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Evaluation of Nutritional and Phytochemical Profiles of Pumpkin Seed and Flesh (*Cucurbita genus*) Collections from Baringo, Uasin Gishu and Elgeyo Marakwet Counties

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Abstract

Pumpkin (Cucurbita genus) is one of the indigenous crops grown globally. Cucurbits are nutrient rich vital food for subsistence farmers and urban consumers. There is currently little knowledge of nutritional, phytochemical and health benefits of pumpkins. This study aimed at evaluating nutritional and phytochemical profiles of 27accessions collected from Baringo, Uasin Gishu and Elgeyo Marakwet counties. Selection was based on physiological parameters. Atomic Absorption Spectroscopy and flame photometry determined quantities of mineral elements. Phytochemical contents were determined following the procedures of Harborne (1973), Obadoni and Ochuko (2001), Boham and Kocipai (1974) and Folin Denis Colometric method. Proximal compositions were determined using standard methods. SPSS Inc. software version 22.0 ($p \leq 0.05$), Duncans Multiple Range Test and Pearson correlations matrix were used in data analyses. Seeds had higher minerals than fruit flesh. (mg/100g) Ca 46.197±6.315, Zn 0.746±0.239, Cu 0.710±0.207, Fe 12.490±1.282, Mg 1.308±10.923, Mn 8.131±0.341, P, Na, K; 0.687±0.164, 103.339±1.362, 149.074±23.506 respectively. Fruit flesh had; Ca 21.751±4.604, Zn 0.086±0.033, Cu 0.070±0.020, Fe 6.920±1.052, Mg 0.367±7.917, Mn 5.633±0.099, Na 71.256±4.427, P 0.209±0.074, K 128.966±17.035. Significant positive correlations were found between: flavonoid in seed and alkaloid in flesh (r = 0.343), tannin in seeds and alkaloids in flesh (r = 0.326) and seed (r = 0.286); tannins in flesh and alkaloids in seed (r = 0.278; saponin in seed and alkaloid in flesh (r = 0.268);saponin in seed significantly correlated with tannin in flesh (r = 0.383) and saponin in seed(r = 0.343); Flavonoids in seed and flesh had significant negative correlation(r = -0.273). Highest proximal contents were observed in: Moisture; 8.162^{a} (TUL 041) seeds, KAP 011 flesh (14.533$^{a)}$. Ash was 7.00^{a} in KAP 003 seeds, CHEP 1 had 19.050^{a}. Lipids were 46.757^{q} in MEG 052 seeds while KAP 011flesh had 9.400^{a}. Proteins in CHEP 2 seeds (38.424^{ab}), 27.895a (EMS 225 flesh). Crude fibre (25.246$^{a)}$ in KAPS 022, 5.800^{a} in RAN 1 flesh. Carbohydrate in NGE 064 seeds (69.217%), EMS 223 flesh (14.255%). CHEP 1 seeds, KAP 011 flesh are good sources of (P, K Na, and Ca). NGE 064 seeds and EMS 223 flesh are excellent sources of carbohydrates, CHEP 2 seeds and EMS 225 flesh are reliable sources of proteins. Breeders should consider pumpkins with high nutritional values to be used in formulating feeds and supplements for infants, expectant mothers and patients. The same will also be helpful in curbing malnutrition.

Keywords: *Cucurbita,* Pumpkin, Seed, Pulp, Accession, Saponin

INTRODUCTION

Pumpkin belongs to Cucurbitaceae family with 825 species. Cucurbitaceae is a morphologically variable genera within the plant kingdom (Aruah et al., 2010). There are three economically important species adapted to different climatical conditions (Balkaya et al., 2010a). They are *Cucurbita moschata, C. Pepo* and *C. maxima*. They have similar plant characteristics hence difficult to distinguish them (Paris, 2000).

Currently, not so much research, development and extension has been undertaken to improve cucurbit adaptations, yield quantity and quality as well as awareness creation among the rural people (Balkaya et al., 2010b). Germplasm collection, characterization, evaluation, conservation and improvement deserve prioritization (Grubben & Denton, 2004).

Documented information of naturalized pumpkin landraces in Kenya is insufficient to identify germplasm that represent the most genetic diversity (Kaźmińska et al., 2017). After characterization and evaluation, a management system that ensures both conservation and utilization should be developed. This can be achieved by protection in nature (*in situ*) or by preservation *ex situ* in gene banks (Phillips & Gardiner, 2015).

Pumpkin is not a popular food crop among Kenyan populace (Karanja et al., 2014). Despite limited accessions available in the gene bank, fewer accessions have been evaluated for agronomic and nutritional parameters (Haytova et al., 2020). Kenya is a secondary centre of genetic diversity with a wide array of pumpkin genotypes that require detailed characterization (Karuri et al., 2010). Pumpkins are referred as "orphaned" (Naluwairo, 2011) since very little information is available on the potential and production of pumpkin that can delineate and standardize pumpkin accessions in Kenya (Ahamed et al., 2011).

Pumpkin species are known to withstand adverse weather conditions (Oioyede, 2005). Farmers deliberately select for specific traits (Thies, 2000). Pumpkins are vital food crops for subsistence farmers who due to survival motives produce crop diversity as a positive externality (Conway, 2019). Improved pumpkin cultivars emerging onto the market are replacing local varieties (Grubben & Denton, 2004).

There are difficulties in accessing germplasm collections with unique genetic traits (Mady et al., 2022) due to death in known material with desirable traits and absence or lack of standard characterization and evaluation (Sharma et al., 2021).

The purpose of this study was to evaluate the nutritional and Phytochemical Profiles of Pumpkin accessions collected from Baringo, Uasin Gishu and Elgeyo Marakwet Counties. This will help mitigate the pangs of hunger and improve the health conditions among malnourished rural poor communities. The information generated can be used by breeders in selection and improvement of the accessions for commercial exploitations and also in production of new cultivars.

MATERIALS AND METHODS

Study Area

A total of 125 pumpkin germplasm collected from Baringo, Elgeyo Marakwet and Uasin Gishu counties were planted at farmers training centre in Eldama Ravine of Baringo County in April 2020.

Germplasm Collection

Twenty seven (27) pumpkin fruits harvested from Eldama Ravine in 2020 were used for nutritional and phytochemical profiling. Selection was based on phenotypic differences of colour, size, shape, origin, pattern, texture and ribbing (Table 1).

Table 1: Inventory list of selected germplasm in three counties in Kenya

Accession	Source	Accession	Source
KAP 003	Uasin Gishu	KAB 125	Uasin Gishu
KAP 011	Baringo	END 182	Baringo
KAP 012	Elgeyo Marakwet	EMS 222	Uasin Gishu
KAPS 022	Uasin Gishu	EMS 223	Uasin Gishu
TUL 045	Uasin Gishu	TAM 231	Elgeyo Marakwet
TUL 048	Uasin Gishu	TAM 235	Elgeyo Marakwet
TUL 049	Uasin Gishu	ARR 268	Uasin Gishu
MEG 052	Baringo	RAN 1	Nairobi
NGE 064	Elgeyo Marakwet	RAN 2	Nairobi
NGE 066	Uasin Gishu	CHEP 1	Uasin Gishu
SIM 082	Uasin Gishu	CHEP 2	Uasin Gishu
KAB 121	Elgeyo Marakwet	CHEP 3	Uasin Gishu
KAB 122	Baringo		

Sample Analysis

The experiments performed to establish the nutritional and biochemical compositions of selected Pumpkins were carried out at the University of Eldoret, Chemistry laboratory.

Pumpkin Procession

Fruit samples were washed and rinsed with distilled water. Dry fruits were cut and seeds removed. The flesh was sliced into small pieces and sundried (Figure 3). Samples were crushed and homogenized into paste used for nutritional and phytochemicals analyses (Haytova et al., 2020).

Analysis of Mineral Elements in Pumpkins

The method of AOAC (1990) was used to determine the mineral contents. One gramme of the pulverized samples was placed in a crucible and ignited in a muffle furnace at 550 ^{0}C for 6 hours. The ash was dissolved into 10ml of 10% HNO3 then heated slowly for 10 minutes. It was filtered after heating and the filtrate was used in determination of mineral content. Atomic Absorption Spectroscopy (AAS) was used for the determination of Ca, Fe, Zn. Cu, Mn, P and Mg, while Flame Emission spectrophotometer was used to determine Na and K in the filtrate (Echessa et al., 2013).

Phytochemical Analysis of Pumkin Seeds and Flesh

Determination of Saponin Content

The method described by Aliyu et al. (2008), was used to determine saponin content. Five (5) g of sample powder was mixed with 50 ml of 20 % ethanol. The sample was heated while stiring continuously over a hot water bath at 55°C for 4 hours. The mixture was filtered then the residue was re-extracted using 50 ml of 20 % ethanol. The combined extracts were reduced to 10 ml over water bath at 90°C. The concentrate was transferred into a separating funnel and shaken vigorously after adding 20 ml of diethyl ether. The aqueous layer was recovered while the ether layer was discarded. A repetition of the purification process was done. Fifteen (15) ml of n-butanol was added to the filtrate then the combined n-butanol extracts were washed twice using 10 ml of 5% aqueous sodium chloride. The remaining solution was heated over a water bath. The samples were dried in the oven to a constant weight. Saponin content was calculated using the formula;

$$\%S = \frac{WS + D - WeD}{Ss} x100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots Eqn\ (1)$$

Where: %S=% Saponin, WS=Weight of saponin, WeD=Weight of empty dish, Ss=Sample size.

Determination of Alkaloid Content

Alkaloid content was determined using the method described by Harborne (1973). Five (5) g of the powdered sample was weighed and placed in a 250 ml beaker, 200 ml of 20% acetic acid in ethanol was added then the beaker was covered to stand for 4 hours. Filtration was done and the extract was then concentrated in a water bath to one-quarter of the original volume. Concentrated ammonium hydroxide was added drop-wise to the extract until precipitation was complete. The precipitate was allowed to settle, and was collected by filtration and weighed. The Alkaloid content was calculated as follows:

$$\%\ Alkaloid = \frac{\text{Weight of alkaloid + paper} - \text{weight of paper}}{\text{Sample size}} x\ 100 \ldots\ldots\ldots\ldots Eqn\ (2)$$

Determination of Flavonoid Content

Determination of Flavonoid content was done following the method of Boham & Kocipai (1974). Ten (10) g of the pumpkin sample was extracted repeatedly with 100 ml of 80% aqueous methanol at room temperature. The solution was filtered using Whatman filter paper No. 42. The extract was transferred into a crucible, evaporated into dryness over a water bath and weighed till a constant weight was obtained. The flavonoid content was calculated as:

$$\%\ Flavonoid = \frac{W1 - W2}{W}\ x\ 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots Eqn(3)$$

Where, W1 =Weight of flavonoid + evaporation dish, W2 =Weight of empty evaporation dish, W=Sample size.

Determination of Tannin Content

The tannin content of the pumpkin accessions were determined using Folin Denis Colometric method (Mohammed, 2004). Five (5) g of the powdered pumpkin sample was mixed with distilled water in the ratio of 1:10 (w/v). The content was stirred at room temperature for 30 minutes then filtered. A standard tannin solution was prepared. Two (2) ml of the standard solution and 2 ml of distilled water were separately placed into 50 ml volumetric flask to serve as standard and reagent blank respectively. Two (2) ml of each of the pumpkin sample extract was put in 50 ml flask where 35 ml distilled water, 1ml Folin Denis reagent and 2.5 mls of saturated Na_2CO_3 solution were added to it. Each flask was then diluted to 50ml using distilled water then incubated for 90 minutes at room temperature. Absorbance was measured at 760 min in a Spectrophotometer with the reagent blank at zero. Tannin content was calculated as follows;

$$\%\ Tannin = \frac{At \times C \times Vt}{W \times As \times Va} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots Eqn(4)$$

Where; W = weight of sample, AT = absorbance of test sample, As = absorbance of standard, C = concentration of standard tannin solution, Vt = total volume of extract, Va = volume of extract analyzed.

Assessment of Proximal Quantities in Pumpkin Accessions

Moisture

The moisture content was determined by drying the seeds in an oven at 105 ± 1°C to a constant weight. The moisture content was expressed in g/100 g sample.

Ash

The total ash content of a substance is the percentage of inorganic residue remaining after the organic matter has been ignited. The ash content was determined using the method of AOAC (1990). Two g of each pumpkin sample was placed in a crucible and ignited in a muffle furnace at 550°C for 6 hours then

cooled in a desiccator and weighed at room temperature to get the weight of the ash, ash content was calculated as per Eqn 5.

$$\%\text{Ash content} = \frac{\text{Weight of ash x 100…}}{\text{Weight of original food}} \quad \text{……Eqn (5)}$$

Protein

One and half (1.5) g of the homogenized paste was weighed and transferred into a clean dry Kjeldahl flask. 2 Kjeltabs and 20 ml of concentrated sulphuric acid was added. The contents were mixed gently and placed in a slanting position then heated gently until frothing stopped. The mixture was left to stand for 90 minutes to allow for the digestion of all organic matter. The samples eventually turned colorless. The digest was allowed to cool and then diluted with 200 ml of distilled water. 5 drops of 0.5 % phenolphthalein indicator were then added and mixed thoroughly. The mixture was distilled to give about 200 mL of the distillate which was collected in the receiver flask that was titrated with 0.1M HCl to a grey-green liquid. The volume of the standard base required for complete neutralization was determined and used to calculate the amount of ammonia evolved (Harborne, 1973). A control was prepared using all other reagents without the sample. It was titrated for correction. Three replicates were performed and their average determined. The nitrogen content was calculated using the equations below (Sadasivam & Manickam, 1996).

$$\%\text{ Nitrogen} = \frac{(T - B) \times 14.007 \times 100}{\text{Weight of sample (mg)}} \quad \text{……..……..……...…Eqn. 6}$$

$$\%\text{ Protein} = \%\text{ Nitrogen} \times 6.25 \quad \text{……...…...Eqn. 7}$$

Where T- Sample titre B- Blank titre

Lipids

About 5 g of the dried sample was weighed and transferred into a clean dry extraction thimble which was connected to the extraction apparatus. In the case of seeds, the husks were first removed manually. Enough petroleum ether (B.P 40-60^{o}C) was added to the collecting flask and lipids were extracted by refluxing for 5 hours. The solvent was removed through evaporation at 60^{o}C. 20 mL of acetone was added then evaporated again at 60^{o}C. The resulting crude lipids was dried in an air oven for 10 minutes at 105^{o}C, they were then transferred into a desiccator to allow it cool to room temperature before being weighed. The percentage yield of crude lipids was determined using equation 9 (Ronald & Sawyer, 1991; Sadasivam & Manickam, 1996).

$$\%\text{ lipids} = \frac{\text{(wt. of crude lipids (g)) x 10…..}}{\text{Wt. of sample (g)}} \text{Eqn.8}$$

Carbohydrates

The quantities of carbohydrates in the seed and pulp samples were established using the formula below (Equation 9) according to Agu et al. (2012).

Total carbohydrate= 100%- (% moisture+ % crude protein+ % crude oil+ % fibre+ % ash).……Eqn 9

Data Analysis

The mean levels of nutrients and phytochemicals were determined using SPSS Inc. software version 22.0; analysis of variance was done to check variations in nutrient and phytochemical levels. Duncans multiple range tests (DMRT) were used to separate the means while Pearson's correlation test was performed to check correlations between accessions.

RESULTS AND DISCUSSION

The harvest from Farmers Training Centre in Eldama Ravine gave pumpkin fruits that were varied in size, shape, colour and ribbing as seen in Figure 1.

Figure 5: Pumpkin fruits harvested at Eldama Ravine.

Twenty seven representatives were selected based on their phenotypic differences. Figure 2a-h shows a few selected pumpkins that were used for nutritional and phytochemical profiling.

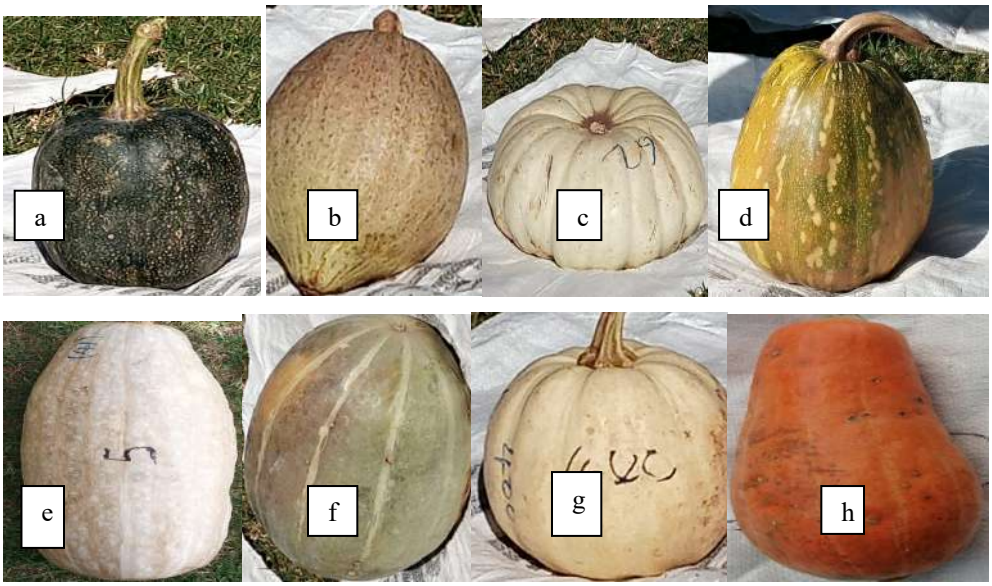

Figure 6: Representative pumpkin accessions for nutritional and phytochemical profiling at Eldama Ravine.

Figure 7: Sun drying of grated pumpkin.

The seeds used in the study varied in size, colour, glossiness and shape as shown in figure 4a-d.

Figure 8: Samples of dried seeds used for nutritional and phytochemical analyses.

Nutrient composition determines the nutritional potential of a particular food; leafy vegetables usually add flavour, taste and also fibre, minerals, vitamins as well as proteins to diets. Sheela et al. (2004) and Kubmarawa et al. (2009) suggested that leafy vegetables are a good source of nutrients and, they also help to maintain healthy lifes and prevent diseases.

Copper

The level of copper set by WHO is 2 – 5 mg intake per day (Kirk & Sawyer, 1998). The level in pumpkin pulp was 0.710±0.207 mg/100 g and that in the seed 0.070±0.020 mg / 100 g; (Table 2) this compares with 0.30±0.05 mg/100 g reported by Mohammed et al. (2004). Levels of copper were highest in END 182 seeds and ARR 268 flesh, pumpkin pulp and seed are not detrimental to health.

Iron

Iron content in the seed was 12.490±1.282 mg/100 g, while that in the pulp was 6.920±1.052 mg/100 g. It was in the range (13.66±1.60 mg/100 g) reported by Mohammed et al. (2004) for C.maxima seed kernels.

Iron was highest in NGE 064 seeds and NGE 066 flesh. Pumpkin seeds are a potential source of iron for the vulnerable groups. Level of iron outlined by WHO is 10 – 30 mg/day (Adebayo et al., 2013). Iron helps in the formation of blood and transfer of oxygen and carbon dioxide from one tissue to another (Jiménez et al., 2014).

Potassium

Potassium plays a role in the synthesis of amino acid and protein (Jiménez et al., 2014). Potassium is the most abundant element

found in the seed and flesh (149.074±23.506, 128.966±17.035 mg/ 100 g). The findings were lower than 397.53 ± 1.18[a] and 185.12±1.21[b] recorded by Amoo et al. (2004) in *cucurbita maxima*. Seeds of CHEP1 and flesh of CHEP 2 had highest percentages of potassium.

Sodium

Concentration of sodium in pumpkin seeds was averaged at 103.339 ± 1.362 mg / 100 g and 71.256 ± 4.427 mg / 100 g in the pulp. This was lower than 172.70 ± 0.41 and 58.22 ± 0.63 mg/100 g recorded by Mohammed et al. (2004). Seeds of CHEP1 had highest percentages of sodium. Sodium regulates blood volume, blood pressure and body fluid balance (Jiménez et al., 2014).

Calcium

Calcium is required for teeth development (Holst & Williamson, 2008). Both Calcium and Magnesium play significant roles in photosynthesis (Kirk & Sawyer, 1998). Pumpkin seed had 46.197±6.315 mg /100 g while the pulp contained 21.751±4.604 mg/100 g. This was lower compared to the findings of Amoo et al. (2004) of 294.74 ppm for *cucurbita maxima*. This indicates that pumpkin is a good source of calcium. Calcium was highest in seeds of EMS 222 and flesh of KAP 011.

Magnesium

According to Dunn & Grider (2021), Magnesium is important in tissue respiration which leads to formation of Adenosine triphosphate. Mean levels of magnesium in pumpkin seeds was 1.308 ± 10.923 mg/100 g while the pulp gave 0.367 ± 7.917 mg/100 g. Magnesium levels were highest in seeds and flesh of TAM 235 and NGE 066.

Phosphorus

Phosphorus is needed for cell growth, bone growth, and for kidney functions (Jiménez et al., 2014). Seeds had 0.687 ± 0.164 mg/100 g while the pulp gave 0.209 ± 0.074 mg/100 g. Mohammed et al. (2004) reported very high values (1044.60 ± 10.00 and 5.80±0.08 mg/100 g in pumpkin seed and kernels. Phosphorus was highest in TUL 041 seeds and KAP 011 flesh.

Zinc

Pumpkin seed presented 0.746 ± 0.239 mg/100 g compared to pulp (0.086±0.033 mg/100 g). This compared well with 1.0 ± 0.6 mg/100 g reported by Mohammed et al. (2004) in seed kernels. MEG 052 and TAM 231 had highest zinc levels in seed and flesh respectively. Zinc plays a role in the proper functioning of sense organs such as ability to tastes, sense and smell (Jiménez et al., 2014).

Manganese

Seeds had 8.131±0.341 mg/100 g and the flesh had 5.633±0.099 mg/100 g. The results were lower than 17.93 ppm recorded by Amoo et al. (2004) in *cucurbita maxima*. KAP 012 seeds and flesh of KAB 125 had highest levels. Manganese plays a vital role in all mental functions and aids in the transfer of oxygen from lungs to cells (Wernimont et al., 2020).

Phytochemicals

Phytochemicals only occur naturally in food plants (Leitzmann, 2016). They contain biologically active non-nutrient compounds which provide health benefits to the human body. They are contained in many fruits and vegetables. Phytochemicals are not necessary for the maintenance of life but are important in maintaining optimal health, they help lower the risk of occurrence of chronic diseases e.g. cancer and coronary heart disease (Kirk & Sawyer, 1998).

Saponins

Saponins act as flavor modifiers for beverages, baked goods, seasonings, candies, chewing gum, herbs and dietary supplements (Xolisa, 2002). The quantities of saponins found in the seeds and flesh of the accessions was low hence cannot pose health problems to the consumers.

Tannins

Tannin can be termed a double edged sword (Kubmarawa et al., 2009). If used in permissible limits; its advantages will benefit mankind. The dose of tannins required to cause a particular disease or disorder is far

beyond the permissible limits (Sharma et al., 2021).

Flavonoids

Most flavonoids are excellent antioxidants, antibacterial and antiviral; they are essential in lowering the risk of cancers, slows ageing and reduces upper respiratory tract infections (Aliyu et al., 2008). Presently, it is deemed safe to consume dietary Flavonoids.

Alkaloids

Alkaloids are secondary metabolites and are present in food and drinks as well as in stimulant drugs (Leitzmann, 2016). Alkaloids have a bitter taste that naturally deters herbivorous organisms (Niu et al., 2017).

Table 2: Mean values of mineral elements in pumpkin accessions

Mineral element	Accession	Mean value (%) Highest	Average mean values (mg/100 g)
Ca(Seed)	EMS 222	64.887	46.197±6.315
Ca (Flesh)	KAP 011	35.276	21.751±4.604
Zn (Seed)	MEG 052	1.117	0.746±0.239
Zn (Flesh)	TAM 231	0.153	0.086±0.033
Cu (Seed)	END 182	1.109	0.710±0.207
Cu(Flesh)	ARR 268	0.106	0.070±0.020
Fe (Seed)	NGE 064	14.907	12.490±1.282
Fe (Flesh)	NGE 066	8.791	6.920±1.052
K (Seed)	CHEP 1	189.535	149.074±23.506
K (Flesh)	CHEP 2	167.420	128.966±17.035
Mg (Seed)	TAM 235	128.596	8.131±0.341
Mg (Flesh)	NGE 066	86.539	5.633±0.099
Mn (Seed)	KAP 012	8.791	1.308±10.923
Mn (Flesh)	KAB 125	0.646	0.367±7.917
Na (Seed)	CHEP 1	10.430	103.339±1.362
Na (Flesh)	CHEP 2	44.137	71.256±4.427
P (Seed)	TUL 041	1.001	0.687±0.164
P (Flesh)	KAP 011	0.401	0.209±0.074

Correlations of Analysis

Positive correlation was observed in alkaloid in seed and flesh (Table 3). Significant positive correlation was seen between flavonoid in seed and alkaloid in flesh (r = 0.343). Flavonoids in seed and flesh had significant negative correlation (r = -0.273). Positive significant correlations of tannin in seeds with alkaloids in flesh (r = 0.326) and Flavonoids in seed (r = 0.286). Significantly positive correlations existed between tannins in flesh and alkaloids in seed (r = 0.278. Saponin in seed had significant positive correlation with alkaloid in flesh (r = 0.268). Saponin in flesh significantly correlated positively with tannin in flesh (r = 0.383) and saponin in seed (r = 0.343).

Table 3: Correlation matrix (Pearson) of phytochemicals in pumpkin accessions

Variables (%)	Alkaloid (seed)	Alkaloid (flesh)	Flavonoid (seed	Flavonoid (flesh)	Tannins (seed)	Tannins (flesh)	Saponin (seed)	Saponin (flesh)
Alkaloid (seed)	**1**							
Alkaloid (flesh)	0.164	**1**						
Flavonoid (seed	0.248	**0.343**	**1**					
Flavonoid (flesh)	0.029	0.145	**-0.273**	**1**				
Tannins (seed)	0.221	**0.326**	**0.286**	-0.100	**1**			
Tannins (flesh)	**0.278**	0.049	0.225	**-0.269**	**0.300**	**1**		
Saponin (seed)	0.079	**0.268**	0.149	0.041	0.002	0.065	**1**	
Saponin (flesh)	0.125	0.172	0.209	0.216	0.234	**0.383**	**0.343**	**1**

Values in bold are different from 0 with a significance level alpha=0.05

Proximal Analysis of Pumpkin Accessions

Moisture in seeds ranged from 8.162[a] (TUL 041) to 4.967[p] (NGE 064). Lowest levels (5.750[q]) in TAM 231 and highest (14.533[a)] in KAP 011 (Table 4). These were higher than 7.93±0.02[a] and 3.06±0.02[a] reported by Mohaammed et al. (2013). They were consistent with (4.4-15.2%) in seeds and lower than (75-91.33%) in the pulp of *C maxima* as reported by Karanja et al. (2013).

Ash was lowest in CHEP 2 seeds (1.583[b]) and KAP 011 flesh (5.383[r]). It was highest in KAP 003 (7.00[a]) seeds and CHEP 1 flesh (19.050[a]). This was within the range of 3.97± 0.02 but higher than 3.06± 0.02% in seeds and pulp of *cucurbita* spp as reported by Aruah et al., (2010) Ash proportion is an indicator of the mineral contents found in the food materials.

Lipid levels were highest in MEG 052 (46.757[q]) seeds and KAP 011 (9.400[a]) flesh. This compared well with the findings of Mohaammed et al. (2013) of 50.96± 0.06 and 16.70± 0.01% in seed and pulp of *cucurbita* spp. Dietary fats helps to increase Palatability of food by absorbing and retaining flavours.

Seeds of KAP 011 had 22.426[a] while CHEP 2 had 38.424[ab] mean protein values, this compares well with 29.15±0.04 and 25.89% reported by Karanja et al. (2013) for *Cucurbita mixta*. The flesh had 7.33[q] and 27.895a in NGE 064 and EMS 225, respectively. This was in agreement with 13.42±0.01 reported by Mohaammed et al. (2013) for *cucurbita* spp

Highest crude fibre was in KAPS 022 (25.246a) which compared well with 11.21-24.98% for the seed reported by Karanja et al. (2013). RAN 1 flesh was high in crude fibre (5.800[a]). Amoo et al. (2004) reported 2.85±0.01in pulp of *cucurbita maxima.* Fibre reduces cholesterol levels in the body and helps maintain healthy bodies.

Highest carbohydrate contents were recorded in the seeds of NGE 064 (69.217%) and flesh of EMS 223 (14.255%).This was similar to the findings of Adebayo, et al. (2013) of 66.64±0.10% in *C. maxima* and within the scope of 6.39± 2.66% reported for *Arachis hypogaea* by Loukou et al. (2007). The high carbohydrate values make pumpkin a good quality food.

Table 4: Proximate means

	Moisture (F)	Moisture (s)	Ash (F)	Ash (s)	Lipids (F)	Lipids (s)	Protein (F)	Protein (s)	Crude Fibre (F)	Crude Fibre (s)	Carb (F)	Carb (s)
TUL 049	13.733b	6.033jkl	10.917 d	4.150 cd	6.867 cd	31.667 n	11.566 k	37.051 cd	2.733 defgh	12.201 ab	54.184 f	8.899 e
TUL 041	11.150 ef	8.162 a	11.450 c	2.717 ij	7.183 c	41.750 e	13.240 h	34.758 i	2.578 defgh	9.700 ij	54.398 f	2.914 ij
RAN 1	7.667 n	6.950 de	10.433 e	2.600 jk	6.117 e	35.150m	22.151 b	35.672 fgh	5.800 a	11.544 bcd	47.832 i	8.084 ef
KAP012	12.133 d	6.500 fgh	8.817 g	4.133 cd	2.183 l	38.533 h	19.194 c	35.728 fgh	3.245 cdefg	8.800 klm	54.428 f	6.305 g
RAN 2	11.000 fg	6.917 e	6.417 no	2.300 kl	6.867 cd	36.900 j	17.846 e	35.350 ghi	4.445 abcd	11.423 cd	53.426 fg	7.110 fg
NGE 066	13.850 b	6.633 f	8.100 hi	3.633 ef	3.500 hi	41.017 f	10.784 mn	36.453 def	2.289 defgh	10.501 fgh	61.477 d	1.763 jk
TAM 231	5.750 q	7.163 cd	11.450 c	3.450 fg	3.900 h	30.967 o	17.453 ef	36.540 def	2.422 defgh	9.989 hij	59.025 e	11.891 c
KAP 011	14.533 a	7.867 b	5.383 r	2.017 l	9.400 a	36.217 k	17.014 f	28.093 m	2.178 defgh	12.001 abc	51.492 gh	13.806 a
TUL 045	8.612 lm	5.958 klm	11.658 c	4.725 b	6.844 cd	39.854 g	22.184 b	34.837 i	1.178 gh	10.267 ghi	49.523 hi	4.359 h
CHEP 1	9.950 k	7.792 b	19.050 a	2.050 l	5.600 f	44.350 b	18.622 d	36.213 ef	3.334 bcdefg	8.349 mn	43.444 j	1.246 k
CHEP 3	10.800 gh	6.367 ghi	7.400 jk	3.817 def	2.583 kl	31.100 o	18.592 d	35.233 hi	3.578 abcdef	10.323 ghi	57.047 e	13.161 ab
TUL 48	6.567 p	5.600 o	6.900 lm	4.200 cd	3.550 hi	30.047 p	10.366 no	38.424 a	5.045 abc	11.245 de	67.573 a	10.484 d
ARR 268	10.667 h	6.300 hi	11.367 c	3.667 ef	7.067 cd	42.717 d	11.269 kl	36.045 efgh	2.267 defgh	7.978 n	57.364 e	3.294 hi
EMS 222	8.500 m	6.150 ijk	9.550 f	2.933 hij	3.117 ij	31.317 no	12.342 j	36.132 efg	3.578 abcdef	11.123 def	62.914 bcd	12.346 bc
EMS 225	8.817 l	5.117 p	16.967 b	3.217 gh	6.817 cd	39.467 g	27.895 a	34.722 i	3.556 bcdef	9.445 jk	35.949 k	8.033 ef
KAB 121	8.767 l	6.567 fg	7.750 ij	2.117 l	1.100 n	42.900 d	12.919 hi	36.642 de	5.556 ab	10.478 fgh	63.909 bc	1.296 k
KAB 122	10.133 jk	7.237 c	9.567 f	3.200 gh	5.550 f	36.517jk	8.727 p	35.218 hi	1.533 fgh	10.722 efg	64.490 b	7.107 fg
KAP 003	12.133 d	5.667 o	8.150 h	7.000 a	2.567 kl	36.417 jk	12.531 ij	31.475 l	2.356 defgh	12.490 a	62.264 bcd	6.952 fg

CHEP 2	11.250 e	6.267 hij	8.600 g	1.583 m	2.883 jk	45.500 a	17.392 ef	38.097 ab	5.511 ab	7.294 o	54.364 f	1.258 k
KAB 125	10.300 ij	5.833 lmno	6.067 op	3.950 de	1.383 mn	38.517 h	10.917 lm	36.152 efg	4.245 abcde	11.223 de	67.088 a	4.325 h
KAPS 022	10.383 i	5.767 mno	7.733 ij	3.950 de	2.317 l	37.667 i	9.972 o	37.102 cd	1.511 fgh	12.623 a	68.083 a	2.892 ij
SIM 082	13.200 c	5.100 p	5.533 qr	3.850 de	6.667 d	42.400 d	18.919 cd	37.464 bc	1.956 efgh	8.656 lmn	53.726 f	2.530 ij
EMS 223	13.033 c	6.350 ghi	9.550 f	3.000 hi	3.200 ij	36.017 kl	9.932 o	31.500 l	2.511 defgh	8.878 klm	61.774 cd	14.255 a
END 182	12.000 d	5.917 klmn	7.900 hi	3.100 ghi	4.917 g	42.583 d	10.468 mn	33.859 j	3.489 bcdefg	8.367 mn	61.227 d	6.174 g
TAM 235	8.400 m	6.150 ijk	7.217 kl	4.133 cd	1.633 m	36.067 kl	12.934 hi	37.541 bc	0.867 h	8.000 n	68.949 a	8.109 ef
MEG 052	10.000 k	5.700 no	6.617 mn	4.083 cd	4.933 g	43.767 c	14.701 g	34.755 i	1.222 gh	9.656 ij	62.527 bcd	2.039 jk
NGE 064	7.200 o	4.967 p	5.883 pq	4.433 bc	7.900 b	35.667 l	7.333 q	32.981 k	2.467 defgh	9.334 jkl	69.217 a	12.619 bc

Key Carb- carbohydrates; F-Flesh; S-Seed

CONCLUSION

From this study, it can be concluded that pumpkins, (*Cucurbita genus*) are good supplemental sources of alkaloids, saponins, Flavonoids and tannins. CHEP 1 seeds are good sources of potassium and sodium, KAP 011 flesh is an excellent source of calcium and phosphorus. NGE 064 seeds and EMS 223 flesh are good sources of carbohydrates, CHEP 2 seeds and EMS 225 flesh are good sources of proteins.

RECOMMENDATION

We hereby wish to recommend use of accessions CHEP 1, KAP 011, NGE 064, EMS 223 and EMS 225 to breed for pumpkins with high nutritional values to be used in formulating feeds and supplements for infants, expectant mothers and patients. The same will also be helpful in curbing malnutrition.

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REFERENCES

Adebayo, O. R, Forombi A. G. & Oyekanmi A. M. (2013). Proximate, Mineral and Anti nutritonal evaluation of pumpkin pulp (*Cucurbita pepo*). *Journal of applied chemistry*. 4(5): 25-28

Agu, H., Ayo, J. A., Onuoha, G., & Adedire, D. T. (2012). Effect of cereals and defatted groundnut paste on the digestibility of Dambu: a local Gurel. *Agriculture and Biology Journal of North America*, *3*(1), 6-10.

Ahamed, K. U., Akhter, B., Islam, M. R. Ara, N., & Humauan, M. R., 2011. Assessment of morphology and yield characteristics of pumpkin (*Cucurbita moschata*) genotype in N. Bangladesh. *Trop. Agric. Res. and Ext*., 14(1), 7-11.

Aliyu, A. B., Musa, A. M., Oshanimi, J. A., Ibrahim, H. A., & Oyewale, A. O. (2008). Phytochemical analyses and mineral elements composition of some medicinal plants of Northern Nigeria. *Nigerian Journal of Pharmaceutical Sciences*, *7*(1), 119-125.

Amoo, I. A, Eleyinmi, A. F, Illelaboye & Akoja, S. S (2004). Characteristics of oil extract gourd (*Cucurbita maxima*) seed. *Food, Agric Environ*. 3:38-39

AOAC (1990). Official method of analysis 15th Edition. Association of Official Analytical Chemist. Washington, DC. USA

Aruah, B. C., Uguru, M. I., & Oyiga, B. C. (2010). Variations among some Nigerian *Cucurbita* landraces. Afri. J. Plant Sci., 4 (10):374-386.

Balkaya, A., Özbakır, M., & Karaağaç, O. (2010a). Pattern of variation for seed characteristics in Turkish populations of *Cucurbita moschata* Duch. Afri. J. Agric. Res., 5(10):1068-1076.

Balkaya, A., Ozbakir, M., & Kurtar, E.S. (2010b). The phenotypic diversity and fruit characterization of w inter squash (*Cucurbita maxima*) populations from the black sea region of Turkey. Afri. J. Biotech., 9:152-162.

Boham, B. A., & Kocipai-Abyazan, R. (1974). Flavonoids and condensed tannins from leaves of Hawaiian vaccinium vaticulatum and V. calycinium. *Pacific sci*, *48*(4), 458-463.

Conway, G. (2019). *The doubly green revolution: food for all in the twenty-first century*. Cornell University Press.

Dunn, J., & Grider, M. H. (2021). Physiology, adenosine triphosphate. in *StatPearls [Internet]*. StatPearls Publishing.

Echessa, P. A., Hudson, N., Alice, O. N., Stanley, O., William, T., Ijani, A. S., & Anne, S. (2013). Evaluation of micronutrients in seeds of pumpkin varieties grown by smallholder farmers in the Lake Victoria Basin. *African Journal of Food Science and Technology*, *4*(10), 221-228.

Grubben, G. J. H., & Denton, O. A. (2004). Plant resources of tropical Africa 2. Vegetables. *Plant resources of tropical Africa 2. Vegetables.*

Harborne, J. B. (1973). Phenolic compounds. In *Phytochemical methods* (pp. 33-88). Springer, Dordrecht.

Haytova, D., Ivanova, P., Petkova, N., & Panayotov, N. (2020). Nutritional quality characteristics of two pumpkins type cultivated in Bulgaria. *Scientific Papers-Series B, Horticulture*, *64*(1), 384-389.

Holst, B., & Williamson, G. (2008). Nutrients and phytochemicals: from bioavailability to bioefficacy beyond antioxidants. *Current opinion in biotechnology*, *19*(2), 73-82.

Jiménez, N., Esteban-Torres, M., Mancheño, J. M., de Las Rivas, B., & Muñoz, R. (2014). Tannin degradation by a novel tannase enzyme present in some Lactobacillus

plantarum strains. *Applied and environmental microbiology*, *80*(10), 2991-2997.

Karanja, J. K., Mugendi, B. J., Khamis, F. M., & Muchugi, A. N. (2014). Nutritional evaluation of some kenyan pumpkins (Cucurbita spp.). *International Journal of Agriculture and Forestry* 4(3): 195-200

Karanja, J., Mugendi, B. J., Khamis, F., & Muchugi, A. (2013). Nutritional composition of the pumpkin (Cucurbita spp.) seed cultivated from selected regions in Kenya. *Journal of Horticulture Letters*, 3(1), pp.-17-22.

Karuri, H. W., Ateka, E. M., Amata, R., Nyende, A. B., Muigai, A. W. T., Mwasame, E., & Gichuki, S. T. (2010). Evaluating diversity among Kenyan sweet potato genotypes using morphological and SSR markers. *Int. J. Agric. Biol*, *12*(1), 33-38.

Kaźmińska, K., Sobieszek, K., Targońska-Karasek, M., Korzeniewska, A., Niemirowicz-Szczytt, K., & Bartoszewski, G. (2017). Genetic diversity assessment of a winter squash and pumpkin (Cucurbita maxima Duchesne) germplasm collection based on genomic Cucurbita-conserved SSR markers. *Scientia Horticulturae*, *219*, 37-44.

Kirk, H., & Sawyer, R. (1998). Frait pearson chemical analysis of food. *Longman Sci. Techn*, *8*, 211-212.

Kubmarawa, D., Andenyang, I. F. H., & Magomya, A. M. (2009). Proximate composition and amino acid profile of two non-conventional leafy vegetables (Hibiscus cannabinus and Haematostaphis barteri). *African Journal of Food Science*, *3*(9), 233-236.

Leitzmann, C. (2016). Characteristics and health benefits of phytochemicals. *Complementary Medicine Research*, *23*(2), 69-74.

Loukou, A. L., Gnakri, D., Djè, Y., Kippré, A. V., Malice, M. J. P. B., Baudoin, J. P., & Bi, I. A. (2007). Macronutrient composition of three cucurbit species cultivated for seed consumption in Côte d'Ivoire. *African Journal of Biotechnology*, *6*(5).

Mady, E., Ibrahim, S. D., Randhir, R., El-Hakim, A., Ahmed, F., & Randhir, T. O. (2022). Genetic variation among pumpkin landraces based on seed qualities and molecular markers. *Molecular Biology Reports*, 1-11.

Mohammed, A. A. (2004) Chemical composition and oil characterization of pumpkin *Cucubita maxima* Res. Bult. *Food science and agric research* (29) 5-18

Naluwairo, R., (2011). *Investing in Orphan Crops to Improve Food and Livelihood Security of Uganda's Rural Poor: Policy Gaps, Opportunities and Recommendations.* ACODE Policy Research Series, No. 43, 2011. Kampala.

Niu, M., Xie, J., Sun, J., Huang, Y., Kong, Q., Nawaz, M. A., & Bie, Z. (2017). A shoot-based Na^+ tolerance mechanism observed in pumpkin—An important consideration for screening salt tolerant rootstocks. *Scientia horticulturae*, *218*, 38-47.

Oloyede, O. I. (2005). Chemical profile of unripe pulp of Carica papaya. *Pakistan journal of nutrition*, *4*(6), 379-381.

Paris, H. S. (2000), "First two publications by Duchesne of *Cucurbita moschata* (Cucurbitaceae)", *Taxonomy,* Vol. 49, pp. 305-319.

Phillips, B. W., & Gardiner, M. M. (2015). Use of video surveillance to measure the influences of habitat management and landscape composition on pollinator visitation and pollen deposition in pumpkin (Cucurbita pepo) agroecosystems. *PeerJ*, *3*, e1342.

Sadasivam, S., & Manickam, A. (1996). Peroxidase. *Methods in Biochemistry. New Age International: New Delhi*, 108-110.

Sharma, K., Kumar, V., Kaur, J., Tanwar, B., Goyal, A., Sharma, R.,... & Kumar, A. (2021). Health effects, sources, utilization and safety of tannins: A critical review. *Toxin Reviews*, *40*(4), 432-444.

Sheela, K., Nath, K. G., Vijayalakshmi, D., Yankanchi, G. M., & Patil, R. B. (2004). Proximate composition of underutilized green leafy vegetables in Southern Karnataka. *Journal of Human Ecology*, *15*(3), 227-229.

Thies, E. (2000). *Incentive measures appropriate to enhance the conservation and sustainable use of agrobiodiversity.* GTZ, Eschborn, Germany.

Wernimont, S. M., Fritsch, D. A., Schiefelbein, H. M., Brejda, J. J., & Gross, K. L. (2020). Food with specialized dietary fiber sources improves clinical outcomes in adult cats with constipation or diarrhea. *The FASEB Journal*, *34*(S1), 1-1.

Xolisa, N. (2002). *Characterization of maize and cucurbit landraces of the "TRANSKEI" region of the Eastern Cape, Republic of South Africa*. A Master of Science Thesis. University of Fort Hare, South Africa.