Nutritional Prospects and Phyto-Therapeutical Potentials of the Selected Indigenous Green Leafy Vegetables Commonly Used in Tanzania

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ABSTRACT
A purposive interview and laboratory analysis of green leafy vegetables commonly used in Tanzania was carried out to determine nutritive prospects as well as therapeutic value. Nine (9) common green leafy vegetables believed to have therapeutical potential on: dietary, anemia, stomach pain, blood pressure, diabetics and peptic ulcers were selected for this study. The micronutrients Ca, Mg, K and P contents were determined using extracts of fresh ALVs, where the effects of cooking were taken into consideration. Calcium level ranged from 496.0 to 1763.5 mg/kg, phosphorus ranged from 309.8 to 572.3 mg/kg, sodium ranged from 72.4 to 187.3 mg/kg and potassium ranged from 309.8 to 595.3 mg/kg. The ratio between Ca and P was 1.30:1 in Ipomoea sp while in Solanum sp was 3.14:1. These values are within the acceptable ratio for the people who are diabetic. The ratio of Na/K in all green leafy vegetables is less than one, hence consumption of these vegetables is beneficial to people with high blood pressure as they tend to reduce their blood pressure. It is recommended that future studies should consider other aspects of green leafy vegetables such as the biological evaluation of the nutrient content in order to determine the bioavailability of the nutrients. Also, it is important to determine the effects of food processing such as cooking on the chemical components and nutritive value of the green leafy vegetables.

Keywords: *Leafy vegetables, Figiri, Cucurbita maxima, minerals, ipomoea, Tanzania*

INTRODUCTION

Indigenous and or traditional leafy vegetables are concepts used mostly to describe leafy vegetables that have been part of the local food systems in Sub-Saharan Africa (SSA) for generations. The term indigenous leafy vegetables are those that have their natural habitat on sub-Saharan Africa while the traditional leafy vegetables were introduced over a century ago

and due to long use, have become part of the food culture in the sub-continent (Smith and Eyzaguirre, 2007). Previously, production of leafy vegetables was mainly on a subsistence basis; and confined to the rural areas. However, these days in the fast-growing city like Dar es Salaam, production of leafy vegetables is the fast-growing activity and offers a significant opportunity for the poorest people to earn a living as producers and/or traders without requiring large capital investments. These vegetables provide an economic pillar upon which women's livelihood is supported (Opiyo, *et al.,* 2015).

African green leafy vegetables have long been part of traditional diets in communities in the continent, yet many of these crops are underutilized and their nutritional value is unknown (Dalziel, 1937). Their utilization could improve the cassava and maize based staple diet and thus reduce the chronic nutrient deficiencies, although their adverse effects are reported among the populations. Despite official statistics indicating a low consumption level of vegetables in Sub-Saharan Africa, it appears that traditional vegetables are usually consumed with the staple food in various forms (Johns, 2004).

For many years, quite a very good number of African indigenous leafy vegetables have long been known and reported to have health protecting properties and uses (Okeno, *et al.,* 2003; Dalziel, 1937). Some of these African indigenous leafy vegetables maintain to be used for prophylactic and therapeutic purposes by rural communities (Getinet, *et al.,* 1997). This indigenous knowledge of the health promoting and protecting attributes of ALVs is clearly linked to their nutritional and non-nutrient bioactive properties (Okon, *et al.,* 2014). Example is kwashiorkor, which is a form of severe acute malnutrition in children for many years especially in Sub-Saharan Africa and Tanzania is not exceptional. Studies shows by providing antioxidants to children with kwashiorkor through their diet improves their survival (Becker, *et al.,* 2005; Badaloo, *et al.,* 2002) specifically the phytochemicals in vegetables and fruits (Liu, 2003).

The ALVs have long been and continue to be reported to significantly contribute to the dietary vitamin and mineral intakes of local populations (Oyejola and Bassir, 1975; Okon, *et al.,* 2014). The increased consciousness of the health protecting properties of non-nutrient bio-active compounds found in fruits and vegetables has led to enormous

concentration to vegetables as fundamental components of dietary intake (Gockowski, *et al.,* 2003). In Tanzania and sub-Saharan African (SSA) populations in general, this attention on vegetables as very important dietary components is significant, as leafy vegetables have long been known to be crucial ingredients in traditional sauces that accompany carbohydrate staples (Smith and Eyzaguirre, 2007). African indigenous as well as traditional leafy vegetables thus have an essential role in the achievement of the World Health Organization's (WHO) global initiative on fruits and vegetables consumption in the sub-continent (Vainio-Mattila, 2000,).

In East Africa and the most of tropical African countries where the daily diet is dominated by starchy staples, the leafy vegetables is added which contribute significantly to household food security and add variety of nutrients to cereal-based staple diets (Van-den-Heever, 1997; Jansen van Rensburg, *et al.,* 2004). The African leafy vegetables (ALVs) are the cheapest and most readily available sources of proteins, vitamins, minerals and essential amino acids (Johns, 2004). These dishes contain these GLV can be prepared with a single plant species like maize or banana or a combination of different species like beans in order to add flavor, taste, color and aesthetic appeal to diet (Marshall, 2001; Fasuyi, 2006; Vainio-Mattila, 2000).

Although it is known African leafy vegetables play an significant role in African agricultural, therapeutic and nutritional systems, still they are regarded as minor crops by African scientists; hence received little attention in most "research and development" programs. The Sub-Sahara area has a diversity of plants and their usage as food; unfortunately, this reservoir is in endangered owing to negligence, inadequate knowledge and population growth which lead to devastation of habitat.

The objective of this study was to investigates the African leafy vegetables commonly consumed in Tanzania specifically Dar es Salaam city. The proximate determination of important mineral content of the leaves was car conducted. Between May and June 2017, a number of knowledgeable persons from different ethinic groups with solid botanical knowledge were interviewed about commonly used green vegetables in their place in order to determine the nutritive as well as medicinal use of the green leaf vegetables in their areas.

METHODOLOGY

Sampling and sample preparation

The samples of 9 species of green leafy vegetables commonly used in Tanzania, were obtained from cultivated farmlands located at Mbezi Luis Dar es Salaam East of Tanzania (Fig 1). Triplicate of each sample (Table 1) had their stalks removed, rinsed with de-ionized water and the residual moisture evaporated at room temperature before sun-drying for 2 -3 days on a clean paper with constant turning over to avert fungal growth.

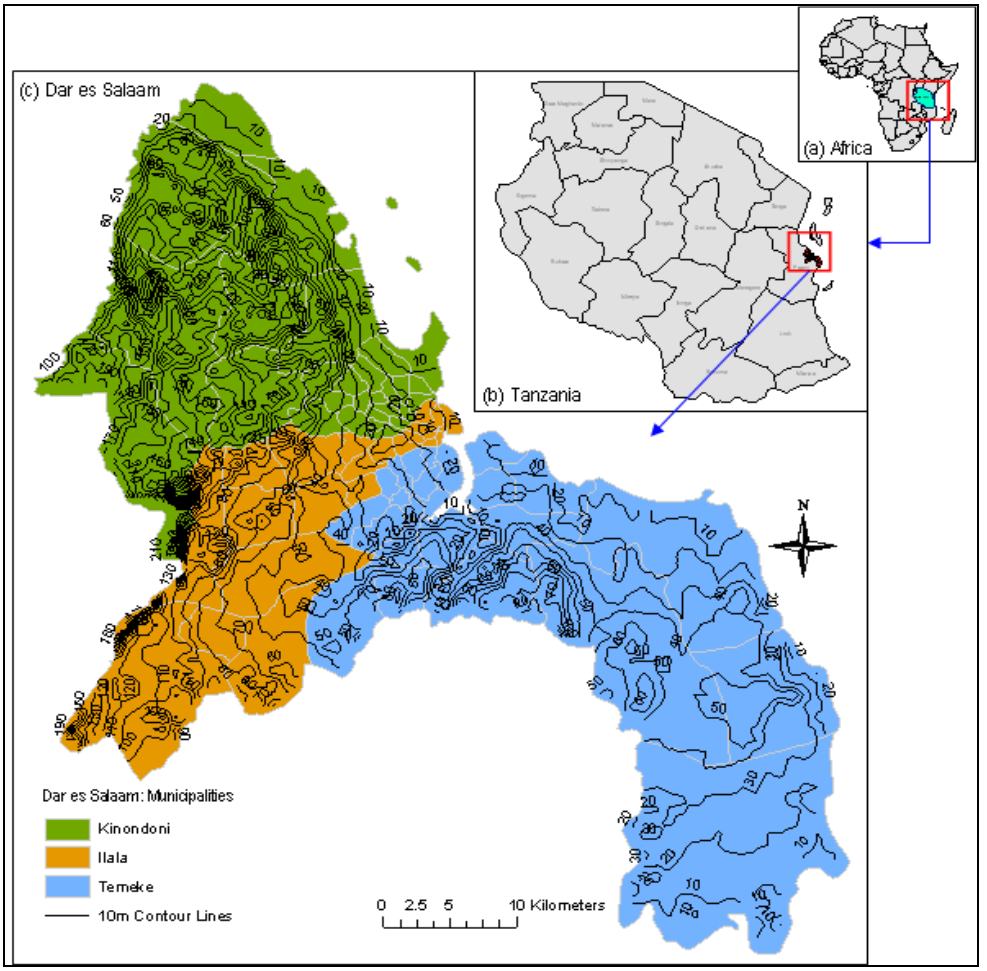

Figure 1: Map of Africa, Tanzania and Dar es Salaam

The sun-dried sample was ground into fine powder using pestle and mortar, and sieved through a 2.0 mm mesh sieve to obtain a dried powdered sample that was used for all the analyses.

Table 1: Samples Collected from Sampling Sites

S/No	Family	Genus and Species	Swahili	Different Vernacular Names
1	Amaranthaceae	*Amaranthus sp*	Mchicha	Kiana (Chagga), Mhahi (Bena) Soswa (Fipa), Iliseke (Wanji) Mzimwa (Nyiha)
2	Brassicaceae	*Brassica L.*	Sukuma Wiki	Figiri (Nyakyusa), Fipa (Mgagala), Nyang'angati (bena), Nyavulesi (Wanji)
3	Compositae	*Bidens pilosa L*	Mashonanguo	Mbeche (Chagga) Manyonyoli (Ngoni) Obukurura (Haya) Madadivilila (Wanji)
4	Compositae	*Lactuca Inermis Forssk*	Mchunga	Nsunga (Luguru), Kware, (Sambaa), Lekule (Maasai)
5	Solanaceae	*Solanum sp*	Mnavu	Mnafu (Chagga), Nyafu (Masai) Foene (Gogo)
6	Tiliaceae	Corchorus *L.*	Mlenda	(Hindawatu (Ngoni), Kuumbi (Fipa), Ilende (Gogo)
7	Euphorbiaceae	*Manihot esculenta Crantz*	Kisamvu	Mhoko (Chagga), Mayau (Ngoni) Katapa (Fipa), Majabhu (Nyakyusa)
8	Cucurbitaceae	*Cucurbita sp*	Maboga	Nanyungu (Ngoni), Msalu (Fipa) Amungu (Wanji), Nyamudza (Bena)
9	Convolvulaceae	*Ipomoea sp*	Matembele	Ibheju Nyakyusa: Mbatata Ngoni: Mafwa (Fipa), Nyamajavo (Wanji)

Mineral analysis

The macro-nutrients: Sodium, Magnesium, Calcium, Potassium and Phosphorus were determined according to the standard procedures l (Shahidi, *et al.*, 1999 and Pearson, 1976). About 2.0 g of each of the processed samples was weighed and subjected to dry ashing in a well-cleaned porcelain crucible at 550^0C in a muffle furnace. The resultant ash was dissolved in 5.0 ml of HNO_3/HCl/H_2O (1:2:3) and heated gently on a hot plate until brown fumes disappeared. To the remaining material in each crucible, 5.0 ml of de-ionized water was added and heated until a colourless solution was obtained. The mineral solution in each crucible was transferred into a 100.0 ml volumetric flask by filtration through Whatman No.42 filter paper and the volume was made to the mark with de-ionized water. This solution was used for elemental analysis by atomic absorption spectrophotometer. Phosphorus content of the digest was

determined colorimetrically according to the method described by Pearson, (1976).

The Phyto-therapeutic potential of green leafy vegetables

In general, phyto-therapeutic potentials studies performed for cognitive and preservative purposes of local knowledge aim at collecting as much information as possible. However, when conducting interviews, it is sometimes useful to select a preferential topic to avoid wasting time, but above all, to investigate and preserve a specific and sometimes mostly endangered type of knowledge.

In the present study, beside the collection of general phyto-therapeutic potentials, the attention was focused on leafy green vegetable medicinal use. The Swahili names of nine (9) different leafy vegetables were given to different ethical group in which each group were represented with at least three members so that they can share common ideas. For each mentioned green leafy vegetable, the informant was asked to provide information regarding the parts of the plant used and whether the plant is still commonly used. Although a pre-structured questionnaire was used for the collection of this information, the candidate was left to speak freely and only at the end of the discussion specific questions were addressed to complete the data. The botanical plant classification was done at the University of Dar es Salaam, herbarium Unit

Quality control and quality assurance

Blanks and quality control standards were measured at every five samples to detect contamination and drift. The elemental concentrations of procedural blanks were generally < 5 % of the mean analyte concentrations for all the metals. Precision and accuracy of analyses were also ensured through replicate analyses of samples against standards reference material for all the heavy metals. The results were found to be within ± 2 % of certified values, thus demonstrating the accuracy of our findings.

FINDINGS AND DISCUSSION

Medicinal values of some commonly used leaf vegetables

Generally, the respondents reported that the indigenous vegetables they consumed had a medicinal value attached to it. Some vegetables were reported to cure more than one illness (Pereira, *et al.*, 1999). A wide range of illnesses was cited as being treated and/or managed by consumption of

leafy vegetables. Results in Table 2 are responses on the medicinal roles of indigenous leafy vegetables.

Table 2: Medical Values of Commonly Used Leafy Vegetables

	Botanical name	**Medicinal Use**
1	*Bidens Pilosa L.*	Used to treat dietary anemia, helping blood flow, prevention of malaria, diabetes, ear treatment, colds and coughs, alleviating toothache, chest pains, improving eye health, cleanse blood, Newcastle in chicken and in treatment of wounds, stomach ache, high blood pressure
2	*Sonchus Luxurians*	Used to treat diabetes, measles, malaria, hernia, stomach pain, blood pressure or body temperature problems, boils and other skin afflictions, chicken pox. Helping with common health complaints of HIV/AIDS patients such as in alleviating stomach pains and sores on the throat, mouth and body.
3	*Solanum villosum*	Increase good eyesight, combat anemia, high blood pressure, diabetes, constipation, peptic ulcers.
4	*Corchonus tritocularies*	Plaster to reduce swellings, treatment of gripe and nausea, high source of potassium, iron, copper, manganese and zinc and are an important high-energy source for both humans and animals.
5	*Brassica carinata L.*	Remedy for arthritis, foot ache, lumbago and rheumatism, treat tumours, anti-scurvy and diuretic.
6	*Manihot esculenta*	styptic, starch mixed with rum can be used for skin problems, treat female infertility, treat sore muscles, also used in treating malaria
7	*Cucurbita sp.*	Used in healing of wounds and internally for the treatment of peptic ulcers, improve the immune system, lower blood pressure, reduce the appearance of varicose veins, maintain healthy of hair, and ease weight loss efforts, can treat malaria, typhoid, stomach ache, constipation
8	*Amaranthus spp*	Stimulate growth and repair of cells, prevent certain chronic diseases, reduce inflammation, boost bone strength, can treat malaria, colds and coughs, AIDs, stomach ache, diarrhea, skin rashes, diabetes, back ache
9	*Ipomea batatis*	Used to increases red blood cells to increase appetite, and are easy to swallow especially for HIV/AIDS patients who may have mouth and throat sores.

The most common illnesses cited were malaria (*Manihot esculenta*, *Cucurbita sp.and Sonchus Luxurians*), diarrhea (*Amaranthus spp* and *Sonchus Luxurians*), anemia (*Solanum villosum* and *Bidens Pilosa L)*, HIV/AIDS (*Ipomea batatis, Amaranthus spp and Sonchus Luxurians)* among others. In addition to determining the medicinal value attached to indigenous vegetables by respondents, the survey also sought other values

attached to these vegetables. The most common values attached were that the vegetables were: satisfying, a delicacy, appetite booster, and able to make one live long. Other values included improved blood flow, able to cleanse blood.

Several scholars (Musinguzi, *et al.,* 2000 and Olembo, *et al.,* 1995), have further shown that countries that retain indigenous vegetable diets and had high consumption of these vegetables are much less likely to be affected by cardiovascular diseases, diabetes and other adverse consequences of the nutrition in transition (Olembo, *et al.,* 1995). These findings concur with those of Musinguzi, *et al.,* (2000), which found out that there was a potential relationship of indigenous vegetables and the ability to treat diabetes, gout, hyperlipidemia, gastro-intestinal tract infections, protozoan parasites, amongst others in Kenya and Tanzania (Olembo, *et al.,* 1995). Olembo, *et al.,* (1995) also states that traditional vegetables have medicinal properties for the management of HIV/AIDS, also indicated some of them can treat stomach-related ailments and other diseases. This is encouraging for intervention geared towards motivating individuals to increase the consumption and utilization of indigenous leafy vegetables.

Most of the traditional vegetables analyzed seem to be used in treating stomach ache or constipation or stomach upset or ingestion. The green vegetable is a calming and soothing herb that has been used to increase bile secretion and encourage bile flow, which helps to speed and ease digestion hence can balance the cholesterol (Ware, 2016).

Mineral content of traditional leafy vegetables

In the context of nutrition and health, the term minerals are chemical elements required as an essential nutrient by human being to perform functions necessary for life. In this study the micronutrient Ca, Mg, K and P content has been determined using extracts of fresh ALVs and the effects of cooking have not been taken into consideration. Cooking has variable effects on micronutrients in ALVs ranging from no effect to reduction due to leaching effect (Uusiku, 2010). The recommended intake obtained from the fresh GLV material is used to obtain the potential beneficial effect as indicated in this paper. Also, it worth to note that it was not possible to specify an average portion size for ALVs, as serving sizes of food even within a country vary considerably depending on season, availability, food traditions in different parts of the country,

people's knowledge, capacity and economy (Smith and Eyzaguirre, 2007).

Calcium content in different traditional green leafy vegetables

Calcium plays an important role in the development and maintenance of bones and, together with phosphate, it provides the main strength within the bones (Uusiku, 2010). Calcium is also needed in the formation of teeth, and has an important role in other body functions; for example, calcium is carried around the body in the bloodstream, where it plays an important role in blood clotting. Calcium is also needed in the body to enable muscles to contract, for the transmission of nerve impulses, and to help the heart function properly.

Calcium level ranges from 496.0 to 1763.5 mg/kg; with *solanum sp* detected with the highest followed by Corchorus L with 1271.1 mg/kg and the lowest detected in *Ipomoea sp* (Fig 2).

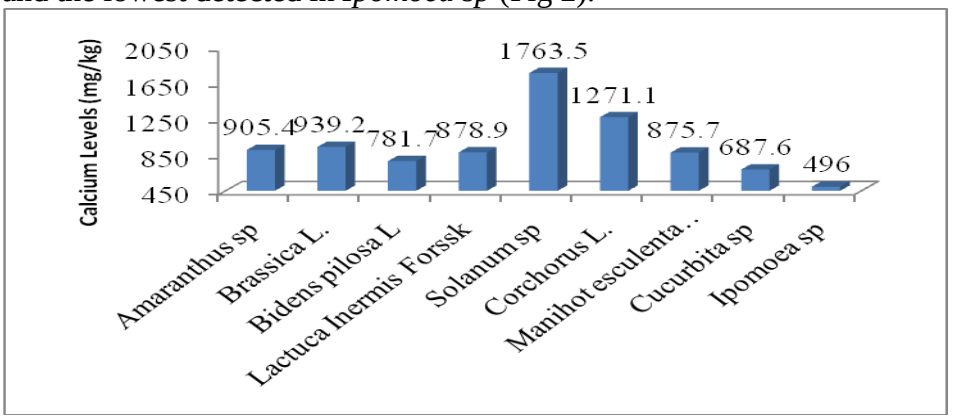

Figure 2: The Level of Calcium in Different Leafy Vegetables

The level detected is twice as much the level determined elsewhere (Akubugwo, *et al.*, 2007), who determine the level of calcium in *Amaranthus hybridus* L. leaves to be 542.0 mg/kg while in the analysis done in *Amaranthus sp* detected to be 905.4 mg/kg. However, the calcium level in the leaves studied was lower than the value reported in some green leafy vegetables consumed in Nigeria (Okon, *et al.*, 2014) detected 2340.4 mg/kg in *Cucurbita maxima* D. Majority of the analysed samples are within the FAO/WHO recommended daily intake for an adult which is 1000 mg (Uusiku, 2010).

Phosphorus content in different traditional green leafy vegetables

The phosphorus content in the analysed samples ranges from 309.8 to 572.3 mg/kg. The value compares favorably with 349.1 mg/kg values determined by Akubugwo, *et al.*, (2007), but lower than 1660 – 6400 mg/kg observed in some green leafy vegetables consumed in Nigeria (Ladan, *et al.*, 1996).

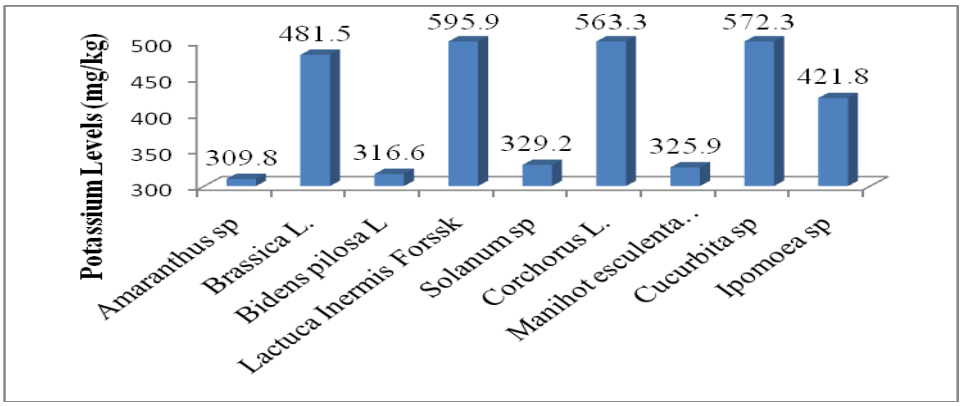

Figure 3: The Level of Phosphorus in Different Leafy Vegetables

The difference identified above could be the same as the one identified by Motherwell and Bullock (1986), which could be due to fertilizer application by the farmers and the amount of phosphorus which was already in the soil before cultivation. It is clear fertilizers such as NPK has phosphorus content which can increase the level of phosphorus in the soil and hence increase the level of phosphorus in plant tissues. However, the level of phosphorus in green leafy vegetables can decrease during cooking, due to leaching of mineral into the cooking medium (Motherwell and Bullock (1986). Care must be taken during preparation and stock used for cooking if phosphorus level is to be maintained.

Magnesium level in different traditional green leafy vegetables

The magnesium content ranges between 300.2 mg/kg and 366.7 mg/kg. *Solanum sp* had the highest magnesium content while the *ipomoea sp* has the lowest. The values are lower than the value determined earlier which ranges between 275.1 to 2886.5 mg/kg (Akubugwo, *et al.*, 2007). However, the levels obtained in this study is low to meet the recommended daily allowance (RDA) of 400 mg/day for men 19-30 years old and 310 mg/day for women 19-39 years old (FAO/WHO (2001).

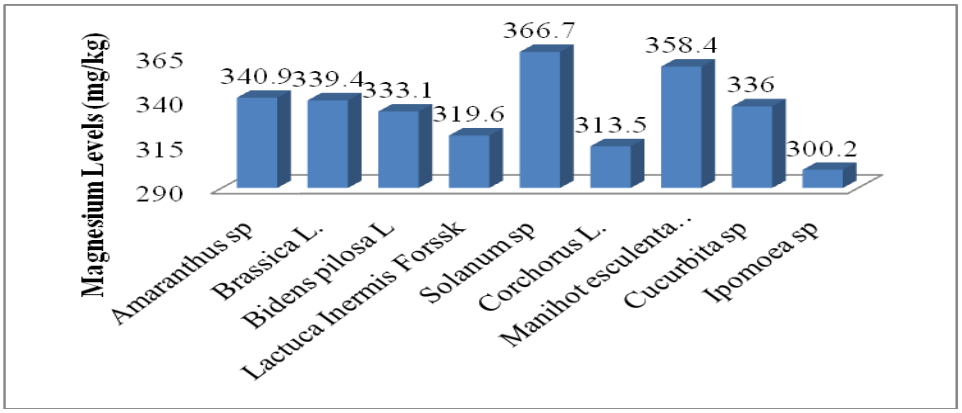

Figure 3: The Level of Magnesium in Different Leafy Vegetables

Magnesium is presumed to be the *"anti-stress"* mineral (Eneji, *et al.*, 2001). Magnesium wards off the formation of blood clots, lowers blood pressure, prevents complications related to diabetes, assists in maintaining bone strength, and reduces the risk of heart disease and limits the effects of free radical damage (Becker, *et al.*, 2005. The higher magnesium content in the leaves could be due to the fact that it is due to the frequency use of chicken and cattle manure in the soil by farmers. Animal manure contains significant amounts of nutrients (nitrogen, phosphorus, potassium, magnesium, copper and zinc) which are easily absorbed by plants (Eneji, *et al.*, 2001).

Magnesium is an essential element in biological systems. Magnesium occurs typically as the Mg^{2+} ion. It is an essential mineral nutrient for life and is present in every cell type in every organism (Lusk, *et al.*, 1968).

Sodium level in different traditional green leafy vegetables

Sodium ions are necessary in small amounts for some types of plants, but sodium as a nutrient is more generally needed in larger amounts by human due to their use of it for generation of nerve impulses and for maintenance of electrolyte balance and fluid balance. Sodium is involved in the regulation of plasma volume, acid-base balance, nerve and muscle contraction (Akpanyung, 2005).

The level of sodium in the analysed samples ranges between 72.4 to 187.3 mg/kg with *ipomoea sp* been the lowest while *brassica L* have the highest (Fig 4).

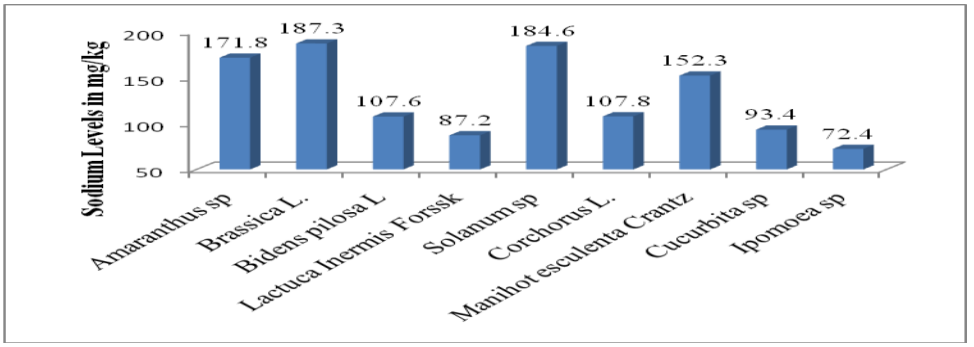

Figure 4: The Level of Sodium in Different Leafy Vegetables

These values compare favorably with the value reported in some green leafy vegetables consumed in Nigeria (Asaolu, *et al.*, 2012).

Potassium Level in Different Traditional Green Leafy Vegetables

The biological importance of potassium levels green vegetables is known to boost heart health by relaxing the blood vessels (Charlton, *et al.*, 2005). Potassium is a vasodilator, which means that it reduces strain and tension in the arteries and blood vessels, lowering blood pressure and reducing the chances of coronary heart disease (Charlton, *et al.*, 2005).

The level of potassium in the analysed samples ranges between 309.8 to 595.3 mg/kg with *amaranthus (mchicha)* been the lowest while *Lactuca Inermis Forssk* have the highest (Fig 5).

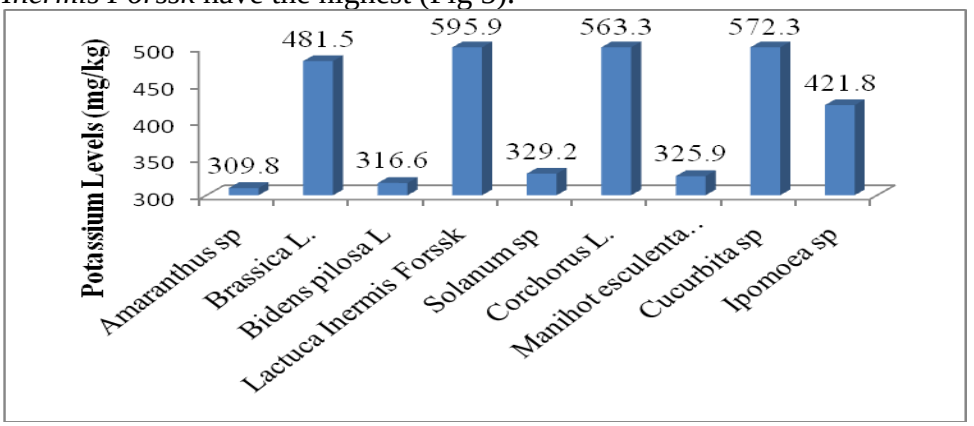

Figure 5: The Level of Potassium in Different Leafy Vegetables

The maximum levels detected by Asaolu, *et al.*, (2012), is three times higher than the values detected in our sample. The level of potassium intake in developed country like United States is recommended 4,700

mg/day (Charlton, *et al.,* 2005), in which the samples contribute half of the recommended.

The Ratio of Sodium to Potassium (Na/K) and Calcium to Phosphorus (Ca/P)

The ratio of sodium to potassium (Na/K) and calcium to phosphorus (Ca/P) are shown in Table 3.

Table 3: The Ratios of Important Minerals

Vegetable	Na	K	Ca	P	Na/K	Ca/P
Amaranthus sp	171.8	309.8	905.4	442.6	0.555	2.046
Brassica L.	187.3	481.5	939.2	484.7	0.389	1.938
Bidens pilosa L	107.6	316.6	781.7	388.5	0.340	2.012
Lactuca Inermis Forssk	87.2	595.9	878.9	396.4	0.146	2.217
Solanum sp	*184.6*	329.2	1763.5	562.2	0.561	3.137
Corchorus L.	*107.8*	563.3	1271.1	655.8	0.191	1.9382
Manihot esculenta C.	*152.3*	325.9	875.7	488.4	0.467	1.793
Cucurbita sp	*93.4*	572.3	687.6	371.5	0.163	1.851
Ipomoea sp	*72.4*	421.8	496	380.7	0.172	1.303

Each data is the mean of three replicates

The calcium/phosphorus ratio is mostly discussed in animal science, when designing diets for herbivorous animals, for example. It has been found (Kemi, *et al.*, 2006) that when a diet that is low in calcium, but high in phosphorus, they develop bone disorders and dental problems (Kemi, *et al.,* 2006 Akubugwo, *et al.*, 2007). According to Mepha, *et al.*, (2007), if the body absorb more phosphorus than calcium in the diet, the body will start to take calcium from its own reserves (the bones) to compensate the defficiency. In this study all samples have higher Ca than P and hence the lowest ratio is 1.3: 1 in and *Ipomoea sp* while the highest is 3.137:1 in *Solanum sp.* Because phosphorus is found in a wide variety of foods, the effect could be not observed, except in diseases that affect absorption, such as diabetes or Crohn's disease.

The Na/K ratio in the body is of great concern for prevention of high blood pressure. Na/K ratio less than one is recommended (FND, 2002). Hence, consumption of all samples analysed would probably reduce high blood pressure diseases because its Na/K is less than one.

CONCLUSION

This study revealed that the leaves of *green leafy vegetable* (GLV) contain considerable amounts of mineral nutrients which are necessary for growth and maintenance of the body. Thus, GLV can contribute significantly to the nutrient requirements of man and should be used as a source of nutrients to supplement other major sources. Indigenous people have basic knowledge of health status of its GLV users as a result of the presence of various compounds vital for good health. They are aware of some of the vegetables contain potent medicine, antihypertensives, malaria and blood building agents and also improves fertility in females when eaten in soups.

Chemical analysis, however, should not be the sole criterion for judging the nutritional value of this plant. It is necessary to consider other aspects such as the biological evaluation of the nutrient content of the plant in order to determine the bioavailability of the nutrients and also the effects of processing on the chemical and nutritive value of the plant.

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