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Full Length Research

Nutritional evaluation and proximate analysis of varieties of some edible leafy vegetables in Northern Nigeria

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ABSTRACT: Vegetables are highly consumed in all the states across Northern Nigeria where they constitute a major source of nutritious food. However, their assessment as food, which is based on their chemical analysis, has not been adequately studied and documented in the areas. Standard procedures were used to determine the proximate and chemical composition of all vegetable species analysed. Atomic absorption and flame spectrophotometer test was used to determine the mineral composition. The results were compared using an analysis of variance test. There were significant differences in the nutritive values of the various vegetables ($p>0.05$) studied. Despite differences in the chemical composition of the vegetable species, the overall nutritional potential of the whole vegetable species was quite good. The results of the analysis showed high significant amounts of protein, and minerals, ranging from 1.24 to 48.44 mg/g and 0.09 to 57.54 mg/g for macro and micro elements respectively. Furthermore, crude fibre ranged between 3.32 to 19.76% and carbohydrate ranged from 20.54 to 64.78%, both of which were found to be relatively high. All species were moderate in fat content, with a range of 1.11 to 8.43%. Although, Pb and Cd were detected in some of the species of the vegetables. However, the results indicated that the studied vegetables can be suggested for human consumption.

Key words: Analysis, macro and micro elements, proximate composition, vegetables.

INTRODUCTION

Vegetables are one of the world's greatest resources of nutritious food. Cultivation of vegetables is the most common practice and may currently be the most economical source of income for the people of Northern Nigeria. Vegetables are rich in protein, minerals, and vitamins, and they contain an abundance of essential amino acids. Therefore, vegetables can be a good supplement to cereals (Alino et al., 2012). However, many people are apprehensive about vegetables as a food and nutritional source. There is a very high incidence of malnutrition, especially of protein deficiency in developing countries. The situation is especially severe in sub-Saharan Africa especially in Northern Nigeria where crisis happen frequently leading to malnutrition, in the Northern part of Nigeria with the highest prevalence of under nourishment with one in three people deprived of access to sufficient food (Birnin-Yauri et al., 2011). Protein malnutrition will become even more acute since the supply of protein for the diet has not kept in pace with population growth (Idris and Ndamitso, 2009). In order to meet the deficit, most developing countries tend to import essential protein sources of food from abroad, spending large sums of their meagre foreign exchange earnings. Such a situation has forced planners and nutritionists to think about unconventional alternative sources of protein such as vegetables and mushrooms (Mbong et al., 2014).

resulting from population explosions. Unfortunately, most of vegetable species of Africa are very poorly researched

A detailed account of the compositional analyses of varieties species of vegetables has been reported elsewhere (Lone, 2003).

Vegetables have been used as human food for centuries, since human creation being valued particularly for the variety of flavours and textures they can provide (Krettzschmar et al., 1998). However, they also have nutritional value and can be useful as food supplements, although species vary in their nutritional value (Uba and Uzairu 2008). Protein tends to be present in an easily digested form and on a dry weight basis vegetable normally range between 20 and 60% protein which is better than many legume sources like soybeans and peanuts, and protein-yielding food items (Uwah et al., 2009; Nirmal et al., 2009). Moreover, vegetable proteins contain all the essential amino acids needed in the human diet and are especially rich in lysine and leucine which are lacking in most staple cereal foods (Sajjad et al., 2009; Mensah et al., 2008). Vegetables are low in total fat content and have a high proportion of polyunsaturated fatty acids (72 to 85%) relative to total fat content, mainly due to linoleic acid. The high content of linoleic acids is one of the reasons why vegetables are considered a healthy food (Natasa et al., 2015, Miroslav and Vladimir 1999). Furthermore, they contain significant amounts of carbohydrates and fibres as well as vitamins, especially B complex vitamins and some vitamin C, and they appear to be rich in inorganic mineral nutrients (Karezewska et al., 1998).

Vegetables, unlike many other supplements such as single cell protein algae, have been used as a food and food supplement throughout the world. Their broad acceptance and high consumption rate is an asset. In Africa's rural village communities, vegetables are highly treasured and appreciated as a delicacy. Most people in Nigeria, especially Northern part of the Nigeria include vegetables in their diet and cultivated a lot in the gardens and their farms during the rainy and dry season through irrigation (Buszewski et al., 2000). Their cheapness supply and distribution make them highly valued and therefore very valuable (Afshin and Masoud, 2008; Aiboni, 2001). However, most villagers in Africa especially in Nigeria, vegetables can be cultivated on home garden and other agricultural farmland, making them available year round. Vegetables, one of the highest protein producers per unit area and time from agro-residues, fit in well with feasible strategies to fight malnutrition (Amusan et al., 2015). Additionally, it is increasingly being realized that many species of vegetables are very effective in boosting the body's immune system. This is of crucial importance in Africa, given the magnitude of the malnutrition pandemic prevailing on the continent (Audu and Lawal, 2006). Vegetables have potential in addressing current food crisis problems in Nigeria as well as future problems and documented, yet their biodiversity is extremely high (Anthony and Aiwonegbe, 2007). Furthermore, in Northern Nigeria the cultivation and consumption of vegetables could in the future provide sources of income, traditional medicinal substances, and high-value pharmaceutical products (Hassan, 2005). Although in many part of Northern Nigeria societies, and elsewhere in the world fresh vegetables have broad acceptance and constitute a traditionally important nutritious food, their assessment as food which is based on their chemical analysis has not been adequately studied, explored and documented (Daniel, 2003; Haw–Tarn, 2004). Although many works have been carried out on the nutritional importance of vegetable but in Northern part of Nigeria absence of realisable scientific data and the contribution of vegetables to the overall nutritive value of the diet is speculative. In recent times, vegetables have assumed greater importance in the diet of both rural and urban dwellers, unlike previously when consumption was confined mostly to certain class in the societies. The assessment of vegetables as food based upon its chemical analysis and the relevance of such information to traditional eating habits is therefore of interest.

To the best of our knowledge so far no nutritive quality data have appeared in the literature on varieties of vegetables consumed and cultivated on gardens, composted solid sisal decortications residues. Therefore, fundamental knowledge of the nutritive composition of these vegetables is needed to facilitate effective popularisation of vegetables cultivation on commercial scales, processing, marketing and consumption at the grass roots level to enable people to break away from the poverty trap and malnutrition, which is prevalent in most developing countries. Local people depend, in one way or the other on these species for food and medicines. Usually to fulfil the nutritional needs peoples collect various vegetable species from the nearby rivers, mountainous agriculture fields. The nutritional evaluations of such wild species are very much important to find out any shortcoming in the daily food of the local public. Green leafy vegetables are well known for their nutritional importance. They are proved rich sources of protein, ascorbic acid, carotene, folic acid, riboflavin, and minerals like calcium, iron and phosphorus. Wild edible green plants are commonly found in countries with rather varied climates. Many researchers have shown several wild species of vegetables fit for human consumption. In some modern cultures people consume wild plants as a normal food source, to obtain good amounts of several nutrients as it is widely accepted that leafy green vegetables are significant nutritional sources of minerals.

But much still needs to be done on the proximate analysis and mineral composition of edible leafy vegetables grown in Nigeria. The aim of this study was to determine the chemical composition and nutritional value of various vegetables cultivated and consumed in Northern part of the country.

MATERIALS AND METHODS

Collection of samples and sample preparation

About ten varieties of vegetable species were studied. The vegetables are African eggplant leaf (*Solanium marcro carpoon*), African Spinach (*Amaranthus hybridus*), Bitter leaf (*Vernonia amygdalina*), Bush buck (*Gongronema latifolium*), Clove Basil (*Ocimum gratissimum*), Curry leaf (*Murraya koenigii*), fluted pumpkin leaves (*Telfairia occidentalis*), jute leaves (*Corchorus telfaria*), water leaf (*Talinum triangulare*) and moringa leaves (*Moringa olefera*). These vegetables were brought from various places: farmers, highways, markets and various spots such as from garden, and near the river side's, waste site in the study areas. Some of the vegetable samples were uprooted, cut, destalked, washed and cleaned to remove extraneous substances, and sun-dried for some days. The vegetables were later milled to obtain vegetable meals using mortar and pestle and this was stored in a container for the analysis.

Determination of the nutritional value

Proximate Analysis

Moisture, ash, crude fat and crude fibre were determined in accordance with the official methods of the association of official analytical chemists (AOAC, 1999), while nitrogen was determined by the micro-kjeldahl method (Pearson, 1976) and the percentage of nitrogen was converted to crude protein by multiplying by 6.25. Carbohydrate was determined by difference.

Mineral analysis

A procedure recommended by Environmental Protection Agency (EPA, Method 3050B) was used as the conventional acid extraction method. 1.00 g of sample was placed in 250 ml flask for digestion. The first step was to heat the sample to 95^{0}C with 10 ml of 50% HNO_3 without boiling. After cooling the sample, it was refluxed with repeated additions of 65% HNO_3 until no brown fumes were given off by the sample. Then the solution was allowed to evaporate until the volume was reduced to 5 cm^3. After cooling, 10 ml of 30% H_2O_2 was added slowly without allowing any losses. The mixture was refluxed with 10 cm^3 of 37% HCl at 95^{0}C for 15 minutes. The digestate obtained was filtered through a 0.45 µm membrane paper, diluted to 100 cm^3 with deionized water and stored at 4^{0}C for analyses. The total extraction procedure lasted for 3 to 4 hours.

The resultant solution was cooled and filtered into 100 cm^3 standard flasks and made to mark with distilled water (Asaolu, 1995). Atomic absorption sphectrophotometer (Buck scientific model 200A) was used for Ca, Mg, Cd, Cu, Fe, Pb, Mn and Zn, for Na and K a flame photometer was used.

Statistical analysis

Microsoft Excel (2007) package was used for statistical analysis employing the independent sample t-test. Summary statistics such as mean, standard deviation (SD) and correlation were computed. Significant tests were carried out at the 0.05 level of significance. It is concluded that there is significant difference if the probability associated with the t-test (p) is less than the level of significance (that is, $p < 0.05$). The data were also subjected to analyses of variance (one-way ANOVA).

RESULTS AND DISCUSSION

The results of proximate analysis of the various vegetables cultivated and consumed in the (Northern Nigeria) study areas are presented in Tables 1 to10 and summary of the proximate composition of the vegetables are presented in Table 11. The moisture content in all varieties of species of vegetables studied ranged from 20.55 to 67.76%. Moisture contents of the vegetables were relatively high with the average value of 44.73±9.67%. African Spinach (*Amaranthus hybridus*) had the highest moisture content (67.76%), while lowest values were recorded in Clove Basil (*Ocimum gratissimum*) and fluted pumpkin leaves (*Telfairia occidentalis*). The high moisture content provides for greater activity of water soluble enzymes and co-enzymes needed for metabolic activities of these vegetables (Crisan and Sands, 1978; Adejumo and Awesanya, 2005; Sivrikaya et al., 2002).

The total ash content ranged from 6.45 to 38.53% for all edible vegetable species studied. Total ash content in moringa leaves (*Moringa olefera*) was higher 38.53%, while in African eggplant leaf (*Solanium marcro carpon*), the total ash content was low (6.45%). The high ash content of *Moringa olefera* (38.53%) when compare with low ash values of *Solanium marcro carpon* (6.45%) which is the least of all the vegetables investigated was an indication that there were more minerals in *Moringa olefera*, *Ocimum gratissimum*, *Corchorus telfaria, Telfairia occidentalis*, *Talinum triangulare* and *Amaranthus hybridus*, than in *Solanium marcro carpon*, *Vernonia amygdalina*, *Murraya koenigii* and *Telfairia occidentalis*. The values of ash content obtained in this studied were comparable to those reported for some vegetables in other similar studies such as *A. hybridus, C. peps and G. africana* (Chandravadana et al., 2005).

The fat contents of vegetables studied range from 1.11 to 8.43%. *Ocimum gratissimum* and *Murraya koenigii* had the highest fat contents of 8.43% and 7.32% respectively

Table 1. Proximate composition of African eggplant leaf (*Solanium marcro carpoon*).

Sample	Ash %	Carbohydrate %	Fat %	Crude Fibre %	Crude Protein%	Moisture%
1	6.52	54.78	1.11	12.32	25.65	49.54
2	8.53	57.99	1.21	11.32	21.32	51.32
3	10.87	48.65	1.55	13.45	21.44	50.55
4	9.88	52.77	1.22	15.33	22.12	49.88
5	9.55	45.89	1.12	10.67	20.23	47.68
6	7.55	46.78	1.45	14.34	21.55	51.44
7	8.34	44.56	1.32	11.21	24.89	49.88
8	7.98	50.54	1.43	9.76	19.23	51.54
9	8.76	47.88	1.21	9.34	17.32	45.67
10	6.45	45.78	1.43	10.54	21.67	47.76
Mean±SD	8.44±1.41	49.56±4.39	1.31±0.15	11.83±1.99	21.54±2.44	49.53±1.93
Range	6.45-10.87	44.56-57.99	1.11-1.55	9.34-15.33	17.32-25.65	45.67-51.54

Table 2. Proximate composition of African spinach (*Amaranthus hybridus*).

Sample	Ash %	Carbohydrate %	Fat %	Crude Fibre %	Crude Protein%	Moisture%
1	16.34	24.78	2.11	10.32	15.65	59.54
2	18.53	27.99	2.21	10.32	21.32	51.32
3	10.87	28.65	2.55	10.45	21.44	60.55
4	19.88	22.77	2.22	12.33	22.12	49.88
5	19.55	25.89	2.12	10.67	18.23	47.68
6	17.55	26.78	2.45	11.34	19.55	61.44
7	8.34	24.56	2.32	11.21	14.89	39.88
8	17.98	20.54	2.43	10.76	19.23	41.54
9	18.76	27.88	2.21	11.34	17.32	55.67
10	16.45	25.78	2.43	10.54	18.67	67.76
Means±SD	16.43±3.82	25.56±2.52	2.31±0.15	10.93±0.63	18.84±2.42	53.53±9.05
Range	8.34-19.88	20.54-28.65	2.11-2.55	10.32-12.33	14.89-22.12	39.88-67.76

Table 3. Proximate composition of Bitter leaf (*Vernonia amygdalina*).

Sample	Ash %	Carbohydrate %	Fat %	Crude Fibre%	Crude Protein%	Moisture%
1	16.52	34.78	4.11	8.32	35.65	49.54
2	12.53	37.99	4.21	9.32	31.32	51.32
3	10.87	38.65	4.55	11.45	31.44	50.55
4	11.88	32.77	4.22	9.33	32.12	49.88
5	9.55	35.89	4.12	9.67	30.23	47.68
6	12.55	36.78	4.45	8.34	31.55	51.44
7	10.34	34.56	4.32	9.21	34.89	49.88
8	17.98	30.54	4.43	11.76	29.23	51.54
9	10.76	37.88	4.21	11.34	27.32	45.67
10	16.45	35.78	4.43	9.54	31.67	47.76
Means±SD	12.94±2.97	35.56±2.52	4.31±0.15	9.83±1.25	31.54±2.44	49.53±1.93
Range	9.55-17.98	30.54-38.65	4.11- 4.55	8.32-11.76	27.32-35.65	45.67-51.54

while *Solanium marcro carpon* and *Gongronema latifolium* had the lowest fat contents of 1.31% each. The percentage of fat in some vegetable species were fairly high especially in *Telfairi occidentalis* and *Murraya koenigii*, when compared with values reported in vegetables in the similar studies (Breene, 1990; Mendel,

Table 4. Proximate composition of Bush buck (*Gongronema latifolium*).

Sample	Ash %	Carbohydrate %	Fat %	Crude Fibre %	Crude Protein%	Moisture%
1	16.52	44.78	1.11	12.32	25.65	49.54
2	18.53	37.99	1.21	11.32	31.32	51.32
3	10.87	38.65	1.55	13.45	31.44	50.55
4	12.88	42.77	1.22	15.33	32.12	49.88
5	19.55	35.89	1.12	10.67	30.23	47.68
6	17.55	36.78	1.45	14.34	31.55	51.44
7	18.34	44.56	1.32	11.21	24.89	49.88
8	17.98	40.54	1.43	9.76	29.23	51.54
9	18.76	37.88	1.21	9.34	27.32	45.67
10	16.45	35.78	1.43	10.54	31.67	47.76
Means±SD	16.74±2.78	39.56±3.42	1.31±0.15	11.83±1.99	29.54±2.67	49.53±1.93
Range	10.87-19.55	35.78-44.78	1.11-1.55	9.34-15.33	24.89-32.12	45.67-51.54

Table 5. Proximate composition of Clove Basil (*Ocimum gratissimum*).

Sample	Ash %	Carbohydrate %	Fat %	Crude Fibre %	Crude Protein%	Moisture%
1	26.52	34.78	3.11	15.32	45.65	29.54
2	28.53	37.99	3.21	15.32	41.32	31.32
3	20.87	38.65	2.55	13.45	41.44	20.55
4	29.88	32.77	3.22	15.33	42.12	39.88
5	29.55	45.89	3.12	15.67	40.23	37.68
6	27.55	46.78	2.45	14.34	41.55	31.44
7	28.34	44.56	3.32	15.21	44.89	29.88
8	27.98	30.54	2.43	14.76	39.23	31.54
9	28.76	47.88	3.21	15.34	37.32	35.67
10	26.45	45.78	2.43	15.54	41.67	27.76
Mean±SD	27.44±2.57	40.56±6.40	2.91±0.38	15.03±0.68	41.54±2.44	31.53±5.44
Range	20.87-29.88	30.54-47.88	2.43-3.32	13.45-15.67	37.32-45.65	20.55-39.88

Table 6. Proximate composition of Cueey leaf (*Murraya koenigii*).

Sample	Ash %	Carbohydrate %	Fat %	Crude Fibre %	Crude Protein%	Moisture%
1	15.52	64.78	6.11	3.32	15.65	49.54
2	10.53	57.99	7.21	4.32	12.32	51.32
3	10.87	58.65	6.55	3.45	14.44	50.55
4	11.88	52.77	6.22	5.33	15.12	49.88
5	12.55	55.89	7.12	5.67	10.23	47.68
6	9.55	56.78	6.45	4.34	11.55	51.44
7	11.34	54.56	7.32	5.21	14.89	49.88
8	12.98	50.54	5.43	3.76	13.23	51.54
9	11.76	57.88	4.21	4.34	13.32	45.67
10	13.45	55.78	5.43	4.54	12.67	47.76
Mean±SD	12.04±1.69	56.56±3.82	6.21±0.97	4.43±0.79	13.34±1.72	49.53±1.93
Range	9.55-15.52	50.54-64.78	4.21-7.32	3.32-5.67	10.23-15.65	45.67-51.54

1989; Kurtzman, 1997). However, the fat content was within the range of the reported value of vegetable species (1.1 to 8.1%) on dry weight basis (Crisan and Sands, 1978). In this study, crude fat content is comparable to that of grains such as millet (2.8%) and maize (4.2%) (FAO, 1972). Vegetable fat is reportedly

Table 7. Proximate composition of fluted pumpkin leaves (*Telfairia occidentalis*).

Sample	Ash %	Carbohydrate %	Fat %	Crude Fibre %	Crude Protein%	Moisture%
1	11.52	24.78	2.11	6.32	35.65	29.54
2	13.53	27.99	2.21	8.32	31.32	31.32
3	10.87	28.65	1.55	9.45	31.44	20.55
4	10.88	32.77	2.22	5.33	32.12	39.88
5	10.55	25.89	2.12	10.67	30.23	37.68
6	11.55	26.78	1.45	7.34	31.55	31.44
7	13.34	24.56	2.32	11.21	34.89	29.88
8	12.98	30.54	1.43	9.76	29.23	31.54
9	10.76	27.88	2.21	9.34	27.32	35.67
10	12.45	25.78	2.43	10.54	31.67	27.76
Mean±SD	11.84±1.14	27.56±2.60	2.01±0.38	8.83±1.96	31.54±2.44	31.53±5.44
Range	10.55-13.53	24.56-32.77	1.43-2.43	5.33-11.21	27.32-35.65	20.55-39.88

Table 8. Proximate composition of Jute leaves (*corchorus*).

Sample	Ash %	Carbohydrate %	Fat %	Crude Fibre %	Crude Protein%	Moisture%
1	16.52	44.78	6.11	17.32	45.65	29.54
2	18.53	47.99	7.21	16.32	41.32	31.32
3	10.87	48.65	6.55	15.45	41.44	40.55
4	19.88	42.77	8.22	15.33	42.12	39.88
5	19.55	45.89	5.12	17.67	40.23	37.68
6	17.55	46.78	6.45	14.34	41.55	41.44
7	18.34	44.56	7.32	11.21	44.89	39.88
8	17.98	40.54	8.43	19.76	39.23	41.54
9	18.76	47.88	7.21	19.34	37.32	35.67
10	16.45	45.78	6.43	14.54	41.67	37.76
Mean±SD	17.44±2.57	45.56±2.52	6.91±0.99	16.13±2.55	41.54±2.44	37.53±4.18
Range	10.87-19.88	40.54-48.65	5.12-8.43	11.21-19.76	37.32-45.65	29.54-41.54

Table 9. Proximate composition of Water leaf (*Talinum triangulare*).

Sample	Ash %	Carbohydrate %	Fat %	Crude Fibre %	Crude Protein%	Moisture%
1	26.52	24.78	6.11	16.32	45.65	39.54
2	28.53	27.99	5.21	18.32	41.32	41.32
3	20.87	28.65	5.55	19.45	41.44	30.55
4	19.88	32.77	6.22	15.33	42.12	39.88
5	19.55	25.89	6.12	18.67	40.23	47.68
6	27.55	26.78	5.45	14.34	41.55	41.44
7	18.34	24.56	6.32	16.21	34.89	39.88
8	27.98	30.54	5.43	19.76	39.23	41.54
9	18.76	27.88	6.21	19.34	37.32	55.67
10	26.45	25.78	5.43	18.54	41.67	37.76
Mean±SD	23.44±4.27	27.56±2.60	5.81±0.42	17.63±1.92	40.54±2.91	41.53±6.51
Range	18.34-28.53	24.56-32.77	5.21-6.32	14.34-19.76	34.89-45.65	30.55-55.67

rich in essential unsaturated fatty acids which are considered essential for human diet and health. The protein contents of the vegetable samples ranged from

10.20% to 45.65%. The high values of protein content were obtained in *Ocimum gratissimum, Talinum triangulare, Corchorus telfaria, Gongronema latifolium*

Table 10. Proximate composition of Moringa leaves (*Moringa olefera*).

Sample	Ash %	Carbohydrate %	Fat %	Crude Fibre %	Crude Protein%	Moisture%
1	36.52	44.78	2.11	15.32	25.65	59.54
2	38.53	47.99	3.21	17.32	21.32	51.32
3	30.87	48.65	2.55	13.45	21.44	60.55
4	29.88	52.77	3.22	15.33	22.12	49.88
5	29.55	45.89	3.12	18.67	20.23	47.68
6	37.55	46.78	2.45	14.34	21.55	61.44
7	28.34	44.56	3.32	16.21	24.89	39.88
8	37.98	40.54	3.43	19.76	19.23	41.54
9	28.76	47.88	3.21	19.34	17.32	55.67
10	36.45	45.78	2.43	15.54	21.67	67.76
Mean±SD	33.44±4.22	46.56±3.18	2.91±0.47	16.53±2.16	21.54±2.44	53.53±3.33
Range	28.34-38.53	40.54-52.77	2.11-3.43	13.45-19.76	17.32-25.65	39.88-67.76

Table 11. Summary results of proximate composition of various Vegetable in the study areas.

Sample	Ash %	Carbohydrate %	Fat %	Crude Fibre %	Crude Protein%	Moisture%
Proximate Composition of African eggplant leaf (*Solanium marcro carpoon*).						
Mean±SD	8.44±1.41	49.56±4.39	1.31±0.15	11.83±1.99	21.54±2.44	49.53±1.93
Range	6.45 – 10.87	44.56 – 57.99	1.11 – 1.55	9.34 – 15.33	17.32 – 25.65	45.67 – 51.54
Proximate Composition of African spinach (*Amaranthus hybridus*).						
Mean±SD	16.43±3.82	25.56±2.52	2.31±0.15	10.93±0.63	18.84±2.42	53.53±9.05
Range	8.34 – 19.88	20.54 – 28.65	2.11 – 2.55	10.32 – 12.33	14.89 – 22.12	39.88 – 67.76
Proximate Composition of Bitter leaf (*Vernonia amygdalina*).						
Mean±SD	12.94±2.97	35.56±2.52	4.31±0.15	9.83±1.25	31.54±2.44	49.53±1.93
Range	9.55 – 17.98	30.54 – 38.65	4.11 – 4.55	8.32 – 11.76	27.32 – 35.65	45.67 – 51.54
Proximate Composition of Bush buck (*Gongronema latifolium*).						
Mean±SD	16.74±2.78	39.56±3.42	1.31±0.15	11.83±1.99	29.54±2.67	49.53±1.93
Range	10.87 – 19.55	35.78 – 44.78	1.11 – 1.55	9.34 – 15.33	24.89 – 32.12	45.67 – 51.54
Proximate Composition of Clove basil (*Ocimum gratissimum*).						
Mean±SD	27.44±2.57	40.56±6.40	2.91±0.38	15.03±0.68	41.54±2.44	31.53±5.44
Range	20.87– -29.88	30.54 – 47.88	2.43 – 3.32	13.45 – 15.67	37.32 – 45.65	20.55 – 39.88
Proximate Composition of Cueey leaf (*Murraya koenigii*).						
Mean±SD	12.04±1.69	56.56±3.82	6.21±0.97	4.43±0.79	13.34±1.72	49.53±1.93
Range	9.55 – 15.52	50.54 – 64.78	4.21 – 7.32	3.32 – 5.67	10.23 – 15.65	45.67 – 51.54
Proximate Composition of fluted pumpkin leaves (*Telfairia occidentalis*).						

Mean±SD	11.84±1.14	27.56±2.60	2.01±0.38	8.83±1.96	31.54±2.44	31.53±5.44
Range	10.55 – 13.53	24.56 – 32.77	1.43 – 2.43	5.33 – 11.21	27.32 – 35.65	20.55 – 39.88

Table 11. Contd.

Proximate Composition of Jute leaves (*Corchorus*).						
Mean±SD	17.44±2.57	45.56±2.52	6.91±0.99	16.13±2.55	41.54±2.44	37.53±4.18
Range	10.87 – 19.88	40.54 – 48.65	5.12 – 8.43	11.21 – 19.76	37.32 – 45.65	29.54 – 41.54
Proximate Composition of Water leaf (*Talinum triangulare*)..						
Mean±SD	23.44±4.27	27.56±2.60	5.81±0.42	17.63±1.92	40.54±2.91	41.53±6.51
Range	18.34 – 28.53	24.56 – 32.77	5.21 – 6.32	14.34 – 19.76	34.89 – 45.65	30.55 – 55.67
Proximate Composition of Moringa leaves (*Moringa olefera*).						
Mean±SD	33.44±4.27	46.56±3.18	2.91±0.47	16.53±2.16	21.54±2.44	53.53±9.05
Range	28.34 – 38.53	40.54 – 52.77	2.11 – 3.43	13.45 – 19.76	17.32 – 25.65	39.88 – 67.76
All samples of Vegetables						
Mean±SD	18.02±7.98	39.46±10.50	3.60±2.04	12.30±4.23	29.15±9.92	44.73±9.67
Range	6.45 – 38.53	20.54 – 64.78	1.11 – 8.43	3.32 – 19.76	10.23 – 45.65	20.55 – 67.76

Values are Means±SD, (n =10), SD = Standard deviation.

and *Vernonia amygdalina*. The protein contents obtained in these species of vegetables were higher than what was reported for some vegetables in similar researches (Khanna et al., 1992; Lee and Chang 1975). Plant materials or foods that provide more than 12% of their calorific value from protein have been shown to be good source of protein. This shows that almost all the vegetables studied are good sources of protein. The crude fibres value ranged from 3.32 to 19.76%, these values fell within the ranged from the reported values for vegetables in similar studies (Crisan and Sands,1978; Mendel, 1989). Crude fibre is also part of a healthy diet. The obtained values in this study were within the reported value of 3 to 35% fibre on a dry weight basis (Breene, 1990). Since the vegetables species examined contained significant amounts of crude fiber, they could be regarded as good sources of dietary fiber for supplementation of some foodstuffs with less fiber, hence utilized as roughage, and mostly its immune-stimulation effects should not be overlooked. Dietary fibre helps to prevent constipation, bowel problems and piles. The total carbohydrate content ranged between 20.54 to 64.78%. A range of carbohydrate values of 53 and 60% of dry weight has been reported for some species of vegetables (Mendel, 1989). The ranged carbohydrate content of 20.54 to 64.78% reported in this present study is only slightly above this reported range. The value of carbohydrate content of 20.54 to 64.78% reported in the present study for all species of vegetables studied, falls within the range of 45 to 77% reported for other vegetable species (Crisan and Sands 1978, Khanna et al., 1992). Although, it is suspected that humans cannot utilise a large percentage of the carbohydrate in vegetables as nutrients, it could function as roughage.

The values of macro and micro elements of the vegetable species in the study areas are shown in Tables 12 to 21, and summary of the value of results are presented in Table 22. As with many foods, the mineral content of vegetables is highly varied. There are many minerals that are essential for a normal healthy body. Vegetables like all living organisms have a good mix of minerals, and their fruiting bodies are characterized by high levels of assailable mineral constituents (Mattila et al., 2001). The calcium content in the vegetable samples ranged from 9.30 to 48.44 mg/g. The concentration of magnesium ranged from 2.14 to 17.99 mg/g. The potassium concentration ranged from 1.39 to 11.99 mg/g while the sodium concentration ranged from 1.24 to 7.43 mg/g. Calcium, magnesium and potassium were abundant in the vegetable species studied. The results showed that the vegetables studied are good sources of mineral elements. Significant differences in mineral content were observed ($p<0.05$) among the various vegetable species analyzed in this study. Calcium was the predominant elements among the macro minerals measured. Zinc and to some extent iron were the most abundant elements among the trace minerals analyzed. Similar observations on mineral content profiles have been reported for vegetables of *Momordica balsamina*, *Basella alba L*, and *Lesianthera africian leaves* species (Chang and Buswell, 1996, Shah et al., 1997). The mineral concentrations of vegetables can be influenced by a number of factors including vegetable species and strain types, age of the vegetables, part of the vegetables used, the composition of the growth substrate and the environment (water, temperature and humidity). The differences in mineral contents of the vegetables used in the present study and those reported in the similar

Table 12. Mineral and heavy metal contents (mg/g) in African eggplant leaf (*Solanium marcro carpoon*).

Metals	Ca	Mg	K	Na	Cd	Cu	Fe	Mn	Pb	Zn
1	18.76	8.69	5.34	3.11	ND	3.11	3.51	0.92	0.10	32.12
2	15.07	11.77	5.32	4.96	0.01	4.96	2.52	0.83	0.07	22.97
3	16.09	10.59	5.43	3.86	ND	3.86	2.98	0.70	0.08	42.55
4	18.10	12.80	4.90	3.79	0.01	3.79	2.25	0.74	0.07	32.07
5	17.07	9.87	4.10	4.68	ND	4.68	2.33	0.88	0.06	42.88
6	19.10	10.99	5.68	2.84	0.01	2.84	2.86	0.67	0.09	32.00
7	17.09	10.79	4.69	3.70	ND	3.70	2.22	0.70	0.09	32.54
8	16.08	10.98	6.33	4.59	0.01	4.59	2.79	0.84	0.08	52.23
9	18.07	11.77	5.34	4.02	0.02	4.02	2.21	0.69	0.05	42.54
10	16.09	11.99	6.12	4.01	ND	4.01	2.16	0.80	0.07	32.68
Mean±SD	17.15±1.33	11.02±1.17	5.33±0.66	3.96±0.67	0.01±0.00	3.96±0.67	2.58±0.44	0.78±0.09	0.07±0.01	36.46±8.39
Range	15.07-19.10	8.69-12.80	4.10-6.33	2.84-4.96	0.00-0.02	2.84-4.96	2.16-3.51	0.67-0.92	0.05-0.10	22.97-52.23

Table13. Mineral and heavy metal contents (mg/g) in African Spinach (*Amaranthus hybridus*).

Metals	Ca	Mg	K	Na	Cd	Cu	Fe	Mn	Pb	Zn
1	18.76	10.69	4.88	2.96	ND	2.96	6.00	0.79	1.55	32.65
2	15.07	9.77	3.88	3.65	ND	3.65	4.12	0.73	0.85	42.10
3	16.09	8.59	5.23	2.90	ND	2.90	6.10	0.84	1.07	22.01
4	18.10	7.80	4.99	4.11	ND	4.11	4.89	0.89	0.81	29.12
5	20.07	10.87	6.45	2.79	ND	2.79	3.40	0.77	0.75	41.99
6	19.10	9.99	7.43	3.01	ND	3.01	6.16	0.80	0.71	35.68
7	17.09	11.79	4.23	1.95	ND	1.95	5.52	0.83	1.06	53.97
8	16.08	9.98	3.68	2.59	ND	2.59	6.79	0.84	0.76	43.23
9	18.07	8.77	5.32	3.66	ND	3.66	5.11	0.73	0.87	33.10
10	17.89	11.99	3.88	2.86	ND	2.86	7.97	0.70	0.97	34.55
Mean	17.63±1.55	10.02±1.37	5.00±1.21	3.05±0.62	ND	3.05±0.62	5.61±1.31	0.79±0.06	0.94±0.25	36.84±8.86
Range	15.07-20.07	7.80-11.99	3.68-7.43	1.95- 4.11	ND	1.95-4.11	3.40-7.97	0.70-0.89	0.71-1.55	22.01-53.97

studies are thought to be due to the above mentioned factors (Towo et al., 2006). The present study shows that the all the vegetables species examined ranged between 1.24 and 48.44 mg/g for major minerals and between 0.09 and 57.54 mg/g for trace minerals. The quantitative mineral compositions observed falls within earlier report of analysis of some vegetables in similar researches (FAO, 2003; Mattila et al., 2001). From the data analysis reported in this research, it seems that the vegetables examined can provide a useful source of zinc, calcium, magnesium, potassium, sodium, iron, copper and manganese. Much of the rural peoples can only afford a diet based primarily on

Table 14. Mineral and heavy metal contents (mg/g) in Bitter leaf (*Vernonia amygdalina*).

Metals	Ca	Mg	K	Na	Cd	Cu	Fe	Mn	Pb	Zn
1	18.76	10.69	4.88	3.43	ND	3.43	2.51	0.12	0.10	51.23
2	20.12	9.77	3.88	3.23	ND	3.23	2.32	0.13	0.17	40.97
3	23.43	8.59	5.23	2.65	ND	2.65	1.98	0.77	0.12	38.55
4	21.44	7.80	4.99	2.79	ND	2.79	2.25	0.14	0.11	47.77
5	25.35	10.87	6.45	2.68	ND	2.68	2.33	0.18	0.13	35.88
6	32.12	9.99	7.43	3.13	ND	3.13	1.86	0.17	0.18	54.00
7	23.57	10.79	4.23	2.70	ND	2.70	2.22	0.10	0.21	42.54
8	26.45	9.98	3.68	2.59	ND	2.59	1.79	0.14	0.16	39.23
9	27.43	8.77	5.32	3.32	ND	3.32	2.21	0.09	0.11	57.54
10	28.90	9.99	3.88	2.43	ND	2.43	2.16	0.20	0.19	41.68
Mean±SD	24.76±4.13	9.72±1.0	5.00±1.21	2.90±0.35	ND	2.90±0.35	2.16±0.23	0.20±0.20	0.15±0.04	44.94±7.27
Range	18.76-32.12	7.80-10.87	3.68-7.43	2.43-3.43	ND	2.43-3.43	1.79-2.51	0.09-0.77	0.10-0.21	35.88-57.54

Table 15. Mineral and heavy metal contents (mg/g) in Bush buck (*Gongronema latifolium*).

Metals	Ca	Mg	K	Na	Cd	Cu	Fe	Mn	Pb	Zn
1	18.76	6.69	4.39	1.39	ND	10.13	1.51	0.12	0.01	25.13
2	19.23	7.77	5.32	2.32	ND	12.23	1.32	0.13	0.01	32.17
3	34.23	8.59	2.09	2.09	ND	11.15	1.98	0.77	0.01	43.15
4	34.21	7.80	2.07	2.07	ND	10.19	1.25	0.14	0.01	36.17
5	31.23	8.87	4.99	1.99	ND	13.18	1.33	0.18	0.01	39.13
6	36.32	5.99	2.88	2.88	ND	9.13	1.06	0.17	0.01	35.20
7	37.88	6.79	2.32	2.32	ND	12.20	1.21	0.10	0.01	35.14
8	32.21	6.98	3.99	1.99	ND	13.19	1.19	0.14	0.01	33.23
9	34.90	8.77	5.77	1.77	ND	13.12	1.20	0.09	0.01	29.14
10	34.79	7.99	2.07	2.07	ND	10.13	1.16	0.20	0.01	38.18
Mean±SD	31.38±6.78	7.62±0.98	3.59±1.47	2.09±0.39	ND	11.47±1.51	1.32±0.26	0.20±0.20	0.01±0.00	34.67±5.13
Range	18.76-37.88	5.99-8.87	2.07-5.77	1.39-2.88	ND	9.13-13.19	1.06-1.98	0.09-0.77	0.01-0.01	25.13-43.15

staple crops, which are generally low in micronutrients, particularly iron and zinc resulting in effects of micronutrient malnutrition particularly among pregnant women and children (Mattila et al., 2001). Thus, the consumption of these vegetables in the diet could be one of the sources of iron, zinc and other micronutrients.

Lead (Pb) and cadmium (Cd) were detected in samples of vegetables studied. Pb was detected in almost all the vegetable samples while Cd was detected in about 50% of the vegetable samples investigated from various locations of the study areas. Although, the concentrations of Pb and Cd in all the vegetable samples studied were very low, the Pb concentration ranged from 0.05 to

Table 16. Mineral and heavy metal contents (mg/g) in Clove basil (*Ocimum gratissimum*).

Metals	Ca	Mg	K	Na	Cd	Cu	Fe	Mn	Pb	Zn
1	42.12	10.69	4.88	3.51	ND	3.33	3.51	0.92	0.95	29.12
2	40.23	9.77	3.88	2.52	ND	2.55	2.52	0.83	0.65	32.97
3	39.34	8.59	5.23	2.98	ND	2.67	2.98	0.70	0.98	28.55
4	38.43	7.80	4.99	2.25	ND	3.21	2.25	0.74	0.97	25.07
5	37.34	10.87	6.45	2.33	ND	3.45	2.33	0.88	0.86	27.88
6	35.21	9.99	7.43	2.86	ND	2.78	2.86	0.67	0.99	32.00
7	36.43	11.79	4.23	2.22	ND	2.99	2.22	0.70	0.99	35.54
8	34.23	9.98	3.68	2.79	ND	2.90	2.79	0.84	0.88	26.23
9	35.32	8.77	5.32	2.21	ND	3.45	2.21	0.69	0.95	32.54
10	31.21	11.99	3.88	2.16	ND	3.44	2.16	0.80	0.97	32.68
Mean±SD	36.99±3.19	10.02±1.37	5.00±1.21	2.58±0.44	ND	3.08±0.35	2.58±0.44	0.78±0.09	0.92±0.10	30.26±3.37
Range	31.21-42.12	7.80-11.99	3.68-7.43	2.16-3.51	ND	2.55-3.45	2.16-3.51	0.67-0.92	0.65-0.99	25.07-35.54

Table 17. Minerial and heavy metal contents (mg/g) in Cueey leaf (*Murraya koenigii*).

Metals	Ca	Mg	K	Na	Cd	Cu	Fe	Mn	Pb	Zn
1	18.76	8.69	5.34	4.00	0.01	2.36	4.00	0.79	0.06	52.65
2	15.35	11.77	5.32	2.12	0.02	3.45	2.12	0.73	0.09	45.10
3	18.32	10.59	5.43	2.10	0.01	2.60	2.10	0.84	0.07	45.01
4	19.43	12.80	4.90	4.89	0.01	3.31	4.89	0.89	0.08	46.12
5	17.57	9.87	4.10	3.40	0.01	2.79	3.40	0.77	0.08	51.99
6	17.76	10.99	5.68	2.16	0.01	2.61	2.16	0.80	0.07	47.68
7	18.77	10.79	4.69	2.52	0.02	3.45	2.52	0.83	0.06	38.97
8	14.23	10.98	6.33	2.79	0.01	2.59	2.79	0.84	0.08	32.23
9	11.35	11.77	5.34	2.11	0.02	2.66	2.11	0.73	0.09	42.10
10	19.32	11.99	6.12	2.97	0.01	2.52	2.97	0.70	0.08	38.55
Mean	17.09±2.64	11.02±1.17	5.33±0.66	2.91±0.94	0.01±0.00	2.83±0.41	2.91±0.94	0.79±0.06	0.07±0.01	44.04±6.29
Range	11.35-19.43	8.69-12.80	4.10-6.33	2.10-4.89	0.01-0.02	2.36-3.45	2.10-4.89	0.70-0.89	0.06-0.09	32.23-52.65

0.10 mg/g, while Cd concentration ranged from 0.01 to 0.02 mg/g. Lead (Pb), a ubiquitous and versatile metal continues to be a significant public health problem in developing countries where there are considerable variations in the sources and pathways of exposure. Therefore, care needs to be taken in the consumption of Pb-contaminated vegetables since Pb exposure is through direct contact. It is known and it has been shown that exposure to Pb can lead to a wide range of biological defects in human depending on duration and level of exposure. Cadmium was detected in some of the vegetable samples. Cadmium accumulates in the intestine, liver and kidney (Reddy and Yellamma, 1996). High exposure can cause problems in the synthesis of haemoglobins, damage to the kidneys, gastrointestinal tract, joints, reproductive system

Table 18. Mineral and heavy metal contents (mg/g) in Fluted pumpkin leave (*Telfairia occidentalis*).

Metals	Ca	Mg	K	Na	Cd	Cu	Fe	Mn	Pb	Zn
1	40.23	12.69	4.88	2.11	ND	2.43	2.51	0.12	0.01	31.23
2	43.23	13.77	3.88	3.96	ND	2.23	2.32	0.13	0.02	29.97
3	43.23	14.59	5.23	2.86	ND	2.65	1.98	0.77	0.01	36.55
4	40.34	15.80	4.99	2.79	ND	2.79	2.25	0.14	0.01	35.77
5	48.43	16.87	6.45	3.68	ND	2.68	2.33	0.18	0.01	39.88
6	42.23	13.99	7.43	2.84	ND	3.13	1.86	0.17	0.02	39.00
7	44.34	14.79	4.23	3.70	ND	2.70	2.22	0.10	0.02	41.54
8	39.43	13.98	3.68	3.59	ND	2.59	1.79	0.14	0.02	33.23
9	38.91	10.77	5.32	2.02	ND	3.32	2.21	0.09	0.01	32.54
10	48.44	17.99	3.88	2.01	ND	2.43	2.16	0.20	0.02	30.68
Mean±SD	42.88±3.43	14.52±2.05	5.00±1.21	2.96±0.75	ND	2.70±0.33	2.16±0.23	0.20±0.20	0.02±0.00	35.04±4.12
Range	38.91-48.44	10.77-17.99	3.68-7.43	2.01-3.96	ND	2.23-3.32	1.79-2.51	0.09-0.77	0.01-0.02	29.97-41.54

Table 19. Mineral and heavy metal contents (mg/g) in Jute leave (*corchorus*).

Metals	Ca	Mg	K	Na	Cd	Cu	Fe	Mn	Pb	Zn
1	18.76	10.69	10.69	4.88	0.01	1.13	1.51	0.12	0.11	45.13
2	21.32	9.77	9.77	3.88	0.01	2.23	1.32	0.13	0.14	32.33
3	19.32	11.59	8.59	5.23	0.01	2.15	1.98	0.77	0.12	39.33
4	18.43	12.80	7.80	4.99	0.02	3.19	1.25	0.14	0.11	42.12
5	21.23	9.87	10.87	6.45	0.02	2.18	1.33	0.18	0.13	45.32
6	22.32	9.99	9.99	7.43	0.01	2.13	1.06	0.17	0.13	39.85
7	19.32	10.79	11.79	4.23	0.01	2.20	1.21	0.10	0.11	44.33
8	21.32	10.98	9.98	3.68	0.02	3.19	1.19	0.14	0.12	35.56
9	23.43	10.77	8.77	5.32	0.02	3.12	1.20	0.09	0.11	36.43
10	23.44	10.99	11.99	3.88	0.01	2.13	1.16	0.20	0.13	41.44
Mean	20.89±1.86	10.82±0.90	10.02±1.37	5.00±1.21	0.01±0.00	2.37±0.64	1.32±0.26	0.20±0.20	0.12±0.01	40.19±4.36
Range	18.43-23.44	9.77-12.80	7.80-11.99	3.68-7.43	0.01-0.02	1.13-3.19	1.06-1.98	0.09-0.77	0.11-0.14	32.33-45.32

and the nervous system. The health effects of chronic exposure of Cd include proximal tubular disease and osteomalacia. Long term exposure to cadmium is associated with renal dysfunction. Cadmium is bio-persistent and once absorbed remains resident for many years. High exposure can lead to obstructive lung diseases and has been linked to lung cancer. Cadmium may also cause bone defects in humans and animals. The average daily intake for humans is estimated as 0.15 mg/g from air and 1 µg from water (Jarup et al., 1998). Maximum limit of 0.2 mg/g Cd in plant and 5.0 mg/g Pb in plant was prescribed by (WHO/FAO, 2007).

Correlation study of the data indicated a weak

Table 20. Mineral and heavy metal contents (mg/g) in Water leaf (*Talinum triangulare*).

Metals	Ca	Mg	K	Na	Cd	Cu	Fe	Mn	Pb	Zn
1	20.21	11.69	1.39	4.88	0.01	3.23	3.51	0.92	0.95	23.34
2	19.23	14.77	2.32	3.88	0.02	2.96	2.52	0.83	0.65	27.33
3	18.43	13.59	2.09	5.23	0.01	2.86	2.98	0.70	0.75	29.37
4	20.23	12.80	2.07	4.99	0.01	2.79	2.25	0.74	0.67	36.44
5	22.32	10.87	1.99	6.45	0.01	3.68	2.33	0.88	0.61	37.88
6	25.90	10.99	2.88	7.43	0.01	2.84	2.86	0.67	0.87	33.22
7	19.33	10.79	2.32	4.23	0.02	2.70	2.22	0.70	0.92	39.32
8	18.79	12.98	1.99	3.68	0.01	2.59	2.79	0.84	0.77	32.44
9	26.99	14.77	1.77	5.32	0.02	3.02	2.21	0.69	0.54	29.38
10	21.32	11.99	2.07	3.88	0.01	3.01	2.16	0.80	0.71	30.33
Mean±SD	21.28±2.	12.52±1.5	2.09±0.3	5.00±1.2	0.01±0.00	2.97±0.	2.58±0.	0.78±0	0.74±0.1	31.91±0.
Range	18.43-26.99	10.79-14.77	1.39-2.88	3.68-7.43	0.01-0.02	2.59-3.68	2.16-3.51	0.67-0.92	0.54-0.95	23.34-39.32

Values are Means±SD,(n =10), SD = Standard deviation.

Table 21. Minerial and heavy metal contents (mg/g) in Moringa leave (*Moringa olefera*).

Metals	Ca	Mg	K	Na	Cd	Cu	Fe	Mn	Pb	Zn
1	32.35	10.69	4.88	1.39	0.01	2.11	3.51	0.92	0.10	34.32
2	29.46	11.77	3.88	2.32	0.02	3.96	2.52	0.83	0.07	28.03
3	32.12	12.59	5.23	2.09	0.01	2.86	2.98	0.70	0.08	31.21
4	32.35	10.80	4.99	2.07	0.01	2.79	2.25	0.74	0.07	42.07
5	28.68	13.87	6.45	1.99	0.01	3.68	2.33	0.88	0.06	34.88
6	38.46	9.99	7.43	2.88	0.01	2.84	2.86	0.67	0.09	30.00
7	33.33	8.79	4.23	2.32	0.02	3.70	2.22	0.70	0.09	42.54
8	28.46	10.98	3.68	1.99	0.01	3.59	2.79	0.84	0.08	32.23
9	30.46	10.77	5.32	1.77	0.02	2.02	2.21	0.69	0.05	28.54
10	35.55	10.99	3.88	2.07	0.01	2.01	2.16	0.80	0.07	22.68
Mean±SD	32.12±3.14	11.12±1.39	5.00±1.21	2.09±0.39	0.01±0.00	2.96±0.75	2.58±0.44	0.78±0.09	0.07±0.01	32.65±6.16
Range	28.46-38,46	8.79-13.87	3.68-7.43	1.39-2.88	0.01-0.02	2.01-3.96	2.16-3.51	0.67-0.92	0.05-0.10	22.68-42.54

Values are Means±SD, (n =10), SD = Standard deviation.

correlation between trace metals determined. Zn/Pb,Zn/Ni and Cu/Mn showed positive correlation, while Co/Cu is negatively correlated.

Conclusions

There is variation in mineral contents of the vegetable species studied but it should be noted that the mineral content of each species is a function of the availability of these elements in

Table 22. Summary results of minerials and heavy metal contents of edible vegetable in the study areas.

Minerals	**Ca**	**Mg**	**K**	**Na**	**Cd**	**Cu**	**Fe**	**Mn**	**Pb**	**Zn**
Minerial and Heavy Metal contents (mg/g) in African eggplant leaf (*solanium marcro carpoon*).										
Mean±SD	17.15±1.33	11.02±1.17	5.33±0.66	3.96±0.67	0.01±0.00	3.96±0.67	2.58±0.44	0.78±0.09	0.07±0.01	36.46±8.39
Range	15.07–19.10	8.69 – 12.80	4.10 – 6.33	2.84–4.96	0.00–0.02	2.84–4.96	2.16–3.51	0.67–0.92	0.05–0.10	22.97–52.23
Minerial and Heavy Metal contents (mg/g) in African spinach (*Amaranthus hybridus*)										
Mean±SD	17.63±1.55	10.02±1.37	5.00±1.21	3.05±0.62	ND	3.05±0.62	5.61±1.31	0.79±0.06	0.94±0.25	36.84±8.86
Range	15.07–20.07	7.80–11.99	3.68–7.43	1.95–4.11	ND	1.95–4.11	3.40–7.97	0.70–0.89	0.71–1.55	22.01–53.97
Minerial and Heavy Metal contents (mg/g) in Bitter leaf (*Vernonia Amygdalina*).										
Mean±SD	24.76±4.13	9.72±1.03	5.00±1.21	2.90±0.35	ND	2.90±0.35	2.16±0.23	0.20±0.20	0.15±0.04	44.94±7.27
Range	18.76–32.12	7.80 –10.87	3.68–7.43	2.43–3.43	ND	2.43–3.43	1.79–2.51	0.09–0.77	0.10–0.21	35.88–57.54
Minerial and Heavy Metal contents (mg/g) in Bush buck (*Gongronema latifolium*)										
Mean±SD	31.38±6.78	7.62±0.98	3.59±1.47	2.09±0.39	ND	11.47±1.51	1.32±0.26	0.20±0.20	0.01±0.00	34.67±5.13
Range	18.76–37.88	5.99–8.87	2.07–5.77	1.39–2.88	ND	9.13–13.19	1.06–1.98	0.09–0.77	0.01–0.01	25.13–43.15
Minerial and Heavy Metal contents (mg/g) in Clove basil (*Ocimum gratissimum*)										
Mean±SD	36.99±3.19	10.02±1.37	5.00±1.21	2.58±0.44	ND	3.08±0.35	2.58±0.44	0.78±0.09	0.92±0.10	30.26±3.37
Range	31.21–42.12	7.80–11.99	3.68–7.43	2.16–3.51	ND	2.55–3.45	2.16–3.51	0.67–0.92	0.65–0.99	25.07–35.54
Minerial and Heavy Metal contents (mg/g) in Cueey leaf (*Murraya koenigii*)										
Mean±SD	17.09±2.64	11.02±1.17	5.33±0.66	2.91±0.94	0.01±0.01	2.83±0.41	2.91±0.94	0.79±0.06	0.07±0.01	44.04±6.29
Range	11.35–19.43	8.69–12.80	4.10–6.33	2.10–4.89	0.00–0.02	2.36–3.45	2.10–4.89	0.70–0.89	0.06–0.09	32.23–52.65
Minerial and Heavy Metal contents (mg/g) in Fluted pumpkin leave (*Telfairia occidentalis*).										
Mean±SD	42.88±3.43	14.52±2.05	5.00±1.21	2.96±0.75	ND	2.70±0.33	2.16±0.23	0.20±0.20	0.02±0.00	35.04±4.12
Range	38.91 – 48.44	10.77 – 17.99	3.68 – 7.43	2.01 – 3.96	ND	2.23 – 3.32	1.79 – 2.51	0.09 – 0.77	0.01 – 0.02	29.97 – 41.54
Minerial and Heavy Metal contents (mg/g) in Jute leave (*corchorus*)										
Mean±SD	20.89±1.86	10.82±0.90	10.02±1.37	5.00±1.21	0.01±0.01	2.37±0.64	1.32±0,26	0.20±0.20	0.12±0.01	40.19±4.36
Range	18.43 – 23.44	9.77 – 12.80	7.80 – 11.99	3.68 – 7.42	0.00 – 0.02	1.13 – 3.19	1.06 – 1.98	0.09 – 0.77	0.11 – 0.14	32.33 – 45.32

Table 22. Contd.

Minerial and Heavy Metal contents (mg/g) in Water leaf (*Talinum triangulare*)										
Mean±SD	21.28±2.97	12.52±1.51	2.09±0.39	5.00±1.21	0.01±0.01	2.97±0.31	2.58±0.44	0.78±0.09	0.74±0.14	31.91±4.98
Range	18.43 – 26.99	10.79 – 14.77	1.39 – 2.88	3.68 – 7.43	0.00 – 0.02	2.59 – 3.68	2.16 – 3.51	0.67 – 0.92	0.54 – 0.95	23.34 – 39.32
Minerial and Heavy Metal contents (mg/g) in Moringa leave (*Moringa olefera*)										
Mean±SD	32.12±3.14	11.12±1.39	5.00±1.21	2.09±0.39	0.01±0.01	2.96±0.75	2.58±0.44	0.78±0.09	0.07±0.01	32.65±6.16
Range	28.46 – 38.46	8.79 – 13.87	3.68 – 7.43	1.39 – 2.88	0.00 – 0.02	2.01 – 3.96	2.16 – 3.51	0.67 – 0.92	0.05 – 0.10	22.68 – 42.54
Minerial and Heavy Metal contents (mg/g) in Fluted pumpkin leave (*Telfairia occidentalis*)										
Mean±SD	26.66±9.66	10.78±2.47	5.14±2.35	3.22±1.33	0.01±0.01	3.88±2.87	2.60±1.41	0.53±0.32	0.34±0.40	36.62±8.37
Range	9.30 – 48.44	2.14 – 17.99	1.39 – 11.99	1.24– 7.43	0.00 – 0.02	1.13 – 13.19	1.06 – 7.97	0.09 – 0.92	0.01 – 1.55	7.53 – 57.54

Values are Means±SD,(n =10), SD = Standard deviation.

their local environment, diet absorptive capability and as well as their preferential accumulation. The results obtained from the proximate analysis of all species of vegetable in northern Nigerian showed that they are good sources of nutrients such as protein, dietary fibre and therefore can be ranked as protein rich food due to their relatively high protein content. Based on the results of the analysis, it appears that the vegetable species studied are highly nutritious and compared favourably with other nutritious food materials. Therefore, it can be concluded that these vegetable species are good source of nutrients. The studies also showed that vegetables are good sources of macro and micro mineral elements. But attention should be given to vegetable species that contained Pb and Cd which could be harmful to human after prolong exposure to these metals even at low concentration.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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