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(RESEARCH ARTICLE)

Determination of the concentrations of Cu, Zn and Fe in five selected leafy vegetables used as relish in Kano State, Nigeria

Yau Datti [1,*] and Bilkisu Mukhtar [1]

[1] *Department of Chemistry, Yusuf Maitama Sule University, Kano, Nigeria.*

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Abstract

In tropical Africa, leafy vegetables are traditionally cooked and eaten as relish together with a starchy staple food. Vegetables usually differ according to their type and nutritive values. In this research the Cu, Zn and Fe contents of five leafy vegetables (African spinach *(Amaranthus hybridus)*, baobab *(Adansonia digitata)*, bitter-leaf *(Vernonia amygdalina),* jute (*Corchorus olitorius)* and sesame leaf *(Sesamum indicum)*) were investigated using Atomic Absorption Spectrophotometer and the results were analyzed. The levels of Cu in the leaves of African spinach, baobab, bitter-leaf, sesame leaf and jute were averagely found be 1.60 mg/Kg, 1.60 mg/Kg, 1.90 mg/Kg, 2.00 mg/Kg and 1.70 mg/Kg respectively; while the Zn levels were averagely found be 1.20 mg/Kg, 0.70 mg/Kg, 0.50 mg/Kg, 1.60 mg/Kg and 0.90 mg/Kg respectively; and the Fe levels were averagely found be 246.12 mg/Kg, 170.23 mg/Kg, 218.10 mg/Kg, 166.76 mg/Kg and 272.80 mg/Kg respectively. The results were then compared to, and found to be within the FAO/WHO recommended values for the daily human intake. This indicates that these vegetables could be good sources and supplements for the elements analyzed.

Keywords: Vegetables; Minerals; Immune system; Anaemia

1. Introduction

Vegetables are the fresh and edible portions of herbaceous plants, which can be eaten raw or cooked. They contain valuable food ingredients which can be successfully utilized to build up and repair the body [1]. Leafy vegetables are regular ingredient in the diet of average Nigerian, with their level of consumption; they can provide appreciable amounts of nutritive minerals [2]. Vegetables, the fresh and edible portions of herbaceous plants, can be eaten either raw or cooked [3, 4], and are recognized for their high carbohydrate, vitamin and mineral contents [2]. Vegetables may be in the forms of edible leaves, stems, roots, seeds or fruits [2], with each group contributing its own share of constituents to the diet [5]. Vegetables contain both essential and toxic elements at certain concentrations depending on their concentrations in the soil in which the vegetables were planted [2].

Metals are circulated by biogeochemical processes. Some metals are essential and their deficiency results in impairment of biological functions. When present in excess, essential metals may become toxic. Other metals not known to have essential function may give rise to toxic manifestations when intakes are in excess [6]. Unlike organic chemicals that can be eliminated from tissue by metabolic degradation, the metals are not biodegradable and therefore have potential for bioaccumulation [7].

Heavy metals inputs need not to be as small as possible because some metals are indispensable for life. Copper, zinc and iron are some of the essential elements whose deficiency gives rise to deficiency problems in plants and animals [8]. Inadequate dietary mineral elements from habitual diets is considered as the single most important cause for the wide spread micronutrient deficiencies among the population specially iron deficiency anemia. Besides their aesthetic value

* Corresponding author: Yau Datti

in food presentation, vegetables enhance the nutritional quality of diets because of their richness in vitamins and minerals such as carotene (provitamin A), ascorbic acid, riboflavin, iron, iodine calcium etc. [9].

This paper aims at reporting the levels of Cu, Zn, and Fe in the leaves of African spinach *(Amaranthus hybridus)*, baobab *(Adansonia digitata)*, bitter leaf *(Vernonia amygdalina),* jute (*Corchorus olitorius)* and sesame leaf *(Sesamum indicum)*.

2. Material and methods

2.1. Sample Collection and Preparation

Five different vegetable samples (African spinach *(Amaranthus hybridus)*, baobab *(Adansonia digitata)*, bitter leaf *(Vernonia amygdalina),* jute (*Corchorus olitorius)* and sesame leaf *(Sesamum indicum)*) were obtained from Yankaba Market, Kano city, Nigeria. The leaves were separately washed with distilled water then air-dried for two weeks. The dried leaves were then grounded with mortar and pestle and then stored in a desiccator (containing silica gel) ready for further analysis.

All the chemicals used were of analytical grade.

2.2. Wet Digestion Method

A 2 cm^3 mixture of 1:3 HCl:HNO_3 was added to 1 g of each of the powdered sample of 100 cm^3 beaker covered to stand overnight. The following day, the samples were digested at 110^0C for 60 mins using hot plate. The solution was allowed to cool and made up the mark of 50 cm^3 volumetric flask with 2% HNO_3. The flask was then covered and kept for analysis [10] the blank was prepared by the same procedure above but in this case the sample was excluded. The concentrations of the metals were determined using Atomic Absorption Spectrophotometer (Buck Model 210 VGP) as reported by Shuaibu *et al.,* [11].

3. Results and Discussion

The results of the analysis of the concentration of Cu, Zn and Fe in the five vegetables are shown in Figures 1, 2 and 3 respectively.

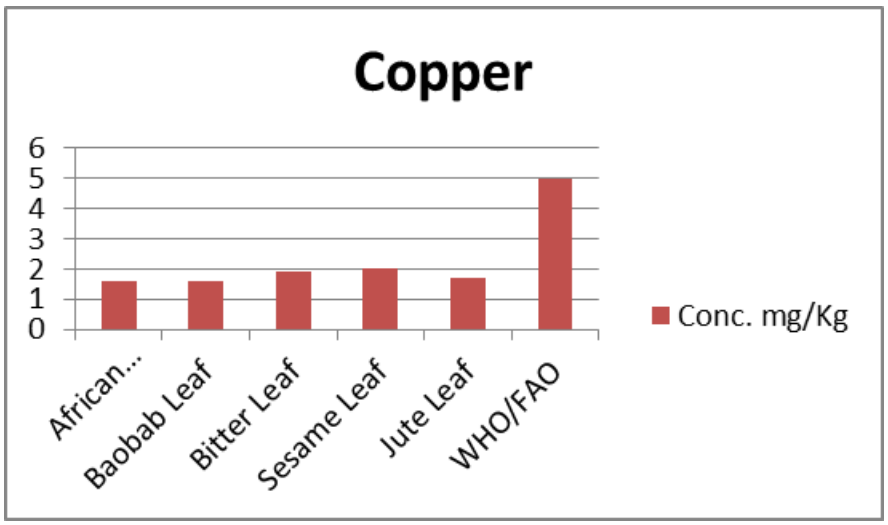

Figure 1 Result of Cu in the Plant Sample

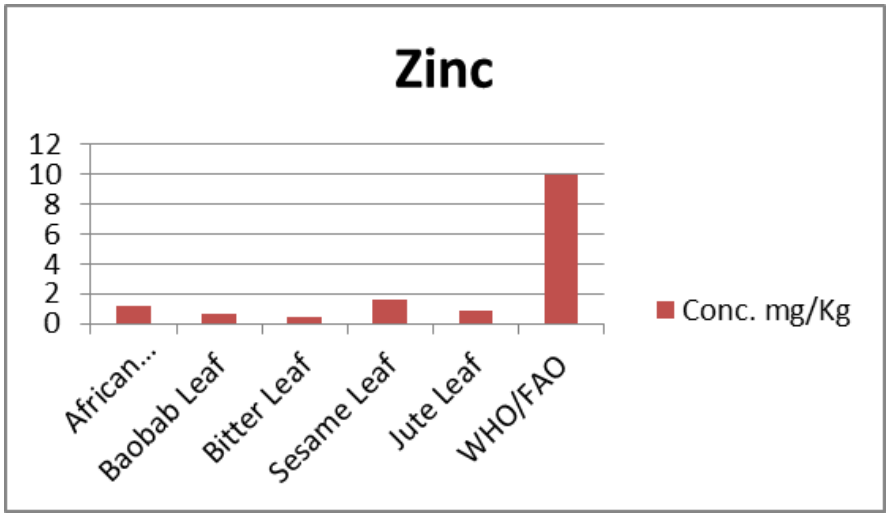

Figure 2 Result of Zn in the Plant Samples

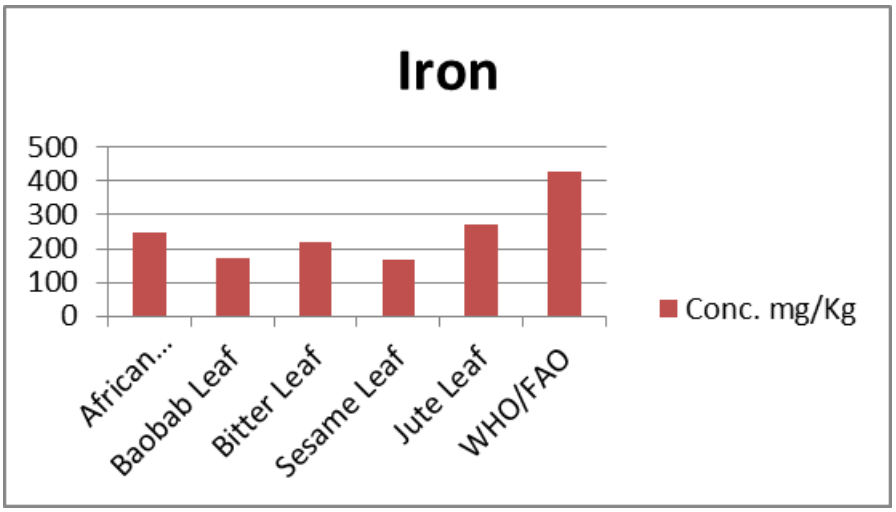

Figure 3 Result of Fe in the Plant Samples

4. Discussion

Copper, an essential trace mineral that is necessary for survival, is found in all body tissues and plays a role in making red blood cells and maintaining nerve cells and the immune system [12]. Copper is also believed to play a role in the formation collagen in the body, helps in iron absorption, and also plays a role in the production of body energy [12]. Most copper in the body is found in the skeletal muscle, heart, liver, kidneys and brain [13], with the possibility of too much and too little copper affecting how the brain works [12]. According to report by Smith *et al.,* [14]; Glew *et al.,* [15]; Barminas *et al.,* [16]; Lockett *et al.,* [17], the amount of copper in the leaves of baobab plants ranges from 0.80 to 1.60 mg/Kg and this supports the findings from this research which shows the amount of copper in the leaves of this plant to be 1.60 mg/Kg. Also in this study, the value for the copper in this analyzed sample of sesame leaf was found to be 3.5 mg/Kg, and this is found to be within the range reported by Nagendra *et al.,* [18] who reported a range of 1.43 to 4.21 mg/Kg. More so in this study, the value for copper in this analyzed sample of African spinach leaf was found to be 1.60 mg/Kg, and this is similar to the result reported by Javed *et al.,* [19] who reported a range of 1.10-1.89 mg/Kg, while Gopalan *et al.,* [20] reported a result of 1.30 mg/Kg. Similarly, the concentration of copper in the analyzed bitter leaf sample was found to be 1.90 mg/Kg. This value was observed to be near to other published results such as that reported by Javed *et al.* [19] who reported a mean concentration of 1.2 mg/Kg, while Muhammad and Shariff [21] reported 0.60 mg/g. Lastly, the value for copper in the analyzed sample of jute leaf was found to be 13.10 mg/Kg, and this is observed to far above that reported by Gwana *et al.,* [22] who reported a mean concentration of 0.99 mg/Kg, and that reported

by Oyekanmi *et al.,* [23] who reported a mean concentration of 0.68 mg/Kg. The result obtained in this study is below the safe limit of copper which is 5.0 mg/Kg. This difference could be due to the fact that many soils are geographically deficient in certain minerals and therefore foods plants grown in them lack those nutrients. A similar problem can be caused by over farming or poor soil management [24].

Zinc is another trace element necessary for a healthy immune system, with its deficiency resulting in diseases and illness [25]. Zinc has many functions in the human body, including stimulation of the activities of many different enzymes in the body; playing a role in wound healing, and helps in treatment of diarrhea [26, 27]. Only a small intake of zinc is necessary to reap the benefits. The element is naturally found in many different foods, but it is also available as a dietary supplement [26]. Zinc is an important aspect of nutrition, its deficiency can occur if there is not a high enough consumption from diet or supplementation [25]. In this study the leaves of baobab was found to contain 0.70 mg/Kg (0.0007 mg/g) zinc and this result is found to be within the range reported by many researchers including Smith *et al.,* [14]; Glew *et al.,* [15]; Barminas *et al.,* [16]; Lockett *et al.,* [17]; Yazzie *et al.,* [28]; Nordeide *et al.,* [29]; Sena *et al.,* [30], who reported a range of values from 0.7 to 12.61 mg/Kg of zinc obtained in different baobab leaves collected from different locations. Also in this study, the value for the zinc in this analyzed sample of sesame leaf was found to be 1.60 mg/Kg, and this is within the range reported by Alege *et al.,* [31] who reported a maximum range of 0.310 mg/Kg and Haftom *et al.,* [32] who reported a maximum range of 43.70 mg/Kg. More so in this study, the value for zinc in the analyzed sample of African spinach leaf was found to be 1.20 mg/Kg, and this is similar to the result reported by Gopalan *et al.,* [20] who reported a value of 3.02 mg/Kg. Similarly, the concentration of zinc in the analyzed bitter leaf sample was found to be 0.50 mg/Kg. This value was observed to be below that reported by other published results such as that reported by Javed *et al.* [19] who reported a mean concentration of 8.5 mg/Kg, while Muhammad and Shariff [21] reported 0.30 mg/g. The difference in the zinc level could be due to the fact that many soils are geographically deficient in certain minerals and therefore foods plants grown in them lack those nutrients. A similar problem can be caused by over farming or poor soil management [23]. Lastly, the value for zinc in the analyzed sample of jute leaf was found to be 0.90 mg/Kg, and this is observed to be below that reported by Kadiri [33] who reported a mean concentration of 2.79 mg/Kg. All the values are below the maximum permissible limit for zinc in vegetables which is 9.94 mg/Kg. This difference could be due to the fact that many soils are geographically deficient in certain minerals and therefore foods plants grown in them lack those nutrients. A similar problem can be caused by over farming or poor soil management [23].

Iron is a mineral that serves several important functions, its main function being to carry oxygen throughout our bodies and making red blood cells [34]. Iron is an essential mineral nutrient, meaning you must get it from food. The recommended daily intake (RDI) is 18 mg. The iron content of normal plant tissue varies with the plant species, but it is usually between the ranges of 20 to 200 mg/Kg [35]. Iron is an essential element for almost all living organisms as it participates in a wide variety of metabolic processes, including oxygen transport, deoxyribonucleic acid (DNA) synthesis, and electron transport. However, as iron can form free radicals, its concentration in body tissues must be tightly regulated because in excessive amounts, it can lead to tissue damage [36]. Iron deficiency occurs when the body doesn't have enough of the mineral iron. This leads to abnormally low levels of red blood cells. That is because iron is needed to make hemoglobin, a protein in red blood cells that enables them to carry oxygen around the body [37]. In this study the leaf of baobab was found to contain 170.23 mg/Kg iron and this result is found to be within the range reported by many researchers including Smith *et al.,* [14]; Glew *et al.,* [15]; Barminas *et al.,* [16]; Lockett *et al.,* [17]; Yazzie *et al.,* [28]; Nordeide *et al.,* [29]; Sena *et al.,* [30]; Chadare *et al.,* [38]; Achille *et al.,* [39], who reported a range of values from 25 to 500 mg/Kg of iron obtained in different baobab leaves collected from different locations. Also in this study, the value for the iron in this analyzed sample of sesame leaf was found to be 166.76 mg/Kg, and this is within the range of 9.6 to 191.7 mg/Kg reported by Gopalan *et al.,* [20]; Dhawan *et al.,* [40]; Deosthale [41]; Nanloh *et al.,* [42]. More so in this study, the value for iron in the analyzed sample of African spinach leaf was found to be 246.12 mg/Kg, and this is similar to the result reported by Javed *et al.* [19] who reported a value of 290.02 mg/Kg. Similarly, the concentration of iron in the analyzed bitter leaf sample was found to be 218.10 mg/Kg. This value was observed to be below that reported by other published results such as that reported by Asaolu *et al.,* [43] who reported a mean concentration of 164.34 mg/Kg. Lastly, the value for iron in the analyzed sample of jute leaf was found to be 272.89 mg/Kg, and this is observed to be within the range reported by Idir**i**s *et al.,* [44]; Kamal *et al.,* [45] who reported a range of 195.36 to 580.31 mg/Kg. The concentrations of iron in this study are below the maximum permissible limit for iron in vegetables which is 425.5 mg/Kg.

5. Conclusion

The assessment of levels of the three metals, copper, zinc and iron, in the five selected vegetables has been carried out. The results indicate that all the vegetable samples analyzed in this study have some significant amounts of the three metals. However, their levels are below permissible limits recommended by Food and Agricultural Organization (FAO)

and the World Health Organization. The presence of these metals in the vegetable samples even though in small quantity and within the permissible safe limits, is still a clear warning sign; as such their concentrations should be monitored since at higher concentrations they may be hazardous and environmentally dangerous.

Compliance with ethical standards

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Disclosure of conflict of interest

Some of the materials required for the research had to be obtained from a sister University, and this has not been as easy as it sounds, because it contradicts the policy of our University.

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