The Effect of Boiling on the Elemental Composition and Proximate Composition of Some Green Leafy Vegetables in Nigeria

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ABSTRACT

Ten different leafy vegetables (Adansonia digitata, Amaranthus hybridus, Arachis hypogaea, Cassia tora, Linn ceiba, Curcubita pepo, Hibiscus cannabinus, Hibiscus sabdarrifa, Manihot utilisima and Vernonia amygdalina) were obtained from farmers and were analyzed for the presence of Na, Co, Zn, Fe, Cu, Ca and Mn, using Atomic Absorption Spectrophotometer. The proximate composition was determined using standard methods. The results of the analysis showed that, for the mineral composition, highest concentration was recorded in Ca in the range of 14.57 mg/kg to 29.17 mg/kg in all the samples analyzed, while Cu, was found to be the least with concentration range of 1.14 mg/kg to 2.62 mg/kg, Co was not detected in the samples with the exception of Adansonia digitata (Dry/Raw). Comparing the mineral contents obtained in this research work with the recommended dietary allowance (RDAs) values, the results indicate that the vegetables could be good supplements for most of the elements analyzed. Data obtained for the proximate composition showed the range of moisture content of the samples from 9.90 % to 15.50 %, Ash content from 5.80 % to 10.30 % protein content from 15.10 % to 17.70 % fat content from 0.60 % to 2.30 % and fibre content from 21.00 % to 28.70 %. Thus the effect of boiling on the elemental composition and proximate composition of the leafy vegetable samples is negligible. Based on these findings, the leafy vegetables could be used as alternatives to the elements found in them, and could be used as a very good source of nutrient.

Keywords: Boiling, Elemental Composition, Proximate Composition and Leafy Vegetables.

INTRODUCTION

Vegetables are the edible parts of plant that are consumed wholly or in parts, raw or cooked as part of main dish or salad. A vegetable includes leaves, stems, roots, flowers, seeds, fruits, bulb and tubers [1,2,3,4,5,6]. Green leafy vegetables occupy an important place among the food crops as they provide adequate amount of many vitamins and minerals for humans [7,8]. They are rich sources of oil, carbohydrates, carotene, ascorbic acid, riboflavin, retinol, folic acid and minerals like calcium, iron, zinc, magnesium, manganese and selenium depending on the vegetable consumed [9,10]. [11], reported that vegetable fats and oil lower blood lipids thereby reducing occurrences of disease associated with damage of coronary artery. Green leafy vegetables constitute an indispensable constituent of human diet in Africa generally and West Africa in particular [12]. Apart from the variety which they add to the menu [13,14] they are valuable sources of nutrients especially in rural areas where they contribute substantially to protein, mineral, vitamin, fibers and other nutrients which are usually in short supply in daily diets [15]. Generally they are consumed as cooked complements to the major staples like cassava, cocoyam, guinea corn, maize, millet, rice and plantain. Indeed most of the meals based on these staples are considered incomplete without a generous serving of cooked green leafy vegetables [16,17,18]. Vegetables are important protective foods and highly beneficial for the maintenance of health and prevention of diseases and also reinforce the resisting ability of the cells to counter bacterial infections due to the fact that they contain valuable food ingredient which is utilized to build and repair the body, the variety of

green vegetables so utilized are diverse [19,20].

In many cultures, conventional green vegetables such as cabbage or spinach are not green at all; leaves of other crops coupled with the use of wild vegetables provide an ample leafy content to the diet. The leaves of sweet potatoes, cassava, melons and some beans are all used as vegetables in some parts of the world [21,22,23]. In some areas in Nigeria, leaves of baobab tree and in Philippines, leaves of papaya and cashew nut trees are cooked and eaten as green vegetables providing considerable amounts of leaf protein. Two important dietary minerals calcium and iron found in vegetables are especially useful [24]. Calcium is essential for strong bones and teeth, while iron is needed for blood formation and essential constituent of hemoglobin. Many vegetables contain vitamin A which is essential for normal growth, vitality, good eye sight, healthy skin and protection against diseases [25,26,27]. By adding vegetables to a diet consisting only of cereals and beans, the quality of the proteins and it's utilization by the body was improved so much that it was almost equivalent to the best animal protein such as contained in milk [28,29,30]. Green leafy vegetables when freshly harvested are consumed immediately because some of their vitamin contents deteriorate on storage [31,32,33,34]. Vitamins and dietary minerals contained in vegetables can be destroyed or lost through unsuitable cooking methods and therefore, cooking time should be as brief as possible. Vegetables have high moisture content from 72% in cassava leaves to 92% in Indian spinach and water leaves [35,36,37]. They also contain cellulose and serve as useful roughage thus promoting normal elimination of waste product. Although leafy vegetables are not good sources of dietary energy because of their high moisture contents they are however rich in dietary minerals and vitamins. Among the nutrients, vegetables may be anti-oxidant, anti-bacterial, anti-fungal, anti-viral and anti-carcinogenic [38,39,40]. It has been estimated that perhaps (60) species of green leaf y plants are so used in Nigeria [41,42,43]. Some like baobab tree are restricted in their distribution while amaranth, are common in all areas of the country. There is also a seasonal variation in the availability of these vegetables, they grow abundantly during the rainy season and are scarce in the dry season except in some areas where dr y season farming by irrigation is practiced. Studies by [44] estimated per capital daily consumption of fresh vegetables in Nigeria to be 65g while another survey [45] showed consumption to be as high as 360g per day. The search for lesser known crops, many of which are potentially valuable as human and animal feeds has been intensified to maintain a balance between population growth and agricultural productivity in the tropical and subtropical areas of the world [46] *This has generated considerable interest by recent studies on the chemical* composition and nutritional value of lesser known plants in Nigeria. Furthermore, survey of diet related illness like kwashiorkor and protein-calorie malnutrition are attributed to shortage of protein which is readily available in vegetables like peas and beans. The fight against malnutrition and under nourishment continues to be a basic goal of development and variety of strategies are being applied. The strategy based on nutrient-rich food like vegetables is considered essential [14]. This is because most leafy vegetables particularly the dark green variety contain pro-vitamin A as do carrots, sweet peppers and some tomatoes, they also supply vitamin C and in many cases iron and calcium as well to the diet.

Aim of the Study

The aim of this study research was to assess and compare the effect of Boiling on the Elemental Composition and Proximate Composition of Some Green Leafy Vegetables in Niger.

MATERIALS AND METHODS
Atomic absorption spectroscopy

AAS is a spectro-analytical procedure for the quantitative determination of

chemical elements using the absorption of optical radiation (light) by free atoms in the gaseous state.

Principle

The technique makes use of absorption spectrometry to assess the concentration of an analyte in a sample, it requires standards with known analyte content to establish the relation between the measured absorbance and the analyte concentration and relies therefore on the Beer- Lambert law.In short, the electrons of the atoms in the atomizer can be promoted to higher orbitals (excited state) for a short period of time (nanoseconds) by absorbing a defined quantity of energy (radiation of a given wavelength). This amount of energy, i.e. wave length, is specific to a particular election transition in a particular element. In general, each wave length corresponds to only one element, and the width of an absorption line is only of the order of a few picometers (pm), which gives the technique its elemental selectivity. The radiation flux without a sample and with a sample in the atomizer is measured using a detector and the ratio between the two values (the absorbance) is converted to analyte concentration or mass using the Beer- Lambert Law.

Sampling and Sample Treatment

Ten types of indigenous leaf y vegetables that are widely used in soup preparation in Nigeria. (Adansonia digitata, Arachis hypogaea, Cassia tora, Linn ceiba, Curcubita pepo, Hibiscus cannabinus, Hibiscus sabdarrifa, Manihot utilisima, Amaranthus hybridus and Vernonia amygdalina) was procured from farmers, samples were young and tender at harvest, each of the samples was destalked as practiced locally, washed with tap water, Half of each of the vegetables was chopped, this was labeled as the raw sample. The other half of each of the vegetables was chopped, two litres of clean water was put inside a pot and boiled at the temperature of 100 0c and 500 g of the chopped vegetables was placed inside the boiling water and allowed to boil for 15 minutes. This was labeled as the boiled sample. Both raw and boiled samples were each air dried separately for some days. The samples were ground into fine powder using stainless steel mortar and pestle, sealed in transparent polythene bags and labeled appropriately for analysis.

Proximate Analysis

Samples were analyzed chemically for moisture, ash, crude fibre, crude protein; crude fat content according to the official methods of analysis described by the Association of Official Analytical Chemist [8]. All analysis was carried out in triplicate.

Analysis of Minerals

The Na, Fe, Zn, Cu, Co, Mn and Ca was determined using the method described by (Onwuka, 2005). 3.0 g of the raw and boiled powdered samples was weighed and pretreated separately with 20 ml concentrated nitric acid and allowed to stay overnight. 10 ml per-chloric acid was added and heated gently, then vigorously until clear solution is obtained. The solution was allowed to cool and then transferred to a 100 ml volumetric flask and made up to mark with distilled water [40]. The solutions was then filtered and stored in plastic bottles for the determination of Zn, Ca, Co, Fe, Mn, K and Na using Atomic absorption spectrophotometr y with cathode lamps that match the different elements. Calibration curves were constructed for each element using standard solution by plotting absorbance versus concentration. By extrapolation, the concentrations of the metals in sample digests were obtained.

Data Analysis

Data was statistically analyzed by a one way analysis of variance (ANOVA) using SPSS/Pc + Package. Differences between means were compared by the use of

Duncan's multiple ranges set. Significance was accepted at a p-value of less than 0.05

(p<0.05).

RESULTS AND DISCUSSION

The potential of a particular food is determined by its nutrient composition. Green leafy vegetables are known to add taste and flavour, as well as substantial amounts of protein, fibre, minerals and vitamins to the diet [30,32]. [13,15,18] reported that leafy vegetables are generally good sources of nutrients and highly beneficial for the maintenance of good health and prevention of diseases. They further opined that leafy vegetables are rich in carotene, ascorbic acid, riboflavin, folic acid and minerals like calcium, iron and phosphorus.

Proximate Composition of the Samples

The results obtained in this study research shows a close agreement with those found in literatures of [19] some of the difference in the percentage composition might be linked to factors like nature of soil, species, application of natural or artificial manure, growing conditions, sample treatment conditions and the period of the analysis. The moisture content of the samples ranged from 9.90 % to 15.50 % with Manihot utilisima (Dr y/Raw) having the highest percentage of 15.50 % while Cassia tora (Dry/Boiled) has the lowest percentage of 9.90 %. These values though higher than most conventional leafy vegetables are close to the lower end of the range expected for dry leafy vegetables 15-30 % [11,30]. The proportion of ash content is a reflection of the mineral contents preserved in food materials [25]. The ash content ranged f rom 5.80 % to 10.30 % where Arachis hypogaea both the (Dry/Raw) and (Dry/Boiled) has a high percentage of 10.30 % Ash content and Curcubita pepo (Dry/Boiled) has a low percentage of 5.80 % Ash content. The observed crude protein content was between 15.10 % in Hibiscus sabdariffa (Dry/Raw) and 17.70 % in Linn ceiba (Dry/Raw). [25,28] stated that any plant food that provide about 12% of their calorific value from protein are considered good source of protein, therefore, all the vegetables in figure 2 meet this requirement. The value of the crude fat for the vegetable samples in figure 2 are low (varying from 0.60 % in Amaranthus hypbridus (Dry/Boiled) to 2.30 % in Adansonia digitata both (Dry/Raw) and (Dry/Boiled) and Linn ceiba (Dry/Raw) when compared with reported values (8.3 % to 27.0 %) in some vegetables consumed in Nigeria and republic of Niger (Sena et al., 1998). This agrees with the findings that leafy vegetables are low lipid containing foods, and this may be an advantage f or people suffering from obesity (Lintas 1992). Dietary fats function in the increase of palatability of food by absorbing and retaining flavours (Antia et al., 2006). A diet providing 1-2 % of its caloric of energy as fat is said to be sufficient to human beings. Excess consumption of fat has been implicated in certain cardiovascular disorders such as cancer, atherosclerosis and aging [15]. Therefore, leafy vegetable diet should be encouraged to reduce the risk of the above diseases in man.

The crude fibre content recorded in figure 2 ranges from 21.00 % in Amaranthus hybridus (Dry/Boiled) to 28.70 % in Hibiscus canabinus (Dr y/Raw). Agostoni et al., (1995) reported that non-starchy vegetables are the richest sources of dietary fibre. Crude fibre is the part of food that is not digested by human beings but the normal functioning of the intestinal tract depends upon the presence of adequate fibre. It increases stool bulk and decreases the time that waste materials spend in the gastro intestinal tract. Fibre helps in the maintenance of human health and has been known to reduce cholesterol level in the body [13]. A low fibre diet has been associated with heart disease, cancer of the colon and rectum, obesity, diabetes, appendicitis and constipation. Therefore the vegetable samples could be recommended as crude fibre source in the diet as a result of their high crude fibre content.
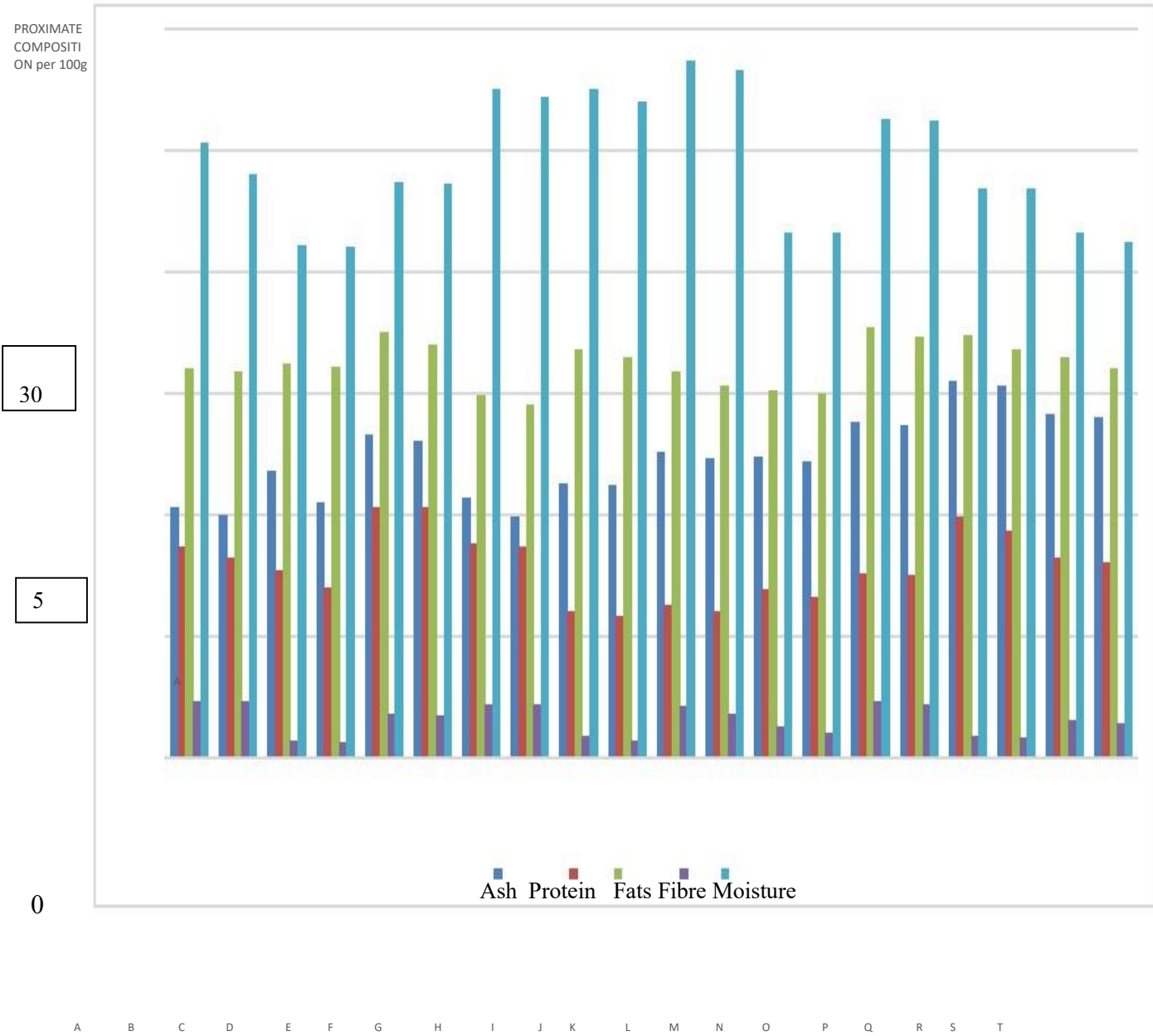
PROXIMATE
COMPOSITI
ON per 100g

Figure 1: Proximate Compositions of the Samples (per 100g)

Mineral Content of the Samples

Among the factors influencing the mineral composition of green leafy vegetables, soil fertility or type and quality of fertilizer used, is the most important [11]. This is probably the reason for the wide variations observed in some of the published data for leafy vegetables. In a study of twelve (12) Nigerian vegetables, [14] for example found that the total iron contents differed significantly ranging from 29.4 mg/kg to 92.6 mg/kg. Most of the early studies [11] have shown that Nigerian leafy vegetables contain appreciable amounts of minerals. Figure 3 shows the mineral composition of some green leaf y vegetables in Nigeria. Sodium varies from 4.79 mg/kg in Linn ceiba (Dry/Bioled) to 8.08 mg/kg in Adansonia digitata (Dry/Raw). The recommended daily intake of sodium is 100 mg/day; it is involved in the regulation of plasma volume, acid-base balance, nerve and muscle contraction [7]. Cobalt was detected in Adansonia digitata (Dry/Raw) with 0.59 mg/kg. Cobalt is an integral part of vitamin B12, cobalamin, which supports red blood cells production and the formation of myelin nerve coverings. It is used to prevent anemia, vitamin B12 is also beneficial in some cases of fatique, digestive disorders and neuro muscular problems. Zinc is an essential micronutrient for human growth and immune functions [10]. An estimated 20 % of the world population is reported to be at risk of inadequate zinc intake [15]. Studies on Nigerians, shows that zinc deficiency affects 20 % of children less than five years, 28.1 % of mothers and 43.9 % of pregnant women (Dioxin et al., 2004). In the samples studied, zinc varied from 0.97 mg/kg to 6.12 mg/kg with Arachis hypogaea (Dry/Raw) having the highest (6.12 mg/kg) and Hibiscus sabdariffa (Dry/Boiled) has the lowest (0.97 mg/kg). Zinc is very useful in protein synthesis, cellular differentiation and replication,

immunity and sexual functions [8]. Iron levels in the samples ranged from 11.81 mg/kg in cassia tora (Dr y/Boiled) to 33.07 mg/kg in Curcubita pepo (Dry/Raw). Iron is important in the diet of both pregnantand lactating mothers as well as infants and the elderly [3] its dietary deficiency which is associated with low blood level called anemia, characterized by weakness and dizziness [16]. These deficiencies can be prevented by regular consumption (100 g/day) of these vegetables in diets, since the tolerable upper intake level for adults is 0.04 g/day [8]. Copper levels in the samples ranged from 1.14 mg/kg in Linn ceiba (Dry/Boiled) to 2.62 mg/kg in Adansonia digitata (Dry/Raw). Copper is an essential component of many enzymes including the antioxidant enzyme, super oxide dismutase which protects the body against harmful effects of free radicals [8]. Calcium is a major factor in sustaining strong bones and plays a part in muscle contraction and relaxation, blood clotting, synaptic transmission and absorption of vitamin B12. Calcium levels in the samples ranged from 14.57 mg/kg in Vernonia amygdalina (Dry/Boiled) to 29.17 mg/kg in Curcubita pepo (Dry/Raw). The relatively high content of calcium in the vegetable samples suggests that, it may be of therapeutic value in hypo calcaemic state like osteoporosis. Manganese content in the vegetable samples ranged f rom 2.48 mg/kg in Linn ceiba (Dry/Boiled) and Arachis hypogaea (Dr y/Boiled) to 8.44 mg/kg in Manihot utilisima (Dry/Raw). A diet rich in these vegetables therefore will help keep the bone strong and healthy, protect the cells from free radical damage and also prevent the adverse eff ect of manganese deficiency which results in paralysis of infants, convulsions, loss of hair colour and bones and low cholesterol level [11].
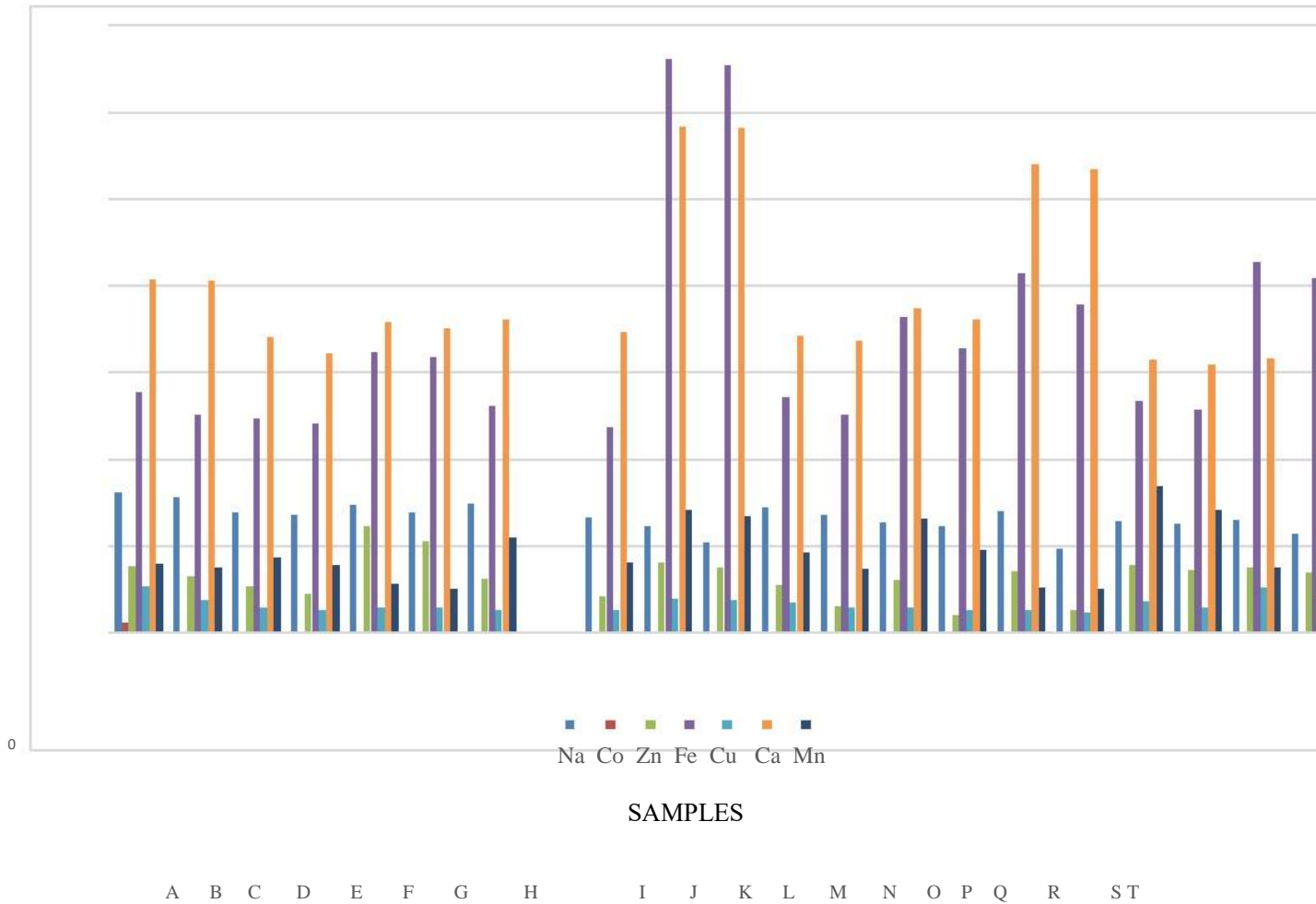
Figure 2: Mineral Content of the Sample (mg/kg)

Summary

The results from this research show that, green leafy vegetables are nutrition goods that provide sufficient amount of nutrients needed for normal body function, maintenance and reproduction. It was found that nutrient compositions in all vegetable samples were different. It has shown from the proximate analysis, the vegetable samples are poor sources of fat that makes them good food for obese people, good source of fibre and can decrease the concentration of high cholesterol level in the body. The vegetables also contained good minerals with abundance of them in sodium, zinc, iron, copper, calcium and manganese. The result suggests that the vegetables if consumed in sufficient amount would contribute greatly towards meeting human nutrition requirement for normal growth and adequate protection against diseases arising from malnutrition.

CONCLUSION

It can be concluded according to findings in this research work that the vegetables analyzed are good sources of the minerals, the effect of boiling on the elemental composition is negligible. Thus the leafy vegetables could be used as a source of minerals.

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