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Comparative evaluation of mineral compositions of green leafy vegetables consumed in South Eastern Nigeria

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Ten green leafy vegetables commonly consumed in South East, Nigeria were analysed for mineral composition. The presence of Fe, Cu, Zn, Cr and Mn were analysed using Atomic Absorption Spectrophotometry, Ca and Mg were analysed by the Versenate EDTA complexometric method, K and Na were analysed by Flame Photometery, total nitrogen was analysed by semi-micro Kjeldahl distillation and P was analysed by the Vanado Molybdate yellow. The vegetables analysed were *Telfaria occidentalis* (ugu), *Gnetum Africana* (ukazi), *Pterocarpus mildbreadii* (oha/ora), *Amaranthus viridis* (inine), *Curcubita maxima (ugboghoro)*, *Solanum melongena (anara)*, *Vernonia amygdalina (onugbu)*, *Ocimum gratissimum* (nchuanwu), *Piper guineense* (*uziza*), *Gongronema laifolium* (*utazi*), and *Talinum triangulare* (water leaf). Each of the vegetables contained mineral constituents which were different when compared with other vegetables. Green leafy vegetables are a good source of macro/micro nutrients.

Key words: Minerals, macro nutrients, micro nutrients, leafy vegetables, South East Nigeria.

INTRODUCTION

Green leafy vegetables are important items of diet in many Nigerian homes and they are valuable sources of nutrients especially in rural areas where they contribute substantially to minerals, vitamins and other nutrients which are usually in short supply in daily diets (Mosha and Gaga, 1999).

Leafy vegetables play a vital role in human wellbeing. It has been established that greens contribute significantly to the daily dietary requirements of Ca and Fe among children within the ages 2 to 5 years (Faber et al., 2007). Leafy vegetables are used to improve the quality of soup and also for their dietary purposes (Sobukola and Dairo, 2007).

Fresh green leafy vegetables serve as a very important protective food and also used for maintenance of health, prevention and treatment of diseases. They contain both

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essential and toxic metals (D'Mello, 2003).

Nigeria has rich resources of cultivated, semi-wild and wild species of crops being used as traditional vegetables and different types are consumed by various ethnic groups for different reasons (Mensah et al., 2008). Vegetables are mostly consumed as part of a meal rather than as a whole meal. These herbaceous plants have different tastes and characteristics ranging from soft to hard, tasteless, aroma and bitterness (Edema, 1987). Herbaceous plants (soft stem) are sources of edible vegetables which are rich in nutrients. Some vegetables, such as bitter leaf, fluted pumpkin, *Piper guineense*, scent leaf and utazi leaf also possess some medicinal properties (Oyenuga and Fetuga, 1975).

The composition of nutrients is different in various leafy vegetables and these are due to differences in climate, soil, post-harvest handling and the use of fertilizers (Fasuyi, 2006). Environmental pollution has caused the contamination of soil and also waste water irrigation resulted in the significant mixing of heavy metal contents of agricultural land (Mapanda et al., 2005). The main cause is the water ways through which heavy metals are leached out to the soil and are taken by the vegetation. If plants decay, these toxic metals are distributed back and as a consequence, their abundance in the agricultural soil occurs; bioaccumulation may result as a result of the entrance of these heavy metals to the ecosystem. Then long term waste water irrigation leads to build up of heavy metals in soil and food crops (Khan et al., 2008).

Polluted sewage water is found to be rich not only in organic water and nutrient and also in heavy metals like Ld, Ni, Cd, Cr, etc., that finally reach to the soil of agricultural area and leads to food chain contamination as crops and vegetables absorb them from the soil. Heavy metals are not easily biodegradable and it leads to their accumulation in human vital organs causing different degrees of illness on acute and chronic exposure (Ward et al., 1995). However, some metals are essential and their deficiency results in the damage of biological functions. When present in excess, essential metals known to have essential functions may give rise to toxic manifestations (Friberg and Norberg, 1986). Heavy metals inputs need to be as small as possible because some metals are indispensable for life (Alloway, 1990).

Vegetables are important ingredient of human diet that contains essential nutrients (Abdulla and Chmielnicka, 1990). The utilization of leafy vegetable is part of African cultural heritage and they play important roles in the traditions and food culture of the African household. Nigeria is provided with a variety of traditional vegetables and different types are consumed by the various ethnic groups for different reasons (Fasuyi, 2006).

In most local Nigeria diets, approximately half of the leafy vegetables consumed are from indigenous sources constituting significant micronutrients sources especially in times of drought and famine (Lockett et al., 2000; Grivetti and Ogle, 2000). Leafy vegetables alleviate the problems of micronutrient malnutrition dominant in tropical Africa (Ejoh et al., 2005).

The objectives of this work were to determine the mineral compositions of some selected green leafy vegetables consumed in South Eastern Nigeria and to compare the levels of these minerals in the vegetables.

METERIALS AND METHODS

Sample collection

Ten fresh green leafy vegetables were purchased from Ahia-Ohuru Market in Aba South Local Government Area, Abia State, Nigeria. They were identified at the Department of Food Science and Technology, Abia State Polytechnic, Aba, Nigeria. The green leafy vegetables were rinsed with water to remove dust particles and then were air dried for one week to retain the green colouration of the leaves. The dried samples of vegetables were ground into fine powder using an electric mill and were stored in a sample container for wet-acid digestion.

Determination of minerals in the leafy vegetables

The mineral elements (Na, Ca, Mn, K, N, Fe, Cu, Zn, Ld, Cr, Mg, and P) were determined with some modifications according to the methods described by Association of Analytical Chemists (AOAC, 1990).

The heavy metals were determined from the digestion using the Atomic Absorption Spectrophotometer (AAS) method. K and Na were determined using the flame photometer method. Ca and Mg were determined by the versenate EDTA complexometric method. P was determined by the Vanado Molybdate yellow method using the spectrophotometer. While the total nitrogen was determined using the semi-micro Kjeldahl distillation method (AOAC, 1990).

RESULTS AND DISCUSSION

The result of mineral elements of the ten leafy vegetables is shown in Table 1. There were generally high Ca levels in all the leaves. The high Ca levels observed in the vegetables show that all the leaves are very nutritious. The result of the present study can be attested to that observed by different authors (Asaolu et al., 2012, Mohammed and Sharif, 2012; Iheanacho and Udebuani, 2009; Angela et al., 2010) who reported similar findings. *Ocimum gratissimum* (Nchuanwu) contained the highest level of Ca (2.87 ± 0.04 g/100 g) which is well above the 800 to 1200 mg/day recommended Ca standard for adults. Asaolu et al. (2012) also reported high content of Ca in some leafy vegetables including *O. gratissimum* (Nchuanwu). Small amount of the plants should be taken so as to ingest the optimum level of Ca intake of about 1000 mg/day (FAO, 2001). The difference in calcium level could be from the soil. Ca is a major factor for sustaining strong bones and plays a part in muscle contraction and relaxation, blood clotting, coordination of inorganic elements present in the body (Brown and Kane, 1994). *Amaranthus viridis* (Inine) had the highest level of magnesium (1.20 ± 0.02 g/100 g), while *P. guineense*

Table 1. Mineral composition of major green leafy vegetables consumed in South East Nigeira.

Vegetable	Mineral composition of leafy vegetable mg/100 g											
	Ca	Mg	K	Na	P	N	Fe	Cu	Zn	Pb	Mn	Cr
Ugu	2.55±0.15	0.94±0.07	0.76±0.03	0.25±0.04	0.53±0.02	2.84±0.05	184.2±1.76	0.36±0.03	1.75±0.05	0.014±0.002	5.79±0.18	$0.0014±4×10^{-4}$
Ukazi	1.53±0.16	0.64±0.05	0.66±0.02	0.39±0.01	0.49±0.003	2.47±0.31	255.6±9.10	0.66±0.004	1.96±0.04	0.009±0.001	4.20±0.1	Trace
Oha	2.18± 0.11	0.95 ±0.06	0.85±0.05	0.45±0.03	0.57±0.03	1.94± 0.1	264.7±8.10	0.35±0.001	2.08±0.02	0.022±0.001	2.13±0.03	$0.001±1×10^{-4}$
Inine	2.30±0.16	1.20±0.02	0.53±0.04	0.28±0.03	0.38±0.01	3.92±0.20	550.6±17.90	0.42±0.03	0.95±0.04	0.015±0.001	2.73±0.06	$0.003±1×10^{-4}$
Ugboghoro	1.81±0.04	0.47±0.04	0.15±0.14	0.19±0.01	0.53±0.01	3.15±0.10	244.1±14.03	0.14±0.03	1.25±0.05	0.058±0.003	1.72±0.02	$0.001±5×10^{-5}$
Onugbu	2.32±0.07	0.96±0.06	0.74±0.03	0.11±0.01	0.24±0.002	2.56±0.04	582.1±12.38	0.15±0.002	1.32±0.02	0.104±0.005	1.25±0.02	Trace
Nchuanwu	2.87±0.04	1.00±0.04	1.73±0.05	0.45±0.06	0.55±0.05	2.34±0.10	583±10.12	0.49±0.01	1.61±0.02	0.011±0.001	1.37±0.01	0.014±2×103
Uziza	1.78±0.06	0.46±0.06	0.63±0.02	0.29±0.01	0.60±0.05	3.46±0.52	270.7±14.49	0.15±0.003	0.63±0.06	0.008±0.001	0.8±0.04	$0.004±1×10^{-4}$
Utazi	1.82±0.02	0.66±0.04	0.70±0.09	0.30±0.02	0.28±0.02	2.37±0.07	235.4±16.14	0.11±0.004	0.65±0.01	0.023±0.008	1.15±0.03	$0.0014±3×10^{-4}$
Water leaf	1.52±0.10	0.61±0.03	1.03±0.03	0.35±0.05	0.40±0.01	4.20±0.1	453.9±2.98	0.25±0.03	0.49±0.01	0.032 ±0.001	3.80±0.02	$0.002±3×10^{-3}$

Values are means of triplicate determinations ± SEM.

(Uziza) had the lowest level of Mg (0.46 ± 0.06 g/100 g). Mg is important in treating of diarrhea and other gastrointestinal defects when taken in about 470 mg/day. It also has the ability to treat duodenal cancers when 1200 mg/day is ingested, secondary coronary heart diseases and congested heart failure when about 384 mg/day is taken. The Mg RDAs ranges between 26 and 260 mg/day for the various human categories (FAO, 2001). The values of magnesium are significantly different from those reported in this work; the difference might due to soil compositions and the rate of uptake of minerals by individual vegetables (Anjorin et al., 2010).

Magnesium is good by human health as it is known to reduce blood pressure (Fasuyi, 2006). The level of K ranges from 0.53 ± 0.04 to 1.73 ± 0.05 mg/100 g with *O. gratissimum* (Nchuanwu) having the highest K content (1.73 ± 0.05 mg/100 g) and *A. viridis* (Inine) had the lowest potassium content (0.53 ± 0.04 mg/100 g). Increasing dietary potassium has lowered blood pressure in humans, which by itself should reduce the risk of stroke; however, some of the protective effects of K appear to extend beyond its ability to lower blood pressure (Brown and Kane, 1994).

N is the major source of protein in nutrition; it is needed for the replacement of body tissue. The range of nitrogen in the vegetables is 1.94 ± 0.1 to 4.20 ± 0.1 mg/100 g.

Fe is important in the diet especially for pregnant and nursing mothers as well as infants. It is also needed by the elderly to reduce cases of diseases associated with deficiency of iron such as anemia (D'Mello, 2003). Fe had a range of 184.2 ± 1.76 to 583.7 ± 0.12 mg/100 g with *O. gratissimum* (Nchuanwu) having the highest composition of 583.7± 0.12mg/100g while *Telfaria occidentalis* (Ugu) had the lowest composition of 184.2 ± 1.7 mg/100 g. Fe is needed in haemoglobin formation (Fasuyi, 2006). *Gnetum* Africana (Ukazi) had the highest level of copper (0.11 ± 0.004 mg/100 g), which is adequate for normal growth; the estimated daily intake of Cu from food is 1.0 to 1.3 mg/day or 0.014 to 1.019 kg/day for adults (Akinyele and Osibanjo, 1982).

Zinc is important for nerve function and male fertility. It is important for normal sexual development especially for the development of testes and ovaries, it is also essential for reproduction (Ayoola et al., 2008). It is also essential for healthy functioning of heart and normal growth. The level of Zn ranges from 0.49 ± 0.01 mg/100 g to 2.08 ± 0.02 mg/100 g with *Pterocarpus mildbreadii* (Uha) having the highest content (2.08 ± 0.02 mg/100 g), while *Talinum traiangulare* (Water Leaf) had the lowest content (0.49 ± 0.01 mg/100 g). The amount of Zn reported in this work is significantly different with the estimated average daily dietary zinc intake range from 5.6 to 13 mg/day in infants and children and from 8.8 to 14.4 mg/day in adults aged 20 to 50 years (FAO, 1990). Regular consumption of leafy vegetables may assist in preventing the adverse effect of zinc deficiency which results in retarded growth and delayed sexual maturation, because of its role in nucleic acid metabolism and protein synthesis. Most of these effects are treatable with adequate amounts of zinc (Barminas et al., 1998). Ld had a

range of 0.008 ± 0.001 mg/100 g to 0.104 ± 0.005 mg/100 g, *Vernonia amygalina* (Onugbu) has the highest ld content (0.104 ± 0.005 mg/100 g), while *P. guineense (Uziza)* had the lowest content (0.008 ± 0.001 mg/100 g). The maximum allowable limit for lead is 0.3 mg/kg. The level of lead reported in this work was found within the maximum limit of the recommended value. Ld concentration in plants depends on the environment where the plant is cultivated. Areas of high level concentration such as highways, industrial areas may lead to high levels of lead in plants. Dietary supplement of iron, Ca and vitamin C has been recommended in preventing lead poisoning.

Mn has the range of 0.88 ± 0.04 to 5.79 ± 0.18 mg/100 g with *T. occidentalis* (Ugu) having the highest content (5.79 ± 0.18 mg/100 g), while *P. guineense* (Uziza) had the lowest content (0.88 ± 0.04 mg/100 g). These findings varied with that reported by Asaolu et al. (2012) who in their study reported a lower concentration in *T. occidentalis* (Ugu) compared to *A. viridis*. Such variation could possibly be due to the differences in soil composition in the plant source. Mn is very important for normal and proper activity of the nervous system. Each of the vegetables contains mineral constituents which are different when compared with other vegetables.

Conclusion

This research work reported the evaluation of mineral composition of green leafy vegetables consumed in South Eastern Nigeria. The result showed that the vegetables are rich source of mineral (Macro and Micro elements). The findings of this research work indicated that the vegetables studied could make significant contributions to the recommended dietary allowances for the nutrients and also provide essential health requirements to the consumers. Minerals are needed in the body because they form structure of the body and help the body systems work effectively. Green leafy vegetables are a good source of macro/micro nutrients.

RECOMMENDATION

Green leafy vegetables are good sources of mineral nutrients. It is recommended that the consumption of these studied green leafy vegetables could provide several essential health benefits and pharmacological uses. Leafy vegetables may be rich in heavy metal accumulation depending on the soil type and environmental activities around the farms where such vegetables are grown; it is therefore recommended that vegetables should not be grown in farms irrigated with water contaminated with heavy metals and sewage water.

Adequate policy should be put in place by various governments especially in Africa to control heavy metal discharge into farm lands through industrial effluents.

Conflict of Interests

The authors have not declared any conflict of interest.

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