Journal of Horticulture Letters
ISSN: 0976-9943 & E-ISSN: 0976-9951, Volume 3, Issue 1, 2013, pp.-17-22.
Available online at http://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000268

NUTRITIONAL COMPOSITION OF THE PUMPKIN (*Cucurbita* spp.) SEED CULTIVATED FROM SELECTED REGIONS IN KENYA

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Received: August 07, 2013; Accepted: September 14, 2013

Abstract- *Cucurbita* is one of the underutilized crops and its existence in Kenya is presently threatened due to neglect. The pumpkin is a rich source of nutrients and has medicinal properties. However, owing to the perception that it is a traditional food and majority of the Kenyan populace being unaware of its high nutritional value it still remains unexploited. The objective of this work was to evaluate the nutritional quality of pumpkin seeds. Proximate composition was determined in accordance with AOAC methods, mineral composition by Atomic Absorption Spectrophotometry, tocopherol and fatty acid profile was analysed using HPLC and GC, respectively. Data analysis was done by Genstat package. Significant differences (p<0.05) were observed among the gps representing crude fibre (11.69-24.85%), crude fat (31.9-41.37%), crude protein (14.05-33.29%) and carbohydrates (8.66-27.35%). Fatty acid profile showed a high content of unsaturated fatty acids and the dominant fatty acids were palmitic (1.16-20.81%), stearic (0.16-5.56%), oleic (15.56-30.79%), and linoleic acids (26.18-81.21%). The highest elemental minerals were potassium and sodium (124-335 and 70-148 mg/100 g) respectively. α-tocopherol content ranged between 8.33 and 122.65 µg/g exhibiting significant differences (p<0.05) among group 7 and the rest of the groups. The seeds were well endowed in crude oil, protein, carbohydrates and crude fibre. The oil contained unsaturated fatty acids and α- tocopherol. The pumpkin seed could be incorporated in foods to increase the nutritional value especially in diets that are deficient in the said nutrients.

Keywords- Proximate composition, fatty acid profile, α- tocopherol, groups

Citation: Karanja J.K., et al. (2013) Nutritional Composition of the Pumpkin (*Cucurbita* spp.) Seed Cultivated from Selected Regions in Kenya. Journal of Horticulture Letters, ISSN: 0976-9943 & E-ISSN: 0976-9951, Volume 3, Issue 1, pp.-17-22.

Introduction

Cucurbitaceae (Cucurbit) is an important family comprising one of the most genetically diverse groups of food plants. They are characterized by prostate or climbing herbaceous vines with large fleshy fruits [1]. Some important Cucurbit family members include; gourd, melon, cucumber, squash and pumpkin [2], the majority of the species in these families are used as food. Cultivation and utilization of the pumpkin in Kenya represents the rich ecological, cultural and ethnic diversity of the country [3]. In Kenya the pumpkins are mainly cultivated as a marginal crop often on the edges of field crops or scantly scattered between other food crops.

Pumpkin seeds are white or brown and are consumed directly by humans as a snack food [4]. Several studies have reported the nutritive value of the pumpkin seed from different regions and varieties. Achu, et al [5] showed that cucurbit seeds from different regions in Cameroon contained a protein content of 28-40%, fat 44-53% and carbohydrate 7-10% content, showing that they could be exploited as oil and protein sources. Younis, et al [6] reported that the seed of *Cucurbita pepo* are rich sources of unsaturated oil, energy and vitamin E, while the dominant fatty acids present in the oil were oleic 29% and linoleic 47%. Nwofia, et al [7] reported that the pumpkin seeds are richly endowed in macro elements (magnesium, phosphorus and calcium) and moderate amounts of micro elements (calcium, manganese, copper and zinc) and thus the seed could be used as a valuable food supplement. Stevenson, et al [8] reported that the four fatty acids present in significant quantities in the pumpkin seed oil from different origins and varieties are palmitic, stearic, oleic, and linoleic acids.

Currently, pumpkin seed oil is not widely used commercially even though it has characteristics that are well suited for domestic use. In addition, there has been no strategic pumpkin germplasm selection and multiplication in Kenya and farmers mainly rely on their own seed or exchange among themselves. Content of particular nutrients in the pumpkin seed have been shown to vary considerably, depending on soil type, climatic conditions and genetic variations, [7] it would be of interest to analyze pumpkin seed from different regions in Kenya where predominantly different *Cucurbita* spp. are cultivated. This work focused on determining the proximate, mineral composition of the pumpkin seed flour, fatty acid profile and α-tocopherol content of the seed oil of the local pumpkins grown in Kenya.

Materials and Methods

Collection and Preparation of Samples

The pumpkin samples *Cucurbita* spp. were collected from farmer's field and markets in Eastern and Central regions of Kenya between July and September 2011. The samples were grouped into 13 categories based on the following phenotypic characteristics: colour, extent of ridging and shape as shown in [Table-1]. Forty five samples were selected from the 13 categories for the analysis. Ripe fruits were cut and the seeds separated. Seeds were cleaned using filter paper to remove the pulp and air-dried at room temperature. The dried seeds were ground to flour using a grinder, the flour was then packed in a clean dry plastic containers, sealed and stored at 10°C until the time for analysis.

Table 1- External Fruit physical characteristics of different pumpkins

Group	Fruit skin Colour	Ridges	Sample(n)
G1	Cream plain	No	1
G2	Cream plain	Yes	6
G3	Cream greenish	No	1
G4	Cream greenish	Yes	3
G5	Yellow orange plain	Yes	2
G6	Yellow orange cream spots	Yes	3
G7	Yellow orange green spots	Yes	1
G8	Dark green	No	1
G9	Dark green	Yes	4
G10	Light green	Yes	5
G11	Green with cream spots	Yes	9
G12	Green with orange spots	No	1
G13	Green with orange spots	Yes	8

Proximate Analysis

The proximate analyses of the samples were carried out in triplicate using the methods described by AOAC [9]. The nitrogen content was described by Pearson [10] and the nitrogen content was converted to protein by multiplying by a factor of 6.25. Crude lipid content was determined using the Soxhlet method [11] and carbohydrate content was determined by difference. All proximate values were reported in %.

Mineral Composition

The minerals Na and K were determined from the resulting solution using AOAC methods as described by James [12]. Emission flame photometer, 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.

Tocopherol Analysis

For determination of tocopherols (TOC) [13], a solution of 250 mg of oil samples in 25 ml hexane were directly used for analysis. The HPLC analysis was conducted using a Merck-Hitachi low-pressure system fitted pump, a Merck-Hitachi F-1000 Fluorescence Spectrophotometer (detector wavelengths 295 nm and 330 nm for emmision) and a D-2500 integration system. A sample in volume of 4 µL was injected onto a normal phase silica column (HPLC mode: Shimadzu, column packing size: 150 cm x 4.6 mm). The column was eluted with a mobile phase of isopropanol : hexane (98 : 2). The flow rate was 1.0 ml per min and the absorption wavelength of 295 nm. Identification of the peaks for α tocopherol was done using pure α tocopherol standards. The tocopherol content was expressed as ppm.

Fatty Acid Composition

Fatty acid methyl esters (FAME) were prepared as described by Joseph and Ackman [14]. FAMEs were transferred into a separating funnel and 4 mL of hexane added. The contents were shaken vigorously at room temperature and let to stand. The hexane layer was collected and the aqueous layer was extracted again. The hexane fractions obtained were mixed together and washed with 3-4 portions of distilled water to remove acid present. Anhydrous sodium sulphate was added for dehydration purposes. The filtrate obtained was bubbled in nitrogen gas to concentrate it then about 0.5 mL was injected into the GC. The standard solutions were also injected and the procedure was repeated for all the samples [9].

Data Analysis

Data was expressed on dry weight basis as the mean and standard deviation (SD) of three experiments and were subjected to way analysis of variance (ANOVA). The mean values were compared at $p<0.05$ significance level by Duncan's multiple range test using Genstat software package [15].

Results

Proximate Composition

The proximate composition of seeds is shown in [Table-2]. Significant differences ($p<0.05$) were observed among the parameters representing moisture content, crude fibre, ash and fat while crude protein and carbohydrate was not significant ($p<0.05$). Moisture content was highest in G10 (10.39%) and lowest in G9 (5.59%) groups.

Table 2- Proximate composition of the dried seed flour in % (dry weight basis)

Groups	Fibre	Fat	Ash	Protein	Moisture	Carbohydrate
G1	18±0.95^{cd}	33.2±1.1^{cd}	3.83±0.9^{a}	25.25±0.1^{abcd}	5.7±0.3^{a}	19.65±1.9^{ab}
G2	20.56±1.7^{abc}	35.52±1.9^{bcd}	3.42±0.7^{a}	27.31±0.2^{abcd}	5.62±0.5^{a}	14.34±2.5^{ab}
G3	24.85±5.6^{a}	34.8±2.0^{cd}	2.47±0.1^{a}	14.05±1.3^{e}	5.81±0.8^{a}	23.83±7.5^{ab}
G4	22.79±1.8^{ab}	41.37±0.6^{a}	3.71±0.2^{a}	20.34±0.5^{cde}	6.8±1.5^{a}	8.66±1.5^{b}
G5	17.25±0.9^{cde}	34.24±0.7^{bcd}	3.59±0.1^{a}	29.91±0.9^{abc}	6.87±0.1^{a}	18.14±0.9^{ab}
G6	13.45±0.7^{ef}	31.9±1.8^{d}	3.22±0.2^{a}	24.08±0.6^{bcd}	8.15±0.1^{a}	27.35±2.4^{a}
G7	24.69±1.4^{a}	39.44±4.0^{ab}	3.26±0.6^{a}	18.59±5.1^{de}	5.59±0.5^{a}	14.01±8.7^{ab}
G8	18.89±0.7^{bcd}	38.1±0.7^{abc}	2.64±0.3^{a}	30.64±0.6^{ab}	7.76±0.6^{a}	9.37±1.1^{b}
G9	11.69±2.6^{f}	34.27±2.6^{bcd}	3.59±0.1^{a}	23.94±3.4^{bcd}	5.59±0.7^{a}	26.52±4.7^{a}
G10	15.82±6.5^{de}	33.33±1.3	3.28±0.4^{a}	20.56±0.4^{cde}	10.39±0.2^{a}	27.0±5.9^{a}
G11	18.16±6.8^{cd}	33.98±1.7^{cd}	3.76±0.2^{a}	33.29±4.7^{a}	6.88±0.5^{a}	16.91±6.9^{ab}
G12	15.99±1.4^{cde}	36.98±3.3^{abcd}	4.21±0.7^{a}	24.62±4.4^{bcd}	6.05±0.8^{a}	18.21±10.6^{a}
G13	16.66±5.1^{cde}	36.11±1.1^{bcd}	3.21±0.8^{a}	23.63±0.1^{bcd}	7.89±1.9^{a}	18.73±5.6^{ab}

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

The seeds had a fibre content ranging from 11.69% to 24.85%. The ash content was significantly higher in G12 and lowest in G3 (4.21% and 2.47% respectively). The crude protein content varied significantly from 14.05% in G3 to 33.29% in G11. Crude fat was highest in G4 (41.37%) and lowest in G6 (31.9%) where it was the main component. The groups G6 and G10 had significantly higher carbohydrate content (27.35% and 27% respectively) while G8 and G4 had the lowest (9.87% and 8.66% respectively).

Mineral Composition of Seed Flours

Significant differences (p<0.05) were observed among the groups for magnesium, potassium, iron, manganese and copper [Table-3]. The most abundant mineral was potassium, ranging from 124.8 to 309 mg/100g. This was followed by sodium, the values ranged between 70.5 to 134.8 g/100g. Results for other minerals were; zinc (0.42-0.96 mg/100g), iron (13.71 to 35.65 mg/100g), magnesium (33.65 to 86.11 mg/100g), calcium (7.1 to 34.82 mg/100g), manganese (3.39 to 8.91 mg/100g), copper (0.24 to 2.39 mg/100g).

Fatty Acid Profile of the Pumpkin Seed Oil

Significant differences (p<0.05) were observed among the groups for palmitic, oleic and linoleic [Table-4]. Palmitic acid varied from 1.16 to 20.81% in G12 and G3, respectively while oleic acid ranged from 15.56% in G12 to 40.51% in G7. The stearic acid content ranged from 0.16% in G5 to 5.56% in G6.

α-Tocopherol Content of Seed Oil

α-tocopherol content of the pumpkin seed oil varied between 8.33-122.65 µg/g in G2 and G7 groups, respectively as shown in [Table-5].

Table 3- Mineral composition of the pumpkin seed (mg/100g)

Groups	Mg	Ca	Na	K	Zn	Fe	Mn	Cu
G1	80.69±0.1^{ab}	27.9±0.5^{a}	134.3±9.9^{a}	309.0±21.5^{ab}	0.85±0.0^{a}	28.20±1.1^{a}	7.26±2.1^{ab}	0.50±0.3^{bc}
G2	67.53±5.1^{ab}	34.82±3.1^{a}	74±12.2^{a}	189.2±10.2^{bc}	0.58±0.0^{a}	13.71±1.3^{a}	4.49±0.9^{b}	1.78±0.1^{abc}
G3	74.41±3.1^{ab}	28.65±1.3^{a}	127.5±10^{a}	235.0±11.3^{abc}	0.68±0.1^{a}	23.29±2.3^{a}	8.91±0.2^{a}	1.71±0.6^{abc}
G4	52.81±1.5^{ab}	9.20±0.5^{a}	88.6±9.9^{a}	124.8±7.4^{c}	0.54±0.0^{a}	20.82±0.6^{a}	3.39±0.7^{b}	1.06±0.1^{abc}
G5	65.03±0.7^{ab}	6.37±0.2^{a}	109.2±9.5^{a}	327.5±3.9^{ab}	0.48±0.1^{a}	26.85±2.6^{a}	5.09±2.5^{ab}	1.07±0.3^{abc}
G6	67.11±12.1^{ab}	14.77±0.9^{a}	110.2±7.2^{a}	220.4±1.9^{abc}	0.69±0.2^{a}	21.36±5.2^{a}	4.20±2.1^{b}	1.58±0.2^{abc}
G7	33.65±0.7^{b}	5.24±1.9^{a}	148.7±7.6^{a}	126.0±4.9^{c}	0.42±0.3^{a}	21.64±1.5^{a}	4.87±4.1^{ab}	0.81±0.2^{abc}
G8	39.26±2.7^{b}	7.10±0.9^{a}	134.8±7.2^{a}	144.2±5.1^{c}	0.49±0.1^{a}	21.49±3.2^{a}	4.66±1.1^{ab}	0.24±0.0^{c}
G9	83.86±3.2^{a}	34.35±3.9^{a}	116.6±6.0^{a}	335.7±7.5^{a}	0.96±0.1^{a}	22.09±0.3^{a}	4.54±0.3^{b}	2.39±0.2^{ab}
G10	83.6±6.5^{a}	38.50±1.4^{a}	127±8.4^{a}	258.1±2.5^{abc}	0.64±0.2^{a}	24.91±1.2^{a}	6.88±1.6^{ab}	0.77±0.2^{abc}
G11	75.76±3.6^{ab}	22.36±8.6^{a}	70.5±9.0^{a}	290.8±3.4^{ab}	0.59±0.0^{a}	25.49±1.6^{a}	6.88±1.2^{ab}	1.63±1.4^{abc}
G12	86.11±7.2^{a}	37.20±0.7^{a}	98.1±4.4^{a}	292.8±7.6^{ab}	0.61±0.0^{a}	35.65±2.7^{a}	4.74±4.2^{ab}	2.67±0.3^{a}
G13	51.07±5.4^{ab}	12.96±2.9^{a}	115.8±4.2^{a}	210.0±7.3^{bc}	0.49±0.1^{a}	24.18±0.3^{a}	5.91±3.0^{ab}	0.76±0.4^{c}

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.

Mg: Magnesium, Ca: Calcium, Na: Sodium, K: Pottasium, Zn: Zinc, Fe: Iron. Mn : Manganese, Cu :Copper

Table 4- Fatty acid content of the pumpkin seed oil (%)

Groups	Stearic	Palmitic	Oleic	Linoleic
G1	5.07±0.1^{a}	7.36±0.3^{ab}	24.19±0.3^{bc}	26.18±1.0^{c}
G2	0.48±0.0^{a}	9.32±0.0^{ab}	23.37±0.1^{bc}	65.25±0.2^{ab}
G3	0.31±0.9^{a}	20.81±0.1^{a}	30.79±0.0^{ab}	47.85±0.6^{bc}
G4	0.71±0.5^{a}	8.37±0.6^{ab}	27.34±0.6^{abc}	60.6±0.8^{ab}
G5	0.16±0.0^{a}	18.2±1.4^{a}	30.50±0.0^{ab}	50.49±0.1^{bc}
G6	5.56±0.0^{a}	11.75±0.2^{ab}	28.44±0.1^{ab}	52.21±1.4^{bc}
G7	0.52±0.3^{a}	13.45±0.1^{ab}	40.51±0.0^{a}	43.40±0.0^{bc}
G8	0.49±0.2^{a}	17.87±0.1^{a}	30.69±0.0^{ab}	50.96±6.1^{bc}
G9	4.28±0.1^{a}	11.89±0.0^{ab}	21.84±0.8^{bc}	46.79±0.1^{bc}
G10	1.02±0.0^{a}	17.92±0.8^{a}	30.46±0.4^{ab}	47.84±2.2^{bc}
G11	3.56±0.1^{a}	17.60±1.2^{a}	25.02±0.9^{bc}	49.13±0.7^{bc}
G12	0.85±0.0^{a}	1.16±0.9^{b}	15.56±0.8^{c}	81.21±0.5^{a}
G13	2.66±0.0^{a}	19.0±0.7^{a}	21.45±3.3^{bc}	52.56±1.4^{bc}

Values are given as means of two replicates ± SD. Means with different small letters within a column are significantly different (p < 0.05). SD= Standard deviation of the mean.

Discussion

The potential of a particular food to be recommended for human consumption is determined primarily by the composition of its nutrients. Vegetables are well known to aid flavour and taste as well as to provide minerals, fibre, proteins and vitamins [16]. The moisture content for each of the group was different, and it was found to be highest in group 10 (10.39%), followed by group 6 (8.15%) and then group 13 (7.89%). Results for the moisture content were comparable with 4.85, 5.21 and 6.10 reported for *Colocynthis citrullus* from Akure, *Cucumeropsis edulis prumus amygdalus* seed flour respectively [17], and ground cantaloupe seeds (5.79%) [18]. Results reported for these cucurbit seeds were higher than 3.46% reported for gourd seed, 5.02% reported for pumpkin seed [19] and those obtained by El-Adawy & Taha [20] for pumpkin seeds, 2.8% for gourd seed and 2.4% reported for soybean [21]. However they were lower to those obtained by Akintayo, et al [22] of 16.84% for *C. maxima* seeds.

Table 5- α-Tocopherol content of the seed oil in (µg/g)

Groups	α-tocopherol
G1	11.59±0.9^{b}
G2	8.33±1.9^{b}
G3	8.58±0.0^{b}
G4	30.96±5.1^{b}
G5	24.42±.2^{b}
G6	36.29±2.4^{b}
G7	122.65±3.1^{a}
G8	35.97±1.2^{b}
G9	35.24±0.7^{b}
G10	31.02±0.5^{b}
G11	13.08±5.1^{b}
G12	25.22±1.9^{b}
G13	23.66±3.0^{b}

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.

Crude fibre contents of between 11.69% to 24.85% was reported and this value was lower that those reported for cantaloupe seed 31.22 [18] and higher than *Cucumeropsis manii* 3.81% *Cucurbita maxima* 3.44%, *Cucurbita moschata* 3.54% and *Legeneria siceraria* 3.68% [5]. The recommended daily allowance (RDA) of fiber are 19 to 25, 21 to 38, 28 and 29%, for children, adults, pregnant and lactating mothers respectively [23]. Thus the seeds of groups 2, 3, 4 and 7 can be considered as a valuable source of dietary fiber in human nutrition. Fibre rich foods are normally prescribed to diabetics for reduction of glycemic response to the food and consequently the need for insulin [24].

The reported value for crude protein content was between 14.05% to 33.29%. Plant foods that provides about 12% of their calorific value from protein are considered good source of protein [14,25]. Furthermore, the pregnant, lactating mothers and adults require 13 to 19, 71 and 34 to 56 g, respectively of proteins daily [26]. Seeds of these *Cucurbita* spp. could only meet the requirement for pregnant and adults. These seeds are usually discarded by people and therefore they do not make use of the nutrients inherent in the seeds. The crude protein content compared favourably with high protein seeds like *Cucumis sativus* (28.68%) and *Cucurbita moschata* (32.03%) [5], *Cucurbita pepo seeds* (27.48%) [27], in addition to those indicated by Ajayi, et al [28], for cashew nuts (22.8%), cotton seed (21.9%) and higher than those of sesame (18.7%) however they were lower than those reported for cucurbit seeds (35%), [29] and 30-40% in egusi seeds as reported by Vodouhe and Capo-Chichi [30].

The crude fat in the seeds varied from 39.4% to 41.37%, the values were greater than 30% and only group 4 reported a value greater than 40% (41.37%). The variation in the seed oil content of samples from the different groups could be attributed to environmental factors, geographical site, agronomic traits and genetic variability [31,32]. The crude fat content shows that these pumpkin seeds contain a good amount of oil that can be exploited i.e (be refined to edible vegetable oil for domestic use). This value fell in the range reported for different species of *Cucurbita* 9.8-52.1% [8]. The oil content of the pumpkin seeds in the study was found to either exceed, or comparable to, that of edible oils such as cottonseed (22-27%) safflower (30-35%), soybean (18-22%) and olive (12-50%) [33], 14.05-20.30% for soybean, locust bean and cotton seed, which are currently exploited and classified as oil seeds [34].

Although pumpkin seed oil is characterized by 9 saturated and unsaturated fatty acids, the four dominant fatty acids (oleic, stearic. Palmitic and linoleic) are the most dominant in the seed oil with values greater than 0.01%. Of the four fatty acids of the pumpkin seed oil only stearic acid was found not to exhibit significant variation (p<0.05). The differences in fatty acid composition reported in this study could probably be due to variation in the harvesting season, geographical locations, method of laboratory analysis and genetic variability [35]. El-Adawy & Taha [20] and Lazos [36] observed the same trend. They reported the content of linoleic acid as 43.1-55.6% and that of oleic 20.4-37.8% in cucurbit seeds, while a study of *C. pepo* by Ardabili, et al [37], found the content of linoleic and oleic to be 39.84 and 38.42% respectively. Linoleic acid (C18:2) was the major fatty acid in the pumpkin seed oil (81.21-26.18%), it is an excellent source the linoleic acid. The linoleic acid content is similar to those reported for corn, cottonseed, sunflower, soya bean and sesame oils (linoleic acid is the most abundant) [38]. Murkovic, et al [35] reported 35.6-60.8% linoleic acid, 21.0-46.9% oleic acid, 9.5-14.5% palmitic acid, 3.1-7.4% stearic acid for styrian pumpkin seed oil. The nutritional value of linoleic acid is due to its metabolism at tissue levels which is precursor to hormones like prostaglandings, which activity includes constriction of smooth vesssels and lowering of blood pressure [39].

The results showed that carbohydrate content varied from 8.66-27.35% The results obtained for all the 13 *Cucurbita* groups for the seeds establishes that G4 and G8 can be ranked as poor sources of carbohydrate compared with the remaining groups. The higher the carbohydrate content the higher the degree of sweetness [40]. High carbohydrate is desirable; deficiency causes depletion of body tissue [41]. The reported results for the seeds are lower to those obtained by Balogun and Olatidoye [42], 42.98% for *Mucuna utilis* seeds and cantaloupe seed 9.62% [18]. Carbohydrates provide the necessary calories in diets, promote the utilization of the dietary fats and reduce wastage of proteins [42].

Usually proximate composition of plants and crops seeds varies depending on cultivars, agro-geoclimatological conditions, maturity and collection time of seed, water and fertilizers application [43].

The ash content ranged between 2.47% to 4.21% indicating that the seeds will be a good source of minerals. Only groups 3 and 8 had an ash content of less than 3%. Since the ash content of a sample is a reflection of the minerals it contains therefore, pumpkin seeds are expected to be rich in minerals needed for good body development [44]. The ash content of the seed was similar to the values reported for some Nigerian grains [45], it compared favourably with those reported for *Cucumeropsis manii* (3.74%), *Cucurbita maxima* (3.95%) and *Cucumis sativus* (3.47%) [5], *Pruns amygdalus* (3.34%) [17] and water melon seeds which ranged between 2.31% to 3.76% [46].

The level of Copper is very low (0.24-2.39 mg/100g). The seeds of groups 9 and 12 could supply the RDA required since the acceptable range is (2 to 5 mg intake per day) set by the World Health Organization [47]. It has been reported that Copper consumption in excess of 3.0 mg/L of drinking water result in nausea and other adverse effects on the gastrointestinal tract (GIT) [48].

Iron is an essential trace element involved in the synthesis of haemoglobin, proper functioning of the central nervous system and in the oxidation of carbohydrates, proteins and fats [49]. The results showed that group G12 (35.65 mg/100g) had the highest concentration of iron. All groups of the seed could supply the required RDA of 8 mg Fe/day for men (19 years and older) and for women over 50 years, only the seed could supply 18 mg/day for the girls and women of about 11-50 years old [50]. The high content of iron in the pumpkin seed makes them a potential source of iron for the vulnerable groups.

As for manganese all groups could supply the RDA of 2-5mg per day Mn for infants, children, pregnant and lactating mothers [51]. An average human being contains 10- 20 mn, a quarter of which is found in the bone and a greater percentage present in tissues [41,52]. Only occasionally have human been found to have Manganese deficiency. The differences between the results obtained in this study in regards to the mineral content may be attributed to the variation of the varieties [44].

Although tocopherols represent an important class of antioxidants, the pumpkin seed oil contained α-tocopherols content of between 8.33-122.65 µg/g with no significant variation (p<0.05) among the groups. The determination of α-tocopherol content in the seed oil is

important owing to its antioxidative effect and positive nutrition influences in human metabolism as biological antioxidant [53]. Several factors attributed to environmental conditions, storage period of the oil and genetic influence have been reported to cause variation in α-tocopherol content [54,55]. It has been reported that the α- tocopherol always increases with temperature during seed maturation and also during drought [56]. This would explain why the samples reported varying amounts of vitamin E. The α- tocopherol content in the pumpkin seed oil was higher than that Stevenson, et al [8] reported (27.1-75.1 µg/g) in *C. maxima*, comparable to that of Styrian pumpkin oil (35.3 µg/g) reported by Murkovic & Pfannhauser [57].

In general, antioxidants such as α- tocopherol scavenge up the free radicals that cause oxidative damage of cell membranes [58]. Since α- tocopherol is one of the fat soluble vitamin E compounds that animal cells are unable to synthesise, they must be obtained from plant dietary sources [56]. The presence of α-tocopherol in pumpkin seed oil makes it an important oil especially in cosmetic applications, human diet, nutrition and health.

Conclusion

All groups of *Cucurbita* spp. seeds were rich in oil, fibre and protein. The fatty acid profile, is similar to that from sesame, sunflower and soybean oils that are rich in polyunsaturated fatty acids. *Cucurbita* seed oil can be considered as a new and valuable source of edible oil.

The results obtained will add to the body of knowledge in relation to nutrient compositions in Kenya, as well as provide more accurate dietary intake and nutrient adequacies from food consumption surveys in Kenya. Further research on the physicochemical properties of the seed is needed.

Acknowledgments

I wish to thank the National Council of Science and Technology, Kenya for financial support, the Food Science and Technology (FST) department, JKUAT, where the chemical analysis were carried out, and finally farmers and traders in Eastern and Central regions of Kenya for the provision of pumpkin samples.

Conflict of Interest: None declared.

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