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EVALUATION OF PHYSICO-NUTRITIONAL AND FUNCTIONAL PROPERTIES OF INDIGENOUS PEAR CULTIVARS GROWN IN RAWALAKOT, AZAD JAMMU ANDKASHMIR

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Present study was designed to seek the physico-nutritional and functional properties of different pear (*Pyrus communis* L.) cultivars grown in Rawalakot, Azad Jammu and Kashmir. Six cultivars of pear [Nashpati (commercial cultivar), Farashishi, Naakh, Koturnal, Botangi and Kashmiri Botangi (indigenous cultivars)] were harvested from private orchards located at Rawalakot valley of District Poonch. Four replicates of twenty fruits were used for each cultivar to conduct different physical, chemical, nutritional and sensory analysis. In terms of physical parameters, commercially grown Nashpati showed better results as compared to other cultivars tested. However, indigenous cultivar Farashishi exhibited higher activity of ascorbic acid, total phenolic content, total flavonoids, and total antioxidant activity. Sensory evaluation of these cultivars also proved that Farashishi cultivar was good in taste, flavour and texture. These findings suggest that Farashishi cultivar has more health promoting activities as compared to all other cultivars tested and hence, could be recommended for commercial scale production in Rawalakot, Azad Jammu and Kashmir.

Keywords: Antioxidant activity, ascorbic acid content, pear germplasm, sensory quality, total phenols

INTRODUCTION

Nutritional and chemical compositional knowledge of native plant species could be an important source of commercialization for these plants (Haider *et al*., 2013, 2014; Nafees *et al*., 2017; Silva *et al*., 2017). It provides an economic substitute to raise the income of native population (Silva *et al*., 2013). These functional and nutritional elements are not only the source of income generation but they are also the main source of human diet (Hardisson *et al*., 2001). In this regard fruits and vegetables have an important role as they are the main source of antioxidants and other functional and nutritional elements. The area of Azad Jammu and Kashmir is highly diverse in terms of natural flora and fauna. This genetic diversity is because of its geographic location, as it is located between the centre of China and Caucasus Mountains (Nisar *et al*., 2015). This mountainous area possesses varied climatic conditions ranging from subtropical to temperate. Many temperate fruits are grown in this area e.g. pear, plum, apple, walnut etc. and a huge genetic diversity is found in these crops that might be because of natural seed based proliferations, hybridization or mutation (Ahmed *et al*., 2009).

Pear (*Pyrus communis* L.) is one of the diversified crops present in this area. The mountainous region of Azad Jammu and Kashmir holds a large number of pear plantations. Along with number of different pear varieties which consists of wild natives and traditional varieties (Ahmed *et al*., 2009). Almost 17 cultivars were identified by Ahmed *et al*. (2009), and many of them were replaced with insect pest and disease resistant cultivars.

Pear ranks second in fruit crops due to its high nutritional and economic importance (Ahmed *et al*., 2009). It is an excellent source of Vitamin C and dietary fibre (Mahammad *et al*., 2010). It is less allergenic in comparison to other fruits. The commercial pear varieties are usually 1-4cm in diameter. Pear fruit is receptacle and a cellular flesh is enclosed in the upper end of the dilated flower stalk (Brian and Cameron, 1995). Selection of cultivar and evaluation is mainly dependent on producer and consumer preferences. Producers prefer high yielding, disease, and insect pest resistant varieties; whereas, consumer demands for good taste, size, shape and quality of fruit (Lace and Lacis, 2015).

The major drawback in commercial utilization of pear fruit grown in the area of Azad Jammu and Kashmir is lack of nutritional information. Pear and its wild relatives exists in this area are not yet characterized in terms of their chemical, nutritional and functional components. Furthermore, no efforts have been made to exploit these indigenous fruit species for different uses. Therefore, the characterization of native pear germplasm is necessary for its nutritional uses. The present work is designed to investigate physical, chemical and antioxidant properties of different pear varieties grown in Rawalakot valley of Azad Jammu and Kashmir. To

our knowledge, no study has been reported earlier on the comparative nutritional analysis of indigenous and commercially cultivated varieties of fresh pear fruit grown in Rawalakot.

MATERIALS AND METHODS

***Plant material*:** Six pear cultivars [Nashpati (commercial cultivar) and Farashishi, Naakh, Koturnal, Botangi and Kashmiri Botangi (indigenous cultivars)] were harvested from private orchards located at Rawalakot valley of District Poonch, Azad Jammu and Kashmir, at altitude of 5374 ft. Healthy fruits having uniform size, shape and free from all external impurities were transported to the Laboratory of Department of Horticulture, The University of Poonch, Rawalakot for further analysis. Twenty fruits with four replicates were used for each cultivar.

***Physical analysis*:** Digital balance (Model: Shimadzu A x 200, Japan) was used to determine fruit weight. Fruit size was determined by gauging fruit length and diameter with the use of digital Vernier calliper (Model: Insize SR44)

Chemical analysis:

***Total soluble solids (TSS)*:** TSS was quantified by using hand refractometer (Kyoto Company, Japan). Briefly, two drops of juice from two ends of fruit were mixed and placed on the glass of refractometer. Results were then articulated in °Brix. Before analysis, refractometer was calibrated against sucrose (Ali *et al*., 2014).

***Titratable acidity*:** Titratable acidity was measured by titrating fruit juice against 0.1N NaOH (Ozturk *et al*., 2009). Results were articulated in citric acid percentage.

***pH*:** Digital pH meter (Model: WTW 82362 Inolab, Germany) was used to determine pH of fruit juice.

Antioxidant assay:

***Ascorbic acid*:** Ascorbic acid was measured according to the method given by Ruck (1969). Briefly, fruit juice (10 ml) was mixed with 90 ml of 0.4% oxalic acid to make a reaction mixture. A 5 ml of reaction mixture was titrated against 2,4,6-dichlorophenol indophenol dye to achieve a persistent light pink colour. Results were expressed as mg ascorbic acid per 100 ml of fruit juice.

***Total flavonoids*:** Total flavonoids were measured by using the spectrophotometric method. Fruit sample (0.5 mg) was grounded by using mortar and pestle followed by mixing with 2.0% methanolic $AlCl_3.6H_2O$ (1.5 ml) in sealed tubes and kept in the dark for 15 min. A UV-vis spectrophotometer (UV 4000 Spectrophotometer, Germany) was used for measuring absorbance at 430 nm. Results were expressed as mmol of qercentin equivalent 100 g fresh fruit weight.

***Total phenolic content*:** Total phenolic content were measured spectrophotometrically by using Folin Ciocalteau (FC) reagent. Fruit juice (0.1 ml) was mixed with 7.0% sodium carbonate (1.5 ml) and FC (0.5 ml). Purified water was added to make volume of mixture up to 10 ml. Reaction mixture was incubated for 2 hours at 40°C. Absorbance was recorded at 750 nm by using a UV–vis spectrophotometer (UV 4000 Spectrophotometer, Germany). Results were expressed as µg of gallic acid per g fresh fruit weight.

***Total antioxidant activity*:** Total antioxidants activity in pear fruit was measured by using Ferric Reducing Antioxidant Power (FRAP) assay. Reaction mixture contained 40 µl of fruit juice and 3 ml of FRAP reagent followed by incubation for 4 min at 37 °C. Absorbance was recorded at 593 nm, and the results were expressed as ferric reducing activity equivalent to1 mg $FeSO_4$ per g of fresh fruit weight. FRAP reagent consisted of 25 ml of 0.03 mM acetate buffer (pH 3.6), 2.5 ml of 20 mM $FeCl_3$ and 2.5 ml of 10 mM 2,4,6-Tripyridyl-s-triazine (TPTZ) solution dissolved in 40 mM HCl.

***Sensory evaluation*:** Sensory evaluation of the fruit for pulp colour, taste, flavour, texture and overall acceptability for all fruit cultivars was done by using the method of Maqbool *et al*. (2011).

***Statistical analysis*:** Data was subjected to basic descriptive statistics followed by analysis of variance (ANOVA) using computer software Statistix 8.1. Significance difference was calculated by using Tukey's test at ($P < 0.05$). Two tailed Pearson's correlation was performed to establish correlation among functional factors.

RESULTS AND DISCUSSION

***Physical quality*:** Results showed significant difference ($P < 0.05$) among weight, length and diameter of different pear cultivars (Table 1). Weight, length and diameter of commercially grown Nashpati was significantly ($P < 0.05$) higher than the indigenous varieties. Farashishi cultivar showed the highest diameter which was comparable with Nashpati and Koturnal (Table 1).

Table 1. Physical properties of pear cultivars grown in Rawalakot, Azad Jammu and Kashmir.

Varieties	Weight (gm)	Length (cm)	Diameter (cm)
Nashpati	146.9 a	7.97 a	6.28 a
Farashishi	125.0 b	6.18 b	6.39 a
Naakh	95.9 c	3.06 c	3.03 b
Koturnal	127.8 b	6.24 b	6.14 a
Botangi	39.6 d	2.94 c	2.60 c
Kashmiri Botangi	44.8 d	3.12 c	2.24 bc

*Values with different letters are significantly different ($P< 0.05$) within same column.

These variations in physical quality could be due to the difference in genetic makeup of cultivar (Ozturk *et al*., 2009). The variation due to difference in genetic makeup has been already reported in different temperate fruits i.e. plum (Milošević and Milošević, 2012), apple (Kumar *et al*., 2006)

and cherry (Sulusoglu, 2011). Beside this genetic difference, the fruit size and weight also depend on micro climate of tree canopy, plant habitat, light distribution and temperature of the area (Nisar *et al*., 2015). Similarly, plant spacing also affects fruit weight and size due to competition of nutrition, light and water (Nawaz *et al*., 2007). These qualitative parameters are the best tool for consumer's choice.

***Chemical quality*:** Significant differences ($P < 0.05$) were observed in all the cultivars tested in terms of chemical parameters studied (Table 2). The highest pH was measured in Botangi and Kashmiri Botangi which was comparable with all other varieties (Table 2). The highest TSS was obtained in Farashishi which was comparable with Naakh and Koturnal. Whereas, higher titratable acidity was observed in Nashpati which was non-significantly different ($P > 0.05$) with Farashishi, Naakh and Koturnal (Table 2). Amount of soluble solid content present in pulp or juice is indicated by TSS and is designated as °Brix. Value of TSS increased with the fruit maturity. Higher value of TSS is suitable for industry purposes. Whereas, the ratio between TSS and acidity are the best indicator for fruit flavour (Abadio Finco *et al*., 2012). However, the nutritional status of fruits depends on climatic factors and endogenous hormonal levels (Nisar *et al*., 2015). Increased amount of TSS and acidity could be due to active osmotic pressure in the fruit which resulted in increased synthesis of osmotic solutes (Barry *et al*., 2004).

Table 2. Chemical properties of pear cultivars grown in Rawalakot, Azad Jammu and Kashmir.

Varieties	TSS (°Brix)	Titratable acidity (%)	pH
Nashpati	7.83 b	0.61 a	4.75 ab
Farashishi	9.86 a	0.59 a	4.68 abc
Naakh	8.73 ab	0.53 a	4.01 b
Koturnal	8.02 ab	0.49 a	4.63 ab
Botangi	5.24 c	0.31 b	5.14 a
Kashmiri Botangi	6.14 bc	0.32 b	4.98 a

*Values with different letters are significantly different ($P< 0.05$) within same column.

***Antioxidant assay*:** Significant differences ($P < 0.05$) were found among commercial and local cultivars in all the parameters tested for antioxidant assay (Fig. 1). Farashishi and Naakh showed higher ascorbic acid (Vitamin C) content in comparison with Nashpati, (Fig. 1a). Higher value of ascorbic acid showed that Farashishi, Naakh and Koturnal cultivars are good source of Vitamin C and can be an established source of this nutrient. FRAP is the only assay that directly measures the reducing ability of antioxidants (Benzie and Strain, 1996). The lowest ascorbic acid content, total flavonoids, total phenolic content and total antioxidant activity were recorded in Botangi and Kashmiri Botangi (Fig. 1a,b).

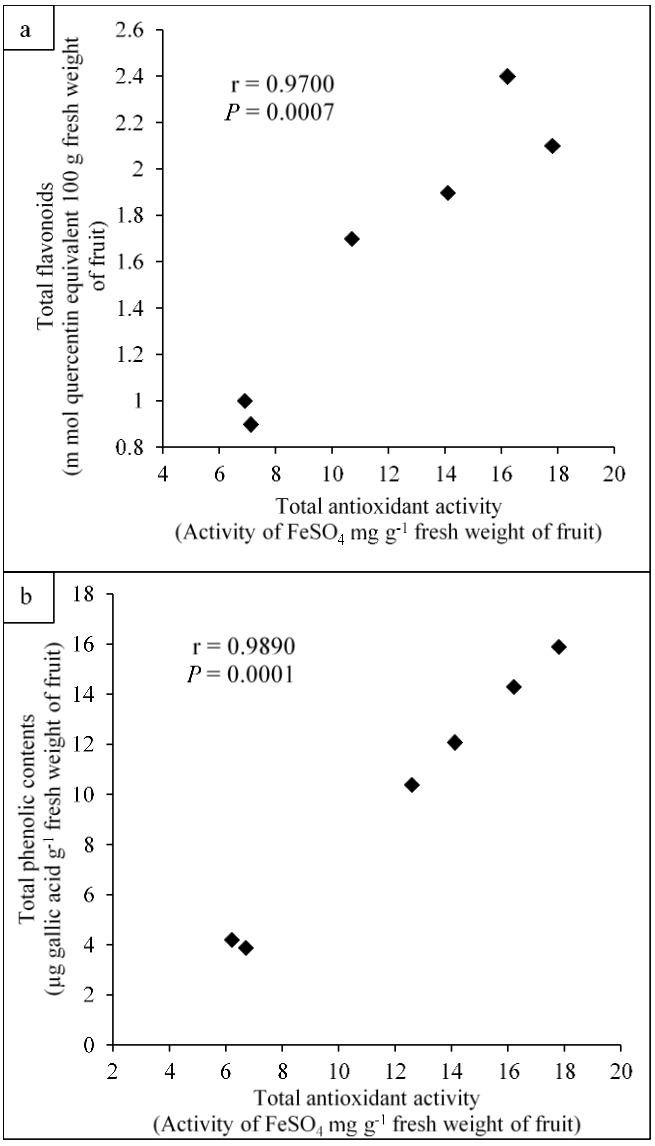

Figure 1. a) Ascorbic acid content and total flavonoids, b) total phenolic content and total antioxidant activity of pear cultivars grown in Rawalakot, Azad Jammu and Kashmir. Error bars shown are the average values from four replicates.

In our results a highly significant correlation was observed between total flavonoids and total antioxidant activity (Fig. 2a). r^2 value $\{(0.97)^2 \times 100\}$, indicates the total flavonoids contribution in total antioxidant activity is 94%. Similarly, a highly positive correlation was observed between total phenolic content and total antioxidant activity (Fig. 2b). r^2 value $\{(0.98)^2 \times 100)\}$, indicates the total phenolic content contribution to variation in total antioxidant activity is 96%. These correlation results showed that total phenolic content and total flavonoids play an important role in the total antioxidant activity in pear.

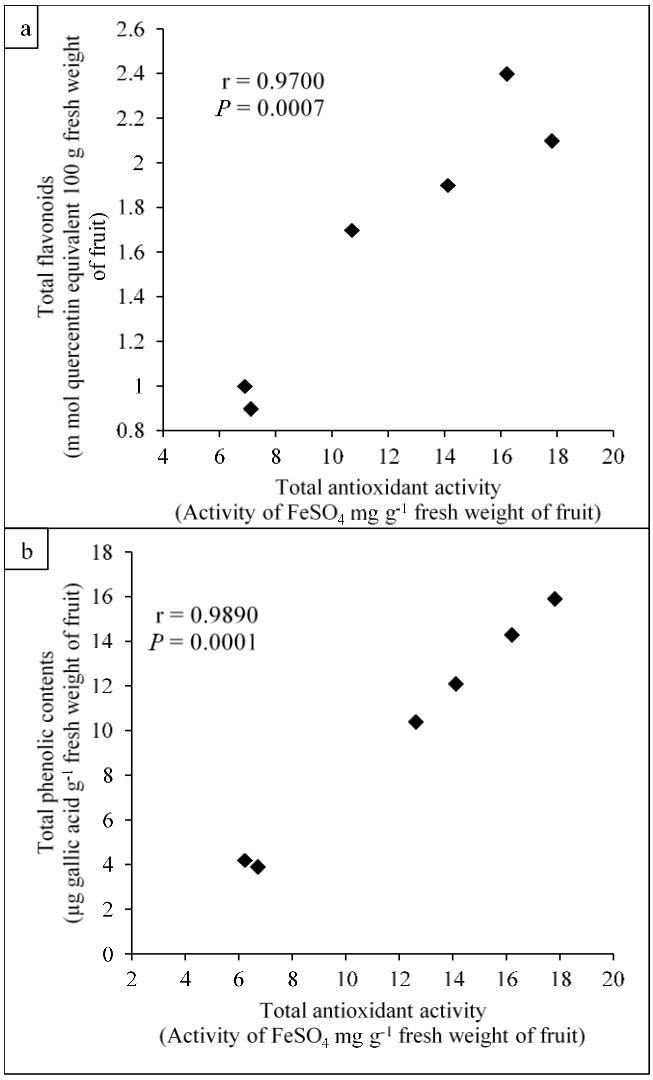

Figure 2. Correlation co-efficient among a) total anti-oxidant activity and total flavonoids b) total antioxidant activity and total phenolic content of pear cultivars grown in Rawalakot, Azad Jammu and Kashmir.

These results are in agreement with others as they reported a highly positive correlation among total phenolic content and total antioxidant activity (Othman *et al*., 2007; Oueslati *et al*., 2012). These phenolic compounds revealed redox potential and acted as reducing agent and oxygen quenchers. Variation in total phenolic content of different cultivars could be due to inter specific variability between them (Hanen *et al*., 2009). Along with total phenolic content, total flavonoids also play an important role as radical scavengers (Hertog *et al*., 1993). It is also reported that the structural characteristics of total flavonoids contribute in its oxidative property. These substances are helpful in anticancer activity, heart disease prevention and antioxidative activity. While some flavonoids have potential anti-human immunodeficiency virus function (Yao *et al*., 2004). In this study the results showed higher value of total phenolic content, total flavonoids and total antioxidant activity in Farashishi pear. Higher total antioxidant activity could be due to the presence of secondary metabolites such as higher vitamin C content, maximum total flavonoids and total phenolic content (Oueslati *et al*., 2012). It is also reported that the variation in total antioxidant activity of different cultivars of fresh fruits and vegetables depends upon different factors such as cultivars, environmental conditions, species, cultural practices, production technology, analytical methods and geographical area (Ali *et al*., 2014). Moreover, total antioxidant activity also highly depends on ripening process of fruits as well. During ripening process lipophylic enzymatic activity may affect the total antioxidant activity of fresh fruits and vegetables.

***Sensory evaluation*:** Sensory evaluation of different pear cultivars showed significant difference ($P < 0.05$) in terms of taste, flavour, texture and overall acceptability (Table 3). Farashishi pear achieved the highest score in all parameters tested which was comparable with Naakh and Koturnal. These results suggest that consumer acceptability towards Farashishi pear is more than other cultivars.

Table 3. Sensory evaluation (score) of pear cultivars grown in Rawalakot, Azad Jammu and Kashmir.

Varieties	Pulp colour	Taste	Flavour	Texture	Overall accept-ability
Nashpati	6.0 a	5.2 b	6.3 ab	6.5 b	5.9 b
Farashishi	7.0 a	7.5 a	7.4 a	7.9 a	8.2 a
Naakh	7.0 a	7.0 a	7.5 a	7.3 ab	7.8 ab
Koturnal	6.5 a	6.9 a	6.8 b	6.8 b	6.8 ab
Botangi	2.7 b	1.9 c	1.6 c	2.2 c	2.0 c
Kashmiri Botangi	3.1 b	2.0 c	1.4 c	2.1 c	1.8 c

*Values with different letters are significantly different ($P< 0.05$) within same column.

***Conclusion*:** Present study indicates that Farashishi pear showed higher total antioxidant activity and all the other biochemical content under study. Similarly, the consumer acceptability was also higher for Farashishi cultivar than commercially grown cultivar. These results suggest that Farashishi pear has higher nutritional values and can act as a good dietary and health promoting fruit. In fact, addressing the physico-chemical properties of pear cultivar is a way to add those cultivars in the market which are not so valued yet. Indirectly, getting to know the functional properties of different cultivars is a way to conserve them.

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