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Physical characteristics, mineral analysis and antioxidant properties of some apricot varieties grown in North India

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Abstract: Eleven apricot varieties (Chinese, Rival, Tilton, Cuminis Haley, Harcot, Margulam, Narmu, Khante, Halman, Badam Chuli, and Cuban) were studied for their mineral analysis, physical characteristics, and antioxidant properties. The physical characteristics varied significantly ($p \leq 0.05$) among the apricot varieties. Cuban and Harcot showed a comparatively larger fruit size. However, Cuminis Haley and Harcot showed the highest edible bulk. Nine minerals (Zn, Ca, Cu, Fe, Mg, Na, Mn, P, and K) were analyzed and were found to vary significantly ($p \leq 0.05$) among the apricot varieties. Mn, Cu, and Zn elements were present in micro amounts, while K, Mg, Ca, P, and Fe levels were present in macro amounts. Halman and Margulam showed significantly ($p \leq 0.05$) higher amount of the minerals. All the varieties showed lower amounts of Cu as compared to the recommended daily intake, ranging from 0–0.82 ppm. All the varieties proved to be rich sources of polyphenols, with significant ($p \leq 0.05$) varietal difference. Khante and Halman showed the significantly ($p \leq 0.05$) highest methanolic 1,1-diphenyl-2-picrylhydrazyl (DPPH•) radical scavenging activity.

Subjects: Food Analysis; Food Engineering; Food Science & Technology; Fruit & Vegetables

Keywords: apricot; physical properties; engineering properties; mineral analysis; antioxidants; polyphenols; *Prunus armeniaca*; reducing power; DPPH; solvent extraction

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PUBLIC INTEREST STATEMENT

Apricot is the main horticultural crop of some hardy regions of North India. The people in these regions depend mainly on apricots for their living. Introduction of these apricot varieties to the world would enhance the economical value of these varieties and simultaneously enhance their production in other suitable regions. These apricot varieties could prove to be an asset to the food and medicinal industries.

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1. Introduction

Prunus armeniaca L. (Rosaceae), widely known as "apricot," is an edible plant famous for its delicious fruits. Its synonymous Latin name is *Armeniaca vulgaris* L., formerly supposed to come from Armenia, where it has been cultivated for a long time. The plant can be botanically described as a hardy tree with 2–10-m height with stone fruits. The fruit usually ripens at the end of July till the middle of August. However, the final maturity depends upon the variety under consideration. It has a drupe form, similar to plum, with a thin outer skin enclosing the yellow flesh (mesocarp), the inner layers becoming woody and forming the large, smooth, compressed stone and the ovule ripening into the kernel. The fruit has a distinctively delicious taste, appealing smell, texture, and varying colors from yellow to orange with a reddish random overlay, to which parameters the quality of apricots is associated with (Erdogan-Orhan & Kartal, 2011; Solis-Solis, Calderon-Santoyo, Gutierrez-Martinez, Schorr-Galindo, & Ragazzo-Sanchez, 2007).

There is a growing interest of natural products in human diet, both due to the possible negative effects of synthetic food additives on human health and the increased consumer perception of this problem in recent years. Numerous studies demonstrate that a great number of medicinal plants, aromatic herbs, fruits, and leaves of some plants biosynthesize phytochemicals, which possess antioxidant activity and may be used as a natural source of free radical scavenging compounds (Mushtaq & Wani, 2013; Nazir et al., 2013; Sacchetti et al., 2005; Yu, Zhou, & Parry, 2005). Fruits, fresh as well as dried, are an important constituent of our daily diet and are rich sources of antioxidants. Consumption of fruits rich in antioxidants has been reported to overcome some of the degenerative diseases that affect humans (Hussain et al., 2013). Besides having antioxidant properties (Wani et al., in press), apricot varieties being rich in a number of secondary metabolites such as polyphenols, carotenoids, fatty acids, volatiles and polysachharides have been shown to exert various biological activities including antimicrobial activity (Rashid et al., 2007), antimutagenic activity (Yamamoto, Osaki, Kato, & Miyazaki, 1992), cardioprotective activity (Parlakpinar et al., 2009), hepatoprotective activity (Ozturk et al., 2009), anti-inflammatory, and antinociceptive activity (Chang et al., 2005) that is highly desirable for human health.

In India, apricots are grown commercially in the hills of Himachal Pradesh, Jammu and Kashmir, Utter Pradesh, and to a limited extent in the north-eastern hills. Some apricots are being grown in dry temperate regions of Kinnaur and Lahaul Spiti in Himachal Pradesh and Ladakh in Jammu and Kashmir. In this article, various apricot varieties from different parts of North India (Chinese, Rival, Tilton, Cuminis Haley, Harcot, Margulam, Narmu, Khante, Halman, Badam Chuli, and Cuban) were analyzed for their different physical characteristics, mineral analysis, and antioxidant properties.

2. Materials and methods

2.1. Materials

The apricot varieties namely Chinese, Rival, Tilton, Cuminis Haley, and Harcot were collected from CITH-Srinagar (Jammu and Kashmir). Other varieties namely Margulam, Narmu, Khante, Halman, Badam Chuli, and Cuban were collected from RRS-Kargil (Jammu and Kashmir). The fruits were harvested at physiological maturity in the months of July (Srinagar) and August (Kargil and Ladakh). Srinagar region of Jammu and Kashmir has a typical temperate climate. However, the rainfall in Kargil and Ladakh is scanty with severe winter (cold desert).

2.2. Physical characteristics

The apricot fruit weight and pit ratio were determined by a digital electronic balance (Srtorious AG, Germany), having a sensitivity of 0.01 mg. Forty randomly selected fruits were analyzed for each variety. The properties of length (L), width (W), and thickness (T) of apricot fruits were measured by a digital calliper (0–150 mm, China) with an accuracy of 0.01 mm. True density was analyzed using kerosene to remove the air spaces between the apricots. Apricot surface area (SA) 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 according to the following equation:

$$D_g = \sqrt[3]{LWT}$$

where L is the length, W is the 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, Fathollahzadeh, & Mobli, 2008):

$$\phi = \frac{D_g}{L} \times 100$$

2.3. Mineral analysis

The mineral contents of apricots were determined according to Association of Official Analytical Chemists (1990). The samples (0.8–1 g) were ashed in a muffle furnace at a temperature of 550 ± 10°C for 6 h and the ash obtained was digested with 5-ml 6 M HCl in a water bath. After drying, 7-ml 0.1 M HNO_3 was added and contents were diluted to 100 ml with double-deionized water as described by Nielsen (1994). Calcium (Ca), Copper (Cu), Iron (Fe), Manganese (Mn), Magnesium (Mg), Sodium (Na), and Zinc (Zn) were determined in an atomic absorption spectrophotometer (ECIL Atomic Absorption Spectrophotometer-4141), Phosphorus (P) using a spectrophotometer (Systronics India UV-vis 108), and Potassium (K) by flame photometer (Systronics-130).

2.4. Extraction

Fresh apricot pulp was extracted in absolute methanol (1:3 w/v) thrice for 12 h. The mixture was strained and the extract was filtered using a filter paper (Whatman 4). The filtrate was concentrated and dried subsequently at 35°C (±2) using a vacuum evaporator (Equitron roteva). The dried samples were stored in a deep freezer until analysis.

2.5. Total phenols

Total phenol content of the extract was determined according to the method of Thaipong, Boonprakob, Crosby, Cisneros-Zevallos, and Hawkins Byrne (2006) One hundred and fifty microliters of extract, 2,400 µL of nanopure water, and 150 µL of 0.25 N Folin–Ciocalteu reagent were combined and then mixed well by shaking. The mixture was allowed to react for 3 min; then, 300 µL of 1 N Na_2CO_3 solution was added and mixed well again by shaking. The solution was incubated at room temperature in the dark for 2 h. The absorbance was measured at 725 nm using a spectrophotometer and the results were expressed as milligram of Gallic acid equivalents per 1 gram (mg GAE/g) of extract using standard curve prepared from Gallic acid solution.

2.6. Reducing power

The reducing power of the selected fruit extracts was investigated largely based on a method outlined by Athukorala, Kim, and Jeon (2006) and later modified by Yang, Guo, and Yuan (2008). In this assay, 1 mL of antioxidant solution (0.5 mL of fruit extract mixed in 0.5 ml of water) was mixed with phosphate buffer (2.5 mL, 0.2 M, pH 6.6) and $K_3Fe(CN)_6$ (2.5 mL, 30 mM). The mixture was incubated at 50°C for 20 min, after which trichloroacetic acid (2.5 mL, 0.6 M) was added to terminate the reaction followed by a centrifugation step (10 min, 5,000 rpm). From the upper layer, 2.5 mL of solution was then removed and mixed with $FeCl_3$ (0.5 mL) and left to incubate for another 10 min.

Formation of ferrous ions (Fe^{2+}) was measured spectrophotometrically at 700 nm, with higher absorbance values indicative of greater reducing capacity of ferric (Fe^{3+}) to ferrous (Fe^{2+}) ions. All the samples were run in triplicate. Moreover, blanks (control) were also run in parallel with their absorbance values subtracted from those of the samples.

2.7. DPPH• radical scavenging activity

The antioxidant activity of the apricot varieties was determined spectrophotometrically according to the method of Matthäus (2002). Briefly, 80 µL of the sample extract was mixed with 200 µL of 0.05% DPPH• in a total volume of 4-ml methanol and allowed to react in the dark for 30 min. Then, the absorbance was read at 515 nm using a spectrophotometer (Hitachi U-2900) and the results were expressed as percent inhibition using the relation,

$$\% \text{ inhibition} = \frac{\text{Absorbance of control} - \text{Absorbance of sample}}{\text{Absorbance of control}} \times 100$$

2.8. Statistical analysis

Keeping the varieties as the sources of variation, the results were subjected to statistical analysis using one-way analysis of variance (ANOVA), using a commercial statistical package (IBM SPSS Statistics 21.Ink). Means were compared by Duncan's Multiple Range test at 5% significance level.

3. Results and discussion

3.1. Physical properties

The physical properties of apricot are important for the design of equipment for harvesting and post-harvesting technologies, transportation, cleaning, separation, sizing, packaging, and processing into different food products. These are very important properties and are taken into consideration for value addition and mechanization of fruit industry (Demir & Hakki Kalyoncu, 2003; Wani, Wani, Shah, & Masoodi, 2013). Table 1 shows the physical properties of 11 apricot varieties studied. The apricot varieties varied significantly ($p \leq 0.05$) in the physical properties analyzed. The physical properties including length (L), width (W), thickness (T), geometric mean diameter (GMD), surface area (SA), sphericity (Sph), fruit weight (FWt), pit ratio (PRt), and true density (TD) varied between 29.79 and 38.40 mm, 28.83 and 37.92 mm, 26.28 and 33.46 mm, 29.24 and 35.07 mm, 2,684.97 and 3,878.18 mm^2, 82.07 and 103.89%, 11.83 and 23.79 g, 5.29 and 9.55, and 0.54 and 0.87 g/ml, respectively. Cuban and Harcot showed the highest geometric mean diameter, which is an indication of a comparatively larger fruit size. However, Cuminis Haley and Harcot showed the highest pit ratio, which is an indication of the edible bulk of the fruits. Being larger in size with higher pit ratio, these varieties are the most suitable for fresh consumption and production of value-added products like jam, juice, and jellies. Khante having the smallest fruit weight is most suitable for drying purposes. Moreover, the variations in fruit size, edible pulp, and other parameters of the fruits may be attributed to the genetic variations among the apricot varieties. Among various physical characteristics, the apricot fruit weight has been reported to be in the range of 8.0–15.1 g and diameter between 2.3 and 2.5 cm, whereas the pulp to stone ratio is between 3.5 and 6.9:1 (Gupta & Sharma, 2009; Sharma, 1994). A comparison of the present data with the previous literature shows that the varieties under consideration here have better physical characteristics, which should enhance their production and use for food and functional purposes. The physical properties of different apricot varieties from different regions of the world have been analyzed by Ali, Masud, and Abbasi (2011) and Hacıseferoğulları, Gezer, Özcan, and MuratAsma (2007) for their industrialization and are in range with the present study.

3.2. Mineral analysis

The apricot varieties were analyzed for nine minerals and the data have been presented in Table 2. A significant difference ($p \leq 0.05$) was seen in the mineral composition of the apricot varieties studied. In the apricot varieties, Zn, Ca, Cu, Fe, Mg, Na, Mn, P, and K were found in the range of 0.5–6.74, 15.62–372.66, 0–0.82, 0.9–12.62, 23.35–64.29, 14.85–28.06, 0–0.98, 9–696, and 2,150–5,416.66 ppm, respectively. Mn, Cu, and Zn elements were present in micro amounts while K, Mg, Ca, P, and Fe levels were present in macro amounts in the varieties studied. However, Cu in Margulam, Cu and Mn in Khante, Mn in Halman, Zn and Mn in Badam Chuli, and Cu in Cuban were not detected and have been assigned zero values in the table. The apricot varieties, namely Hacihaliloglu, Hasanbey, Soganci, Kabaasi, Cataloglu, Cologlu, Hacikiz, Tokaloglu, Alyanak, Igdir, and Bursa (Akin, Karabulut, & Topcu, 2008), Alman, Habi, Khakhas, Mirmalik, Neeli, and Shai (Ali et al., 2011), and Zerdali, Cataloglu,

Table 1. Physical properties of some apricot varieties grown in North India (n = 40)

Varieties	Physical properties								
	L (mm)	W (mm)	T (mm)	GMD (mm)	SA (mm²)	Sph (%)	F.Wt. (g)	P.Rt.	TD (g/ml)
Chinese	33.04 ± 0.06^{d}	31.96 ± 0.10^{f}	29.29 ± 0.05^{e}	31.39 ± 0.06^{f}	3,094.77 ± 11.98^{e}	94.99 ± 0.02^{f}	23.37 ± 0.09^{h}	8.50 ± 0.05^{f}	0.64 ± 0.04^{b}
Rival	34.94 ± 0.05^{g}	33.90 ± 0.06^{h}	31.34 ± 0.08^{g}	33.36 ± 0.04^{h}	3,495.31 ± 9.03^{g}	95.47 ± 0.06^{g}	23.79 ± 0.10^{i}	7.32 ± 0.05^{d}	0.73 ± 0.03^{c}
Tilton	32.09 ± 0.06^{b}	29.64 ± 0.05^{b}	26.28 ± 0.05^{a}	29.24 ± 0.04^{a}	2,684.97 ± 8.98^{a}	91.11 ± 0.06^{c}	18.21 ± 0.06^{g}	6.14 ± 0.04^{c}	0.64 ± 0.02^{b}
Cuminis Haley	36.71 ± 0.07^{h}	32.69 ± 0.10^{g}	31.35 ± 0.04^{g}	33.51 ± 0.02^{i}	3,526.89 ± 4.40^{h}	91.27 ± 0.24^{c}	23.27 ± 0.08^{h}	9.04 ± 0.05^{g}	0.62 ± 0.03^{b}
Harcot	37.24 ± 0.05^{i}	34.63 ± 0.12^{i}	33.46 ± 0.10^{j}	35.07 ± 0.08^{j}	3,863.94 ± 19.37^{i}	94.18 ± 0.17^{e}	17.54 ± 0.10^{e}	9.55 ± 0.05^{h}	0.74 ± 0.04^{c}
Margulam	33.45 ± 0.08^{e}	28.83 ± 0.12^{a}	28.82 ± 0.09^{d}	30.29 ± 0.03^{b}	2,881.23 ± 5.83^{b}	90.54 ± 0.22^{b}	18.26 ± 0.08^{g}	5.86 ± 0.05^{b}	0.63 ± 0.02^{b}
Narmu	33.11 ± 0.10^{d}	31.58 ± 0.07^{e}	27.27 ± 0.07^{c}	30.55 ± 0.06^{c}	2,931.07 ± 13.34^{c}	92.25 ± 0.16^{d}	16.09 ± 0.05^{c}	5.89 ± 0.05^{b}	0.54 ± 0.01^{a}
Khante	32.38 ± 0.14^{c}	31.11 ± 0.06^{d}	29.18 ± 0.05^{e}	30.86 ± 0.06^{d}	2,991.31 ± 12.68^{d}	95.31 ± 0.29^{fg}	11.83 ± 0.07^{a}	8.04 ± 0.05^{e}	0.72 ± 0.02^{c}
Halman	29.79 ± 0.12^{a}	32.59 ± 0.06^{g}	30.54 ± 0.06^{f}	30.95 ± 0.01^{e}	3,008.86 ± 2.09^{d}	103.89 ± 0.41^{i}	16.58 ± 0.08^{d}	9.55 ± 0.05^{h}	0.77 ± 0.02^{c}
Badam Chuli	38.40 ± 0.11^{j}	30.45 ± 0.09^{c}	26.77 ± 0.07^{b}	31.52 ± 0.02^{g}	3,119.76 ± 5.27^{f}	82.07 ± 0.16^{a}	15.42 ± 0.06^{b}	5.29 ± 0.02^{a}	0.85 ± 0.03^{d}
Cuban	34.53 ± 0.07^{f}	37.92 ± 0.07^{j}	33.15 ± 0.08^{h}	35.14 ± 0.05^{j}	3,878.18 ± 11.71^{i}	101.77 ± 0.05^{h}	17.88 ± 0.07^{f}	7.34 ± 0.03^{d}	0.87 ± 0.02^{d}

Notes: L, fruit length; W, fruit width, T, fruit thickness; GMD, geometric mean diameter; SA, surface area; Sph., sphericity; F.Wt., fruit weight; P.Rt., pit ratio; and TD, true density.

Each value is the mean ± standard deviation.

Means with different letters in the column for each apricot variety are significantly ($p \leq 0.05$) different.

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Table 2. Mineral analysis of some apricot varieties grown in North India (n = 3)

Varieties	Mineral analysis (ppm FW)								
	Zn	Ca	Cu	Fe	Mg	Na	Mn	P	K
Chinese	0.50 ± 0.05^{b}	15.62 ± 0.20^{a}	0.82 ± 0.02^{g}	12.62 ± 0.34^{h}	38.11 ± 1.01^{cd}	17.03 ± 1.39^{b}	0.12 ± 0.02^{d}	31.00 ± 1.00^{b}	3,450.00 ± 50.00^{d}
Rival	0.65 ± 0.04^{c}	23.05 ± 0.15^{b}	0.18 ± 0.01^{c}	9.26 ± 0.30^{e}	52.20 ± 2.03^{f}	17.37 ± 0.77^{b}	0.05 ± 0.00^{b}	31.66 ± 1.52^{b}	2,716.66 ± 76.37^{c}
Tilton	1.01 ± 0.03^{d}	58.65 ± 0.27^{e}	0.55 ± 0.01^{f}	11.34 ± 0.48^{g}	35.87 ± 0.77^{bc}	21.43 ± 0.35^{d}	0.08 ± 0.00^{c}	250.00 ± 10.00^{d}	3,383.33 ± 76.37^{d}
Cuminis Haley	1.23 ± 0.05^{e}	82.58 ± 0.18^{g}	0.82 ± 0.03^{g}	6.86 ± 0.07^{c}	35.10 ± 1.01^{b}	25.44 ± 0.33^{e}	0.22 ± 0.02^{e}	111.66 ± 12.58^{c}	4,283.33 ± 76.37^{e}
Harcot	1.15 ± 0.05^{e}	63.66 ± 1.03^{f}	0.43 ± 0.03^{e}	10.66 ± 0.57^{f}	44.07 ± 1.00^{e}	16.43 ± 0.51^{ab}	0.64 ± 0.04^{f}	29.66 ± 2.51^{b}	2,150.00 ± 50.00^{a}
Margulam	2.82 ± 0.14^{g}	370.60 ± 1.21^{i}	0^{a}	10.09 ± 0.10^{f}	74.13 ± 1.20^{h}	24.78 ± 1.57^{e}	0.98 ± 0.01^{g}	9.00 ± 1.00^{a}	5,416.66 ± 76.37^{f}
Narmu	1.14 ± 0.04^{e}	58.02 ± 1.00^{e}	0.45 ± 0.05^{e}	5.17 ± 0.20^{b}	23.35 ± 1.52^{a}	15.05 ± 1.00^{a}	0.04 ± 0.00^{b}	9.33 ± 0.57^{a}	4,383.33 ± 76.37^{e}
Khante	0.66 ± 0.05^{c}	128.20 ± 1.31^{h}	0^{a}	0.90 ± 0.10^{a}	42.14 ± 0.79^{e}	18.98 ± 0.97^{c}	0^{a}	20.00 ± 2.00^{ab}	4,266.66 ± 251.66^{e}
Halman	6.74 ± 0.10^{h}	372.66 ± 2.51^{j}	0.24 ± 0.04^{d}	8.54 ± 0.50^{d}	64.29 ± 2.06^{g}	28.06 ± 0.91^{f}	0^{a}	696.66 ± 25.16^{f}	5,350.00 ± 132.28^{f}
Badam Chuli	0^{a}	33.30 ± 0.90^{c}	0.05 ± 0.00^{b}	10.52 ± 0.50^{f}	37.65 ± 1.52^{cd}	14.85 ± 0.73^{a}	0^{a}	20.33 ± 2.51^{ab}	2,516.66 ± 125.83^{b}
Cuban	1.58 ± 0.12^{f}	38.31 ± 1.07^{d}	0^{a}	10.29 ± 0.62^{f}	38.94 ± 1.78^{d}	15.86 ± 0.77^{ab}	0.23 ± 0.02^{e}	560.00 ± 10.00^{e}	2,300.00 ± 100.00^{a}

Notes: FW, fresh weight.

Each value is the mean ± standard deviation.

Means with different letters in the column for each apricot variety are significantly ($p \leq 0.05$) different.

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Table 3. Total phenols and antioxidant properties of some apricot varieties grown in North India (*n* = 3)

Varieties	Total phenols (GAE/g)	Reducing power (%)	DPPH (% Inhibition)
Chinese	30.90 ± 0.79^{cd}	76.61 ± 0.53^{d}	59.41 ± 0.52^{h}
Rival	32.86 ± 0.77^{e}	83.46 ± 0.45^{e}	34.16 ± 1.04^{b}
Tilton	29.58 ± 0.52^{bc}	74.55 ± 0.50^{c}	47.41 ± 0.52^{g}
Cuminis Haley	24.87 ± 0.60^{a}	70.33 ± 0.38^{b}	44.62 ± 0.56^{f}
Harcot	25.45 ± 0.50^{a}	66.58 ± 0.55^{a}	21.68 ± 0.61^{a}
Margulam	32.08 ± 1.10^{de}	82.34 ± 1.19^{e}	35.46 ± 0.50^{c}
Narmu	28.71 ± 0.41^{b}	75.47 ± 0.81^{cd}	38.41 ± 0.52^{d}
Khante	41.31 ± 1.75^{f}	86.14 ± 1.02^{f}	69.78 ± 1.07^{j}
Halman	30.05 ± 1.37^{bc}	75.25 ± 1.09^{cd}	62.81 ± 0.85^{i}
Badam Chuli	30.55 ± 0.39^{cd}	82.38 ± 1.21^{e}	41.72 ± 0.63^{e}
Cuban	29.48 ± 0.50^{bc}	82.27 ± 1.11^{e}	42.64 ± 0.70^{e}

Notes: Each value is the mean ± standard deviation.

Means with different letters in the column for each apricot variety are significantly ($p \leq 0.05$) different.

Hacihaliloglu, Hasanbey, Soganci, and Kabaasi (Hacıseferoğulları et al., 2007), have been analyzed for their mineral contents and are comparable to the results of the present study.

The highest level of Zn was seen in Halman (6.74 ± 0.10 ppm) and the lowest detectable concentration was seen in Chinese (0.50 ± 0.05 ppm). Halman (372.66 ± 2.51 ppm) and Margulam (370.60 ± 1.21 ppm) showed the highest concentrations of Ca, whereas Chinese (15.62 ± 0.20 ppm) showed the lowest concentration. Cuminis Haley (0.82 ± 0.03 ppm) and Chinese (0.82 ± 0.02 ppm) showed the highest concentrations of copper that are well below the recommended daily intake levels recommended by most authorities. However, Badam and Chuli (0.05 ± 0.00 ppm) showed the minimum detectable level of Cu. Chinese (12.62 ± 0.34 ppm) showed the highest concentration of Fe and Khante (0.90 ± 0.10 ppm) showed the lowest concentration. All the varieties studied here are good sources of Mg, with Margulam (74.13 ± 1.20 ppm) showing the highest and Narmu (23.35 ± 1.52 ppm) showing the lowest concentrations. The varieties studied here are generally rich in Na with Halman (28.06 ± 0.91 ppm) showing the highest concentration and Narmu (15.05 ± 1.00 ppm) showing the lowest concentration. The highest concentration of Mn was found in Margulam (0.98 ± 0.01 ppm) and the lowest detectable concentration was found in Rival (0.05 ± 0.00 ppm). The apricot varieties were generally found to be very rich in Phosphorus (P), with Halman (696.66 ± 25.16 ppm) showing the highest concentration and Margulam (9.00 ± 1.00 ppm) showing the lowest concentration. Potassium, which is required in higher amounts, was seen to be the highest in Halman (5,350.00 ± 132.28 ppm) and the lowest in Harcot (2,150.00 ± 50.00 ppm). The reasons behind the varietal difference in the mineral composition of the apricot varieties may be due to genetic and geographical reasons.

3.3. Total phenols

Data pertaining to the total phenolic content of the various apricot varieties have been presented in Table 3. The total phenolic content showed a significant difference, varying in the range of 24.87–41.31 mg GAE/g among the apricot varieties studied. Khante (41.31 ± 1.75 mg GAE/g) showed the highest total phenolic content. However, Cuminis Haley (24.87 ± 0.60 mg GAE/g) and Harcot (25.45 ± 0.50 mg GAE/g) showed the lowest total phenolic content. The phenolic compounds present in apricots mainly comprise gallic acid, chlorogenic acid, neochlorogenic acid, caffeic acid, p-coumaric acid, ferulic acid, (+)-catechin (-)-epicatechin, procyanidin B1, B2, and B3, quercetin-3-galactoside, quercetin-3-glucoside, quercetin-3-rutinoside, and kaempferol-3-rutinoside as analyzed in three apricot varieties, namely Keckemetska ruza, Madjarska najbolja, and Velika rana by Dragovicuzelac, Levaj, Mrkic, Bursac, and Boras (2007). The apricot varieties, namely Hacihaliloglu, Hasanbey, Soganci, Kabaasi, Cataloglu, Cologlu, Hacikiz, Tokaloglu, Alyanak, Igdir, and Bursa, have

been reported to possess total phenolic content in the range of 4,233–8,180 mg GAE/100 g on dry weight basis (Akin et al., 2008). High phenolic contents in the investigated varieties demonstrated an increased antioxidant activity. Total phenolic content in the range of 4,591–7,310 mg GAE/100 g on dry weight basis has also been reported in six apricot varieties, namely Alman, Habi, Khakhas, Mirmalik, Neeli, and Shai (Ali et al., 2011). Total phenolic content of various apricot cultivars have also been studied by Leccese, Bartolini, and Voiti (2007, 2012). Total phenolic content of apricot varieties in the present analysis is comparable to previous studies.

3.4. Reducing power

Reducing power showed a significant difference among the apricot varieties (Table 3). Khante (86.14 ± 1.02%) showed the highest reducing power, while Harcot (66.58 ± 0.55%) showed the lowest reducing power. The reducing power works on the mechanism of transformation of ferric ion (Fe^{3+}) to the ferrous ion (Fe^{2+}) and is estimated spectrophotometrically by the potassium ferricyanide reduction method. The presence of reductants such as antioxidant substances in the extracts of the different apricot varieties causes the reduction of Fe^{3+} and the yellow color of the solution changes into various shades of green and blue in a dose-dependent manner. It has been shown that the reducing power is related with antioxidant activity and may give a significant indication of the antioxidant activity (Oktay, Gülçin, & Küfrevioğlu, 2003). Compounds with reducing power indicate that they are electron donors and can thus act as primary and secondary antioxidants (Yen & Chen, 1995).

3.5. 1,1-diphenyl-2-picrylhydrazyl (DPPH•) radical scavenging activity

Radical scavenging activity is very important due to the deleterious role of free radicals in foods and in biological systems. Diverse methods are currently used to assess the antioxidant activity of plant phenolic compounds. Chemical assays are based on the ability to scavenge synthetic free radicals, using a variety of radical-generating systems and methods for detection of the oxidation end point. The DPPH• radical scavenging assay is a spectrophotometric procedure that is regularly used for relatively rapid evaluation of the antioxidant activity of different food components (Amarowicz, Pegg, Rahimi-Moghaddam, Barl, & Weil, 2004; Jang et al., 2007; Locatelli et al., 2009). Therefore, radical scavenging activities of ethanol, methanol, and water extracts of the apricot varieties were determined by the assays.

DPPH• is a stable free radical, even at room temperature, and shows strong absorbance at 515 nm. The DPPH• radical accepts an electron or hydrogen radical to become a stable diamagnetic molecule with a different color. Thus, the degree of its discoloration from purple to yellow in the presence of an antioxidant compound is attributed to the hydrogen-donating ability of the added compound, which is indicative of its radical scavenging potential (Gülçin, Oktay, Kireççi, & Küfrevioğlu, 2003). Antioxidant compounds usually transfer a proton to the DPPH• free radical so they scavenge the free radical form of DPPH as shown in the following equation.

$$A\text{-}H + DPPH\bullet \rightarrow A\bullet + DPPH\text{-}H$$

Apricots contain a wide variety of phytochemicals that function as antioxidants. They are attributed to scavenge free radicals and thus quench a certain amount of DPPH• in the experimental essay. The DDPH• radical scavenging activity of the different apricot varieties was found to be significantly different among the different apricot varieties, as shown in Table 3. For the methanolic extraction, DDPH• radical scavenging activity varied in the range of 21.68–69.78%. Khante (69.78 ± 1.07%) showed significantly the highest DDPH• radical scavenging activity, while Harcot (21.68 ± 0.61%) showed the lowest DPPH• radical scavenging activity. The DDPH• radical scavenging activity varied in the range of 26.82–69.62%. Halman (59.62 ± 0.56%) showed significantly the highest DDPH• radical scavenging activity, while Harcot (26.82 ± 0.75%) showed the lowest DPPH radical scavenging

activity that varied insignificantly with Chinese (27.52 ± 0.54%). Results of the present analysis are in accordance with (Wani et al., in press).

4. Conclusion

To the best of our knowledge, the North Indian apricot varieties analyzed in this piece of research have not been explored so far. These apricot varieties were found to be very good sources of different minerals like K, P, Mg, Ca, Na, and Fe. The varieties namely Cuban, Cuminis Haley, and Harcot are best suited for fresh consumption and production of value-added products because of their larger size and pit ratio. Khante and Halman could be used for extraction of antioxidant compounds due to their high antioxidant properties. Owing to the properties analyzed, it can be concluded here that these unexplored apricot varieties could be utilized for food and functional purposes.

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Competing interests
The authors declare no competing interest.

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