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Proximate composition of pumpkin gourd (*Cucurbita pepo*) seeds from Zimbabwe

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Abstract: *Curcubita pepo* seeds have been widely consumed in Zimbabwe way back in the 1970s, but still locally, there is no data on the nutritional quality of *Curcubita pepo* seeds, hence the study attempted to avail this information. *Curcubita pepo* seeds from selected places in Zimbabwe were analysed. The proximate analysis including major nutrients and minerals were determined. The C. pepo seed had a moisture content of 5.662±0.016gkg^{-1}. Significantly, Curcubita pepo had high amounts of crude oil and proteins as compared to other edible oil rich seeds. The crude oil content and protein were 43.460±0.098gkg^{-1} and 32.860±0.103gkg^{-1} respectively. Other components such as carbohydrates, crude fibre and energy were 12.160±0.142gkg^{-1}, 2.578±0.007gkg^{-1} and 562.82±0.132gkg^{-1} correspondingly. Ash content was 3.324±0.010gkg^{-1} which was further analysed into various major minerals giving analysed means as Na (67.956±0.037gkg^{-1}), Zn (1.244±0.010gkg^{-1}), P (1040.8±0.663gkg^{-1}), Fe (11.980±0.086gkg^{-1}), Ca (141±0.316gkg^{-1}) and Mg (344.6±0.245gkg^{-1}). The findings indicated that *C. pepo* seeds are a good alternative source of highly nutritious food for instance proteins and lipids as well as minerals (Mg, Ca, Zn, P and Fe) that could greatly contribute to human nutritional requirements. However, it still remains important to further profile the quality of the lipids and proteins from *C. pepo* seed so as to verify their essentiality and availability to the human body as well as evaluating the presence of other bioactive and antinutritional factors that might be present in these seeds.

Keywords: Proximate, *Cucurbita Pepo*, Nutrition, Seed

1. Introduction

Knowledge of the nutritive value of local dishes, soup ingredients and local foodstuffs is necessary in order to encourage the increased cultivation and consumption of those that are highly nutritive. Consumption of nutritive local foodstuffs will help to supplement the nutrients of the staple carbohydrate foods of the poor who cannot afford enough protein foods of animal origin [1;2]. Moreover, Cucurbits are widely grown in Southern Africa [22]. Achu et al. (2013) reported that, pumpkins can be grown in both temperate and tropical regions.

Pumpkin, belonging to the genus *Cucurbita* and family *Cucurbitaceae* refers to any one of the species *Cucurbita moschata, Cucurbita mixta, Cucurbita maxima,* and *Cucurbita pepo* [3]. Pumpkin (*C. pepo*) is mostly used to refer to cultivars with round fruits which are used in the mature state for baking or feeding livestock [7]. Pumpkin is among the economically most important vegetable crops worldwide and is grown in both temperate and tropical regions. Depending upon the species, virtually all parts of the plant can be used for food, including leaves, shoots, roots, flowers, seeds, and immature and mature fruits [28].

The nutritional value of the *Cucurbitaceae* seeds is dependent on the strain, species type as well as climatic conditions where it is grown [28]. From a study conducted in Cameroon, the results confirmed the strain dependency of the nutritional value of *Cucurbitaceae* seeds from various species namely, *Cucumeropsis mannii, Cucurbita maxima, Cucurbita moschata, Lagenaria siceraria* and

Cucumis sativus [2]. Studies on Cucurbitaceae seeds and their defatted cakes are rich in proteins (28 to 40.49 and 61 to 73.59% respectively). They also contain high lipid levels similar to those of the other oilseeds. These seeds can thus be considered as sources of proteins and oils [2] Loukou *et al*., (2007) also found similar results with *Cucurbit* seeds from Côte d'Ivoire where they found that these seeds had protein levels ranging from 29 to 36%. However, it was reported that *Cucurbit* seeds from Sudan had a low protein content ranging from 14 – 17.5%, and from these findings the nutritional content of these seeds depends on the regions as enhanced by the low values obtained from Sudanese seeds. In addition to remarkable nutritive value of *Cucurbitaceae* seeds, they do have other uses such as soup thickeners and also when cooked, toasted/roasted and dried, can serve as snacks. Moreover, they are less expensive and widely distributed and can therefore be easily cultivated and consumed or sold by the masses. Seeds of pumpkins can also be roasted as a snack and made into a paste that resembles peanut butter [1; 21] , for instance in Zimbabwe this has been the traditional practice and even to date.

Seeds from *Cucurbita* and family *Cucurbitaceae* including *Cucurbita pepo* contain bioactive compounds which have antifatigue activity and can elevate exercise performance. The seeds were said to have bioactivities such as hepatoprotection, anti-diabetes, anticancer, and anti-obesity properties [25].

In Zimbabwe *Curcubita pepo* seeds are consumed widely mainly in summer as a snack, however, there remains no data on the nutritional quality of *Curcubita pepo* seeds, therefore the present study attempted to determine the proximate composition of dry seeds.

2. Materials and Methods

2.1. Samples Collection and Preparation

A total of 100 samples were collected from five districts namely Mazowe, Shamva, Mtoko, Mrehwa and Domboshava where a total of twenty *Curcubitae pepo* fruits were collected per each district. The fruits were identified as *Curcubitae pepo (Mubovora/Munhanga* in Shona*,)* [19] or (*ibobola* in Ndebele) at National Herbarium and Botanical Gardens, Harare, Zimbabwe. The districts selected present ideal climatic conditions for the growing of *Curcubitae pepo* fruit*.* The *Curcubitae pepo* fruits selected were mature, fresh and ready for the market. The selected fruits were immediately transported to the Food Laboratory at Harare Institute of Technology within one day of sampling. In the laboratory the seeds were recovered from the *Curcubitae pepo* fruits within two days of arrival. The seeds were dried using a solar dryer until their moisture content was approximately 10%. Despite different sources of the fruits, the seeds were homogeneously mixed and sent to a national standards laboratory where nutritional composition of the seeds was determined. Sample analysis commenced within 15 days after recovery from the fruit. Samples analysis was done in triplicates and reported as mean ± standard error of the mean.

2.2. Sample Analysis

Proximate analysis was carried out using the AOAC (1990) [4] standard methods which are for quantifying nutrients in samples. Moisture was determined by oven drying method (Gallenkamp, plus II oven, Germany) using a representative sample of 5g *Curcubitae pepo* seeds at 105 °C until constant weight was obtained (Sadiq *et al.*, 2013). Crude proteins were estimated by an NCS- elementary analyser Flash 2000 (Flash 2000 Organic Elemental Analyser, Germany). Total proteins were automatically calculated by the machine by multiplying the estimated nitrogen content by 6.25 as the appropriate conversion factor. Crude fat content was determined using Soxhlet apparatus using hexane as organic solvent. The extraction was performed for 14 hours and hexane was later recovered by drying the sample in an oven (Gallenkamp, plus II oven, Germany) set at 110 °C for 30 minutes. To determine crude fibre a 5g sample of dried sample was digested with 1.25 M sulphuric acid and 1.25 M sodium hydroxide solution. The insoluble residue obtained was washed with hot water and dried in an oven (Gallenkamp, plus II oven, Germany) at 105°C until constant weight. The dried residue was then incinerated, and weighed for the determination of crude fibres content. Available carbohydrate and calorific value are determined by calculation [4;5;12]. For percentage carbohydrates the following formula was used: % Carbohydrates: 100 – (% moisture + % proteins + % lipids + % ash + % fibres). The energy value was determined using the AOAC (1990)[4] formula: Energy = (g protein x 2.44) + (g lipid x carbohydrate x 8.37 x 3.57).

Ash content was determined by initially charring the 5g dried homogenous powdered sample in a muffle furnace (Carbolite RHS 1600, Germany) at 250 °C until the sample turned black. Thereafter, the sample was incinerated in the same muffle furnace (Carbolite RHS 1600, Germany) at 550 °C for 5 hours until the ash turned white. The results of water content were expressed on wet sample basis while those of ash, fibre, protein, lipid and carbohydrate contents were expressed on dry matter basis [10].

2.3. Mineral Analysis

Mineral analysis (Ca, Mg, Na, Fe, Zn, and P) was performed by inductive coupled plasma atomic emission spectroscopy (iCap 6000 series, Germany) [14]. Mineral analysis was carried out using the ash obtained during ashing of the (5 g) sample. The ash obtained was dissolved in 5 mL of hydrochloric acid /nitric acid and analysed thereafter using ICP-spectroscopy.

2.4. Statistical Analysis

All the statistical analyses were performed and data presented as an average of triplicate readings. Data was analysed using EXCEL (MicroSoft) and presented as mean ± standard error of the mean.

3. Results

Tables 1 and 2 give a summary of the main results of this study and Table 1 gives a comparison with previous studies.

Table 1. *Proximate composition of Curcubita pepo*

Components (%)	*C_m Dried seeds	Other Studies**
Water content	5.662±0.016	5.149
Crude Ash	3.324±0.010	5.315
Crude Fibre	2.578±0.007	10.851
Crude Protein	32.860±0.103	29.811
Crude Fat	43.460±0.098	45.676
Carbohydrates	12.160±0.142	14.019
Energy (kCal/100g)	562.82±0.132	559

*C_m Dried seeds readings expressed as Mean ± standard error of the mean.
** *Source: Kim et al., (2007)*

Table 2. *Mineral composition of Curcubita pepo*

Element (mg/100g)	dried seeds
Sodium	67.956±0.037
Iron	11.980±0.086
Phosphorous	1040.8±0.663
Calcium	141±0.316
Zinc	1.244±0.010
Magnesium	344.6±0.245

*Readings expressed as Mean ± standard error of the mean

The nutritional quality of *Curcubita pepo* from selected places in Zimbabwe was profiled on the basis of major nutritional components (reported as percentages) such as proteins, fats, carbohydrates, fibre and gross ash, and further itemised into major minerals (reported as mg/100g) including sodium, magnesium, calcium, iron, phosphorus, zinc and magnesium as shown in Tables 1 & 2. Also moisture content of the dry seeds was determined. Significantly, *Curcubita pepo* had high amounts of crude oil and proteins as compared to other edible oil rich seeds. The crude oil and protein content were reported as 43.460±0.098gkg^{-1} and 32.860±0.103gkg^{-1} respectively. In addition to that, other components such as carbohydrates and crude fibre were 12.160±0.142gkg^{-1} and 2.578±0.007gkg^{-1} respectively. Moisture content averages at 5.662±0.016gkg^{-1}. Ash content calculated as average was 3.324±0.010gkg^{-1} which was further analysed into various major minerals giving analysed averages as sodium (67.956±0.037gkg^{-1}), zinc (1.244±0.010gkg^{-1}), phosphorus (1040.8±0.663gkg^{-1}), iron (11.980±0.086gkg^{-1}), calcium (141±0.316 gkg^{-1}) and magnesium (344.6±0.245gkg^{-1}).

4. Discussion

According to Applequist (2006) [6] , *Curcubitae pepo* (pumpkin) is a vegetable which is unique in that the flesh, skin and the seeds can be consumed as food. From the analysis of the composition of the seed it can be seen that this food source is a notable source of protein, lipid and carbohydrate as well as most of the macronutrients that are required for healthy living (Table 1) [6]. Chigwe and Saka (1991) [9] indicated that pumpkins supply calcium, iron, vitamin A, oil (25 - 55%, rich in unsaturated oleic and linoleic acids), protein (25 - 35%) with high amounts of arginine, aspartate and glutamic acid, although they are deficient in lysine and sulphur- containing amino acids (Chigwe and Saka, 1994). An analysis of the parameters listed in Table 1 shows that the composition of the Zimbabwean variety of *C. pepo* does not differ from that reported in literature. Most of the values reported in this study (Table 1) do not differ from those quoted in literature by more than 5%. This is in line with the studies carried out by Achu et al. (2005) [1] and Loukou et al. (2007) [21] (mainly in Côte d'Ivoire) which revealed similar results on the analysis of *Cucurbitaceae* seeds. For instance, their studies revealed oil and protein content within the ranges of 28 - 40.49 and 61 to 73.59% respectively, while this study gave 43.460±0.098% and 32.860±0.103. Furthermore, the nutritional value of the *Cucurbitaceae* seeds is species dependent and is also influenced by climate [28], hence similar results are possible. However, some studies in Sudan revealed very low amounts of proteins content ranging from 14 – 17.5%, and these results conclusively confirmed the dependency of nutritional content of these seeds to regional climates.

The composition of *C. pepo* seeds in relation to the Recommend Daily Allowance (RDA) values is shown in Table 3.

Table 3. *Nutritional analysis of Curcubita pepo with respect to Recommended Daily Allowances*

Parameter	*C. pepo*	RDA (and Reference)	% of RDA based on Reference
	Per 100g serving		
Crude Fibre	2.58g		
Crude Protein	32g	120g*	27
Crude Fat	43g		
Carbohydrate	12g		
Sodium	69mg	2400 mg**	75
Iron	12mg	15mg	
Phosphorous	1040mg	1000 mg	104
Calcium	141mg	1000 mg	
Zinc	1.2mg	15 mg	
Magnesium	344mg	350 mg	98

Sources * Adopted from Wolf & Miller (2008) and ** from http://www.lenntech.com

From Table 3, it is clear that *C. pepo* seeds are an excellent source of phosphorus and magnesium, with a 100 g serving providing 104% and 98%, of the Recommended Daily Allowance (RDA). Despite the nutritional and positive health benefits of consuming *C. pepo* seeds in particular, this vegetable has suffered a poor image and has been generally grouped together with other "poor man's crops" such as cassava and finger millet. Indeed, *C. pepo* is widely consumed among the poor rural communities, where it also doubles as a food security commodity for times of drought, but is shunned in the modern, urban settings.

Besides the immediate benefits of growing *curcubits* on domestic scale that include improved income for households (Isaboke et al., 2012) and increased food variety arising from their edible leaves, fruit and seeds, there are several reasons why the cultivation of *curcubits* on a commercial scale may be desirable. These include the fact that that the *Curcubita* crop matures early and has long shelf life due to easy storage [17] C. pepo can tolerate temperately harsh environmental conditions, resistant to many pests of the cucurbits and it can be grown well in small pieces of land and yield relatively good returns with minimal fertilizer inputs [8], factors which support the notion that the crop has a huge untapped market with high income possibilities [23].

The relatively high fat content of *C. pepo* seeds subtends their utility value as a potential commercial source of edible oil. Compared with other oil-bearing seeds, *C. pepo* is relatively a good source of triglycerides with 43% crude fat, which compares favourably with other established sources including cottonseed (18-26%), linseed (30-48%), safflower seed (25-35%) and sunflower seed (19-56%) (http://www.containerhandbuch.de). *C. pepo* seeds can thus be considered as sources of proteins and oils. Intra-family analysis also shows that *C. pepo* has slightly higher fat and protein content (43 and 31%), as compared to *C. fortidissma* (25-40% and 22-29%, respectively). However, these differences may also be the result of variations in cultivation, climate and soil profile conditions [20].

While this study focused on the nutritional aspects of the seeds of *C. pepo* (Zimbabwe variety), there is considerable evidence of medicinal properties of benefit to man associated with this plant. For example, El Zawane Kamarudin et al., 2014 showed that the peel of Cucurbita and family *Cucurbitaceae* possesses antibacterial compounds and could be a potential source for a new class of antibiotics. For instance at cellular level polysaccharide from *Curcubita moschata* was also shown to effectively inhibit the H2O2-catalysed decrease of cell viability, lactate dehydrogenase leakage, and malondialdehyde formation [27; 11]. The polysaccharide also reduced the H2O2-catalysed decline of superoxide dismutase activity and glutathione depletion in cultured mouse peritoneal macrophages, which, on the overall, indicated that pumpkin polysaccharide possessed significant cytoprotective effect and antioxidative activity [27]. Additionally, *Cucurbita* and family *Cucurbitaceae* such as *Cucurbita moschata* has been found to have anti-inflammatory and antiulcer activity, and this could be the next generation safe and effective anti-inflammatory drugs [13]. *C. pepo* seeds have also been used in traditional medicine as a vermifuge, for example, in Turkey, pumpkin seeds are used to treat tapeworm, where the dried seeds are eaten on an empty stomach [7].

5. Conclusion

The study focuses on proximate analysis of the *C. pepo* seeds. From the results obtained, C. pepo seeds are good alternative source of food with high nutritional content for instance proteins, lipids, fibres, carbohydrates and minerals (Mg, Ca, Zn, P and Fe). Therefore, this study revealed that some of the most traditionally consumed seeds are highly nutritious in particular *C. pepo* which can meet some of the Recommended Daily Allowance (RDA) of micronutrients such as Ca and P [16]. Importantly, these results strongly suggest that the studied *C. pepo* seeds if adequately consumed in sufficient quantities would immensely improve human nutritional requirement. Therefore, this alone can also greatly contribute to household food security and nutritional requirements which consequently enhance normal growth and adequate protection against diseases and malnutrition in most vulnerable groups of the society such as children, pregnant/lactating mothers and elderly people. However, it is of significance importance to further profile the quality of the oil and protein of *C. pepo* seeds so as to assure their essentiality and availability to the human body. Investigation should also be carried to ascertain the presence of other bioactive and anti-nutritional factors that might be present in these seeds. Once this information is availed this might otherwise trigger wider cultivation and consumption of *C. pepo* seeds.

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