COMPARATIVE STUDY ON THE NUTRITIONAL VALUE OF THE PUMPKIN, *CUCURBITA MAXIMA* VARIETIES FROM DIFFERENT REGIONS IN KENYA

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Abstract
The proximate analysis, evaluation of the nutritionally valuable minerals, β- carotene content, and the fatty acid profile of the pumpkin *C. maxima* were studied. The treatments comprised fresh fruits (fruit pulp) and whole seed (flours). The results showed that proximate composition of the pumpkin pulp ranged between 75.8 – 91.33 % moisture (fresh weight), 0.34 – 2 % crude ether extract, 0.2 – 2.7 % crude protein, 0.47 – 2.1 % crude fibre, 0.38 – 2.1 % crude ash and 3.1 – 13 % carbohydrate content (by difference). While those of the seeds were, 4.4 – 15.2 %, 31.28 – 43.35 %, 14 – 42 %, 11.21 – 24.98, 2.0 – 4.2 % and 6.7 – 30.5 % for the respectively, for the parameters above. The results indicate that the pumpkin seeds are rich sources of lipids, fibre and proteins. Physicochemical analysis of the extracted oil showed a high content of unsaturated fatty acids and the three dominant fatty acids were palmitic 0.3 – 20.81 %, oleic 15.61 – 40.51 %, and linoleic acids 25.38 – 79.61 %, the highest oil was linoleic acid i.e. it was the principal fatty acid. Fruits and seeds contained varying amounts of potassium, magnesium, zinc, manganese, iron, calcium, copper and sodium. The highest elemental mineral was potassium while the lowest were copper and zinc, in overall the seed had a higher concentration of minerals compared to the pulp. The fresh fruits had a β carotene content of the range between 9.15 to 41.28 µg/g on fresh weight basis. The established superior nutritional composition of these pumpkins highlighted their usefulness in terms of addressing nutritional deficiency particularly in Kenya and should therefore be promoted due to their high nutritional value.

Keywords: Pumpkin, fruit pulp, seed, nutritional value

Introduction

Pumpkin (*C. maxima*) is an angiosperm belonging to the Cucurbitaceae family generally characterized by climbing herbaceous vine with tendrils (Acquaah, 2004). The fruits vary in size, colour, shape and weight and have a moderately hard rind, with a thick edible flesh, and numerous seeds in the fruit which are either plump and tan or soft white (Robinson and Decker-Walters, 1997). Several studies have reported the nutritive value of the pumpkin from different regions and varieties. Achu *et al*. (2005) showed that cucurbit seeds from different bioclimatic 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*. (2000) reported that the seed of *Cucurbita pepo* are rich in oil, carbohydrates and α- tocopherol, while the four dominant fatty acids present in the oil were palmitic 13.3%, stearic 8%, oleic 29% and linoleic 47%. Lazos (1986) reported that the seeds are richly endowed in macro elements (magnesium, phosphorus and potassium) and moderate amounts of micro elements (calcium, manganese, copper and zinc) and thus the seed could be used as a valuable food supplement. The pumpkin fruit is cooked as a vegetable when immature, while when mature it is used in the manufacture of beverages such as pumpkin apple soup. The fruit is a good source of β-carotene and has moderate content of carbohydrates, vitamins and minerals (Mukesh *et al*., 2010). Consumption of foods containing carotene helps in prevention of skin diseases, eye disorders and cancer (Bendich, 1989).

In recent times, increased attention has been focussed on under-utilized indigenous crops, for example the pumpkin, and their promotion would help maximize the available resources, eradicate the dearth in food supply and be useful in food industries in the formulation of value added products thus cater for the daily needs of the citizens nutritionally. Despite the pumpkin being regarded as a 'poor mans' food and as an orphaned crop, it represents a cheap but quality nutrition for large parts of the population in both rural and urban areas (Chweya and Eyzaguirre, 1999).

Access to food is a basic human right. In order for the entire population to be healthy and undertake nation building, the relation between food, nutrition and health should be advocated for. In developing countries such as Kenya, one of the possible ways of achieving this is by the exploitation of the available resources, so as to satisfy the growing needs of the increasing population (Achu *et al*., 2005).
Keeping in view the importance of pumpkins in terms of nutrition**,** the objective of the study was to evaluate the nutritional composition of the pumpkin seed and fresh pulp of the pumpkin species *C. maxima* varieties grown in Kenya. This information will highlight the potential usefulness of pumpkins to alleviate widespread food and nutritional insecurity in Kenya.

2 Materials and methods

2.1 Collection and Preparation of Samples

The pumpkin samples (*C. maxima*) were collected from farmers and markets in Eastern and Central regions of Kenya from July to September 2011. Ripe fruits were cut and the seeds separated. Seeds were cleaned to remove the pulp using filter paper and air-dried at room temperature. The dried seeds were ground to flour using an electric grinder, the flour was then packed in a low dense polyethylene (LDPE) bag and stored in a dry cupboard while the pumpkin pulp was stored in a freezer at -4 ^{0}C until the time for analysis.

2.2 Reagents

All reagents including solvents, fatty acid methyl esters (FAMES) 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 and seed flour was determined using the AOAC methods (2000) as described by Indrayan *et al.* (2005). The moisture content of the pumpkin pulp and 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 each 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 ^{0}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 2 g of moisture free sample with hexane in a soxhlet extractor for six hours in a water bath at 80 $^{\circ}$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 H2SO4 and a catalyst to convert any organic nitrogen to ammonium sulphate (NH4)2SO4, in solution followed by the decomposition of (NH4)2SO4 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 ^oC 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.

2.5 Fatty Acid Composition

The extracted fat was dissolved in 4mL hexane, transferred to a conical flask and evaporated on a hot plate. Four mL of 95% methanolic HCl solution was then added and heating was done under reflux for 1½ hours. It was then cooled under tap water. Methyl esters 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 one more time. The hexane fractions were combined and washed with 3-4 portions of distilled water to remove acid. Anhydrous sodium sulphate was added in sufficient quantities to remove water. The filtrate was concentrated using nitrogen gas to about 0.5 mL and the sample was injected into the GC. The standards were also injected and the procedure was repeated for all the samples (AOAC, 2000).

2.6 Beta Carotene

Approximately 2 g of fresh pumpkin pulp was weighed accurately. It was then placed in a motor with about 10mL of acetone and ground thoroughly. The acetone extract was then transferred to a 100 mL volumetric flask and the residue extracted again with 10 mL of acetone and transferred to the volumetric flask. The extraction with acetone was repeated until the residue no longer gave colour to acetone. The combined extract was made to the 100mL mark. 25 mL of the extract was evaporated to dryness on a rotary evaporator and the residue dissolved in about 1 mL of petroleum ether. The solution was introduced into chromatographic column and eluted with petroleum ether. The beta-carotene was then collected in a flask. Beta-carotene went through the column as a yellow pigment very quickly. The beta-carotene was eluted to a volume in the 25mL volumetric flask with petroleum ether. Five solutions of standard pure beta carotene with concentrations between 0.5µg/mL and 2.5µg/mL were prepared from a stock solution containing 2.5µg/mL. The absorbance values of the solution were determined at 440 nm using UV-vis spectrophotometer (UV mini 1240 model, Shimadzu Corp., Kyoto, Japan) and plotted against their corresponding concentration to give a standard curve (AOAC. 2000.)

2.7 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. Pair wise comparison was determined using LSD at 5% level of confidence using Genstat software (Buysee *et al*., 2004).

3 Results and Discussion

3.1 Proximate Composition

Table 1 and 2 shows the proximate composition of *C. maxima's* fresh pulp and seed flour. The fruit pulp had lower crude fibre (0.47 - 2.1 %) content as compared to the whole seed (11.21 - 24.98 %). There were significant ($p<0.05$) differences among the 27 varieties for both the seeds and fruit pulp. Values for the seed were higher than those obtained by El-Adawy *et al.* (2001) for pumpkin seeds and in close agreement to those obtained by Alfawaz (2004) of 16.84% for *C. maxima* seeds and the African pear (17.9%) (Omoti and Okiy, 1987). Fibre rich foods are normally prescribed to diabetics for reduction of glycemic response to the food and consequently the need for insulin (Guillon and Champ, 2000). Diverse sources of fibre are recommended for the young population to avoid insulin resistance syndrome and to decrease the incidence of other metabolic diseases such as obesity and cardiovascular diseases (Guillon and Champ, 2000). The pumpkin seed could serve as a good source of dietary fibre. Fibre content of vegetables varies owing to many factors including growth conditions (climate, soil), time of harvest and species (Ozcan and Haydar (2004). Fibre is determined as material insoluble in dilute acid and dilute alkali.

The seeds contained a higher ash content (2-4.2%) compared to the fruit pulp (0.38-2.1). The ash content of seeds compare well to those obtained by Achu *et al.* (2005) and Lazos (1986) that ranged from 3.5-5.3%, 3.85 - 4.65 for egusi seeds and pumpkin seeds respectively. However they were lower than values (5.1-6.3 %) obtained by Idouraine *et al.* (1996) for *C. pepo* seeds. There were significant ($p<0.05$) differences among the 27 varieties for both the seeds and fruit pulp in terms of crude fat content. The fruits contained lower amounts of crude fat (0.34-2%) compared to the seeds (31.28-43.35%), where it was the main component. Fats provide more energy than proteins and carbohydrates, they make a meal more satisfying, enrich its flavour and delay onset of hunger, and more importantly, are a medium of transport of fat soluble vitamins (A, D, E and K). They are a source of antioxidants and bioactive compounds. Fats are also incorporated as structural components of the brain and cell membranes (Wardlaw and Kessel, 2002).

The values of the seed oil were lower than those obtained by El-Adawy *et al.* (2001) for C. *pepo* seeds with oil content of 51.01%. Martin (1998) found cucurbit seeds to contain 50% lipids while Achu *et al.* (2005) found the seeds to contain 41 - 54%. They were in close comparison to those obtained by Lazos (1986) of 37 - 45% for pumpkin seeds and Idouraine *et al.* (1996) of 34.5-43.6% for *C. pepo* seeds. Due to the high content of lipids in pumpkin seeds they are a good source of vegetable oil.

The pumpkin seeds contained higher protein content (14 - 42 %) than the fruits (0.2 - 2.7 %) and the different varieties showed significantly ($p< 0.05$) higher protein content. These values obtained for the seeds are similar to those reported by Martin (1998) for cucurbit seeds having 35% of protein and a protein content of 30 - 40% in egusi seeds as reported by Vodouhe and Capo-Chichi (1998). The fluted pumpkin (*Telflaria occidentalis)* seed was found to contain 30.1 % protein (Asiegbu, 1987). The seeds for pumpkin varieties in Kenya are rich in proteins, hence good for children, lactating mothers and old people who need more protein for growth, maintenance and repair of worn out tissues.

There were significant ($p>0.05$) differences among varieties for both the seeds and pulp in moisture content. Fruit pulp showed higher moisture content (75.8 - 91.33%) compared to seeds (4.4 - 15.2%) indicating a lower and higher dry matter, respectively. The values for dry seeds are similar to those obtained by Kershaw and Hackett (1987). For other edible oil seeds such as cotton seeds (6.46%), peanuts (4.58%), palm kernel (5.31%), sesame (4.60%) and sunflower seeds (6.58%). Some are in comparison to (11.07%) and coconut seeds, 14.3% (FAO, 1982). This might be advantageous in terms of the shelf life of the seeds.

There were significant ($p>0.05$) differences between the individual varieties differences for both the seeds and pulp. The fruit pulp lower carbohydrate content (3.1 - 13%) as compared to the seed (6.7 - 30.5 %). The values for the seeds are in close comparison to those obtained by Plat (1962) 10 % for pumpkin seeds, peanuts (18.6%) (Oyenuga, 1968) cashew nuts (26.2%), sesame (20.2%) and sunflower seeds (26%) (FAO, 1982).

Table 1. Proximate composition of the fresh pumpkin pulp and seed flour (dry weight basis)

Groups	Pulp			Seed		
	FIBRE	**ASH**	**FAT**	**FIBRE**	**ASH**	**FAT**
1(n=1)	0.47 ±0.2^{ab}	1.18 ± 0.4^{bcde}	1.26 ± 0.2^{cdefg}	18.00± 0.9^{cdef}	3.83±0.3^{ghijkl}	33.28 ± 0.9^{abcd}
2(n=3)	1.17 ± 0.3^{abcde}	1.19 ±0.2^{bcde}	1.85± 0.1^{hij}	22.24± 1.6^{fghij}	3.38±0.3^{defghi}	38.80 ± 3.7^{cde}
3(n=3)	1.31 ± 0.4^{bcdef}	1.42 ± 0.7^{cdef}	1.49± 0.5^{defghi}	18.89± 1.7^{defgh}	3.46±0.3^{efghij}	32.24 ± 1.3^{abcd}
4(n=1)	1.95 ± 0.1^{fg}	1.6 ± 0.2^{ef}	1.74± 0.1^{ghij}	24.85± 3.6^{ij}	2.47±0.4^{abc}	34.80 ± 1.2^{abcd}
5(n=2)	1.46 ± 0.0^{bcdefg}	0.93 ± 0.2^{abc}	0.6 ± 0.2^{a}	25.98± 1.4^{j}	3.27±0.1^{defgh}	39.39 ± 1.6^{de}
6(n=1)	1.42 ± 0.4^{bcdefg}	0.51 ± 0.1^{ab}	1.17 ± 0.2^{cd}	19.59± 4.6^{defghi}	4.15±0.1^{ijkl}	43.35 ± 1.1^{e}
7(n=1)	0.97 ± 0.2^{abc}	0.86 ± 0.3^{abcde}	0.82± 0.2^{abc}	16.82± 0.4^{bcdef}	3.53±0.2^{efghijk}	29.02 ± 2.2^{a}
8(n=1)	0.96 ± 0.2^{abc}	1.15 ± 0.2^{abcde}	0.34 ±0.4^{a}	17.68± 0.9^{cdef}	3.64±0.2^{fghijk}	39.47 ± 1.4^{de}
9(n=1)	1.90 ± 0.9f^{g}	1.41 ± 0.2^{cdef}	1.52 ± 0.3^{def}	15.41± 4.4^{abcde}	2.29± 0.3^{abc}	31.80 ± 1.2^{abc}
10(n=1)	1.28 ± 0.2^{bcdef}	1.48 ± 0.7^{def}	1.12 ± 0.3^{bcde}	10.29± 0.95^{a}	3.22±0.9^{defg}	31.28 ± 1.1^{ab}
11(n=1)	2.10 ± 0.2^{g}	2.1 ± 0.8^{f}	1.66±0.1^{fghij}	14.66±1.7^{abcd}	4.14± 0.7^{ijkl}	32.61 ± 1.9^{abcd}
12(n=1)	1.17 ± 0.17^{abcde}	0.81± 0.5^{ab}	1.69 ± 0.2^{ghij}	24.69± 5.6^{ij}	3.26±0.1^{defgh}	39.44 ± 2.0^{de}
13(n=1)	1.78 ± 0.1^{defg}	0.63 ± 0.1^{abc}	1.73± 0.3^{hgij}	18.89±1.8^{defg}	2.64± 0.2^{abcd}	38.10 ± 0.6^{cde}
14(n=1)	1.16 ± 0.1^{abcde}	0.78 ±0.2^{abc}	1.45 ± 0.2^{defgh}	11.94± 0.9^{abc}	4.26±0.1^{kl}	34.28 ± 0.7^{abcd}
15(n=1)	1.16 ± 0.1^{abcde}	1.1 ±0.4^{abcde}	1.09± 0.3^{bcd}	11.91± 0.7^{abc}	2.79±0.2^{bcde}	35.35 ± 1.8^{abcd}
16(n=2)	1.34 ± 0.2^{bcdefg}	0.38±0.1^{a}	2.0 ± 0.3^{j}	11.21±1.4^{ab}	3.71±0.6^{fghijk}	33.17 ± 4.0^{abcd}
17(n=1)	1.64 ± 0.1^{bcdefg}	0.78 ± 0.2^{abcd}	1.46± 0.2^{def}	16.13± 0.7^{abcde}	3.00± 0.3^{cdef}	32.47 ± 0.7^{abcd}
18(n=4)	1.73 ± 0.3^{cdefg}	1.45 ± 0.6^{def}	1.32 ± 0.1^{defg}	15.52±2.6^{abcde}	3.56± 0.1^{efghijk}	34.19 ± 2.6^{abcd}
19(n=1)	1.24 ± 0.1^{bcdef}	1.23 ± 0.3^{bcde}	1.95± 0.3ij	19.66±6.5^{defghi}	4.49 ± 0.4^{l}	36.55 ± 1.3^{bcde}
20(n=3)	1.09 ± 0.1^{abcd}	0.99 ± 0.3^{abcde}	1.94± 0.1^{hij}	15.10± 6.8^{abcde}	4.52 ± 0.2^{l}	32.72 ± 1.7^{abcd}
21(n=4)	1.48 ± 0.4^{bcdef}	1.59 ± 0.6^{ef}	1.9 ± 0.1^{hij}	16.63±1.4^{bcdef}	3.99±0.7^{ghijkl}	34.21 ± 3.3^{abcd}
22(n=1)	1.82 ± 0.5^{defg}	1.01± 0.1^{abcde}	1.49 ± 0.4^{defghij}	21.24± 5.1^{efghij}	2.02± 0.8^{a}	32.45 ± 1.1^{abcd}
23(n=1)	1.24 ± 0.9^{bcdef}	0.7 ± 0.3^{abcd}	1.58 ± 0.2^{efghij}	15.99±1.8 ^{abcde}	4.21± 0.2^{jkl}	36.98± 2.9^{bcde}
24(n=3)	1.89 ± 0.5^{efg}	0.92 ± 0.2^{abcde}	0.59 ± 0.4^{a}	15.51± 1.6^{abcde}	3.87±0.5^{ghijkl}	34.89 ± 1.3^{abcd}
25(n=1)	1.61 ± 0.49^{bcdefg}	0.98 ± 0.6^{abcde}	0.69 ± 0.3^{ab}	17.40± 2.5^{cdef}	4.05± 0.2^{hijkl}	34.24 ± 2.2^{abcd}
26(n=3)	1.29 ± 0.6^{bcdef}	1.21 ± 0.6^{bcde}	0.51± 0.2^{a}	18.28±3.3^{def}	2.78±0.2^{bcde}	37.01 ± 1.6^{bcde}
27(n=1)	0.47 ± 0.6^{a}	1.16 ± 0.2^{abcde}	0.37 ± 0.2^{a}	15.44± 1.4^{abcde}	2.15± 0.3^{ab}	38.28 ± 0.9^{bcde}
L.S.D	0.6	0.7	0.4	5.1	0.7	6.1

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

Table 2. Proximate composition of the fresh pumpkin pulp and seed flour in (dry weight basis)

	Pulp			**Seed**		
Groups	**PROTEIN**	**MOISTURE**	**CARBS**	**PROTEIN**	**MOISTURE**	**CARBS**
1(n=1)	1.36 ±0.0^{cdefghi}	88.8 ±0.5^{efgh}	6.3 ± 0.8^{abcdef}	25.25±1.3^{abc}	5.70±0.2^{ab}	19.65±0.9^{bcdefghij}
2(n=3)	2.73 ±0.8^{j}	86.98±1.4^{defg}	5.74±2.0^{abcde}	27.50±0.6^{abc}	5.90±0.4^{ab}	10.42±10.0^{abc}
3(n=3)	1.45 ± 0.1^{cdef}	84.82 ±3.8^{bcd}	9.29±3.4^{efgh}	27.13±5.1^{abc}	5.34±0.4^{ab}	18.27±5.5^{bcdefghi}
4(n=1)	1.81 ±0.1^{ghi}	90.09 ±0.4^{fgh}	2.63±0.7^{a}	14.05±0.1^{a}	5.81±0.2^{ab}	23.83±4.78^{fghijk}
5(n=2)	1.53 ±0.2^{defghi}	89.51 ±1.3^{fgh}	6.82±0.9^{bcdefgh}	18.39±6.5^{ab}	7.59±3.5^{abc}	6.7±3.2^{a}
6(n=1)	1.83 ± 0.0^{hi}	90.22 ±0.9^{gh}	4.68±1.2^{abcd}	22.30± 0.9^{abc}	6.01±0.8^{ab}	10.62±3.8^{abc}
7(n=1)	1.21 ± 0.1^{cdefg}	86.67 ±2.1^{defg}	9.29±2.1^{efgh}	35.62±3.1^{cd}	5.93±0.9^{ab}	15.01±4.3^{abcdefgh}
8(n=1)	0.64 ± 0.1^{ab}	82.13 ±1.6^{bc}	13.58±1.7^{i}	24.21±1.3^{abc}	7.80±1.0^{bc}	21.27±3.6^{defghijk}
9(n=1)	1.27 ±0.1^{cdefgh}	88.89 ±0.2^{efgh}	4.78±1.1^{abcd}	20.76±0.9^{abc}	15.00±1.6^{e}	29.73±5.7^{jk}
10(n=1)	2.73 ±0.0^{j}	82.76 ±1.4^{bc}	10.16±1.9^{fghi}	24.62±0.1^{abc}	5.02 ±0.3^{ab}	30.59±1.9^{k}
11(n=1)	0.49 ±0.1^{a}	85.33 ±0.5^{cde}	8.25±0.9^{defgh}	26.85±0.2^{abc}	4.44 ±0.5^{a}	21.74±2.5^{defghijk}
12(n=1)	1.76 ±0.1^{cdefghi}	86.43 ±0.3^{defg}	7.89±0.7^{cdefgh}	18.59±1.3^{ab}	5.59 ±0.8^{ab}	14.01±7.5^{abcdef}
13(n=1)	1.58± 0.0 ^{cdefgh}	91.16 ±1.1^{h}	3.10 ±1.0^{ab}	30.64±0.5^{jkl}	7.76 ±1.5^{bc}	9.37±1.5^{ab}
14(n=1)	1.35 ±0.1^{cdefghi}	91.33 ±0.8^{h}	3.853 ±1.0^{abc}	20.00±0.9^{ab}	5.84 ±0.1^{ab}	29.53±0.9^{jk}
15(n=1)	1.11±0.0^{bcde}	88.49 ±2.9^{defg}	6.94±3.1^{bcdefgh}	25.66±0.6^{efghij}	5.52 ±0.1^{ab}	24.29±2.4^{ghijk}
16(n=2)	1.08±0.2^{bcd}	88.99 ±1.6^{efgh}	6.09±1.5^{abcdef}	26.16±5.1^{abc}	5.43 ±0.5^{ab}	25.75±8.7^{ijk}
17(n=1)	1.74 ±0.1^{fghi}	89.16 ±1.3^{fgh}	5.01±1.3^{abcd}	17.72±0.6^{ab}	15.17±0.6^{e}	30.68±1.1^{k}
18(n=4)	1.66 ±0.5^{defghi}	88.08 ±3.7^{defgh}	5.5±3.7^{abcde}	23.41±3.4^{abc}	5.62 ±0.7^{ab}	23.32±4.7^{fghijk}
19(n=1)	2.56 ±0.1^{j}	81.62 ±0.6^{b}	10.92±0.4^{hi}	27.98±0.4^{abc}	4.96 ±0.2^{ab}	11.32±5.9^{abcd}
20(n=3)	1.49 ±0.7^{cde}	87.90 ±2.7^{defgh}	6.42 ±3.2^{abcdefg}	42.85±4.7^{d}	5.98 ±0.5^{ab}	24.82±6.9^{hijk}
21(n=4)	1.45 ±0.9^{cdefghi}	87.16 ±2.1^{defg}	5.94 ±2.0^{abcde}	30.64±4.5^{bcd}	5.60 ±0.8^{ab}	18.91±10.6^{bcdefghi}
22(n=1)	0.91 ± 0.1^{abc}	85.07 ±1.1^{bcd}	9.57 ±1.6^{efgh}	31.69±0.1^{bcd}	10.98±1.9^{d}	12.61±5.6^{abcde}
23(n=1)	1.31 ±0.1^{cdefgh}	75.08 ± 4.5^{a}	19.76 ± 5.3^{j}	24.62±0.3^{abc}	6.05±2.2^{ab}	18.21±1.5^{bcdefghi}
24(n=3)	1.17 ±0.7^{bcdef}	88.01 ±0.8^{defgh}	7.28 ± 0.7^{bcdefgh}	19.08±1.8^{ab}	7.86±5.2^{bc}	19.98±7.4^{cdefghij}
25(n=1)	1.94 ±0.1^{i}	87.65 ± 0.9^{defgh}	6.90 ±1.6^{bcdefgh}	29.84±0.8^{bcd}	5.74 ±0.3^{ab}	14.48±2.9^{abcdefg}
26(n=3)	1.34 ±0.6^{cdefghi}	84.90 ±2.4^{bcd}	10.55 ±3.6^{ghi}	21.41±7.5^{abc}	7.46 ±3.9^{abc}	20.52±6.2^{cdefghij}
27(n=1)	1.83 ±0.1^{hi}	88.04 ± 0.7^{defgh}	7.91±0.2^{cdefgh}	24.18±0.1^{abc}	10.48±1.0^{cd}	19.95±0.6^{cdefghij}
L.S.D	0.6				2.7	8.5

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

3.2 Minerals

Eight elements were assayed in both the pumpkin pulp and seed flour. Their composition apparently revealed relatively high concentrations of sodium, potassium, magnesium and calcium (Table 3). The mineral contents of both the pumpkin pulp and seed flour individual groups varied significantly ($P>0.05$). Other mineral elements detected in relatively low amounts were zinc, iron manganese and copper. 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 (Ishida *et al.,* 2000). Calcium plays an important role in bone formation and maintenance of healthy teeth. It is noteworthy that, the Ca content in the pumpkins was relatively high thus could supply the required RDA (The RDA is 1000-1200mg for adults and 1300mg for those aged between 9-18 years) (Fawzi and Hunter, 1998). The Na/K ratio in the body is of great importance for prevention of high blood pressure. Na/K ratio of less than one is recommended (FND, 2002). In this study both the seed and the pulp had a Na/K ratio higher than one. Both these two ions aid in maintaining the water balance in the body and blood composition (Gibson, 2003). Children, women of reproductive age and pregnant women need food with high iron content since they are most vulnerable to micronutrient deficiency and anaemia. 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 that both the pulp and seed 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 (FNB, 2001). The high content of iron in the pumpkins makes them a potential source of iron for the vulnerable groups.

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

Group	Pulp				Seed			
	magnesium	**calcium**	**Sodium**	**pottasium**	**magnesium**	**Calcium**	**sodium**	**pottasium**
1(n=1)	23.63 ± 0.1^{ef}	20.26± 3.8^{jklm}	75.56 ± 4.3^{fgh}	183.2 ±1.2^{defgh}	80.69 ±13.4^{efghi}	27.9± 0.5^{i}	134.3 ± 9.9^{ghi}	309 ± 21.5^{i}
2(n=3)	42.5 ± 0.4^{l}	16.9 ± 0.6^{ghij}	116.27 ±6.5^{n}	189.7 ± 4.8^{fghi}	35.8 ± 3.1^{ab}	12.92 ±3.1^{de}	45.7 ± 27.9^{b}	118.8± 3.0^{b}
3(n=3)	30.29 ±1.0^{hij}	21.4 ± 7.4^{klm}	72.28 ±1.3^{efg}	175.9± 2.3^{bcde}	99.25 ± 5.1^{j}	56.74 ± 1.3n	102.2 ±11.5^{de}	259.5 ± 14.7^{g}
4(n=1)	7.39 ± 0.2^{ab}	25.53 ± 0.7^{o}	118.28 ± 5.3^{n}	186.2± 8.0^{efgh}	74.41±10.6^{defgh}	28.65 ± 0.5^{i}	127.5 ±11.2^{fghi}	235 ± 11.3^{f}
5(n=2)	32.95 ± 0.1^{ijk}	12.44± 0.2^{cdef}	95.58 ±10.3^{kl}	198.2 ±5.5^{ij}	25.71 ± 1.5^{a}	9.38 ± 0.2^{cd}	66.6 ± 12.4^{c}	118.3 ± 5.47^{b}
6(n=1)	42.77 ± 8.6^{l}	38.96 ± 1.4^{q}	89.28± 6.3^{ij}	185.3 ± 6.0^{efgh}	79.91 ±18.9^{efghi}	9.02 ± 0.9^{bcd}	110.6±12.9^{defg}	131.2 ± 3.9^{bcd}
7(n=1)	20.67 ± 0.7^{e}	9.30 ± 0.4^{abc}	52.24 ± 6.2^{a}	215.8 ± 8.1^{k}	39.62 ± 0.7^{ab}	9.44 ±1.9^{cd}	97.9 ± 11.8^{d}	329.4 ± 7.4^{j}
8(n=1)	23.55 ± 0.6^{ef}	13.62±0.7^{defg}	85.92 ± 4.1^{ij}	182.2±7.4^{cdefgh}	91.06 ± 14.6^{ij}	3.31 ± 0.9^{a}	120.4±13.3^{defgh}	325.7± 11.9^{j}
9(n=1)	8.47 ± 2.0^{ab}	10.57 ±0.3^{bcd}	103.16±3.8^{lm}	178.7 ±6.4^{cdef}	41.99 ±3.6^{b}	4.59 ±3.9^{ab}	138.9 ± 9.5^{hi}	101.6 ± 1.9^{a}
10(n=1)	33.92 ± 0.8^{jk}	25.08 ±0.8^{no}	83.09 ± 2.1^{hij}	185 ± 6.1^{efgh}	89.09 ± 6.5^{hij}	14.05 ±1.4^{e}	74.4 ± 9.9^{c}	304.3 ± 4.9^{hi}
11(n=1)	8.53± 0.25^{ab}	14.71 ±0.9^{efgh}	105.16± 4.9^{m}	153.1 ± 5.9^{a}	70.24 ±3.4^{cdef}	25.68±8.7^{hi}	117.2 ±7.6^{defgh}	255.4 ± 11.9^{g}
12(n=1)	25.52 ± 1.5^{fg}	17.3 ± 0.6^{hij}	68.28 ± 6.0^{def}	166 ± 5.1^{b}	33.65 ± 2.7^{ab}	5.24 ± 0.7^{abc}	148.7 ± 19.3^{i}	126.3 ± 5.0^{bc}
13(n=1)	15.89 ± 2.9^{d}	13.76±0.1^{defg}	56.39± 7.3^{abc}	186.4 ± 3.4^{efgh}	39.26 ± 2.7^{ab}	7.1 ± 2.9^{abc}	134.8 ±2.1^{ghi}	144.2 ± 5.0^{d}
14(n=1)	29.26 ±0.5^{ghi}	46.16 ± 1.2^{r}	71.26 ±2.9^{efg}	166.7 ± 2.8^{b}	77.94 ± 2.2^{defghi}	61.22 ±1.1^{o}	25 ± 9.9^{a}	347.2 ± 9.9^{k}
15(n=1)	10.25±0.1bc	14.62 ± 0.3^{efgh}	53.66 ± 2.9^{ab}	185.5 ± 7.1^{efgh}	82.82 ± 3.7^{efghi}	32.69 ±1.2^{j}	131.1 ±16.4^{fghi}	330.5 ± 7.6^{jk}
16(n=2)	49.87 ± 6.4^{m}	6.28 ± 0.6^{a}	70 ± 3.0^{def}	179.6 ± 2.9^{cdefg}	90.86 ± 12.7^{ij}	9.24 ±1.1^{cd}	193.8 ± 5.9^{j}	329.3 ± 2.5^{j}
17(n=1)	30.14 ± 2.6^{hij}	22.2± 0.6^{lmn}	106.92 ±5.4^{m}	191 ± 9.9^{ghi}	98.86 ± 4.9^{j}	35.14 ±1.1^{jk}	127.9 ±13.1^{fghi}	293.4 ± 7.5^{hi}
18(n=4)	36.12 ± 0.3^{k}	9.15 ± 0.3^{ab}	71.06 ±3.1^{efg}	193.4± 8.0^{hi}	68.34 ± 6.7^{cde}	41.86 ± 2.3^{l}	126.1 ± 4.7^{efghi}	223.1 ± 3.4^{f}
19(n=1)	36.28 ± 0.8^{k}	15.72 ±0.5^{fghi}	83.92 ±3.0^{hij}	185.4 ± 7.2^{efgh}	80.89 ± 7.2^{efghi}	24.67 ±1.1^{hi}	135.5 ± 25.9^{hi}	337.3 ± 12.1^{jk}
20(n=3)	27.42 ±0.5^{fgh}	18.95±0.0^{ijkl}	82.03 ±3.5^{hij}	193.3 ± 6.9^{hi}	64.31 ± 5.4^{cd}	26.55 ± 0.2^{i}	108.2 ±4.2^{def}	181.6 ± 8.9^{e}
21(n=4)	55.58± 0.3^{n}	18.99± 1.1^{ijkl}	148.48 ± 5.31^{o}	181.3±4.9^{cdefgh}	72.93 ± 3.5^{defg}	15.84 ±0.7^{ef}	121.1 ± 4.5^{defgh}	287.2 ± 6.7^{h}
22(n=1)	5.79 ± 0.5^{a}	19.82±0.75^{jklm}	69.98± 4.9^{def}	176.4±11.5^{bcde}	84.9 ± 10.6^{fghij}	52.57±1.1^{m}	127.9 ±13.1^{fghi}	347.7 ± 9.9^{k}
23(n=1)	5.54 ± 0.3^{a}	18.74 ±0.8^{ijk}	63.96 ± 4.6^{cde}	173 ± 1.9^{bcd}	86.11 ± 8.8^{ghij}	37.2 ± 3.5^{k}	98.1 ± 16.0^{d}	292.8 ± 7.3^{hi}
24(n=1)	13.12 ±0.4^{cd}	22.76± 1.9^{mno}	79.95 ±3.9^{ghi}	170.9 ± 2.8^{bc}	29.07 ± 2.3^{ab}	3.03 ±1.7^{a}	114.8 ± 2.1^{defgh}	224.8 ± 13.0^{f}
25(n=1)	29.22 ± 2.1^{ghi}	32.55 ± 0.5^{p}	54.79 ± 4.1^{ab}	208 ± 6.8^{jk}	35.49 ± 5.7^{ab}	7.22 ±3.4^{abc}	126.8± 4.1^{fghi}	136.3 ± 13.9^{cd}
26(n=3)	45.62 ± 0.4^{l}	17.26± 1.7^{hij}	61.33 ±4.1^{bcd}	179.9 ± 6.0^{cdefg}	56.71 ± 2.0^{c}	22.03±0.5^{gh}	101.3 ± 7.9^{d}	177.5 ±10.4^{e}
27(n=1)	26.76 ±0.4^{fgh}	11.91±0.2^{bcde}	67.68± 3.9^{def}	172.4 ± 4.6^{bcd}	83.26 ± 9.0^{efghi}	19.56± 0.8^{fg}	120.2 ±7.6^{defgh}	301.3 ± 12.5^{hi}
L.S.D	3.1	2.9	8.0	10.2	12.5	3.9	20.6	16.0

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

Table 4. Micro-element composition of the pumpkin pulp and seed flour in (mg/100g dry weight basis)

Group	Pulp				Seed			
	zinc	**iron**	**manganese**	**copper**	**zinc**	**iron**	**manganese**	**copper**
1(n=1)	0.04± 0.0^{ab}	6.83 ±0.61^{j}	0.35 ±0.1^{abcde}	0.77± 0.2^{def}	0.85± 0.0^{no}	28.2 ± 2.4^{hi}	7.26 ± 0.9^{ghi}	0.50 ± 0.1^{a}
2(n=3)	0.07±0.0^{abcd}	4.28 ± 0.4^{efg}	0.36 ±0.2^{abcde}	0.4 ± 0.1^{abc}	0.58± 0.0^{hi}	3.36 ±1.1^{a}	3.42 ±2.1^{bc}	0.24 ± 0.1^{a}
3(n=3)	0.19± 0.2^{e}	3.13 ±0.3^{abcd}	0.47± 0.2^{def}	1.03 ± 0.1^{fgh}	0.57 ± 0.0^{hi}	24.06±1.3^{efg}	5.56±2.5^{cdefgh}	3.31 ± 0.6^{f}
4(n=1)	0.09±0.0^{abcd}	3.49 ± 0.7^{bcde}	0.39 ±0.1^{bcde}	0.41± 0.1^{abc}	0.68 ± 0.0^{kl}	23.29 ±1.1	8.91 ± 0.2^{ij}	1.71± 0.3^{c}
5(n=2)	0.06± 0.0^{abc}	3.95 ± 0.7^{cdef}	0.32 ±0.1^{abcd}	0.66± 0.1^{cde}	0.21 ± 0.1^{b}	11.28± 0.6^{b}	2.40 ± 0.7^{ab}	0.29 ± 0.1^{a}
6(n=1)	0.03± 0.2^{a}	8.72 ± 0.9^{k}	0.71±0.0^{f}	1.11 ± 0.3^{ghi}	0.87 ± 0.0^{o}	30.35 ± 2.7^{ij}	4.37 ± 1.2^{bcde}	1.83 ± 0.2^{cd}
7(n=1)	0.0 ±0.0^{abc}	17.06 ± 0.8^{m}	0.10 ± 0.0^{ab}	1.31±0.2^{hij}	0.30± 0.00^{c}	20.05±5.7^{cde}	5.45 ±1.2^{cdefgh}	0.39 ± 0.2^{a}
8(n=1)	0.03± 0.0^{a}	5.1 ± 0.4^{ghi}	1.13 ±0.2^{g}	1.35± 0.1^{ij}	0.66 ± 0.0j^{k}	33.66 ±3.7^{jk}	4.73 ± 0.7^{bcdef}	1.74 ± 0.2^{c}
9(n=1)	0.05±0.0^{abc}	2.95 ±0.3^{abc}	0.42 ± 0.2^{cde}	0.45±0.0abc	0.48 ± 0.0^{fg}	22.72±1.5^{defg}	4.02 ± 0.6^{bcde}	0.61 ± 0.0^{ab}
10(n=1)	0.06±0.0^{abc}	5.87 ± 0.4^{ij}	0.25 ± 0.2^{abcd}	0.51± 0.2^{abcd}	0.75 ± 0.0^{lm}	30.31±0.3^{ij}	4.41 ± 4.1^{bcde}	1.73 ± 0.1^{c}
11(n=1)	0.05± 0.0^{abc}	3.14 ±0.4^{abcd}	0.47 ± 0.2^{def}	1.13 ± 0.1^{ghi}	0.83 ± 0.0^{no}	11.05 ± 2.9^{b}	4.19 ± 0.3^{bcde}	2.41 ± 0.1^{de}
12(n=1)	0.10± 0.0^{bcd}	3.62 ± 0.1^{cde}	0.09 ± 0.1^{a}	0.51 ±0.1^{abcd}	0.42 ± 0.0^{ef}	21.64 ± 0.3^{de}	4.87 ± 0.3^{bcdefg}	0.81 ± 0.0^{ab}
13(n=1)	0.09±0.0^{abcd}	5.77 ± 0.9^{i}	1.78 ± 0.2^{g}	1.44 ± 0.0^{j}	0.49 ± 0.0^{fg}	21.49±1.2^{de}	4.66 ±1.1^{bcde}	0.24 ± 0.0^{a}
14(n=1)	0.08±0.0^{abcd}	5.61 ± 0.2^{hi}	0.97 ± 0.3^{g}	0.91 ± 0.4^{efg}	0.09 ± 0.0^{a}	2.74±1.6^{a}	0.38 ± 0.2^{a}	0.97 ± 1.4^{ab}
15(n=1)	0.08±0.0^{abcd}	14.2 ±0.3^{l}	0.62 ± 0.2^{ef}	1.01± 0.1^{fg}	0.79±0.1^{mn}	25.73± 2.7^{fgh}	5.69 ±1.6^{cdefgh}	3.03 ± 0.3^{ef}
16(n=2)	0.06±0.0^{abc}	2.98 ±0.7^{abc}	0.37 ± 0.1^{abcde}	0.65±0.0^{cde}	1.99 ± 0.0^{p}	37.79 ± 3.0^{l}	7.56 ± 1.2^{hi}	3.19 ± 0.4^{f}
17(n=1)	0.06±0.0^{abcd}	2.92± 0.5^{abc}	0.38 ± 0.1^{abcde}	0.57± 0.1^{bcd}	0.78 ± 0.0^{mn}	32.85 ± 3.6^{jk}	10.03 ± 0.8^{j}	0.59 ± 0.5^{ab}

18(n=4)	0.07±0.0^{abcd}	3.38 ±0.1^{bcde}	0.15 ± 0.^{abc}	0.97 ±0.1^{fg}	0.49 ± 0.1f^{g}	16.97 ± 0.4^{c}	3.73 ± 0.5^{bcd}	0.95 ± 0.4^{ab}
19(n=1)	0.12± 0.0^{d}	4.184±1.0^{defg}	0.40 ± 0.2^{bcde}	0.88±0.1^{efg}	0.45 ± 0.0^{efg}	28.37 ± 0.7^{hi}	6.14 ± 0.5^{defgh}	2.66 ± 0.3^{ef}
20(n=3)	0.07±0.0^{abcd}	8.81 ± 0.3^{k}	0.35 ± 0.0^{abcde}	0.92± 0.2^{efg}	0.48 ± 0.0^{fg}	21.22 ± 0.9^{de}	6.14 ±0.6^{defgh}	1.67 ± 0.2^{c}
21(n=4)	0.09±0.0^{abcd}	3.29 ±0.1^{bcde}	0.34± 0.0^{abcde}	0.65± 0.0^{cde}	0.74 ± 0.0^{m}	30.2 ± 2.4^{ij}	7.39 ± 0.4hi	1.86 ± 0.3^{cd}
22(n=1)	0.09±0.0^{abcd}	3.19±0.4^{abcd}	0.47 ± 0.3^{def}	0.25 ± 0.1^{a}	0.71 ± 0.0^{klm}	22.17±3.4^{defg}	7.86 ± 1.3^{hij}	0.33 ± 0.2^{a}
23(n=1)	0.06±0.0^{abcd}	5.93 ± 0.4^{ij}	0.34± 0.1^{abcde}	0.99 ± 0.2^{fg}	0.61 ± 0.0^{ij}	35.65±3.3^{kl}	4.74 ±1.0^{bcdefg}	2.67 ± 0.2^{ef}
24(n=3)	0.06±0.0^{abcd}	4.79 ±0.9^{fgh}	0.33± 0.0^{abcde}	0.29± 0.1^{ab}	0.72 ±0.1^{klm}	21.95± 3.5^{def}	6.39 ±1.2^{efgh}	0.29 ± 0.1^{a}
25(n=1)	0.06±0.0^{abcd}	2.19 ± 0.2^{a}	0.141± 0.0^{abc}	1.48± 0.0^{j}	0.52 ± 0.0^{gh}	29.84 ±1.1^{ij}	6.50 ±0.1^{efgh}	0.90± 0.3^{ab}
26(n=3)	0.09±0.0^{abcd}	2.51 ±0.3^{ab}	0.29± 0.0^{abcd}	1.02± 0.1^{fg}	0.40 ± 0.0^{de}	18.98 ±1.4^{cd}	3.58 ± 0.3^{bc}	1.16 ± 0.2^{bc}
27(n=1)	0.11± 0.0^{cd}	4.68 ± 0.9^{fgh}	0.35± 0.2^{abcde}	0.99± 0.1^{fg}	0.35 ± 0.0^{cd}	25.93 ±0.4^{gh}	7.15 ± 0.3^{fghi}	0.69 ± 0.1^{ab}
L.S.D	0.1	0.9	0.3	0.3	0.1	3.5	2.1	0.6

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

3.3 Beta-Carotene

The β- carotene content of the pumpkin pulps are presented in table 5 below. There were significant ($p>0.05$) differences in the individual groups of the pumpkin pulp. The β- carotene content in fresh pumpkin pulp samples ranged from 9.15 to 41.28 µg/g.

Pumpkins are good sources of pro-vitamin A. The high content of pro-vitamin A in the fruits can be utilised by availing the pumpkins to the markets worldwide, device cultivation methods for large production, and determined conditions for long storage shelf life. In some countries, including Kenya, the flowers and leaves of the fruits are also consumed as vegetables (Pepping *et al* 1988).
Brazilian cucurbits analysed by open column chromatography (Arima and Rodriguez-Amaya 1988), 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. The baianinha variety, was reported to have much higher average values of 47 µg/g and 235 µg/g for α- carotene and β-carotene, respectively (Arima and Rodriguez-Amaya 1990). The *C. maxima* species Exposicao variety was reported to have a β- carotene content of 3.1-28 µg/g, while the Tetsukabuto and Jerimum Caboclo varieties reported a content of 8.7 - 18 µg/g and 14-34 µg/g, respectively.

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 (Rodriguez-Amaya 1993).

Table 5. β-Carotene content of the fresh pumpkin pulp in (µg/g)

Groups	Pulp β-carotene
1(n=1)	32.1 ± 0.2^{ijkl}
2(n=3)	31.78 ± 0.1^{ijk}
3(n=3)	35.06 ± 0.6^{kl}
4(n=1)	14.7 ± 0.3^{b}
5(n=2)	13.04 ± 0.2^{ab}
6(n=1)	31.95 ± 0.0^{ijkl}
7(n=1)	20.09 ± 0.0^{cd}
8(n=1)	41.28 ± 11.6^{m}
9(n=1)	33.14 ± 0.1^{ijkl}
10(n=1)	17.3 ± 0.0^{bc}
11(n=1)	31.48 ± 0.1^{ijk}
12(n=1)	29.68 ± 0.0^{ijk}
13(n=1)	34.7 ± 0.1^{jkl}
14(n=1)	24.5 ± 0.1^{efg}
15(n=1)	34.66 ± 0.0^{jkl}
16(n=2)	28.87 ± 0.1^{ghi}
17(n=1)	36.49 ± 3.3^{kl}
18(n=4)	26.54 ± 0.1^{fgh}
19(n=1)	24.45 ± 3.2^{efg}
20(n=3)	19.31 ± 0.0^{cd}
21(n=4)	31.84 ± 0.0^{ijk}
22(n=1)	9.26 ± 0.0^{a}
23(n=1)	35.09 ± 0.0^{kl}
24(n=3)	9.15 ± 0.0^{a}
25(n=1)	26.37 ± 0.1^{fgh}
26(n=3)	37.01 ± 5.8^{lm}
27(n=1)	22.12 ± 0.2^{def}
L.S.D	4.4

Values are given as means of three replicate ± SD for β-carotene. Means with different superscript letters within a column are significantly different ($P < 0.05$). SD = Standard deviation of the mean. LSD= Least significant difference.

3.4 Fatty Acid Profile of the Pumpkin Seed Oil

The fatty acid composition from the seed oil of *C. maxima* is presented in table 6 below. There were significant (p>0.05) differences among the individual varieties. There were wide variations in the contents of palmitic (0.3 - 20.81%), stearic (0.038 - 11.038%), oleic (15.61 - 40.51%), and linoleic acids (25.38-79.61%) of the seed oils, and the oil in highest content was linoleic acid. The major fatty acids were linoleic, followed by oleic.

Lazos (1986) and El-Adawy and Taha (2001) observed the same trend. They reported the content of linoleic acid as 43.1-55.6% and that of oleic 20.4-37.8% ion cucurbit seeds, while a study of *C. pepo* by Gohari *et al*., (2011), the content of linoleic and oleic were 39.84 and 38.42, respectively. The differences in the pumpkin seed fatty acid profile in this study could probably be due to variation in the harvesting season, geographical location, maturity, genetic variability and variety (Murkovic *et al.,* 1999).

Fatty acid composition of the pumpkin seed oil can be used to evaluate its stability and nutritional quality. The high level of un-saturated fatty acids in pumpkin seed oil makes it a good source of cooking oil. Generally foods containing high levels of un-saturated fats can improve digestibility and bind to low molecular weight proteins. A higher degree of oil unsaturation makes it more succeptible to oxidative deterioration.

Reduction in saturated and a moderate increase in monounsaturated fatty acids such as oleic and *n*-3 and *n*-6 polyunsaturated fatty acids in human nutrition is recommended in order to prevent coronary heart diseases and reducing blood levels of low-density lipoprotein (LDL) (Nakic *et al*., 2006). Pumpkin seed oil could offer an alternative source for dietary fatty acids.

Table 6. Fatty acid profile of the pumpkin seed oil (%)

GROUPS	Stearic	Palmitic	Oleic	Linoleic
1 (n=1)	5.07 ± 0.1^{abc}	7.36 ± 0.3^{ab}	24.19 ± 1.0^{b}	26.18 ± 0.7^{a}
2 (n=3)	0.84 ± 0.1^{a}	1.06 ± 0.1^{a}	15.61 ± 0.6^{a}	79.61 ± 1.8^{i}
3 (n=3)	0.12 ± 0.0^{a}	17.57 ± 0.0^{bc}	31.13 ± 0.2^{cde}	50.89 ± 0.2^{def}
4 (n=1)	0.31 ± 0.0^{a}	20.81 ± 0.6^{c}	30.79 ± 0.8^{cde}	47.85 ± 0.5^{cde}
5 (n=2)	0.77 ± 0.9^{a}	16.2 ± 1.4^{bc}	24.66 ± 0.8^{b}	54.54 ± 23.1^{efg}
6 (n=1)	0.65 ± 0.5^{a}	0.54 ± 0.2^{a}	30.01 ± 6.3^{cd}	66.66 ± 7.9^{h}
7 (n=1)	0.04 ± 0.0^{a}	16.01 ± 0.1^{bc}	29.79 ± 0.1^{c}	53.41 ± 0.3^{defg}
8 (n=1)	0.28 ± 0.0^{a}	20.4 ± 0.0^{c}	31.21 ± 0.2^{cde}	47.57 ± 0.1^{cde}
9 (n=1)	0.07 ± 0.0^{a}	0.3 ± 0.0^{a}	34.73 ± 1.4^{g}	62.62 ± 1.3^{gh}
10 (n=1)	11.04 ± 0.1^{d}	14.36 ± 0.8^{bc}	17.82 ± 0.6^{a}	47.38 ± 1.4^{cde}
11(n=1)	BDL	20.59 ± 1.2^{f}	32.78 ± 0.8^{d}	46.63 ± 2.0^{g}
12 (n=1)	0.52 ± 0.2^{a}	13.45 ± 0.9^{bc}	40.51 ± 0.4^{f}	43.4 ± 1.2^{bcd}
13 (n=1)	0.49 ± 0.1^{a}	17.87 ± 0.7^{bc}	$30.69\ \ 0.8^{cde}$	50.96 ± 0.1^{fgh}
14 (n=1)	1.43 ± 0.3^{a}	6.86 ± 1.5^{ab}	29.79 ± 3.5^{bc}	59.09 ± 2.7^{fgh}
15 (n=1)	7.12 ± 0.6^{cd}	13.16 ± 0.8^{bc}	17.89 ± 0.8^{a}	55.91 ± 2.4^{efg}
16 (n=2)	BDL	15.66 ± 0.7^{e}	17.85 ± 0.9^{bc}	25.38 ± 0.7^{b}
17 (n=1)	0.31 ± 0.0^{a}	20.81 ± 0.6^{c}	30.79 ± 0.8^{cde}	47.85 ± 0.5^{cde}
18 (n=4)	$1{,}72 \pm 1.7^{ab}$	15.04 ± 1.5^{bc}	30.14 ± 2.4^{cd}	47.82 ± 2.7^{cde}
19 (n=1)	8.88 ± 10.3^{cd}	19.46 ± 1.4^{c}	24.1 ± 1.1^{b}	47.43 ± 9.8^{cde}
20 (n=3)	0.12 ± 0.0^{a}	14.79 ± 0.2^{bc}	22.82 ± 0.0^{a}	62.27 ± 0.1^{gh}
21 (n=4)	0.23 ± 0.1^{a}	16.91 ± 0.1^{bc}	35.23 ± 0.1^{e}	47.11 ± 0.0^{cde}
22 (n=1)	5.02 ± 1.2^{abc}	19.23 ± 1.9^{c}	17.95 ± 0.7^{a}	39.7 ± 3.2^{bc}
23 (n=1)	0.85 ± 0.1^{a}	1.16 ± 0.13^{a}	15.56 ± 0.7^{a}	81.21 ± 0.6^{i}
24 (n=3)	1.26 ± 0.3^{a}	19.64 ± 24.8^{c}	22.98 ± 6.3^{b}	53.6 ± 16.9^{defg}
25(n=1)	6.30 ± 0.1^{bc}	18.36 ± 1.8^{bc}	23.64 ± 0.7^{b}	50.87 ± 1.1^{def}
26 (n=3)	0.84 ± 0.1^{a}	1.06 ± 0.1^{a}	15.61 ± 0.6^{a}	79.61 ± 1.8^{i}
27 (n=1)	2.23 ± 0.2^{ab}	20.57 ± 0.9c	23.56 ± 0.8^{b}	26.18 ± 1.7^{a}

L.S.D	4.2	9.9	4.2	9.0

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. BDL= below detectable level. LSD= Least significant difference

4 Conclusion

The pumpkin fruit pulp studied contained high β-carotene content (9.15 – 41.28 µg/g) and thus vitamin A deficiency could be easily eradicated by increased consumption of the pumpkin fruit.
The pumpkin seeds are better sources of proteins (14 – 42 %) and oil (31.28 – 43.35 %) than the pumpkin fruits since the fruit pulps contain relatively low amounts of between (0.2 – 2.7 %) and (0.34 – 2 %) for the two, respectively. Overall the pumpkins seed and pulp contain nutritive components that could be processed and potentially be incorporated to food systems to improve the nutritional content through the value addition process; hence their production and utilization should be encouraged.

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