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Nutritional Variation in Fruits and Seeds of Pumpkins (*Cucurbita Spp)* Accessions from Nigeria

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Abstract: Fruits and seeds of Nineteen accessions of *Cucurbita* collected from three agro ecological zones of Nigeria were evaluated for their physical attributes, proximate values, minerals, vitamins and anti-nutritional factors. The result indicated that there was significant differences in the accessions for moisture content, crude fibre, ash, crude protein, fat and carbohydrate in the fruits ($p<0.01$) while crude fibre and carbohydrate was not significant in the seeds ($p>0.05$). The moisture content ranged from 78.46 to 91.97% in the fruits while in the seeds, it ranged from 44.73 to 53.04%. The ash, crude fat and crude protein content was generally higher in the seeds than the fruit pulp indicating that the seeds are high in essential nutrients. The Nigerian accessions of *Cucurbita* species have low levels of tannin, flavonoids, phenols and alkaloids but the hydrogen cyanide was high. The vitamin C content was high among the fruits and seeds while thiamine and riboflavin content was moderate. The variations observed among the accessions can be explained with the first four principal component axis which accounted for 84.5% of the total variations observed with crude fibre, moisture and crude protein being the most important contributing variables. Genetic component analysis showed that most of the traits had more genetic than non-genetic factors contributing to the variability which indicates that selection can be effective in the improvement of these traits. This was further validated by such traits such as ash, niacin, flavonoids and alkaloids having high heritability and high genetic advance which means that they can be improved by selection directly.

Key words: Pumpkins (*Cucurbita*), Nigerian accessions, nutrients, vitamins

INTRODUCTION

Pumpkins belong to the family cucurbitaceae that consists of about 118 genera and 835 species (Jeffrey, 1990). It is regarded as one of the underutilized crops and its existence is currently being threatened due to neglect in Nigeria (Aruah *et al*., 2012). Pumpkins are cultivated in Nigeria at subsistence level without any commercial importance. Pumpkins are usually warm season annuals and is a vine crop that plays an important role in the traditional setting as a vine crop and weed control agent (Delahaut and Newhouse, 2006). It is traditionally grown for its leaves, fruits and seeds and consumed either by boiling the leaves and fruits or by roasting or baking the fruits (Facciola, 1990; Aruah *et al*., 2012). The leaves, fruits, flowers and seeds are health promoting food. Different parts of the plant are used as medicine (Aruah *et al*., 2012). The leaves are haematinic, analgesic and are also used externally for burn treatment. The pulp is used to relieve intestinal inflammation or enteritis, dyspepsia and stomach disorder (Seutu and Debjani, 2007). The fruit is an excellent source of vitamin C, vitamin E, lycopene and dietary fibre (Pratt and Matthews, 2003; Ward, 2007).

In recent years consumption of fruits and vegetables has received increased recommendations (Bennett *et al*., 2006). Traditional vegetables are an important source of nutrients and vitamins for the rural population (Mnzara *et al*., 1999; Mosha and Gaga, 1999). Farmers have cultivated these vegetables for generations as an additional food source. These vegetables are increasingly being recognized as possible contributors of micronutrients and bioactive compounds to the diets of the rural poor in Africa. It has been shown that these vegetables contain antioxidants and also provide beta carotene, iron, calcium and zinc to the daily diets (Smith and Eyzaguirre, 2007). The rise in the search for sufficient dietary intake of essential nutrients and consumption of health promoting compounds through the improvement of plant nutritional properties, nutrient composition and concentration would contribute significantly to human nutrition and health (Bouis, 1996; Grusak and DellaPenna, 1999).

Determination of variability in germplasm collections for crucial characters is essential for genetic improvements of crops (Anshebo *et al*., 2004). Few studies have focused on genetic variation in vegetables for mineral accumulation (Kopsell *et al*., 2004; Mehmet *et al*., 2009; Nwofia and Ojimelukwe, 2012). The main plant breeding objective over the last decade has been to increase yield but in recent years focus have shifted to improving the

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nutritional quality of plants with respect to both nutrient composition and concentration (Bouis, 1996; Kopsell *et al*., 2004). Nutrient concentration is dependent on phenotypic or genotypic variation and an understanding of the heritability is important in breeding programmes (Grant *et al*., 2008).

Extensive research efforts have been made on nutritional composition of *Cucurbita* but the Nigerian accessions have not been adequately analyzed and the genetic variability and heritability of the proximate, mineral, anti-nutrients and vitamins have not been reported adequately. In order to bridge this gap, we evaluated the proximate, mineral, anti-nutrients and vitamins in the fruits and seeds of these Nigerian accessions as well as the variability and heritability of these constituents. The information obtained in this study will aid in the improvement of this important crop.

MATERIALS AND METHODS

The experimental materials comprised of 19 accessions of *Cucurbita* spp collected from three agro ecological zones in Nigeria namely: Rainforest, derived savannah and guinea savannah where the crop is cultivated (Table 1). The fruits and seeds were washed and ground into paste and then put into airtight containers and used for analyses.

Fruit physical attributes: The fruit physical attributes such as fruit weight (kg), fruit length and circumference at the widest portion(cm), fruit color and fruit morphotype were taken immediately after collections.

Proximate analysis: The proximate analyses of the fruits and seeds was done to obtain values for moisture content, crude fibre, carbohydrate, ash, crude fat and crude protein. Moisture content was determined by the method of Pearson (1976) and James (1995). Crude protein (N* 6.25) was determined by the Kjedahl method (AOAC, 1990). The recommended method of Association of Official Analytical Chemist (1990) was used for the determination of ash, crude fat and crude fibre. The carbohydrate content was obtained by the difference as the nitrogen free extract.

Mineral and vitamin analysis: The mineral content of the samples was determined by the dry ash extraction method described by James (1995) and Kirk and Sawyer (1998). Calcium and magnesium was determined by the versanate EDTA compleximetric titration method while phosphorus was determined by molybdovanadate colorimetric method (James, 1995). Vitamin C was determined according to the method outlined by Kirk and Sawyer (1998), while the B-vitamins was determined by the spectrophotometric method described by Okwu (2004).

Anti-nutritional analysis: Alkaloids were estimated by the alkaline precipitation gravimetric method as described by Harbourne (1973). Tannins were determined using Folin-Deins spectrophotometric method as described by Hang and Lantzsch (1983). Flavonoids were determined using acidification and ethyl acetate extraction as described by Harboune (1973). Hydrogen cyanide was estimated using the alkaline extraction method as described by AOAC (1990) while phenols was determined according to the method described by Edeoga *et al*. (2006). All the determinants were done in triplicates.

Data analysis: Data for all determinations were subjected to analysis of variance using Genstat Discovery Edition 4 (Genstat, 2007) software. The least

Table 1: List of *Cucurbita* accessions showing the place of collection

Accessions	Place of Collection	Ecological zone
Bende-01	Bende, Abia State	Humid Rain forest
Bende-02	Bende, Abia State	Humid Rain forest
Bende-03	Bende, Abia State	Humid Rain forest
Odukpani-01	Odukpani, Cross River State	Humid Rain forest
Odukpani-02	Odukpani, Cross River State	Humid Rain forest
Isikwuato-01	Isikwuato, Abia State	Humid Rain forest
Mbano-01	Mbano, Imo State	Humid Rain forest
Mbano-02	Mbano, Imo State	Humid Rain forest
Mbano-03	Mbano, Imo State	Humid Rain forest
Ndioro-01	Ndioro, Abia State	Humid Rain forest
Ndioro-02	Ndioro, Abia State	Humid Rain forest
Ndioro-03	Ndioro, Abia State	Humid Rain forest
Ngwa-01	Isialangwa, Abia State	Rainforest
Ngwa-02	Isialangwa, Abia State	Rainforest
Ngwa-03	Isialangwa, Abia State	Rainforest
Okigwe-01	Okigwe, Imo State	Derived Savanna
Okigwe-02	Okigwe, Imo State	Derived Savanna
Okigwe-03	Okigwe, Imo State	Derived Savanna
Zaria-01	Zaria, Kaduna State	Southern Guinea Savanna

significant difference test was used to identify significant differences among treatments means ($p<0.05$) as outlined by Obi (2002). Factor analysis based on principal component analysis (PCA) was performed to characterize the accessions in relation to the most discriminating nutrient trait (Johnson, 1998). The analyses of variance were used to partition the gross variability into the components due to genetic and non-genetic environmental factors and to estimate their magnitude. Genotypic, phenotypic and error variances were estimated using the formulae of Wricke and Weber (1986) and Prasad *et al.* (2010):

$$VG = \frac{MSG-MSE}{r} \qquad VP = \frac{MSG}{r} \qquad VE = \frac{MSE}{r}$$

Where MSG,MSE and r are the mean squares genotypes, mean squares error and number of replication respectively. The Phenotypic (PCV) and Genotypic (GCV) coefficients of variations were estimated by the methods of Burton (1952) and Johnson *et al.* (1955) and Kumar *et al.* (1985) as follows:

$$PCV = \frac{\sqrt{VP}}{\bar{X}} \times 100 \qquad GCV = \frac{\sqrt{VG}}{\bar{X}} \times 100$$

Where VP, VG and X are phenotypic and genotypic variances and grand mean respectively for each attribute under consideration. Broad sense heritability (h^2B) expressed as the ratio of VG to the VP was estimated on genotypic mean basis as described by Allard (1991). Genetic advance was estimated by the method of Fehr (1987) as GA = k (Sp) h^2B where k is a constant (2.06 at 5% selection pressure), sp is the phenotypic standard deviation $\sqrt{VP}$, h^2B is the broad sense heritability. GA was calculated as a percentage of the mean.

RESULTS AND DISCUSSION

The morphological attributes of the nineteen accessions of *Cucurbita* spp are shown in Table 2. Fruit weight varied from 0.4-4.9 kg. The accessions Bende-01 had the longest and widest fruit (34.9 cm and 76 cm respectively) while Isikwuato-01 had the shortest fruits. The fruit color were mainly light green, green and light yellow while some were smooth, spotted or warted and rough.

The proximate composition of the fruits and seeds are shown in Table 3 and 4. Significant differences ($p<0.01$) was observed for moisture content, crude fibre, ash, crude protein, fat and carbohydrate in the fruits (Table 3) while crude fibre and carbohydrate was not significant in the seeds ($p>0.05$) (Table 4). Moisture content of the fruits ranged from 78.46% in Ndioro-03 to 91.97% in Odukpani-01. In the seeds, moisture content was highest in Mbano-03 and lowest in Zaria-01 accessions. Fruits of Mbano-02 and Odukpani-02 had the highest crude fibre contents while the lowest was observed in the fruits of Ngwa-01.

The ash content was significantly higher in Zaria-01(4.26%) while Okigwe-01 had the lowest (2.13%) among the fruits. In the seeds, ash content was significantly higher in Zaria-01 and lowest in Bende-01 (7.54% and 3.07% respectively). Generally the ash content of the seeds were higher than the fruits indicating that the seeds will be a good source of minerals. Crude protein varied from 2.04% in Ndioro-02 and Okigwe-03 to 1.34% in Ngwa-01. Significantly higher crude protein was observed among the seeds. The crude protein content varied significantly from 12.89% in Mbano-02 to 18.32% in Bende-01. Crude fat among the fruits was highest in Isikwuato-01 accession(0.53%) and lowest in Bende-01(0.34%). The seed crude fat was highest in Zaria-01(41.30%) and lowest in Mbano-03

Table 2: The morphological attributes of the nineteen accessions of *Cucurbita* spp from Nigeria

	Attributes				
Accessions	Fruit weight (kg)	Fruit length (cm)	Fruit circumference (cm)	Fruit Color	Fruit morphology
Bende-01	4.9	34.9	76.0	Green	Smooth
Bende-02	1.2	22.1	46.0	Green	Smooth
Bende-03	1.0	19.5	46.0	Green	Smooth
Odukpani-01	0.5	14.5	35.0	Green	Smooth
Odukpani-02	0.6	15.6	36.0	Green	Smooth
Isikwuato-01	0.9	19.2	30.3	Green	Spotted, Smooth
Mbano-01	1.9	25.1	48.1	Light Green	Smooth
Mbano-02	2.0	26.2	52.5	Light Green	Smooth
Mbano-03	2.2	28.5	51.5	Light Green	Smooth
Ndioro-01	0.4	14.2	30.2	Green	Smooth
Ndioro-02	0.5	15.0	34.5	Green	Smooth
Ndioro-03	0.8	19.0	36.5	Green	Smooth
Ngwa-01	0.9	17.1	33.5	Green	Smooth
Ngwa-02	0.9	16.5	31.0	Green	Smooth
Ngwa-03	0.7	16.0	30.5	Green	Smooth
Okigwe-01	0.8	17.5	38.5	Green	Smooth
Okigwe-02	1.0	23.1	45.2	Green	Warted, Rough
Okigwe-03	2.4	26.5	52.5	Green	Spotted, Smooth
Zaria-01	1.5	29.5	58.2	Light Yellow	Smooth

Table 3: Proximate composition of the fruit pulp of nineteen accessions of *Cucurbita* spp from Nigeria

	Attributes					
Accessions	Moisture content	Crude fibre	Ash	Crude protein	Fat	Carbohydrate
Bende-01	84.82	0.67	2.59	1.52	0.47	3.39
Bende-02	87.48	0.83	3.34	1.69	0.34	3.33
Bende-03	90.05	0.88	2.87	1.87	0.35	3.13
Odukpani-01	91.97	0.67	2.83	1.52	0.47	2.45
Odukpani-02	91.76	1.03	2.44	1.87	0.45	2.45
Isikwuato-01	88.21	0.95	2.48	1.81	0.53	3.24
Mbano-01	91.75	0.87	2.14	1.81	0.47	3.08
Mbano-02	90.69	1.04	2.17	1.52	0.43	3.59
Mbano-03	88.84	0.93	2.16	1.98	0.53	3.83
Ndioro-01	91.01	0.66	2.24	1.75	0.37	3.07
Ndioro-02	88.81	0.79	2.17	2.04	0.41	3.83
Ndioro-03	78.46	0.56	2.34	1.46	0.42	3.26
Ngwa-01	90.17	0.55	2.33	1.34	0.33	3.24
Ngwa-02	90.19	0.89	2.17	1.98	0.38	3.76
Ngwa-03	91.66	0.93	3.08	1.81	0.36	3.41
Okigwe-01	89.27	0.63	2.13	1.63	0.44	3.87
Okigwe-02	89.59	0.83	2.15	1.81	0.39	3.62
Okigwe-03	86.81	0.95	2.36	2.04	0.35	2.97
Zaria-01	83.20	0.93	4.26	1.81	0.57	3.69
$LSD_{0.05}$	0.798	0.043	0.074	0.189	0.029	0.838

Table 4: Proximate composition of seeds of nineteen accessions of *Cucurbita* spp from Nigeria

	Attributes					
Accessions	Moisture content	Crude fibre	Ash	Crude protein	Fat	Carbohydrate
Bende-01	50.40	1.09	3.07	18.32	36.32	0.81
Bende-02	45.27	1.03	6.49	17.79	39.13	0.80
Bende-03	49.75	1.01	6.49	16.92	36.74	0.78
Odukpani-01	51.75	1.08	4.49	13.71	38.39	0.71
Odukpani-02	48.72	1.07	6.47	14.06	39.12	0.83
Isikwuato-01	49.26	1.06	4.08	17.02	36.51	0.82
Mbano-01	51.56	1.03	6.49	11.96	38.16	0.80
Mbano-02	52.93	1.02	5.60	12.89	36.82	0.73
Mbano-03	53.04	1.06	6.42	13.53	35.09	0.86
Ndioro-01	49.65	1.05	5.03	14.18	40.53	0.91
Ndioro-02	49.14	1.06	5.98	15.28	40.71	0.84
Ndioro-03	47.64	1.07	4.74	16.22	39.52	0.81
Ngwa-01	52.11	1.09	3.27	16.33	36.41	0.79
Ngwa-02	48.04	1.08	5.47	14.58	40.06	0.77
Ngwa-03	46.51	1.04	6.97	15.98	38.55	0.76
Okigwe-01	52.19	1.04	5.31	14.47	36.32	0.68
Okigwe-02	52.68	1.08	6.09	14.00	36.67	0.81
Okigwe-03	51.97	1.09	5.22	14.93	35.91	0.88
Zaria-01	44.73	1.08	7.54	15.52	41.30	0.85
$LSD_{0.05}$	1.55	NS	0.138	0.241	0.422	NS

(35.09%).The accessions Mbano-03 and Okigwe-01 had significantly higher carbohydrate content in their fruits (3.83%) while Odukpani-01 and Odukpani-02 had the lowest carbohydrate contents in their fruits(2.45%). The carbohydrate content of the seeds was not significant ($p>0.05$).

The potential of any food is determined by its nutrient composition. Vegetables are known to aid taste and flavor as well as provide proteins, fibre, minerals and vitamins to the diet (Oyenuga and Fetnga, 1975). Sheela *et al.* (2004) and Kubmarawa *et al.* (2009) reported that leafy vegetables are good sources of nutrients and are beneficial to the maintenance of good health and prevention of diseases. Moisture content of these *Cucurbita spp* were high (78.46%-91.97%) and this implies that the fruits have a short fruit shelf life. High moisture content in vegetables makes them vulnerable to microbial attack, hence spoilage (Desai and Salunkhe, 1991). Moisture content of any food is an index of its water activity (Frazier and Westoff, 1978) and is used as a measure of stability and the susceptibility to microbial contamination (Scott, 1957; Darey, 1989). This high moisture content also implies that dehydration would increase the relative concentrations of other food

Table 5: Mineral composition of fruit and seeds of nineteen accessions of *Cucurbita* spp from Nigeria

Attributes				
		Ca		
Accessions	mg	mg/100 g	P	mg
Bende-01	45.43	29.39	39.33	13.36
Bende-02	40.10	36.07	39.87	16.02
Bende-03	38.77	28.06	40.53	10.68
Odukpani-01	46.77	29.39	40.53	17.36
Odukpani-02	41.43	29.39	41.07	14.69
Isikwuato-01	42.77	28.06	40.13	17.36
Mbano-01	34.77	33.40	40.80	9.35
Mbano-02	42.77	34.74	40.67	18.70
Mbano-03	25.43	29.39	40.40	17.37
Ndioro-01	34.77	22.71	41.20	13.36
Ndioro-02	46.77	25.39	40.70	18.70
Ndioro-03	45.43	24.05	40.13	18.70
Ngwa-01	38.77	30.71	39.60	14.69
Ngwa-02	36.26	18.70	39.73	13.35
Ngwa-03	42.77	30.73	39.07	14.69
Okigwe-01	46.77	26.72	43.13	13.35
Okigwe-02	42.77	32.06	40.13	16.03
Okigwe-03	42.77	29.39	40.80	17.37
Zaria-01	46.77	24.05	42.30	16.03
$LSD_{0.05}$	6.561	NS	1.292	NS

nutrient and therefore improve the shelf-life and preservation of the fruits (Aruah *et al*., 2012). There is also need to store the fruit in cool condition if they are to be kept for a long period without spoilage especially in the tropics were wastage of vegetable crops is estimated to be around 50% due to high moisture content (Thompson, 1996). Crude fibre recorded in these *Cucurbita* Spp accessions were low compared to the reports of Aruah *et al*. (2012). The ash content was higher in the seeds than the fruits. The proportion of ash is a reflection of the mineral contents of the food material (Omotosho, 2005; Nnamani *et al*., 2009). This result tends to suggest that the seeds of *Cucurbita* spp have higher deposit of minerals than the fruits.

The observed crude protein content was between 1.34% to 2.04% in the fruits and 12.89% to 18.32% in the seeds. The values obtained in the fruits were low compared to the earlier reports of Aruah *et al*. (2012) but the seeds were comparatively higher in crude protein. Ene-Obong (1992) reported that diet is nutritionally satisfactory, if it contains high caloric value and a sufficient amount of protein. It have been shown that any plant foods that provides about 12% of their calorific value from protein are considered good source of protein (Ali, 2010; Effiong *et al*., 2009). The seeds of these accessions of *Cucurbita* spp meets this requirements. Incidentally these seeds are usually discarded by the indigenous people and therefore they do not make use of the nutrients inherent in the seeds. The crude fat in the fruits varied from 0.34% to 0.53% while in the seeds it varied from 35.09% to 41.3%. The fruit crude fat in the fruit were low when compared to other leafy vegetables such as *Talinum triangulare, Amaranthus hybridus* and *Calchorus africanum* (Ifon and Bassir, 1979; Akindahunsi and Salawu, 2005). This low lipid concentration in the fruits shows that the lipids are mobilized and stored in the seeds and thereby making the fruits a good food for people suffering from obesity. Excess fat consumption have been implicated in certain cardiovascular disorders such as atherosclerosis, cancer and aging (Antia *et al*., 2006). Therefore diets of pumpkin should be encouraged in other to reduce the risk of the above disorders in man. The seed crude fat content shows that these accessions contain a good amount of oil that can be exploited instead of being discarded as is presently done by the indigenous populace. Pumpkin seed oil typically is highly unsaturated and contains palmitic, stearic, oleic and linoleic acids (Stevenson *et al*., 2007) and is also used medicinally in traditional medicine in China, Mexico, Brazil, Argentina etc (Gohari Ardabili *et al*., 2011).

The mineral composition of the fruit and seeds of nineteen accessions of *Cucurbita* spp from Nigeria are shown in Table 6. Highly significant differences ($p<0.01$) was observed in the fruits among the accessions for magnesium and phosphorus while calcium was not significant magnesium contents of the seeds was also not significant ($p>0.05$). Magnesium varied from 25.43 mg/100 g in Mbano-03 to 46.77 mg/100 g in Odukpani-01, Okigwe-01 and Zaria-01 while phosphorus varied from 39.07 to 43.13 mg/100 g in Ngwa-03 and Okigwe-01 respectively. The seed magnesium content though not significant was moderate and ranged from 9.35 mg/100 g in Mbano-01 to 18.07 in Mbano-02, Ndioro-02 and Ndioro-03 accessions. Minerals are considered to be essential in human nutrition (Ibanga and Okon, 2009). These minerals are vital for the overall mental and physical well being and are important constituents of bones, teeth, tissues, muscles, blood and nerve cells (Soetan *et al*., 2010). They also help in the maintenance of acid-base balance, response of nerves to physiological stimulation and blood clotting (Hanif *et al*., 2006).

The antinutritional composition of fruits and seeds of the nineteen accessions of *Cucurbita* spp from Nigeria are shown in Table 7. The antinutrient screening showed that the *Cucurbita* accessions had low values of tannin, flavonoid, phenols and alkaloid in the fruits and seeds but hydrogen cyanide contents was high in both the fruit and seeds. The hydrogen cyanide content was significantly higher in Mbano-01 (9.10 mg/g) than in Zaria-01 (6.08 mg/g). Tannins ranged from 0.16 to 0.19 mg/g, flavonoids 0.15 mg/g to 0.63 mg/g while phenols and alkaloids ranged from 0.18 to 0.33 and 0.26-0.64 mg/g respectively. Tannins usually form insoluble complexes with proteins, thereby interfering with their bioavailability (Enujiugha and Agbede, 2000). Poor palatability is usually attributed to high tannin diets

Table 6: Antinutritional composition of fruits and seeds of nineteen accessions of *Curcubita* spp from Nigeria

Accessions	Fruits HCN	Fruits Tannin	Fruits Flavonoid	Fruits Phenols	Fruits Alkaloids	Seeds HCN	Seeds Tannin	Seeds Phenols	Seeds Alkaloids
	mg/g								
Bende-01	6.60	0.19	0.45	0.24	0.45	3.25	0.09	0.07	0.29
Bende-02	7.26	0.17	0.51	0.22	0.41	2.28	0.09	0.06	0.17
Bende-03	7.25	0.19	0.45	0.23	0.43	2.78	0.08	0.07	0.23
Odukpani-01	8.33	0.19	0.21	0.21	0.27	1.98	0.06	0.05	0.17
Odukpani-02	7.59	0.16	0.29	0.22	0.39	1.88	0.09	0.04	0.14
Isikwuato-01	6.73	0.18	0.15	0.25	0.49	1.92	0.11	0.08	0.21
Mbano-01	9.10	0.17	0.35	0.21	0.23	3.98	0.11	0.08	0.21
Mbano-02	7.53	0.19	0.31	0.22	0.27	2.93	0.12	0.08	0.17
Mbano-03	6.75	0.17	0.45	0.22	0.37	2.21	0.06	0.08	0.22
Ndioro-01	6.26	0.17	0.63	0.18	0.46	2.05	0.09	0.07	0.25
Ndioro-02	6.52	0.16	0.55	0.18	0.51	2.66	0.09	0.06	0.17
Ndioro-03	6.93	0.17	0.44	0.18	0.35	1.44	0.11	0.09	0.21
Ngwa-01	7.19	0.17	0.25	0.24	0.37	2.52	0.07	0.07	0.23
Ngwa-02	7.32	0.16	0.35	0.21	0.43	2.11	0.08	0.06	0.29
Ngwa-03	7.97	0.17	0.23	0.22	0.29	3.09	0.11	0.08	0.28
Okigwe-01	6.91	0.19	0.41	0.18	0.34	3.17	0.11	0.07	0.13
Okigwe-02	8.33	0.18	0.43	0.18	0.26	3.48	0.08	0.10	0.15
Okigwe-03	7.09	0.17	0.25	0.19	0.32	3.29	0.07	0.07	0.09
Zaria-01	6.08	0.18	0.62	0.33	0.64	1.30	0.07	0.08	0.27
$LSD_{0.05}$	0.614	0.005	0.026	0.013	0.028	0.249	0.005	0.005	0.031

Table 7: Vitamin composition of the fruits of nineteen accessions of *Cucurbita* spp from Nigeria

Accessions	Fruits Vitamin C	Thiamine mg/100 g	Riboflavin
Bende-01	7.74	0.06	0.15
Bende-02	8.80	0.05	0.13
Bende-03	9.39	0.06	0.14
Odukpani-01	8.33	0.07	0.21
Odukpani-02	9.50	0.06	0.16
Isikwuato-01	11.26	0.04	0.11
Mbano-01	11.15	0.04	0.11
Mbano-02	6.45	0.05	0.13
Mbano-03	9.39	0.06	0.14
Ndioro-01	7.63	0.05	0.15
Ndioro-02	5.87	0.06	0.16
Ndioro-03	7.63	0.06	0.16
Ngwa-01	11.15	0.04	0.20
Ngwa-02	11.15	0.06	0.15
Ngwa-03	9.39	0.05	0.11
Okigwe-01	11.15	0.06	0.15
Okigwe-02	9.97	0.05	0.11
Okigwe-03	9.39	0.06	0.16
Zaria-01	9.39	0.06	0.18
$LSD_{0.05}$	0.973	0.005	0.017

(Mehansho *et al*., 1987). Tannins are capable of lowering available protein by antagonistic competition and can therefore elicit protein deficiency syndrome, ´kwashiokor'. The concentrations of the anti nutrients were generally low except hydrogen cyanide that was quite high. This may be one of the reasons why the pumpkin is not consumed raw in Nigeria but rather cooked into porridge as it has been shown that processing breaks down hydrogen cyanide in foods.

The vitamin composition of the fruits of the nineteen accessions of *Cucurbita* spp from Nigeria are shown in Table 7. There was a highly significant ($p<0.01$) difference among the accessions for vitamin C, thiamine and riboflavin contents of the fruits. Isikwuato-01 had the highest vitamin C (11.26 mg/100 g) but this did not differ significantly from Mbano-01, Ngwa-01, Ngwa-02 and Okigwe-01 while the lowest was observed in Mbano-02 (6.45 mg/100 g). Thiamine content ranged from 0.04 mg/100 g-0.07 mg/100 g while riboflavin varied from 0.11 mg/100 g-0.20 mg/100 mg. The results obtained in this study showed that pumpkin is an excellent source of vitamin C which plays a major role in nutrition (Pandey *et al*., 2003). The vitamin plays an active role in human health and welfare mostly as an antioxidant.

Principal Component Analysis showed that the first four PCS were important and explained 84.50% of the total variation in the proximate compositions of the fruits of the nineteen accessions of *Curcurbita* spp from Nigeria (Table 8).

PC1 had an eigenvalue of 11.7455 and accounted for 29.10% of the total variation. This represents three variables and indicates that crude fibre, moisture content and crude protein were important contributing variables. PC2 had high loading for ash, crude fat and moisture content with an eigenvalue of 1.4827 and percentage variation of 24.70%. PC3 had an eigenvalue of 1.065 contributing 17.70% of the variation and had ash and fat as the contributing factors. PC4 had eigenvalues of less than one, indicating that ash, carbohydrate, moisture

Table 8: Eigen vector values for principal components using the six proximate nutrient traits of the fruits and seeds of nineteen accessions of *Curcurbita* spp

	Fruits				Seeds			
Attribute	PC1	PC2	PC3	PC4	PC1	PC2	PC3	PC4
Ash	0.0798	0.5689	0.5846	-0.3430	-0.4169	0.5334	0.0886	-0.0847
Carbohydrate	0.0927	0.1951	0.0860	-0.4188	-0.1595	0.0055	-0.7030	-0.6858
Fat	-0.0596	0.5811	-0.7711	-0.0856	-0.5986	0.0245	0.2196	-0.1912
Fibre	-0.6463	0.2457	0.0600	-0.1597	0.0972	-0.3908	0.5995	-0.5969
Protein	-0.6033	0.1339	0.1937	0.5328	-0.1462	-0.6991	-0.2925	0.3372
Moisture	0.4471	-0.4714	-0.1232	-0.6247	0.6415	0.2707	-0.0699	-0.1266
Eigen values	1.7455	1.4827	1.065	0.777	2.0211	1.4693	1.0605	0.8934
Percentage variation	29.10	24.70	17.70	13.00	33.70	24.50	17.70	14.90
Cumulative	29.10	53.8	71.60	84.50	33.70	58.20	25.80	90.70

Table 9: Eigenvector values for principal components using the four antinutritional traits of the seeds of nineteen accessions of *Cucurbita* spp from Nigeria

Attributes	PC1	PC2	PC3
Hydrogen cyanide	-0.7099	0.2320	-0.1416
Alkaloid	0.2015	-0.8377	-0.1251
Phenols	-0.5992	-0.4307	-0.3500
Tannins	-0.3106	0.2427	0.9175
Eigenvalues	1.33189	1.12304	0.9547
Percentage variation	33.30	28.10	23.90
Cumulative	33.30	61.40	85.20

Table 10: Eigenvector values for principal components using the five antinutritional traits of the fruits of nineteen accessions of *Cucurbita* spp from Nigeria

Attributes	PC1	PC2	PC3
Alkaloid	-0.6097	0.0551	0.2009
Flavonoid	-0.4549	-0.2432	0.6052
Hydrogen cyanide	0.5605	0.1199	-0.0687
Phenols	-0.3154	0.6530	-0.4305
Tannin	0.0875	0.7050	0.6350
Eigenvalues	2.35705	1.27367	0.79215
Percentage variation	47.10	25.50	15.80
Cumulative	47.10	72.60	88.50

content and protein were the contributing factors. The PCA for the proximate contents of the seeds showed their PC1 had eigenvalue of 2.0211 and accounted for 33.70% of the total variation. This represents three variables ash, fat and moisture content. PC2 had high loading for ash, fibre and protein with an eigenvalue of 1.46933 and 24.50% variations. PC3 had an eigenvalue of 1.06049 and contributed 17.70% of the total variation and had carbohydrate and crude fibre as the contributing factors. PC4 had eigenvalue of less than one, indicating that three variables (Carbohydrate, crude fibre and protein) were the contributing factors (Table 8).

The PCA analyses of antinutritional traits of the fruits and seeds of the nineteen *Cucurbita* spp accessions from Nigeria are shown in Table 9 and 10. The first three PCS in the seeds accounted for 85.20% of the total variation observed in these *Cucurbita*. PC1 had eigenvector value of 1.33189 and accounted for 33.30% of the total variation. This represents three variables and indicates that hydrogen cyanide, phenols and tannins were important contributing variables. PC2 had high loading for alkaloids and phenols with an eigenvector value of 1,12304 and percentage variation of 28.10%.

PC3 had eigenvector value of 0.95470 and this accounted for 23.90% of the variation. PC3 had high loading for tannins and phenols.

The PCA of the antinutritional traits of the fruits of the nineteen accessions of *Cucurbita* spp from Nigeria are shown in Table 10. The first three PCS accounted for 88.50% of the total variation observed in these Cucurbita spp. PC1 had eigenvalues of 2.35705 and accounted for 47.10% of the total variation. This represents three variables and indicates that hydrogen cyanide, alkaloid, flavonoids and phenols were contributing variables. PC2 had eigenvalue of 1.27367 and accounted for 25.50% of the variation. PC2 had high loading for phenols and tannins. PC3 had an eigenvalue of less than one indicating their tannin, flavonoids and phenols were the contributing traits. The PCA of the vitamins in the fruits of nineteen accessions of *Cucurbita* spp from Nigeria are shown in Table 11. The first three PCS accounted for 86.60% of the total variation.PC1 had eigenvalues of 1.89516 and accounted for 47.40% of the total variation. This represents three variables and indicates that niacin, riboflavin and thiamine were the contributing variables. PC2 had an eigenvalue of 0.92474 and accounted for 23.10% of the total variation. PC2 had high loading for vitamin C, riboflavin and niacin indicating that they are the contributing traits. PC3 with an eigenvalue of 0.64495 and accounted for 16.10% of the total variation. PC3 had high loading for niacin and riboflavin. Moisture, ash and crude fat had positive PCS in PC1 and PC2 in both the fruits and seeds and this indicates that they contributed maximally to the variations among the accessions and hence can be improved upon by direct selection. Prasad *et al*. (2010) reported that PCA helps to identify traits that substantive and meaningful contribution towards the observed variation. The PCS of the anti-nutrients showed hydrogen cyanide, phenols and tannin with positive PCS can also be improved upon by selection. This is important because the high hydrogen cyanide observed in these accessions can be eliminated through selection of low cyanide *Cucurbita*

Table 11: Eigenvector values for principal components using the four vitamin traits of the fruits of nineteen accessions of *Cucurbita* spp from Nigeria

Attributes	PC1	PC2	PC3
Niacin	0.5143	0.3149	0.7779
Riboflavin	-0.5021	-0.4565	0.6096
Thiamine	-0.5790	0.1292	0.1512
Vitamin C	0.3849	-0.8220	0.0168
Eigenvalues	1.89516	0.92494	0.64495
Percentage variation	47.40	23.10	16.10
Cumulative	47.40	70.50	86.60

Table 12: Phenotypic (Vp), genotypic (Vg) and error (Ve) variances for proximate, minerals, vitamins and antinutritional traits of the fruits of nineteen accessions of Cucurbita spp from Nigeria

Attribute	Vp	Vg	Ve
Proximate			
Ash	0.2964473	0.295779	0.0006683
Carbohydrate	0.1744	0.089133	0.0852667
Fibre	0.0228951	0.0226698	0.000338
Moisture content	11.67933	11.602033	0.0773
Protein	0.0419667	0.03764	0.00432667
Fat	0.004969733	0.004864733	0.000105
Minerals			
Magnesium	30.05	24.81667	5.2333
Phosphorus	0.93713	0.734167	0.202967
Calcium	-	-	-
Vitamins			
Vitamin C	2.607	2.134	0.473
Thiamine	0.0000748367	0.0000713433	0.0000034933
Niacin	0.014817	0.01478836	0.000028713
Riboflavin	0.0008287033	0.0007955433	0.00003316
Anti-nutrients			
Flavonoids	0.0191007	0.0190167	0.0000839667
Hydrogen cyanide	0.637	0.5912667	0.045733
Alkaloid	0.0103143	0.0102216	0.00009267
Tannin	0.0001205333	0.0001202408	0.00000029247
Phenols	0.001226333	0.001204507	0.0000218267

- Not significant

spp. Similarly niacin and vitamin C with positive values in PC1 and PC2 can also be improved by direct selection.

Estimates of the variance components for all the traits showed that the phenotypic and genotypic components were close to each other. The error variances were lower than the genotypic variances for all the traits. This is an indication that the genotypic component was the major contributor to the total variance for these traits (Table 12 and 13). It can be concluded that most of the variability observed in proximate, mineral, vitamin and anti nutrients in *Cucurbita* spp accessions from Nigeria has more of genetic than non-genetic basis and indicates that selection can be effective for this traits among the accessions. Similar results have been reported by Baye (2002); Nwofia *et al.* (2006); Nwofia and Ojimelukwe (2012). Estimates of the Genotypic Coefficient of Variation (GCV) and heritability in the broad sense and genetic advance as a percentage of the mean. For proximate, mineral, vitamins and anti-nutrients of fruits and seeds are shown in Table 14 and 15. PCV ranged from 3.85-163.26 in the proximate traits, 17.55-23.12 in the vitamins and 6.27 -35.80 in the anti-nutrients. GCV

Table 13: Phenotypic (Vp), genotypic (Vg) and error (Ve) variances for proximate and antinutritional traits of the seeds of nineteen accessions of *Cucurbita* spp from Nigeria

Attribute	Vp	Vg	Ve
Proximate			
Ash	1.471	1.469	0.0023193
Carbohydrate	-	-	-
Fibre	-	-	-
Moisture content	6.563	6.273	0.290
Protein	2.993	2.985	0.007053
Fat	3.456	3.434	0.02172
Antinutrients			
Phenols	0.0001828	0.00017948	0.000003287
Hydrogen cyanide	0.524	0.516	0.007587
Alkaloid	0.0032140	0.00309473	0.0001193
Tannin	0.000341	0.0003377	0.000003253

- Not significant

Table 14: Phenotypic Coefficient of Variation (PCV), Genotypic Coefficient of Variation (GCV), Broadsense heritability(h^2B) and genetic advance of proximate, mineral, vitamins and antinutrients of fruits of nineteen accessions of *Cucurbita* spp from Nigeria

Attributes	PCV	GCV	h^2Bs	GA
Proximate				
Ash	21.43	21.41	99.77	44.05
Carbohydrate	163.26	116.71	51.11	171.88
Fibre	18.48	18.39	91.02	37.69
Moisture content	3.85	3.84	99.34	7.89
Protein	11.71	11.09	89.69	21.19
Fat	16.63	16.45	97.89	33.53
Minerals				
Magnesium	13.32	12.10	82.58	22.66
Phosphorus	2.39	2.11	78.34	3.85
Calcium	-	-	-	-
Vitamins				
Vitamin C	17.55	15.88	81.86	29.59
Thiamine	16.05	15.69	95.33	31.52
Riboflavin	19.58	19.19	95.99	38.73
Niacin	23.12	33.09	98.81	47.52
Anti-nutrients				
Flavonoids	35.80	35.73	99.56	73.43
Hydrogen cyanide	11.09	10.69	92.82	21.21
Alkaloid	26.45	26.33	99.10	54.24
Tannin	6.27	6.26	99.76	12.89
Phenols	16.21	16.21	98.22	32.80

- Not significant

Table 15: Phenotypic Coefficient of Variation (PCV), Genotypic Coefficient of Variation (GCV), Broadsense heritability(h^2B) and genetic advance of proximate and antinutrients of fruits of nineteen accessions of *Cucurbita* spp from Nigeria

Attributes	PCV	GCV	h^2Bs	GA
Proximate				
Ash	21.90	21.89	99.83	45.06
Carbohydrate	-	-	-	-
Fibre	-	-	-	-
Moisture content	5.14	5.02	95.58	10.12
Protein	11.40	11.39	99.73	23.43
Fat	4.89	4.88	99.36	10.01
Anti-nutrients				
Phenols	18.78	18.61	98.18	37.98
Hydrogen cyanide	28.47	28.25	98.55	57.74
Alkaloids	27.67	27.15	96.29	54.38
Tannin	21.23	21.12	99.05	43.30

- Not significant

ranged from 3.84-116.71 in the proximate traits, 15.69-33.09 in the vitamins and 6.26-35.73 in anti-nutrients. PCV was generally higher than the GCV for all the traits and in some attributes the difference between PCV and were small. This suggests that the traits were affected by the environment. GCV provides information on the genetic variability present in quantitative traits but the determination of the amount of variation heritable is not possible from GCV alone. The improvement efficiency is related to the magnitude of GCV, heritability and genetic advance (Johnson *et al*., 1955). Traits with high GCV, h^2Bs and GA can be improved through direct selection. Such traits such as ash, niacin, flavonoids and alkaloids can be improved through direct selection.

In conclusion, this study have been shown that fruits and seeds of *Cucurbita* accessions from Nigeria contributes useful amounts of nutrients to the diet of the indigenous people. It contains good levels of protein and fat in the seeds which are usually discarded by the indigenous people. The anti-nutrients were low except hydrogen cyanide but this can easily be solved by cooking. Such traits such as ash, niacin, flavonoids and alkaloids can be selected for improvement programmes.

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