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Variation of Micronutrients in Pumpkin FruitVarieties Grown Within the Lake Victoria Basin

Echessa A.C. Peter[1*], Nyambaka Hudson [1], Ondigi N. Alice[2], Omuterema Stanley[3], Toili William[3] and Sande Anne[3]

1. Department of Chemistry, School of pure and applied Sciences, Kenyatta University

P.O.BOX 43844 00100 GPO NAIROBI, KENYA

2. Department of Hospitality and Tourism Management, Kenyatta University

P.O.BOX 43844 00100 GPO NAIROBI, KENYA

3. Department of disaster management and humanitarian Assistance, MasindeMuliro

University of Science and Technology.

P.O.BOX 190-50100 KAKAMEGA, KENYA

* E-mail: echessap@yahoo.com

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Abstract

Food shortage is a common occurrence in the developing countries. The shortage is emancipated in both low quantity and poor quality resulting in deficiency based diseases. The fact that pumpkins have an easy production (3-4 month), long shelf life (over six month) and therefore available, should increase their likelihood incorporation in the diet. The study set out to establish the varieties and levels of micronutrients in the fruits of the pumpkins grown by small holder farmers in four districts of Busia, Gucha, Jinja and Tarime within the Lake Victoria Basin. A questionnaire was administered to determine information on the varieties. The levels of β-carotene, α-tocopherol and the B-complex vitamins were determined with RP HPLC. Vitamin C was analysed by titration while AAS was used for the analysis of trace elements (zinc, iron and selenium). Standards were run and calibration curve equations with $0.955 \leq R^2 \leq 0.999$ used to calculate the concentrations. Three species of pumpkins *Cucurbita maxima, Cucurbitapepo* and *Cucurbitamoschata* were widely distributed. Ten different varieties were sampled. The levels of micronutrients in different varieties (Fruits) showed significant differences that could not be accounted for by chance. At 95 % confidence limit, moisture (p = 0.001), β-carotene (p = 0.002), thiamine (p = 0.000), riboflavin (p = 0.001), niacin (p = 0.009) and pyridoxine (p = 0.000) varied significantly. Further comparison of the samples from each district equally showed significant differences ($p < 0.05$) in all micronutrients except vitamin C (p = 0.08) and selenium (p = 0.447) levels. These results indicate non universality in levels of micronutrients in different varieties and between locations enhancing the need for focusing on those superior varieties (like the banana variety) as established in this study. From the levels of the micronutrients (β-carotene 2.220-2.670 mg / 100 g, zinc 0.986-1.728 mg / 100g, iron 2.16-1.68 mg / 100g) established, it is appropriate to popularize the utilization of pumpkins as a conventional rich food source to supplement the traditional cereal based diets aimed at combating the problem of food shortages and malnutrition in the Lake Victoria Basin and developing countries in general.

1. Introduction

Food security in developing countries is caused by inability of people to gain access to food due to poverty (Interacademy, 2004). The food security situation in Africa has worsened since 1970 and the proportion of the malnourished has remained within 33 to 55 percent range in the sub Saharan Africa (Rosegrant*et al.,* 2005). Over reliance on water, arable land and marine catches that are collapsing (Crib, 2008), unpredictable weather, internal displacements due to war, floods, mudslides and earthquakes aggravates this problem. These are common phenomena in and around the lake Victoria Basin in East Africa. It supports a population of over 30 million rural inhabitants (swallow e*t al*., 2002). Poverty in the region rates at 50% or more especially in the lake shore where this situation is further complicated by high incidents of HIV/AIDS and water associated diseases. Households in the region are characterized by high incidents of malnutrition, largely driven by poverty

(Awange*et al*., 2006). It is estimated that 40.2% of the children and 5.7% of the mothers are malnourished (Greb*et al.,* 2007).

The staple food crops relied on in the region to fight food insecurity include maize, beans, finger millet, sorghum, cassava, bananas (Jaetzold*et al.,* 1993). These food stuffs are not only limited in their nutrients but that most of them cannot be stored for long without use of chemicals because they are easily attacked by fungi and insects. The micronutrients like carotenes levels in highly milled cereals or starch staple foods such as cassava and tubers are not stable (Weise *et al.,* 2002) and decrease on storage.

The documented and undocumented deficiency cases due to inadequate micronutrients are many within the Lake Victoria Basin and developing countries. Over the last ten years an unprecedented number of cases and outbreaks of nutritional deficiency diseases (Scurvy, xerophthalmia, pellagra, beriberi and anaemia) have been registered as high in refugee camps (Mayan *et al.,* 1983; Descencloz*et al*., 1989; Seaman and River, 1989). Hundreds of thousands of refugees, particularly in arid regions of Africa have been affected. Studies within the Lake Victoria Basin indicate high deficiency levels due to Vitamin A (or precursors), zinc and thiamine (Bwibo*et al*., 2003). Ngare and Kennedy (1994) in a separate study indicated serious health problems in children in the same region. To combat these deficiencies, the governments in the region have intervened by promoting micronutrient supplementation and fortification programs targeting critical vehicle foods such as cooking oil, flours of wheat and maize, salt and sugar (ACC/SCN, 2000). However production of fortified foods and supplements in developing countries has had minimal benefits due to high current costs tagged to establishment of adequate infrastructure used in the production of supplemented and fortified vehicle foods (IFPRI, 2002). Previous studies (Mason and Garcia, 1993, ACC/SCN, 1997; IFPRI, 2002, Anon, 2005) report cheaper and sustainable means of controlling nutrition and health disorders related to vitamin A and mineral dense foods with high cultural acceptability that have a potential for increasing vitamin A and mineral status in the population. Other strategies of preventing vitamin A deficiency that have been proposed include bio fortification (IFPRI, 2002; Anon, 2005).

Conservation and sustainable use of genetic resources of indigenous food crops offer a tremendous tool for addressing the problem of food security meaning both inadequate quality and quantity at both national and house hold levels (Mathenge, 1995). Though indigenous vegetables like pumpkins in developing countries including Kenya, Uganda and Tanzania have been grown for generations using indigenous knowledge it is unfortunate that unlike other crops, its varieties and their nutritional status have not been documented. This is unlike U.S.A, Central America, Japan and many countries of South East Asia, where their food potential have been put into considerations (Gwanama*et al*., 2002). Research studies in Tanzania have been limited to surveys for seed collection appropriate agronomic practices and pest management methods (Hamishy, 2002). Ondigi*et al*., 2008 in a recent study on the indigenous knowledge on the pumpkin growing in the region established that pumpkin growing is an acceptable practice with many cultural practices attached. It has an economic potential in the region.

A mature pumpkin fruit can stay for over six month without chemicals if kept in dry cool place (Pumpkin, 2009). The β-carotene levels in the pumpkins increase on storage (Pumpkin, 2009). Bio fortification can be achieved through pumpkins. The Lake Victoria Basin is endowed with fertile soils, good agro climatic zone with average rainfall of 16 mm annually (Majungu, 2006). These conditions favour pumpkin growing which would offer sustainable and low cost way to reach people with poor access to health care system if bio fortification is embraced (Shrimpton*et al*., 1995; IFPR, 2002; Anon 2005).

In seeking solutions to food security and malnutrition in developing countries, this study investigated varieties of pumpkins, the levels of β- carotene, α-tocopheral, thiamine, niacin, zinc and selenium in the pumpkin fruit varieties grown within the lake Victoria Basin.

2. Materials and Methods

Freshly harvested mature pumpkin fruits were purposively collected from pumpkin growing households randomly chosen from the lists provided by agricultural extension officers in four districts in the Lake Victoria Basin. The four were Tarime ($1^{0}21^{1}0^{11}$S, $34^{0}22^{1}0^{11}$E, altitude range 900-1800 m above sea level), Jinja ($0^{0}25^{1}28^{11}$N, $33^{0}12^{1}15^{11}$E, altitude 1167 m), Gucha ($0^{0}25^{1}27^{11}$N, $33^{0}12^{1}15^{11}$E, altitude range 1000-2000 m) and Busia ($0^{0}1^{1}36^{11}$S, $34^{0}54^{1}32^{11}$E, altitude range 1130-1375 m). They were purposively selected to represent the key land scape features within the Lake Victoria Basin. The samples collected were kept for four weeks before three small pieces of each fruit were removed, bulked and harmonized with a blender before extractions were done. Standards were run at the same time as extracts. Calibration equations were derived and used to determine concentrations in each case.

2.1 β- Carotene

Nyambaka and Ryle, (2001) procedure was adopted in the extraction though instead of petroleum ether, hexane was used. This protocol agrees with AOAC (1989) method. In each extraction about 5.00 g of the mashed samples were used. The extracts were purified and diluted to a standard volume of 50 ml in the mobile phase constituted as methanol: dichloromethane: water (79:18:3). Three extractions were done in duplicate for each fruit. The extracts were filtered using a 0.45 micro millipore filter before 30 µl were injected in a HPLC (Hitachi, model L4000H), pump (L6000), RP C_{18} column (25 cm x 4.5 mm) set at 1 ml / min with a UV/Visible detector at 450 nm.

2.2 The B-Complex Vitamins

The method of Vinas*et al*., (2003) was adopted in the extraction and determination though there was use of methanol instead of acetonitrile in the mobile phase. About 5.00 g of the mashed sample was homogenized with 50 ml 0.1M HCl for ten minutes before heating in a water bath set at 80^0 C for a similar duration. Sodium acetate was added for pH adjustment before 1.00 g of taka diastase was added and the mixture incubated at 50^0 C for two hours. Acetonitrile was added, shaken before the mixture was heated to 90^0 C in a water bath. The mixture was filtered, topped up to 50 ml and about 30 µl injected into the HPLC with UV/Visible detector set at 234 nm (thiamine) and 261 nm (niacin). The concentrations were calculated from the integrated peak areas of the sample and corresponding standards. In each case the mobile phase was 0.1 mM KH_2PO_4 (pH =6):CH_3OH (90:10) and flow rate fixed at 1 ml / 1 min. The column was operated at 25 ^{0}C.

2.3 Zinc and Selenium

Wet ashing using 10 ml of 69 % concentrated nitric acid on about 5.00 g of the dry sample. The digest was cooled, 2 ml perchloric acid added and before further heating. Filtration was done, topped up to 100 ml with distilled water. The standards and the samples were run in an AAS (Buck, model 210 VGP) machine at 324.8 nm for zinc. The hydride generation atomic absorption spectrophotometer, wavelength 196.4 nm, was used for selenium.

2.4 Classification of Pumpkins

The seeds from the pumpkin fruit analysed from various districts were dried and planted in duplicate on 4 x 3 m plots in keumbu, Kisii central. The sample plant characteristics were used to classify the pumpkin into the species on the basis of purse glow (1968) keys. Varieties were identified as per the procedure given in www.riverforco.uk 2/7/2009.

2.5 Data Analaysis

The percentage availability of the pumpkin varieties was determined as a fraction of households that had that variety against the whole sample population involved. The SPSS version 11.5 program was run to give the mean levels of micronutrients, analysis of variance which was to check variations in micronutrients between the varieties from the same location and different locations. Duncan tests were performed to establish varieties which were extremely high in the tested micronutrients. Correlation coefficients were calculated to seek associations between the different micronutrients.

3. Results and Discussion

Three species of pumpkins *Cucurbita Maxima Cucurbitapepo, Cucurbitamoschota*and a gourd *LegenariaSiceraria* were found to be grown by households within the lake Victoria Basin. The species were spread as ten different varieties (Table 1).Jinja had eight different varieties with carnival squash (89 % distribution), Connecticutfield (72%) and Valenciano (67%) as the dominating varieties. The number of varieties (8) is within those reported (7) in the article "Pumpkin, the new money spinners" (New Vision, Uganda 26/7/2009). The varieties dominating are of *Cucurbita Maxima* which are of high quality and quantity making them competitive. The main purpose of growing pumpkins in this region is for Commercial purposes in addition to consumption (New Vision, Uganda, 2009; Ondigi*et al*., 2008). Thus the purpose influences the varieties embraced by most households. Few households also grew bottle gourd unlike in the other three study districts.

This could be attributed to the members of the Asian Community whose population is significant within Jinja town, as compared to other study districts. Busia district had six varieties with carnival squash (90%) dominating away from the connecticutfield (61%) and valenciano (59%). Three varieties of crown prince (88%), super delight (82%) and the green Kabacha (73%) were the only varieties evenly distributed among the households in Tarime. Though farming is the main source of income in Tarime, the animal keeping is also significant (4%) as compared to neighboring Gucha district with only 1.9% (Ondigi*et al*., 2008). This means that a significant portion of land is used for animal keeping in Tarime limiting the varieties to only three. Super delight dominated Gucha and Tarime, two neighboring districts possibly due to cross boarder exchanges. At least a variety of *Cucurbita maxima* was found in each of the four districts in the study area. Most of the varieties in this species' fruits weigh as high as 34 kg (pumpkin, 2007) as compared to the *Cucurbitapepo* whose fruits average 4-8 kg. This is a quality that would partly support its popularity within the study districts.

3.1 Micronutrients

The levels of β-Carotene, thiamine, Niacin, Zinc and selenium in the pumpkin samples in the area of study were determined. This was with a view of establishing any differences in their levels in the species within and between locations (Table 2).

3.1.1β- Carotene

This ranged from 1.27 mg / 100 g in green Kabacha collected in Gucha to as high as 3.75 mg / 100 g in banana squash variety collected in the same district. Within the same species variations were also noted between different locations. Green Kabacha (1.27 mg / 100 g) as compared to the same variety (0.92 mg / 100 g) in Busia. The levels within the species from different districts also varied. Banana squash, a *Cucurbita Maxima* (3.75 mg / 100 g widely varied as compared with carnival squash (2.69 mg / 100 g) collected from Jinja. These variations conform to similar study conducted in Australia (Murkovic*et al*., 2002) in which different varieties of pumpkins from the same locality were analysed for concentration of carotenoids which ranged from 0.06 mg to 7.4 mg / 100g.

3.1.2 Thiamine

The levels in different pumpkins in the same districts or between districts varied. Carnival squash in Gucha averaged 0.60 mg / 100 g as compared to the same variety in Busia 0.39 mg / 100 g. Interspecies variations were notable. Banana squash from Gucha averaged 0.69 mg / 100 g as compared to Butternut squash collected from the same district (0.38 mg / 100 g) or from Busia (0.42 mg / 100 g). Cunningham *et al*., 2002 established that nutritional levels are affected by factors such as variety, time of harvest, climate and soil.

3.1.3 Niacin

The levels of niacin varied from 0.48 mg / 100 g Butternut to 1.94 mg / 100 g in Banana squash. Within species marked variations were noted. Crown prince averaged 0.65 mg / 100 g in Tarime while 1.33 mg / 100 g in Jinja. Green Kabacha averaged 1.19 mg / 100g in Gucha varieties as compared to similar collected from Jinja (0.86mg/100g). The variation, as noted by Cunningham *et al*., (2002) depend on variety and soil.

3.1.3 Zinc and Selenium

The values of zinc in the pumpkin fruits varied from as low as 0.65 mg / 100 g in the carnival squash to 1.24 mg / 100 g in Crown prince both collected from Gucha district. Variations were also within and between the species in selenium levels. Significant differences were noted between varieties. Banana squash collected from Gucha averaged 5.02 µg / 100 g Selenium while Crown prince of the same species collected from Tarime showed 1.37 µg / 100 g. Similar varieties collected from different locations also varied. The green Kabacha collected from Jinja averaged 2.28 µg / 100 g Selenium which was lower as compared to the same variety collected from Gucha that showed 4.41 µg / 100 g. A similar analysis but on Chilli (*Capsicum annum L*) showed variation in ascorbic acid and mineral content (Khadi*et al*., 1987). These variations are due to variations in the soil nutrients among other factors (Cunningham *et al.,* 2002). Analysis of variance was done on the data collected to establish if there were any significant differences in the levels of micronutrients in the various varieties of pumpkins grown in the Lake Victoria Basin. This was done to confirm the observations made above (Table 3).

A significant difference was noted in the level of β-carotene, thiamine and niacin ($P < 0.05$). The difference in the concentration in this case was so large that it could not be accounted for by chance but real effects like varieties which must have differed significantly at 95% confidence level. This variation in micronutrient is supported by findings of a similar study on determination of B-vitamins in grain and cereal grain food (Lebiedzinska and Szefer, 2006) which showed a significant difference in the same micronutrients. Murkovic*etal.,* (2002) in the analysis of carotenoids in different varieties of pumpkins showed a range of 0.06 mg to 7.4 mg/100 g. A comparative study on carotenoids content of three varieties of *cucurbitamoschata* and two of *cucurbitapepo* (Gouado*etal*., 2007) also showed significant variation in the micronutrients. In the determination of trace metals in the vegetables procured from local markets of Karachi city (Hashmi*etal*., 2005) pumpkins showed significant differences in the studied minerals. A post hoc analysis to establish the actual varieties that differed in the various micronutrients was done (Table 4).

The bottle gourd showed the least amount of β-carotene as compared to other varieties. The banana variety had the highest concentration of β-carotene as compared to other varieties analysed. The amounts of thiamine were significantly higher in the bottle gourd than in other varieties. The green kabacha exhibited the lowest amount of thiamine. The banana variety had comparable concentrations with butternut squash and bottle gourd but differed significantly with crown prince (which had the lowest), carnival squash and green kabacha. The selenium levels differed between the banana variety with carnival squash and the green kabacha. Using the results in the table 4, the varieties with the highest of the micronutrients were identified as in Table 5.White gourd exhibited the highest amounts of thiamine and selenium. The banana variety had the highest amount of β-carotene, niacin, zinc and iron. This clearly distinguishes it as a better variety for it has high levels of micronutrients.

A one way analysis of variance was also done by grouping pumpkin fruits from a given district. This was done with a view to establish if significant differences existed between locations. The results are as shown in Table 6. All the micronutrients analysed except selenium significantly varied from one district to another ($P < 0.05$). This variation has been obtained in similar studies. A study on dry matter content established that micronutrients vary widely depending on the cultivar, geographical area, climate, day length, soil type, incidence of pests and disease and cultivation practices (Garrow*etal*., 1998); Woolfe, 1992). Other factors like variety of the item, time of harvest, ripeness, and general random variation in mineral content (Greenfield *etal*., 1992; Torelm*etal*., 1998) also affect. The plant carotenoid content is known to vary among fruits of the same cultivar or even the same plant (Bauenfeind, 1992). It is also affected by the plant nutritional status and longevity of storage, normally increasing with storage (Mcdonald, 1988). A pumpkin variety from one location (district or region) differs in the level of micronutrients with a similar one from other districts within Lake Victoria Basin.

The relationship between the micronutrients was determined using Pearsons correlation coefficients at 95% confidence level (Table 7). The levels of some micronutrients in the pumpkin varieties were positively correlated. There was a strong positive correlation between, β-carotene (0.33) and zinc (0.54). Similar positive correlations are between the B-complex vitamins.

The correlation between the trace elements Zn and Se is similar to a finding in the comparison of the mineral and element concentration between ”gazpacho” and the vegetables used in its elaboration (Romero *etal*., 2008). The study found significant correlation existing between the analysed minerals except calcium.

A positive relationship between the levels of zinc and β-carotene was noted. This supports a study (Dijkhuisen*etal*., 2004) in which zinc plus β-carotene supplementation of expectant mothers was found superior to β-carotene supplementation alone in improving vitamin A status in both mothers and infants. This indicates a specific role of zinc in the vitamin A metabolism. The B-complex vitamins (B_1, B_3) correlated strongly with the trace elements (zinc and selenium). High concentrations of these trace elements do not reduce the levels of these vitamins.

A food source, rich with micronutrients like pumpkin is quite ideal in the diet to avert the technicalities of food fortification like ascorbic acid lowering intake of zinc directly and indirectly by supporting iron uptake (FAO / WHO, 2002) when they are mixed.
The overall average micronutrients levels in the pumpkin fruits were found (Table 8) and compared with USDA nutrient database.Most of the values are in agreement with those established by the USDA (2006) as in the last column though some of the pumpkins showed higher micronutrient levels for example zinc (0.98 ± 0.74) mg / 100 g are more than the USDA average values. Since trace element concentrations in plant matter depends on the soil among other factors (Garrow*etal*., 1998; Woolfe, 1992) this differences are expected. This implies that the soils within the Lake Victoria Basin are rich in the trace elements and that pumpkins are good sources.

4. Conclusion and Recommendations

Some of the malnutrion problems arising from poverty in most developing countries can addressed using indigenous mechanism. There are many pumpkin varieties found within the Lake Victoria basin in East Africa. The varieties embrased within the region differ significantly in the levels of micronutrients analysed. It is recommended that other studies are done on other varieties grown elsewhere and that farming of those established to be high in particular nutrients be promoted in an attempt address food shortage in developing countries.

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Table 1: Percentage availability of pumpkin varieties in the study area.

District	Species	Varieties	% Availability
Jinja	*Cucurbita maxima*	Crown prince	46
		Banana	11
		Carnival Squash	87
		Valenciano	67
	Lagenariasiceraria	Bottle gourd	06
	Cucurbitapepo	Green Kabacha	28
		Connecticutfield	72
	Cucurbitamoschata	Butternut squash	35
Busia	*Cucurbita maxima*	Crown prince	51
		Carnival squash	92
		Valenciano	59
	Cucurbitapepo	Green Kabacha	24
		Connecticutfield	61
	CucurbitaMoschata	Butternut Squash	41
Tarime	*Cucurbita Maxima*	Super delight	88
		Crown prince	82
	Cucurbitapepo	Green Kabacha	76
Gucha	*Cucurbita Maxima*	Super Delight	62
		Carnival Squash	49
		Crown prince	78
		Banana	71
		Valenciano	64
	Cucurbitapepo	Green Kabacha	48
		Red Kabacha	25
		Connecticutfield	31
	Cucurbitamoschata	Butternut Squash	08

Table 2: The average levels of micronutrients in the pumpkin fruits collected

		Concentration in mg / 100 g dry matter				µg / 100 g
Pumpkin Variety	District	β-carotene	Thiamine	Niacin	Zinc	Selenium
Banana	Gucha	3.746±0.135	0.690±0.180	1.943±0.480	1.137±0.097	5.024±2.036
Crown prince	Tarime	3.354±0.050	0.380±0.095	0.652±0.006	0.884±0.115	1.372±0.779
	Busia	3.473±0.261	0.373±0.884	0.752±0.270	1.243±0.216	2.949±0.186
	Jinja	3.688±0.042	0.880±0.377	1.332±0.622	0.984±0.106	2.413±0.751
Carnival Squash	Gucha	2.997±0.428	0.603±0.279	1.702±0.851	0.649±0.321	2.984±0.614
	Busia	2.677±0.305	0.399±0.122	0.973±0.862	0.876±0.259	2.267±1.101
	Jinja	2.694±0.249	0.429±0.096	0.802±0.562	0.751±0.168	2.413±0.751
Green Kabacha	Gucha	1.270±0.274	0.405±0.095	1.192±0.201	0.774±0.215	4.415±1.324
	Busia	0.924±0.144	0.285±0.164	0.883±0.801	0.906±0.219	5.024±2.036
	Jinja	1.132±0.022	0.294±0.010	0.861±0.481	0.841±0.211	2.287±0.295
Butternut	Gucha	3.163±0.266	0.379±0.094	0.481±0.745	0.978±0.295	3.596±2.518
	Busia	3.285±0.253	0.415±0.146	0.572±0.170	1.026±0.347	2.669±1.348
W. gourd	Jinja	0.0834±0.008	0.852±0.362	1.306±0.556	0.895±0.211	4.508±2.608

Table 3: A one way ANOVA of levels of micronutrients in the pumpkin varieties sampled.

Nutrient	F –Value	P -Value
β- carotene	3.947	0.004
Thiamine	6.594	0.000
Niacin	3.425	0.009
Zinc	2.285	0.059
Selenium	3.004	0.035

Table 5: The varieties of pumpkin fruit which had the lowest and highest of each micronutrient

Content	Variety(lowest concentration)	Variety(highest concentration)
β-Carotene	White gourd	Banana Squash
Thiamine	Green Kabacha	White Gourd
Niacin	Butternut Squash	Banana Squash
Zinc	Crown prince	Banana Squash
Selenium	Carnival Squash	White Gourd

Table 6: The mean ± SD, F- and P- values in pumpkin fruits sourced from the four districts.

Nutrient	Average conc. mg / 100 g per district				F- value	P- value
	Gucha	Tarime	Busia	Jinja		
β- carotene	2.04 ±0.64	2.35 ±0.37	1.84 ±0.62	1.84 ±0.92	8.516	0.000
Thiamine (B_1)	0.52 ±0.06	0.38 ±0.05	0.37 ±0.02	0.61 ±0.08	3.455	0.023
Niacin(B_3)	1.33 ±0.21	0.65 ±0.03	0.79 ±0.07	1.07 ±0.09	6.355	0.001
Zinc	0.88 ±0.09	0.88 ±0.06	1.01 ±0.06	0.90 ±0.02	4.736	0.006
Selenium	4.01 ±0.06	1.37 ±0.04	3.41 ±0.06	2.45 ±0.03	0.903	0.447

Table 7: Micronutrients Pearsons correlation coefficients at 95% confidence level.

Nutrient	β-Carotene	B_1	B_3	Zn	Se
β-Carotene	1				
B_1	0.06	1			
B_3	0.39**	0.69**	1		
Zn	0.32*	0.47**	0.55**	1	
Se	0.23	0.27*	0.27*	0.59**	1

*correlation is significant at the 0.05 level (2-tailed test)
**correlation is significant at the 0.01 level (2-tailed test)

Table 8: Levels of some micronutrients in the pumpkin fruits

Nutrient	Unit per 100 g DM	Values obtained mean ± S.D	USDA nutrient database 2006 RDA values
β- Carotene	(mg)	2.22 ± 0.45	2.21
Thiamine (B_1)	(mg)	0.48 ± 0.24	0.50
Niacin (B_3)	(mg)	0.93 ± 0.53	0.60
Zinc	(mg)	0.98 ± 0.74	0.32
Selenium	(μg)	0.34 ± 0.17	0.30