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Original Article

MICRONUTRIENTS CONSTITUENTS OF THE LEAVES OF SELECTED FRESH LEAFY VEGETABLES OBTAINED FROM MINNA TOWN, NIGERIA

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ABSTRACT

Determination of micronutrients in food stuff is an important aspect in nutritional study, as it gives the ideal of the levels of micronutrients constituents in the food stuffs found in a particular location. It is for this reason that this research was conducted to determine the concentrations of β-carotene, vitamin C and mineral elements (Fe, Cu, Mg, Na and K) in *Amaranthus scruentus*, *Hibiscus sabdariffa*, *Corchorus olitorius, Telfairia occidentalis* and *Vernonia amygdalina* obtained from Minna, Nigeria. Colourimetric, titrimetric and spectrophotometric methods were used to evaluate the concentrations of β-carotene, vitamin C and mineral elements, respectively, in the leafy vegetables. The results showed that the concentrations of β-carotene in *Amaranthus cruentus* (11956.78 µg/100 g) and *Hibiscus sabdariffa* (12106.00 µg/100 g) were not significantly different, however, the β-carotene

contents in *Corchorus olitorius* (18432.33µg/100 g), *Telfairia occidentalis* (18859.33 µg/100 g) and *Vernonia amygdalina* (19515.33 µg/100 g) were significantly ($p<0.05$) higher than in *Amaranthus cruentus* and *Hibiscus sabdariffa*. The significant ($p<0.05$) increase in vitamin C profile in the different leafy vegetables was in the following order: *Telfairia occidentalis* (192.28 mg/100 g) > *Corchorus olitorius* (78.90 mg/100 g) =*Amaranthus cruentus* (69.34 mg/100 g) > *Vernonia amygdalina* (30.68 mg/100 g) = *Hibiscus sabdariffa* (27.44 mg/100 g). The Fe content in *Corchorus olitorius* (26.03 mg/Kg) and *Telfairia occidentalis* (192.28 mg/Kg) were not significantly different from each other, but its concentrations in these vegetables were significantly ($p<0.05$) higher compared to *Amaranthus cruentus* (19.18 mg/Kg), *Hibiscus sabdariffa* (18.51 mg/Kg) and *Vernonia amygdalina* (15.63 mg/Kg). The leafy vegetables are excellent sources of Cu as the mineral contents in the vegetables meet the recommended daily allowance of 1.5-3.0 mg/day). The levels of Mg in *Amaranthus cruentus* (27.78 mg/Kg) and *Hibiscus sabdariffa* (22.08 mg/Kg) were significantly the same, however, the mineral concentrations in these vegetables were significantly ($p<0.05$) lower than values found in*Corchorus olitorius* (61.79 mg/Kg), *Telfairia occidentalis* (48.81 mg/Kg) and *Vernonia amygdalina* (55.28 mg/K). Concentrations of Na in *Amaranthus cruentus* (12.30 mg/Kg) and *Telfairia occidentalis* (11.48 mg/Kg) were significantly higher compared to the values in *Corchorus olitorius* (9.03 mg/Kg), *Vernonia amygdalina* (7.96 mg/Kg) and *Hibiscus sabdariffa* (6.16 mg/Kg). The concentration profile of K in the vegetables were in the following order; *Vernonia amygdalina* (288.92 mg/Kg) =*Amaranthus cruentus* (241.88 mg/Kg) >*Telfairia occidentalis* (183.92 mg/Kg) = *Corchorus olitorius* (176.38 mg/Kg) >*Hibiscus sabdariffa* (61.88 mg/Kg). The study concludes that these selected leafy vegetables are excellent sources of some micronutrients required for normal metabolic activity of the body particularly, β-carotene, vitamin C, Fe, Cu and K.

Keywords: β-carotene, Leafy vegetables, Mineral elements, Vitamin C.

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INTRODUCTION

Leafy vegetables offer the cheapest means of providing adequate supplies of vitamins, minerals and dietary fibre for maintenance of good health (Aliyu and Morufu, 2006; Adeboye and Babajide, 2007; Lola, 2009). The leaves of green vegetables manufacture carbohydrate by a natural process called photosynthesis. The starch and sugar produced are not stored in the leaves but translocated to other parts of the plant for use or to be stored. Therefore, the leaves have low energy value and can be included in large quantity in sliming diets (George, 1999). Vegetables contain actively growing tissues and those which are dark green e.g. *Telfairia occidentalis*, *Amaranthus cruentus, Corchorus olitorius, Vernonia amygdalina,* water

leaf, etc, have high content of chlorophyll and are probably the most nutritious. The dark green leaves of vegetables are rich in β-carotene (provitamin A). They are also important sources of vitamin B complex, folic acid, vitamin C and mineral elements such as Calcium, Iron, Zinc, Potassium, Copper, Magesium and phosphorus (Shahnaz *et al.,* 2003; Aliyu and Morufu, 2006; Weerakkody, 2006; Adeboye and Babajide, 2007; Ogbadoyi *et al*., 2011; Musa and Ogbadoyi, 2012).

The concentration of nutrients is higher in tropical vegetables than those of temperate region (Schippers, 2000). The chemical constituents of leafy vegetables are influenced by soil types, season of the years, differences in temperature, length of day, light intensity and other micro factors (Bolanle *et al.,* 2004; Singh, 2005; Aliyu and Morufu, 2006; Adeboye and Babajide, 2007). Besides these factors, differences in species and cultivars are also known to influence the bioaccumulation of nutrients in the leaves of vegetables. It is against this background that the research was conducted to assess the concentrations of some micronutrients in the widely consumed leafy vegetables (*Amaranthus cruentus, Hibiscus sabdariffa, Corchorus olitorius, Telfairia occidentalis and Vernonia amygdalina*) in Minna town, Nigeria. This is with the aim of establishing the baseline concentrations of the micronutrients in the selected vegetables.

MATERIALS AND METHODS

Source of leafy vegetables

The fresh samples of *Amaranthus cruentus, Hibiscus sabdariffa, Corchorus olitorius*, *Telfairia occidentalis* and *Vernonia amygdalina* were bought each in three sets at different time from Maikunkele, Bosso and Chanchanga markets in Minna town, Nigeria.

Chemicals

All the chemicals used in this work were of analytical grade and were procured from BDH and Sigma Chemical Companies, both of England.

Analytical procedure

The β-carotene concentration in the fresh leaves of the vegetables was analysed by ethanol and petroleum ether extraction method as described by Musa *et al*. (2010). While the vitamin C content in the samples was determined by 2, 6-dichlorophenol indophenol titrimetric method (Jones and Hughes, 1983). The mineral elements (Fe, Cu, Mg, Na and K) in the test samples were determined according to the method of Ezeonu *et al*. (2002) involving the use of atomic absorption spectrophotometer (Alpha 4A AAS) and flame photometer (Jenway PFP7) for Na and K only.

Statistical analysis

Analysis of variance (ANOVA) was carried out using statistical package Minitab to determine the variation in the concentrations of the selected

nutrients in the leaves of the different leafy vegetables. The DUNCAN's Multiple Range Test (DMRT) was used for comparison of mean.

RESULTS

β-carotene content

The determination of β-carotene concentration in the fresh leaves of the different leafy vegetables showed that the β-carotene content in *Corchorus olitorius, Telfairia occidentalis* and *Vernonia amygdalina* were not significantly different ($p<0.05$). However, its concentration in these three leafy vegetables was significantly ($p<0.05$) higher than those of *Amaranthus cruentus* and *Hibiscus sabdariffa*. While the concentration of β-carotene in *Amaranthus cruentus* and *Hibiscus sabdariffa* were not significantly different from each other. The mean values of β-carotene content in the different fresh leafy vegetables were 11956.78, 12106.00, 18432.33, 18859.33 and 19515.33 µg/100 g for *Amaranthus cruentus*, *Hibiscus sabdariffa*, *Corchorus olitorius, Telfairia occidentalis* and *Vernonia amygdalina*, respectively (Fig. 1).

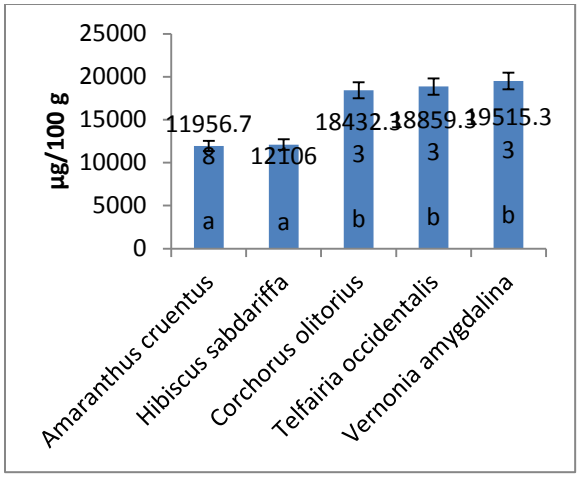

Figure 1: β-concentration in different fresh leafy vegetables obtained from Minna, Nigeria. Bars carrying the same letters are not significantly different ($p > 0.05$).

Vitamin C content

The mean concentrations of vitamin C in *Amaranthus cruentus*, *Hibiscus sabdariffa*, *Corchorus olitorius, Telfairia occidentalis* and *Vernonia amygdalina* were 69.34, 27.44, 78.90, 192.28 and 30.68 mg/100 g, respectively. The order of significant ($p<0.05$) increase in the vitamin C profile in the studied leafy vegetables were; *Telfairia occidentalis* > *Corchorus olitorius* = *Amaranthus cruentus* > *Vernonia amygdalina* = *Hibiscus sabdariffa* (Fig. 2).

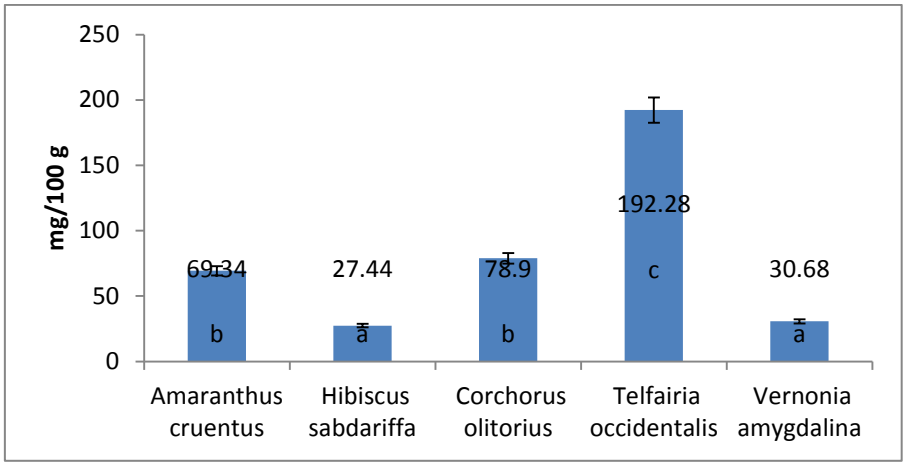

Figure 2: Vitamin C concentration in different fresh leafy vegetables obtained from Minna, Nigeria. Bars carrying the same letters are not significantly different ($p > 0.05$).

Iron content

Analysis of Fe content in the different leafy vegetables revealed that its concentration in *Amaranthus cruentus, Hibiscus sabdariffa* and *Vernonia amygdalina* were not significantly different from each other; however, the Fe concentration in these vegetables was significantly ($p < 0.05$) lower than in the fresh leaves of *Corchorus olitorius* and *Telfairia occidentalis*. The mean values of 19.18, 18.51, 26.03, 23.43 and 15.63 mg/kg were recorded for Fe in *Amaranthus cruentus*, *Hibiscus sabdariffa*, *Corchorus olitorius, Telfairia occidentalis* and *Vernonia amygdalina*, respectively (Fig. 3).

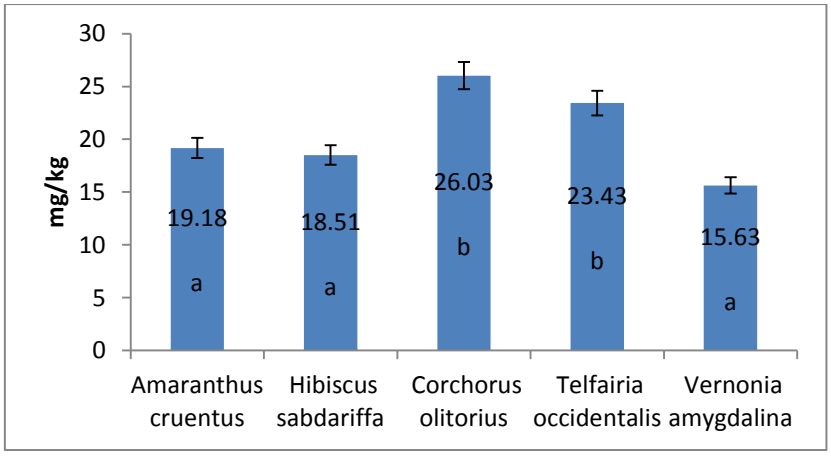

Fig. 3: Iron concentration in different fresh leafy vegetables obtained from Minna, Nigeria. Bars carrying the same letters are not significantly different ($p > 0.05$).

Copper content

The concentration of Cu in the fresh leaves of the selected vegetables were; *Amaranthus cruentus* (24.24 mg/kg), *Hibiscus sabdariffa* (26.67 mg/kg), *Corchoru solitorius* (30.57 mg/kg), *Telfairia occidentalis* (18.70 mg/kg) and *Vernonia amygdalina* (36.70 mg/kg). Data analysis showed that there was no significant difference in the concentration of Cu between *Amaranthus cruentus, Hibiscus sabdariffa, Corchorus olitorius* and *Telfairia occidentalis*, however, the concentration of Cu in *Telfairia occidentalis* was significantly ($p < 0.05$) lower than that of *Corchorus olitorius*. The results also showed that the concentration of Cu in *Vernonia amygdalina* was significantly ($p < 0.05$) higher when compared to other leafy vegetables analysed (Fig. 4).

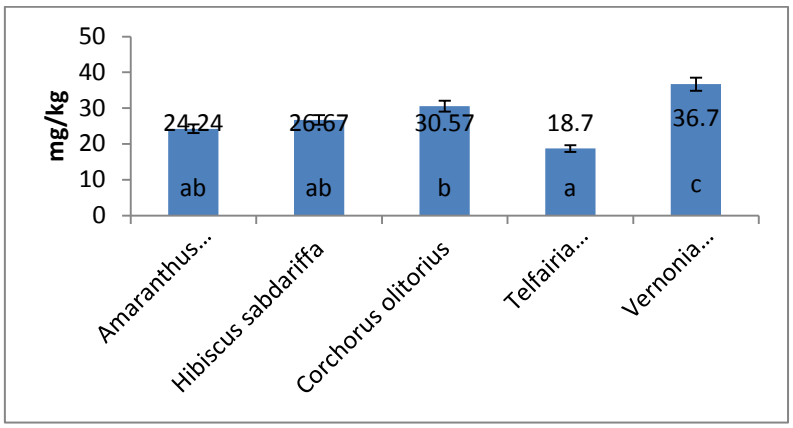

Fig. 4: Copper concentration in different fresh leafy vegetables obtained from Minna, Nigeria. Bars carrying the same letters are not significantly different ($p > 0.05$).

Magnesium content

The Mg content in *Corchorus olitorius, Telfairia occidentalis* and *Vernonia amygdalina* were not significantly different from each other, however, the concentration of the mineral element in each of these vegetables was significantly ($p < 0.05$) higher than the values obtained each in *Amaranthus cruentus* and *Hibiscus sabdariffa*. Statistical analysis also showed that the Mg concentration in *Amaranthus cruentus* and *Hibiscus sabdariffa* were significantly the same. The mean concentrations of 22.78, 22.08, 61.79, 48.81 and 55.28 mg/kg were obtained for Mg in the fresh leaves of *Amaranthus cruentus*, *Hibiscus sabdariffa*, *Corchorus olitorius, Telfairia occidentalis* and *Vernonia amygdalina*, respectively (Fig. 5).

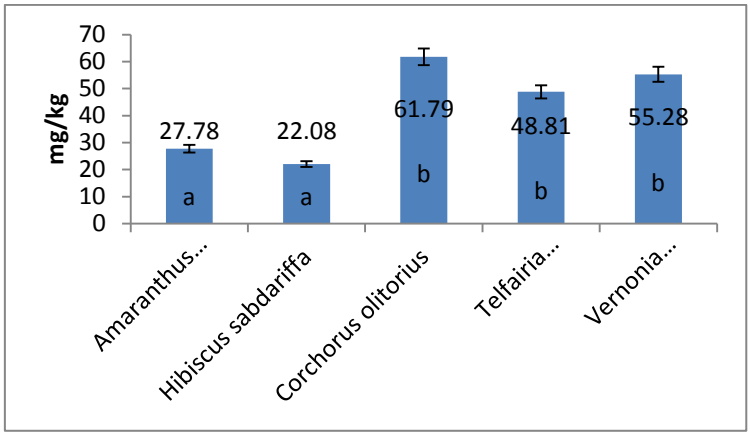

Fig. 5: Magnesium concentration in different fresh leafy vegetables obtained from Minna, Nigeria. Bars carrying the same letters are not significantly different (P > 0.05)

Sodium content

The concentration of Na in the fresh leaves of the different leafy vegetables were; *Amaranthus cruentus* (12.30 mg/kg), *Hibiscus sabdariffa* (6.12 mg/kg), *Corchorus olitorius* 9.03 mg/kg), *Telfairia occidentalis* (11.48 mg/kg) and *Vernonia amygdalina* (7.96 mg/kg). The results revealed that no significant difference in Na concentration was observed between the leaves of *Corchorus olitorius* and leaves of other vegetables analysed except that the concentration of this mineral element in *Telfairia occidentalis* and *Amaranthus cruentus* each was significantly($p < 0.05$) higher than those of *Hibiscus sabdariffa* and *Vernonia amygdalina* each (Fig. 6)

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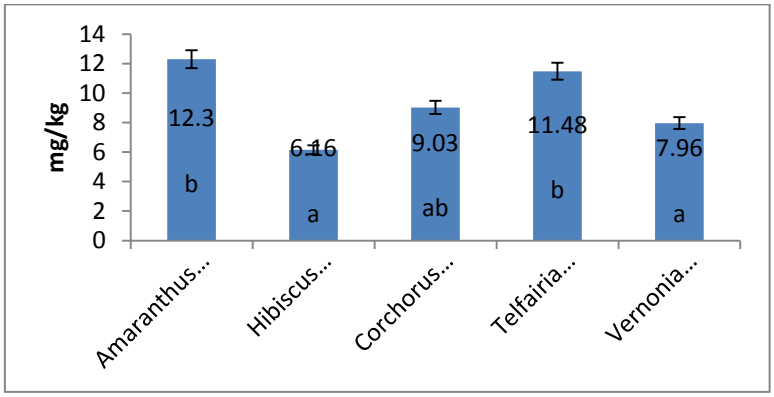

Fig. 6: Sodium concentration in the different fresh leafy vegetablesm obtained from Minna, Nigeria. Bars carrying the same letters are not significantly different (p > 0.05).

Potassium content

The mean concentrations of K in *Amaranthus cruentus*, *Hibiscus sabdariffa*, *Corchorus olitorius, Telfairia occidentalis* and *Vernonia amygdalina* were 241.88, 61.88, 176.38, 183.92 and 288.92 mg/kg, respectively. The significant ($p < 0.05$) increase order in K concentration in the fresh leafy vegetables were *Vernonia amygdalina* = *Amaranthus cruentus* > *Telfairia occidentalis* = *Corchorus olitorius* > *Hibiscus sabdariffa* (Fig. 7).

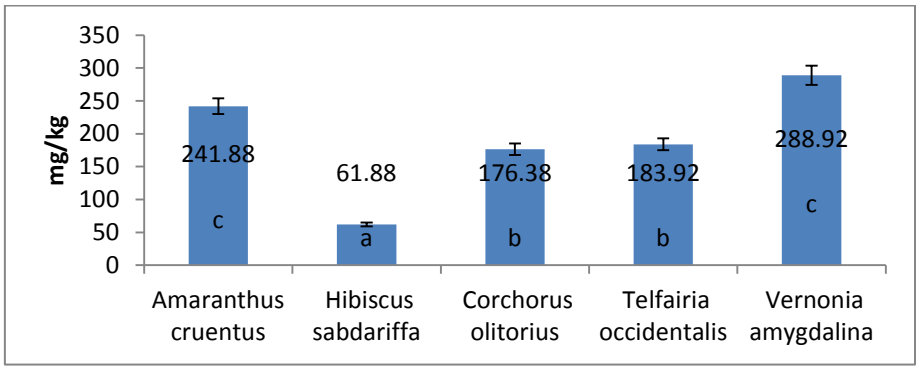

Fig. 7: Potassium contcentration in different fresh leafy vegetables obtained from Minna, Nigeria. Bars carrying the same letters are not significantly different ($p > 0.05$).

DISCUSSION

The fresh leaves of the analysed vegetables are very reach sources of β-carotene (precursor of vitamin A). Each of the vegetables can provide enough vitamin A required for adult recommended daily allowance of 900µg vitamin A (George, 1999; Akanya, 2004). The results therefore, suggest that consumption of any of these leafy vegetables will promote good sight, boost immune system and other health benefits associated with adequate intake of β-carotene (George, 1999; Musa and Ogbadoyi, 2011, Musa *et al.*, 2013).

The range of vitamin C (27.44 –192.28 mg/100g) in the fresh leaves of the leafy vegetables revealed that fresh leaves of *Telfairia occidentalis, Corchorus olitorius* and *Amaranthus cruentus* contained enough of the vitamin required to meet the recommended daily allowance of 60mg (Olaofe, 1992; George, 1999) if 100g of the samples are consumed. However, the concentration of vitamin C in *Hibiscus sabdariffa* and *Vernonia amygdalina* is lower than the recommended daily allowance. Generally, leafy vegetables are regarded as good sources of vitamin C; however, these two vegetables cannot be regarded as a rich source of this water soluble vitamin that is involved

in wound healing, powerful antioxidant and boosting of immune system (Musa and Ogbadoyi, 2012). The findings, therefore suggest that complete reliance on *Hibiscus sabdariffa* and *Vernonia amygdalina* for vitamin C may led to nutritional problems associated with the vitamin deficiency such scurvy.

Comparing the range of Fe (18.51-26.03 mg/kg) in the fresh sample of the vegetables with the available literatures; the vegetables contain an appreciable amount of the mineral. Adequate intake of any of the vegetable could provide the body with the recommended daily intake of 18 mg/day of Fe for normal adults (Tietz *et al.*, 1994).

The concentrations of the Cu in fresh sample of the vegetables could meet the range of the recommended daily allowance of 1.5 - 3.0mg/day of Cu (Tietz *et al.*, 1994), if 100g of samples were consumed.

The range of 21.69-61.69mg/kg of Mg obtained in the fresh samples of the vegetables is lower than the levels reported in available literature for some leafy vegetables. Like 3700 mg/kg for *Amaranthus hybridus* and 3259 mg/kg for *Corchorus olitorius* (Bolanle *et al.*, 2004), 860 mg/kg for *Cleome gynandra* (Chweya and Nameus, 1997), 550 mg/kg for spinach (George, 1999) and 266.80 mg/kg *Cnidoscolusa contifolus* (Oboh, 2005). The values were however, higher than the Mg content reported in *extra-cotyledonous* deposit of *Caesalpina pulcherrina* by Prohp *et al.* (2006). The results obtained indicated that the Mg content in fresh samples of the vegetables is low. Therefore, the vegetables are not likely to supply the mineral to meet the recommended daily allowance of 350mg of mg/day for normal adult (George, 1999). The implication of this observation is very clear, that complete dependency on these vegetables to provide this important co-factor of enzymes involved in cell respiration, glycolysis and transmembrane transporter (Ryan, 1991; Tietz *et al.*, 1994) may lead to the deficiency of the mineral. To avoid this condition, there is a need to balance up the nutrient contents of the soil, to improve the Mg uptake by the plants and inclusion of cereals and nuts, which are rich in Mg in our diets as supplements (George, 1999, Musa *et al.*, 2013).

The differences in the minerals concentrations observed in vegetables from the results of other workers on the same species are probably a reflection of differences of the soil/location and other environmental factors of site in which the vegetables were grown. However, the differences in β-carotene, vitamin C and mineral element concentrations between the different leafy vegetables may be a reflection of differences in species/cultivars, which is genetically determined (Bolanle *etal.*, 2004; Signh, 2005; Aliyu and Morufu, 2006; Weerakkody, 2006).

The concentrations of Na (6.16 -12.30 mg/kg) in these vegetables fall far below values reported in available literature (Chweya and Nameus, 1997; Oboh, 2005; 2006; Aliyu and Morufu, 2006), therefore, the vegetables may be regarded as a rich sources of this mineral element that is require for maintenance of fluid balance and normal osmotic pressure in the body for cellular activities (Tietz *et al*., 1994; Aliyu and Morufu, 2006).

The K contents (61.88 -288.92 mg/Kg) in the fresh leaves of the studied vegetables revealed that they contained an appreciable quantity of the element responsible for maintaining intracellular osmotic pressure, except *Hibiscus sabdariffa* with concentration of the element far below the values reported in available literature (Tietz *et al*., 1994; Musa *et el*., 2013).

CONCLUSION

The study revealed that *Amaranthus cruentus*, *Hibiscus sabdariffa*, *Corchorus olitorius, Telfairia occidentalis* and *Vernonia amygdalina* are good sources of some micronutrients require for normal metabolic activity of the body, particularly, β-carotene, vitamin C, Fe, Cu and K. Therefore, the vegetables can be used to alleviate the problems of micronutrients deficiency prominent in West African Countries. However, these vegetables have low levels of Sodium and Magnesium.

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