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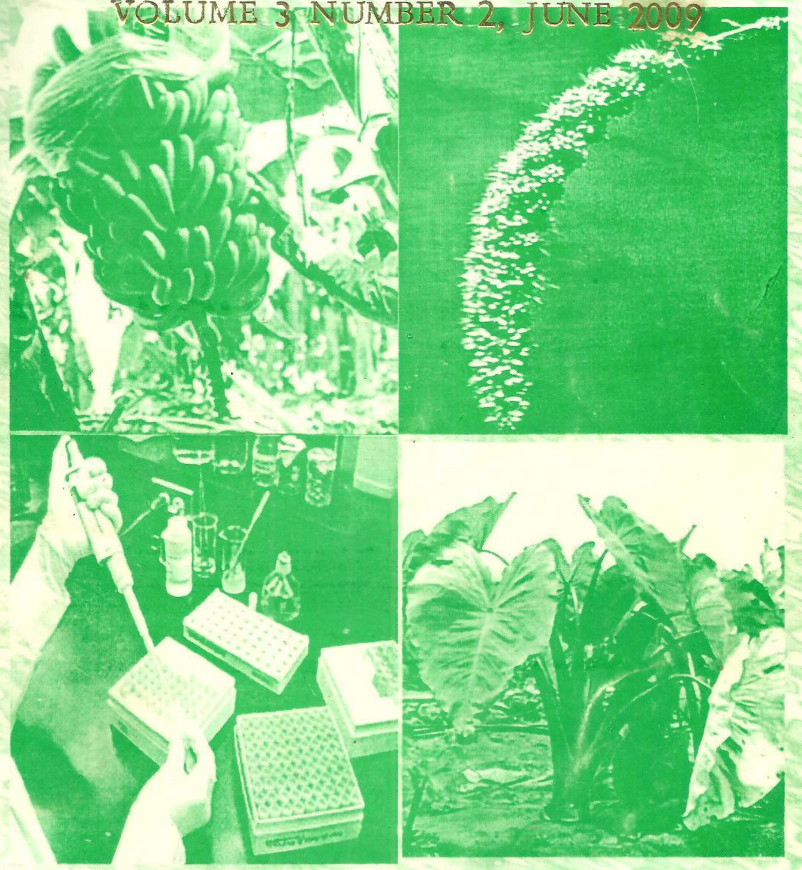

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PROXIMATE AND MINERAL COMPOSITION OF THE LEAVES OF *ABELMOSCHUS ESCULENTUS*

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ABSTRACT: *The analysis of proximate and mineral composition of the leaves of Abelmoschus esculentus were carried out using standard methods of food analysis. The results of proximate composition indicated that the leaves contained 82.53±1.60% moisture, 18.48±0.03% ash, 7.63 ±0.06% crude protein, 12.98±0.03% crude lipid and 27.54±0.27% available carbohydrate. The leaves also had high energy value of 225.58±1.25 kcal/100g respectively. Mineral analysis showed that potassium (2107.50±0.03 mg/100g) and magnesium (75.85±0.02 mg/100mg) were the dominant elements. The leaves also contained appreciable concentrations of Na (37.50±0.83 mg/100g), Ca (57.03±0.12 mg/100g), P (7.33±0.04 mg/100g), Cu (3.22±0.02 mg/100g), Fe (20.78±0.15 mg/100g), Mn (17.25±0.22 mg/100g) and Zn (8.64±0.04 mg/100g). The present research revealed that the leaves of A. esculentus are rich sources of potassium, iron, copper, manganese and zinc as well as high energy. The leaves could thus be a veritable food sources.*

Keywords: *Abelmoschus esculentus, proximate composition, mineral elements, leafy vegetable*

INTRODUCTION

Abelmoschus esculentus also called Okra, Lady's Finger and gumbo in English, is a flowering plant in the mallow family (along with such species as cotton and cocoa) valued for its edible green fruits. The vernacular names include Kubewa (Hausa), Okwulu, (Igbo), Kpanmi (Nupe) and Ila, Ilasa, Ilasado (Yoruba) (Abdullahi *et al.*, 2003). The species is an annual or perennial, growing to 2 m tall. The leaves are 10-20 cm long and broad, palmately lobed with 5-7 lobes. The flowers are 4-8 cm diameter, with five white to yellow petals, often with a red or purple spot at the base of each petal. The fruit is a capsule up to 18 cm long, containing numerous seeds. *A. esculentus* leaves may be cooked in a similar manner as the greens of beets or dandelions. The leaves are also eaten raw in salads. The cooked leaves are also a powerful soup thickener. *A. esculentus* is also enjoyed in Nigeria where it soup (Draw soup) is a special delicacy eaten with garri (eba) or akpu.
Abelmoschus esculentus is among the most heat and drought-tolerant vegetable species in the world. It will tolerate of poor soils with heavy clay and intermittent moisture. It is cultivated throughout the tropical and warm temperate regions of the world for its fibrous fruits or pods containing round, white seeds. The fruits are harvested when immature and eaten as a vegetable. A traditional food plant in Africa, this little known vegetable has potential to improve nutrition, boost food security, foster rural development and support sustainable land care (Okra, 2008). In view of the potential beneficial attributes of leafy vegetables, there is need to comprehensively establish the nutritional properties before advocating their increased utilization.
The purpose of this study was to conduct an investigation of the nutritional composition of the leaves of *A. esculentus* in order to ascertain it's suitability for use in human diets or animal feeds.

MATERIALS AND METHODS

Sample collection and sample treatment: The sample of *Abelmoschus esculentus* used in this study was collected from a farm site at Barkin-Saleh in Minna town, Niger state, Nigeria. The chemicals used were manufactured by M & B and BDH chemicals of England. Prior to analysis, the leaves were separated from the stalk and washed with distilled water. The residual moisture was evaporated at room temperature thereafter the leaves were wrapped in large paper envelopes and oven dried at 60^{0}C until constant weight was obtained (Fasakin, 2004).
The dried leaves were then ground in porcelain mortar, sieved through 2 mm mesh sieve and stored in plastic container (Umar *et al.,* 2007). The powdered sample was used for both proximate and mineral analysis. Moisture content was however, evaluated using fresh leaves.
Proximate analysis: The moisture content of the leaves were determined by drying 5 g of the leaves (in triplicate) in a Gallenkamp oven at 105^{0}C until constant weight was attained (AOAC,

1990). Ash content was determined according to the method described by Ceirwyn (1998) and among others involved dry ashing in Lenton muffle furnace at 600°C until grayish white ash was obtained. Crude protein content was calculated by multiplying the value obtained from kjeldahl's nitrogen by a protein factor of 5.3, a factor recommended for vegetable analysis (Bernice and Merril, 1975). Crude lipid was quantified by the method describe by AOAC (1990) using the soxhlet apparatus and n-hexane as a solvent. Available carbohydrate was determined by Clegg Anthrone method using Jenway 6100 spectrophotometer at 625 nm with glucose and maltose as the standard. The sample calorific value was estimated (in Kcal) according to the formula: Energy = (g crude protein x 2.44) + (g crude lipid x 8.37) + (g available carbohydrate x 3.57) (Asibey– Berko and Taiye, 1999).

Samples preparation for mineral quantification: Six (6) gram of the powdered sample was weighed into a crucible and gently heated over a Bunsen burner until it charred. The charred sample with the crucible was transferred into a Lento muffle furnace at about 600°C and content ashed until grayish white ash was obtained. It was cooled first at room temperature and then in a desiccator. 5 cm^3 of concentrated HCl was added and heated for 5 minutes on a hot plate in a fume cupboard. The mixture was then transfer into a beaker and the crucible washed several times with distilled water. The mixture was made up to 40 cm^3 and boiled for 10 minutes over a Bunsen burner. This mixture was then cooled, filtered into a 100 cm^3 volumetric flask and distilled water was used to rinse the beaker into the volumetric flask and solution made up the volume to 100 cm^3 (Ceirwyn,1998). The solutions were prepared in triplicates.

Mineral quantification: Sodium (Na) and Potassium (K) were analyzed by flame atomic emission spectrophotometer with NaCl and KCl used to prepare the standards. Phosphorus (P) was determined with Jenway 6100 spectrophotometer at 420 nm using vanadium phosphomolybdate (vanadate) colorimetric method, with KH_2P0_4 as the standard (Ceirwyn, 1998). The concentrations of calcium (Ca), magnesium (Mg), copper (Cu), Iron (Fe), Manganese (Mn) and Zinc (Zn) in the solutions were determined with a Unicam 969 model atomic absorption spectrophotometer, with standard air–acetylene flame (AOAC, 1990). $CaCl_2$, Mg metal, Cu metal, Fe granules, $MnCl_2.4H_20$ and Zn metal were used to prepare the standards.

Data Analysis: Data were generated in triplicates and the mean standard deviation determined according to Steel and Torrie (1980).

RESULTS AND DISCUSSION

Proximate composition: Table 1 showed the proximate composition of the leaves of *A. esculentus*. As with most fresh leafy vegetables, the leaves have high moisture content (82.53±1.60%). This values is low when compared to the 91% found in Vietnamese water spinach *(Ipomoea aquatica)* leaves (Ogle *et al.*, 2001) and that of sweet potato *(Ipomoea batatas)* leaves (83.7 – 87.1%) (Asibey – Berko and Taiye, 1999; Ishida *et al.*, 2000).

The high ash content of the leaves of *A. esculentus* (18.48±0.03%) is an indication that the leaves contain nutritionally important mineral elements. This value is high when compared to 10.83±0.80% recorded in water spinach *(Ipomoea aquatica* Forsk) leaves (Umar *et al.*, 2007) and 14.44% (on dry weight basis) reported in *I. aquatica* leaves grown in Vietnam (Ogle *et al.*, 2001).

Table 1: Proximate composition of the leaves of *A. esculentus* (%)

Parameter	Concentration (% Dry Weight)
Moisture Content	82. 53 ± 1.60
Ash	18.48 ± 0.03
Crude protein	7.63 ± 0.06
Crude lipid	12.98 ± 0.03
Available carbohydrate	27.54 ± 0.27
Energy (Kcal/100g)	225.58 ± 1.25

The data are mean values ± standard deviation (SD) of three replicates

The crude protein of the leaves of *A. esculentus* is low (7.63±0.06% dry weight). This value is high compared to 0.5-5.0% recorded for fresh vegetables (Lintas, 1992) but low when compared to 8.0% and 11.67–18.00% reported for *I. batatas* leaves (Asibey–Berko and Taiye, 1999; Ishida *et al.*, 2000). The protein content of this plant leaves even though appearing to be low, could make significant contribution to dietary intake protein. The crude lipid content of *A. esculentus* leaves (12.98±0.03%) is also high compared to the 11.00±0.50% found in water spineach (*I. aquatica*

Forsk) leaves (Umar *et al.*, 2007), but within the range (8.5–27.0%) reported in some wild green leafy vegetables of Nigeria and Republic of Niger (Ifon and Bassir, 1980; Sena *et al.*, 1998).
The samples available carbohydrate content (27.54±0.27%) is low compared to the 54.20±0.68% found in water spinach (*I. aquatica*) leaves (Umar *et al.*, 2007), 51.8% in *Moringa stenopetala* (Abuye *et al.*, 2003) and 75.0% recorded in *Corchorus tridents* leaves (Asibey – Berko and Taiye, 1999). Carbohydrates are the most important sources of energy for the body. Carbohydrates are also important for the correct workings of the brain, heart, nervous, digestive and immune systems. The energy values of most vegetables are low (30-50 Kcal/100g) (Umar *et al.*, 2007). The energy value of the leaves of *A. esculentus* is remarkable (225.58±1.25 Kcal/100g on dry weight basis). This value is low compared to the 300.94±5.31 Kcal/100g on dry weight basis recorded for water spinach (*I. aquatica* Forsk) leaves (Umar *et al.*, 2007) and 307.1 Kcal/100g found in *Gnetum africanum* leaves (Isong *et al.*, 1999).
Mineral content: Table 2 showed that potassium content (2107.50±0.03 mg/100g dry matter) in the leaves of *A. esculentus* is high compared to the 220.00±7.8 mg/100g recorded in *Tribulus terrestris* leaves (Hassan *et al.*, 2005), but lower than the 5458.33±954.70 mg/100g recorded in water spinach (*I. aquatica* Forsk) leaves (Umar *et al.*, 2007) and 8000 mg/100g reported in *Talinum trianglare* (Smith, 1983). The result indicated that the leaves of *A. esculentus* are good sources of potassium.
Sodium is associated with potassium in the body in maintaining proper acid–base balance and nerve transmission (Setiawan, 1996). The sodium concentration was found to be 37.50±0.83 mg/100g dry matter, which is high compare to the 5.00±0.6 mg/100g in *T. terrestris* leaves (Hassan *et al.*, 2005). The value is also low compared to the 45 mg/100g found in *Senna obtusfolia* (Faruq *et al.*, 2002) and the 135.00±2.50 mg/100g reported in water spinach (*I. aquatica*) leaves (Umar *et al.*, 2007). From the result, it was shown that the concentration of potassium was far greater than that of sodium. The high amount of potassium may be due to its abundance in Nigeria soil (Oshodi *et al.*, 1999). The K/Na ratio was also high (56:20). This is advantageous as potassium is only taken from diet unlike sodium, which is added during cooking.

Table 2: Mineral Composition of the leaves of *A. esculentus*

Mineral elements	Concentration (mg/100g dry matter)
K	2107.50 ± 0.03
Na	37.50 ± 0.83
Ca	57.03 ± 0.12
P	7.33 ± 0.04
Mg	75.85 ± 0.02
Cu	3.22 ± 0.02
Fe	20.78 ± 0.1
Mn	17.25 ± 0.22
Zn	8.64 ± 0.0.4

The data are mean value ± standard deviation (SD) of three replicates.

Calcium and phosphorus are associated with each other in the development and proper functioning of bones, teeth and muscles (Dosunmu, 1997; Turan *et al.*, 2003). The calcium content of the leaves of *A. esculentus* in the present study was 57.03±0.12 mg/100g dry matter. This values is high compare to the 33 and 38 mg/100g recorded in lettuce and sickle pod respectively (Faruq *et al.*, 2002), but lower than the 101 mg/100g found in Vietnamese *I. aquatica* leaves (Ogle *et al.*, 2001). The phosphorus content of 7.33±0.04 mg/100g on the other hand is low compared to the 109.29±0.55 mg/100g indicated in water spinach (*I. aquatica*) leaves (Umar *et al.*, 2007) and 12–125 mg/100g reported for vegetables (Lintas, 1992).
According to Guil-Guerrero *et al.* (1998), for good calcium and phosphorus intestinal utilization, to be achieved, Ca/P ratio must be close to unity. The leaves of *A. esculentus* have high ratio (7.78). This shows that the leaves are good source of calcium over that of phosphorus; consequently the diet based on this leaves should be supplemented with other food materials rich in phosphorus.
Magnesium content of *A. esculentus* leaves was 75.85±0.02 mg/100g dry matter. High magnesium concentration in these leaves is expected since magnesium is a component of leaves chlorophyll (Dosunmu, 1997; Akwaowo *et al.*, 2000). The value in this finding is higher than the magnesium content of *T. terrestris* leaves (30.00±0.6 mg/100g) (Hassan *et al.*, 2005) and the 19 mg/100g found in *S. obtusfolia* leaves (Faruq *et al.*, 2002).
The concentration of copper in this sample was 3.22±0.02 mg/100g dry matter. This value is high compared to the 0.36±0.01 mg/100g in water spinach leaves (Umar *et al.*, 2007) and the 1.28

mg/100g found in *T. terrestris* leaves (Hassan *et al.*, 2005). Compared to the recommended dietary allowance (RDA) for copper set by the United State of America National Research Council, (NRC, 1989), which are 1.5 – 3 mg/day for adult male and female, pregnant and lactating mothers and 1-3 mg /day for children (7-10 years), it implies that the leaves of *A. esculentus* are good sources of copper.

The sample iron content of 20.78±0.15 mg/100g is high compared to the 16.67 mg/100g reported in Vietnamese *I. aquatica* leaves (Ogle *et al.*, 2001) and 2.80±0.7 mg/100g indicated in *T. terrestris* leaves (Hassan *et al.*, 2005). *A. esculentus* leaves are good source of iron compared to the RDA for iron, which are 10 mg/day for adult male and children (7-10years), 13 mg/day for pregnant and lactating mothers and 15 mg/day for adult female (NRC, 1989) respectively. The result also indicated that adequate consumption of these leaves will serve as good iron supplement.

The manganese content (17.25±0.22 mg/100g) of the leaves of *A. esculentus* is high compared to the 2.14±0.22 mg/100g in water spinach leaves (Umar *et al.* 2007) and the 4.83–10.03 mg/100g recorded in *Ipomoea batatas* leaves (Ishida *et al.*, 2000) respectively. The result indicated that these leaves are good sources of this mineral element compared to the RDA for manganese which are 2-5 mg/day for adult male and female, pregnant and lactating mothers, and 2-3 mg/day for children (7-10 years) (NRC, 1989).

The Zinc concentration for the sample was 8.64±0.04 mg/100g. This is high compared to the 2.47±0.27 mg/100g in water spinach leaves (Umar *et al.*, 2007) and the range of 3.95 to 6.86 mg/100g found in *I. batatas* leaves (Monamodi *et al.*, 2003). RDA for zinc are 10 mg/day for children (7-10years), 12 mg/day for Adult female, 15 mg/day for adult male and 19 mg/day for pregnant and lactating mothers (NRC, 1989). This shows that the leaves of *A. esculentus* are moderate sources of zinc.

The contribution of the leaves of *A. esculentus* to the dietary intake of essential elements was evaluated as described by Hassan *et al.* (2005). This was presented in table 3. The leaves were rich sources of Iron, copper, Potassium and manganese, moderate source of zinc and magnesium and poor source of sodium, calcium and phosphorus when compared with their respective recommended dietary allowances. This indicated that the leaves supplement other dietary sources of iron, copper, potassium, manganese, zinc and magnesium.

Table 3: Contribution to the dietary intake to some mineral element by the leaves of *A. esculentus*

Minerals	RDA (mg)	Contribution to RDA (%)
K	2000	105
Na	500	8
Ca	1200	5
P	1200	1
Mg	350	22
Cu	1.5 -3	107 – 215
Fe	10-15	139 – 208
Mn	2-5	345 - 863
Zn	12 – 19	45 - 72

CONCLUSION

The result of the proximate and mineral analysis of the leaves of *A. esculentus* carried out revealed that the leaves are good source of carbohydrates, energy and minerals. The leaves are good sources of iron, potassium, copper, manganese and zinc. Thus, adequate consumption of this plant leaves my help in preventing adverse effects of dietary deficiencies of these micronutrients. Inadequate intake of micronutrient is recognized as an important contributor to the global burden of disease.

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