g). These results compared favourably with those of *C. olitorius* (177.55 kcal/100 g), *A. cruentus* (176.67 kcal/100 g) and *C. argenta* (174.93 kcal/ 100 g) as reported by Chionyedua et al. (2009). However, these values are lower than *A. hybridus* (286.92 kcal/100 g DW) Akubugwo et al. (2007) and those of some Nigerian vegetables (248.80 to 307.10 kcal/100 g DW) (Isong et al., 1999; Antia et al., 2006). Asibey-Berko and Tayie (1999) also reported comparable energy content in some Ghanaian green leafy vegetables. Thus, the energy value is in agreement with the general observation that vegetables have low energy values (Lintas, 1992).

Compositions of various parts of the vegetable samples are shown in Table 3. The metals analysed in the leaf and stem of the vegetables collected are magnesium, calcium, potassium, sodium, and iron. The results showed that iron was completely absent in both the leaves and stems of the vegetable samples collected. The magnesium content of the vegetables analysed from the leaves and stems showed that it is below detection limit. The results of sodium content in the vegetables revealed that the concentration of sodium in the leaves and stems are higher than those reported in *A. hybridus* (7.43 mg/100 g) (Akubugwo el al., 2007); *V. doniana* (20.00 mg/100 g), *Z. zanthoxyloides* (10.00 mg/100 g) and *A. cissamploides* (8.0 mg/100 g) (Nnamani et al., 2009). The results of potassium content in *C. olitorius* leaf, curry leaf, *T. occidentalis* leaf and stem showed complete absence of the element. However, the results of *C. olitorius* stem (60.00 mg/100 g) and curry stem (127.50 mg/100 g) are higher than those reported for *A. hybridus* (54.20 mg/100 g) (Akubugwo et al., 2007); *Z. zanthoxyloides* (35.00 mg/100 g), *V. doniana* (35.00 mg/100 g) and *A. cissamploides* (32.00 mg/100 g) (Nnamani et al., 2009). The results of scent leaf (0.75 mg/100 g) and stem (3.75 mg/100 g), and water leaf (3.00 mg/100 g) and stem (0.83 mg/100 g) are lower than those earlier reported.

The results of calcium content in the vegetables are lower than those reported for calcium in some vegetables. It is higher than those of *A. cruentus* (27.90 mg/100 g), *C. argenta* (27.70 mg/100 g) and *C. olitorius* (23.30 mg/100 g) (Chionyedua et al., 2007). These results compared favourably with those reported in *A. hybridus* (54.20 mg/100 g) (Akubugwo et al., 2007); *Z. zanthoxyloides* (90.10 mg/100 g) and *A. cissamploides* (54.10 mg/100 g) (Nnamani et al., 2009).

Thus, these calcium rich vegetables in daily diet ensure the 20 to 25% of the daily requirement for calcium that aid strong bones and health teeth (Raghuvanshi and Singh, 2001). They are also required for growth and maintenance of bones, teeth and muscles (Dosunmu, 1997; Turan et al., 2003). Calcium and phosphorous are minerals present in largest quantity in the structure of the body and in the bone (Chionyedua et al., 2009). These vegetables can supplement the daily requirement of calcium which have been put at 260 mg/day by (FAO/WHO, 2001).

Table 3. Result of mineral compositions of the various parts of plant samples (Mg/100 g).

Name of plant	Plant parts	Magnesium	Calcium	Potassium	Sodium	Iron
A. hybridus	Leaf	BDL	6.75	0.90	32.25	N.D
	Stem	BDL	8.25	7.50	51.75	N.D
C. olitorius	Leaf	BDL	7.50	N.D	33.00	N.D
	Stem	BDL	5.25	60.00	38.25	N.D
O. gratissimum	Leaf	BDL	3.75	0.75	34.58	N.D
	Stem	BDL	0.90	3.75	45.00	N.D
T. occidentalis	Leaf	BDL	7.13	N.D	42.75	N.D
	Stem	BDL	4.50	127.50	28.50	N.D
T. occidentalis	Leaf	BDL	0.23	N.D	33.75	N.D
	Stem	BDL	3.75	N.D	47.25	N.D
T. triangulare	Leaf	BDL	5.63	3.00	48.38	N.D
	Stem	BDL	9.75	0.83	52.25	N.D

N.D = Not Detected, BDL: Below Detection Limit.

Conclusion

Vegetables are very important part of a diet. The data obtained from the analysis showed that these vegetables contain appreciable amount of proteins, fat, fibre, carbohydrate, calorific value, and sufficient amount of mineral elements needed for normal body functioning, maintenance of the body, and reproduction. It can therefore, be concluded that these vegetables can contribute significantly to the nutrients of man and animals and should be used as source of nutrients to supplement other major sources of nutrients. Vegetables have now become major components of human that should be eaten all year round. Since these vegetables are poor source of fats, it is recommended to those who are obese and those who are diabetes, since they do not contain high carbohydrate. They contain appreciable amount of these minerals, it is therefore, recommended to be consumed to supplement the daily requirement of Ca, K and Na recommended by FAO and WHO, respectively. It has also been shown that vegetables are also rich in fibre; hence, their consumption can help to lower cholesterol level in the body. Chemical analysis however should not be used as a sole criterion for judging the nutritional value of plants. It is therefore, recommended that other aspects, such as biological evaluation of the nutrient content of the plant should be done as a further work in order to determine the bioavailability of the nutrients and also the effects of processing on the chemical and nutritive value of the plant. It is also recommended that further research should be done on the area of vitamins, amino acid content, alkaloids content, and phytochemical screening and anti-nutrients present in the vegetables should be carried out. Enlightenment campaign should be carried out on the importance and usefulness of nutrients and mineral compositions present in these vegetables to the public as their inclusion into our diet could potentially address some of the challenges, such as food security, and increase life expectancy in Sub-Saharan African.

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