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Full Length Research Article

Nutrient Content of Four Lesser – Known Green Leafy Vegetables Consumed by Efik and Ibibio People in Nigeria

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ABSTRACT: Leaves of four lesser – known leafy vegetable species (*Heinsiacrinita, Lasiantheraafricana, Colocasiaesculenta and Ipomeabatatas*) used for traditional food preparations by the Efik and Ibibio ethnic groups in Nigeria were analyzed for proximate composition, amino acid profile and mineral contents. The leaves were washed, cut (2-3mm width) and dried in a conventional oven at 50^{o}C prior to analysis. Crude protein, crude lipid, ash, crude fibre, available carbohydrate and caloric value ranged from 17.15 – 20.73%, 3.67 – 4.66%, 11.50 – 13.75%, 17.98 – 19.36%, 43.78 – 47.23% and 289.62 – 299.98 kcal/100g, respectively. The total amino acids, total essential amino acids and percentage total essential amino acid to total amino acid ranged from 59.58 – 72.24g/100g protein, 27.52 – 31.01g/100 protein and 41.36 – 46.19%, respectively. The K, Ca, Na, Mg, Fe and Zn contents in the leaves ranged from 62.55 – 395.26mg/100g, 127.38 – 763.90mg/100g, 25.59 – 75.69mg/100g, 102.38 – 140.68mg/100g, 7.36 – 18.59mg/100g and 57.65 – 65.35mg/100g, respectively. The result of the study reveals that the four vegetable species contained appreciable levels of crude protein, mineral and crude fibre but low crude lipid. The high crude fibre content suggests that the vegetables may be used in the management of diabetes, obesity and gastrointestinal disorders.
Keywords:*Heinsiacrinita, Lasiantheraafricana, Colocasiaesculenta, Ipomeabatatas,* proximate composition, amino acids.

INTRODUCTION

Green leafy vegetables as components of traditional foods are essential for rural subsistence livelihood and health. They occupy an important place among the food crops as they provide appreciable and the most affordable sources of micronutrients and health promoting phytochemicals for humans (Ihekoronye and Ngoddy, 1985; Chinma and Igyor, 2007). Apart from the variety which they add to the diets, green leafy vegetables are rich sources of vitamins which include provitamin A carotenoid, especially beta-carotene, ascorbic acid, riboflavin, folic acid, thiamine and minerals like calcium, potassium, iron, magnesium and phosphorus (Fasuyi, 2006; Ejoh*et al.,* 2007; Odukoya*et al.,* 2007). Ihekoronye and Ngoddy(1985) noted that although protein in leafy vegetables is low what is present is of good quality. Most vegetables are high in fibre(Ihekoronye and Ngoddy, 1985) and bioactive compounds of therapeutic importance (Aletor and Adeogun, 1995; Liu, 2004). They can, therefore, play a dual role of providing essential nutrients and protecting the body against a number of biochemical, physiological and metabolic disorders (Aletor and Adeogun, 1995). In addition to this, epidemiological studies have shown that the consumption of vegetables can protect humans against oxidative damage by inhibiting or quenching free radical and reactive oxygen species (Ames *et al.*, 1993).

The Niger Delta Region of Nigeria is blessed with numerous species of green leafy vegetables. These vegetables are either grown wild in the forest or under cultivation in the rural areas. However, little is known about most of them as their nutritional compositions are yet to be adequately studied and utilized. Poor nutrition education has precipitated the unpopularity of green leafy vegetables in some traditional diets consumed in Nigeria (Udofia and Obizoba, 2005).

Lasiantheraafricana, Heinsiacrinita, Colocasiaesculenta and Ipomeabatatas leaves are among the several lesser-known leafy vegetables that are used for the preparation of traditional dishes by the Efik and Ibibio ethnic groups in Nigeria and their contribution to household food security is significant. *Lasiantheraafricana andHeinsiacrinita* leaves are used for the preparation of indigenous traditional soups known respectively as "editan" and "atama" soups. Both leaves have, for several years, been exploited by traditional herbalists for the treatment of various ailments, including typhoid fever, diarrhoea, candidiasis and for the management of diabetes mellitus (Ebana*et al.,* 1996; Andy *et al.,* 2008). *Colocasiaesculenta* (tender leaves) and *Ipomeabatatas*leaves are used for the preparation of indigenous traditional food called "ekpangnkukwo". These traditional foods play significant role in maintaining the wellbeing and health of indigenous people. According to Adewale*et al.* (2013), food security, quality of life and livelihood for billions of people in the present and future is only guaranteed by the availability of diversity of genetic resources of many crops.

The importance and awareness of nutrition in public health issues have resulted in increased demand of knowledge of the nutrients in foods (Chinma and Igyor, 2007). Notwithstanding the long term use of the aforementioned vegetables in various traditional dishes preparations, there is paucity of information on their nutritional composition. The present study was, therefore, aimed at evaluating the proximate composition, amino acids and minerals in the four lesser-known leafy vegetables grown in AkwaIbom State, Nigeria.

MATERIALS AND METHODS

Material Procurement and Preparation

*Lasiantheraafricana, Heinsiacrinita, Ipomeabatatas*leaves and very tender leaves of *Colocasiaesculenta* (taro cultivar) were harvested from farmlands at AtanOffot in Uyo Local Government Area of AkwaIbom State, Nigeria. Except for *Colocasiaesculenta*, the leaves of the other three vegetable species were destalked, washed in potable water, spread under a shade to air dry and cut to small pieces (2-3mm width). As it is usually processed before being used for the preparation of “ekpangnkukwo”, the petiole and mid rib of *Colocasiaesculenta* leaf were stripped off and discarded. Only the lamina was washed, spread under a shade to air dry and cut to small pieces (2-3mm width). Each of the cut vegetable species (1kg per species) was dried at 50°C in a conventional air oven (Model PP 22 US, Genlab, England) to constant weight, milled separately using a manual grinder into fine powder and stored in well labelled air tight containers at 4°C for analysis.

Methods of Analysis

Crude protein, crude lipid, ash and crude fibre in the samples were determined following the methods described in AOAC (2000). Available carbohydrate was calculated by difference (Ihekoronye and Ngoddy, 1985). Caloric value was calculated using Atwater factor formula as described by Osborne and Voogt (1978). Amino acid profile of the samples was determined by the method described by Spackman*et al.* (1958). The samples for amino acid determination were dried to constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator (Labratorums Technic AG, Model CH – 9230) and loaded into a Technicon Multi-sample Amino Acid Analyzer (TSM) (Technicon TSM-1, Model DNA 0209, Dublin Republic of Ireland). Mineral elements (K, Ca, Na, Mg, Fe and Zn) were determined using atomic absorption spectrophotometer (UNICAM, Model 939, UK) as described in AOAC (2000).

Statistical Analysis

All analyses were carried out in triplicates. Data generated were analyzed by Analysis of Variance (ANOVA) using SPSS version 18 statistical package (SPSS, Inc., USA). Duncan’s Multiple Range Test (DMRT) was used to compare mean variance. Significance was accepted at $p<0.05$ level of probability.

RESULTS AND DISCUSSION

Proximate Composition

The proximate composition of *Lasiantheraafricana, Heinsiacrinita, Colocasiaesculenta and Ipomeabatatas* leaves is shown in Table 1. The result show variations in crude protein, crude lipid, ash, crude fibre and available carbohydrate among the four vegetable species. The crude protein and crude fibre in *Lasiantheraafricana, Colocasiaesculenta* and *Ipomeabatatas*were not significantly ($p>0.05$) different from each other but were significantly ($p<0.05$) higher than the value in*Heinsiacrinita.*The crude lipid content in the four vegetables species was not significantly ($p>0.05$) different from each other. The ash content was significantly ($p<0.05$) higher in *Heinsiacrinita*and *Lasiantheraafricana* than in *Colosiaesculenta*and *Ipomeabatatas.* The available carbohydrate contents in*Heinsiacrinita*and *Ipomeabatatas*were not significantly ($p>0.05$) different from each other but were significantly ($p<0.05$) higher than the values in *Lasiantheraafricana*and *Colocasiaesculenta.* Similar variations in the proximate composition of different species of vegetables have been reported by Mepba*et al.* (2007), Lewu*et al.* (2009) and Nkafamiya*et al.* (2010). Generally, the results indicate that the four vegetable species had high contents of crude protein, crude fibre and available carbohydrate. *Colocasiaesculenta* leaf had the highest crude protein content (20.73±0.11%) while *Heinsiacrinita* leaf had the least protein value (17.15±0.14%). The values for crude protein content obtained in this study were within the range of 14.67% to 21.28% reported by Nkafamiya*et al.* (2010) for 14 non-conventional leafy vegetables consumed by rural populace in Michika Local Government Area of Adamawa State in Nigeria. The high crude protein content of the four vegetable species suggests that they do contribute to the protein needs of the low and medium income earners especially in the rural communities.

Table 1: Proximate composition of four lesser-known green leafy vegetables (Dry matter basis)

Parameters	*H.crinita*	*L.africana*	*C.esculenta*	*I.batatas*
Crude Protein (%)	17.15^{b}±0.14	19.25^{a}±0.06	20.73^{a}±0.11	18.91^{a}±0.03
Crude Lipid (%)	4.00^{a}±0.00	3.98^{a}±0.15	4.66^{a}±0.04	3.67^{a}±0.10
Ash (%)	13.46^{a}±0.08	13.75^{a}±0.13	11.90^{b}±0.08	11.50^{b}±0.00
Crude fibre (%)	17.98^{b}±0.10	18.82^{a}±0.07	18.93^{a}±0.16	19.36^{a}±0.21
Carbohydrate	47.23^{a}±0.04	44.20^{b}±0.11	43.78^{b}±0.03	46.56^{a}±0.00
Caloric value (Kcal/100g)	293.52^{a}±0.51	289.62^{b}±0.03	299.98^{a}±0.21	294.91^{a}±0.34

Values are Means ± SD (standard deviation) of triplicate determinations. Means on the same row with different superscripts are significantly different at $p<0.05$.

All the vegetable species exhibited low crude lipid content (3.67±0.10% to 4.66±0.04%). This result agrees with the report by Lintas (1992) that leafy vegetables are low lipid containing food, and this may be an advantage for people suffering from obesity. The ash content ranged from 11.50±0.00% for *Ipomeabatatas* leaf to 13.75±0.13% for *Lasiantheraafrican* leaf. The ash contents for *Heinsiacrinita and Lasiantheraafricans* leaves were higher than the values (8.01% - 11.25%) reported by Nkafamiya*et al.* (2010) for non-conventional leafy vegetables grown in

Adamawa State. The high ash content is of significance in measuring the mineral content of the vegetables as the amount of ash shows the richness of food in terms of mineral composition.

High levels of crude fibre in the four vegetable species involved in this study confirm the report by Agostoni*et al.* (1995) that non-starchy vegetables are the richest sources of dietary fibre. The fibre content of the vegetables evaluated ranged from 17.98±0.10% for *Heinsiacrinita*leaf to 19.36±0.21% for *Ipomeabatatas*leaf. By strict definition, fibre is not considered dietary essential but the health promoting benefits of high fibre diets have made this class of nutrient very recognizable in the rapidly developing nutraceutical field (Jalili*et al.*, 2000). Fibre consumption has been linked to decreased incidence of heart disease, various types of cancer and diverticulosis (Jalili*et al.,* 2000). High levels of fibre in food also help in digestion and prevention of colon cancer (Saldanha, 1995). The results of this study suggest that with the high fibre content, these vegetables may be employed in the management of diabetes, obesity, colon cancer and gastrointestinal disorder (Saldanha, 1995; Jalili*et al.,* 2000). The caloric value of the leaves ranged from 289.62±0.03 to 299.98±0.21kcal/100g. Lewu*et al.* (2009) similarly reported caloric value for some accessions of *Colocasiaesculenta*leaves within the range of 298.61±0.34 to 338.65±1.16kcal/100g.

Amino Acids

The amino acid profile of the four lesser-known leafy vegetables is presented in Table 2. Sixteen amino acids were detected and identified in the four vegetable species. The most abundant amino acid in the four vegetables was glutamic acid which ranged from 8.57±0.03g/100g protein for *Heinsiacrinita*to 9.98±0.05g/100g protein for *Colocasiaesculenta*. The second and third most abundant amino acids were aspartic acid (7.56±0.11g/100g protein to 9.53±0.12g/100g protein) and leucine(6.90±0.10g/100g protein to 8.01±0.12g/100g protein). In all the vegetables, methionine (0.85±0.03 – 1.16±0.11g/100g protein) and cystine (0.71±0.06 – 1.03±0.04g/100g protein) were the least in value. *Lasiantheraafricana* leaf had the highest total amino acid (72.24±0.03g/100g protein) and total essential amino acid (31.01±0.11g/100g protein) while *Heinsiacrinita*leaf had the least total amino acid value (59.58±0.03g/100g protein) and total essential amino acid (27.52±0.02g/100g protein). On the other hand, *Heinsiacrinita*leaf had the highest percentage (46.19%) of total essential amino acid to total amino acid while *Colocasiaesculenta* leaf had the least value (41.36%). The percentages of total essential amino acid to total amino acid obtained in this study (41.36 – 46.19%) were above 36% value which is considered adequate for an ideal protein (FAO/WHO, 1990). The percentage chemical scores of the essential amino acids (Table 3) show that methionine was the major limiting amino acid in the four vegetable species.

Table 2: Amino acid profile of four lesser-known green leafy vegetables (g/100g protein)

Amino acids	*Heinsiacrinita*	*L.africana*	*C.esculenta*	*I.batatas*	**Reference Value*
Lysine	3.50^{c}±0.01	4.01^{b}±0.12	4.59^{a}±0.05	5.02^{a}±0.11	5.44
Histidine	1.81^{b}±0.00	2.06^{a}±0.03	2.06^{a}±0.10	2.31^{a}±0.06	1.00
Arginine	4.05^{c}±0.03	5.06^{a}±0.10	4.20^{c}±0.03	4.85^{b}±0.01	
Aspartic acid	7.56^{c}±0.11	9.01^{b}±0.06	9.53^{a}±0.12	9.38^{a}±0.12	
Threonine	2.56^{b}±0.02	3.52^{a}±0.03	2.78^{b}±0.00	3.00^{a}±0.04	4.00
Serine	3.01^{a}±0.05	2.60^{b}±0.02	2.31^{b}±0.13	2.74^{b}±0.10	
Glutamic acid	8.57^{b}±0.03	9.61^{a}±0.02	9.98^{a}±0.05	9.76^{a}±0.13	
Proline	2.64^{b}±0.12	3.02^{a}±0.14	3.03^{a}±0.11	3.32^{a}±0.00	
Glycine	3.04^{b}±0.00	3.80^{a}±0.00	4.01^{a}±0.02	3.68^{a}±0.02	
Alanine	4.04^{a}±0.10	3.92^{a}±0.01	3.25^{b}±0.05	3.44^{b}±0.11	
Cystine	0.71^{b}±0.06	0.97^{a}±0.05	0.90^{a}±0.00	1.03^{a}±0.04	
Valine	4.35^{a}±0.01	4.29^{a}±0.11	3.15^{b}±0.11	3.89^{a}±0.11	5.00
Methionine	0.85^{b}±0.03	1.16^{a}±0.10	0.88^{b}±0.03	1.08^{a}±0.05	3.52
Isoleucine	3.21^{a}±0.03	3.96^{a}±0.10	2.86^{b}±0.12	2.99^{a}±0.03	4.00
Leucine	6.90^{b}±0.10	8.01^{a}±0.12	7.55^{a}±0.04	7.33^{a}±0.12	7.04
Tyrosine	2.78^{a}±0.05	3.24^{a}±0.03	2.31^{b}±0.12	2.63^{a}±0.00	
Phenylalanine	4.34^{a}±0.11	4.00^{a}±0.05	4.00^{a}±0.02	4.33^{a}±0.10	6.08
TAA	59.58^{c}±0.03	72.24^{a}±0.03	67.39^{b}±0.06	66.45^{b}±0.12	
TEAA	27.52^{b}±0.02	31.01^{a}±0.11	27.87^{b}±0.00	29.95^{a}±0.11	
TEAA/TAA (%)	46.19^{a}±0.13	42.93^{b}±0.02	41.36^{b}±0.03	45.07^{a}±0.03	
TSAA	1.56^{b}±0.11	2.13^{a}±0.04	1.78^{b}±0.11	2.11^{a}±0.05	

Values are Means ± SD (standard deviation) of triplicate determinations. Means on the same row with different superscripts are significantly different at $p<0.05$.

TAA =total amino acid; TEAA=total essential amino acid; TSAA = total sulphur amino acid

*FAO/WHO (1973) Reference Value (g/100g protein)

Table 3: Amino acid scores (%) of the essential amino acids of four lesser-known green leafy vegetables.

Essential Amino Acids	***H.crinita***	***L.africana***	***C.esculenta***	***I.batatas***
Lysine	64.34	73.71	84.38	92.28
Histidine	181.00	206.00	206.00	231.00
Threonine	64.00	88.00	69.50	75.00
Valine	87.60	85.80	63.00	77.80
Methionine	24.15	32.95	25.00	30.68
Isoleucine	80.25	99.00	71.50	74.75
Leucine	98.01	113.78	107.24	104.12
Phenylalanine	71.38	65.79	65.79	71.23
Limiting amino acid	Methionine	Methionine	Methionine	Methionine

Minerals

The mineral contents of the four vegetable species are presented in Table 4. The mineral content in the vegetables varied significantly ($p<0.05$) among the species. *Heinsiacrinita*had significantly ($p<0.05$) higher potassium and calcium contents than the other three vegetables. Sodium and magnesium contents were significantly ($p<0.05$) higher in *Lasiantheraafricana*than in the other vegetables. Iron and zinc contents in *Heinsiacrinita*and *Colocasiaesculenta*were not significantly ($p>0.05$) different from each other but were significantly ($p<0.05$) higher than the values in *Lasiantheraafricana*and *Ipomeabatatas.* Similar variations in the mineral content of some Nigerian edible leafy vegetables were reported by Chinma and Igyor (2007) and Mepba*et al.* (2007). The result revealed that the four vegetables contained appreciable levels of minerals elements. Minerals in food are required for diverse metabolic functions (Grosvernor and Smolin, 2002).

Calcium was the most abundant mineral in the vegetables ranging from 127.25±0.92mg/100g for *Ipomeabatatas*leaf to 763.90±0.03mg/100g for *Heinsiacrinita*leaf. The high calcium content in the leaves is significant because the cells need calcium and more than 99% of calcium in the body is used as a structural component of bones and teeth (Grosvernor and Smolin, 2002). Calcium ions are needed for blood clotting and successful functioning of nerves and muscles. The calcium content in the leaves suggests that their consumption can increase the calcium level in the body and help in blood clotting process. The potassium content ranged from 62.55±0.18mg/100g for *Colocasiaesculenta* leaf to 395.26±0.10mg/100g for *Heinsiacrinita*leaf while sodium content ranged from 29.59±0.92mg/100g for *Ipomeabatatas* leaf to 75.69±0.11mg/100g for *Lasiantheraafricana*leaf. Also, the magnesium content ranged from 102.38±0.18mg/100g for *Ipomeabatatas*leaf to 140.68±0.15mg/100g for *Lasiantheraafricana* leaf. The iron and zinc contents ranged from 7.36±0.23mg/100g and 57.65±0.54mg/100g for *Ipomeabatatas* leaf to 18.59±0.05mg/100g and 65.35±0.03mg/100g for *Heinsiacrinita*leaf, respectively. High amount of potassium, calcium and magnesium have been reported to reduce blood pressure in human (Ranhotra*et al.,* 1998). Blood pressure and blood volume in the human body are under the regulation and control of sodium (Grosvernor and Smolin, 2002). The low sodium content in the leaves makes them suitable for use in sodium restricted diets. Iron and magnesium play a major role in the metabolic processes that take place in human system and regulation of blood. Iron is also essential for haemoglobin formation (Grosvernor and Smolin, 2002).

Table 4: Mineral content of four lesser-known green leafy vegetables (mg/100g)

Minerals	***H. crinita***	***L. africana***	***C. esculenta***	***I. batatas***
K	395.26^{a}±0.10	78.98^{c}±0.13	62.55^{d}±0.18	88.47^{b}±0.22
Ca	763.90^{a}±0.03	190.25^{b}±0.04	128.75^{c}±0.13	127.25^{c}±0.10
Na	57.82^{c}±0.05	75.69^{a}±0.11	70.15^{b}±0.52	29.59^{d}±0.92
Mg	115.58^{b}±0.12	140.68^{a}±0.15	109.28^{c}±0.20	102.38^{d}±0.18
Fe	18.59^{a}±0.05	13.96^{c}±0.00	18.25^{a}±0.60	7.36^{b}±0.23
Zn	65.35^{a}±0.03	59.50^{b}±0.12	63.10^{a}±0.31	57.65^{b}±0.54

Values are Means ± SD (standard deviation) of triplicate determinations. Means on the same row with different superscripts are significantly different at $p<0.05$.

CONCLUSION

In conclusion, this study has shown that *Heinsiacrinita, Lasiantheraafricana, Colocasiaesculenta and Ipomeabatatas*leaves contained varied and appreciable levels of nutrient contents. The amino acids profile of the protein showed adequate ratios of total essential amino acids to total amino acids. The high crude fibre contents suggest that the vegetables may be useful in the management of diabetes, obesity and gastrointestinal disorders.

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