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Assessment of macro and micro elements present in three commonly eaten vegetables in Nigeria

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ABSTRACT

The study investigated the nutritive elements of four species of *Basella* and two other commonly eaten vegetables (*Amaranthus hybridus* and *Talinum triangulare*). The vegetables are found throughout the year. The mineral compostion of the vegetables was carried out using standard procedures to determine which of these would be of more health benefit to the consumers. Leaves were collected at the initiation of flowering and air-dried under shade for 7 days after which they were kept in an oven at 60°C for 24 hours. These dried materials were mechanically powdered and stored in airtight containers until used for analysis. The phosphorous content of the vegetables ranged from 83.95±0.01 to 136.30±0.01 mg/100g. The potassium content ranged from 733.20±17.7 mg/100g to 4084.20±0.03 mg/100g. Sodium content in the vegetables ranged from 89.25±0.04 to 241.50±0.02 mg/100g. Zinc content ranged from 8.00±2 mg/100g to 28.90±4 mg/100g. The mineral contents of the *Basella* forms are comparable to *Amaranthus hybridus* and *Talinum triangulare*. Overlap observed in the values of the nutrient elements suggests interspecies relationship. Copper was present in *Basella rubra* and *Amaranthus hybridus,* while Molybdenum was absent in all. This study revealed that the consumption of these vegetables is dependent on the dietary need of the users.

Keywords: Consumption, diet, nutrient, values, vegetables.

INTRODUCTION

Green leafy vegetables are important in the diet of Africans and Nigerians in particular because they are rich in essential nutrients and energy. They contain both essential and toxic elements over a wide range of concentrations (Okorondu et al., 2013) which can be successfully utilized to build up and repair the body as well as maintain alkaline reserve of the body (Okolo et al., 2015). They also act as buffering agents for acidic substances produced during the digestion process (Badau et al., 2013. Most vegetables add taste and flavour to the monotonous starchy foods and some are rich in essential oils, glycosides and pigments which stimulate appetite. The large number of species and varieties of vegetables are raw materials for preparing a variety of soups, thus, improving the range of enriching food. The chemical composition of vegetables shows high water content, sugars, protein,

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starch, fat, energy value (in calories) (Caunii et al., 2010).

Vegetables are the edible plants that are consumed wholly or in parts, raw or cooked as part of main dish or salad (Fasuyi, 2006). Green leafy vegetables occupy an important place among the food crops because they provide adequate amounts of vitamins and minerals for humans. They are rich sources of oil, carbohydrates, carotene, ascorbic acid, riboflavin, folic acid and minerals like calcium, iron, zinc, magnesium, manganese, depending on the type of vegetable consumed (Fasuyi, 2006). They are typically low in calories and fat, and high in protein per calorie, dietary, fiber, vitamin C, pro-vitamin A, carotenoids, foliate, manganese and vitamin K (Adjatin et al., 2013). Leafy vegetables are highly beneficial for maintenance of health and prevention of diseases (Aregheore, 2012).

Consumption of leafy vegetables have been reported to contribute to the improving the health status of marginal population in developing countries (Achikanu et al., 2013). Fruits and vegetables are important components of healthy diet and including fruits and vegetables as reported by World Health Organization (W.H.O) (2019). Part of the diet reduce the risk of some non-communicable diseases such as cardiovascular disease and certain types of cancer, prevents weight gain and risk of obesity. A daily recommended value of 400 grams have been reported to improve overall health.

The importance of vegetables is well discussed in scientific literatures. The aim of this study is investigate the mineral compositions of the species of *Basella*, *Amaranthus*. *hybridus* and *Talinum triangulare* found in Ondo, Nigeria.

MATERIALS AND METHODS

Plant Collection

Plant materials (seeds) were collected from different parts of south-western Nigeria and were planted and established on the field at Adeyemi College of Education, Ondo. Seeds were sown in well drained loamy prepared by loosening the soil with shovel and ridges were made. Seedlings were transplanted after two weeks of germination and spacing between plants were 25 cm between rows and 20 cm within rows. The plants were rain fed and no fertilizer was applied. The experiment was arranged in a randomized complete block design with 3 replicates each. The plants are species of *Basella* (*B. rubra* Linn, *B. cordifolia* Lamk, *B. alba* Linn, having ovate leaves, and *B. alba* with almost round leaves), *A. hybridus* and *T. triangulare*. Weeding was done at intervals. Leaves were collected at the initiation of flowering and dried under shade for 7 days after which they were kept in an oven at 60ºC for 24 hours. These dried materials were mechanically powdered and stored in airtight containers until used for analysis.

Mineral analysis

X - Ray Fluorescence (XRF) was used to determine the following elements; Potassium, Calcium, Copper, Iron, Manganese, Zinc, Chlorine, Rubidium and Molybdenum. The dried powdered of the leaves of the *Amaranthus hybridus*, *Talinum triangulare* and four forms of *Basella*, were pulverized and pelletized into pellets using a 13mm dice with the aid of hydraulic press. The pellets of each sample were then irradiated with X-ray in a sample chamber for 20 seconds viz-a viz a current at 50 µA and a voltage at 25 KV using X-ray machine; Model PX2CR, Power supply and Amplifier for XR-100CR S detector.

The sample spectrum was gotten with the aid of FTIR-ATR software and each element was identified on a respective peak for qualitative analysis. The quantitative analysis was performed with the aid of software called X-Ray Fluorescence with Fundamental Parameters (XRS–FP) which employed fundamental parameter techniques. X-Ray Fluorescence (XRF) analysis was carried out at the Centre for Energy Research, Obafemi Awolowo University, Ile-Ife, Nigeria and were done in triplicates.

Atomic Absorption Spectrophotometry was used to determine Sodium, Magnesium, Phosphorous, Molybdenum and Mercury**.** Grounded leaves of *Amaranthus* hybridus, *Talinum triangulare* and four forms of *Basella* were analyzed for Sodium, Magnesium, Phosphorous, Molybdenum and Mercury. Two (2.0) g of each of the processed four forms of *Basella*, *Amaranthus* and *T. triangulare* was weighed and subjected to dry ashing in a well – cleaned porcelain crucible at 550ºC in a muffle furnace. The resultant ash was dissolved in 5.0 ml of $HNO_3/HCl/H_2O$ at ratios 1:2:3 and heated gently on a hot plate until brown fumes disappeared. To the remaining material in each crucible, 5.0 ml of de-ionized water was added and heated until a colorless solution was obtained. The mineral solution in each crucible was transferred into a 100 ml volumetric flask by filtration through Whattman No. 42 filter paper and the volume was made to the mark with de–ionized water. This solution was used for elemental analysis by atomic absorption spectrophotometer. A 10 cm long cell was used and concentration of each element in the sample was calculated on percentage (%) of dry matter i.e. mg/100 g sample. Phosphorus content of the digest was determined colorimetrically. Atomic Absorption Spectrophotometric analysis was carried out at the laboratory of National Institute of Science, Laboratory and Technology (NISLT) Samonda, Ibadan, Nigeria. Analyses were done in triplicates.

RESULTS

Phosphorous: The phosphorous content of the vegetables ranged from 83.95±0.01 to 136.30±0.01 mg/100g. *T. triangulare* had the least, 83.95±0.01 mg/100g. *B. alba* round, 89.33±0.04 mg/100g; *B. alba*, 114.52 ± 0.02 mg/100g; *B. cordifolia* 121.43 ± 0.01 mg/100g; *B. rubra*, 128.96 ± 0.01 mg/100g while *A. hybridus*136.33 ± 0.01 mg/100g.

Potassium: The potassium content ranged from 733.20±17.70 mg/100g to 4084.20±0.03 mg/100g. *B. alba* round had the highest 4084.70±0.03 mg/100g. *B. rubra*, 3325.30±0.04 mg/100g; *B. cordifolia* 3698.30±0.04 mg/100g; *B. alba* 3409.30±0.04 mg/100g; *A. hybridus* 733.20±17.70 mg/100g while *T. triangulare* had 4053.00±0.03 mg/100g.

Sodium: Sodium content in the vegetables ranged from 89.25±0.04 mg/100g to 241.50±0.02 mg/100g. *B. alba* form had the highest sodium content 241.50±0.02 mg/100g while *A. hybridus* has the least, 89.25±0.04 mg/100g. *B. rubra* has 92.00±0.02 mg/100g; *B. cordifolia* form 141.00±0.02 mg/100g; *B. alba* round 155.50 ±0.02 mg/100g and *T. triangulare* had 117.25±0.02 mg/100g of sodium.

Calcium: The Calcium content of the vegetables ranged from 737.80±12.00 to 3981.60 ± 0.03 mg/100g. *B. alba* round had the least calcium content, 737.80±12.00 mg/100g, *B. rubra*, 1340.80±0.02 mg/100g; *B. cordifolia*, 1076.00±0.02 mg/100g; *B. alba* had 1181.50±0.02 mg/100g; *Talinum triangulare*, 832.30±13.30 mg/100g and the highest calcium content occurred in *Amaranthus hybridus*, 3981.60± 0.03 mg/100g.

Magnesium: The value for magnesium in these vegetables ranged from 52.37±0.05 to 309.48±0.02 mg/100g. The value for magnesium in *B. rubra* is 52.37±0.05 mg/100g; *B. cordifolia*, 309.48±0.02 mg/100g which was the highest value. *B. alba*, 1677.50±0.04 mg/kg; *B. alba* round 53.13±0.03 mg/100g; *Amaranthus hybridus*, 102.13±0.02 mg/100g and *Talinum triangulare*, 281.88±0.02 mg/100g.

Manganese: The ranges of value of manganese in the vegetables were 2.30±0.00 to 11.40±6.00 mg/100g. *B. rubra*, *B. alba* round and *T. triangulare* had manganese values of 2.30±0.00 mg/100g each. Manganese was not detected in *B. alba*. The value of manganese for *B. alba* cordate form is 9.40± 0.50mg/100g while *A. hybridus* had 11.40±0.60 mg/100g, the highest value of manganese among the vegetables.

Iron: The Iron content of the vegetables ranged from 11.80±4.00 to 119.60 ±19.00 mg/100g. *B. alba* round had the least value of 118±4 mg/kg; *B. rubra*, 38.80±0.80 mg/100g; *B. cordifolia*, 23.30__±0.7 mg/100g; *B. alba*, 29.80±0.70 mg/100g; *A. hybridus*, 119.60± 1.90 mg/100g and *T. triangulare*, 22.60±0.50 mg/100g.

Zinc: The Zinc content ranged from 8.00±0.20mg/100g to 28.90±0.40 mg/100g. The highest value of Zinc was found in *B. cordifolia*, 28.90±0.40 mg/100g while the least value was encountered in *A. hybridus* 8.00±0.20 mg/100g. The value of Zinc in *B. rubra* is 26.10±0.40 mg/100g, *B. alba* 26.80±0.40 mg/100g; *B. alba* round 17.7±0.30 mg/100g; *T. triangulare*, 8.50±0.20 mg/100g.

Chlorine: Chlorine values of the vegetables ranged from 106.10±4.00 to 373.80±8.20 mg/100g. Chlorine was not detected in *A. hybridus*. Chlorine value for *B. rubra* is 291.20±7.20 mg/100g*; B. cordifolia*, 189.70±6.40 mg/100g; *B. alba* 378.80±8.20 mg/100g and this was the highest. *B. alba* round, 170.40±4.80 mg/100g and *T. triangulare*, 106.10±4.00 mg/100g and this was the least value.

Rubidium: Rubidium content of the vegetables ranged from 0.90±0.00 to 2.20±0.10 mg/100g. The value of Rubidium for *B. alba* round form and *T. triangulare* was 0.90±0.00 mg/100g, *B. rubra*, 1.20±0.10 mg/100g; *B. alba*, 2.20±0.10 mg/100g. Rubidium was not detected in *B. cordifolia* and *A. hybridus*.

Copper: The Copper content of the vegetables ranged from 1.70±0.00 to 62.20±0.50 mg/100g, copper was not detected in *B. cordifolia*, *B. alba*, *B. alba* round form and *T. triangulare*. The copper value for *B. rubra* is 1.70±0.00 mg/100g and that of *A. hybridus* was 62.20±0.50 mg/100g.

Molybdenum: Molybdenum was not present in all the vegetables.

DISCUSSION

Most of the nutritive elements observed in this study are the dominant ones in plants. According to Caunii et al. (2010) these elements produce alkalizing effects on acidic foods.

Phosphorous: The Phosphorous value determined by Asaolu et al. (2012) is 15.38 g/100g for *Basella* and 32.63 g/100g for *Amaranthus*. Phosphorous is an essential component of bone mineral. Deficiency of phosphorous – calcium balance results in osteoporosis, arthritis, pyorrhea, rickets and tooth decay (Asaolu et al., 2012). The functions of phosphorus in the body include mineralization of bones and teeth, facilitation of energy transaction, absorption and transport of nutrients, regulation of protein activity, component of essential body compounds and in regulation of acid-base balance. The recommended dietary intake of phosphorus for adults is 700 mg per day (Srilakshmi, 2006). The value of phosphorous recorded for the *Basella* forms and the two other vegetables are more than the recommended value for daily intake. These vegetables are good sources of this element. A deficiency in phosphorus is rare but can result in weak or fragile bones, teeth, fatigue, weakness, loss of appetite, joint pain and stiffness, confusion, less energy, and a susceptibility of infections.

Potassium: The values of potassium in all the *Basella* forms are close to each other and that of *T. triangulare*, suggesting that when there is absence of *Basella* forms. T. triangulare can be used and vice versa. Asaolu et al. (2012) reported that *Amaranthus* has 168.96 mg/100g and *Basella* has 16.85 mg/100g of potassium. Potassium is the principal intracellular cation and mainly involved in membrane potential and electrical excitation of nerve muscles (Rahmatllah and Mahbobeh, 2010; Asaolu et al., 2012). Potassium functions in maintaining water balance and distribution via the sodium potassium pump, acid-base balance, muscle and nerve cell function, energy production, heart function, kidney and renal function, insulin secretion and in the prevention and treatment of; hypertension by regulating normal blood pressure. (Idrayan et al., 2005). The recommended dietary intake of potassium for adult is 2000 mg per day (Idrayan et al., 2005). The amount of potassium recorded in this study for the vegetables are well above the recommended value, thus the vegetables are good sources of this element.

Sodium: Sodium ranged from 920±0.02 mg/kg in *B. rubra* to 241.50±0.02 mg/100g in *B. alba*. The Sodium content of *B. cordifolia* and *B. alba* round are 141.00±0.02 mg/100g and 155.50±0.02 mg/100g. *A. hybridus* had the least sodium content; 89.25±0.04 mg/100g while *T. triangulare* had 117.25±0.02 mg/100g. The value of sodium in the green stemmed *B. alba* forms are higher than that of *A. hybridus* and *T. traingulare*. Mensah et al. (2008) reported a value of 5.11mg/100g while Asaolu et al. (2012) reported a value of 15.01mg/100g.

The major functions of sodium in the body include regulating blood pressure and water balance in cells; maintaining acid-base balance and aiding in muscle contraction and nerve impulse transmission. Deficiency is rarely caused by inadequate dietary intake; rather it is usually caused by vomiting and diarrhea. The symptoms of deficiency include weakness, dizziness, headache, muscle cramps, shock etc. The recommended dietary intake of sodium for adult is 2300 mg per day. Too much sodium may lead to high blood pressure in those who are sensitive to sodium. Sodium may lead to a serious build-up of fluid in people with congestive heart failure, cirrhosis or kidney disease. (Idrayan et al., 2005).

The values of sodium in the vegetables studied are lower than the recommended daily intake, they can however be used to supplement the diet. In this case there would not be too much or too low of sodium intake, indicating no adverse health implication.

Calcium: Calcium ranged from 737.80±12.00 mg/100g in *B. alba round* to 1340.80 mg/100g in *B. rubra*. *B. cordifolia* has 1076.00±0.02 mg/100g while *B. alba* has 1181.50±0.02 mg/100g. *A. hybridus* and *T. triangulare* have calcium values of 3981.60±0.03 mg/100g and 832.30±13.30 mg/100g. Value of calcium in *A. hybridus* is higher than those of the *Basella* while the value in *T. triangulare* is close to that of *B. alba* round but a bit higher. Mensah et al. (2008) noted a value of 2.32 mg/100g for *B. rubra* while Asaolu et al. (2012) reported a value of 61.19 mg/100g. These authors also recorded the following values for *Amaranthus* as 2.05 mg/100g and 70.40 mg/100g respectively.

The values of Calcium in this study are at variance with those reported in literatures; however, there might be other factors such as environmental especially soil chemical constituents that could have led to the differences.

Calcium has been described as the major component of bones and assists in teeth development. Calcium is a mineral needed for strong bones and teeth, good posture, walking and they are believed to be beneficial until you grow older. Calcium deficiency lead to osteoporosis which is a condition associated with a loss in bone density and bone mass and is primarily found in middle age and elderly women. Its major symptom is an increased vulnerability to bone fractures (Idrayan et al., 2005). The recommended dietary intake of calcium for adult is 1,000mg per day. The Calcium contents of the vegetables are quite high to meet the recommended dietary intake.

Magnesium: Magnesium ranged from 52.38±0.05 mg/100g in *B. rubra* to 309.48±0.04 mg/100g in *B. cordifolia. B. alba* has 167.75±0.04 mg/100g while *B. alba* round has 53.13±0.03 mg/100g. *A. hybridus* and *T. triangulare* had magnesium values of 102.13±0.02 mg/100g and 281.88±0.02 mg/100g respectively. Mensah et al. (2008) noted a value of 0.06 mg/100g for *B. rubra* while Asaolu et al. (2012) reported a value of 27.51mg /100g. These authors also recorded the following values for *Amaranthus*, 2.53mg/100g and 249.92 mg/100 g respectively. The values of Magnesium in this study are higher than those reported in literatures. Magnesium is the most abundant intracellular divalent cation and it is a cofactor for a multitude of enzymatic reactions that are important for the generation of energy from ATP and for physiological processes, including neuromuscular function and maintenance of cardiovascular tone (Rahmatllah and Mahbobeh, 2010). FAO/WHO (2002) reported that soft tissue magnesium functions as a cofactor of many enzymes involved in energy metabolism, protein synthesis, RNA and DNA synthesis and maintenance of the electrical potential of the nervous tissues and cell membranes and that magnesium is important in regulating potassium influxes and its involvement in the metabolism of calcium.

Rahmatllah and Mahbobeh (2010) noted that geochemical and other variables rarely have influence on its contents in foods. Thus any difference observed in this study when compared with literatures could not have resulted from variation in environmental factors because it is stable. Recommended daily allowance (RDA) is 400mg per day for men 19 – 30 years old and 310 mg for women between 19 – 39 years old (FNB,1997). The vegetables will supply part of needed Magnesium in the diet.

Manganese: Manganese ranged from 2.30± 0.00 mg/100g in *B. alba* round, *B. rubra* and *T. triangulare* to 9.40 ±0.50 mg/100g in *B. cordifolia*. *A. hybridus* had the highest value of manganese, 11.40±0.60 mg/100g. Manganese was not detected in *B. alba*.

Dietary deficiency of manganese affects the central nervous systems and cause skeletal anomalies in children (Barminas et al., 1998). Manganese is a trace mineral that is present in tiny amounts in the body. It is found mostly in bones, the liver, kidneys, and pancreas. Manganese helps the body form connective tissues, bones, blood clotting factors, and sex hormones. It also plays a role in fat and carbohydrate metabolism, calcium absorption, and blood sugar regulation. Manganese is also necessary for normal brain and nerve functions. The recommended daily allowance of manganese is 2.5 to 5.0 mg (FAO/WHO, 2002). The manganese contents of the vegetables studied is greater than the daily allowance. Therefore, they are good sources of Manganese in the human diet.

Iron: Iron content ranged from 11.80± 0.40 mg/100g in *B. alba* round to 38.80±8.00 mg/100g in *B. rubra*. *B. alba* has 29.80±7.00 mg/100g while *B. cordifolia* has 23.30±7.00 mg/100g. Among the vegetables studied, *A. hybridus* has the highest value, 119.60±1.90 mg/100g while *T. triangulare* has 22.60±5.00 mg/100g. Mensah et al. (2008) reported a value of 0.04 mg/100g for *B. rubra*. Asaolu et al. (2012) reported a value of 34.47 mg/100g. These authors also recorded the following values for *Amaranthus*, 0.12mg/100g and 39.04mg/100g respectively. Majolagbe et al. (2013) reported that the iron concentration of *B. alba* is 107 ± 7µg/g and this falls within the WHO range of 70 – 200 µg/g. The values of Iron in the vegetables studied are higher than those reported as well as higher than WHO recommendation, thus good sources of iron. U.S Food and Nutrition Board (2001) recommended daily allowance of iron for adults as 8mg for the men and 18mg for the women. This shows that the vegetables studied are good sources of iron because their iron content are within the recommended value.

Iron is important in the diet especially for pregnant women and nursing mothers as well as infants. It is also needed by the convalescent and the elderly to reduce cases of disease associated with iron deficiency such as anaemia. Anaemia is characterized by fatigue, shortness of breath, pale skin, concentration problem, dizziness, weakened immune system and energy loss (Majolagbe et al., 2013). Iron plays crucial role in haemopoiesic, control of infection and cell mediated immunity (Bhaskaran, 2001). Iron is an essential component of haemoglobin and facilitates the oxidation of carbohydrates, proteins, and fat, thereby controlling body weight, which is an important factor in diabetes (Khan *et al*., 2008). Majolagbe et al. (2013) also noted that excessive dietary iron is toxic. The excess ferrous iron reacts with peroxides in the human body, producing free radicals. The side effects of taking high doses of iron include constipation, nausea and vomiting and stomach pain. Very high doses of iron can be fatal, particularly in children, a disease called hemochromatosis results. The excess iron accumulates in the liver, resulting in siderosis and organ damage. However, iron deficiency anaemia is the most common form of anaemic conditions in growing children. The deficiency is also found in young girls and women due to excessive monthly menstrual bleeding.

Zinc: Zinc ranged from 17.70 ± 0.30 mg/100g in *B. alba* round to 28.90 mg/100g in *B. cordifolia*. *B. alba* has 26.80±0.40 mg/100g while *B. rubra* has 26.10±0.40 mg/100g. Zinc content of *A. hybridus* is 8.00±0.20 mg/100g while that of *T. triangulare* is 8.50±0.20

mg/100g. The Zinc contents of the *Basella* forms are higher than those of *A. hybridus* and *T. triangulare*. Zinc value in this study are higher for the *Basella* forms than the report by Asaolu et al. (2012) which is 3.71 mg/100g for *Basella* and 21.63mg/100g for *Amaranthus* respectively. Zinc is important for nerve function and male sterility (Mohammed and Sharif, 2011). It is important for normal sexual development especially for the development of testes and ovaries, it is also essential for reproduction (Ayoola et al., 2010), healthy functioning of the heart and normal growth. Soetan et al. (2010) noted that the primary roles of zinc appear to be in cell replication and gene expression and in nucleic acid and amino acid metabolism. They noted also that vitamins A and E metabolism and bioavailability are dependent on zinc status. It is necessary for optimum insulin action as zinc is an integral constituent of insulin.

Zinc is an essential mineral that is naturally present in some foods, added to others and available as a dietary supplement. Zinc is found in cells throughout the body. It is needed for the body's defensive (immune) system to properly work. It plays a role in cell division, cell growth, wound healing and the breakdown of carbohydrates. Zinc is also needed for the senses of smell and taste. During pregnancy, infancy, and childhood the body needs zinc to grow and develop properly. The recommended dietary intake of zinc for adult is 11mg per day (Orazulike, 2003). The vegetables studied are good sources of Zinc and are recommended for consumption.

Rubidium: Rubidium ranged from 0.90±0.00 mg/100g in *B. alba* round to 2.2±0.10 mg/100g in *B. alba*. *B. rubra* has 1.20±0.100 mg/100g of Rubidium while it is 0.90±0.00 mg/100g in *T. triangulare*. Rubidium is not observed in *B. cordifolia* and *A. hybridus*. Literatures on the presence of rubidium in vegetables are scarce. Rubidium prevents the lesion characteristic of potassium depletion in rats (Soetan et al., 2010). This study has filled the knowledge gap of natural sources of Rubidium.

Copper: Copper was present only in *B. rubra* with a value of 17.0±0 mg/kg and in *A. hybridus* with a value of 622±5 mg/kg. Asaolu et al. (2012) reported the value of copper for Indian spinach has 0.14 g/100g. Other vegetables in this study did not have copper.

Copper is an essential micronutrient which functions as a biocatalyst required for body pigmentation in addition to iron, maintain a healthy central nervous system, prevent anaemia and interrelated with functions of zinc and iron (Akinyele and Osibanjo, 1982). Copper along with iron, help in the formation of red blood cells. It also helps in keeping the blood vessels, nerves, immune system and bones healthy. The recommended daily intake of copper for adult is 900 µg per day. Although the amount of Copper found in the *B. rubra* and *A. hybridus* is higher than the recommended dose, it will be necessary to look out for other sources of the nutrient in order to meet dietary needs.

Molybdenum: Molybdenum was not observed in all the vegetables. This confirms the report of Mohammed and Sharif (2011) that information on the presence of molybdenum in plants is scarce. However, the recommended daily allowance for molybdenum is 0.075 to 0.250 mg/g (Nielson, 1996). Molybdenum is a cofactor for enzymes necessary for the metabolism of sulphur containing amino acid and nitrogen containing compounds present in DNA and RNA, the production of uric acid and the oxidation and detoxification of various compounds (Soetan et al., 2010). There is the need therefore to search for more natural sources of Molybdenum.

Table 1: Nutritive element analysis of the four forms of *Basella*, *Amaranthus* and *T. triangulare* (mg/100g).

Nutrient	***B. rubra***	***B. alba***	***B. cordifolia***	***B. alba* round**	***A. hybridus***	***T. triangulare***
Phosphorus	128.96±0.01	114.52±0.02	121.43±0.01	89.33±0.04	136.33±0.01	83.95±0.01
Potassium	3325.30 ± 0.04	3409.30 ± 0.04	3698.30± 0.04	4084.20± 0.03	733.20± 177	4053.00 ± 0.03
Sodium	92.00±0.02	241.50±0.02	141.00±0.02	155.50±0.02	89.25±0.04	117.25±0.02
Calcium	1340.80 ± 0.02	1181.50± 0.02	1076.00 ± 0.02	737.80±2.00	3981.60 ±0.03	832.30 ± 13.30
Magnesum	52.38±0.05	167.75±0.04	309.48±0.02	53.13±0.03	102.13±0.02	281.88±0.02
Manganese	2.30±0.00	-	9.40 ± 0.50	2.30 ± 0.00	11.40 ± 0.60	2.30 ± 0.00
Iron	38.80 ± 0.80	29.80 ± 0.70	23.30 ± 0.70	11.80 ± 0.40	119.60± 1.90	22.60 ± 0.50
Zinc	26.10 ± 0.40	26.80 ± 0.40	28.90 ± 0.40	17.70 ± 0.30	8.00 ± 0.20	8.5 ± 0.20
Chlorine	291.20 ± 7.20	373.80 ± 8.20	189.70 ± 6.40	170.40 ± 4.80	-	106.10 ± 4.00
Rubdium	1.20 ± 0.10	2.20 ± 0.10	-	0.90 ± 0.00	-	0.90 ± 0.00
Copper	1.70 + 0.00	-	-	-	62.20 ± 0.50	-
Molybdenum	-	-	-	-	-	-

Legend: - =Absence of nutrients

Conclusion

All the vegetables are good sources of the nutrient elements studied and within recommended value. The nutrient element contents of the *Basella* forms are comparable to *A. hybridus* and *T. triangulare*. The optimal intake of sodium, potassium, magnesium, calcium, manganese, copper and zinc could reduce individual risk factors, including those related to cardiovascular disease (Rahmatllah and Mahbobeh, 2010). They can be consumed interchangeably as they all possess the necessary nutrient elements for normal growth.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

Collections of preliminary data and collection of samples during survey were done by TAA-A. The interpretation of results, analysis of data, discussion, writing original draft and editing were done by both authors (FMO and TAA-A). The financial aspect of the research was also done by both authors.

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