American Journal of Food Science and Nutrition
2018; 5(1): 26-31
http://www.aascit.org/journal/ajfsn
ISSN: 2375-3935

American Association for Science and Technology

Evaluation of the Nutritional Composition of Some Less Common Edible Leafy Vegetables in Nigeria

Adeniyi Adeyeye*, Olufunmilayo Deborah Ayodele, Gentle Akinwumi Akinnuoye

Department of Chemical Sciences, Oduduwa University, Ipetumodu, Via Ile–Ife, Nigeria

Email address

niyade2002@yahoo.com (A. Adeyeye)

*Corresponding author

Citation

Adeniyi Adeyeye, Olufunmilayo Deborah Ayodele, Gentle Akinwumi Akinnuoye. Evaluation of the Nutritional Composition of Some Less Common Edible Leafy Vegetables in Nigeria. *American Journal of Food Science and Nutrition.* Vol. 5, No. 1, 2018, pp. 26-31.

Received: May 30, 2017; **Accepted**: August 3, 2017; **Published**: February 12, 2018

Abstract: The proximate composition and mineral contents of six less common, edible leafy vegetables in Nigeria, including *Solanum nodiflorum, Launaea taraxacifolia, Senecio biafrae, Cucurbita maxima, Crassocephalum crepidioides* and *Solanum nigrum* have been reported in this study. Analysis was carried out using standard procedures of the AOAC. The moisture contents, an indication of the freshness of the vegetables, ranged between 89.25% in *C. maxima* and 91.64% in *S. nigrum*. The samples contained low protein, fat, ash, fibre and carbohydrate contents, with values ranging as follows: protein (minimum and maximum) 3.22% in *C. crepidioides* and 3.78% in *S. nodiflorum*, fat 0.58% in *C. crepidioides* and 0.77% in *C. maxima*, ash 1.15% in *C. crepidioides* and 1.28% in *S. nodiflorum*, fibre 1.44% in *S. nigrum* and 1.68% in *S biafrae* and carbohydrate 2.25% in *S. nigrum* and 3.92% in *C. crepidioides* respectively. The metal contents had their range of values (mg/kg) as calcium 1360–5985, magnesium 220–480, iron 24.70–40.60, manganese 2.30–7.29, copper 1.70–2.85, zinc 1.20–1.52 and cobalt 0.80–0.95 respectively. Nickel was below 0.01mg/kg in all samples. The values for lead and cadmium were below detection limits. The low fat, protein and carbohydrate contents, and hence low calorific energy values of the vegetables, qualify them to be ideal for consumption by all, especially the hypertensive, diabetics and the obese. Their consumption therefore becomes appropriate for strong and healthy living.

Keywords: Leafy Vegetables, Proximate Composition, Chemical Contents, Nutrient Contents, Mineral Elements

1. Introduction

The West African region is well endowed with several green leafy vegetables that either grow traditionally around homes or are grown in vegetable farms and gardens, where fresh and cheap supplies are readily available. They are regular ingredients in the diet of an average Nigerian and the West African, and are the cheapest, highly valuable and most available sources of important nutrients including protein, mineral elements, vitamins, fibre, essential amino acids and other nutrients which are usually in inadequate supply in daily diets [1, 2]. In addition, green leafy vegetables are used in the diet of postpartum women during which time it is claimed that they aid the contraction of the uterus [3]. They are important commodities for poor households because their prices are relatively affordable compared with other food items. Scarcity of vegetable in the diet is a major cause of vitamin A deficiency, which causes blindness and even death in young children throughout the Arid and semi-Arid areas of Africa [4].

Vegetables form the cheapest and most valuable source of important essential amino acids, vitamins, minerals and fibre. This is an advantage for the poor and the under-privileged in both rural and urban settings as these vegetables play a highly significant role in their food security, and also form a source of income generation [5].

Vegetables form a concentrated source of nutrients in the home diet and are used as food supplement. The percentage concentration of protein in leaves is low but what is present is of the high grade, while the quantity of vitamin E in leafy vegetables increases with their greenness. They increase variety and add flavour to diets and constitute important common foodstuff and are a component of most meals [6].

Some of these leafy vegetables are also important for their high medicinal values. The high edible mucilaginous fibre, leaves and stem of vegetables are used as laxative and as purgative to treat indigestion [7]. The dark green leaves, just like the deep yellow fruits, provide a high amount of carotene, ascorbic acid and micro-minerals which play important roles in nutrient metabolism and slowing down of degenerative diseases [8]. Health disorders such as appendicitis, haemorrhoid, gallstone, heart diseases, obesity and constipation can either be corrected or treated by copious consumption of vegetables [9]. Some other leafy vegetables, such as *Vernonia amygdalina*, apart from being used as purgatives, also serve as remedies for kidney disorder, hic-cups, antihelmintics and antiasthmatics [10]. Diets with high vegetable contents have been reported to have an ameliorating effect on the blood pressure of hypertensive patients and lowers systolic and diastolic blood pressure, blood viscosity and plasma fibrinogen [11]. The protective action of vegetables is attributable to the antioxidants present in them. The antioxidants prevent the potential cancer-inducing oxidative damage caused by reactive oxygen species such as free radicals that are generated in the body by a variety of, sources [12].

Even though the leafy vegetables play a very significant role in food security of the under-privileged in Nigeria and other West African countries, there is little and inadequate scientific knowledge on their chemical composition and nutritive potentials. There have been some previous reports on the chemical composition of some leafy vegetables in Nigeria [13–19]. However, little or no information is available on the vegetables here treated. This study therefore reports the nutritional composition of some of the less common but traditionally important leafy vegetables in Nigeria in order to provide more useful information on the potentials of these vegetables as good sources of micro-nutrients, necessary for the good health and well-being of the consumers.

2. Materials and Methods

2.1. Sample Collection and Preparation

Samples of fresh vegetables were obtained from a local market in Moro, a small town in Ife North Local Government area of Osun State, Nigeria. Each fresh sample was stored in a large polythene bag as soon as purchased and transported to the laboratory within the shortest time possible for immediate processing. About 1kg of each vegetable sample was washed in clean portable water to remove unwanted matter, cut into small pieces and oven-dried at 60°C. Each dried sample was ground into a fine powder and stored in a polythene bag in a refrigerator, ready for analysis.

2.2. Sample Treatment

The AOAC method was used for proximate analysis [20]. Available carbohydrates were calculated by difference. Calorific values were calculated using the following formula: Calorific value: (% proteins x 2.44) + (% carbohydrates x 3.57) + (% lipids x 8.37) [21]. Solutions of the vegetables were prepared for metal analysis by dry–ashing the sample at 550°C in a muffle furnace and dissolving the ash in 10% HNO_3, warming and filtering it into a 100ml standard flask and using distilled de-ionized water to make it up. Sodium and potassium were determined from the resulting solution by flame photometry and the other metals by using the Atomic Absorption Spectrophotometer (AAS). The results were compared with absorption of standards of these metals. Sampling and analyses were carried out on each sample in triplicates.

3. Results and Discussion

3.1. Proximate Composition

Table 1. *Proximate composition of the vegetable samples (g/100g fresh weight).*

Name of Vegetable	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Fibre (%)	Carbo-hydrate (%)	Dry matter (%)	Calorific energy (kcal/100g)
Solanum nodiflorum (Ogunmo)**	90.89	3.78	0.75	1.28	1.49	2.70	9.11	27.70
Launaea taraxacifolia (Yanrin)	89.76	3.54	0.62	1.26	1.57	3.25	10.24	25.43
Senecio biafrae (Worowo)	90.65	3.44	0.64	1.26	1.68	3.06	9.35	24.67
Cucurbita maxima (Elegede)	89.25	3.60	0.77	1.22	1.57	3.62	10.75	24.58
Crassocephalum crepidioides (Ebolo)	89.70	3.22	0.58	1.15	1.45	3.92	10.30	26.71
Solanum nigrum (Efo-odu)	91.64	3.28	0.64	1.23	1.44	2.25	8.36	21.39

** = Nigerian Yoruba names in bracket. Results are averages of triplicate analyses.
Calorific value = (% protein x 2.44) + (% carbohydrate x 3.57) + (% lipids x 8.37) [18].

The results of the proximate compositions of the vegetable samples are presented in Table 1. Moisture contents ranged between the lowest of 89.76% in *L. taraxacifolia* and the highest of 91.64% in *S. nigrum*. The moisture contents of the vegetables are comparable to those reported in Owo, southwest of Nigeria, for raw *S. biafrae* (89.68%) and *S. nigrum* (89.49%) [22]. They are also similar to or slightly higher than those reported for some leafy vegetables from southwest of Nigeria with values ranging between 75% in *S. aethiopicum* and 91.5% in *T. triangulare* [13], but slightly higher than the value reported for *O. gratissimum* (86.9%) [3], for *C. crepidioides* (85.08%) and *S. biafrae* (87.5%) [23], and some vegetables in Ivory Coast [24]. Variation in the compositions of the same food type from different sources may be due to the location, soil, variety, maturity and the cultural practices adopted during planting [25]. The leave's available moisture provides for greater activity of water soluble enzymes and co-enzymes needed for metabolic activities of the vegetables [26]. The high moisture contents of the vegetables are indicative of their freshness, and make them to aid digestion of food better. But the high moisture contents also facilitate bacterial action on them, giving them a very short shelf life and easy perishability [6].

The crude fibre contents of the vegetables ranged from the least (1.44%) in *S. nigrum* to the highest (1.68%) in *S. biafrae*. These values are slightly higher than those reported in Iree, Osun State, Nigeria, for *S. nodiflorum* (0.78%) and *S. biafrae* (0.92%) by Adeleke & Abiodun [25], and also for *S. biafrae* (1.05%) and *S. nigrum* (1.13%) reported in Owo by Ajala [22], both studies in the south west of Nigeria. Fibre is useful for maintaining bulk motility and increasing intestinal peristalsis by surface extension of the food in the intestinal tract. It is necessary for healthy condition, curing of nutritional disorders and for food digestion. Dietary fibre is also reported to lower the risk of coronary heart diseases, hypertension, diabetes and colon and breast cancer, piles and appendicitis [5].

Leafy vegetables are generally noted for their low protein and fat contents as contained in these samples. All the vegetables had low crude protein contents, with values ranging from the highest in *S. nodiflorum* (3.78%) to the lowest in *C. crepidioides* (3.22%). The values are comparable to those found in Ibadan, in the southwest of Nigeria, for *O. gratissimum* (3.4%) and *C. esculenta* (3.0%), and for *S. nodiflorum* (3.31%) and *S. biafrae* (3.03%) from Iree, also in the southwest of Nigeria [6; 25]. The values are within the range of 2.5–6.4% reported for 10 green leafy vegetables in the southwest of Nigeria and those for 27 vegetables from Kogi State in the middle belt of Nigeria [13; 27]. They are slightly lower than those reported in Owo, in the southwest of Nigeria, for *S. biafrae* and *S. nigrum* (4.03 & 4.63% respectively) [22], but higher than the values of 1.2% and 1.93% reported in Nigeria for *Launea tetraxidioide* and *Basella rubra* respectively [28]. Protein is nutritionally significant in food as a source of amino acids in the diet of man, and also plays a part in the organoleptic properties of foods (5). It is an essential food content without which our bodies would be unable to repair, regulate or protect itself. Essential body processes such as water balancing, nutrient transport and muscle contractions require protein to function properly, while it is also required for the formation of enzymes and hormones. It also aids in the formation of antibodies that enable the body to fight infection [29].

All the samples had low fat contents, ranging from 0.58% in *C. crepidioides* to 0.77% in C. maxima. The values are similar to those for *C. chayamansa* (0.72%), *S. nodiflorum* (0.87%) and *S. biafrae* (0.61%), all from Iree [25], for *C. esculentus* and *O. gratissimum* leaves (0.80% and 0.90% respectively) both from the southwest of Nigeria [6], and also for 10 leafy vegetables (0.1–0.8%) in the southwest of Nigeria [13]. They are however lower than the values for raw *S. biafrae* (0.92%) and *S. nigrum* (0.96%) reported in Owo in the southwest of Nigeria [22]. The very low fat contents of the vegetables could be advantageous for individuals suffering from obesity and other related diseases. Indeed, a diet providing 1–2% of its calorific energy from fat is sufficient in human beings as excessive consumption has been implicated in certain cardiovascular disorders, such as atherosclerosis, cancer and aging. Health disorders such as appendicitis, haemorrhoids, gallstones, heart diseases and constipation are either corrected or treated by copious consumption of vegetables because of the low fat contents [9].

The low carbohydrate contents of the vegetables are a common phenomenon with leafy vegetables in Nigeria and West Africa. Because they are also low in fat and protein contents, they contribute very little to the energy values of meals. With low calories and low quantities of utilizable energy, the leafy vegetables are ideal for the obese and diabetics who can satisfy their appetites without consuming much carbohydrate and, at the same time, control their weight and health.

3.2. Mineral Elements Composition

Table 2. *Mineral and heavy metal contents of the vegetable samples (mg/kg fresh weight).*

Name of Vegetable	Na	K	Ca	Mg	Fe	Mn	Cu	Zn	Co	Ni	Pb	Cd
Solanum nodiflorum (Ogunmo)**	2520	5400	2015	365	36.9	2.4	1.45	1.28	0.80	<0.01	ND	ND
Launaea taraxacifolia (Yanrin)	3600	5760	1960	220	34.7	3.9	1.85	1.22	0.95	<0.01	ND	ND
Senecio biafrae (Worowo)	3600	6120	1360	420	37.7	7.2	1.75	1.34	0.90	<0.01	ND	ND
Cucurbita maxima (Elegede)	1980	4320	5985	480	24.7	2.7	0.70	1.20	0.95	<0.01	ND	ND
Crassocephalum crepidioides (Ebolo)	3600	5580	1625	250	40.6	3.5	1.35	1.52	0.90	<0.01	ND	ND
Solanum nigrum (Efo-odu)	1800	4140	2145	250	38.2	2.3	1.05	1.47	0.95	<0.01	ND	ND

** = Nigerian Yoruba name in bracket. Results are averages of triplicate analyses.

The mineral elements contents of the vegetables are shown in Table 2. Potassium had the highest value of all the mineral elements in all samples, followed by sodium, calcium and magnesium in that order. Potassium content was highest in *S. biafrae*, followed by its value in *L. taraxacifolia* and was least in *S. nigrum*. *L. taraxacifolia, S. biafrae* and *C. crepidioides* had the highest sodium contents, while the least was found in *S. nigrum*. The range of values for most of the mineral elements was very small and all the vegetables had remarkable quantities of the major minerals. For example, the range of values for sodium in the samples was between 2520 and 3600 mg/kg, while that for zinc was between 1.20 and 1.52 mg/kg. The higher concentration of potassium in each sample relative to the other elements is in agreement with previous reports [25; 30]. *Launaea taraxacifolia, S. biafrae and C. crepidioides* were richer in sodium and potassium contents than the other vegetables. The least values of these mineral elements were observed in *S. nigrum* and *C. maxima*. Potassium and sodium are essential in human body for maintenance of body fluid acid-base balance, and also for nerve activity and muscle contraction [30]. Patients with soft bone problems are usually placed on high potassium and calcium vegetable meals. Sodium and potassium are also important intracellular and extracellular cations respectively, which are involved in the regulation of plasma volume, acid-base balance, as well as nerve and muscle contraction [31]. Sodium to potassium (Na/K) ratio of less than one has been recommended for the prevention of high blood pressure [32]. These vegetables all gave the Na/K ratios of less than one. Hence they would be very adequate for the hypertensive patients in the management and control of hypertension.

Cucurbita maxima had the highest calcium content of 5985 mg/kg, followed by that in S. nigrum (2145mg/kg), while the least was in *S. biafrae* (1360mg/kg), (Table 2). The calcium contents in these vegetables were higher than found in some vegetables elsewhere in Nigeria [30; 33], in the range of values reported for *C. esculenta* from Ibadan in the southwest of Nigeria [3], and those from Ivory Coast and South Africa [24; 34]. The values were, however, lower than those reported for some vegetables in Ghana [35]. Calcium plays an important role in the formation and sustenance of strong bones and teeth at both early and later life. It also plays a part in muscle contraction and relaxation, blood clotting, synaptic transmission and absorption of vitamin B12 [30]. The good calcium contents of the vegetables suggest that they may be of therapeutic value in hypocalcaemic state like osteoporosis, and could help in preventing arthritis, pyorrhea, rickets and tooth decay [33].

The magnesium contents ranged between the highest in C. maxima (480 mg/kg) and the lowest in *L. taraxacifolia* (220 mg/kg), (Table 2). These values are comparable to those for *Amaranthus hybridus* and *Telfaria occidentalis* [14], and for magnesium in vegetables in other reports [36]. The high magnesium concentrations are expected since magnesium is a component of the chlorophyll of plant leaves. It is important in connection with ischemic heart disease and calcium metabolism in bones. A deficiency of magnesium increases the risk of osteoporosis [29]. Magnesium has also been linked with blood pressure lowering properties, by dilating arteries, and preventing heart rhythm abnormalities [30]. It also helps in energy metabolism, protein synthesis, RNA and DNA synthesis and maintenance of electrical potential of nerve tissues [37]. It is known to prevent cardio-myopathy, muscle degeneration, growth retardation, alopecia, dermatitis, immunologic dysfunction, gonadal atrophy, impaired spermatogenesis, congenital malformations and bleeding disorders [38].

Iron contents in the vegetable samples ranged between 24.7 mg/kg in *C. maxima* and 40.7mg/kg in *C. crepidioides*. The values are higher than those reported for some vegetables elsewhere in Nigeria [13; 25; 30], but lower than some other reported values in literature [10; 33; 36]. Iron is an important element in the human body. Its importance is felt in many body functions, including immune function, cognitive development, temperature regulation, energy metabolism and work performance. It is essential for haemoglobin formation, normal functioning of the central nervous system and in the oxidation of carbohydrates, protein and fats [38]. The deficiency of iron has been described as the most prevalent nutritionally, and iron deficiency anaemia is estimated to affect more than one billion people worldwide [39]. Iron deficiency effects include reduced work capacity, impairments in behaviour and intellectual performance and decreased resistance to infection. These vegetables present a good source of iron, and thus guiding against its deficiency effects when regularly consumed.

The values for copper obtained in this study ranged between the least of 0.7 mg/kg in C. maxima and the highest of 1.85 mg/kg in *L. taraxacifolia*. These values are similar to those reported for some vegetables in Egypt, higher than the values of 0.013–0.022 mg/kg reported for some vegetables from Lagos, Nigeria, but lower than the values of 3.07–28.96 mg/kg reported for some vegetables in the Southeast of Nigeria [40–42]. Copper is an essential micronutrient which functions as a biocatalyst. It is required for body pigmentation in addition to iron, to maintain a healthy central nervous system and to prevent anaemia, while it is interrelated with the functions of zinc and iron in the body. It is also necessary for normal biological activities of amino-oxides and tyrosinase enzymes. Tyrosinase enzyme is required for the catalytic conversion of tyrosine to melanin, the vital pigment located beneath the skin, which protects the skin from dangerous radiation [43].

The zinc contents in the vegetable samples ranged between 1.20 mg/kg in *C. maxima* and 1.52mg/kg in *C. crepidioides*. The values are higher than those reported for some fruits and leafy vegetables in Lagos, Nigeria, and those from the southeast of Nigeria, but similar to or lower than found in some other reports in Nigeria, Pakistan and South Africa [10; 25; 27; 33; 36; 41; 42; 44]. Zinc is one of the most important mineral elements for normal growth and development in humans. It is a co-factor for enzymes such as arginase and diaminase and it takes part in the synthesis of DNA and insulin. It is essential for the normal functioning of the cells including protein synthesis, carbohydrate metabolism, cell growth and cell division [43]. It is also important for normal sexual development, especially for the development of testes and ovaries, and also essential for reproduction, and for healthy functioning of the heart [10]. Because of its role in nucleic acid metabolism and protein synthesis, these vegetables may assist in preventing the adverse effects of zinc deficiency which results in retarded growth and delayed sexual maturation [45].

Manganese is another mineral element essential for human nutrition, acting as an activator of many enzymes. The values obtained in this report ranged between 2.3 mg/kg in *S. nigrum* and 7.2 mg/kg in *S. biafrae*. These are within the range of values reported for some vegetables in Ado-Ekiti and Ibadan, both in the southwest of Nigeria [6; 14]. They are also lower than those reported for *Amaranthus viridis* from Sokoto in the northwest of Nigeria and those from Iree the in southwest of Nigeria, but higher than those for *C. crepidioides* and *S. biafrae* from Ado-Ekiti, also from southwest of Nigeria, and the vegetables from Pakistan [23; 25; 36; 45]. Dietary deficiencies of manganese have adverse effects on the central nervous system and may lead to skeletal anomalies among children [46].

Senecio biafrae was the richest in sodium, potassium and manganese. It also had the second highest contents of iron, manganese, copper, zinc and cobalt. Its consumption is therefore highly recommended as a rich source of these mineral elements. *L. taraxacifolia* gave high contents of sodium, potassium, calcium and iron. Thus, even though *S. biafrae* gave high contents of several of these mineral elements, each of the vegetables showed relatively high contents of one mineral element or the other. They, therefore, will be of immense benefit to the health and well-being of the regular consumer.

4. Conclusion

This study has reported the nutritional composition and mineral contents of six, less common, leafy vegetables in the south western areas of Nigeria. The results showed that the vegetables have rich proximate compositions and are rich sources of mineral elements which are highly beneficial for the maintenance of the normal body functions and a healthy living of the consumers. The vegetables had low carbohydrate, protein and fat contents, the values of which are not enough to provide the recommended dietary allowances (RDAs) that the body needs, and therefore cannot be a total substitute for the staple foods. But, as they are used in soup making for the consumption of the staple foods, they complement the staple foods in providing the necessary mineral elements, the lack of which is detrimental to healthy living. The relatively high values of the nutrient elements in these vegetables, therefore, make them the much needed and cheap sources of the elements which may, otherwise, be missing from the commonly consumed staple foods. Their low fat and carbohydrate contents but good fibre contents, as well as the non-detection of lead and cadmium in them, become advantageous as these qualify them to be good for consumption by all, and especially the obese and the diabetics. Their cheap and easy accessibility also make them readily affordable for the low income group of the society, providing the necessary mineral elements for their good, strong and healthy living. Their high consumption is therefore recommended for their invaluable health benefits.

References

[1] Mosha T. C. and Gaga H. E. (1999). Nutritive value of blanching on trypsin and chymotrypsin inhibitor activities of selected leafy vegetables. Plant Foods Human Nutr., 54: 271-283.

[2] Akinfolarin O. M. and Gbarakoro S. L. (2016). Proximate analyses of Atama (Heinsia crinita) and Editan (Lasianthera africana). IOSR J. Appl. Chem. 9: 3 (version I): 76-79.

[3] Emebu P. U. and Anyika U. (2011). Proximate and composition of Kale (Brassica oleracea) grown in Delta State, Nigeria. Pak. J. Nutr. 10: 190-194.

[4] Okigbo B. N. (1986). Broadening the Food base in Africa. The potential of traditional food plants. Food Nutrition. 1986. 12: 4-17.

[5] Orech F. O., Akenga T., Ochora J., Friis H. and Aagaard–Hassen J. (2005). Potential toxicity of some traditional leafy vegetables consumed in Nyang'oma Division, Western Kenya. Afri. J. Food Agric. Nutri. Devt. Online 5 (1).

[6] Adepoju O. T. and Oyewole E. O. (2008). Nutritional importance and micronutrient potentials of two non–conventional indigenous green vegetables from Nigeria. Agric. J. 3 (5): 362-365.

[7] Fowomola M. A. and Akindahunsi A. A. (2005). Protein quality indices of sandbox (Hura crepitans) seed. J. Food Agric. Environ. 3: 16-19.

[8] Yi–Fang C., Jie S., Xian–Hong W. U. and Rui–Hai (2002). Antioxidant and antiproliferative activities of common vegetables. A Review. J. Agric. Food Chem. 50: 6910-6916.

[9] Whitney E. N., Hamilton E. M. N. and Rolfes S. R. (1990). Understanding Nutrition (5th Edn), West Publishing Co., St. Paul, USA.

[10] Ayoola P. B., Adeyeye A. and Onawumi O. O. (2010). Trace element and major mineral evaluation of Spondias mombin, Vernonia amygdalina and Momordica charantia leaves. Pak. J. Nutri. 9 (8): 755-758.

[11] Adebawo O. O., Salau B. A., Adeyanju M. M., Famodu A. A. and Osilesi O. (2007). Fruits and vegetables moderate blood pressure, fibrinogen concentration and plasma viscosity in Nigerian hypertensives. Afri. J. Food Agric. Nutri. Develop. 7 (6): 1-12.

[12] Halliwell B. and Gutteridge J. M. (1989). Free radicals in biology and medicine. Clarendon Press, Oxford.

[13] Olaiya C. and Adebisi J. (2010). Phytoevaluation of the nutritional values of ten green leafy vegetables in South–Western Nigeria. The Internet J. of Nutrition & Wellness 9 (2).

[14] Asaolu S. S., Adefemi O. S., Oyakilome I. G., Ajibulu K. E. and Asaolu M. F. (2012). Proximate and mineral composition of Nigerian leafy vegetables. J. Food Res. 1 (3): 214-218.

[15] Adeniyi S. A., Ehiagbonare J. E. and Nwangwu S. C. O. (2012). Nutritional evaluation of some staple leafy vegetables in Southern Nigeria. Int. J. Agric. Fd. Sci. 2 (2): 37-43.

[16] Yekeen T. A., Akintaro O. I., Akinboro A. and Azeez M. A. (2013). Evaluation of cytogenotoxic and nutrient composition of three commonly consumed vegetables in South – Western Nigeria. Afri. J. Food Agric. Nutri. Develop. 13 (2): 7452-7466.

[17] Shittu S. A., Olayiwola O. A. and Adebayo O. R. (2014). Nutritional composition and phytochemical constituents of the leaves of Cnidoscolous aconitifolius. Am. J. Fd. Sci. Nutri. Res. 1 (2): 8-12.

[18] Arowosegbe S., Oyeyemi S. D. and Alo O. (2015). Investigation on the medical and nutritional potentials of some vegetables consumed in Ekiti State, Nigeria. Int. Res. J. Natural Sciences 3 (1): 16-30.

[19] Mohd A. M., Idris M. B. and Abdulrasheed A. (2016). The mineral composition and proximate analysis of T. occidentalis (Fluted Pumpkin) leaves consumed in Kano metropolis, northern Nigeria. Am. Chem. Sci. J. 10 (1): 1-4.

[20] AOAC. (2002). Official Methods of Analysis. 16th ed. Association of Official Analytical Chemists, Washington DC.

[21] FAO. (2002). Food energy: methods of analysis and conversion factors. FAO Ed., Rome.

[22] Ajala Lola (2009). The effects of boiling on the nutrients and anti–nutrients in two nonconventional vegetables. Pak. J. Nutrition 8 (9): 1430-1433.

[23] Dairo F. A. S. and Adanlawo I. G. (2007). Nutritional quality of Crassocephalum crepidioides and Senecio biafrae. Pak. J. Nutrition 2007. 6 (1): 35-39.

[24] Acho C. F., Zoue L. T., Akpa E. E., Yapo V. G. and Niamke S. L. (2014). Leafy vegetables consumed in Southern Cóte d'Ivoire: a source of high value nutrients. J. Animal & Plant Sciences 20 (3): 3159-3170.

[25] Adeleke R. O. and Abiodun O. A. (2010). Chemical composition of three traditional vegetables in Nigeria. Pak. J. Nutrition 9 (9): 858-860.

[26] Iheanacho K. and Ubebani A. C. (2009). Nutritional composition of some leafy vegetables consumed in Imo State, Nigeria. J. Appl. Sci. Environ. Manage. 13 (3): 35-38.

[27] Omale J. and Ugwu C. E. (2011). Comparative studies on the protein and mineral composition of some selected Nigerian vegetables. Afri. J. Fd. Sci. 5 (1): 22-25.

[28] Isa F. O,. Adesala S. O. and Ojo F. A. (2006). Effect of maturity on the nutritional composition of selected green leafy vegetables. Proceedings of the 30th Annual Conference of Nigerian Institute of Food Science and Technology, ASCON. Conference Centre, Badagry, Nigeria.

[29] Brosnan J. (2003). Inter-organ amino acid transport and its regulation. J. of Nutrition 133: 2068-2072.

[30] Mensah J. K., Okoli R. I., Ohaju-Obodo J. O. and Eifediyi K. (2008). Phytochemical, nutritional and medical properties of some leafy vegetables consumed by Edo people of Nigeria. African J. Biotech. 7 (14): 2304-2309.

[31] Akpanyung E. O. (2005). Proximate and mineral composition of bouillon cubes produced in Nigeria. Pak. J. Nutrition 4: 142-149.

[32] FNB. (2001). Food and Nutrition Board. Institute of Medicine. Dietary Reference Intakes for vitamins A & K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium and zinc. Washington D. C. National Academy of Science.

[33] Idoko O., Emmanuel S. A., Aguzue O. C., Akanji F. T., Thomas S. A. and Osuagwu I. (2014). Phytochemical screening, proximate analysis and mineral composition of some leafy vegetables consumed in Nigeria. Int. J. Adv. Chem. 2 (2): 175-177.

[34] Odhav B., Beekrum S., Akula U. and Baijnath H. (2007). Preliminary assessment of nutritional values of traditional leafy vegetables in Kwazulu-Natal, South Africa. J. Food Composition & Analysis 20: 430-435.

[35] Glew R. S., Amoako-Atta B., Ankara-Brewoo G., Presly J., Chuang L., Millson M. and Smith R. (2009). Non-cultivated plant foods in West Africa: Nutritional analysis of the leaves of three indigenous leafy vegetables in Ghana. Food 3: 39-42.

[36] Umar K. J., Hassan L. G., Dangogo S. M., Maigandi S. A. and Sani N. A. (2001). Nutritional and anti-nutritional profile of spiny amaranthus (Amaranthus viridis Linn). Studia Universitatis "Vasile Goldis", Sevia Stintele Vietii. 21 (4): 727-737.

[37] FAO/WHO. (2002). Report of a joint FAO/WHO Expert Consultation on human vitamin and mineral requiments. Expert Consultation, Bankok, Thailand.

[38] Chaturvedi V. C., Shrivastava R. and Upreti R. K. (2004). Viral infections and trace elements: A complex trace element. Current Science 87: 1536-1554.

[39] Trowbridge F. and Martorell M. (2002). Forging effective strategies to combat iron deficiency. Summary and recommendations. J. Nutri. 84: 875-880.

[40] Radwan M. A. and Salama A. K. (2006). Market basket survey for some heavy metals in Egyptian fruits and vegetables. Food Chem. Toxicol. 44: 1273-1278.

[41] Sobukola O. P., Adeniran O. M., Odedairo A. A. and Kajihausa O. E. (2010). Heavy metal levels of some fruits and vegetables from selected markets in Lagos, Nigeria. Afri. J. Food Sci. 4 (2): 389-393.

[42] Ujowundu C. O., Kalu F. N., Nwosunjoku E. C., Nwaoguikpe R. N. and Okechukwu R. I. (2011). Iodine and inorganic mineral contents of some vegetables, spices and grains consumed in Southeastern Nigeria. Afri. J. Biochem. Res. 5 (2): 57-64.

[43] Hussain J., Rehman N. U., Khan A. L., Hussain H., Al-Harrasi A., Ali L., Sami F. and Shinwari Z. K. (2011). Determination of macro and micronutrients and nutritional prospects of six vegetable species of Mardan, Pakistan. Pak. J. Bot. 43 (6): 2829-2833.

[44] Hashmi D. R., Ismail S. and Shaikh G. H. (2007). Assessment of the level of trace metals in commonly consumed edible vegetables locally available in the markets of Karachi city. Pak. J. Bot. 39 (3): 747-751.

[45] Ismail F., Anjum M. R., Mamon A. N. and Kazi T. G. (2011). Trace metal contents of vegetables and fruits of Hyderabad retail market. Pak. J. Nutri. 10 (4): 365-372.

[46] Barminas J. T., Charles M. and Emmanuel D. (1998). Mineral composition of non-conventional leafy vegetables. Plant Foods for Human Nutrition 53: 29-36.