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Nutritional Composition of Water Spinach (*Ipomoea aquatica* Forsk.) Leaves

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Abstract: Analyses of the nutritional composition of water spinach (*Ipomoea aquatica*) Forsk leaves were carried out using standard methods of food analysis. The proximate composition as well as mineral elements were determined. The leaves were found on dry weight basis to have high moisture (72.83±0.29%), ash (10.83±0.80%), crude lipid (11.00±0.50%), crude fibre (17.67±0.35%) and available carbohydrate (54.20±0.68%), but low in crude protein content (6.30±0.27%). The leaves also have energy value (300.94±5.31 kcal/100 g) that is within the range reported in some Nigerian leafy vegetables. The mineral element contents were high with remarkable concentration of K (5,458.33±954.70 mg/100 g) and Fe (210.30±2.47 mg/100 g). Also the leaves content moderate concentrations of Na (135.00±2.50 mg/100 g), calcium (416.70±5.77 mg/100 g), Magnesium (301.64±12.69 mg/100 g) and P (109.29±0.55 mg/100 g), with low Cu (0.36±0.01 mg/100 g), Mn (2.14±0.22 mg/100 g) and Zn (2.47±0.27 mg/100 g) contents. Comparing the mineral content with recommended dietary allowance, it was showed that the plant leaves is good sources of K, Mn and Fe for all categories of people, while Mg is adequate enough for adult female and children. From the result, *Ipomoea aquatica* Forsk leaves could be used for nutritional purposes, due to the amount and diversity of nutrients it contains.

Key words: Wild leafy vegetables, *Ipomoea aquatica* Forsk., proximate composition, mineral elements

INTRODUCTION

Green leafy vegetables have been recognised as rich source of micronutrients (minerals and vitamins) and antioxidants (Kala and Prakash, 2004). In most developing nations where food shortages and famine is mostly experienced, greens are the means of livelihood; Niger famine of 2005 is a clear evidence, in which many populace depend on leaves of Anza or Dilo (*Boscia senegegalensis*) and Roselle (*Hibiscus sabdariffa*) leaves as a means of survival. The roles played by leafy vegetables particularly during food shortage could probably be due to its being the first edible plant part to grow coupled with relative abundance compared to other plant parts used as a food item. This important feature demonstrated by the wild leafy vegetable attracts a lot of scientific research so as to assess their nutrients content. (Ogle and Grivetti, 1985; Ladan *et al*., 1996; Nordeide *et al*., 1996; Smith *et al*., 1996; Freiberger *et al*., 1998; Cook *et al*., 2000; Lockeett *et al*., 2000; Ogle *et al*., 2001; Faruq *et al*., 2002; Gupta *et al*., 2005).

Water spinach (*Ipomoea aquatica* Forsk) is a vascular semi-aquatic plant native to tropics and subtropics that grow wild and some time cultivated in Southeast Asia, India and Southern China (Gothberg *et al*., 2005). Water spinach is a herbaceous perennial plant belonging to the family *Convolvulaceae*. It has a long, hollow and viny stem, grow prostrate or floating and the roots are produced from the nodes and penetrate into wet soil or mud. The leaf shape ranges from saggitate to lanceolate (USDA, 2005; Gothberg *et al*., 2005; Wikipedia, 2005)

Despite the use of this plant as food especially by the inhabitants of the area where this plant grows, no report was available on its nutritional content. Thus, this is the aim of this work with the following objectives.

- To report the proximate composition of water spinach leaves
- To report the mineral content of water spinach leaves
- Compared the results obtained with other values reported in some species of *Ipomoea* and other green leafy vegetables.

MATERIALS AND METHODS

Sample collection and sample treatment: Sample of water spinach (*Ipomoea aquatica*) used in this study was collected along the bank of River Zamfara at Nassarawa, a village near Jega in Kebbi State, Nigeria. Prior to

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analysis, the plant leaves were separated from the stalk and washed with distilled water. The residual moisture was evaporated at room temperature. The leaves were then put in large paper envelopes and oven dried at 60°C until constant weight was obtained (Fasakin, 2004). The dried leaves were then ground in a porcelain mortar, sieved through 20 mesh sieve and stored in plastic container. 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 *I. Aquatica* leaves were determined by drying ten leaves (in triplicate) in a Gallenkamp oven at 105°C until constant weight was attained (AOAC, 1990). Ash content was determined by dry ashing in Lenton muffle furnace at 525°C for 24 h. 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. Crude fibre was estimated by acid-base digestion with 1.25% H_2SO_4 (w/v) and 1.25% NaOH (w/v) solutions (AOAC, 1990). Available carbohydrates were calculated by difference i.e., total sum of crude protein, crude lipid, crude fibre and ash deducted from 100% DM (AOAC, 1990). The sample calorific value was estimated (in kcal) according to the formula: Energy = (g protein×2.44)+(g lipid×8.37)+(g available carbohydrate×3.57) (Asibey-Berko and Tayie, 1999).

Mineral analysis

Sample digestion: One gram powdered sample was put in digestion flask followed by addition of 25.0 cm^3 concentrated HNO_3. The flask was then heated in Tecator digestion block until evolution of brown fume stopped. 1 cm^3 of perchloric acid was added to the mixture and the content was further heated to a clear solution. After heating, 30 cm^3 of hot distilled water was added to the digest and heated to boiling. The solution was then filtered hot into a clean 50 cm^3 volumetric flask, cooled and made up to the mark with distilled water (Tayie and Asibey-Berko, 2001). Two more duplicate digest solutions and a blank were prepared.

Mineral quantification: The concentrations of Ca, Mg, Cu, Co, Fe, Mn and Zn in the digest were performed with an Alpha-4 model atomic absorption spectrophotometer with standard air-acetylene flame. The Na and K content was analysed by flame atomic emission spectrophotometry using corning 400 spectrophotometer. P was analysed with Jenway 6100 spectrophotometer using ammonium vanadate-molybdate colorimetric method (AOAC, 1990). For Ca and Mg determination, in order to avoid potential anionic interferences, 4 cm^3 of 5% lanthanum chloride ($LaCl_3.7H_2O$) solution was added to 1 cm^3 of the digest in a 50 cm^3 volumetric flask and the solution made up to the mark with distilled water (Amaro-Lopez *et al*., 1999).

RESULTS AND DISCUSSION

Proximate composition: As shown in Table 1 the leaves moisture content (72.83±0.29%) was low when compared with value of 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 leaves moisture content was however within the range of 58.0-90.64% reported in some Nigerian green leafy vegetables (Ladan *et al*., 1996; Tomori and Obijole, 2000).

The high ash content of *Ipomoea aquatica* leaves (10.83±0.80%) is an indication that the leaves contain nutritionally important mineral elements. The value recorded in this study is low compared to 14.44% (on dry weight basis) in *Ipomoea aquatica* leaves grown in Vietnam (Ogle *et al*., 2001) and 17.87% found in leaves of *Ipomoea* sp. grown in Swaziland (Ogle and Griretti, 1985). In contrast, the value is higher than that of *Ipomoea batatas* leaves (1.8 g/100 g dry weight) reported by Asibey-Berko and Taiye (1999).

The crude protein content in *Ipomoea aquatica* leaves (6.30±0.27%) analysed is higher than that reported in *Ipomoea aquatica* leaves (4.25% dry weight) grown in Vietnam (Ogle *et al*., 2001). When compared with other species such as *Ipomoea batatas* leaves with crude protein content of 8.0% (Asibey-Berko and Taiye, 1999), 11.67-18.00% (Ishida *et al*., 2000) and 24.37-29.46% (Monamodi *et al*., 2003), the plant leaves analysed have low crude protein content. The value on the other hand, accord with the protein content for fresh vegetables (0.5-5.0%) as reported by Lintas (1992). Furthermore, the protein content of this plant leaves even though appear to be low, could make significant contribution to the dietary intake especially during pre-harvest period when domesticated food are in short supply.

Table 1: Proximate Composition of *Ipomoea aquatica* Forsk Leaves

Parameters	Concentration (% Dry weight)*
Moisture content[a]	72.83±0.29
Ash	10.83±0.80
Crude protein	6.30±0.27
Crude lipid	11.00±0.50
Crude fibre	17.67±0.35
Available carbohydrate	54.20±0.68
Calorific value (kcal/100 g)	300.94±5.31

*The data are mean value±standard deviation (SD) of three replicates.
[a]Value expressed as % wet weight

Table 2: Mineral composition of *Ipomoea aquatica* forsk leaves

Mineral element	Concentration [mg/100 g dry matter]*	Recommended dietary allowances** Adult (Male)	Adult (Female)	Children (7-10 years)	Pregnant and lactating mothers
K	5,458.33±954.70	2000	2000	1600	2000
Na	135.00±2.50	500	500	400	500
Ca	416.70±5.77	800	800	800	1,200
Mg	301.64±12.69	350	2802	170	375
P	109.29±0.55	800	800	800	1,200
Cu	0.36±0.01	1.5-3	1.5-3	1-3	1.5-3
Fe	210.30±2.47	10	15	10	13
Mn	2.14±0.22	2-5	2-5	2-3	2-5
Zn	2.47±0.27	15	12	10	19
Co	0.02±0.00	-	-	-	-
K/Na	40.43				
Ca/P	3.81				

* The data is mean value±standard deviation (SD) of three replicated, ** Source: Thangadari *et al.* (2001)

The sample crude lipid content (11.00±0.50%) is high when compared with the values of 0.74% (Asibey-Berko and Taiye, 1999) and 2.56-6.82% dry weight (Ishida *et al.*, 2000) reported in *Ipomoea batatas* leaves, 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).

Similar to crude lipid, *Ipomoea aquatica* leaves have high available carbohydrate content (54.20%) comparable to 51.8% in *Moringa stenopetala* leaves (Abuye *et al.*, 2003) and 52.85% (dry weight) found in *Bauhenia purpurea* (Raghuvanshi *et al.*, 2001). The value obtained was higher than those found in some tropical green leafy vegetable such as fluted pumpkin, *Telferia occidentalis* (Akwaowo *et al.*, 2000) and *Ceratotheca sesamoides* (Fasakin, 2004). Conversely, the sample value was lower than 75.0 and 82.8% found in *Corchorus tridents* and *Ipomoea batatas* leaves, respectively (Asibey-Berko and Taiye, 1999).

Ipomoea aquatica leaves have high crude fibre (17.67±0.35%) when compared to 3.7% found in *Ipomoea batatas* leaves (Asibey-Berko and Taiye, 1999), but lower than value of 45.70-46.05% (dry weigh) reported as dietary fibre in Japanese *Ipomoea batatas* leaves (Ishida *et al.*, 2000). The value was also within the range of 8.5-20.9% found in some Nigerian vegetables (Ifon and Bassir, 1980). High fibre content in food causes intestinal irritation and lower nutrient bioavailability (Aletor and Adeogun, 1995; Plessi *et al.*, 1999; Vadivel and Janandanan, 2000). Apart from negative effect, intake of fibre can stimulate weakening hunger, stimulating peristaltic movement, increasing excretion of bile acids, increasing moisture content of excrements, lower the serum cholesterol level, risk of coronary heart disease, hypertension, diabetes, colon and breast cancer (Gorecka *et al.*, 2000; Ishida *et al.*, 2000; Ramula and Rao, 2003).

The calorific values of most vegetables are low (30-50 kcal/100 g) (Devlin, 1982). The result obtained in *Ipomoea aquatica* leaves was substantial (300.94±5.31 kcal/100 g on dry weight basis), which was slightly higher than 288.3 kcal/100 g found in *Ipomoea batatas* leaves (Asibey-Berko and Taiye, 1999) and comparable to calorific content of two varieties of *Gnetum africanum* leaves, Asutan (307.1 kcal/100 g) and Oron (303.2 kcal/100 g) (Isong *et al.*, 1999).

Mineral content: Table 2 shown that potassium content (5,458.33±954.70%) was higher than that of *Ipomoea batatas* leaves (750-4,953.49 mg/100 g dry weight) (Taiye and Asibey-Berko, 2001; Ishida *et al.*, 2002; Monamodi *et al.*, 2003); but lower than the amount reported in some Nigerian leafy vegetables such as *Talinum trianglare* (8,000 mg/100 g), *Crassocephalum biafrae* (6,500 mg/100 g) and *Solanum nigrum* (6,700 mg/100 g) (Smith, 1983). However the value was comparable to values obtained in leaves of *Celosia argentea* (5,200 mg/100 g) and *Solanum aethiopicum* (5,000 mg/100 g) (Smith, 1983). Sodium is associated with potassium in the body in maintaining proper acid-base balance and nerve transmissions (Setiawan, 1996). The concentration of this mineral element was found to be 135.00±2.50 mg/100 g DM, which was higher than those of *Ipomoea batatas* leaves (Taiye and Asibey-Berko, 2001; Ishida *et al.*, 2002). This value was lower than the values reported in *Talinum trianglare* (248.8-280 mg/100 g) (Ifong and Bassir, 1979; Smith, 1983), *Telferia occidentalis* (229.1 mg/100 g), *Amaranthus caudatus* (427.9 mg/100 g), *Amaranthus hybridus* (258.9 mg/100 g) and *Vernonia amygdalina* (117.4 mg/100 g) (Smith, 1983). From the result it was shown that the concentration of potassium was far greater than that of sodium as also evenced from value in literature compared with. The high

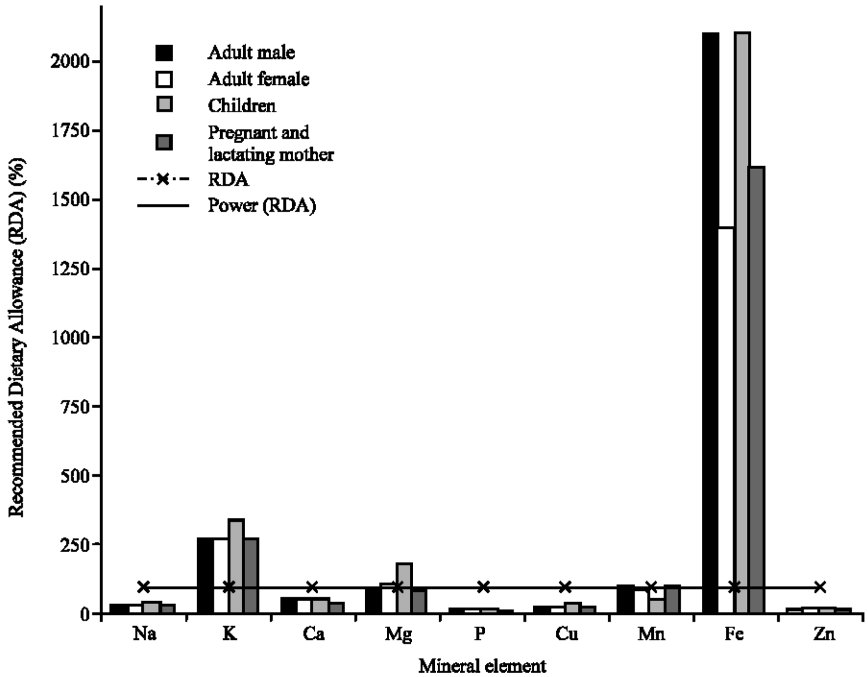

Fig. 1: Comparison of mineral content of *Ipomoea aquatica* leaveas with recommended dietray allowances

amount of potassium may be due to its abundance in Nigerian soil (Oshodi *et al*., 1999). The K/Na was also high (40.43). This is advantageous as potassium is only taken from diet unlike sodium which is added during cooking. Furthermore taken into consideration that potassium depresses while sodium enhances blood pressure, thus, high amount could be an important factor in prevention of hypertension and atherosclerosis (Yoshimura *et al*., 1991).

Calcium and phosphorous are associated with each other for development and proper functioning of bones, teeth and muscles (Dosunmu, 1997; Turan *et al*., 2003). The calcium and phosphorus content in the leaves sample were 416.70±5.77 mg/100 g and 109.29±0.55 mg/100 g respectively, which were low compared with the respective value in *Ipomoea batatas* leaves (9,300-19,300; 170-220 mg/100 g) as reported by Monamodi *et al*. (2003). The calcium content, however, was higher than that of Vietnamese *Ipomoea aquatica* leaves (101 mg/100 g) (Ogle *et al*., 2001) and leaves of Indian *S. tubirosam* (100 mg/100 g) (Singh and Garg, 2006). The phosphorous content on the other hand, was lower than that found in Indian *Solanum tubirosam* (237 mg/100 g). According to Guil-Guerrero *et al*. (1998), for good calcium and phosphorus intestinal utilisation, Ca/P ratio must be close to unity. *Ipomoea aquatica* leaves had a high ratio (3.81). This showed that the leaves are good sources of Ca over that of P; consequently the diet based on this leaves required to be supplemented with other food material rich in phosphorus.

Ipomoea aquatica leaves contain significant amount of magnesium (301.64±12.69 mg/100 g). High Mg concentration in these leaves is expected since Mg is a component of leaves chlorophyll (Dosunmu, 1997; Akwaowo *et al*., 2000). The value in this finding is higher than the Mg content of *Ipomoea batatas* leaves (79-107 mg/100 g) (Ishida *et al*., 2000). The leaves Mg is within the range reported in some green vegetables (Ladan *et al*., 1996).

Iron deficiency, according to World Health Organisation (WHO); affect about 3.7 billion people out of which 2 billion people are anaemic (Meng *et al*., 2005). In this analysis; an outstanding finding was made on iron content in the leaves of *Ipomoea aquatica* (210.30±2.47 mg/100 g), which is higher than the value of 16.67 mg/100 g reported when similar work was done in Vietnam (Ogle *et al*., 2001) and those of *Ipomoea sp.* (41.27 mg/100 g dry weight) and *Ipomoea batatas* leaves (36.69-147.87 mg/100 g dry weight) (Ishida *et al*., 200; Tayie and Asibey-Berko, 2001). However, Ladan and co-workers (1996) reported high iron content (110-325 mg/100 g) in some green leafy vegetables consumed in Sokoto. High iron content in green is more often than not, attributed to soil contamination

(Gowda *et al*., 2004). However considering the site of sampling this factor could not probably be the cause but could rather be due to soil composition.

The concentration of copper (0.36±0.01 mg/100 g), manganese (2.14±0.22 mg/100 g) and zinc (2.47±0.27 mg/100 g) in this sample was low compared with that of *Ipomoea batatas* leaves (3.34-3.95, 4.83-10.03 and 3.95-6.86 mg/100 g), respectively (Tayie and Asibey-Berko, 2001; Ishida *et al*., 2002; Monamodi *et al*., 2003), but the zinc content was higher than that of *I. aquatica* leaves analysed by Ogle *et al.* (2001). Thus, adequate consumption of this plant leaves may 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 (Black, 2003).

Nutritional significant of mineral elements is usually compared with the standard recommended dietary allowance. In this study, mineral content of Ipomoea aquatica leaves was compared with standard values of US recommended dietary allowances (Table 2). Figure 1, it showed that the plant leaves is good sources of potassium, manganese and iron for all categories of people, while magnesium is adequate enough for adult female and children assuming total assimilation of these minerals.

CONCLUSIONS

The results of the nutritional analysis shown that *Ipomoea aquatica* Forsk leaves, like other leafy vegetables are good source of plant fibre, carbohydrate and minerals (particularly K, Fe, Mg and Mn). The results suggests that the plant leaves if consumed in sufficient amount could contribute greatly towards meeting human nutritional requirement for normal body growth and adequate protection against diseases arising from malnutrition. From the result, *Ipomoea aquatica* Forsk leaves are recommend for continues used for nutritional purposes, considering to the amount and diversity of nutrients it contains. Chemical analysis alone however, should not be the exclusive criteria for judging the nutritional significance of a plant parts. Thus, it becomes necessary to consider other aspects such as presence antinutritional/toxicological factors and biological evaluation of nutrients content.

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