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ORIGINAL ARTICLE

Chemical and nutritional evaluation of major genotypes of nectarine (*Prunus persica* var *nectarina*) grown in North-Western Himalayas

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Abstract Nectarine is an important stone fruit after plum and peach. The area under peach cultivation is now getting replaced by nectarine due to its fuzzless nature and high nutritive value. Nectarines are juicy, delicious fruits having low calorific value and have high antioxidant capacity. In India, its cultivation is confined to North-Western and North-Eastern Himalayas. In this study, five major nectarine cultivars growing in India namely, 'Silver Queen', 'Red Gold', 'Spring Bright', 'Independence' and 'Missourie' were harvested at commercial maturity and analyzed for various chemical and nutritional aspects. Our results showed that there were quantitative differences among the genotypes in different parameters analyzed. The predominant sugar in nectarine was fructose which was highest in 'Silver Queen' (14.48 mg 100 g^{-1} FW) and lowest in 'Independence' (9.04 mg 100 g^{-1} FW). Major organic acids were malic, succinic, citric and acetic acid. The highest malic acid content was recorded in 'Independence' (1.13 mg 100 g^{-1} FW) and lowest in 'Red Gold' (0.61 mg 100 g^{-1} FW). Nectarine genotypes chiefly contained phloridizin dihydrate and chlorogenic acid as the phenolic component. However, chlorogenic acid was highest in 'Spring Bright' (17.63 μg g^{-1} FW) and lowest in 'Red Gold' (3.67 μg g^{-1} FW). Similarly, a wider variability was recorded in major and minor mineral concentrations among the genotypes. Based on these observations, it can be concluded that among the major nectarine varieties cultivated in India, 'Silver Queen' have higher mineral nutrients than other varieties, and 'Spring Bright' have higher phenolics and antioxidants.

Keywords Functional food · Nutritional composition · Phenolic compounds · CUPRAC · FRAP

Abbreviations

CUPRAC	Cupric reducing antioxidant capacity
FRAP	Ferric reducing ability of plasma
HPLC	High performance/pressure liquid chromatography
μg g^{-1}	Microgram per gram
ROS	Reactive oxygen species

Introduction

Nectarine (*Prunus persica* var *nucipersica*) is a smooth-skinned mutant of peach, belonging to family Rosaceae; sub-family Prunoidae and genus *Prunus* (Gil et al. 2002). It is now considered as an important stone fruit, after peach and plum. Nectarines are widely grown throughout the warmer temperate regions of both the Northern and Southern hemispheres between latitudes 30° and 45°N and S. In India, nectarine cultivation is confined to small area because of its unfamiliarity among the farmers. However, its commercial cultivation has started in the North-Western

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and some regions of North-Eastern Himalayas recently (Sharma and Krishna 2016).

Nectarines have red, yellow or white pulp with most of the varieties of nectarine bearing attractive red colour of varying shades (Wen et al. 1995). Fruit shape also varies considerably from beaked and round-to-flat. Nutritionally, nectarines are on par with peaches. Fresh nectarines provide twice the vitamin A, slightly more vitamin C and much more potassium and fiber than peaches and possess strong flavour and aroma (Wang et al. 1996). Its fruits contain fairly good amount of antioxidant vitamins such as C, A, E and flavonoid polyphenolic antioxidants like lutien, zeaxanthin and β-cryptoxanthin (Colaric et al. 2005). Further, nectarines are juicy, delicious fruits having low calorific value (44 calories/100 g pulp) and have high antioxidant capacity which prevents oxidative stress by suppressing the ROS production in human plasma. Hence the consumption of nectarines which is now considered as functional food is inevitable as it provides protection from chronic diseases (Abidi et al. 2011).

Due to its smooth texture and attractive colour, nectarine fruits are becoming popular among consumers and hence, peach orchards are being replaced by nectarine at a faster rate in different parts of India. Consequently several varieties have been introduced in India, and several new plantings of different nectarine varieties have been established in the recent past. However, there is a paucity of work related to evaluation of varietal wealth for nutritional aspects, although some basic work on fruit growth and physical attributes of six different varieties has been reported by Milosvic et al. (2012) in Siberian region. Hence, we selected five major varieties of nectarine such as Silver Queen, Spring Bright, Red Gold, Independence and Missourie which are being grown in India with an objective to analyze their nutritional composition.

Materials and methods

Experimental material and site

The studies were conducted in the Division of Food Science & Postharvest Technology, ICAR-IARI, New Delhi-110 012 during the fruiting season of 2015–16. The fruits of five major varieties of nectarine grown in India such as 'Silver Queen', 'Spring Bright', 'Red Gold', 'Independence' and 'Missourie' were harvested at full maturity i.e., climacteric (ready-to-eat) in the month of May–June from orchard of Regional Horticultural Research Station, Dr Y. S. Parmar University of Horticulture and Forestry, Bajaura, H.P. The harvested fruits were transported to Delhi for further experimentation.

Determination of moisture content, fruit firmness and quality attributes

Five-randomly selected fruits were used for the determination of moisture content that were determined by weight difference after drying of sample (AOAC 2000). Fruit firmness was determined using a texture analyzer (model: TA + Di, Stable micro systems, UK) using compression test, and expressed as N (Newton). The total soluble solids of nectarine fruit samples were estimated using FISHER hand refractrometer (0–50) and was expressed in °Brix. Titratable acidity in the nectarines was determined by the method described by Ranganna (1999). The content of vitamin C was measured by titration method using 2, 6-dichlorophenol-indophenol dye (Ranganna 1999). Five-randomly selected fruits of each variety were used for the estimation of these parameters, replicated thrice.

Estimation of total antioxidant capacity

Antioxidant capacity was determined in five-randomly selected nectarine fruits of each variety by using two methods viz., CUPRAC (Cupric Reducing Antioxidant Capacity) method (Apak et al. 2004) and FRAP (Ferric Reducing Ability of Plasma) method (Benzie and Strain 1996).

Profiling of sugars and organic acids

The sugars and organic acids were estimated in five-randomly selected nectarine fruits of each variety by high performance liquid chromatography (HPLC) method (Kelebek et al. 2009). Standards of sugars and organic acids were purchased from Sigma-Aldrich, India. Waters high performance liquid chromatography consisting of binary pump model 515, 2414 refractive index (RI) and 2998 photodiode array (PDA) detector was used for all analysis. Sugars and organic acids in aqueous phase were quantified by using Aminex HPX-87H (Bio-Rad Laborataries, Hercules, CA) column operated with 5 mM H_2SO_4 as a mobile phase at a flow rate of 0.5 mL min^{-1} and the oven temperature was kept at 50 °C using both detectors in series (PDA @ 210 nm). The concentrations of sugars and organic acids in nectarine cultivars were expressed as g L^{-1}.

Profiling of phenolic compounds

Extraction of phenolics in five-randomly selected nectarine fruits of each variety was carried out as per the procedure described by Wu and others (Wu et al. 2007). A 20 µL volume of each sample was manually injected into the Water Alliance HPLC System (Waters Chromatography, Milford, MA) attached with a photodiode array detector (PDA). C18 column (5 µm, 4.6 × 250 mm) was used to estimate the individual phenolic components. The concentration of phenolic compounds was expressed as µg g^{-1} FW.

Profiling of fatty acids

Fatty acid methylated esters (FAMEs) were evaluated in five-randomly selected nectarine fruits of each variety according to trans-esterification method. The fatty acids were methylated after dissolving the sample in methanol (2 mL), followed by the addition of few drops of concentrated H_2SO_4. The corresponding FAMEs were extracted with hexane by adding salt solution (10 mL) for complete recovery. GC–MS analysis was carried out using 7890A GC (Agilent Technologies) equipped with a HP-5MS column (30 m × 0.25 mm 0.25 µm, Agilent Co., USA), which was directly connected to a triple axis HED-EM 5975C mass spectrometer (Agilent Co., USA) as described by Wu and others (Wu et al. 2007). The injection volume was one µL with flow mode in split control. The carrier gas flow was set at 1 mL min^{-1} helium. Helium (High purity, New Delhi, India) was used as carrier gas at a head pressure of 10 psi. The oven temperature was initially kept at 40 °C for 1 min. Thereafter, temperature was raised with a gradient of 2 °C min^{-1} up to 220 °C and held for 1 min. Finally, the temperature was raised up to 280 °C with an increment of 5 °C min^{-1}. The total run time was 111 min. Other settings included as 250 °C interface temperature and electron impact ionization (EI) at 70 Ev. The fatty acid profile was represented as percent relative area (Saha et al. 2016).

Nutrient profiling

For estimation of macro and micro nutrient elements in five-randomly selected nectarine fruits of each variety, fruit sample (1 g) was digested in a microwave digestion system (Anton Par: Multiwave ECO) with concentrated nitric acid (Suprapur grade, Merck, Germany) and digested samples were transferred to 100 mL volumetric flask to make up the dilution volume. The concentrations of elements were analyzed using ICP-MS platform with auto-sampling protocol (Perkin Elmer, Model: NexION 300 ICP-MS) and represented as mg 100 g^{-1} for macro elements and µg g^{-1} for micro elements.

Statistical design and analysis of data

The data obtained from the experiments were analysed as per Completely Randomized Design (CRD) using the SAS (Statistical Analysis System, US) and the results were compared from ANOVA by calculating the Least Significant Difference, LSD (Panse and Sukhatme 1984).

Results and discussion

Moisture content, fruit firmness and quality attributes

The attributes such as moisture content (%), fruit firmness (N), soluble solids concentrates (°Brix), titratable acidity (%) and ascorbic acid content (mg 100 g^{-1} pulp) differed significantly among different varieties of nectarine (Table 1). All these physical parameters along with eating quality attributes to the overall acceptability of fruits in the market, hence these parameters plays paramount role in marketability of fruits. Among varieties, the highest moisture content was recorded in 'Independence' (89.94%) and lowest in 'Missourie' (82.99%). Further, fruit firmness, which is one of the most important parameter used for determining the acceptability of fruits by the consumer, was found to be highest in 'Spring Bright' (9.2 N) and lowest in 'Independence' (6.6 N). Soluble solids content were highest in 'Missourie' (13.5°B) and lowest each in 'Silver Queen' and 'Spring Bright' (10.7°B). Furthermore, titratable acidity of nectarine fruits was also significantly influenced by variety, being highest in 'Spring Bright' (0.424%) and lowest in 'Red Gold' (0.134%). Similarly, significant influence of varietal variability was observed on ascorbic acid contents of nectarine as well. These contents were significantly highest in 'Spring Bright' (13.53 mg 100 g^{-1} pulp) and lowest in 'Red Gold' (4.18 mg 100 g^{-1} pulp).

The variability in moisture content, fruit firmness, soluble solids concentrate, titratable acidity and ascorbic acid content among different genotypes of nectarine may be attributed to genetic variability existing amongst them as per the report by Gil et al. (2002). Our results support the findings of Adrees et al. (2010) who reported variability in vitamin C content, dry matter and TSS among different guava genotypes. Significant variability in TSS and fruit firmness of different nectarine cultivars grown in Italy has been reported by Vaio et al. (2014). Similarly, Milosevic et al. (2012) also reported the variation in firmness in different varieties of nectarine grown in Siberian region, maximum being in 'Caldesi 2000' and minimum in 'Nectared'.

Concentrations of sugars

The predominant sugar in nectarine was found to be fructose. However, considerable amount of glucose and sucrose was also present in different varieties (Fig. 1). Among the

Table 1 Moisture content, fruit firmness and some quality attributes of different nectarine genotypes

Variety	Moisture content (%)	Fruit firmness (N)	Total soluble solids (°B)	Titratable acidity (%)	Ascorbic acid (mg 100 g^{-1} pulp)
Silver Queen	85.87 ± 0.006	8.5 ± 0.370	10.7 ± 0.100	0.400 ± 0.04	05.11 ± 0.84
Independence	89.94 ± 0.006	6.6 ± 0.074	11.4 ± 0.057	0.234 ± 0.01	09.76 ± 0.98
Missourie	82.99 ± 0.089	7.2 ± 1.443	13.5 ± 0.100	0.201 ± 0.05	08.36 ± 1.76
Red Gold	88.79 ± 0.023	7.8 ± 0.497	12.7 ± 0.100	0.134 ± 0.03	04.18 ± 0.81
Spring Bright	84.47 ± 0.102	9.2 ± 0.925	10.7 ± 0.100	0.424 ± 0.04	13.53 ± 2.3
LSD at 5%	0.11	0.49	0.17	0.059	1.46

Each value is expressed as mean ± standard deviation, n = 3

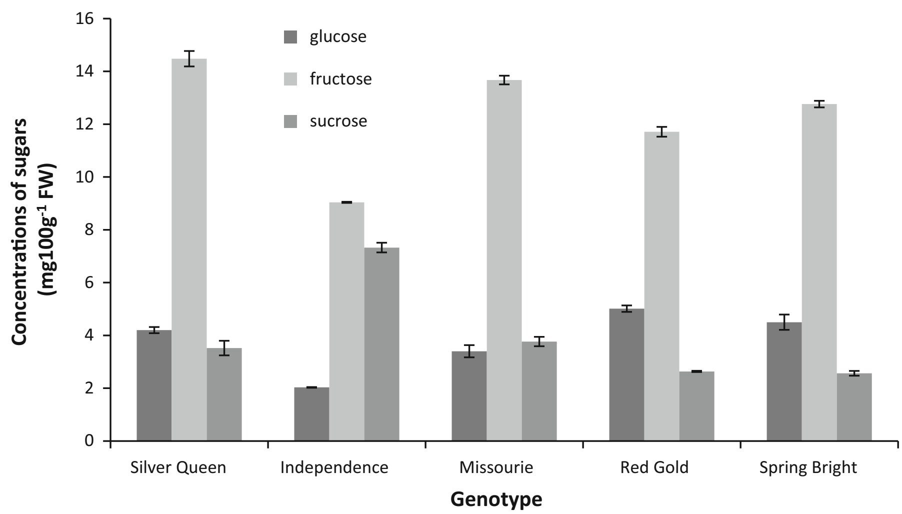

Fig. 1 Concentrations of different sugars (mg 100 g^{-1}) in nectarine genotypes

varieties, the highest fructose content was observed in 'Silver Queen' (14.48 mg 100 g^{-1} FW) and lowest in 'Independence' (9.04 mg 100 g^{-1} FW). Further, the highest glucose content was observed in 'Red Gold' (5.01 mg 100 g^{-1} FW) and lowest in 'Missourie' (3.40 mg 100 g^{-1} FW) (Fig. 1). Similarly, the highest sucrose content was found in 'Independence' (7.32 mg 100 g^{-1} FW) and the lowest in 'Spring Bright' (2.53 mg 100 g^{-1} FW), non significantly followed by 'Red Gold' (2.63 mg 100 g^{-1} FW) (Fig. 1).

In a similar study, Abidi et al. (2011) also reported that there is considerable variation in soluble sugar content and antioxidant capacity of nectarine progenies which is explained by the quantitative performance of this quality trait. Such differences in the concentration of different sugars among nectarine varieties may be due to genetic differences among the genotypes. Adrees et al. (2010) had also observed differences in sugar content in different guava cultivars grown in Pakistan. Similar variability in the concentrations of different sugars in eight apple cultivars grown in 'Shandong' province of China was reported by Wu et al. (2007).

Organic acids

We observed that different genotypes of nectarine have exerted a significant influence on concentrations of different organic acids. The most predominant organic acid was malic followed by succinic, citric and acetic acid (Table 2). The highest malic acid content was found each in 'Independence' and 'Silver Queen' (1.13 mg 100 g^{-1} FW) and lowest in 'Red Gold' (0.61 mg 100 g^{-1} FW). Similarly, fruits of 'Missourie' contained maximum concentration of succinic acid (1.18 mg 100 g^{-1} FW) and that of Silver Queen' the minimum (0.33 mg 100 g^{-1} FW). Furthermore, the highest citric acid content was recorded in the fruits of 'Independence' (2.20 mg 100 g^{-1} FW) and lowest in 'Missourie' (1.53 mg 100 g^{-1} FW) and 'Spring Bright' (1.53 mg 100 g^{-1} FW) (Table 2). Acetic acid was highest in the fruits of 'Missourie' (0.36 mg 100 g^{-1} FW) and lowest in 'Spring Bright' (0.21 mg 100 g^{-1} FW). Similarly, the concentrations of total organic acids were recorded to be highest in 'Independence' (4.56 mg 100 g^{-1} FW) and lowest in 'Red Gold' (3.33 mg 100 g^{-1} FW) (Table 2).

Table 2 Concentrations of organic acids (mg 100 g^{-1} FW) in different genotypes of nectarine

Variety	Organic acids (mg 100 g^{-1} FW)				
	Malic acid	Succinic acid	Citric acid	Acetic acid	Total acids
Silver Queen	1.06 ± 0.02	0.33 ± 0.05	1.68 ± 0.02	0.34 ± 0.01	3.41 ± 0.09
Independence	1.13 ± 0.25	1.02 ± 0.03	2.20 ± 0.20	0.24 ± 0.01	4.56 ± 0.48
Missourie	0.68 ± 0.02	1.18 ± 0.04	1.53 ± 0.25	0.36 ± 0.02	3.72 ± 0.31
Red Gold	0.61 ± 0.01	0.77 ± 0.02	1.62 ± 0.01	0.31 ± 0.01	3.33 ± 0.04
Spring Bright	0.76 ± 0.03	1.16 ± 0.11	1.53 ± 0.02	0.21 ± 0.01	3.60 ± 0.16
LSD (0.05%)	0.21	0.11	0.26	0.02	0.49

Each value is expressed as mean ± standard deviation (n = 3)

Variability in the concentrations of different organic acids may be due to significant variability among different genotypes of nectarine. Reig et al. (2013) observed a fivefold range differences in malic acid concentration in different cultivars of peach grown in Spain.

Phenolic acids

Phenolic acids are major source of dietary antioxidants which reduces the risk of many chronic disorders, including cancer (Boyer and Liu 2004). They are anti-mutagenic and anti-cancerous in nature, phenolic acid acts as protective agents of DNA against free radicals, by inactivating carcinogens, inhibiting enzymes involved in pro-carcinogen activation and by activating of xenobiotics detoxification enzymes. In this study, our data elucidated that different genotypes of nectarine contained phloridizindihydrate and chlorogenic acid as major phenoic compounds acid and smaller quantities of coumaric acid and 3-hydroxy cinnamicacid (Table 3). Chlorogenic being a major phenolic acid, was found to be higher concentration in 'Spring Bright' (17.63 µg g^{-1} FW) and lowest in 'Red Gold' (3.67 µg g^{-1} FW). Further, coumaric acid was found maximum in 'Spring Bright' (3.50 µg g^{-1} FW) and minimum in 'Red Gold' (2.01 µg g^{-1} FW).

Wu et al. (2007) in a similar study, reported that there was a significant variation in the phenolic acid components among different cultivars of apple, major being chlorogenic acid.

Antioxidant capacity

Antioxidant capacity in different genotypes of nectarine was determined by using two methods namely, CUPRAC (Cupric reducing antioxidant capacity) and FRAP (Ferric reducing antioxidant power). Maximum antioxidant activity was recorded in 'Spring Bright' (24.10 µmol TE g^{-1} FW) and minimum in 'Missourie' (20.06 µmol TE g^{-1} FW) in CUPRAC method (Table 3). Similarly using FRAP method, maximum AOC capacity was observed in 'Spring Bright' (12.15 µmol TE g^{-1} FW) and minimum in 'Missourie' (9.66 µmol TE g^{-1} FW) (Table 3). All genotypes showed higher AOX activity when determined with CUPRAC (Cupric reducing antioxidant capacity) than FRAP (Ferric reducing antioxidant power) method.

The health-promoting properties of fruits and vegetables are mainly due to the presence of different antioxidant

Table 3 Concentrations of different phenolic acids (µg g^{-1} FW) and antioxidant capacity among nectarine genotypes

Variety	Phenolic acids (µg g^{-1} FW)					Antioxidant capacity (µmol TE g^{-1} FW)	
	Chlorogenic acid	Coumaric acid	3-Hydroxy cinnamic acid	Phloridizindihydrate	Total	CUPRAC	FRAP
Silver Queen	17.53 ± 0.02	2.82 ± 0.05	0.56 ± 0.02	16.62 ± 0.03	37.54 ± 0.04	23.60 ± 0.40	11.17 ± 0.05
Independence	5.76 ± 0.26	2.60 ± 0.12	0.92 ± 0.04	18.80 ± 0.29	28.10 ± 0.64	21.41 ± 0.08	10.23 ± 0.02
Missourie	4.38 ± 0.15	3.18 ± 0.06	0.71 ± 0.01	19.65 ± 0.25	27.93 ± 0.43	20.06 ± 0.07	9.66 ± 0.09
Red Gold	3.67 ± 0.27	2.01 ± 0.03	0.03 ± 0.05	22.11 ± 0.14	27.94 ± 0.38	20.81 ± 0.15	9.81 ± 0.15
Spring Bright	17.63 ± 0.02	3.50 ± 0.07	0.81 ± 0.03	16.20 ± 0.12	38.16 ± 0.14	24.10 ± 0.01	12.15 ± 0.07
LSD (0.05)	0.35	0.12	0.03	0.35	0.72	0.37	0.1628

Each value is expressed as mean ± standard deviation (n = 3) components, including phenolics. Similar variation in composition and antioxidant activity of different genotypes of 25 cultivars of peach and nectarines grown in California was reported by Gil et al. (2002).

Percentage relative area of different fatty acids

Our study revealed that major fatty acids (% relative area of peak) present in different nectarine genotypes were: 2-furoic acid, pentanoic acid, levulinic acid, 1, 2-benzene dicarboxylic acid, linoleic acid, 8, 11-octadecadienoic acid and hexanedecoic acid. Among different fatty acids, maximum concentration was of pentanoic acid, and the minimum was of 8, 11-Octadecadienoic acid (Table 4). In general, there was a very high degree of variability with respect to different fatty acids among the genotypes. Pentanoic and levulinic acid were dominant in all the nectarine genotypes.

Our study is in line with the study regarding the variability in fatty acid composition in different varieties of apple. Similarly, Saha et al. (2016) reported the compositional and functional difference in cumin essential oil extracted by different methods.

Mineral content

We observed significant difference in major mineral constituents among different genotypes of nectarine (Table 5). Among the varieties evaluated, calcium content was highest in 'Silver Queen' (54.404 mg kg^{-1} DW) and lowest in 'Spring Bright' (23.572 mg kg^{-1} DW). Apart from calcium, magnesium content also showed considerable variation among different genotypes, maximum being in 'Silver Queen' (53.275 mg kg^{-1}DW) and minimum in 'Independence' (24.314 mg kg^{-1} DW) (Table 5). Similarly, the highest potassium content was recordedin 'Silver Queen' (77.732 mg kg^{-1} DW) and least in 'Spring Bright' (51.532 mg kg^{-1} DW).

Nectarines are good source of minor minerals such as iron, manganese, zinc, copper, nickel and cobalt and its concentration differs significantly among the studied genotypes of nectarine fruits. Among varieties, the highest iron content was recorded in 'Silver Queen' (3.590 mg kg^{-1} DW) and lowest in 'Spring Bright' (1.554 mg kg^{-1} DW) (Table 5). Zinc content was maximum in 'Silver Queen' (1.030 mg kg^{-1} DW) and minimum in 'Red Gold' (0.386 mg kg^{-1} DW). Similarly, the highest manganese content was recorded in 'Missourie' (0.317 mg kg^{-1} DW) and the lowest in 'Spring Bright' (0.122 mg kg^{-1} DW). However, the maximum copper content was reported maximum in 'Silver Queen' (0.377 mg kg^{-1} DW) and minimum in 'Missourie' (0.179 mg kg^{-1} DW). Furthermore, the highest nickel content was observed in 'Silver Queen' (18.466 μg kg^{-1} DW) and the lowest in 'Spring Bright' (7.133 μg kg^{-1} DW). Similarly, the highest cobalt content was recorded in 'Red Gold' (8.830 μg kg^{-1} DW) and the lowest in 'Independence' (5.300 μg kg^{-1} DW).

A significant variability was observed for most of the major and minor elements among the studied nectarine genotypes, which may be attributed to genotypic variability. In a similar study, Aziz et al. (2013) studied the mineral constituents of apple pulp and reported variation in chemical composition among the cultivars. Similarly, Fazli and Fazli (2014) studied the mineral constituents of various fruits and found that fruits differ in their mineral composition.

Conclusion

Nectarine is a delicious fruit with immense nutrients and antioxidant capacity which makes them the most favorable among the consumers. Apart from the nutritional benefits, good appeal of fruit compared to peaches, makes it popular among consumers as well as growers. Even if it's a familiar

Table 4 Percentage relative area of different fatty acids in different genotypes of nectarine

Variety	Fatty acids (% Relative area)						
	2-Furoic acid	Pentanoic acid	Levulinic acid	1,2-Benzene dicarboxylic acid	Linoleic acid	8,11-Octadecadienoic acid	Hexanedecoic acid
Silver Queen	0.12	46.9	0.13	2.29	3.41	0.03	0.95
Independence	0.0	0.0	62.67	2.83	2.2	0.01	0.25
Missourie	0.23	41.23	0.56	2.58	3.98	0.01	0.85
Red Gold	0.18	35.56	0.89	2.03	0.05	0.01	0.25
Spring Bright	0.0	61.24	0.98	9.12	0.07	0.02	0.31

Each value is expressed as mean ± standard deviation (n = 3)

Table 5 Variation in concentrations of different minerals among nectarine genotypes

Variety	Major minerals			Minor minerals					
	Ca (mg kg^{-1})	Mg (mg kg^{-1})	K (mg kg^{-1})	Fe (mg kg^{-1})	Zn (mg kg^{-1})	Mn (mg kg^{-1})	Cu (mg kg^{-1})	Ni (μg kg^{-1})	Co (μg kg^{-1})
Silver Queen	54.40 ± 0.02	53.27 ± 0.01	77.73 ± 0.20	3.59 ± 0.07	1.03 ± 0.01	0.27 ± 0.02	0.38 ± 0.01	18.47 ± 0.25	7.50 ± 0.20
Independence	22.85 ± 0.17	24.31 ± 0.02	72.73 ± 0.05	2.07 ± 0.01	0.47 ± 0.01	0.29 ± 0.02	0.25 ± 0.01	15.40 ± 0.30	5.30 ± 0.20
Missourie	35.66 ± 0.03	32.18 ± 0.02	68.70 ± 0.15	2.36 ± 0.02	0.57 ± 0.02	0.32 ± 0.01	0.18 ± 0.09	7.77 ± 0.11	7.50 ± 0.20
Red Gold	32.35 ± 0.01	28.73 ± 0.03	67.40 ± 1.0	1.96 ± 0.03	0.39 ± 0.01	0.14 ± 0.01	0.24 ± 0.01	8.39 ± 0.70	8.83 ± 0.15
Spring Bright	23.57 ± 0.02	28.43 ± 0.01	51.53 ± 0.55	1.55 ± 0	0.84 ± 0.00	0.12 ± 0.01	0.19 ± 0.01	7.13 ± 1.40	6.80 ± 0.10
LSD at 5%	0.041	0.043	0.964	0.045	0.026	0.032	0.019	1.189	1.189

Each value is expressed as mean ± standard deviation (n = 3) (mg kg^{-1} DW) crop in international market, in India, its cultivation began few years back and now getting popular. In this study, by analyzing the major genotypes for various physical and biochemical attributes we conclude that among the major varieties cultivated in India,'Silver Queen' have higher mineral nutrients content as compared to the other varieties, and 'Spring Bright' have higher phenolics and antioxidants. The major phenolic component is chlorogenic acid which is a potent antioxidant and anti-carcinogenic in nature.

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