Nutrient Composition of Selected Indigenous Vegetables in Kendu Bay, Homa Bay County

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Abstract

This study aimed at assessing the nutrient and mineral composition of various selected indigenous vegetables, in Kendu Bay, Homa Bay County. The experimental design was adopted. A total of 48 samples for each vegetable variety were collected from various parts around Kendu Bay. Samples were collected from selected plants during flowering stage for purposes of botanical identification. Healthy and disease-free edible parts of the vegetables were selected to assess nutritional composition. Six samples; Solanumnigrum (Osuga), Cleome gynandra (Akeyo), Justiciaflava (Atipa), Amaranthushybridus (Ododo), Vignaunguiculata (Boo) and Crotalaria brevidens (Mitoo) were analyzed. The samples were manually washed with distilled water and residual moisture evaporated at room temperature. Samples were oven dried in paper envelope at 55°C for 24 hours, ground into fine powder using pestle and mortar and sieved through 20-mesh sieve. The sieved samples were weighed and 2.0 g subjected to wet ashing (digestion) and analysed for K, Mg, Ca, Fe, and Mn. The samples were macerated for vitamins A and C analyses. Moisture was analyzed by loss of mass on drying through oven drying. Minerals Mg, Ca, Fe and Mn were analyzed using atomic absorption spectrometry (AAS) while K was analyzed using both AAS and flame photometer. The vitamins; provitaminA (beta carotene) and vitamin C were analyzed using UV-spectrophotometry and titrimetric methods, respectively. The beta carotene contents of the vegetables were used to estimate retinol equivalent (vitamin A content). Moisture and ash contents of these vegetable species were determined using Association Official of Analytical Chemists (AOAC) methods. Validity of the instruments was tested by regression, Horwitz ratio and standard recovery method. The results obtained were ash 9.71-19.83 mg / 100 g, moisture 77-87%, all the vegetables had vitamin C above recommended daily allowance (RDA) of 40-70 mg, β-carotene 3.34-9.40 mg. Mineral contents varied among species with K 309 mg / 100g in Amaranthus hybridus, Mg 17-24 mg / 100 g, Ca 90-149 mg / 100 g, Mn 5.78-22 mg / 100 g, and Fe 41-77 mg / 100 g. The findings of the study will provide additional information on the nutritional status of the selected vegetable and will be of great interest to the consumers, farmers, the Ministry of Public health and nutritionists in the provision of public awareness.

Key Words: Indigenous Vegetables, Nutritional Composition, Essential Nutrients

INTRODUCTION

Nutrient analysis of vegetables plays a crucial role in assessing their nutritional significance (Grivetti & Ogle, 2000). In order to improve nutrition education programmes, knowledge of nutrient levels of indigenous vegetables is essential (Pretorius and Schonfeldt, 2011). Plant foods have almost all of the mineral and organic nutrients established as essential for human nutrition (Benbrook *et al.*, 2008). Vegetables hold an important position in well–balanced diets. Green leafy vegetables are believed to occupy a modest place as a source of trace elements due to their high water content (Marschner, 2012). Nutritional information is used increasingly by public agencies and agricultural industries to promote fresh products. Today, there is a high interest in nutrient contents in diets and consumers are aware of the health benefits of the nutrients. They have special interest in food sources rich in antioxidant vitamins (vitamins A, C and E), calcium, magnesium, and potassium and fibre (Guenther *et al.*, 2008). Most of these nutrient requirements can be solved by increasing the consumption of fresh vegetables. In addition to meeting nutrient intake levels, better consumption of fruits and vegetables is associated with reduced risk of cardiovascular diseases and stroke (Van Duyn & Pivonka, 2000).

Alongside other food alternatives, vegetables are considered cheap source of energy, vegetables are rich sources of essential biochemicals and nutrients such as carbohydrates, carotene, proteins, vitamins, calcium, iron, ascorbic acid and palpable concentration of trace minerals (Hussain *et al.*, 2009). Minerals

account for approximately 4% of body-weight. Some, such as calcium and phosphorus, are present in the body in relatively large amounts and are known as macronutrients whereas others occur in very small quantities and are known as trace elements (Van Duyn & Pivonka, 2000).

Vitamin A as such, naturally occurs only in animal materials-meat, milk, eggs (Olson, 1996). Plants contain vitamin A precursor, beta carotene. Humans and other animals need either vitamin A or beta carotene, which they easily convert to vitamin A (Yusuf *et al.,* 2000). Beta carotene is found in oranges and yellow vegetables as well as green leafy vegetables. A deficiency of vitamin A leads to blindness, failure of normal bone and tooth development in the young, diseases of epithelial cells and membranes of the nose, throat, and eyes, which can decrease the body's resistance to infection (Rosati *et al.,* 2000).

In order to be healthy, people need to eat foods that meet nutritional requirements (Hussain *et al.,* 2009). These food sources should be safe, cheap and readily available, for example, vegetables which are natural sources of nutrients. When nutrient rich foods are consumed in the diet, people are likely to have no problem of malnutrition (Benbrook*et al.,* 2008). In Kendu Bay, there is frequent use of the indigenous vegetable species by the local people in the diet. Consumption of foods without nutritional information increases risks of malnutrition and related diseases which could be costly on both the consumers and the government. The availability of information on nutrients will enable consumers to make informed choices. It is expected that the findings of this study will provide additional information of the nutritional status of the vegetables grown in the area.

MATERIALS AND METHODS

Research Design

The experimental research design was employed in this study and involved determination of nutritional composition of green leafy vegetables using atomic absorption spectrophotometry, flame photometry, UV-spectrophotometry, titrimetry, ashing and moisture methods. Food analysis involved quantitative determination of specific minerals and vitamins; ash and moisture contents in selected vegetables.

The study determined provitamin A (β-carotene), vitamin C, calcium, magnesium, potassium, iron and manganese levels in the selected vegetables (*Solanum nigrum*, *Cleome gynandra*, *Justicia flava*, *Amaranthus hybridus*, *Vigna unguiculata*, and *Crotalaria brevidens*). It was the intention of the study to find out whether these vegetables met the dietary requirements of the consumers, particularly vitamins and minerals.

There is limited data to show the nutritional status of the indigenous vegetables in Kendu Bay. It is expected that the findings of this study will provide additional information on the nutritional status of the vegetables grown in the area. The choice of the vitamins and minerals were based on their importance in human diet. Beta carotene and vitamin C were analyzed since they are found in green leafy vegetables. Mineral analysis involved the elements calcium, magnesium, potassium, iron and manganese.

It was envisaged that the findings of the study will provide additional information on the nutritional status of the vegetables: *Solanum nigrum*, *Cleome gynandra*, *Amaranthus hybridus Crotalaria brevidens*, *Vigna unguiculata* and *Justicia flava.* The findings of the study will be of great interest to farmers, the Ministry of Public health and nutritionists in the provision of public awareness. The above factors, therefore, justified the study.

Area of the Study

This study was carried out in Kendu Bay area, Rachuonyo North District, in Homa Bay County. The area has relatively low annual rain fall and sandy soil which favour growth of drought resistant indigenous vegetable. Any other county with the same soil type and climatic conditions would give the same results as obtained in Homa Bay.

Sampling and Pretreatment

Vegetable samples were collected from fields and gardens in various parts of Kendu Bay. The area was divided into two zones; Kendu Bay and Homa Bay. Kendu Bay consisted of East Karachounyo and the

neighbouring Oyugis town while Homa Bay consisted of West Karachuonyo and the neighbouring Homa Bay town. The area was zoned to take care of vegetables that could be getting into Kendu Bay area from the neighbouring Oyugis and Homa Bay towns, respectively. From each zone, 24 samples of each vegetable variety were collected. Samples were collected from selected plants in flowering and fruiting stage for correct botanical identification. Healthy and disease-free edible parts of vegetables were selected to assess nutritional composition.

For β-carotene analysis, samples from the two zones were mixed together and thoroughly homogenized to give a composite laboratory sample, which were quartered to get a representative test sample for each vegetable. The samples for mineral determination were manually washed with distilled water and residual moisture evaporated at room temperature. These were further dried in an oven until a constant weight was obtained and were stored in plastic bags free from moisture, ready for mineral analysis. Samples for vitamin and moisture analysis were not washed with water but were wiped with dry tissue paper and weighed for immediate analysis.

Quantitative Determination of Nutrients

Minerals were determined by atomic absorption spectrophotometry (AAS) and flame photometry methods. AAS method was used to analyze potassium, calcium, magnesium, manganese and iron while flame photometric method was used to analyze potassium element.

UV-spectrophotometry was used to analyze provitamin A whereas vitamin C was analyzed by titrimetric method.Total ash content was determined by dry ashing method. Wet ashing was used for samples for specific elemental analysis while moisture content was determined by oven drying method.

Moisture Determination by Drying Method

The moisture contents of the vegetables were determined according to the method described by Jacobs (1999): The percentage weight loss of water was calculated after removal of water by heating and after standardization. This technique is known as loss on drying (LOD). In this study a sample of material was placed in a clean, dry pre-weighed crucible and weighed using analytical balance (Mettler 160). The sample was heated in an oven (Universal Hot Air Oven, Vitco - India) for an appropriate period, cooled in the dry atmosphere of a desiccator and then reweighed. Moisture and total solid contents of foods were calculated as follows using oven drying procedures:

$$\text{Moisture content on a wet weight basis (wwb)} = \text{weight of wet sample} - \text{weight of dry sample}$$

$$\%\ Moisture\ Content = (\text{weight of wet sample} - \text{weight of dry sample})\ x\ 100$$

$$\%\ Moisture\ content\ (dry\ matter) = \frac{\%\ Moisture\ Content}{weight\ of\ dry\ sample}$$

$$\%\ total\ solid\ \left(\frac{w}{w}\right) = \frac{weight\ of\ dry\ sample}{weight\ of\ wet\ sample}\ x\ 100$$

Titrimetric Method for Vitamin C

Vitamin C contents in the vegetables were determined by titration with potassium iodate according to the method described by Spinola *et al.* (2012) and Kanafe & Azrin (2009). Potassium iodate was used as a titrant and when added to an ascorbic acid solution that contained strong acid and potassium iodide (KI), the KIO_3 reacted with KI, liberating molecular iodine (I_2) as below:

$$KIO_3 + 5KI + 6H^+ \rightarrow 3I_2 + 6K^+ + 3H_2O$$

During the titration, as long as the solution contains ascorbic acid, the iodine (I_2) produced in equation 1 is used up in a rapid reaction with ascorbic acid, AA, (equation 2), during which dehydroascorbic acid, DHA, ($C_6H_6O_6$) and iodide ion (I^-) are formed:

$$C_6H_8O_6 + I_2 \rightarrow C_6H_6O_6 + 2I^- + 2H^+$$

Once all the ascorbic acid has been consumed, any excess iodine (I_2) will remain in solution. This excess iodine reacts with starch to form an intensely blue coloured complex indicating that the endpoint is reached.

A 25 g blended sample was homogenized with about 50 ml of 5% metaphosphoric acid - 10% acetic acid solution. This was quantitatively transferred into a 250 ml beaker and filtered using a funnel and glasswool into a 250 ml volumetric flask. The residue in the funnel was washed using the extracting solvent. The filtrate and the washing were shaken gently for a homogeneous solution. It was then diluted up to the mark by the 5% metaphosphoric acid - 10% acetic acid solution. The solution was used to determine the content of vitamin C in the sample.

A 5.00 g of potassium iodide (KI) was dissolved in a 500 ml volumetric flask and filled to the mark with distilled water to make 0.06 M potassium iodide solution.A 0.268 g of potassium iodate (KIO_3) was dissolved in a 500 ml volumetric flask and filled to the mark with distilled water to make 0.0025 M potassium iodate solution.A volume of 4 ml of 3 M sulphuric acid was used for each titration to provide acidic condition.

Vitamin C standard solution: 0.250 g of vitamin C was dissolved in 100 ml of distilled water and diluted to volume in a 250 ml volumetric flask with distilled water.

A 1% Starch solution: 1.0 g of soluble starch was accurately weighed using analytical balance and made with a little water to form a paste. The paste was then poured with constant stirring into a 100 ml beaker containing boiling water and boiled for one minute. The solution was then allowed to cool and followed by the addition of 2 g of potassium iodide. It was finally transferred into a 100 ml volumetric flask and kept stoppered.

Standardization of potassium iodate solution with the vitamin C standard solution:A 25.0 ml of vitamin C standard solution was pipetted into an Erlenmeyer flask. A 4 ml of 3 M sulphuric acid and 5 ml of 0.06 M potassium iodide solution was added followed by 10 drops of 1% starch solution. A burette was rinsed with 10 ml of potassium iodate solution and then filled with the potassium iodate solution. The solution in the Erlenmeyer flask was titrated against potassium iodate solution until the end point was reached (the first sign of blue colour that remains after at least 20 seconds of swirling). This titration was repeated two more times and final volume recorded.

Molarity of potassium iodate was calculated as follows:

$$Molarity\ of\ Iodate = \frac{(molarity\ of\ ascorbic\ acid\ x\ \text{volume of ascorbic acid pipetted})}{volume\ of\ iodate\ titrated\ (titre)}$$

The standardized iodate solution was used in titration of analytical sample.

Titration of juice samples: A 25.0 ml of vegetable sample was pipetted into a 125 ml Erlenmeyer flask and treated as vitamin C standard above and then titrated against potassium iodate. The titration was repeated two more times and results recorded.
Concentration of vitamin C was determined by the formula:

$$Conc\left(\frac{mg}{100g}\right) = \frac{3\ x\ V\ x\ M\ x\ Mw\ x\ d\ x\ 100}{S}$$

V = volume of titrant (L)
M = molarity of titrant (mol L^{-1} = 0.0025)
Mw = molar mass for ascorbic acid (mg / mol = 176000 mg mol^{-1})
d = dilution factor = 10
S = sample weight (g = 25 g)

UV-Spectrophotometric Determination of Provitamin A

ProvitaminA contents in the indigenous vegetables were determined by the spectro-photometric method as described by Mustapha and Babura (2009) and Fikselova*et al.* (2008).

A sample of each vegetable was washed and ground to a fine pulp using pestle and mortar. The operation was done under dim light to reduce the rate of carotene oxidation. A 10 g of macerated sample was weighed using analytical balance (Mettler PE 160) for β-carotene analysis.

Into a conical flask containing 50 ml of 95% ethanol, 10 g of the macerated sample was placed and maintained at a temperature of 70-80^{o}C in a water bath for 20 minutes with periodic shaking. The supernatant was decanted, allowed to cool and its volume measured by means of a measuring cylinder and recorded as initial volume. The ethanol concentration was brought to 85 % by adding 15 ml of distilled water into a 100 ml volumetric flask and topping to the mark with absolute ethanol. This ethanol mixture was further cooled in a container of ice cold water for about 5 minutes. The sample mixture was transferred into a separating funnel and 25 ml of petroleum ether added and the cooled ethanol poured over it. The funnel was swirled gently to obtain homogeneous mixture and latter allowed to stand until two separate layers were obtained. The bottom layer was run off into a beaker while the top layer was collected into a conical flask. The bottom layer was transferred into the funnel, re-extracted with 10 ml petroleum ether for 5-6 times until the extract became fairly yellow.

The entire petroleum ether was collected into a 250 ml conical flask and transferred into separating funnel for re-extraction with 50 ml 80% ethanol. The final extract was measured and poured into amber sample bottles for further analysis.

The absorbance of the extract was measured using a spectrophotometer (UV/VIS Spectro Scan 30 Biotech Engineering Management Co. Ltd, UK) at a wavelength of 450 nm. A cuvette containing petroleum ether (blank) was used to calibrate the spectrophotometer to zero point. Samples of each extract was placed in cuvettes and readings recorded.

The concentration of β-carotene was calculated using Beer- Lambert's law:

$$Conc = \frac{A \; x \; d \; x \; V}{\epsilon^{1\%}_{1\,CM} \; x \; W}$$

Where:
A = Absorbance
d = dilution = 10
w = sample weight (g) = 10 g
v = volume of sample solution (L) = 50 x 10^{-3} L
ε = Extinction coefficient for beta carotene in petroleum ether (2592 x 10^{-4} $Lmg^{-1}cm^{-1}$) The vitamin A content was estimated by dividing the beta carotene content by 6.

Ashing Method

Dry ashing of the vegetables for the determination of the total ash was carried out using the method described by Jorhem (2000): An empty crucible was weighed using analytical balance (Mettler PE 160) and a 5-10 g sample put into the pre-weighed crucible and reweighed. This was ignited in a muffle furnace at a temperature of 550 °C until free from carbon. Muffle furnace was turned off and opened when the temperature dropped to below 250 °C. The door was carefully opened to avoid losing ash that may be fluffy. The crucible and its contents were removed from the muffle furnace and allowed to cool for a moment and placed in desiccators until cooled. The cold crucible and its content was transferred from the desiccators and reweighed.

Total ash = (weight of crucible + sample after ashing) - weight of empty crucible

%Ash on wet weight basis = (Total ash / weight of original sample) x 100

%Ash on dry weight basis = {Total ash / (original sample weight x dry matter coefficient)} x 100

Wet ashing of the vegetable samples was carried out using the method described by Jacobs (1999): A dried, ground 2.0 g sample was accurately weighed (Mettler PE 160) into a 150 ml Griffin beaker. A 10 ml concentrated HNO_3 was added and allowed to soak. If the material had a high fat content, it would be allowed to soak overnight. A 3 ml of 60% perchloric acid, $HClO_4$ was carefully added and slowly heated on a hot plate until frothing stopped and HNO_3 almost evaporated. Boiling was continued until perchloric reaction occurred (copious fumes), and then watch glass placed on beaker, the sample solution became

light straw in colour.Beaker was removed from hot plate and let to cool. Watch glass was washed with a minimum of distilled deionized water and 10 ml of 50% HCl added. This was transferred to appropriate volumetric flask (50 ml) and diluted with distilled, deionized water. This was ready for elemental analysis.

Flame Photometric Method for the Determination of Potassium

Potassium content of the vegetables was determined according to the method described by Afolayan &Jimoh (2008).

Concentration of the analyte was worked out as follows:

$$Conc\ (mg/100g) = \frac{[(A - C)\ x\ V\ x\ d\ x\ 100]}{S\ x\ m}$$

Where:
A = absorbance
c = intercept of absorbance axis
V = volume of analyte solution = 0.1 L
S = sample weight (g) = 10.0 g
m = slope of the linear graph (L mg^{-1})
d = dilution factor = 10

Analysis of sample solution: An aliquot portion of the sample was prepared as described in the above preparation of working curve. The emission intensity was measured for the unknown. After correcting the data for background, the concentration of the unknown was determined by comparison with the working curve.

Atomic Absorption Spectrophotometric Method for Analysis of K, Mg, Ca, Fe and Mn

The minerals K, Mg, Ca, Fe and Mn contents in the vegetable samples were determined according to the AAS method described by Bartram and Rupérez (2002).

The analyte concentration was determined using regression equation:

$$Absorbance = m\ concentration + c$$

$$Conc\ (mg/100g) = \frac{[(A - C)\ x\ V\ x\ d\ x\ 100]}{S\ x\ m}$$

Where:
A = absorbance
c = intercept of absorbance axis
V = volume of analyte solution = 0.1 L
S = sample weight (g) = 2.0 g
m = slope of the linear graph (L mg^{-1})
d = dilution factor = 1

Reproducibility

Reproducibility test was done by analyzing standards for elements K, Mg, Ca, Fe and Mn as well as vitamin C and beta carotene. The mean, standard deviation, % recovery, repeatability and relative standard deviations (RDS_r and RSD_R) and Horwitz ratio (HorRat) were calculated.

Result Analysis

Results obtained were expressed as mean, standard deviation (SD), % relative standard deviation (RSD_r),Howitz predicted % relative standard deviation (RSD_R). Correlation coefficients were determined by using MS Excel. The standard deviation of the instrument response was determined by using linest function of MS Office, Excel 2007 and this deviation was used to calculate limit of detection (LOD).

$$LOD = \frac{3SD}{S}$$

Where:
SD = Standard deviation of instrument response
S = Slope of the regression line.

Horwitz equation: $RSD_R = 2^{(1 - 0.5\log c)}$

Where:
C = mean concentration of analyte in sample as a decimal fraction.
The value obtained from the above equation was used to calculate the Horwitz ratio (HorRat). HorRat value = RSDr / RSD_R
The HorRat values and % recovery values were used for result acceptability.

RESULTS AND DISCUSSION

Total Ash Determination

The ash contents of the selected indigenous vegetables were as shown in the table below:

Table 1. Ash contents of the selected indigenous vegetables

Vegetable	KB Zone Sample g/100 g (dry)	HB Zone Sample g/100 g (dry)	Mean Ash content g/100 g (dry)
Amaranthushybridus	18.73	19.48	19.10 ± 0.53
Justiciaflava	19.87	19.80	19.83 ± 0.05
Crotalaria brevidens	9.80	9.62	9.71 ± 0.12
Vignaunguiculata	12.67	12.49	12.58 ± 0.12
Solanumnigrum	12.95	12.84	12.90 ± 0.08
Cleome gynandra	15.27	15.06	15.17 ± 0.15

There was minimum variation of ash contents among the sampled vegetables. The mean ash contents on dry matter were between 9.71 g / 100 g to 19.83 g / 100 g. *Justicia flava* had the highest value of 19.83 g / 100 g. A similar research work by Adeyeye and Omolayo (2011) on *Amaranthus hybridus* recorded 17.2 g / 100 g total ash whereas Pretorius and Schonfeldt (2011) recorded much lower value of 1.42 g / 100 g and 2.77 g / 100 g for *vigna unguiculata* and *Cleome gynandra*, respectively. In a study by Odhav *et al.* (2007) *Amaranthus hybridus*, *Justiciaflava* and *Solanum nigrum* recorded 4.91, 3.32 and 2.24 / 100 g ash contents, respectively. The difference could be attributed to different soils and climatic conditions of the study areas.

Moisture Contents

Moisture contents of the vegetables are as shown in table below:

Table 2. Moisture contents of the selected indigenous vegetables

Vegetable	Kendu Bay zone Sample % (wet)	Homa Bay zone Sample % (wet)	Mean SD
Amaranthushybridus	76.63	78.10	77.37 ± 1.04
Justiciaflava	78.91	85.22	82.07 ± 4.46
Crotalaria brevidens	75.47	81.49	78.48 ± 4.26
Vignaunguiculata	83.00	83.33	83.17 ± 0.23
Solanumnigrum	86.03	87.46	86.75 ± 1.01
Cleome gynandra	84.69	83.96	84.33 ± 0.52

Moisture contents of the sampled vegetable species were in the range 75- 87% and there was minimum variation among the species as well as between the two sampling zones. *Amaranthus hybridus* recorded

moisture content of 77.37%, *Justiciaflava* 81.93%, *Crotalaria brevidens* 78.48%, *Vignaunguiculata* 83.17%, *Solanumnigrum*, 86.75% and *Cleome gynandra* 84.33%. A similar study by Pretorius and Schonfeldt (2011) reported moisture content on *Cleome gynandra* 84.2% and *Vignaunguiculata* 87.6%, which was in agreement with the findings of this study. The similarity in moisture contents could be attributed to similar adaptation features to the environment by same vegetable species. In their work, Maina and Mwangi (2008) reported 88.9% and 87.8% moisture for *Amaranthushybridus* and*Solanumnigrum*, respectively.

Vitamin C Contents

Table 4.5 below gives a summary of vitamin C contents of the selected indigenous vegetables in mg / 100 g (wet matter basis)

Table 4.5. Vitamin C contents

	Cleome gynandra	*Vignaunguiculata*	*Justiciaflava*	*Solanumnigrum*	*Amaranthushybridus*	*Crotalaria brevidens*
Kendu Bay	60.7	80.8	79.2	52.8	116.2	70.2
Homa Bay	61.2	64.9	52.8	63.4	59.7	73.9

Vitamin C contents were between 52 and 116 mg / 100 g in which *Amaranthus hybridus* recorded the highest content (116.2 mg / 100 g). *Justicia flava* had the lowest value of 52.8 mg / 100 g. All the sampled vegetables recorded vitamin C contents that met the recommended daily intake of 40-70 mg if consumed in large quantity and when the vitamin C degradation is minimized. In similar studies on *Amaranthus hybridus* by Maina and Mwangi (2008) and Ogunlesi et al. (2010) recorded vitamin C contents of 42 mg / 100 g and 60.12 mg / 100 g, respectively. Chweya and Mnzava (1997) recorded vitamin C contents in the range127-484 mg / 100 g for *Cleome gynandra*. The differences in vitamin C values obtained could be attributed to different climatic conditions in study areas.

β-carotene Determination

Results for β-carotene contents in the indigenous vegetables in mg / 100 g (wet weight) are shown in table below:

Table 3. β-carotene contents of the selected indigenous vegetables

Vegetable	Absorbance	β-carotene	Retinol (vitamin A)
Cleome gynandra	0.7710	7.44	1.24
Vignaunguiculata	0.5133	4.95	0.83
Justiciaflava	0.9360	9.03	1.51
Solanumnigrum	0.9750	9.40	1.57
Amaranthushybridus	0.3460	3.34	0.56
Crotalariabrevidens	0.6452	6.22	1.04

Beta carotene contents of the indigenous vegetables were found to be in the range 3.34- 9.40 mg / 100 g (wet). This when converted to retinol, ranged between 0.56 to 1.57 mg / 100 g. *Solanumnigrum* recorded the highest β-carotene content of 9.40 mg / 100 g, whereas *Amaranthus hybridus* had the lowest of 3.34 mg / 100 g. Research study by Pretorius and Schonfield (2011) on *Vigna unguiculata* and *Cleome gynandra* recorded 2.229 and 4.117 mg / 100g, respectively. In a similar study by Chweya and Mnzava (1997) on *Cleome gynandra* value of 6.7-18.9 mg / 100 g β-carotene was recorded. On average the contents did not meet the recommended daily allowances of 0.7-1.0 g; besides, there were losses of β-carotene attributed to oxidation during the cooking process (Pretorius and Schonfeldt, 2011; Fikselova et al., 2008; Chweya and Mnzava, 1997).

Mineral Analysis

The concentration of K, Mg, Ca, Fe and Mn from six indigenous vegetable species (*Amaranthushybridus, Cleome gynandra, Justiciaflava, Solanumnigrum and Vignaunguiculata*) from Kendu Bay and Homa Bay zones and soils from where the vegetables were collected was determined.

AAS Mineral Analysis

The AAS method was used for the mineral nutrients K, Mg, Ca, Fe and Mn on dry weight (mg /100g). The findings are shown in table below:

Table 4. Mineral content of selected vegetables

	K		Mg		Ca		Fe		Mn	
	KB	HB	KB	HB	KB	HB	KB	HB	KB	HB
Cleome gynandra	267.4	240.3	20.4	20.1	131.9	149.3	55.6	55.1	8.5	5.8
Vignaunguiculata	37.6	206.1	22.2	18.2	142.6	ND	61.9	41.2	22.0	14.0
Justiciaflava	296.9	40.6	17.4	20.7	ND	13.3	73.0	76.4	15.0	13.9
Solanumnigrum	262.2	306.1	21.7	21.8	134.0	132.4	58.5	64.5	14.6	11.8
Amaranthushybridus	309.2	243.8	21.3	24.4	ND	104.7	73.6	51.8	17.4	8.7
Crotalaria brevidens	264.5	39.1	21.4	20.9	90.8	136.5	77.3	51.8	16.5	8.6

ND- Not detectable KB- Kendu Bay HB- Homa Bay

Mineral contents of the vegetables varied among the species as well as from one place to another. Since the vegetables were collected from different places that had different soil characteristics, nutrient variations were expected. The mineral contents in vegetables varied according to mineral availability and the specific mineral uptake ability of the plant.

Flame photometer Determination of Potassium

Results for potassium contents in the vegetables using flame photometer on dry matter basis (mg/100 g) were as indicated in table below:

Table 5. Potassium contents in the vegetables

	Kendu Bay Zone	Homa Bay Zone
Cleome gynandra	274.82	250.70
Vignaunguiculata	48.22	226.62
Justiciaflava	318.23	43.39
Solanumnigrum	270	323.05
Amaranthushybridus	265.19	298.94
Crotalariabrevidens	245.9	43.69

CONCLUSION AND RECCOMENDATIONS

This research study assessed the contents of nutrients, potassium, magnesium, calcium, iron, manganese, vitamin C and Vitamin A as well as moisture and total ash in selected varieties of indigenous vegetables. Based on the findings of this study, it can be concluded that;

1. Total ash content was between 9.71- 19.83 g / 100 g whereas moisture contents were high. This high moisture contents implied more water in plants to aid nutrient uptake through mass flow and diffusion.

2. All the sampled vegetable varieties had vitamin C contents that met the recommended daily allowance.
3. Vitamin A contents of the vegetables met the recommended daily allowance of 0.7- 1.0 mg except *Amaranthus hybridus*. Those that met the RDA had values very close to it.

4. The assessed minerals in the vegetables did not meet the recommended daily allowance. Mineral levels varied from region to region due to different soils with different characteristics, and it also depended on plants ability to absorb these minerals from the soil

RECOMMENDATIONS

1. Consumption of indigenous vegetables as sources of vitamin C, beta carotene and minerals such as potassium, iron and manganese should be encouraged to help alleviate nutrient deficiency related diseases. Vitamin A supplementations in foods like flour and sugar should be encouraged as conversion of beta carotene to vitamin A varies among individuals and there are some losses attributed to oxidation during the cooking process. It is also not possible practically to have complete conversion of all of the ingested beta carotene to vitamin A.
2. Investigation should be carried out on stems, leaves and seeds where applicable, of the indigenous vegetables to assist in quantifying their mineral contents.

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