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4 authors:

James Karanja
Ghent university and Institut Polytechniqu…

Jane Mugendi
Dedan Kimathi University of Technology

Fathiya Khamis

Alice Muchugi
Consultative Group on International Agricu…

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Nutritional Evaluation of Some Kenyan Pumpkins (*Cucurbita* spp.)

James K. Karanja[1,*], Beatrice J. Mugendi[2], Fathiya M. Khamis[1,3], Alice N. Muchugi[1]

[1]Department of Biochemistry and Biotechnology, Kenyatta University, P.O BOX 43844, Nairobi, Kenya
[2]Department of Food Science and Technology, Dedan Kimathi University of Technology, P.O BOX 62000, Nairobi, Kenya
[3]International Centre of Insect Physiology and Ecology (*icipe*), P.O BOX 30772, Nairobi, Kenya

Abstract The nutritional potential of thirteen varieties of *Cucurbita* fruits collected from selected regions of Kenya were evaluated for their proximate values, mineral and β-carotene content. The results indicated that the moisture content was high and it varied significantly ($p<0.05$) among the groups. Ash values were significantly different at ($p<0.05$) and ranged from 0.63 to 1.67%, crude protein was low in all the pumpkin groups and varied from 0.93 to 2.09%. The pumpkins also varied significantly ($p<0.05$) in crude fibre content (0.47- 1.95) among the groups. Potassium and sodium were the most prevalent minerals potentially useful amounts of potassium (199-172.3 mg/100g), sodium (56.39-118.28 mg/100g) and other essential minerals. The lowest micro-elements were copper and zinc. The results indicated that there were no significant differences among the groups in the β-carotene content ($p<0.05$). The nutrient information presented in this report should stimulate the nutritionists and agricultural officers in Kenya to consider the question of recommending the pumpkin to be consumed by adults and children alike in Kenya, including pregnant women and others with higher than normal nutritional requirements

Keywords Nutritional, *Cucurbita*, Proximate, Mineral composition

1. Introduction

Cucurbita (Pumpkin) is one of the underutilized crops which belong to the family, cucurbitaceae. Its existence is presently been threatened due to neglect in Kenya. Pumpkin is cultivated in Kenya in a subsistence level with virtually no commercial importance. Pumpkin is an angiosperm characterised by climbing herbaceous vines and, it plays an important role in the traditional setting as a cover crop and weed controlling agent [1]. In Kenya, it is a traditional crop, commonly regarded as a poor man's food and as an orphaned crop, it is cultivated mainly for its fruits. Seeds are thrown away as waste or preserved for the next plantation. Pumpkin seeds have a high nutritional value, provides good quality oil mainly consisting of unsaturated fatty acids and excellent source of protein and fibre [2, 3]. In addition to good health benefits, pumpkin seeds are less expensive and are widely distributed. In the traditional medicine in North America and Mexico, pumpkin seeds have been used as an antihelmintic agent and for supportive treatment in functional disorders of the bladder i.e digestion problems [2].

Traditionally, the pulp is used to relieve intestinal inflammation or enteritis, dyspepsia and stomach disorders [4]. Pumpkin fruit is an excellent source of pro-vitamin A which the body needs for proper growth, healthy eyes and protection from disease. It is also rich in vitamin C, vitamin E, lycopene, dietary fibre though it contains low amounts of fibre and fat [5, 6]. In Africa, traditional vegetables which are often disregarded by the urban populations are an important source of nutrients and vitamins for the rural population, as many nutritional studies have shown [7, 8] The fruit pulp has a low lipid concentration indicating that the lipids are mobilized and stored in the seeds and thereby making the fruits a good food for people suffering from obesity. Excess fat consumption has been implicated in certain cardiovascular disorders such as atherosclerosis, cancer and aging [9]. Therefore, diets of pumpkin should be encouraged in order to reduce the risk of the above ailments in man.

The difference between the world's supply of quality foods and the growth of the global population continues to widen and, ways and means of bridging this gap have become a matter requiring urgent attention. The current surge in the search of nutritious foods is therefore not surprising. The ultimate has not been achieved and this is evidenced by the paucity of literature available on the subject. Several plants exist with very high nutritive value and yet remain unexploited for human and animal benefits [10]. Although extensive research efforts have been made on the nutritional composition of *Cucurbita*, the proximate composition and mineral contents of Kenyan *Cucurbita* species have not been comprehensively analyzed.

In Kenya the populace are unaware of the high nutritional

* Corresponding author:
Karanjaj11@yahoo.com (James K. Karanja)
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and nutracetical values of the pumpkin, rather it is regarded as an orphaned crop mainly for the low income earners, thus has not benefited of research attention given to other vegetable crops like the cucumber, fluted pumpkin etc. This has created an information gap that may have discouraging high income earners and urban dwellers form making this crop a part of their diet. In order to ascertain the nutritive value of the crop species and thereby stimulate in interest in its utilization beyond the traditional localities, this study was designed to evaluate the nutritional value of the Kenyan pumpkin fruits. This will aid in the promotion of the use of pumpkin and the management of nutritionally related problems in Kenya. It will also help to address the current global food security problems since the crop grows and yields well with very little attention.

Table 1. External Fruit physical characteristics of different pumpkins

Group	Fruit skin Colour	Ridges
G1	Cream plain	No
G2	Cream plain	Yes
G3	Cream greenish	No
G4	Cream greenish	Yes
G5	Yellow orange plain	Yes
G6	Yellow orange cream spots	Yes
G7	Yellow orange green spots	Yes
G8	Dark green	No
G9	Dark green	Yes
G10	Light green	Yes
G11	Green with cream spots	Yes
G12	Green with orange spots	No
G13	Green with orange spots	Yes

2. Materials and Methods

2.1. Collection and Preparation of Pumpkin Samples

Pumpkin *(Cucurbita)* samples collected from each agro ecological zone (Eastern and Central Kenya) were assembled at Kenyatta University. Details of the samples were counter-checked with field recorded data. The samples were then grouped based on the following phenotypic characteristics: colour and extent of ridging as shown in table 1 above. After selection the individual pumpkins, thirteen groups were identified. The total sample selected was 45 which were used for analysis. The pumpkins were cut and seeds removed, the pumpkin pulp was kept under a freezer at 4°C till the time for of analysis.

2.2. Reagents

All reagents including solvents and β-carotene standards used in this study were purchased from Kobian scientific company Ltd (Sigma Aldrich, Switzerland).

2.3. Chemical Analysis

Chemical composition of the pumpkin pulp was determined using the AOAC methods [11] as described by [12]. The moisture content of the seed flour was determined using the air oven drying method using a 2 g of the sample at 105°C until a constant weight was obtained. The loss of weight was regarded as a measure of moisture content. For determination of ash content, 2 g of the sample was weighed into a crucible. The crucible was first heated on a heating mantle till all the material was completely charred, followed by incineration in a muffle furnace at 550°C for 3 - 5 hours. It was then cooled in a desiccator and weighed (ash became white or greyish white). Weight of ash gave the ash content. Crude fat content was determined by extracting 2g of moisture free sample with hexane in a soxhlet extractor for six hours in a water bath at 80°C; hexane was then evaporated in vacuum evaporator. Increase in weighed of beaker gave the crude fat. Determination of crude protein was done using semi micro Kjeldahl method which involved the digestion of approximately 2 g of the sample with concentrated H_2SO_4 and a catalyst to convert any organic nitrogen to ammonium sulphate $(NH4)_2SO_4$, in solution followed by the decomposition of $(NH4)_2SO_4$ with NaOH. The ammonia liberated was distilled into 5% boric acid. The nitrogen from ammonia was deduced from titration of the trapped ammonia with 0.05N HCl using methylene red and methylene blue (double indicator solution) indicators. Percentage crude protein was calculated using nitrogen-to-protein conversion factor of 6.25. Crude fibre was obtained from the loss in weight on ignition of dried residue remaining after digestion of fat-free samples with 1.25% each of H_2SO_4 and NaOH solutions under specified conditions. Carbohydrate content was determined by subtracting the total ash, crude fat, crude protein and crude fibre contents from the total dry matter.

2.4. Mineral Composition

The total ash obtained after dry-ashing at 550°C was dissolved in 6 N HCL acid in a conical flask and then filtered into a 100 mL standard flask. It was then made up to the mark with de-ionized water prior to aspirating in the AAS. The minerals Na and K were determined from the resulting solution using emission flame photometer (Model A A-6200, Shimadzu, Corp., Kyoto, Japan), while Mg, Fe, Zn, Mn, Ca and Cu were determined using atomic absorption spectrophotometer (Model A A-6200, Shimadzu, Corp., Kyoto, Japan) using standard methods as described by [13].

2.5. Beta Carotene

β-carotene was determined by Standard Official Methods of Analysis [11].

2.6. Data Analysis

The data was presented as mean ± standard deviation. The proximate, fatty acid profile, β-carotene, α-tocopherol composition and mineral data obtained from this study were subjected to one-way analysis of variance (ANOVA) to establish the means with significant differences using

GenStat software [14].

3. Results and Discussion

3.1. Proximate Composition

The proximate analysis of the thirteen *Cucurbita* groups studied is presented in table 2. Significant differences among the groups ($p<0.05$) were observed for moisture content, crude fibre, ash, fat and carbohydrate in the fruits. Moisture content of the fruits ranged from 75.08% in G12 to 91.16% in G8. High moisture content in vegetables makes them vulnerable to microbial attack, hence spoilage [15]. Moisture content of any food is an index of its water activity [16] and is used to measure the stability and the susceptibility to microbial contamination [17, 18]. This moisture content also implies that dehydration would increase the relative concentrations of other food nutrients and therefore improve the shelf-life and preservation of the fruits [19]. There is also need to store the fruit in cool condition if they are to be kept for a long period without spoilage especially in the tropics where wastage of vegetable crops is estimated to be around 50 % due to high moisture content [20].

Fruits of G8 (1.78%) and G3 (1.98%) had the highest crude fibre contents while the lowest was observed in the fruits of G1 (0.47%). These values were higher compared to Berlaindier Neetle Spurge seed (*Jatropha cathartica*) (1.6%) reported by [10] but relatively lower when compared to bitter leaves (*Vernonia amygdalina*) (6.5%) [21]. Crude fibre is the part of food that is not digested by human beings but the normal functioning of the intestinal tract depends upon the presence of adequate fibre.

The ash content was significantly higher in G6 (1.7%) while G8 (0.6%) had the lowest. Ash content gives an idea about the inorganic content from where mineral content could be obtained. These results could suggest a low deposit of mineral elements in the pumpkin fruits. Ash content of 1.5-2.50% for the nut has been recommended for suitability as animal feed [22].

Crude protein among the groups varied from 0.93 % in G5 to 2.09 % in G2. These values were lower compared to those reported by [23] in yams 7.31 to 9.67 % indicating that, these pumpkins had lower protein content. Ene-Obong reported that diet is nutritionally satisfactory, if it contains high caloric value (12%) and a sufficient amount of protein.

Crude fat among was highest in G11 (1.8%) and lowest in G13 (0.54%). These results are in the lower range when compared with reported values (8.3 to 27.0%) in some vegetables consumed in Nigeria and Niger republic. The results showed that the carbohydrate content varied significantly from (19.76%) in G12 and (1.44%) in G5. High carbohydrate feed is desirable; deficiency causes depletion of body tissue [25].

3.2. Mineral Composition of the Pumpkin Fruits

Highly significant differences ($p<0.05$) was observed in the elements; magnesium, sodium, potassium, zinc, iron, manganese and copper while calcium was not significant. The most abundant mineral was potassium. The value obtained was; 166-191.8 (in G7 and G4 mg/100g). This was followed by Sodium, the values ranged between 56.39-97.12 (G8 and G3 mg/100g). The other values obtained for pulp samples were; Zinc (0.02-0.13 mg/100g), Iron (3.5-11.08 mg/100g), Magnesium (5.54-36.39g/100g), Calcium (11.45-25.53mg/100g), Manganese (0.09-1.78mg/100g), Copper (0.41-1.44 mg/100g).

Magnesium content is a component of chlorophyll and it is an important macro-mineral element in connection with ischemic heart disease and calcium metabolism in bones, in addition to its coenzyme activity [26]. Magnesium is important in tissue respiration, specifically in oxidative phosphorylation leading to the biosynthesis of Adenosine triphosphate (ATP). It is also involved in normal muscular contraction; calcium stimulates muscles while magnesium initiates the relaxation process [27]. Magnesium deficiency results in uncontrollable twisting of muscles henceforth leading to convulsion and tetanus, which may both lead to fetal [28].

Table 2. Proximate composition of the fresh pumpkin pulp % (dry weight basis)

Groups	Protein	Moisture	Carbohydrate	Fibre	Ash	Fat
G1	1.36 ± 0.0^{a}	88.8 ± 1.4^{abc}	6.3 ± 1.9^{cd}	0.47 ± 0.2^{d}	1.18 ± 0.7^{abcd}	1.26 ± 0.3^{bc}
G2	2.09 ± 0.1^{a}	85.9 ± 0.5^{bc}	7.52 ± 0.9^{bc}	1.24 ± 0.2^{abc}	1.31 ± 0.8^{abc}	1.67 ± 0.1^{ab}
G3	1.81 ± 0.1^{a}	90.09 ± 0.3^{ab}	2.63 ± 0.7^{d}	1.95 ± 0.17^{a}	1.6 ± 0.5^{ab}	1.74 ± 0.2^{ab}
G4	1.68 ± 0.1^{a}	89.87 ± 1.1^{c}	5.75 ± 1.0^{cd}	1.44 ± 0.1^{bc}	0.72 ± 0.1^{cd}	0.89 ± 0.3^{cd}
G5	0.93 ± 0.1^{a}	84.4 ± 0.8^{c}	11.44 ± 1.0^{b}	0.97 ± 0.1^{cd}	1.01 ± 0.2^{bcd}	0.58 ± 0.2^{d}
G6	1.49 ± 0.1^{a}	85.66 ± 2.9^{c}	7.89 ± 3.1^{bc}	1.76 ± 0.1^{ab}	1.67 ± 0.4^{a}	1.43 ± 0.3^{ab}
G7	1.76 ± 0.2^{a}	86.43 ± 1.6^{bc}	7.89 ± 1.5^{bc}	1.17 ± 0.2^{bc}	0.81 ± 0.1^{cd}	1.69 ± 0.3^{ab}
G8	1.58 ± 0.1^{a}	91.16 ± 1.3^{a}	3.1 ± 1.3^{d}	1.78 ± 0.1^{ab}	0.63 ± 0.2^{d}	1.73 ± 0.2^{ab}
G9	1.18 ± 0.5^{a}	89.6 ± 3.7^{ab}	5.63 ± 3.7^{cd}	1.22 ± 0.3^{bc}	0.75 ± 0.6^{cd}	1.51 ± 0.1^{ab}
G10	1.7 ± 0.1^{a}	88.62 ± 0.6^{abc}	5.26 ± 0.4^{cd}	1.69 ± 0.1^{abc}	1.12 ± 0.3^{bcd}	1.39 ± 0.1^{abc}
G11	1.60 ± 0.7^{a}	85.44 ± 2.7^{c}	8.21 ± 3.2^{bc}	1.41 ± 0.1^{abc}	1.21 ± 0.3^{bc}	1.82 ± 0.1^{a}
G12	1.31 ± 0.9^{a}	75.08 ± 2.1^{d}	19.76 ± 2.0^{a}	1.24 ± 0.4^{bc}	0.7 ± 0.6^{cd}	1.58 ± 0.1^{ab}
G13	1.57 ± 0.1^{a}	87.15 ± 1.1^{bc}	8.16 ± 1.6^{bc}	1.32 ± 0.5^{abc}	1.07 ± 0.1^{cd}	0.54 ± 0.4^{d}

Values are given as means of three replicates ± SD. Means with different superscript letters within a column are significantly different ($P < 0.05$). SD = Standard deviation of the mean

Table 3. Macro and micro-element composition of the pumpkin pulp in (mg/100g dry weight basis)

Groups	Mg	Ca	Na	K	Zn	Fe	Mn	Cu
G1	23.63±0.1^{ab}	20.26±3.8^{a}	75.56±4.3^{ab}	183.2±1.2^{ab}	0.04±0.0^{cd}	6.83±0.4^{ab}	0.35±0.1^{bc}	0.77±0.2^{abc}
G2	36.39±0.4^{ab}	19.15±0.6^{a}	94.28±6.5^{ab}	182.8±2.3^{ab}	0.13±0.2^{a}	3.71±0.3^{ab}	0.42±0.2^{bc}	0.72±0.1^{abc}
G3	7.39± 1.0^{ab}	25.53±0.7^{a}	118.28±1.3^{a}	186.2±5.5^{ab}	0.09±0.2^{abc}	3.49±0.6^{b}	0.39±0.2^{bc}	0.41±0.1^{c}
G4	37.8± 0.26^{a}	25.7±0.2^{a}	92.43±6.2^{ab}	191.8±4.8^{ab}	0.05±0.1^{bcd}	6.34±0.9^{ab}	0.52±0.1^{bc}	0.89±0.1^{abc}
G5	22.11±0.1^{ab}	11.45±1.4^{a}	69.08±6.3^{b}	199±6.0^{a}	0.02±0.0^{d}	11.08±0.7^{a}	0.62±0.1^{b}	1.33±0.1^{ab}
G6	16.97±0.7^{ab}	16.790.4^{a}	97.12±4.1^{ab}	172.3±8.1^{b}	0.05±0.2^{bcd}	3.98±0.9^{b}	0.38±0.2^{bc}	0.69±0.3^{bc}
G7	25.52±0.6^{ab}	17.3±0.7^{a}	68.28±3.8^{b}	166±6.4^{ab}	0.1±0.1^{ab}	3.62±0.7^{ab}	0.09±0.0^{c}	0.51±0.2^{c}
G8	15.89±2.0^{ab}	13.76±0.3^{a}	56.39±2.1^{b}	186.4±6.1^{ab}	0.09±0.0^{abc}	5.77±0.4^{ab}	1.78±0.20^{a}	1.44±0.2^{a}
G9	29.79±0.8^{ab}	22.35±0.8^{a}	64.97±4.9^{b}	177.3±5.1^{ab}	0.07±0.2^{bc}	7.59±0.8^{ab}	0.65±0.3^{b}	0.86±0.0^{abc}
G10	33.13±0.2^{ab}	15.68±0.9^{a}	88.99±2.9^{ab}	192±3.7^{ab}	0.07±0.1^{bcd}	3.15±0.4^{b}	0.27±0.2^{bc}	0.77±0.2^{abc}
G11	31.27±1.5^{ab}	18.36±0.6^{a}	96.1±3.0^{ab}	184.1±3.4^{ab}	0.09±0.3^{ab}	4.87±0.1^{ab}	0.39±0.1^{bc}	0.68±0.3^{c}
G12	5.54± 2.9^{b}	18.74±0.1^{a}	63.9±2.9^{b}	173±2.8^{ab}	0.06±0.1^{bcd}	5.93±0.9^{ab}	0.34±0.3^{bc}	0.99±0.1^{abc}
G13	28.68±0.5^{ab}	21.12±1.2^{a}	65.94±3.1^{b}	182.8±8.0^{ab}	0.08±0.0^{abc}	3.542±0.3^{b}	0.28±0.0^{bc}	0.95±0.1^{abc}

Values are given as means of three replicates ± SD. Means with different superscript letters within a column are significantly different ($P < 0.05$).
SD = Standard deviation of the mean. LSD= Least significant difference
Mg: Magnesium, Ca: Calcium, Na: Sodium, K: Potassium, Zn: Zinc, Fe: Iron, Mn: Manganese, Cu: Copper

Iron is an essential trace element for haemoglobin formation, normal functioning of the central nervous system and in the oxidation of carbohydrates, proteins and fats. In this study, it is evident all the groups could supply the required RDA of 8 mg Fe/day for men (19 years and older) and for women over 50 years, 18 mg/day for the girls and women of about 11 - 50 years old [29]. The high content of iron in the pumpkins makes them a potential source of iron for the vulnerable groups.

Manganese was found to be the third least among all the minerals analysed. Manganese plays an important role in all mental functions and aids in the transfer of oxygen from lungs to cells, it also acts as an activator for enzyme-based reactions involved in carbohydrate, fat and protein metabolism [30]. Pumpkin pulp presented low values for Zinc. Zinc is known for boosting the health of our hair, it is believed to play a role in the proper functioning of some sense organs such as those required for tastes, sense and smell [30]. Zinc plays a critical role in protein and carbohydrate metabolism and also vitamin A mobilization from its storage site in the liver and facilitates the synthesis of DNA and RNA [27].

3.3. Beta-Carotene

The β-carotene content of the pumpkin pulp are presented in table 4 below. Although the β carotene content were not significant among the *Cucurbita* evaluated, the groups had a β carotene content ranging between 14.7-35.09 µg/g and this could imply that they are rich in pro-vitamin A. The high content of pro-vitamin A can be maintained in the fruits if their worldwide availability, ease of production, and long storage shelf life is put into consideration. In some countries, including Kenya, the flowers and leaves of fruits and vegetables are also consumed [31].

Brazilian cucurbits analysed by open column chromatography, the Menina Verde of the species *C. moschata* was reported to have the highest mean levels of α-carotene (23 µg/g) and β- carotene (39 µg/g) at the mature stage. [32]. The Baianinha variety, was reported to have a much higher average values: 47 µg/g α-carotene and 235 µg/g β-carotene [33]. The *C. maxima* species Exposicao variety was reported to have a β- carotene content of 3.1-28 µg/g while other varieties Tetsukabuto and Jerimum Caboclo 8.7 - 18 µg/g and 14-34 µg/g, respectively [33].

The marked variations observed in the pro vitamin A contents, even between samples of the same cucurbit variety, may be attributed to the long period during which these fruits can be harvested, their extended shelf life, climate or geographical region. In fact, some of the low levels reported may be due to the analyses of immature squashes and pumpkins [34].

Table 4. β-Carotene content of the fresh pumpkin pulp content in (µg/g)

Groups	β-carotene
G1	32.1±0.2^{a}
G2	33.42±0.3^{a}
G3	14.7±0.1^{a}
G4	22.49±0.6^{a}
G5	30.69±0.2^{a}
G6	27.31±0.0^{a}
G7	29.68±0.1^{a}
G8	34.7±0.2^{a}
G9	29.34±0.0^{a}
G10	31.52±3.1^{a}
G11	21.21±2.2^{a}
G12	35.09±1.4^{a}
G13	23.66±2.0^{a}

Values are given as means of thee replicates ±SD. Means with different superscript letters within a column are significantly different ($P<0.05$).SD= Standard deviation of the mean

4. Conclusions

In conclusion, the study revealed that the *Cucurbita* fruits, consumed in East and Central Kenya contribute useful amounts of crude fat and carbohydrates to human diet. The fruits contained high levels of minerals potassium, iron, sodium and appreciable amounts of pro-vitamin A good for animal and human health. As expected, the moisture content was high giving a indication of a lower dry matter upon drying. Pumpkin is an excellent source of nutrients and should be promoted.

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