GSJ: Volume 8, Issue 7, July 2020, Online: ISSN 2320-9186
www.globalscientificjournal.com

Analyses of Mineral Elements in Some Plant Tissues obtained from Yankaba and Janguza Markets of Kano Metropolis, Nigeria

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Abstract

Mineral elements are elements in form of minerals salts required by plants for normal growth and development and their deficiency can easily manifest on plants. Twenty (20) different samples of plant tissue from Yankaba and Janguza markets of Kano State were analyzed for the level of Cu, Fe, Zn, Mn, Ca, Mg, K and Na. These elements are grouped into heavy metal (Cu, Fe, Zn, Mn) and light metals (Ca, Mg, K, Na) that affect the well being of plants and animals at high concentrations. Based on persistent nature and cumulative behaviour of these elements, there is need to test and analyze food items to ensure that the level of these elements meet international stanards. This is particularly important for farmers in West Africa where only limited data are available. The level of Cu, Fe, Mg, Zn,Ca and Mn were determined by atomic absorption spectroscopy while that of K and Na were determined by flame photometric method. Samples from Yankaba market indicated highest mean levels of Cu (0.100mg/g), Fe (0.230mg/g), Zn (0.088mg/g), Mn (0.085m/g), Ca (2.661mg/g), Mg (1.660mg/g), K (1.06mg/g) and Na (2.302mg/g). While those from Janguza market indicated highest levels of Cu (0.820mg/g), Fe (0.082mg/g), Zn (0.044mg/g), Mn (0.040mg/g), Ca (1.725mg/g), Mg (0.467mg/g), K (0.286mg/g) and Na (1.385mg/g). Comparison of the results obtained from the two markets showed that the mean concentration of the mineral elements of plants tissues obtained from Yankaba markets were generally lower than that of Janguza market.

Key Words: Mineral Elements, plant tissue, Kano, Market.

1. Introduction

Plants have great importance due to their nutritive value and continue to be a major source of nutrients to man as they have been found throughout human history [1]. All human beings require complex organic compounds as added caloric requirements for their muscular activities such as carbohydrates, fats and protein. Minerals and vitamins from a smaller part of plant materials form major portion of the diet and their nutritive value is important [2]. The human body comprises of chemical compounds such as water, protein, fatty acids, nuclei acid and carbohydrates. These in turn consist of elements such as carbon, hydrogen, oxygen, nitrogen and phosphorous and may or may not contain mineral such as calcium, iron, magnesium and zinc [3].

Essential element is any of a number of elements required by living organisms to ensure normal growth, development and maintenance. There are three criteria for determining whether or not an element is essential. These includes direct involvement on the organism metabolism, inability of the organism to grow complete in its life cycle without adequate supply of the element, and the element cannot be-replaced by any other [4]. Essential elements are elements whose lack gives rise to deficiency problems in plants and animals [3].

Food plants that tolerate high concentration of potentially hazardous elements (Phyto-accumulation) create greater health risk to their consumers than those that are more sensitive. In general, food plants are sensitive to Cu and Zn than to Pb and Cd. Excessive uptake of both essential (e.g. Cu and Zn) and non-essential (e.g. Pb and Cd) metals may result in an adverse effect on soil biota [3]. Based on persistent nature and cumulative behaviour of elements, there is need to test and analyze these food items to ensure that the level of these elements meet international stanard. This is particularly important for farmers in West Africa where only limited data are available [4].

Mineral elements are required in quantities by plants and their deficiency can easily manifest on the plants as stumped growth, coloration, rolling etc [5]. The soil contains most of the elements in various concentrations; some of the elements such as oxygen, aluminum, iron, calcium and sodium are present in large amounts; while many others such as silver, selenium and molybdenum are present in trace amounts.

These elements form an important part of plants and affect their physiology in various ways. Absorbed by the plants, they undergo many complex changes. Some of them such as nitrogen, phosphorus and sulphur are consumed in building up the plant body. Some other elements, such as calcium, phosphorus and magnesium have both tissue building and metabolic functions in plant life. Nonetheless, all these elements play important roles in both the vegetative as well as the reproductive growth and are indispensable for production of foliage, fruits and seeds.

The importance of mineral elements in human, animal and plant nutrients has been well recognized [6]. Deficiency or disturbances in the nutrition of all animals cause a variety of diseases and can arise in several ways [7]. When a mineral element is deficient, a characteristic syndrome is produced which reflects the specific functions of the nutrient in the metabolism and tissue structure. To assess the dietary intake and adequacy of minerals, information needs to be collected on mineral elements content of foods [8]. There is limited information on the mineral element content of numerous plant foods consumed in some less developed countries. Grazing livestock from tropical countries often do not receive mineral supplementation except for common salt and must depend almost exclusively upon forage for the mineral requirements [9]. Mineral deficiencies or imbalances in soils and forages account partly for low animal production and reproductive problems. Soil acidity and seasons are further factors affecting mineral uptake by plants.

Plants use mineral elements as structural components in carbohydrates and proteins; organic molecules in metabolism, such as magnesium in chlorophyll and phosphorus in ATP, enzyme activators like potassium, and for maintaining osmotic balance. Calcium is highly implicated in the maintenance of firmness of fruits [10] and its requirements in fruits are related to cell wall stability and membrane integrity. Mineral elements play important roles in health and disease states of humans and domestic animals. For example, iron deficiency aneamia and goiter due to iodine deficiency are reported to be problems of public health importance in some communities. Trace elements of significance to people with HIV are zinc and selenium. Selenium is an antioxidant that increases immune system function and lower calcium levels in HIV positive men [11].

Several factors directly or indirectly influence the levels of minerals in plants and hence the amounts available for humans and animals that depend on plants for foods and feed respectively. The amount of a particular nutrient in the diet may be insufficient to meet the requirements. However, the metabolism of the animal may be affecet by the interaction of dietary environmental and genetic factors [7].

Location has been reported to influence the mineral element compositions of rice, wheat, oats and barley [11] and these are mainly attributed to the altered soil conditions. The nature and chemical composition of the soil are also involved in the location differences observed in the mineral elements present in grain sorgum. Feeds grown on high selemium soils are good sources of selenium and may be used in ration formulation for poultry in order to supply a source of selenium. Uptake of copper, zinc and manganese by plants is affected by the level of phosphate fertilizer has been reported to affect the uptake of copper [11]. Environmental factors such as location rather than genotype is reported to have greater influence on the mineral and trace element composition of sorghum grain. Cobalt, copper, iodine and selenium deficiencies in the soil and flora in certain areas of the world have led to deficiencies of these minerals in domestic animals [12]. Also, the increment of selenium in the soil may lead to high levels in plants which are toxic to animals. Nutritional disorders involving the mineral elements may arise as simple deficiencies or excess of particular elements but the extent to which the other organic or inorganic nutrients are present in the diets will determine the deficiencies or toxicities. The conditioning factors may be a reflection of the soils on which the plants are grown, or they may be related to the presence of specific plants that are seleiferous or goitogenic [12]. Mineral deficiencies or imbalances in soils forages have been implicated, in part, for low animal production, and poor reproductive performance in the developing regions of the world [13].

Anti-nutritional factors (ANF) present in plants could also affect the absorption and availability of some minerals by humans and animals. Anti-nutritional factors reduce the nutrient utilization and or food intake of plant foods. The need for adequate processing to reduce the anti-nutritional factors in plants used as human foods and animal feeds have been reviewed. The levels of these substances in plants vary with specie of plant, cultivar and post-harvest treatment. Examples of ANF which could reduce the bioavailability of minerals are oxalates and phytates. Oxalalic acid, like phytic acid, has the ability to bind some divalent metals such as calcium and magnesium thereby interfering with their metabolism [11]. Chelates bind many elements making them nutritionally unavailable, thereby inducing dietary deficiencies [14]. Zinc may compete with calcium-phytate and lead to inefficient utilization of dietary zinc. Phytic acid reduces the absorption of calcium from the gastro-intestinal tract and consequently implicated in the development of rickets when chicks are fed with cereals such as sorghum [14]. Zinc and iron deficiency symptoms have been reported in man and chicken disease when fed with diets high in phytic acid. There is a significant inverse relationship between phytic acid content and the availability of calcium, magnesium, phosphorus and zinc in products like soya bean, palm kernel, rapeseed and cotton seed meals (11).

This study is an attempt to determine and compare the concentrations of selected mineral elements in some plant tissues obtained from two markets within Kano metropolis. This is important to obtain data and imformation on plants consumed by the people around and outside the market to ensure healthy life and to advice farmers on good farm practices.

2.0 MATERIALS AND METHODS

Analytical reagent grade chemicals and de-ionized water were used throughout the study. All glassware and plastic containers were washed with detergent solution followed by soaking in 20% (v/v) nitric acid and rinsed with tap water and finally with de-ionized water.

2.1 Sample Collection

Samples were obtained from Yankaba and Janguza markets of Kano State, Nigeria. Kano, the most densily populated area in Nigeria with a population of about 10 million according to 2006 National Population Census report. These markets were selected because of their strategic position in Kano, volumes of farm produce and the high number of patronizers that invade the markets on daily basis. To ensure goog representative samples as a result of the large volume of farm produce brought to the the two markets, twenty (20) samples representing different crops (Table 1) were analyzed for their total content of several mineral elements. The crops samples from the two markets were brought by the farmers from different areas around the state. Kano is the commercial nerve centre of Northern Nigerial where numerous economic and industrial activities take place on a daily basis.

2.2 Sample and Treatment

In the laboratory, each sample (1kg) was washed with tap water and thereafter with de-ionized water and then dried in an oven at 80°C for 5 days, and ground in an all-steel Wiley mill to pass a 50-mesh stainless steel sieve. The ground material was re-dried to constant weight before weighing 0.5g of each sample for analysis

2.3 Procedure for Extraction of Samples

Sample extraction was done according to a method reported by Indrayan *et al* [1]. A 0.5g each of the samples was weighed out into a wide mouthed 125cm^3 polyethylene bottles fitted with polyethylene lined caps. Each sample was mixed with a 20 % (w/v) trichloroacetic acid solution as extraction solution. Sample was shaken on a reciprocating shaker for 4hr at room temperature. The bottles containing the samples were fitted with polypropylene caps to withstand the pressure and to prevent evaporation. All samples were filtered through Whatman No. 42 filter paper.

2.4 Instrumental Analysis

Sample instrumental analysis was carried out according to tha method reported by Abdulmojeed and Abdulrrahman in [15] because of the accuracy and simplicity of the method. The 20 digested samples each of the plant tissue were analyzed for Cu, Fe, Zn, Mg and Mn, by atomic absorption spectrophotometry (Buck scientific model 210 VGP) while Ca, K and Na by flame emission photometry (Janwey Model PEP7). The actual concentration of the metals in the plant samples were determined from the Calibration curve of each element after diluting the filtrate with a solution containing 1% La and 5% HCl. This is to prevent the formation of stable compounds or complexes which are not easily decomposed when the sample is aspirated into the flame during analyses.

Table 1: Plant Samples Used for the Analyses

S/N	Sid	Sample	Botanical name	Plant part used
1	S1	Hot pepper	*Capsicum frutescens*	shoot
2	S2	Sweet pepper	*Capsicum annum*	shoot
3	S3	Yellow pepper	*Dioscorea caryeruasisi*	root
4	S4	Soya beans	*Gyycine max*	seed
5	S5	Onion	*Alum cepa*	shoot
6	S6	Spinach	*Amaratus caudatus*	leaf
7	S7	Cabbage	*Brassica eguleta*	shoot
8	S8	Okra	*Hibiscus esculentus*	shoot
9	S9	Sweet potato	*Ipomea batatus*	root
10	S10	Carrot	*Darus carota*	shoot
11	S11	Tomato	*Lycopersicon esculentus*	shoot
12	S12	Beans	*Phaseolus vulgari*	seed
13	S13	Groundnut	*Arachis hypogeal*	seed
14	S14	Cassava	*Manihot utilissimi*	root
15	S15	Ginger	*Zingiber officinate*	stem
16	S16	Pumpkin	*Telfeiria eduleser*	leaf
17	S17	Bitter leaf	*Verronia amygdalina*	leaf
18	S18	Melon	*Nectarines papaya*	seed
19	S19	Garden egg	*Solanum melongena*	shoot
20	S20	Peas	*Dacrudes edulis*	seed

S= Sample, Sid = Sample Identification.

3.0 RESULTS AND DISCUSSION

The difference in mineral element contents of some plant samples used from JGM and YKM of Kan Metropolis are shown in table 2. It can be clearly seen that there is a variation between plant sample from JGM and YKM.

3.1 Copper (Cu)

The mean concentration of Cu was generally higher for plants obtained from JGM while that of YKM were generally low (Fig 1). The highest mean concentration of Cu was found to be 0.100 mg/g in spinach (*Amaratus caudate*) from JGM. The concentration of similar plant from YKM was 0.073 mg/g. The lowest concentration of Cu was found to be 0.026 mg/g in soyabeans (*Glycine Max*) from JGM. Similar plants from YKM gave a mean concentration of 0.035mg/g. The concentration of Cu in the plants sample obtained from YKM range from 0.026 mg/g to 0.100 mg in soyabeans and spinach respectively from the same market. The value of 0.0696 mg/g was reported as the mean concentration for spinach from some garden in Kano State

Table 2.0: Difference in mineral contents of some plant samples used from JGM and YKM of Kan Metropolis

S/N	Element	Concentration in present study (JGM) (mg/g)	Concentration in present study (YKM) (mg/g)	Difference in concentration in mg/g	Plant used	Concentration in other studies (mg/g)	Reference
1	Cu	0.100	0.073	0.027	Spinach	0.0696	[15]
2	Fe	0.230	0.010	0.220	Sweet pepper	0.036	[19]
3	Zn	0.088	0.031	0.057	spinach	0.643	[15]
4	Mn	0.850	0.030	0.550	Sweet pepper	0.400	[15]
5	Ca	2.661	0.950	1.711	Soya bean	x	-
6	Mg	1.660	0.233	1.427	spinach	0.600	[18]
7	K	1.060	0.191	0.869	okra	x	-
8	Na	2.302	0.892	1.410	onion	x	-

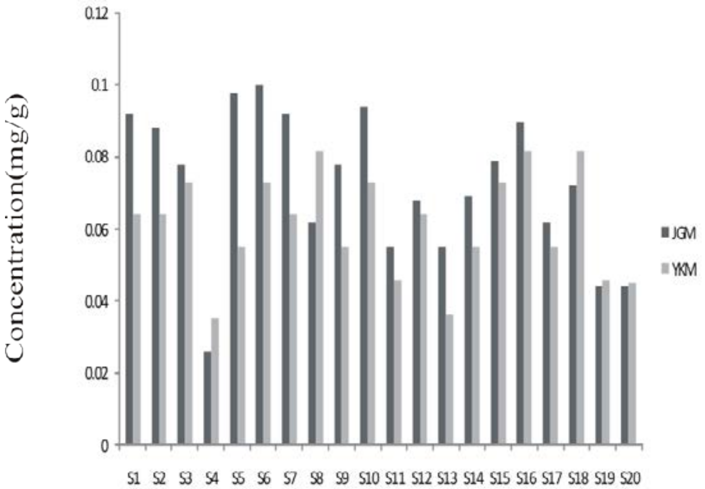
X = no similar sample record found

[15]. These differences in values obtained for Cu may be due to source of water for irrigation, soil composition or rate of element uptake by individual plants. In a study of the response of three vegetables Cu toxicity, it was found that Cu levels in both root and shoot increased, but root Cu concentration increased more sharply than shoot with increasing Cu levels in growth media. Cu mainly accumulates in root while small fraction (10 %) of absorbed Cu was transported to the shoot [16]. Cu concentration in the shoots was significantly influenced by Cu concentration in the soil and increased markedly with an increase in the soil Cu concentration [17].

3.2 Iron (Fe)

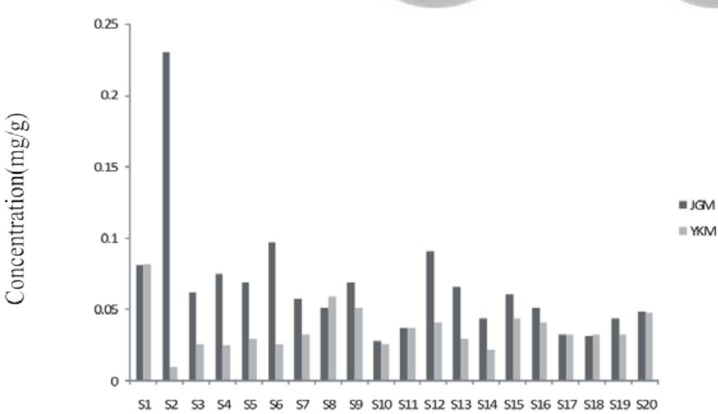
The values obtained for mean concentration of iron are comparatively higher in plants obtained from JGM than that of YKM (Fig 2). The highest concentration was 0.23 mg/g in sweet pepper (*Capsicum anmum*) from JGM and a value of 0.010 mg/g for similar plant from YKM.

The concentration of Fe is exceptionally higher in sweet pepper as a result of high rate of absorption from the soil was.



Crop type

Fig 1: Variation of total mean concentration of Cu in crops from the two markets.



Crop type

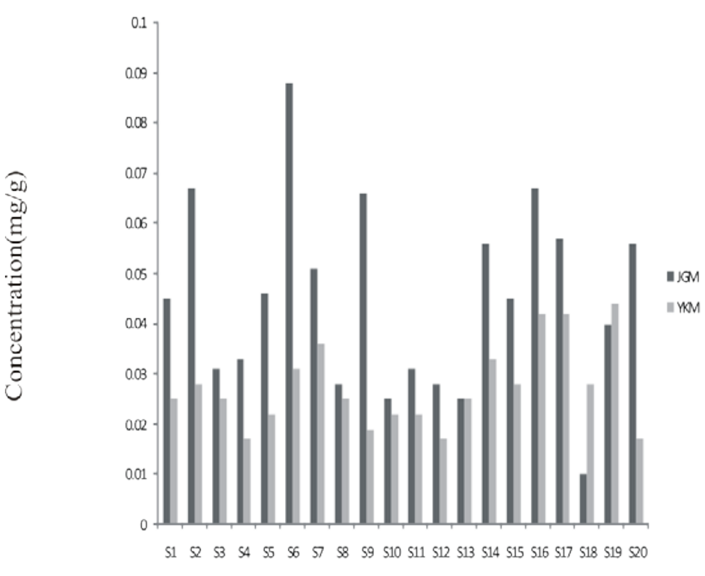
Fig 2: Variation of total mean concentration of Fe in crops from the two markets.

Generally, the mean concentration of Fe from JGM ranges from 0.028 mg/g to 0.230 mg/g in carrot (*Dacus Carato*) and sweet pepper respectively while those of plants from YKM ranges from 0.010 mg/g to 0.082 mg/g in sweet pepper and hot pepper respectively. Available literatures showed that sweet pepper (*Capsicum annum*) and hot pepper (*Casicum frutescens*) obtained from shahire are 0.0356 mg/g for raw food staff [19]. Low intake of iron in animals may cause anemia, tiredness, and pallid physique, while high intake may result into hepatic megaly, cardiac infraction and nephric malfunction. The acceptable limit for consumption of iron is 8 to 11 mg per day for infants as well as adult. Iron has a much higher concentration in sweet paper compared to the other samples possibly as a result of its high concentration on the soil where it was grown. Other factors such as high affinity of iron intake by sweet paper could also contribute to this.

3.3 Zinc (Zn)

The mean concentration of Zn was also found to be generally higher in plants obtained from JGM. It ranges from 0.010 mg/g in melon to 0.088 mg/g in spinach from JGM (Fig. 3). Result published showed that spinach has a mean Zn concentration of 0.643 mg/g [15]. Similarly 0.031 mg/g of Zn was also obtained in this study for spinach from YKM and 0.0280 mg/g for melon from thesame market. Other studies showed that Zn has a concentration between 0.19 to 0.228 mg/g in various food stuffs [19].

These values showed significant differences which may be due to the concentration of the elements in the soils where the plants were cultivated. The maximum tolerable daily intake of Zn is 0.3 to 1 mg/g [20].



Crop type

Fig 3: Variation of total mean concentration of Zn in crops from the two markets.

Zinc deficiency in diet may be more detrimental to human health than too much Zn in the diet. The recommended dietary allowance is 15 mg Zn per day for men and 12 mg Zn per day for women. On the contrary, high concentration of Zn in vegetables may cause vomiting and renal damage. The acceptable limit for human consumption of Zn is 150 mg per day [21].

3.4 Manganese (Mn)

The highest concentration of 0.085 mg/g found in sweet pepper from JGM while that of YKM was 0.030mg/g (Fig 4). A value of 0.015 mg/g was recorded for bitter leaf (*Veronia Amygdalina*) of YKM while that of JGM gave 0.022 mg/g of Mn. Abdulmojeed and Abdulrahman [15] showed that *Veronia Amygdalina* has a concentration of 0.400 mg/g.Various values have been reported previously for leafy vegetable which includes 0.027mg/g Mn *Veronia Amygdalina* [22]. The recommended daily allowance of Mn for humans is 2.5 to 500 mg [20]. The US National Academy of Sciences recommended acceptable limit for manganese is 2.5 to 5 per day [23].

Therefore, the concentrations of Mn in these studied plants were not up to the extent that can likely cause damage to the people consuming them since the concentrations are below daily recommended intake.

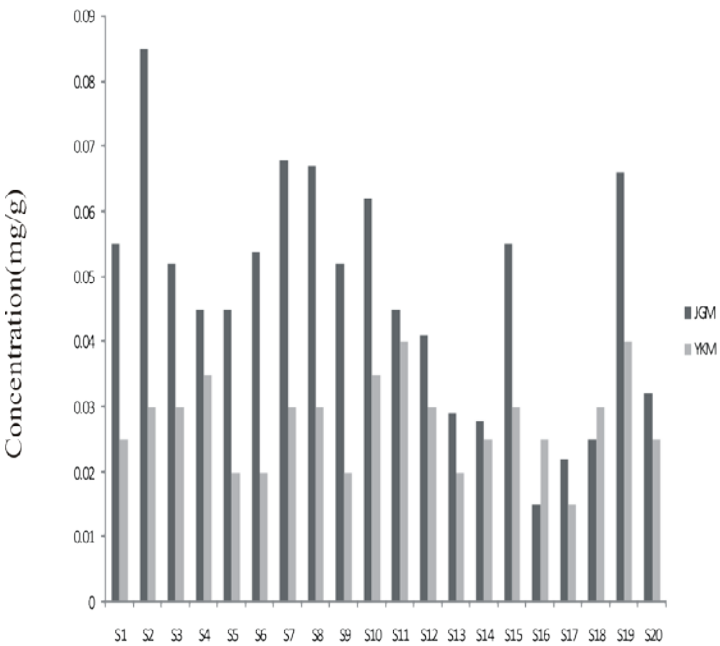
3.5 Calcium (Ca)

The mean concentration of calcium was higher in plants obtained from JGM while plants from YKM showed lower concentration of calcium (Fig 5). Soyabeans from JGM recorded a mean concentration of 2.661mg/g as the highest concentration of calcium while a mean concentration of 0.950 mg/g was recorded for soya beans from YKM. The lowest concentration of 0.08 mg/g calcium was found in peas (*Dacry des Edulis*) from YKM while that of JGM was 0.079 mg/g. These values closely agree with each other. Therefore, the agreement between the values could possibly be as a result of cultivation on similar type of soil or water used as source of irrigation.

3.6 Magnesium (Mg)

Mg was higher in concentration almost all the plants obtained from JGM while plants from YKM showed lower concentration when compared (Fig 6).

A concentration of 1.660 mg/g was recorded for yellow pepper and spinach as the highest concentration of Mg from JGM while similar plants from YKM gave 0.150 mg/g and 0.233 mg/g for yellow pepper and spinach respectively.



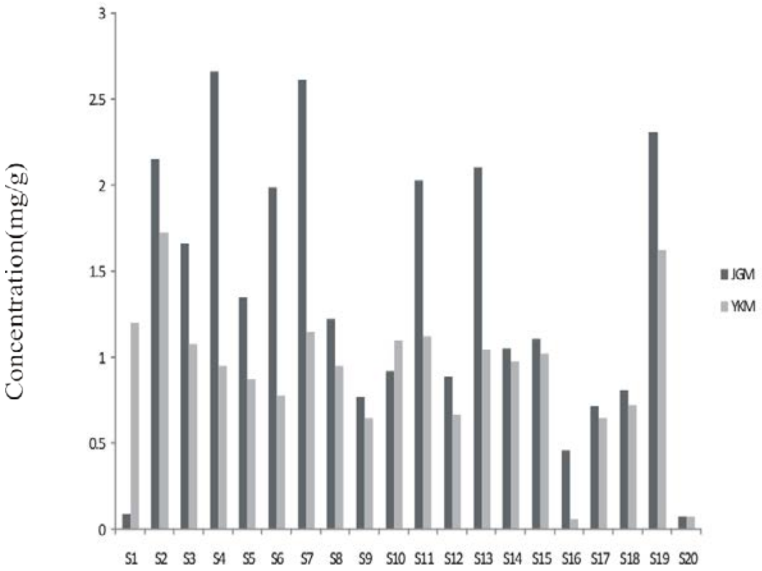
Crop type

Fig 4: Variation of total mean concentration of Mn in crops from the two markets

Generally, the mean concentration of Mg in plants obtained from JGM range from 0.162mg/g to 1.660 mg/g while that of YKM ranges from 0.050 mg/g to 0.467 mg/g. These differences in mean concentration could be due to availability of elements in the soil or rate of nutrient up-take by plants. Since the plants are brought to both markets from different environment. When people do not live up to Mg recommended daily allowance, their health decrease but, when the uptake is too high, health problems also occur [24].

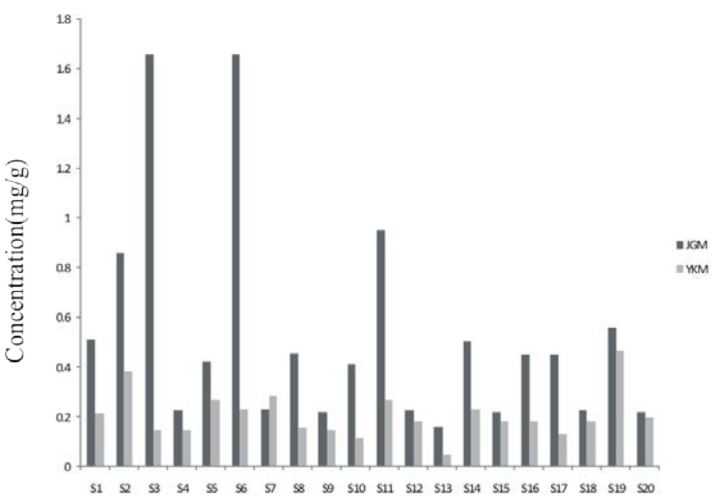
3.7 Potassium (K)

The mean concentrations of K were comparatively higher in plants obtained from JGM while that of YKM showed lower concentrations (Fig 7). The highest concentration was found in Okra which was 1.060 mg/g from JGM. Similar sample from YKM gave a mean concentration of 0.191mg/g. The lowest concentration was found in peas from JGM which was 0.021mg/g. similar sample from YKM has a mean concentration of 0.191mg/g. The mean concentrations of K in plants from JGM ranges from 0.021mg/g to 1.060mg/g in Okra and peas respectively while that of YKM ranges from 0.095mg/g to 0.286mg/g in hot pepper and yellow pepper respectively.



Crop type

Fig 5: Variation of total mean concentration of Ca in crops from the two markets

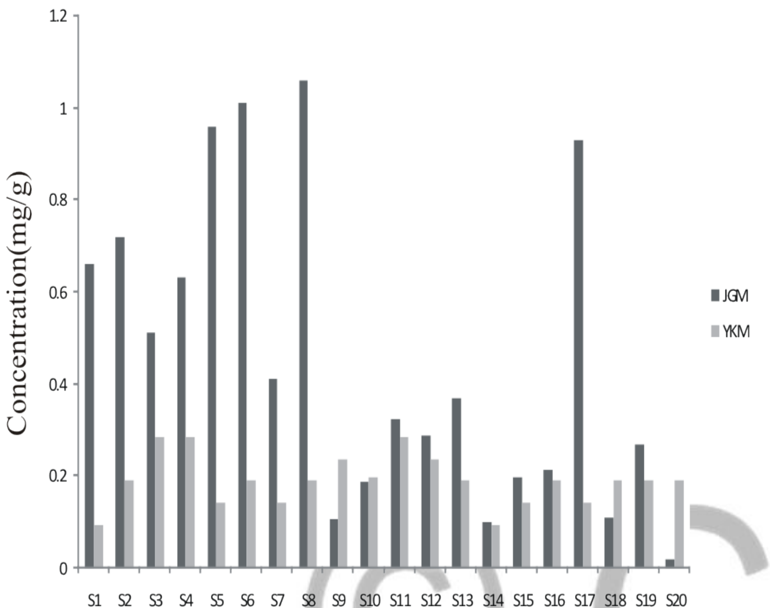


Crop type

Fig 6: Variation of total mean concentration of Mg in crops from the two markets.

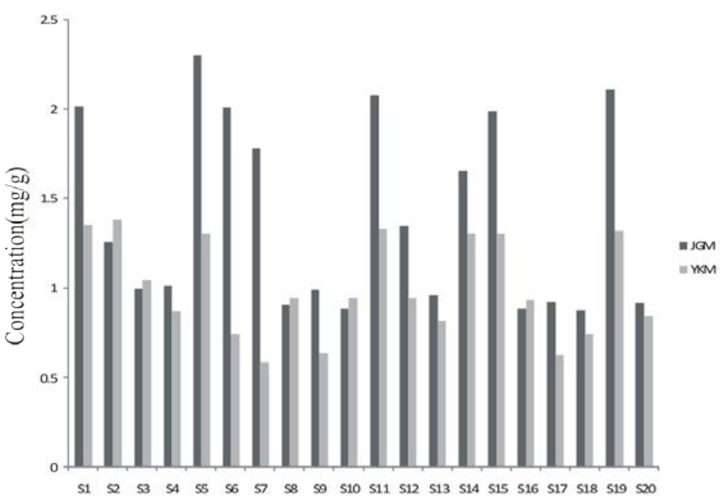
3.8 Sodium (Na)

Sodium and calcium have the highest mean concentration in the plants analyzed from both markets. From Fig. 8, it is clearly seen that, like other metals analyzed, Na generally has highest mean concentration in almost all the plants analyzed from both markets. The highest concentration was found to be 2.302 mg/g in onion (*Allun Cepa*) from JGM while the lowest concentration was found to be 0.590 mg/g in cabbage (*Brassica Spp*) from YKM. Generally, the mean concentration of Na in plants from JGM ranges from 0.881mg/g to 2.302 mg/g in melon and onion respectively, while that of YKM ranges from 0.590mg/g to 1.385mg/g in cabbage and sweet pepper respectively.



Crop type

Fig 7: Variation of total mean concentration of K in crops from the two markets.



Crop type

Fig 8: Variation of total mean concentration of Na in crops from the two markets.

5.0 Conclusions

The results of this study indicated higher concentration of the elements in samples obtained from Janguza market to those obtained from Yankaba market. Farmers from this regions are therefore advised to obtain information on the causes of the differences in the concentrations of these mineral elements in the plants samples studied in this work in order to ascertain whether the variations in concentrations is due to soil mineral composition, source of water for irrigation, fertilizer application or rate of mineral intake by plants. Therefore, to assure food safety and to protect the end users from food that might affect their health and for the effective growth and reproduction of plants, farmers from such environments should adopt the appropriate forms of farm practices in terms of fertilizer application, irrigation etc to avoid concentrations that might cause problems for plants and animals.

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