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Functional Properties, Proximate and Mineral Compositions of Seeds of Selected Cucurbit Species

A. H. N. Preethimali[1], R. M. Dharmadasa[2,*], D. C. Abeysinghe[1], M. N. A Mubarak[2]

[1]Department of Plantation Management, Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila (NWP), 60170, Sri Lanka
[2]Industrial Technology Institute, 363, Bauddhaloka Mawatha, Colombo 07, 00700, Sri Lanka
*Corresponding author: dharmadasarm@gmail.com

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Abstract The study aimed to determine the total antioxidant capacity (TAC), total phenolic content (TPC), total flavonoid content (TFC), proximate composition and mineral composition in seeds of selected cucurbit species, which include Cucumber, Pumpkin, Crookneck pumpkin, Watermelon, Snakegourd, Ash gourd, Bottle gourd and Kekiri. The Folin-Ciocalteu method, a colorimetric method and ferric reducing antioxidant power (FRAP) assay were used to determine TPC, TFC and TAC respectively. On the other hand, the AOAC method and Atomic Absorbance Spectrophotometric method were used for proximate composition and mineral composition, respectively. The results showed that seeds of watermelon had the highest TPC (1.97 ± 0.06 mg GAE/g DW) and TAC (2.87 ± 0.14 mg TE/g DW) compared to the other selected cucurbit seeds. Meanwhile, seeds of ash gourd had the highest TFC (5.60 ± 0.27 mg RE/g DW). Snake gourd seeds had the highest moisture content (88.92 ± 1.93 %), while seeds of ash gourd had the highest crude ash content (5.18 ± 0.25%). Pumpkin had the highest crude fat content (19.75 ± 1.92 %), while cucumber seed had the highest crude protein content (35.60 ± 0.27). Additionally, cucurbit seeds were found to be rich in K (8,632 mg/ Kg), Mg (3,997 mg/ Kg), Ca (1,369.25 mg/ Kg) and Na (156.25 mg/ Kg). In conclusion, the tested cucurbit species' seeds could be effectively used as nourishing healthy snacks and for nutraceutical and pharmaceutical industries.

Keywords: *antioxidant capacity, cucurbitaceae, cucurbit seeds, functional properties, mineral composition*

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1. Introduction

With the ever-increasing world population, food security has become a major challenge worldwide [1]. This problem gives the rationale for researcher to discover as many as possible cheaper sources of nutrients to meet the requirements. This goal could be accomplished by identifying and using food supplies that are derived from plants.

Cucurbitaceae is a widespread family with 130 genera and 800 species [2]. The cucurbit plant family was discovered in moderate climates, valued for its nutritious fruits and medicinal properties, and commonly known as cucurbits. A wide variety of edible plants, such as watermelons (*Citrullus lanatus*), Pumpkin (*Cucurbita maxima*), Cucumber (*Cucumis sativus*), and gourd species belong to the genus Cucurbitaceae, and their seeds are frequently discarded as waste [3].

They are crucial in preventing oxidative stress, which is a buildup of free radicals and antioxidants that can cause cellular and tissue damage [4]. Most vegetables from the Cucurbitaceae family are rich in bioactive compounds responsible for yellow-red pigmentation called carotenoids. Some of them are known to be absorbed, metabolized, and used for health benefits by the human body [5].

Cucurbits have been used for medicinal purposes for centuries due to their healing properties, depending on phytochemical composition. Various parts of cucurbits such as flowers, fruits, leaves, stems, seeds, petioles and roots are used in traditional therapy [6]. They have antihypoglycaemic, insecticidal/anthelmintic, anti-inflammatory and anti-lipidemic like therapeutic properties [4]). Therefore, cucurbits can be used to treat chronic or acute eczema, inhibit the angiotensin-converting enzyme and the oxidation of linoleic acid [7].

The aim of the current study is to determine the functional properties, proximate and mineral compositions of seeds of commonly cultivated cucurbit species in Sri Lanka, as there is currently a lack of comprehensive research on these aspects despite the potential health benefits of consuming cucurbit seeds.

2. Methodology

Location

The study was carried out in the Laboratory of Department of Plantation Management, Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila (NWP) and Industrial Technology Institute (ITI), Bauddhaloka Mawatha, Colombo 7, from November 2022 to March 2023.

Sample Collection

Homogenous, representative seed samples of eight cucurbit species (Table 1) were collected in November 2022 from Kegalle district and transported to the laboratory.

Table 1. Botanical Names and Varieties of Selected Cucurbit Species

Common Name	Botanic Name	Variety
Cucumber	*Cucumis sativus*	Kalpitiya white
Pumpkin	*Cucurbita maxima*	*ANK Ruhunu*
Crockneckpumpkin	*Cucurbita moschata*	*Walthem*
Watermelon	*Citrullus lanatus*	*Thilini*
Snake Gourd	*Trichosanthes cucumerina*	MI short
Ash Gourd	*Benincasa hispida*	Local
Bottle Gourd	*Lagenaria siceraria*	Local
Kekiri	*Cucumis melo*	*Mal kekiri*

Sample Preparation

A completely randomized design (CRD) with three replicates of all samples were used in the experiment. The fresh seeds of all selected cucurbit varieties were thoroughly washed under running water. They were air dried at room temperature (28 ±°C) for 4-5 days.

Extraction of Phytochemicals

All air-dried samples were powdered using a coffee grinder and sieved with a 0.25 mm mesh. Powdered sample (1 g) was mixed with 5 mL of 80 % methanol and vortexed for 15 min. Then it was placed in a water bath at 60 °C for 40 min and vortex procedure was repeated in 10 min intervals. After centrifugation at 4,000 rpm for 5 min to remove the solid fraction, the supernatant was decanted into a 15 mL falcon tube and the pellet was re-extracted with 5 mL of 80% methanol. Supernatants were pooled and stored at -20°C until further analysis.

Determination of Total Phenolic Content

Total phenolic content (TPC) was determined using the modified Folin-Ciocalteu method (Abeysinghe *et al.*, [8].

Determination of Total Flavonoid Content

Total flavonoid content (TFC) was determined by a colorimetric method as described by Liu *et al*. [9] with slight modifications.

Determination of Total Antioxidant Capacity

Total antioxidant capacity (TAC) was determined using ferric reducing antioxidant power (FRAP) assay described by Benzie and Strain [10] with slight modifications.

Determination of Proximate Composition

The moisture and crude ash contents of samples were determined using the methods described by AOAC (1990). Crude fat content was determined using the Soxhelt extraction method (AOAC, 1990) and the crude protein content was determined using the Kjeldahl method (AOAC, 1990) [11].

Determination of Mineral Composition

Mineral contents were determined by using an Atomic Absorbance Spectrophotometer (icetm 3000 series Thermo Scientific, U.S.A.). Concentrated HNO3 (10 mL) was added to 0.5 g of the sample in a reaction tube. The dispersion was digested in a digestion unit (Model-MARS 6 240/50) for 1 hr. After cooling, the digested products were diluted 50 mL with DI water. The clear solution was taken for mineral determination.

Statistical Analysis

To verify the statistical significance of all parameters, mean values ± SD were calculated. Statistical comparison of mean values was performed by General Linear Model (GLM) of ANOVA followed by Tukey's Multiple Range Test using SAS statistical software (Version 9.4).

3. Results and Discussion

Bioactive Compounds

Results on total phenolic content (TPC) and total flavonoid content (TFC) are shown in Table 2. TPC of tested extracts of seeds were varied from 0.41 ± 0.02 to 1.97 ± 0.06 mg GAE/g DW. Significantly the highest TPC was observed in seeds of watermelon (1.97 ± 0.06 mg GAE/g DW), while the lowest TPC was observed in the seeds of cucumber (0.41 ± 0.02 mg GAE/g DW). The seeds of watermelon and all selected gourds (snake gourd, ash gourd and bottle gourd) had significantly higher TPC than other selected species. However, there was no significant difference observed in between pumpkin and *kekiri* as well as between ash gourd and bottle gourd. However, they had a significant difference with other species for TPC. According to our findings, phenolic contents of pumpkin, watermelon and ash gourd are agreed with the results of Gade *et al*. [12], who reported nutritional and antioxidant properties of selected cucurbit seeds. The extraction duration, the nature and concentrations of solvents affect the extraction rate of phenolic compounds when soil type, geographical origin and maturity of fruits would influence the phenolic compounds contents [13,14] TFC of tested extracts of seeds were ranged from 0.26 ± 0.02 to 5.60 ± 0.27 mg RE /g DW (Table 1). The highest TFC (5.60 ± 0.27 mg RE/g DW) was observed in seeds of ash gourd and the lowest TFC (0.26 ± 0.02 mg RE/g DW) was observed in seeds of cucumber. Further, same as TPC the seeds of watermelon and all selected gourds (snake gourd, ash gourd and bottle gourd) had significantly higher TFC than other selected cucurbit species. According to our findings, flavonoid contents of pumpkin, watermelon and ash gourd are disagreed with the results of Gade *et al*. [15] who reported nutritional and antioxidant properties of selected cucurbit seeds. Those are varied with numerous factors such as variety, environmental conditions, maturity stage and genetic factors [16].

Total Antioxidant Capacity (TAC)

Total antioxidant capacity (TAC) of tested extracts of seeds of selected cucurbit species were varied from 0.25 ± 0.01 to 2.87 ± 0.14 mg TE/g of DW (Table 2). Significantly the highest TAC was observed in seeds of watermelon (2.87 ± 0.14 mg TE/ g DW), whereas, significant the lowest TAC was observed in seeds of cucumber (0.25 ± 0.01 mg TE /g of FW). However, there were no significant difference between cucumber, *kekiri*, snake gourd and ash gourd. But they had a significant difference with other species for TAC. Like TFC, our findings regarding flavonoid contents of pumpkin, watermelon and ash gourd are disagreed with the results of Gade *et al*. [14]. Those are varied with numerous factors such as variety, environmental conditions, maturity stage and genetic factors (Tomas and Espin, [15]), beside various parameters related to the extraction method (time contact, temperature, solvent type etc.) and method of finding TAC (Pinelo *et al*., [16]).

Table 2. Total Antioxidant Capacity (TAC), Total Phenolic Content (TPC) and Total Flavonoid Content (TFC) of Seeds of Selected Cucurbit Species

Species	TPC (mg GAE/g DW)	TFC (mg RE/g DW)	TAC (mg TE/g DW)
Cucumber	0.41± 0.02 ^{f}	0.26 ± 0.02 ^{e}	0.25 ± 0.01 ^{e}
Pumpkin	1.11 ± 0.02 ^{d}	0.95 ± 0.11 ^{d}	1.45 ± 0.14 ^{c}
Crockneck pumpkin	0.96 ± 0.00 ^{e}	1.11 ± 0.06 ^{cd}	0.95 ± 0.05 ^{d}
Watermelon	1.97 ± 0.06 ^{a}	3.25 ± 0.10 ^{b}	2.87 ± 0.14 ^{a}
Snake Gourd	1.23 ± 0.05 ^{c}	1.44 ± 0.05 ^{c}	0.52 ± 0.08 ^{e}
Ash Gourd	1.66 ± 0.05 ^{b}	5.60 ± 0.27 ^{a}	0.50 ± 0.06 ^{e}
Bottle Gourd	1.56 ± 0.04 ^{b}	3.16 ± 0.30 ^{b}	2.27 ± 0.06 ^{b}
Kekiri	1.11 ± 0.02 ^{d}	0.74 ± 0.02 ^{d}	0.44 ± 0.02 ^{e}

Mean denoted by the same letters in a column represent non – significant differences (<0.05); TE-Trolox Equivalents; GAE – Gallic Acid Equivalent; RE – Rutin Equivalent; DW – Dry Weight

Correlation of TAC and Phenols

In selected seeds of cucurbit species, TAC showed positive correlation with the TPC (R^2 = 0.4604). This correlation suggest that the phenolic compounds contribute to the antioxidant capacity of seeds of selected cucurbit species.

Proximate Composition

Proximate composition of seeds of selected cucurbit species are shown in Table 3. Considering the moisture content, snake gourd was recorded a significantly highest moisture content (88.92 ± 1.93 %) followed by cucumber (73.62 ± 2.33 %) and ash gourd (73.37 ± 1.56 %). A significantly highest crude ash content was detected in seeds of ash gourd (5.18 ± 0.25 %). Cucurbit seeds are prominent source of dietary proteins and fat. A significantly higher crude fat contents were recorded in pumpkin (19.75 ± 1.92 %) and Crockneck pumpkin (17.21 ± 0.35 %). A significantly highest crude protein content was in cucumber (35.60 ± 0.27 %) followed by pumpkin (29.82 ± 0.27 %) and *kekiri* (29.12 ± 0.40 %). This is an agreement with the data recorded by Petkova and Antova [17], which indicated the crude protein content of *kekiri* remains around 30 %.

Table 3. Proximate Composition of Seeds of Selected Cucurbit Species

Species	Moisture (%)	Crude Ash (%)	Crude Fat (%)	Crude Protein (%)
Cucumber	73.62 ± 2.33 ^{b}	2.32 ± 0.08 ^{bc}	8.37 ± 0.45 ^{b}	35.60 ±0.27 ^{a}
Pumpkin	56.82 ± 1.41 ^{d}	2.31 ± 0.17 ^{bc}	19.75 ± 1.92 ^{a}	29.82± 0.27 ^{b}
Crockneck Pumpkin	66.71 ± 1.61 ^{c}	3.17 ± 0.18 ^{b}	17.21 ± 0.35 ^{a}	25.79 ± 0.20 ^{c}
Watermelon	55.44 ± 0.90 ^{d}	1.33 ± 0.11 ^{d}	2.12 ± 0.06 ^{d}	20.20± 0.27 ^{f}
Snake Gourd	88.92 ± 1.93 ^{a}	1.87 ± 0.77 ^{cd}	1.28 ± 0.31 ^{d}	17.74 ± 0.27 ^{g}
Ash Gourd	73.37 ± 1.56 ^{b}	5.18 ± 0.25 ^{a}	7.60 ± 0.28 ^{bc}	22.47 ± 0.20 ^{e}
Bottle Gourd	15.94 ± 4.55 ^{e}	2.90 ± 0.42 ^{b}	5.09 ± 0.56 ^{c}	23.52 ± 0.66 ^{d}
Kekiri	59.74 ± 2.07 ^{d}	1.55 ± 0.19 ^{cd}	5.61 ± 0.66 ^{c}	29.12 ± 0.40 ^{b}

Mean denoted by the same letters in a column represent non – significant differences (<0.05)

Mineral Composition

Table 4 represents mineral composition of cucurbit seeds. Cucurbit seeds are considered as major source of macro (K, Na, Ca and Mg) and micro (Mn, Al, Si and Zn) minerals. Higher potassium (K) content was found in all cucurbit seeds when compared with other tested minerals. The next most abundant minerals found in cucurbit seeds was magnesium (Mg) flowed by calcium (Ca) and sodium (Na). In our study much, higher potassium was recorded in watermelon seeds (9426 mg/Kg) than the value reported by Nasiru and Oluwasegun [18] for watermelon (800 mg/Kg). However, content of other minerals present in watermelon in our study is an agreement with the data recorded by Nasiru and Oluwasegun. The current study revealed that the most abundant minerals in cucurbit seeds were potassium, magnesium calcium and sodium.

4. Conclusions

In conclusion, the seeds of selected cucurbit species have shown promising functional properties, proximate and mineral compositions. The results of this study indicated that the seeds of these cucurbit species have potential applications in the food and pharmaceutical industries due to their rich content of protein, fat and minerals such as potassium, sodium, magnesium and calcium. These seeds are also a good source of antioxidants, which could be beneficial for preventing and managing chronic diseases.

Table 4. Mineral Composition of Seeds of Selected Cucurbit Species

Species	Metal Content (mg/ Kg)							
	K	Na	Mg	Ca	Mn	Al	Si	Zn
Cucumber	6378.0	214.0	4063.0	1102.0	38.4	18.4	57.9	77.5
Pumpkin	10794.0	168.0	4888.0	1139.0	52.7	11.9	118.4	53.8
Crock neck Pumpkin	10687.0	181.0	4716.0	1453.0	57.3	14.1	83.8	58.2
Watermelon	9426.0	161.0	4162.0	1033.0	49.0	29.3	60.7	57.3
Snake Gourd	12085.0	130.0	3844.0	4154.0	81.6	11.9	34.4	48.9
Ash Gourd	7414.0	183.0	3367.0	697.0	29.3	17.2	66.0	36.5
Bottle Gourd	6845.0	77.0	3026.0	403.0	21.3	27.0	27.3	51.1
Kekiri	5427.0	136.0	3917.0	973.0	39.8	27.6	48.1	58.8

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References

[1] Bhat, R. and Karim, R.R. (2009). Exploring the Nutritional Potential of Wild and Underutilized Legumes. *Comprehensive Reviews in Food Science and Food Safety*, 8, 305-333.

[2] Oyeleke, A.W., Oluwajuyitan, D.T., Oluwamukomi, O.M. and Enujiugha, N.V. (2019). Amino Acid Profile, Functional Properties and In-vitro Antioxidant Capacity of *Cucurbita maxima* and *Cucurbita mixta* Fruit Pulps and Seeds. *European Journal of Nutrition and Food Safety*, 10 (4), 224-241.

[3] Patel, S. and Rauf, A. (2017). Edible seeds from Cucurbitaceae family as potential functional foods: Immense promises, few concerns. *Biomedicine and Pharmacotherapy*, 91, 330–337.

[4] El-Rehem, F. and Ali, R.F.M. (2013). Proximate compositions, phytochemical constituents, antioxidant activities and phenolic contents of seed and leaves extracts of Egyptian leek (*Allium ampeloprasum* var. kurrat). *European Journal of Chemistry*, 4 (3), 185-190.

[5] Montesano, D., Roccheti, G., Putnik, P. and Lucini, L. (2018). Bioactive profile of pumpkin: An overview on terpenoids and their health-promoting properties. *Current Opinion in Food Science*, 22, 81–87.

[6] Naik, R., Borkar, S. D., Bhat, S. and Acharya, R. J. (2017). Therapeutic potential of wild edible vegetables. *Journal of Ayurveda and Integrated Medical Sciences*, 6, 85-97.

[7] Falade, O.S., Otemuyiwa, I.O., Adekunle, A.S., Adewusi, S.A. and Oluwasefunmi, O. (2020). Nutrient composition of watermelon (*Citrullus lanatus* (Thunb.) Matsum & Nakai) and egusi melon (*Citrullus colocynthis* (L.) Schrad.) seeds. *Agriculturae Conspectus Scientificus*, 85, 43–49.

[8] Abeysinghe, D.C., Li, X., Sun, C., Zhang, W., Zhou, C. and Chen, K. (2007). Bioactive compounds and antioxidant capacities in different edible tissues of citrus fruits of four species. *Food Chemistry*, 104, 1338-1344.

[9] Liu, M., Li, X.Q., Weber, C., Lee, C.Y., Brown, J. and Liu, R.H. (2002). Antioxidant and antiproliferative activities of raspberries. *Journal of Agricultural and Food Chemistry*, 50 (10), 2926-2930.

[10] Benzie, I.F. and Strain, J.J. (1996). The ferric reducing ability of plasma (FRAP) as a measure of “antioxidant power”: the FRAP assay. *Analytical Biochemistry*, 239 (1), 70-76.

[11] Association of Official Analytical Chemists (1990). Official Methods of Analysis 12th Ed. AOAC Washington D.C.

[12] Hue, S.M., Boyce, A.N. and Somasundaram, C. (2012). Antioxidant activity, Phenolic and flavonoid contents in the leaves of different varieties of sweet potato *(Ipomoea batatas). Australian Journal of Crop Science*, 6, 375 – 380.

[13] Rusak, G., Komes, D., Likic, S., Horzic, D. and Kovac, M. (2008). Phenolic content and antioxidative capacity of green and white tea extracts depending on extraction conditions and the solvent used. *Food Chemistry*, 110, 852-858.

[14] *Gade, S.R., Meghwal, M., Prabhakar, P.K. and Giuffre, A.M.A. (2022). Comparative Study on the Nutritional, Antioxidant, Thermal, Morphological and Diffraction Properties of Selected Cucurbit Seeds. Agronomy*, 12 (10), 2242-2262.

[15] Tomas, F.A. and Espin, J.C. (2001). Phenolic Compounds and related enzymes as determinants of quality in fruits and vegetables. *Journal of the Science of Food and Agriculture*, 81, 853-876.

[16] Pinelo, M., Rubilar, M., Jerez, M., Sineiro, J. and Núñez, M.J. (2005). Effect of Solvent, Temperature, and Solvent-to-Solid Ratio on the Total Phenolic Content and Antiradical Activity of Extracts from Different Components of Grape Pomace. *Journal of Agricultural and Food Chemistry*, 53 (6), 2111-2117.

[17] Nasiru, A. and Oluwasegun, A. (2019). Phytochemical, nutritional and amino acid composition of *Citrullus lanatus* (Cucurbitaceae) seeds cultivated in South Nigeria. *Journal of Pharmacognosy and Phytochemistry*, 8, 3738-3740.

[18] Petkova, Z. and Antova, G. (2015). Proximate composition of seeds and seed oils from melon (*Cucumis melo* L.) *cultivated in Bulgaria. Cogent Food and Agriculture*, 1, 1.