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Vitamin C Quantification and Elemental Analysis of Five Local Vegetables in Jos-South Local Government Area of Plateau State, Nigeria

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ABSTRACT

Vegetables provide adequate amount of vitamins and minerals for humans and contain some bioactive compounds which have antioxidant properties. The study was conducted to quantify Vitamin C content and other major elements such as Na, K, Ca, Mg and P of local vegetables namely; spring onion, cabbage, Chinese cabbage, Karkashi and lettuce leaves eaten as food in Jos-South Local Government Area of Plateau State, Nigeria. Fresh vegetables were separately reduced into pieces and blended with 50 ml distilled water using 'Calamansi' juice extractor, filtered and then marked up to 100 ml with distilled water. The extracted juice was titrated against standardized iodine solution after its initial volume was noted until a permanent dark-blue color was obtained and the final volume of iodine solution in the burette recorded. The concentration of Vitamin C was then calculated. The elemental analysis was done on dried samples using atomic absorption spectrophotometer. The data were analyzed using WHO daily requirement standard and student's t-test was used to evaluate the significant difference between the mean value of the measured parameters in the respective test and control samples. The results revealed that the vegetables contained appreciable amount of Vitamin C and Na, K, Ca and Mg and should be included in diets to supplement the daily allowance needed by the body to meet the nutritional requirement of normal growth and adequate protection against diseases.

Keywords: Spring onion, Cabbage, Chinese cabbage, Karkashi and lettuce

INTRODUCTION

Green leafy vegetables constitute an indispensable constituent of the human diet [1,2]. Apart from the variety which they add to the menu, they are also valuable sources of daily nutrients needed by the body [3]. Low consumption of green leafy vegetables in diets is one of the major factors which lead to a deficiency of vitamins, minerals and iron in the body since they cannot be synthesized by humans [4]. Vitamin C is required for the prevention of scurvy, maintenance of healthy skin, gums and blood vessels helps in collagen formation, absorbs inorganic iron, reduce plasma cholesterol level, inhibits nitrosamine formation, enhances immune system functioning and acts as an antioxidant by reacting with singlet oxygen and other radicals to reduce the risk of arteriosclerosis, cardiovascular diseases and some forms of cancer [5,6].

MATERIALS AND METHODS

Plant collection, identification and preparation

Samples of vegetables: spring onion, cabbage, Chinese cabbage, Karkashi, and lettuce leaves were collected from Jos- South Local Government Area of Plateau, Nigeria on the 21st June 2017 and were identified in the field using descriptions and keys described by Flora of West Tropical Africa and Woody Plants of Ghana [7,8]. The identity of the leaves was authenticated at the Department of Horticulture and Landscape Technology, Federal College of Forestry, Jos by a taxonomist and assigned Voucher specimen Numbers (FHJ 341, FHJ 342, FHJ 343, FHJ 344 and FHJ 345) respectively. All the extraneous matters were removed and the leaves properly washed with water and made ready for the extraction process.

Plants extraction

The vegetables were separately reduced into pieces and blended with 50 ml distilled water using '*Calamansi*' juice extractor. The juices were filtered into separate beakers and poured into separate graduated cylinders and the solutions were diluted to 100 ml in each case and stored in a refrigerator at the temperature of 5 until when required for use.

Chemicals and reagents

Analytical graded chemicals purchased from Sigma-Aldrich Company (St. Louis, MO, USA) used include 1% starch solution, 10% H_2SO_4, 70% Perchloric acid, 2% Iodine solution, 10% HNO_3 and Standard ascorbic acid solution (stock standard solution was prepared by dissolving 0.25 g of ascorbic in 100 ml of distilled water and then made up to 250 ml in a volumetric flask).

Standardization of iodine solution

Vitamin C standard solution (25 ml) was measured and transferred into 125 ml Erlenmeyer flask and 10 drops of 1% starch solution was added and mixed with it. A burette was rinsed with a small volume of iodine solution and then filled with an iodine solution. The initial volume of the iodine solution was noted. The iodine solution was then titrated against the standard Vitamin C solution until a blue color that persisted for 20 seconds of swirling was observed (Table 1). The final volume of the iodine solution in the burette was recorded and subtracted from the initial volume to determine the volume of the iodine used. The procedure was repeated two more times and the average was determined. The concentration of iodine solution was then determined using the equation

$$M = \frac{\text{Mass (Vitamin C)} \times 1 \text{ mole (Vitamin C)} \times 1000\text{ml/L}}{176.12\text{ g} \times \text{volume (iodine solution)}}$$

Where M is the concentration of iodine solution and 176.12 g is the molar mass of Vitamin C.

Procedure for determination of Vitamin C

The methods described by Akinnibosun and Adeola [9] and Olujobi [10] were adopted with modifications. Sample solution (25 ml) was measured and poured into 125 ml Erlenmeyer flask and 10 drops of 1% starch solution was added and mixed with it. A burette was rinsed with a small volume of iodine solution and then filled with an iodine solution. The initial volume of the iodine solution was noted. The iodine solution was then titrated against the standard Vitamin C solution until a blue color that persisted for 20 seconds of swirling was observed. The final volume of the iodine solution in the burette was recorded and subtracted from the initial volume to determine the volume of the iodine used. The procedure was repeated two more times and the average was determined to find the amount of Vitamin C present in the different samples of the fresh vegetables using the equation:

Mg (Vitamin C) = M (Iodine solution) × ml (Iodine solution) × 176.12 g/mole

Where Mg is the concentration of Vitamin C, M is the concentration of iodine solution, ml is the volume of iodine solution used and 176.12 g/mole is the molar mass of Vitamin C (Table 2).

Method used for elemental analysis

The method described by Achikanu et al., [11] was used with modifications. The minerals in the leafy vegetables were analysed from the solution obtained when 0.2 g of the powdered samples were digested with 1.2 ml of 70%

perchloric acid, 1 ml of 10% H_2SO_4, and 5 ml of 10% HNO_3. The mixtures were placed on a water bath and evaporated to dryness. The solution was cooled and filtered into a 100 ml standard flask and diluted to the required volume with distilled water. An atomic absorption spectrophotometer was then used to analyze the minerals after acid digestion.

Statistical analysis

The data were analyzed using the WHO daily requirement standard for Vitamin C: 45 mg/day; Calcium: (1000-1200) mg/day, Potassium: (4500-4700) mg/day, Magnesium: (320-420) mg/day, Sodium: (1200-1500) mg/day and Phosphorus: (580-1055) mg/day [12] and student's t-test to evaluate the significant difference between the mean value of the measured parameters in the respective test and control samples (Table 3).

RESULTS

Ethnobotanical survey

Table 1: Result of the standardization of iodine solution

Mass of Vitamin c used (g)	Initial volume of iodine solution used (ml)	Final volume of iodine solution used (ml)	Volume of iodine solution used (ml)	Concentration of iodine solution (m)
0.25	66.40	53.10	13.30	0.106728324
0.25	53.10	40.10	13.00	0.109191285
0.25	40.10	26.90	13.20	0.107536872

Table 2: Result of the concentration of Vitamin C in vegetables

Vegetables	Amount of Vitamin- C (mg/100 ml)
Spring Onion *(Allium fistulosum L.)*	43.04 ± 0.90
Cabbage *(Brassica oleracea var. capitate)*	17.09 ± 1.55
Chinese Cabbage *(Brassica rapa subsp. pekinensis)*	28.48 ± 1.55
Karkashi *(Sesamum indicum L.)*	29.12 ± 0.90
Lettuce *(Lactuca sativa)*	12.03 ± 0.90

Table 3: Result of the concentration of various elements in vegetables

Vegetables	Sodium (Na) (ppm)	Potassium (K) (ppm)	Calcium (Ca) (ppm)	Magnesium (Mg) (ppm)	Phosphorus (P) (ppm)
Spring Onion *(Allium fistulosum L.)*	3335	14000	2900	2500	ND
Cabbage *(Brassica oleracea Var. capitate)*	555	14000	2475	2700	ND
Chinese Cabbage *(Brassica rapa subsp. Pekinensis)*	1665	5000	755	2800	ND
Karkashi *(Sesamum indicum L.)*	1665	25000	5100	2600	ND

Lettuce *(Lactuca sativa)*	2220	30500	1755	2700	ND

DISCUSSION

The Vitamin C content of the five (5) major vegetables consume in Jos- South Local Government Area of Plateau State, Nigeria was found to be quantitatively and relatively appreciable as compared with the WHO recommended daily intake [12] with spring onion having the highest concentration and lettuce, with the lowest. The Vitamin C content of these vegetables could explain the alleged curative uses in herbal medicine by the locality for the treatment of sores, cuts, wounds, abscesses, malaria, skin diseases, cold, cardiovascular diseases, etc. and also proved its ability to scavenge free radicals and acts as antioxidant [13,14]. The vegetables contained Na, K, Ca, and Mg and the amounts were within the daily intake of elements recommended by W.H.O [12] except for the amount of sodium in Karkashi and Calcium in cabbage which were just a little lower. Phosphorus content was not detectable; not necessarily because it was absent but the quantity contained might be negligible.

Sodium is an essential electrolyte that helps maintain the balance of water in and around the cells. It is important for proper muscle and nerve function and also helps in maintaining a stable blood pressure level. The low sodium level in the blood (*hyponatremia*) can lead to lethargy, confusion and fatigue. Too much sodium in the blood (*hypernatremia*) can increase the risk of high blood pressure, stroke and heart failure. It can also increase the risk of osteoporosis, stomach cancer, kidney diseases, kidney stones, an enlarged heart muscle, and severe headache and could even alter facial appearance [2].

Potassium is one of the most important minerals in the body. It helps regulate fluid balance, muscle contractions and nerve signals. Potassium in the diet may help reduce blood pressure and water retention, protect against stroke and prevent osteoporosis and kidney stones. Low level of potassium in the blood (*hypokalemia*) can cause muscle weakness, cramp, twitch or even muscle paralysis and abnormal heart rhythms. A high level of potassium in the blood (*hyperkalemia*) can lead to dangerous and possibly deadly charges in the heart rhythms [3]. Calcium is very essential in muscle contractions, oocyte activation, building strong bones and teeth, blood clotting, nerve impulse transmission, regulating heartbeat and fluid balance within the cells. Low calcium level in the blood (*hypocalcemia*) for a long time can lead to dental changes, cataracts, and alteration in the brain and osteoporosis which causes the bones to become brittle. High calcium in the blood (*hypercalcemia*) can lead to excessive thirst and urination and causes the kidneys to work harder. It also leads to stomach pain and digestive problems, bone pain, muscle weakness, confusion, lethargy, fatigue, depression, high blood pressure and abnormal heart rhythms [9]. Magnesium is needed for more than 300 biochemical reactions in the body. It helps to maintain normal nerve and muscle functions, supports a healthy immune system, keeps the heartbeat steady and helps bones remain strong. It also helps adjust blood glucose levels and in the production of energy and protein. Magnesium deficiency in the blood (*hypomagnesemia*) can result in muscle twitches and cramps, mental disorders, increased blood pressure, asthma and irregular heartbeats. Though magnesium toxicity is rare (*hypermagnesemia*), taking certain magnesium supplements at high doses may cause diarrhea accompanied by nausea and abdominal cramping [11].

The main function of phosphorus in the body is in the formation of bones and teeth. It plays an important role in how the body uses carbohydrates and fats and needed in the body for it to make protein for growth, maintenance, and repairs of cells and tissues. A low level of phosphorus in the blood (*hypophosphatemia*) occurs only when the phosphate level in the blood becomes very low. Muscle weakness develops, followed by stupor, coma and death. In mild chronic hypophosphatemia, the bones can weaken, resulting in bone pain and fractures. Patients may become weak and lose their appetite. High phosphorus levels in the blood can cause damage to the body by pulling calcium out of the bones and make them weak [14].

CONCLUSION

The present study has shown that the Nigerian vegetables examined in Jos- South Local Government Area of Plateau State have an appreciable quantity of Vitamins and minerals and if consumed in the right proportion, would contribute greatly towards meeting the nutritional requirement for normal growth and protection against diseases. This explained why the local people of the area use them for the management of malnutrition, bone and muscle weakness, and in combination with other herbs for the management of hypertension, edema and cardiac failure.

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