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Comparative study on nutrient contents in the different parts of indigenous and hybrid varieties of pumpkin (*Cucurbita maxima* Linn.)

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ABSTRACT

Two varieties (indigenous and hybrid) of pumpkin (*Cucurbita maxima*) are cultivated and widely used as food sources in Bangladesh. The aim of this study is to compare nutrient contents in different parts of two varieties of pumpkin. The nutritional compositions were analyzed by standard methods. Fatty acids and amino acids were analyzed by GC/MS and amino acid analyzer. The proximate compositions analysis data indicate that a higher amount of moisture ($p < 0.001$) and fat ($p < 0.01$) were observed in the seed of indigenous but the seed of hybrid were rich in crude fiber ($p < 0.01$) and carbohydrate ($p < 0.001$). On the contrary carbohydrate content was predominant in the flesh ($p < 0.05$) and peel ($p < 0.01$) of indigenous. The energy content was high in the peel, seed and flesh of indigenous ($p < 0.001$, 0.001 and 0.05 respectively). A significant amount of reducing sugar was found in the peel, flesh ($p < 0.05$) and seed ($p < 0.001$) of hybrid. Vitamin C content was high in peel ($p < 0.001$) and seed ($p < 0.01$) of indigenous and only in the flesh ($p < 0.001$) of the hybrid. A remarkable amount of Na, K, Fe and Zn were present in peel ($p < 0.001$) of hybrid. The notable amount of P and Cu ($p < 0.01$) were present in the seed and K, Fe and Ca ($p < 0.001$) were in the flesh of indigenous. The seed of hybrid was enriched with saturated fatty acid (capric acid, $p < 0.001$; myristic acid, $p < 0.01$ and stearic acid, $p < 0.05$), whereas unsaturated fatty acids (oleic, linoleic and linolenic acid, $p < 0.05$) were rich in the seed of indigenous. A significant amount of threonine, serine, methionine, isoleucine and tyrosine were present in the seed of indigenous ($p < 0.01$) but only alanine in the seed of hybrid ($p < 0.01$). These results suggested that a considerable amount of nutrients were present in all three parts of the two varieties, thus both varieties could be the potential source of nutraceuticals.

1. Introduction

Pumpkin (*Cucurbita* spp.) is not only the most popular consumed vegetables in Bangladesh, it is also recognized as a functional food around the world [1, 2, 3]. In Bangladesh, this plant is locally known as "Mistikumra". Pumpkin belongs to the family Cucurbitaceae with different species and cultivated all over the world for multiple purposes ranging from commercial to agricultural intentions comprising with decorative uses [4].

Pumpkin is a good source of carotene, pectin, minerals, vitamins and other substances that are beneficial to health [5]. It is believed that bioactive compounds of pumpkin have a protective role against many diseases, including hypertension, diabetes, and cancer [6, 7, 8, 9] and coronary heart diseases [10]. The pulp of the fruit is used to relieve intestinal inflammation or enteritis, dyspepsia and stomach disorder [11, 12, 13]. Pumpkin seeds generally considered agro-industrial waste, are an extraordinarily rich source of bioactive compounds with interesting nutraceutical properties [14]. Due to the presence of interesting natural bioactive compounds, such as carotenoids, tocopherols, and sterols, pumpkin-derived products have a wide spectrum of biological activity, proven by in vivo experiments [15]. Stevenson et al. 2007 [16] summarized fatty acid (FA) composition and reported significant differences among various cultivars of pumpkin seed oil extracted from various pumpkin sources. Pumpkin is an excellent source of vitamin A, needs for proper growth, healthy eyes and protection from diseases. It is also rich in vitamin C, vitamin E, lycopene and dietary fiber [17, 18]. The

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anti-oxidant activity might be important for pre-diabetes, diabetes, and patients with vascular injury, in addition to fat-soluble antioxidants (tocopherols and carotenoids), Vitamin C is a strong water-soluble antioxidant that protects cellular components from free radicals by donating electrons, and regenerating other antioxidants, such as vitamin E (tocopherols) [19]. Therefore, in this study, we evaluated the content of vitamin C in the different parts of the two varieties. Pumpkin seed is also a good source of potassium, phosphorus and magnesium; contains it moderately high amounts of Ca, Na, Mn, Fe, Zn and Cu, and these elements make pumpkin seed valuable for food supplementation [20]. Food supplements and nutraceuticals are both considered to be derived from foodstuffs, The term nutraceutical is often used for products available on the market without proper assessment of their beneficial health effects. As pumpkin is a rich source of nutrient and well documented for health benefits it may be considered as nutraceuticals.

In recent decades, there has been formal research by national agricultural research program and international research organizations on cultivation methods of the vegetables to improve their yield [21]. In Bangladesh, two varieties (indigenous and hybrid) of pumpkin (*Cucurbita maxima*) are cultivated and used as food sources. Recently among the two varieties, farmers are interested to cultivate the hybrid variety due to the low cost of cultivation and high production. As a result hybrid variety is available in the market as compared to the indigenous one. Usually, pumpkin is cooked and consumed in many ways and most parts from the fleshy shell. People have different perceptions about the deliciousness and nutritional values of both varieties of pumpkin but the reason behind these perceptions is not well documented.

To the best of our knowledge, pumpkin as a popular vegetable with a rich source of nutrients but the comparative proximate composition of peel, flesh, and the seed of indigenous and hybrid pumpkin are not well recorded. The contents of Na, K, Fe, Ca, Zn, P, Mn, and Vit. C in the locally available indigenous and hybrid varieties of Bangladesh are yet unexplored. But it is well documented that different species and/or varieties of *Cucurbita* spp. grown in different areas of the world have a difference in their phytochemicals [22, 23, 24, 25]. Thus the present study focused on to analyze the nutritional and biochemical composition of locally available pumpkin (*C. maxima* Linn) indigenous and hybrid varieties of Bangladesh.

2. Materials and methods

2.1. Collection and processing

Two fresh indigenous and hybrid varieties of Pumpkin (*Cucurbita maxima*) were collected from the local market of Jashore town, Bangladesh. Both varieties of pumpkin were taken to separate the peel, flesh, and seed. The peel, flesh and the seed of the two varieties were separately chopped and make into small pieces. After then, the peel, flesh, and seed were shade dried for five consecutive days and crushed into a fine powder. The powdered material was dried at 60 °C for 3 h by the electric oven. All chemicals used were analytical grade and the results were depicted as the mean value of the three replicates on a dry weight basis.

2.2. Proximate analysis

The proximate analysis was done to obtain values for the moisture content, ash content, crude protein, crude fat, energy and carbohydrate content in the peel, flesh, and seed of the two varieties of indigenous and hybrid pumpkin (AOAC, 2005) [26] were used to determine the chemical composition of the pumpkin seeds including the contents of moisture, ash, total lipid, total protein, total sugar, and crude fiber. The moisture content was determined by drying the seeds in an oven at 105 ± 1 °C to a constant weight and the ash content by burning at 900 °C till constant mass (AOAC, 923.03). Total lipids were determined by continuous extraction in a Soxhlet apparatus for 12 h using hexane as solvent. After evaporation of the solvent, the oil content was determined gravimetrically. Ash was determined by incinerating the sample at 550 °C in a muffle furnace. Total protein was calculated from the nitrogen content measured by the Kjeldahl method (AOAC. 978.04) using a factor 6.25, and calculated as N x 6.25. The content of crude fiber was determined according to the gravimetric procedure of AOAC (920.860). Total carbohydrate was obtained by subtracting (crude protein + crude fat + ash + crude fiber) from 100. The moisture content was expressed in g/100 g sample and the other values were reported on a dry basis. All the analyses were performed in triplicate.

2.3. Mineral analysis

Na content was determined by a flame photometer (Corning, model 403, UK) [27]. Ca, Mg, P, K, Fe, Zn, and Cu were determined using atomic absorption spectrophotometer (Perkin-Elmer model 403, USA) [28].

2.4. Estimation of vitamin C

Vitamin C content in the different parts of the two varieties of pumpkin is usually determined by the official method of vitamin C estimation, AOAC (2005) [26].

2.5. Estimation of total sugar

The total sugars content was determined by the phenol-sulfuric acid method [29]. Hereby, 0.6 g of each of the pumpkin powder (peel, flesh, and seed) was mixed with 0.6 ml of 5% phenol solution and 1.0 ml of concentrated sulfuric acid. The mixture was left to stand for 30 min and then the absorbance was read at 490 nm, using a UV spectrophotometer (Beijing Instrument Co. Ltd., China). Distilled water was used as a blank and glucose as standard for calibration.

2.6. Reducing sugars

The reducing sugar content was determined following the Nelson-Somogyi method with minor modifications [30].

2.7. Fatty acids composition

2.7.1. Analysis of fatty acid composition

2.7.1.1. Sample preparation for fatty acid composition by gas chromatography

2.7.1.1.1. Preparation of fatty acid methyl ester (FAME). Relative concentrations of fatty acid (FA) derived from the oil samples were measured as their corresponding methyl esters according to the method described in IUPAC with only minor modifications. 5 to 7 drops of oil were added into a 15 ml test tube and 3ml of 0.5 M sodium methoxide (prepared by mixing metallic sodium in methanol) was added and digested by stirring in a boiling water bath for approximately 15 min. It was allowed to cool to room temperature and 1ml of petroleum ether (b.p 40–60 °C) was added followed by 10 ml deionized water, mixed gently and allowed to settle for some time. The distinct upper layer of methyl ester in the petroleum ether was separated carefully in a capped vial and used for analysis. 200mg of different fatty acid standard (FAME mix; Sigma-Aldrich, St. Louis, Missouri, USA) in their respective methyl ester form were dissolved separately in 10ml petroleum ether (b.p 40–60 °C) in a series of screw-capped test tubes. Aliquots of 1μl FAME (Fatty Acid Methyl Ester) were injected and the peaks of fatty acids were recorded for their respective retention times and presented as relative percentages. This was done utilizing the automated GC software (V6.14 SP1).

2.7.1.1.2. Gas chromatography analysis. The fatty acid compositions were analyzed with Shimadzu GC-14B series gas chromatograph equipped with a flame ionization detector and fused silica capillary column

(FAMEWAX, Crossbond® polyethylene glycol, 15 m × 0.25 mm×0.25μm film thickness, Restek; Pennsylvania, USA). Splitless injection technique with nitrogen as carrier gas at a constant flow rate of 20 ml/min was used. The injector temperature was 250 °C, the initial oven temperature was 150 °C and maintained for 5 min. The temperature was increased at 8 °C/min to 190 °C and then increased to 200 °C at a rate of 2 °C/min and held for 10 min. The fatty acids were identified by using respective fatty acid methyl ester standards (FAME mix; Sigma-Aldrich, St. Louis, Missouri, USA).

2.8. Amino acid composition

Total amino acid composition of the two varieties of seed (weight equivalent to 4% protein) was assayed by first hydrolyzing a sample with 6.0 N HCl in a sealed glass tube at 110 °C for 24 h [12]. After hydrolysis, the sample was filtered and adjusted to 50 ml with distilled water. A 1.0 ml of diluted sample was filtered with a 0.2 l m membrane and analyzed using an amino acid analyzer (S433D; Sykam Co. Ltd, Eresing, Germany).

2.9. Statistical analysis

Data from triplicate analysis for the same sample were subjected to one way ANOVA. Means were separated at the significance level of $p < 0.05$. The statistical analysis was performed using OriginPro 8.0 (Origin Lab Corporation, MA, USA).

3. Results and discussion

The proximate composition of the different parts of the two varieties of pumpkin is shown in Table 1. No significant differences of moisture, ash, fat and crude fiber were observed in the peel and flesh of the two varieties of pumpkin but the moisture, fat, and energy content were significant in the seed of indigenous one ($p < 0.001$, 0.01 and 0.05 respectively). The significant amount of total protein and carbohydrate were present in the peel of indigenous variety ($p < 0.05$ and 0.01) but, interestingly, the seed of hybrid variety were enriched with carbohydrate ($p < 0.001$) and crude fiber ($p < 0.01$). It has been reported that the crude fiber content in the seeds of *C. pepo* has significantly lower that of other spices of pumpkin [31]. Data relative to moisture, ash and protein are in good agreement with those reported by Kim et al. 2012 [19] for Korean pumpkin (*C. maxima*) flesh. Generally, the proximate composition is extremely variable [32, 33], due to the differences among the species and/or varieties of *Cucurbita* spp. grown in different areas of the world. A remarkable amount of fat was observed in the seed of indigenous variety ($p < 0.01$). The protein content in the peel of indigenous variety was significant ($p < 0.05$) as compared to hybrid variety but it was not significant in the flesh and seed part. Similar results have been reported that the protein content in the buffalo gourd (*Cucurbita foetidissima*) and naked seed squash (*Cucurbita pepo* L.) have different [34]. The result obtained in this study indicated that proximate composition varies between indigenous and hybrid varieties. Table 2 represents the total sugar, reducing sugar and vitamin C contents in the different parts of the two varieties of pumpkin. No significant amount of total sugar present in the flesh and seed of the indigenous variety as compared to hybrid one but it is interesting that total sugar content in the peel of the hybrid pumpkin was significant ($p < 0.05$). A significant amount of reducing sugar present in the peel and flesh of the hybrid variety as compared to the indigenous one ($p < 0.05$) but it was predominant in the seed of hybrid one ($p < 0.001$). Similar results have been observed by Young Kim et al. 2012 [19] in the flesh parts of *C. maxima* cultivated in Korea. From Table 2, it is observed that an amusing amount of vitamin C content in the flesh part of the hybrid variety ($p < 0.001$) but it is interesting that the higher amount of vitamin C was observed in the peel and seed of the indigenous variety ($p < 0.001$ and 0.01). Although both the hybrid and indigenous varieties were cultivated in the same environment, the vitamin C content was less in the peel of hybrid as compared to the indigenous one. It may be due to the thickness of the peel and the genetic influence of the hybrid variety. It has been reported that several factors attributed to environmental conditions, the storage period of the oil and genetic influence may cause variation in alpha-tocopherol content [35, 36]. Although the peels are usually discarded in Bangladesh, this study observed that peel of the pumpkin (especially indigenous) is rich in vitamin C.

The mineral content (main and trace elements) in the peel, flesh and seed part of the indigenous and hybrid varieties of pumpkin are summarized in Table 3. The high level of Na, K, Fe, and Zn were found in the peel ($p < 0.001$) of the hybrid but, interestingly, the amount of K, Fe and Ca were significant in the flesh ($p < 0.001$) of indigenous but Na content was higher in the flesh ($p < 0.01$) of hybrid. The remarkable amount of P, Zn, and Cu were present in the seed of indigenous variety ($p < 0.01$, 0.05 and 0.01 respectively). On the contrary, K content was higher in hybrid ($p < 0.001$) and the level is higher than those reported by Karanja et al. 2013 [37] in the seed of *Cucurbita* spp. No significant changes of Mn and Mg contents observed in the peel, flesh, and seed of the two varieties of pumpkin.

The fatty acids content in the indigenous and hybrid varieties were represented in Table 4. The fatty acid analysis results showed that the saturated fatty acid, capric acid, myristic acid, and stearic acid were higher in hybrid ($p < 0.001$, 0.01 and 0.05 respectively). But,

Table 1
Proximate composition in the different parts of indigenous and hybrid varieties of pumpkin.

Factors		Indigenous variety	Hybrid variety
Moisture (mg/100g)	Peel	89.527 ± 0.72	88.470 ± 0.68
	Flesh	92.453 ± 0.71	91.587 ± 0.67
	Seed	56.740 ± 0.70***	41.630 ± 0.38
Ash(mg/100g)	Peel	7.317 ± .37	5.513 ± 0.77
	Flesh	5.527 ± 0.75	3.560 ± 0.51
	Seed	3.537 ± 0.68	3.787 ± 0.60
Fat(mg/100g)	Peel	1.650 ± 0.39	2.660 ± 0.55
	Flesh	1.403 ± 0.49	1.873 ± 0.52
	Seed	23.447 ± 0.72**	17.893 ± 0.55
Protein (mg/100g)	Peel	14.670 ± 0.61*	11.613 ± 0.69
	Flesh	10.447 ± 0.39	10.623 ± 0.50
	Seed	21.313 ± 0.50	20.677 ± 0.61
Carbohydrate (mg/100g)	Peel	12.407 ± 0.45**	6.720 ± 0.60
	Flesh	8.507 ± 0.68*	5.537 ± 0.69
	Seed	5.183 ± 0.67	14.540 ± 0.48***
Fiber (mg/100g)	Peel	13.383 ± .64	12.280 ± 0.70
	Flesh	1.553 ± 0.84	3.447 ± 0.82
	Seed	46.647 ± 0.84	52.377 ± 0.61**
Energy (kcal/100g)	Peel	124.47 ± 0.59***	92.065 ± 0.56
	Flesh	79.563 ± 0.70**	75.587 ± 0.78
	Seed	311.54 ± 0.56***	227.64 ± 0.75

Values are represented as mean ± SE (n = 3). *$p < 0.05$; **$p < 0.01$ and ***$p < 0.001$ are considered as significant.

Table 2
Sugar and Vitamin C contents (mg/100g) in the different parts of indigenous and hybrid varieties of pumpkin.

Factors		Indigenous variety	Hybrid variety
Total Sugar	Peel	7.633 ± 0.52	10.761 ± 0.72*
	Flesh	10.494 ± 0.57	9.388 ± 0.75
	Seed	9.733 ± 0.54	8.057 ± 0.61
Reducing sugar	Peel	6.663 ± 0.47	8.588 ± 0.46*
	Flesh	3.793 ± 0.54	6.175 ± 0.69*
	Seed	22.595 ± 0.41	36.541 ± 0.42***
Vitamin C	Peel	10.000 ± 0.58***	2.500 ± 0.58
	Flesh	12.500 ± 0.58	39.500 ± 0.58***
	Seed	15.000 ± 0.58**	10.750 ± 0.29

Values are expressed as mean ± SE (n = 3). *$p < 0.05$; **$p < 0.01$ and ***$p < 0.001$ are considered as significant.

Table 3
Main and trace elements contents (mg/100g) in the different parts of the indigenous and hybrid varieties of pumpkin.

Factors		Indigenous variety	Hybrid variety
Na	Peel	9.652 ± 0.55	60.570 ± 0.52***
	Flesh	20.759 ± 0.51	24.770 ± 0.53**
	Seed	1.350 ± 0.31	0.980 ± 0.01
K	Peel	687.467 ± 0.62	1232.674 ± 0.60***
	Flesh	1616.394 ± 0.57***	1517.573 ± 0.74
	Seed	434.714 ± 0.57	557.645 ± 0.44***
Fe	Peel	4.004 ± 0.58	15.749 ± 0.52***
	Flesh	42.070 ± 0.59***	4.787 ± 0.55
	Seed	6.017 ± 0.58	5.507 ± 0.57
Ca	Peel	1.360 ± 0.35	0.960 ± 0.01
	Flesh	0.820 ± 0.01***	0.740 ± 0.01
	Seed	4.000 ± 0.58	3.757 ± 0.54
Zn	Peel	0.150 ± 0.01	18.777 ± 0.50***
	Flesh	0.230 ± 0.01	0.210 ± 0.01
	Seed	18.777 ± 0.50*	16.433 ± 0.56
P	Peel	1.419 ± 0.35	0.740 ± 0.01
	Flesh	1.363 ± 0.32	0.980 ± 0.01
	Seed	0.740 ± 0.01**	0.680 ± 0.01
Cu	Peel	0.025 ± 0.00	0.023 ± 0.00
	Flesh	0.060 ± 0.01	0.056 ± 0.00
	Seed	0.310 ± 0.01**	0.260 ± 0.01
Mn	Peel	0.360 ± 0.01	0.380 ± 0.01
	Flesh	0.450 ± 0.01	0.430 ± 0.01
	Seed	1.350 ± 0.33	0.980 ± 0.01
Mg	Peel	3.353 ± 0.33	3.607 ± 0.69
	Flesh	5.643 ± 0.58	4.770 ± 0.54
	Seed	4.340 ± 0.51	3.693 ± 0.60

Values are stated as mean ± SE (n = 3). *p < 0.05; **p < 0.01 and ***p < 0.001 are considered as significant.

Table 4
Fatty acid concentration (mg/100g) in indigenous and hybrid varieties of pumpkin seed oil.

Fatty acid	Indigenous pumpkin seed oil	Hybrid pumpkin seed oil
Saturated		
Capricacid (C10:0)	0.453 ± 0.01	0.631 ± 0.01***
Lauric acid (C12:0)	1.336 ± 0.33	2.279 ± 0.38
Myristic acid (C14:0)	0.009 ± 0.00	0.178 ± 0.01**
Palmitic acid (C16:0)	20.784 ± 0.50	22.840 ± 0.50
Stearic acid (C18:0)	4.519 ± 0.50	6.600 ± 0.54*
Unsaturated		
Oleic acid (C18:1)	25.417 ± 0.51*	23.823 ± 0.67
Linoleic acid (C18:2)	49.416 ± 0. .68*	46.511 ± 0.52
Linolenic acid (C18:3)	2.248 ± 0.49*	0.359 ± 0.06

Values are indicated as mean ± SE (n = 3). *p < 0.05; **p < 0.01 and ***p < 0.001 are considered as significant.

interestingly, the unsaturated fatty acid, oleic, linoleic and linolenic acids were higher in indigenous ($p < 0.05$). In the current study, we focused on the analysis of fatty acid composition only in the seed because the fat contents in the peel and flesh parts are not noticeable. The fatty acid analysis results showed that the saturated fatty acids (lauric acid, palmitic acid and stearic acid) and monounsaturated fatty acid, oleic acid and polyunsaturated fatty acid, linoleic acid are predominant in both varieties of seed oils but stearic acid contents in indigenous and hybrid were 4.519% and 6.600% respectively, which was significant in hybrid ($p < 0.05$). On the other hand, monounsaturated fatty acid, oleic acid in indigenous and hybrid were 25.417% and 23.823% respectively. Similarly, polyunsaturated fatty acid linoleic acid in indigenous and hybrid were 49.416% and 46.511% respectively. Both the oleic acid and linoleic acid contents were significant ($p < 0.05$) in indigenous as compared to the hybrid. Several previous studies reported that palmitic, stearic, and linoleic acid is the major fatty acids in pumpkin seeds [38, 39]. It is reported that linoleic acid concentration in *C. moschala* seeds is higher than *C. pepo* [40, 41]. It is also reported that monounsaturated fatty acids and

Table 5
Amino acid concentration (g/100g) in indigenous and hybrid varieties of pumpkin seed oil.

Amino acid	Indigenous pumpkin seed oil	Hybrid pumpkin seed oil
Aspartic acid	2.050 ± .58	1.920 ± 0.52
Threonine	0.830 ± 0.01**	0.790 ± 0.01
Serine	0.640 ± 0.01**	0.600 ± 0.01
Glutamic acid	3.733 ± 0.63	3.597 ± 0.57
Glycine	1.636 ± 0.50	1.408 ± 0.32
Alanine	0.740 ± 0.01	0.790 ± 0.01**
Valine	1.363 ± 0.33	0.980 ± 0.01
Methionine	0.670 ± 0.01**	0.630 ± 0.01
Isolucine	0.810 ± 0.01**	0.770 ± 0.01
Leucine	2.297 ± 0.51	2.317 ± 0.35
Tyrosine	0.830 ± 0.01**	0.790 ± 0.01
Histidine	1.399 ± 0.32	1.378 ± 0.32
Lysine	3.493 ± 0.56	2.913 ± 0.56
Arginine	1.698 ± 0.43	1.723 ± 0.48

Values are designated as mean ± SE (n = 3). *p < 0.05; **p < 0.01 and ***p < 0.001 are considered as significant.

polyunsaturated fatty acids are the most abundant (41.7% and 37.2%, respectively) in Berrettina pumpkin seed oil with a high content of oleic and linoleic acid (41.4% and 37.0%, respectively) [42]. Orsavova et al. 2015 [43] reported that monounsaturated fatty acid (MUFA) may reduce low-density lipoprotein (LDL) cholesterol, while it may increase HDL cholesterol, and that oleic acid may promote insulin resistance contrary to polyunsaturated fatty acid (PUFA), with protection against insulin resistance. The high content of linoleic acid is an important nutritional aspect, because it is an essential fatty acid (EFA), together with linolenic acid, and a lack of either of the two leads to ill health and causes deficiency symptoms. Also, several studies [44] have positively correlated EFA intake with the reduction of numerous disorders (cardiovascular, neurological, visual, and cancerous).

Amino acid composition analysis of the two varieties of the pumpkin seeds was listed in Table 5. The significant amount of threonine, serine, methionine, isoleucine, and tyrosine were observed in the seed ($p < 0.01$) of indigenous while only alanine was present abundantly in the seed ($p < 0.01$) of hybrid one. No significant changes of aspartic acid, glutamic acid, glycine, valine, leucine, histidine, lysine, and asparagine were found in both the indigenous and hybrid variety of seeds. The level of essential amino acids methionine, threonine and isoleucine were higher in the indigenous variety as compared to the hybrid. A similar result has been reported by Marioed et al. 2010 [45] in the Sudanese *Annonasquamosa*.

4. Conclusion

The results reported in this study confirmed that different parts (peel, flesh and seed) of pumpkin are rich sources of protein, vitamin C, reducing sugar, minerals, fatty acids and some essential amino acids. Seed oils are interesting vegetable oils with important nutritional value, related to the presence of monounsaturated fatty acid (MUFA) and polyunsaturated fatty acid (PUFA). Information obtained from this research could help to assess the potential of peel and seed from this pumpkin cultivar to be commercially exploited for the nutraceutical application, and incorporated into food formulations for the benefit of human health. In this study, it was found that the peel and seed parts of both varieties also contain a low percentage of free water with a high level of energy and nutrition. This study revealed that all parts (Peel, flesh and seed) of both varieties were rich in various micronutrients. As several nutrients are discarded through away the peel and seed of the pumpkin. Thus this comparative nutritional analysis suggested that along with the used part, the unused parts (Peel and Seed) of both varieties also may be an important source of nutraceuticals.

Declarations

Author contribution statement

Ziaul Amin, M. Jashim Uddin: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Tahera Islam, M. Rassel Uddin: Performed the experiments M. Mashiar Rahman: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

M. Abdus Satter: Performed the experiments; Contributed reagents, materials, analysis tools or data.

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Competing interest statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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