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Some physico-chemical attributes of pear (*Pyrus communis* L.) cultivars grown in Pakistan

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Abstract

Four pear (*Pyrus communis* L.) cultivars grown in District Hunza-Nagar, Gilgit-Baltistan, locally called Shughri, Batung, Puno-Batung and Phycho were analyzed for their physio-chemical and functional attributes. Physico-chemical characteristics of the tested genotypes revealed variable amounts of moisture (80.17-86.67%), crude fiber (5.10-10.00%), ash (1.56-1.83%), total soluble solids (11.03-14.42°Brix), total sugars (10.19-11.12%), pH (4.12-5.24) and titratable acidity (0.12-0.26% in terms of malic acid) respectively. Similarly, ascorbic acid was established in the range of 2.80-4.30 mg/100g, total phenolic content 29.13-38.87 mg GAE/100g and antioxidant activity from 29.36-46.73% among the investigated genotypes. Some mineral estimation (mg/100g) was also carried out which showed reasonable concentrations of K (163.27-833.85), Mg (38.57-86.74), Ca (23.26-48.39), P (5.20-13.70), Na (0.95-4.19) and Fe (0.40-2.86) in the tested cultivars. Physical and geometric dimensions such as fruit length ranged from 40.10 to 87.50 mm, width 36.22 to 68.85 mm, thickness 37.36 to 73.80 mm, geometric mean diameter 37.71 to 74.69 mm, volume 22.33 to 227.4 cm^3, surface area 4468 to 17527 mm^2, sphericity 84.20 to 89.90 % and fruit weight ranged from 35.11 to 231.96 g. The findings of this study showed that Shughri and Phycho grown in both locations were rich in functional components and mineral contents, while, Batung and Puno-Batung were prominent in physical and geometric traits.

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Introduction

The pear fruit *(Pyrus communis* L.*)* belongs to the family Rosaceae, subfamily *Maloideae* or *Spiraeoideae* and genus *Pyrus* L. It is a typical fruit cultivated in temperate zones throughout the world. Due to its low caloric value, good taste and high nutritive value, the pear fruit is much appreciated among the consumers (Senser *et al.*, 1999). Currently, the cultivation of pear is continuously increasing throughout the world especially in Asia (Fischer and Weber, 2005). Pear is also one of the popular pome fruit of Pakistan. The total production is 24152 tons per year (Anon. 2008). Annual production of pear in Gilgit-Baltistan is 2579 tons which is mostly produced in high altitude areas such as Hunza-Nagar district, Bagrote, Haramosh valleys of Gilgit and different valleys of Baltistan region (DOA, 2009). Pear fruit is rich in both macronutrients and micronutrients (Senser *et al.*, 1999). It is an excellent source of dietary fiber and also a good source of vitamin C (Silos *et al.*, 2003). It contains a higher percentage of dietary fiber as compared to other fruits and vegetables. The fiber content of this fruit can be seen as a potential food additive (McKee and Latner, 2000). A medium sized fresh pear weighing 100g contains 15.46g carbohydrates, 9.80g sugars, 0.38g protein, 0.12 g fat, 83.71g water, 119.00 mg potassium, 4.20mg vitamin C, 11.00mg magnesium, 7.00mg iron and 0.10mg zinc (USDA, 2011). Pear fruit also contains health promoting bioactive compounds such as carotenoids (anthocyanins, flavanols, quercetin, kaempferol, isorhamnetin) and plant sterols (Andreotti *et al.*, 2006). The fruit also contains a wide range of phenolic compounds comprising different flavonoid classes (chlorogenic, syringic, ferulic and coumaric acids, arbutin and (-)-epicatechin, hydroxyphenolic acids and the p-hydroquinone-glucoside arbutin) (Schieber *et al.*, 2001; Petkou *et al.*, 2002; Salta *et al.*, 2010). The antioxidant activity of pears depends on the cultivar (Alonso *et al.*, 2004), orchard, harvest date, storage period and storage environment (Morais *et al.*, 2001; Larrigaudiere *et al.*, 2001, 2003; Franck *et al.*, 2003). The interest in pear fruit in the world is increasing due to its numerous health benefits and rich nutritional profile. The pear fruit from this part of the world has not been investigated for their compositional information. Therefore, the data generated would be of great value for postharvest technology and also for consumer awareness. Determining physico-chemical properties of fruit will be important for the designing of equipments for harvesting, transporting, sorting, cleaning and packaging etc (Ozturk *et al.*, 2009). It further helps to determine the maturity or harvesting time and evaluation of product quality. No previous data is available on the compositional potential of pear fruit grown in this region. Therefore, this study was aimed to determine the physico-chemical attributes and some functional characteristics of commonly grown pear cultivars to produce firsthand information for researchers, producers, marketing entrepreneurs and the consumers.

Materials and methods

Materials

Four pear cultivars (Shughri, Batung, Puno-Batung and Phycho) grown in the Hunza and Nagar valleys were used for this study. The fruits were harvested at their commercial maturity during October 2011 and were transported to the Department of Food Technology, PMAS-Arid Agriculture University, Rawalpindi in polyethylene bags to reduce water loss during transportation. The fruits were cleaned, graded and packaged in polyethylene bags, kept under refrigeration temperatures and analyzed immediately for their compositional attributes.

Proximate composition, chemical and functional properties

Moisture, crude fiber and total sugars were determined by the standard procedures of AOAC (2000). Total soluble solid content (^{o}Brix) was determined in the pulp of each sample using a digital refractometer PL-3 (ATAGO, Japan) at 29±1^{o}C and temperature correction was made accordingly. The pH values were measured by using a pH-meter (Inolab. WTW Series, Germany) while titratable

acidity was estimated by titrating a 5 ml of fruit juice with 0.1 N NaOH and results were expressed as percentage of malic acid. Ascorbic acid was determined using 2, 6-dichlorophenolindophenol titration method (AOAC, 2000).

Measurement of total phenolics

The total phenolic content of the fruit samples was measured by using the Foilin-Ciocalteau's assay as described by Sponas and Wrolstad (1990). Five grams of the sample were extracted with 25 ml methanol by shaking for one hour. To 100 µL of the sample extract (dilute 1:5 (v/v) with methanol) 6 ml of double distilled water and 500 µL of Folin-Ciocalteau reagent was added. After 5 minutes at room temperature, 1.5 ml of sodium carbonate (20% w/v) was added. The extract was mixed and left for 30 minutes at 40 °C before measuring the absorbance at 765 nm. A mixture of water and reagent was used as blank. The total phenolic content will be expressed as gallic acid equivalents (GAE) in mg per kg of edible fruit.

Measurement of antioxidant activity

The antioxidant activity of the fruit samples was determined by using a modified method of Brand-William *et al.* (1995) which involved the use of free radical 1.1-diphenyl-2-picrylhydrazy (DPPH). Five grams of ground frozen tissue were taken in triplicate, homogenized and extracted with 10 ml methanol for 2 hours. From the above extracted 0.1 ml was taken in the test tube and 3.9 ml of DPPH solution (6×10^{-5} mol/L) was added and incubated at room temperature for 30 minutes. After incubation absorbance was measured at 517 nm. The DPPH solution was freshly prepared daily, stored in a flask covered with aluminum foil and kept in the dark at 4°C between measurements. A blank sample was prepared containing the same amount of methanol and DPPH solution and measured daily. Radical scavenging activity was calculated as % of inhibition of DPPH radical by the following formula:

DPPH scavenging activity (%) = [(Abs Control - Abs Sample)/Abs Control] × 100.

Analysis of the mineral contents

Mineral contents of pear cultivars were determined according to AOAC (2000). One gram sample was ashed in a muffle furnace at a temperature of 550±10 °C for 5 to 6 hours. The obtained ash was then digested with 5 ml 6M HCl on a water bath. After drying 7 ml 0.1M HNO_3 was added and the contents were diluted to 100 ml with double deionized water. Atomic Absorption Spectrophotometer (GBC-932 Australia) was used to determine the Mg, Fe and Ca whereas Na and K by Flame Photometer (Model PFP 7 Jenway, England) and Phosphorus by using a Spectrophotometer (CE-2021, 2000 series CECIL Instruments Cambridge, England).

Determination of physical and geometric traits

The physical parameters (fruit weight and pulp weight) of pear cultivars were determined by a digital electronic balance (Inolab. WTW Series, Germany), with a 0.001 g sensitivity, using 12 randomly selected fruits from each cultivar. Geometric dimensions i.e. length (L), width (W), thickness (T) of fruits was measured by a digital caliper (0-150mm, China) with an accuracy of 0.01 mm. Volume (V) of pear samples was determined by the liquid displacement method, while surface area (S) was determined according to Baryeh (2001) by the following formula:

$S = \pi D_g^2$

Where, D_g is the geometric mean diameter of the fruit.

The geometric mean diameter (D_g) was calculated by using the following equation:

$D_g = (LWT)^{0.333}$

Where *L* is length, *W* is width and *T* is the thickness of the fruit as described by Mohsenin (1970).

Sphericity of the fruit was determined by the following formula (Ahmadi *et al.*, 2008):

$\Phi = (D_g/L) \times 100$.

Statistical analysis

The data obtained was analyzed by using analysis of variance (ANOVA) technique and the comparison of means were done by using Statistix 8.1 software as interpreted by following Steel *et al.* (1997).

Results

Approximate composition of pear

The proximate composition of the pear fruit cultivars is presented in Table 1. The moisture content ranged from 80.17 to 86.67% among the tested genotypes. Highest moisture contents were recorded in Batung cultivated in Hunza (86.67%), which was followed by Puno-Batung produced in Hunza, Batung (Nagar), Puno-Batung (Nagar), Shughri (Hunza), Shughri (Nagar) and Phycho (Nagar), while the lowest in Phycho (Hunza) (80.17%). All the values differed significantly at $p < 0.05$ from each other except Batung and Puno-Batung cultivated in Nagar. TSS contents (°Brix) were found moderately significant among the cultivars and ranged from 11.03 to 14.42 °Brix, whereas the values did not statistically vary for Puno-Batung of both locations (Hunza and Nagar). The highest TSS was recorded in Puno-Batung (Hunza) which was 14.42 followed by Puno-Batung (Nagar), Batung (Nagar), Phycho (Nagar), Shughri (Hunza), Phycho (Hunza), Shughri (Nagar) and the lowest in Batung (Hunza) respectively. Among the compositional attributes, moisture content of fruit is important in determining the keeping quality and an important sign of freshness of any food commodity. In the current study the moisture content was recorded from 80.17 to 86.67% in the evaluated fruit cultivars. Earlier studies by Ozturk *et al.* (2009) and Mahammad *et al.* (2010) on moisture content in pear fruit closely relate to our findings. Chemical properties of fruits such as total soluble solids may provide proximal information to the consumers in terms of recognizing a more nutritious fruit (Drogoudi *et al.* 2008). Our results are well supported by the findings of Janick (2006), Faisal and Ahmed (2007), Sanchez *et al.* (2003) and Chen *et al.* (2007) who reported the TSS content of pear cultivars from 6 to 18 °Brix at different maturity stages. Significant differences for TSS have also been reported in quince (*Cydonia oblonga*) clones (Guisado *et al.* 2009) and higher TSS was observed in the mango fruit harvested during the noon as compared to morning or evening times (Amin *et al.* 2009).

Table 1. Proximate composition of pear cultivars grown in Pakistan.

Variety	Location	Parameters					
		Moisture content	Crude Fiber	Ash	Reducing sugars	Non-reducing sugars	Total sugars
		----------(%)----------					
Shughri	Nagar	84.13±0.01e	10.00±0.10a	1.71±0.01c	5.17±0.01c	5.05±0.01d	10.22±0.02e
	Hunza	85.10±0.02d	9.23±0.11b	1.67±0.01cd	5.31±0.01b	5.51±0.02b	10.82±0.03c
Batung	Nagar	85.30±0.02c	7.53±0.15d	1.61±0.01ef	5.32±0.02b	5.48±0.04b	10.80 ±0.04c
	Hunza	86.67±0.02a	6.13±0.15e	1.56±0.01f	5.14±0.01c	5.05±0.03d	10.19±0.05e
Puno Batung	Nagar	85.23±0.04c	5.66±0.15f	1.63±0.01de	5.37±0.01a	5.65±0.05a	11.03±0.05b
	Hunza	85.38±0.02b	6.30±0.10e	1.60±0.01ef	5.41±0.02a	5.72±0.02a	11.12±0.02a
Physhu	Nagar	80.84±0.01f	9.53±0.15b	1.93±0.04a	5.32±0.01b	5.51±0.02b	10.82±0.01c
	Hunza	80.17±0.04g	8.10±0.20c	1.83±0.02b	5.29±0.01b	5.33±0.04c	10.62±0.03d

Note: - Results were expressed on fresh weight basis
- All the values are means of three replications + SD
- Values with same letter (s) within the column are not statistically different at alpha 0.05.

Results pertaining to the ash content of pear samples indicated significant differences ($P<0.05$) except Batung (Nagar) and Puno-Batung (Hunza) which were statistically same. The highest ash content was observed in Phycho grown in Nagar (1.93%) followed by the same cultivar grown in Hunza, Shughri (Nagar), Shughri (Hunza), Puno-Batung (Nagar), Batung (Nagar) and Puno-Batung (Hunza), while the lowest ash content was recorded in Batung grown in Hunza (1.56%). The study also showed varied amounts of crude fiber (5.66 to 10.00%) among the investigated samples with minor similarities. Shugri from Nagar had maximum fiber content (10.00%) followed by Phycho Nagar, Shugri Hunza with no statistical difference ($P<0.05$), Phycho Hunza, Batong Nagar. Similarly, the fiber content in Batung and

Puno-Batung from Hunza had non-significant variations, while the minimum value was recorded for Puno-Batung Nagar. Our results regarding ash content of pear cultivars are well supported by studies of Barroca *et al.* (2006), Nwosoagwu *et al.* (2009) and Ozturk *et al.* (2009) who reported 1.60 to 2.40, 1.67 to 2.85 and 2.02 to 4.00% in different pear cultivars at different maturity stages. Pear fruit and its juices are an excellent source of dietary fiber. Earlier studies indicate that diets rich in dietary fiber may reduce the risk of cardiovascular diseases and certain cancer types (Honda *et al.* 1999). The findings of this study revealed a rich profile of crude fiber in the pear samples of this region, which were in agreement with the studies of Xie *et al.* (2007) on different pear cultivars from China.

Table 2. Some chemical and functional properties of pear cultivars grown in Pakistan.

Variety	Location	Parameters					
		TSS (°Brix)	pH	TA (mg/100g Malic acid)	AA (mg/100g)	TPC (mg GAE/100g)	AoA (%)
Shughri	Nagar	11.73±0.04e	5.05±0.03c	0.17±0.01c	4.03±0.05ab	38.86±0.30a	46.73±0.32a
	Hunza	13.45±0.03cd	5.24±0.01a	0.13±0.01 de	4.30±0.20a	35.70±0.20b	36.86 ±0.40c
Batung	Nagar	13.77±0.07b	4.46±0.01d	0.21±0.01b	3.20±0.17d	29.13±0.30f	27.96±0.35f
	Hunza	11.03±0.25f	4.12±0.01e	0.23±0.01b	2.80±0.10e	30.06±0.15e	32.66±0.45d
Puno Batung	Nagar	14.26±0.08a	5.15±0.02b	0.26±0.01a	3.56±0.15cd	30.23±0.11de	29.36±0.15e
	Hunza	14.42±0.02a	5.18±0.03b	0.28±0.01a	3.80±0.10bc	30.40±0.10de	30.16±0.11e
Physhu	Nagar	13.71±0.02bc	5.13±0.01b	0.15±0.01cd	4.20±0.10a	31.96±0.15c	39.76±0.45b
	Hunza	13.29±0.02d	5.18±0.02b	0.12±0.01e	4.00±0.10ab	30.76±0.21d	36.13±0.20c

Note: - TA=Titratable acidity, AA=Ascorbic acid, TPC=Total phenolic compounds, AoA= Antioxidant activity
- Results were expressed on fresh weight basis
- All the values are means of three replications + SD
- Values with same letter (s) within the column are not statistically different at alpha 0.05.

The results regarding sugars indicated moderate differences ($P<0.05$) in reducing, non-reducing and total sugars among all the tested cultivars of both locations. Maximum total sugar was found in Puno-Batung (Hunza) (11.12%) followed by Puno-Batung (Nagar), Phycho (Nagar), Shughri (Hunza), Batung (Nagar), Phycho (Hunza) and Shughri (Nagar) respectively, while the lowest total sugars was found in Batung (Hunza). The highest reducing sugars (5.40%) were found in Puno-Batung (Hunza) and the lowest (5.14%) was recorded in Batung (Hunza), and for non-reducing sugars, maximum value (5.71%) was found in Puno-Batung (Hunza) and the lowest (5.05%) was recorded in the Shughri (Nagar). Pear fruit contains considerable amounts of sugars that was true in case of our study. The present findings on the amount of sugars were in line with the earlier studies of Brown and Walker (1990) and Chen *et al.* (2007) who studied genotypic variations in fruit quality of apricots and pear varieties. The variable exists on the nutritional contents are related to the variations, geography, agronomic practices and agro-climatic conditions (Ali *et al.* 2011).

Chemical and functional attributes of pear fruit

Chemical and functional attributes of pear samples have been given in Table 2, in which pH values were found in the range of 4.12 to 5.24. Significant differences ($P<0.05$) were recorded in the pH values between the pear cultivars except Puno-Batung (Hunza) and Phycho (Hunza). The variations in titratable acidity in terms of malic acid ranged from 0.12 to 0.28 mg/100 g. Maximum TA was obtained in Puno-Batung (Hunza) followed by the same cultivar grown in Nagar, Batung (Hunza), Batung (Nagar), Shughri (Nagar), Phycho (Nagar) and Shughri (Hunza), while the lowest was observed in Phycho (Hunza). The content of titratable acidity is an important quality parameter and a key determinant of fruit taste. Previously, Chen *et al.* (2007), Sanchez *et al.* (2003) and Arzani *et al.* (2011) studied the titratable acidity in terms of malic acid in pear fruit

and found in the range of 0.10 to 0.46 mg/100 g, which were in close agreement with our findings (0.12 to 0.28 mg/100 g malic acid). Furthermore, studies of Edizer and Gunes (1997), Guleryuz and Ercisli, (1997) and Sanchez *et al.* (2003) on pear fruit revealed the pH values supports the findings of the current study (4.12 to 5.24).

Ascorbic acid content was found in the range of 2.80 to 4.30 mg/100 g in the tested cultivars (Table 2). Maximum ascorbic acid (4.30 mg/100 g) was established in Shughri (Hunza) followed by Phycho (Nagar), Shughri (Nagar), Phycho (Hunza), Puno-Batung (Hunza), Puno-Batung (Nagar) and Batung (Nagar) respectively. Similarly, the low ascorbic acid content (2.80 mg/100 g) was recorded in Batung grown in Hunza. Results from previous studies showed the ascorbic acid content of pear fruit in the range of 1.94 to 11mg/100g (Chen *et al.* 2007; Sanchez *et al.* 2003; Edizer and Gunes 1997; Xie *et al.* 2007) which are in line with the current study showing a range of 2.80 to 4.30 mg/100g. However the ascorbic acid content of fruits can be affected by genotype difference, harvesting methods, preharvest climatic factors and maturity.

Table 3. Mineral contents of Pear cultivars grown in Pakistan.

Variety	Location	Parameters					
		Na	Ca	K	P	Mg	Fe
		---------- (mg/ 100g)----------					
Shughri	Nagar	2.16±0.01c	48.39±0.71a	395.75±1.10c	12.50±0.1b	45.54±1.36e	2.34±0.02b
	Hunza	2.11±0.02c	44.83±0.47b	374.40±1.64d	13.70±0.1a	41.34±0.56f	2.86±0.07a
Batung	Nagar	1.59±0.02d	29.24±0.59e	236.36±2.49e	8.97±0.04d	48.53±1.12d	0.55±0.01e
	Hunza	0.95±0.03f	23.26±0.33g	163.27±1.92g	9.65±0.21c	38.57±0.75g	0.40±0.21f
Puno Batung	Nagar	1.56±0.03de	24.71±0.59fg	200.62±1.99f	6.99±0.09f	62.93±0.27c	1.49±0.02c
	Hunza	1.49±0.02e	25.76±0.27f	190.87±1.77f	6.92±0.11f	62.14±1.05c	1.44±0.02c
Physhu	Nagar	4.19±0.02a	40.71±0.74c	833.85±5.41a	7.81±0.06e	86.74±1.09a	0.61±0.01e
	Hunza	3.98±0.06b	36.85±0.36d	811.57±2.52b	5.20±0.04g	82.36±0.93b	0.78±0.01d

Note: - Na= Sodium, Ca = Calcium, K = Potassium, P = Phosphorus, Mg = Magnesium, Fe = Iron
- Results were expressed on fresh weight basis
- All the values are means of three replications + SD
- Values with same letter (s) within the column are not statistically different at alpha 0.05.

Total phenolics The values of total phenolic compounds have been presented in Table 2, which were found in the range of 29.13 to 38.86 mg GAE/100g. The differences were statistically significant ($p < 0.05$) except for Batung (Nagar) and Puno-Batung grown in both locations. Higher phenolic contents were found in Shughri (38.86 mg GAE/100g) grown in Nagar valley followed by the same cultivar grown in Hunza (35.70 mg GAE/100 g) that were followed by Phycho (Nagar), Phycho (Hunza), Puno-Batung (Hunza), Puno-Batung (Nagar) and Batung (Hunza), while the lowest value (29.13 mg GAE/100g) was recorded in Batung (Nagar).

Pears fruit is reported to contain a comparatively lower amount of phenolic concentration and antioxidant activity than other fruits (Campanella *et al.* 2003; Alonso *et al.* 2004), but have higher antioxidant activity as compared to common vegetables used in the diet. The results of present study (29.13 to 38.86 mg GAE/100g) regarding the phenolic content in pear cultivars were supported by Karadeniz *et al.* (2005) who reported that the phenolic content in different pear cultivars ranged from 32.6 to 47.7 mg GAE/100g. However variation recorded in present results might be attributed to prevailing environmental conditions, harvesting of fruits at different time of maturity/ripening and variability in genotypes (Ali *et al.* 2011).

Antioxidant activity

The antioxidant activity was found in the range of 27.96 to 46.73% among different cultivars (Table 2). Maximum antioxidant activity was recorded in Shughri (Nagar) followed by Phycho (Nagar), Shughri (Hunza), Physho (Hunza), Batung (Hunza), Puno-Batung (Hunza) and Puno-Batung (Nagar), while the lowest was observed in Batung grown in Nagar. The results were found significant (P<0.05) among the cultivars except Batung grown in locations as well as Shughri and Physho cultivated in Hunza, which were statistically same. Fruits rich in antioxidants help in lowering the prevalence of degenerative diseases like cancer, arteriosclerosis, cardiovascular and speeding up the ageing process (Feskanich *et al.* 2000). Our findings revealed lower antioxidant activity among the investigated samples; however the differences were significant for all genotypes except for Puno-Batung from both locations. Shugri was dominating among the cultivars for antioxidant activity, which correlates with the total phenolic contents. It was previously reported that pear cultivars had low antioxidant activity (9.97 to 14.07%) as compared to the other fruits (Ozturk *et al.* 2009).

Table 4. Some physical and geometrical properties of pear cultivars grown in Pakistan.

Variety	Location	Parameters							
		FL (mm)	FW (mm)	FT (mm)	GMD (mm)	FV (cm^3)	SA (mm^2)	Sph. (%)	F Wt. (g)
Shughri	Nagar	79.537±0.11f	61.11±0.13f	67.03±0.06d	68.51±0.04e	169.00±0.57f	14748±15.04f	86.14±0.16cd	174.89±0.05f
	Hunza	84.64±0.36b	63.72±0.05d	68.01±0.13cd	71.27±0.06c	179.33±0.57e	15958±28.36d	84.20±0.29f	185.20±0.09e
Batung	Nagar	83.08±0.32c	68.85±0.19a	73.80±0.11a	74.69±0.09a	227.33±0.57a	17527±42.09a	89.90±0.24b	231.96±0.04a
	Hunza	87.50±0.50a	67.30±0.07b	71.90±0.12b	74.43±0.19a	199.33±0.57d	17407±91.00b	85.05±0.27e	206.84±0.03d
P. Batung	Nagar	82.45±0.02d	63.29±0.02e	68.89±0.02c	70.80±0.01d	212.33±0.57c	15748±4.50e	85.810±0.09d	218.23±0.02c
	Hunza	80.52±0.02e	67.00±0.02c	70.97±0.01b	72.30±0.01b	221.00±1.00b	16423±2.30c	89.78±0.02b	227.37±0.02b
Physhu	Nagar	47.60±0.12g	37.41±0.16g	39.88±0.02e	41.43±0.35f	23.00±1.00g	5347±92.46g	86.36±0.21c	37.58±0.05g
	Hunza	40.10±0.03h	36.22±0.015h	37.36±0.02f	37.71±0.01g	22.33±0.57g	4468±1.73h	94.03±0.064a	35.11±0.13h

Note: - FL= Fruit length, FW= Fruit width, FT= Fruit thickness, GMD= Geometric mean diameter, FV = Fruit volume, SA = Surface area. Sph. =
Sphericity, F Wt. = Fruit weight,
- All the values are means of thirty six (n = 12) replications + SD
- Values with same letter (s) within the column are not statistically different at alpha 0.05.

Mineral contents of pear

The observations regarding mineral contents (mg/100g) of pear are presented in Table 3. According to the obtained data, K (163.27 to 833.85) was most abundant mineral followed by Mg (38.57 to 86.74), Ca (23.26 to 48.39), P (5.20 to 13.70), Na (0.95 to 4.19) and Fe (0.40 to 2.86) among tested samples. The results were found significantly differed (p<0.05) among all the tested pear cultivars. The cultivar Pycho (Nagar) had significantly higher contents of Na, K and Mg, Shugri (Hunza) was dominating in P and Fe, while Ca was high in Shugri from Nagar. The overall comparison of pear cultivars revealed Phycho Nagar as the leading one in terms of mineral contents among the investigated samples. These findings are in line with previous reports of Xie *et al.* (2007), who have also reported Ca, Fe, Mg, P, K and Na in different pear cultivars. Similar views have also been reported by Mahammad *et al.* (2010) and Chen *et al.* (2007) on mineral composition of pear.

Physical and geometrical attributes

The results pertaining to geometrical attributes of four pear cultivars have been given in Table 4. The mean values for fruit weight were found in range of 35.11 to 231.96 g, fruit length 40.10 to 87.50 mm, width from 36.22 to 68.85 mm, thickness from 37.36 to 73.80 mm, fruit volume from 22.33 to 221.00 cm^3, sphericity from 84.20 to 94.03%, geometric mean diameter from 37.71 to 74.69 mm and surface area from 4468 to 17527 mm^2. All the physical and geometrical attributes analyzed were found significantly different ($p < 0.05$) among the four pear cultivars. The physical attributes are important to be taken under consideration for value addition and mechanization of packaging, grading and washing equipment (Demir *et al.* 2003). In addition, the

physical dimensions determine the shape of the fruit and thus provide an aesthetic sense and attract consumers (Omobuwajo *et al.* 2000). The results of present study of four pear fruit cultivars established Batung as the prime cultivar followed by Puno-Batung, Shughri and Phycho.

Conclusion

From the present study it was concluded that pear fruit cultivated in Hunza and Nagar valleys has a rich nutritional profile and functional components such as antioxidant activity, total phenolics, ascorbic acid and sugars. Among the investigated cultivars, Shughri was found as the leading cultivar in antioxidant activity, total phenolics and ascorbic acid, Puno-Batung was dominating in sugars, TSS and titratable acidity, while Batung was prominent in physical dimensions. The current study provides first hand nutritional information on four pear cultivars that will be supportive for the researchers and growers in developing postharvest management systems and industrialization of pear fruit in the area.

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