THE NUTRITIONAL VALUES AND FUNCTIONAL PROPERTIES OF WILD *IPOMOEA AQUATIC* (WATER SPINACH) FOUND IN THE FADAMA AREAS OF MINNA, NIGER STATE, NIGERIA

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ABSTRACT

Analysis of the chemical composition, amino acid profile and functional properties of the leaves and stem of Ipomoea aquatic (water spinach) was carried out using standard methods of food analysis. The results of the proximate analysis showed high crude protein in the leaves (17.48±0.035%) while the stem was lower in crude protein (1.74±0.042%). The carbohydrate content of the leaves and stems were relatively high (57.47±0.035 and 66.55±0.030% respectively). The fat, crude fibre, ash and moisture contents were within the range of values expected for dry leafy vegetables. The anti-nutritional factors analyzed in the leaves and stem namely tannin, saponin, oxalate, alkaloids and flavonoids significantly differed from one another at p≤ 0.05. All the essential amino acids were present in good quantities in both samples in comparison with the WHO/FAO reference protein. The investigation of mineral contents in mg/kg showed that the leaves and stems of Ipomoea aquatic were relatively high in potassium, magnesium, sodium, and phosphorus. The functional properties of the leaves and stems namely; bulk density, pH, water absorption, oil absorption capacity, gelatinization temperature, viscosity and wettability showed significant differences between the two parts of the plant analyzed.

Keywords: Functional properties, ant nutritional factors, proximate, essential amino acids, Ipomoea aquatic

INTRODUCTION

Food is the first of the three essentials of life, the others being shelter and clothing. Man's existence depends on his capacity to produce, store, process and distribute food. Technically, an agreeable food consists of non-toxic, socially acceptable, digestible, palatable and nutritive parts of plant and animals which are collectively referred to as a diet (NRC, 2000). In general, the extent to which a diet meets the nutritional requirements defines the nutritional status of any population. The poor nutritional status of developing countries and the present prevalence of malnutrition and under-nutrition are as a result of complex factors like national poverty mainly brought about by corruption, low productivity, processing and distribution of foods coupled with a general ignorance of the choice of the right foods for a given age group(NRC, 2000). This could be solved by dramatic improvements in indigenous food production. Consequently in the last two or three decades, concerted efforts have been made by scientists, nutritionists and other bodies towards raveling ways by which our local foods can be nutritionally improved.

From ancient times to present day, man has made a steady progress of feeding himself with the plants and animals available to him. These products have been established to contain adequate levels of nutrients for proper body development. Among other food nutrients, the

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protein is primarily important since it provides the very essence of life and it is needed to repair damages caused by accident and diseases. Generally, pregnant women and growing children need extra protein to meet their nutritional requirements (NRC, 2000). In addition essential micronutrients like iron are needed to build up the quality of blood and increase resistance to stress and disease (Nutrition Almanac, 1999).Plant foods, including the legumes, have been recognized generally as rich sources of micro nutrients (minerals, vitamins) and anti oxidants (Kala and Prakash, 2004). The aim of this study is to determine the proximate, amino acids, some of anti-nutritional factors, functional properties and mineral contents of the stem and leaves of this plant.

MATERIALS AND METHODS

Sample Collection

The *Ipomoea aquatica* plant used in this study was collected along the bank of River Chanchaga, Chanchaga local government area, Minna Niger state, Nigeria.

Methods

Moisture Content

From each sample, 2.00g were measured in triplicate and put into crucibles, dried in an oven (Leniscope, England) at 105^{o}C overnight. The dried samples were cooled in a dessicator for 30 minutes and weighed to a constant weight. The percentage loss in weight was expressed as percentage moisture content (AOAC, 1990).

Ash Content

2.00 g of each of the grounded samples were placed in each crucible and ashed in a muffle furnace (Lenton Furnaces, England) at 600^{0}C for 3 h. The hot crucibles were cooled in a dessicator and weighted. The percentage residual weighed was expressed as ash content (AOAC, 1990).

Crude Lipid Content

From the pounded samples, 2.00g were separately taken and were used for determining the crude lipid by extracting lipid from them for 5h with petroleum ether in a soxhlet extractor.

Protein Determination

Total protein was determined by the Kjeldahl method as modified by Williams *et al.* (1964). About 0.5g of the samples were weighed into a filter paper and put into a Kjedahl flask, 8-10 cm^3 of concentrated H_2SO_4 were added and then digested in a fume cupboard until the solution becomes colourless. Distillation was carried out with about 10 cm^3 of 40% of NaOH. The distillate was received with 5 cm^3 of 4% boric acid in a mixed indicator till the boric acid solution turned green. Titration was done in the receiver flask with 0.01 M HCl until the solution turned red.

Crude Fibre Content

2.00g of each sample were used for estimating crude fibre by acid and alkaline digestion methods with 20% H_2SO_4 and NaOH solution.

Carbohydrate Determination

The carbohydrate content was calculated using following: available carbohydrate (%), = 100 – [protein (%) + Moisture (%) + Ash (%) + Fibre (%) + Fat (%)].

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Metabolisable Energy

The metabolisable energy was calculated in Kilojoules per 100g (kJ/100g) by multiplying the crude fat, protein and carbohydrate values by Atwater factors of 37, 17 and 17 respectively.

Minerals Analysis

Sodium and potassium were determined using Gallenkamp Flame analyzer, while calcium, magnesium, iron, manganese, zinc, chromium, lead and copper were determined using Buch Model 205 Atomic Absorption Spectrophotometer. Phosphorus level was determined using the phosphovanadomolybdate colorimetric techniques on JENWAY 6100 Spectrophotometer (AOAC, 1990).

Anti-Nutritional Properties

Oxalate and cyanide contents were determined using the method of Trease and Evans, (1978). Phytate content was determined by the method described by Ola and Oboh, (2000), flavonoids and alkaloids were determined using the method of Harborne, (1973). Saponins content was determined by the method described by Oloyede, (2005), tannins content was also determined by Onwuka, (2005) and hydrocyanic acid was determined by the method AOAC, (1990).

Functional Properties

The functional properties were determined using the standard method of AOAC, (1990).

Amino Acid Contents

50 g of ground seed sample was defatted with chloroform and methanol mixture in a ratio 1:1, then, 30 g of the defatted sample was put into a glass ampoule, 7 ml of 6 M HCl was added and oxygen expelled by passing nitrogen into the ampoule was put in the oven at 105^{o}C for 22 h, allowed cool and filtered. The filtrate was then evaporated to dryness at 40^{o}C under vacuum in a rotary evaporator. The residue was dissolved with 5ml acetate buffer (pH 2.0) and loaded into the amino acid composition and the seed samples were determined by ion exchange chromatography (IEC) method using the Technicon Sequential Multi-sample Amino acid Analyzer (Technicon Instruments Corporation, New York).

RESULTS AND DISCUSSION

Table 1. The proximate composition of the leaves and stems of *Ipomoea aquatica* (%)

Parameters	*Samples*	
	Leaves	*Stem*
Moisture	9.36±0.01^{a}	12.33±0.02^{b}
Ash content	2.53±0.20^{a}	3.52±0.02^{b}
Crude fat	13.21±0.20^{a}	15.92±0.25^{b}
Crude fibre	6.83±0.15^{b}	2.93±0.35^{a}
Crude protein	17.48±0.05^{b}	1.74±0.42^{a}
Crude Carbohydrate	57.47±0.35^{a}	66.55±0.03^{b}
Calorific value(kcal/100g)	418.51±0.25^{b}	416.21±0.30^{a}

KEY: Values in the same row bearing same superscripts are significantly not different at $p \geq 0.05$

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Table 2. The functional properties of the leaves and stems of *Ipomoea aquatica*(in %)

Parameters	*Samples*	
	Leaves	*Stem*
Bulk density	0.41±0.15 [a]	0.38±0.05[a]
pH	5.83±0.15[a]	5.80±0.20[a]
Water absorption capacity	73.50±0.01[a]	80.75±0.02[b]
Oil absorption capacity	36.25±0.25[b]	22.20±0.15[a]
Gelatinization temperature	60.90±0.10[a]	63.10±0.10[b]
Viscosity	51.00±1.00[b]	24.00±1.00[a]
Wettability	12.14±0.15[b]	8.07±0.20 [a]
Emulsification capacity	40.67±0.15[b]	27.40±0.20[a]

KEY: Values in the same row bearing same superscripts are significantly not different at $p \geq 0.05$

Table 3.The mineral contents of the leaves and stems of *Ipomoea aquatica*(in mg/kg)

Parameters	*Samples*	
	Leaves	*Stem*
Sodium	400.00±1.52[a]	1000.00±2.20[b]
Potassium	4450.23±3.32[a]	5562.54±4.45[b]
Calcium	37.25±0.14 [a]	65.00±1.13[b]
Magnesium	2300.32±8.43[b]	2225.35±6.26[a]
Phosphorus	225.67±5.45[a]	130.23±3.23[b]
Iron	155.23±2.32[b]	150.34±2.16[a]
Zinc	25.21±0.34[b]	2.34±0.13[a]
Manganese	8.23±0.12[b]	7.28±0.08[a]
Copper	36.07±0.02[b]	15.35±0.31[a]

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Table 4. The amino acid profiles of the leaves and stems of *Ipomoea aquatica* (in g/100g Protein)

Parameters	*Samples*	
	Leaves	*Stem*
Lysine	5.22±0.42[b]	2.91±0.01[a]
Histidine	2.30±0.10[b]	1.55±0.03[a]
Arginine	5.71±0.015[b]	4.30±0.10[a]
Aspartic acid	9.76±0.02[b]	6.36±0.03[a]
Threonine	4.31±0.02[b]	2.30±0.10[a]
Serine	4.30±0.02[b]	1.73±0.02[a]
Glutanmic acid	11.91±0.02[b]	7.27±0.02[a]
Proline	3.63±0.04[b]	2.69±0.57[a]
Glycine	6.93±0.02[b]	2.22±0.02[a]
Alanine	5.81±0.03[b]	3.23±0.02[a]
Cystine	0.71±0.02[a]	1.13±0.02[b]
Valine	4.97±0.02[b]	0.57±0.02[a]
Methionine	1.82±0.02[b]	0.71±0.15[a]
Isoleucine	5.30±0.10[b]	3.63±0.02[a]
Leucine	7.54±0.31[b]	6.39±0.58[a]
Tyrosine	4.42±0.03[b]	2.52±0.15[a]
Phenylalanine	5.45±0.06[b]	3.63±0.15[a]
Tryptophan	1.19±0.15[b]	0.53±0.15[a]

KEY: Values in the same row bearing same superscripts are significantly not different at $p \geq 0.05$

Table 5. The anti-nutritional factors of the leaves and stems of *Ipomoea aquatica* (in %)

Parameters	*Samples*	
	Leaves	*Stem*
Oxalate	1.31±0.02[b]	0.36±0.00[a]
Tannins	0.04±0.00[a]	0.03±0.00[a]
Saponins	2.53±0.02[b]	1.13±0.00[a]
Alkaloids	0.65±0.02[a]	0.69±0.02[a]
Flavonoids	0.35±0.02[a]	0.52±0.03[b]
Phytates	6.09±0.02[a]	11.53±0.02[b]

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DISCUSSION

The results of the proximate analysis as seen in Table1 revealed that the leaves of *Ipomoea aquatic* contained lower moisture (9.36±0.010) than the stem (12.33±0.020%). It also showed that they had lower ash (2.53±0.020), crude fat (13.21±0.020) and carbohydrate (57.47±0.035) than the stem whose respective values were 3.52±0.020, 15.92±0.025% and 66.55±0.030%. However, the crude fibre, crude protein and energy contents of the leaves were higher than those of the stem. The two parts of the plant had good calorific values and could be of high nutritional importance.

The functional properties of the leaves and stem of this plant were as seen in Table 2 and showed that the leaves had higher bulk density, oil absorption capacity, viscosity, wetttability and emulsification capacity of 0.41±0.015, 36.25±0.025, 51.00±1.00, 12.14±0.015 and 40.67±0.153% respectively than the stems. On the other hand, the gelatinization temperature and water absorption capacity (63.10±0.0100 and 80.75±0.020%) of the stem were higher than those of the leaves. However, the respective pH values of 5.83±0.015 and 5.80±0.020 for the leaves and stems were relatively the same and these indicated that both parts of the plant were only slightly acidic.

The investigation of mineral contents of these samples (Table 3) showed that the leavesof *Ipomoea aquatic* had higher Mg, P, Fe, Zn, Mn, and Cu which were respectively 2300±0.023, 225±0.003, 155±0.020, 25±0.000 8±0.002 and 36±0.002mg/kg than the stems. On the other hand, the stems had higher Na, K, and Ca whose respective values were 1000±0.020, 5562.5±0.003 and 65.00±0.01mg/100kg. These minerals play significant roles in several biological processes; bone growth and turnover are influenced and regulated by the metabolism of calcium, phosphorus and magnesium, while iron is important in the formation of haemoglobin (Burtis and Ashwood, 2003).

Table 4: shows the amino acid compositions of the leaves and stems of *ipomoea aquatic*. In this study, 18 amino acids were found in varying proportions in the two parts of the plant and all the essential amino acids were present. These essential amino acids in the plant compared well with the WHO/FAO protein standards. However, the amino acid with the highest value was the glutamic acid (11.91±o.o15 and 7.27±0.020g/100g protein respectively). For the leaves, cystine was the least (0.71±0.002g/100g protein) while for the stems tryptophan was the lowest (0.53±0.153g/100g protein). Among the essential amino acids, leucine was found to be the highest for both the leaves and stems of *Ipomoea aquatic* with the respective values of 7.54±0.306 and 6.39±0.583g/100g protein.

The leaves and stems of *Ipomoea aquatic* contained some vital anti-nutritional factors as shown in Table 5. Phytates limit the availability of some notable minerals like zinc, magnesium, iron and calcium by forming complexes that are indigestible, thereby decreasing their bioavailability (Groff, *et al.* 1995). In this work the leaves contained 0.56±0.20% phytate while the stem contained 1.15±0.20% phytates. These values showed that this plant could be consumed without much fear of harm to humans and his animals in respect of phytic acid toxicity.

Oxalates are known to combine with and isolate some useful metallic elements thus causing them to be deposited in solid forms. This, in effect, makes them unavailable for adsorption in human system (Alamu, *et al.* 2013). The respective oxalate contents were1.31±0.020 and 0.36±0.02%, while the respective tannin values were 0.04±0.00 and 0.03±0.00% respectively. On the other hand, the respective saponin contents were 2.53±0.02 and 1.13±0.00%.

Alkaloids are often toxic to men and may have dramatic physiological activities on his systems hence they are widely used in medicine (Olaefe, 2007). The alkaloid contents of

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these samples were 0.65±0.02 and 0.68±0.02% for the leaves and stems respectively. Flavonoids which are phenolic compounds that serve as flavouring ingredients of spices and vegetables (Olaefe, 2007).Also, the respective flavonoid contents of the samples were 0.52±0.03 and 0.34±0.02% for the leaves and stems respectively. In general anti-nutritional factors are usually occurring substances found in fruits, vegetables and grains which do not have nutritional values, they influence various body processes. They work together with nutrients and dietary fibre to protect the body against diseases, slow ageing processes and reduce the risk of many diseases such as cancer, heart diseases, stroke, high blood pressure, cataracts and urinary tract infection (Okwu and Ndu, 2006).

CONCLUSION

This study revealed that the leaves and stem of *Ipomoea aquatic* could serve as good sources of food for man and like other leafy vegetables could serve as good sources of plant fibre, protein, carbohydrate and minerals particularly K, Mg, Na and P. The results also suggested that this plant if consumed in sufficient amounts, could contribute greatly towards meeting the nutritional requirements of both man and his animals especially for body growth and adequate protection against diseases arising from malnutrition.

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