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Estimation of Iron, Copper and Zinc in Some Vegetables Commonly Consumed in Amassoma, Niger Delta, Nigeria

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Abstract: Iron, copper and zinc contents in edible parts of some fresh vegetables sold in markets in Amassoma, Niger Delta region of Nigeria were determined using atomic absorption spectrometry. For the study, vegetables were divided into three groups according to edible parts: leaves (bitter leaf and fluted pumpkin), fruits (garden egg, okra and plantain) and roots (sweet potato). Levels of Fe, Cu and Zn were found to be higher in the green leafy vegetables than other vegetables analyzed. The concentration of Fe was observed to be the highest in all the vegetables. The highest content of Fe was found in the leaves of fluted pumpkin, *Telfaria occidentalis* (2.787±0.18 ppm), while the smallest content was shown in plantain, *Musa paradisiaca* (0.360±0.23 ppm). The mean concentration of Zn ranged from of 0.283±0.57 ppm in *Musa paradisiaca* to 1.058±0.12 ppm in bitter leaf, *Vernonia amygdalina*. The Cu value was observed to be the lowest in all the vegetables. The highest Cu value was obtained in *Vernonia amygdalina* (0.173±0.16 ppm) and the lowest in garden egg, *Solanium melongena* (0.014±0.57 ppm). The respective concentrations of the trace metals in all the vegetable samples analyzed in this study were found to be lower than the FAO/WHO guidelines but fall within safety limits for human health and hygiene.

Key words: Health, trace elements, vegetables

INTRODUCTION

Vegetables are edible parts of plants that include leaves, stem, root, flowers, seeds, fruits, bulbs and tubers. They are important protective foods and highly beneficial for the maintenance of health and prevention of diseases. They contain valuable food ingredients such as minerals and vitamins, which can be successfully utilized to build up and repair the body tissues (Enwere, 1998). Soluble minerals such as calcium, magnesium and potassium in vegetables maintain the acid-base balance of the hydrogen ion concentration of the body tissue. They help complete the absorption of vitamins, proteins, fat and carbohydrates and eliminate excess of liquid and salt. The dietary fibre in vegetables reduces food transit time in the gastro-intestinal tract and the incidence of constipation and other related diseases (Purseglove, 1977; Enwere, 1998).

Vegetables also supply trace elements such as iron, copper and zinc which are involved in the function of several enzymes and are essential for maintaining good health throughout life (FNB, 2001; Uauy, 1998). These micronutrients are also necessary for proper plant development. Iron is a constituent element of chlorophyll in plants and therefore it is important for plant photosynthesis. Iron deficit in humans and animals is a very urgent global problem. It is estimated that Fe deficit affects about 65% of people, particularly in African and Asiatic countries (Brown, 2004). However, the high concentration of Fe in vegetable may increase the nutritional health of the people in an area (Fiona *et al*., 2010) but was also reported to increase the risk of colon cancer (Lund *et al*., 2001).

Copper is an essential nutrient that plays an integral role in the body, acting as a ligand to many proteins and enzymes (Wu *et al*., 2006). The synergistic interaction of Cu and Fe is crucial in human health. Copper acts as a ligand to ferroxidase II which oxidizes iron, allowing it to be mobilized and transported from hepatic stores to the bone marrow for use in erythropoiesis (Turnlund *et al*., 1998). However, a large number of symptoms comprising anaemia, depressed growth, dermatitis, dwarfism, electrolyte-imbalance, gastro-intestinal disorders and nausea have been associated in humans with copper deficiency as well as toxicity due to excessive intake (Akan *et al*., 2009; Fiona *et al*., 2010).

Zinc is an essential trace element in the human body, where it is found in high concentration in red blood cells as an essential part of the enzyme carbonic anhydrase, which promotes many reactions relating to carbon dioxide metabolism (Sandstead, 1994; FNB, 2001). Zinc also supports normal growth and development during pregnancy, childhood and

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adolescence (Simmer and Thompson, 1985). A daily intake of Zn is required to maintain a steady state because the human body has no specialized Zn storage system.

High concentration of Zn and Cu has been reported to cause diarrhoea, depressed immune function, impairment of growth and reproduction (Gordon, 1985; Norlan, 2003). According to WHO (1973) report deficiency of these trace elements may arise either as a result of decreased dietary intake or as a result of decreased availability from foods.

The vegetable crops namely: *Vernonia amygdalina* (Bitter leaf), *Telfaria occidentalis* (fluted pumpkin)-leafy vegetables; *Hibiscus esculentus* (okra), *Solanium melongena* (garden egg), *Musa paradisiaca* (plantain)-fruit vegetables and *Ipomoea batatas* (sweet potato), a root vegetable, are commonly consumed by the general populace of the Niger Delta region of Nigeria. Thus, this study was undertaken to comparatively examine the contents of iron, copper and zinc in these vegetables.

MATERIALS AND METHODS

Sampling area: Three accessions of each vegetable sample were purchased from three different sellers at the open market in Amassoma, Niger Delta region in Nigeria. Amassoma town is located in a humid tropical wetland area with mean annual rainfall of about 2539 mm and average mean temperature of 26.2°C. The vegetables are usually planted in clay sandy soils. The vegetable samples were chosen because they are commonly consumed as delicacies throughout the year.

Sample treatment: The leafy vegetables were destalked while the sweet potato (*Ipomoea batatas)* and plantain (*Musa paradisiaca*) were peeled, rinsed with tap water and then with distilled water. All the samples were cut into small sizes and subsequently dried in the oven-dried at 70°C to constant weight. The dried samples were ground into powder with mortar and pestle and then passed through a 0.5 mm mesh size sieve. The samples were stored in plastic containers until analysis.

Mineral analysis: One gram of each of the sample was weighed and digested with 10 mL of HNO_3 and 30 mL of H_2SO_4 on a hot plate. The digested sample was made up to 50 mL. Blank and standard solutions of each metal to be determined were prepared and the analyses were carried out using flame atomic absorption spectrophotometer (Buck scientific model 200A). All analyses were carried out in three replicates.

Statistical analysis: Results were presented as simple ranges, means and standard deviations.

RESULTS AND DISCUSSION

The results of the concentrations of Fe, Cu and Zn are presented in Table 1 and Fig. 1.

The concentration of iron is the highest in all the vegetables analyzed as evidenced from the data in Table 1 and in Fig. 1. Iron is an essential element in production of red blood cells. Its mean concentration in the vegetables under investigation ranged from 0.360±0.23 ppm in *Musa paradisiaca* to 2.787±0.18 ppm in *Telfaria occidentalis*. The acceptable limit for human consumption of Fe is 8 to 11 mg/day for infants as well as adults (ATSDR, 1994). The Fe contents in the

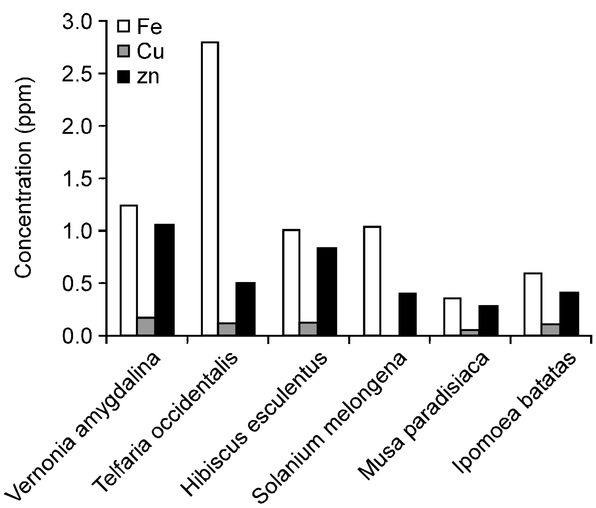

Fig. 1: Mean concentrations of Fe, Cu and Zn in vegetable samples

Table 1: Concentrations of Fe, Cu and Zn in vegetable samples

	Fe (ppm)		Cu (ppm)		Zn (ppm)	
Vegetable	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
Vernonia amygdalina	0.887-1.489	1.238±0.18	0.159-0.190	0.173±0.16	1.048-1.072	1.058±0.12
Telfaria occidentalis	2.004-3.255	2.787±0.68	0.105-0.133	0.115±0.17	0.450-0.547	0.497±0.49
Hibiscus esculentus	0.853-1.304	1.013±0.23	0.110-0.166	0.131±0.30	0.713-1.024	0.830±0.17
Solanium melongena	0.316-1.781	1.043±0.73	0.137-0.148	0.014±0.57	0.394-0.420	0.406±0.32
Musa paradisiaca	0.353-0.681	0.360±0.23	0.034-0.045	0.041±0.95	0.252-0.329	0.283±0.57
Ipomoea batatas	0.277-0.911	0.588±0.13	0.095-0.112	0.104±0.85	0.394-0.420	0.406±0.32
WHO Limit (2001)		3.000		2.000		3.000

SD-Standard deviation

vegetables are found to be lower than 3.000 ppm limit set by WHO, but they were within the normal range of 0.1-3.0 ppm for vegetables. Low intake of Fe has shown to cause anaemia, tiredness and pallid physique.

Most of the earlier studies showed that Nigerian vegetables contain appreciable amount of iron (Oke, 1968; Ifon, 1977; Faboya, 1983; Aletor and Adeogun, 1995). This was confirmed by more recent studies (Mohamme and Sharif, 2011; Agbaire, 2011; Asaolu *et al*., 2012; Jimoh *et al*., 2012). However, the high concentration of Fe in vegetable may increase the nutritional health of the people in an area (Fiona *et al*., 2010) but was also reported to increase the risk of colon cancer (Lund *et al*., 2001). Iron, copper and zinc concentrations are found to be higher in green leafy vegetables than in most other vegetables (Atukorala, 1987; Hart, 2005; Jawad, 2010). This is corroborated in our study where the levels of Fe, Cu and Zn were high in the green leafy vegetables *Telfaria occidentalis* and *Vernonia amygdalina* and low in *Ipomoea batatas* and Musa *paradisiaca*. According to Hart (2005), the higher concentrations in pumpkin leaves, followed by bitter leaf, garden egg and okra, all green vegetables, compared to sweet potato and plantain, might be due to the participation of the green vegetables in the synthesis of ferredoxin, an attribute which makes them useful sources of iron. Pumpkin leaves, being of a darker green colour than bitter leaf, garden egg and okra, were significantly higher in iron content as noted by Davidson and his co-workers (1979).

Among the three trace metals, Zn is the least toxic and an essential element in the human diet as it is required to maintain the proper functions of the immune system. The levels of Zn in the vegetable samples are relatively low compared to that of Fe. The highest concentration of Zn was found in *Vernonia amygdalina* with a mean concentration of 1.058±0.12 ppm, while the lowest concentration was observed in *Musa paradisiaca* with a mean concentration of 0.283±0.57 ppm. The acceptable limit for human consumption of Zn is 150 ppm (Nair *et al*., 1997). Our results obtained for Zn in the vegetable samples are below the maximum permissible limit of 3.000 ppm reported by WHO but they are within the normal range of 0.1-3.0 ppm for fruits and vegetables (Johnson, 1997).

The Cu contents of the vegetable samples are generally the lowest compared to Fe and Zn. The lowest Cu level was observed in *Solanium melongena* (0.014±0.57 ppm) and the in *Vernonia amygdalina* (0.173±0.16 ppm). The acceptable limit for human consumption of Copper (Cu) is 10 ppm (Nair *et al*., 1997). All the vegetable samples investigated had their Cu contents below the maximum tolerable limit of 2.000ppm set by WHO and all except *Solanium melongena* (0.014±0.57 ppm) and *Musa paradisiaca* (0.041±0.95 ppm) are within the 0.1-2.0 ppm reported as normal range for Cu in fruits and vegetables (Johnson, 1997). Thus the trend of concentration of the trace metals in studied vegetables is as follows: Fe>Zn>Cu. This is in agreement with the findings of Audu and Lawal (2006), Adeleke and Abiodun (2010) and Iyaka (2007).

Generally, the levels of all the trace metals were observed to be lower than some of previous work published and regulating standards. According to Oguntona (1998) the composition of minerals in vegetables is influenced by the soil fertility, type and or quality of fertilizer used in the area where the vegetables were being investigated. This might be the reason for the reported wide variations of metals in some of the published data on vegetables.

Conclusion: It was generally observed that the respective concentrations of the trace metals (Fe, Cu and Zn) in all the vegetable samples analyzed in this study were lower than the FAO/WHO (2001) guidelines but fall within safety limits for human health and hygiene; hence the vegetables can be consumed without any risk.

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