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Evaluation of apricot genotypes for table use, drying and their storage life

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ABSTRACT

Fifteen apricot (*Prunus armeniaca* L.) varieties/genotypes grown under temperate ecosystem were evaluated for table use, drying, quality maintenance and shelf life during their storage at refrigerated temperature (60% RH and 4±2°C Temp.). Storage life of fresh fruit PLW, TSS, acidity, ascorbic acid was measured in stored fruits at 4 days interval till 28 days of storage. Present investigations revealed that there were significant differences for physico chemical characteristics of different apricot varieties/genotypes, their drying potential and quality maintenance during storage period. The varieties CITH-AP-1, CITH-AP-2, CITH-AP-6, Heartly, Turkey and New Castle were better with respect to quality parameters like weight, size, firmness, TSS, TSS/acid ratio, ascorbic acid and β-carotene and maximum shelf life, whereas, after drying varieties such as CITH-AP-2, CITH-AP-3, Afghani, Turkey and Erani were having good quality characteristics like colour, firmness, TSS, ascorbic acid, β-carotene and better shelf life. These varieties need further exploitation for commercialization and significantly high returns.

Key words: Apricot varieties, Drying, Quality, Shelf-life, Table use

Apricot (*Prunus armeniaca* L.) is the species of *Prunus* classified with prunoidae sub family Rosaseae, family of Rosales order (Haydar *et al.* 2007). The apricot is native to central and western China. Turkey, Spain, Greece and France are major producers of apricot (Ghorpade *et al.* 1995). In India, major apricot producing states are Jammu and Kashmir, Himachal Pradesh and Uttarakhand. Area under apricot cultivation in J & K is 4886 ha with annual production of 16739 tonnes (FAO 2011). The β- carotene and lycopene activity of apricots may prevent the heart disease. Apricots are good source of fiber, which has a health benefit such as prevents digestive conditions called as diverculosis. These fruits are anti-pyretic, antiseptic, emetic and ophthalmic (Pramar and Kaushal 1982). The decoction of apricot bark is used to smooth inflamed and irritated skin conditions (Chevallier 1996). In addition to consumed as fresh, apricots are processed as dried apricots, frozen products, jams, jelly, nectars and extrusion products. Moreover, apricot kernel is used in production of oil, benzydehyde, cosmetic activity, carbon and aroma perfume (Yildiz 1994). Due to low sugar and moderate high acidity, the apricot varieties grown in mid hills and valley areas are not suitable for drying (Sharma *et al.* 2004).

Several reports appear in literature regarding the nutritional value of different apricot genotypes and varieties; however, little information is available on chemical composition, drying potential, and storage life of apricot varieties grown in temperate regions. The market demand for high qualitative standards and having new attractive appearance and good flavour cultivars are needed to satisfy consumers demand for table use and as value added products. Apricot is a climacteric fruit with high respiratory and metabolic rate and highest ethylene emission. Rapid post harvest softening is one of the major problems of apricot which limits its availability and marketing (Chambroy *et al.* 1995, Souty *et al.* 1995). Owing to these features, shelf life of apricot is extremely short (1-2 weeks) at 0° C temperature and 90% relative humidity (Rubio and Infante 2010).

In most of the countries in addition to consumption of fresh apricots, there is huge demand of its dried products. Availability of fresh fruit in the market is from May end to August while dried fruits may be available round the year. The apricot is preserved mainly by conventional methods like sun drying without any pre drying chemical treatments.

In view of the above statements, the main objective of present investigation was to screen specific varieties for table use and drying purpose and further evaluation for their shelf-life.

MATERIALS AND METHODS

The study was carried out during the summer(s) of 2011 and 2012. The apricot trees budded/grafted on peach seedlings planted in 2003 at a spacing of 5m × 5m were used as study material. Fifteen varieties of apricot trained on central head system with recommended cultural practices were evaluated.

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Yellowish green firm and ripe apricots fruits of different varieties were directly harvested from research orchards of CITH, Srinagar (J & K). Single tree of each cultivar constituted an experimental unit, which was replicated four times. After collection, fruits were immediately transferred to laboratory. The fruits were washed in running tap water, chlorinated with 100 ppm sodium hypochlorite, cleaned and dried with muslin cloth. After drying, sorted fruits were divided into equal lots. One lot was used for recording initial physico-chemical characteristics of the fruits of different apricot cultivars under experimentation; second lot was packaged in polyethylene bags and cartons, stored at refrigerated temperature (RH 60% and Temp. 4±2°C) While as, third lot was used for drying and their quality analysis. The quality characters of fresh and dried fruits such as colour, size of fruit, fruit weight, , ascorbic acid and β carotene were determined as described by AOAC 2000. TSS of fruits was determined by using digital hand refractometer.

Physical characteristics of the fruits like weight and size, pit size, stone weight, kernel weight were recorded by standard procedures.

Firmness (RI) was determined on two opposite checks as the equatorial zone using a hand held fruit firm tester (Model No. 63776) with 0.25 mm tip.

After analysis for firmness, apricot fruits were cut into small pieces and homogenised in a grinder and 10 g of ground apricot were suspended in 100 ml of distilled water and then filtered. The titratable acidity, TSS and ascorbic acid were measured using methods described by AOAC (2000).

External colour of apricot fruits was evaluated with a Hunter Lab colorimeter following the recording of individual L* (brightness0, a*(redness), b* (yellowness). Four readings were taken at different locations on each fruit, using a total of 12 fruits for each treatment. Measurement was done in triplicate.

Weight loss was expressed as percent loss of the initial total weight. For each measurement, 25 fruits corresponding to each treatment were used and experiment was performed in triplicate.

Shelf-life of fresh fruit for PLW, TSS, acidity, ascorbic acid was measured in stored fruits at an interval of 4, 8, 12 ...., 28 days after storage.

Hedonic scale was used to record fruit skin colour and organoleptic rating on the basis of appearance taste and flavour by panel of ten judges as described by the Larmond (1977).

Sensory evaluation based on general visual appeal, colour and visible structural integrity was conducted using a 7 point hedonic scale. The scores were: like extremely (7); like very much (6); like moderately (5); neither like nor dislike (4); dislike moderately (3); dislike very much (2); and dislike extremely (1). Fruits scored above 4 were considered acceptable.

The experiment was laid out in complete randomized design (CRD). The treatment means were compared using the least significant difference (LSD) values of ≤ 0.5%. All the analysis was conducted using procedure of the Statistical Analysis System (SAS, Institute Inc., Cary, NC, USA) and described by AOAC (2000).

Dehydration procedure given in flow chart was followed according to method described by Singh *et al*. (2014)

Flow chart for drying of apricot

Selection of mature and ripe fruit

↓

Washing of fruits and treated with disinfectant for 30 seconds

↓

(100 ppm sodium hypochlorite)

↓

Halving of fruits and removing of stones

↓

Blanching in 1% KMS (15 min.)

↓

Halved and blanched fruits spread on aluminium trays

↓

Dried in cabinet cross flow drier at 55 C° for 5 hours.

↓

Moisture in finished product 15± 2% moisture

↓

Packing in 100g LDPE and final packing in glass jars

RESULTS AND DISCUSSION

Fruit quality traits at physiological maturity stage

The main pomological characters (physico-chemical) of different apricot genotypes under temperature climate of Kashmir are given in Table 1. Maximum fruit weight was recorded in var. CITH-AP-1 (88.8 g) followed by CITH-AP-2 (64.2 g) and CITH-AP-8 (61.4 g). Significant variation in size of pit was recorded in all the varieties. Results reveal that size of fruit (L×B) was maximum in CITH-AP-1 (49.5 × 56.3 mm) followed by CITH-AP-8 (48.2 × 47.2 mm) and CITH-AP-2 (46.2 × 46.3 mm). Maximum length of the pit was recorded in var. CITH-AP-1 (33.0 cm), Harcot CITH-AP-8 (31.6 cm in each) and CITH-AP-2 (30.8 cm), whereas maximum breadth of the pit was recorded in var. Australia (27.7 mm), Harcot (26.9 mm) and CITH –AP-1 (26.6 mm). Similarly, stone weight also differed significantly and maximum of 4.5 g was recorded in var. CITH-AP- 1, 3.8 g in CITH-AP-8 and CITH-AP-2 (3.1 g). Size of the stone (length × breadth) was recorded maximum in var. CITH – AP- 1 (28.4 mm × 24.3 mm) followed by CITH-AP-8 (27.1 × 21.2 mm), CITH-AP-2 (24.9 x 21.8 mm). Highest kernel weight was recorded in var. CITH-AP- 8 (1.4 g), Erani (1.1 g). Kernel thickness was maximum in var. Australian (22.0 mm) followed by CITH-AP-8 (21.2 mm). These variations could be due to varietal characteristics. Similar variation in fruit shape, size and physico, chemical characteristics and quality of apricot fruits are reported by Kazankaya (2002), Sharma *et al. (*2005) and Bhat *et al .(*2013).

Significant variation was recorded for fruit firmness

Table 1 Physical characteristic of apricot genotypes grown under temperate ecosystem

Variety	Fruit wt. (g)	Size of fruits (mm)		Size of pit (mm)		Stone wt. (g)	Size of stone (mm)		Kernel weight (g)	Kernel thickness (mm)	Firmness (RI)	OR rating
		L	B	L	B		L	B				
CITH-AP-1	88.8	49.5	56.3	33.0	26.6	4.5	28.4	24.3	1.0	15.8	37.7	9.0
CITH-AP-6	20.1	28.2	30.8	24.2	19.2	1.7	19.1	16.5	0.9	14.1	33.7	9.0
Harcot	45.1	44.2	39.9	31.6	26.9	2.0	24.2	18.9	0.9	14.7	38.5	8.0
Afghan	39.5	40.6	39.3	23.6	20.3	2.3	22.5	18.9	0.9	16.7	39.7	7.5
CITH-AP-8	61.4	48.2	47.2	31.6	25.5	3.8	27.1	21.2	1.4	21.2	38.5	7.0
CITH-AP-19	21.6	33.8	32.5	25.8	23.3	2.2	21.6	17.3	0.9	16.8	31.0	7.0
Australian	55.4	45.6	43.4	26.5	27.7	2.8	26	18.8	1.0	22.0	35.2	6.8
CITH-AP-16	23.9	32.1	33.3	26.2	23.8	2.3	21.2	17.8	1.0	16.3	39.2	7.5
CITH-AP-18	18.0	28.2	30.4	23.8	20.3	1.9	21.7	16.7	0.7	16.7	37.8	7.0
CITH-AP-2	64.2	46.2	46.3	30.8	22.3	3.1	24.9	21.8	0.7	15.9	40.1	8.5
Erani	41.7	39.6	42.9	24.6	23.7	3.0	23.1	19.7	1.1	16.1	41.0	7.6
CITH-AP-3	20.2	30.2	31.5	22.5	19.1	2.0	20.5	17.2	0.8	14.2	40.5	7.5
Turkey	17.5	27.79	30.87	23.1	21.0	2.0	19.8	16.9	0.9	15.1	44.0	8.0
Heartly	23.32	23.7	38.7	21.1	20.1	2.1	18.9	17.1	0.9	15.1	34.1	7.0
New Castle	22.1	31.1	32.1	22.5	19.2	2.1	20.2	17.9	1.0	15.3	39.5	8.0
CD (P=0.05)	1.75	1.97	1.90	1.92	2.0	0.70	1.23	1.70	0.10	0.97	0.90	0.07

among different cultivars. Maximum firmness of fruits was recorded in var. Turkey (44.0 RI) followed by Erani (41.0 RI), CITH –AP-3(40.5 RI), however, these were found at par statistically. CITH -AP-19 was found to be very soft having firmness of 31.0 RI followed by CITH-AP-6 (33.0 RI) and Heartly (34.1RI). Firmness of flesh may also vary as a result of variation in pectin substances (Vardzelashvili and Lebanze 1974) and due to variation in crop load (Spayed *et al.* 1986, Bhat *et al.* 2013). Significantly overall acceptance (OA) of excellent was recorded in CITH-AP-1 and CITH-AP-6 (9.0 for each), CITH-AP-2 (8.5), Hearlty, Turkey, New Castle (8.0 each).

Chemical characteristics

It was found that cultivars CITH-AP-16 recorded significantly higher TSS (25.6°B) followed by CITH-19 (23.0), CITH-AP-18 (22.8), CITH-AP-6 (21.7), whereas minimum TSS°B was recorded in cultivars New Castle (13.80) followed by Turkey (14.00), CITH-8(15.2) (Table 2). Whereas, titrable acidity (%) was found maximum in Harcot (0.92%) followed by CITH-1-AP-6 (0.75%). Erani (0.58) whereas minimum was recorded in CITH-AP-19 (0.22%) followed by Afghan and CITH-AP-16 (0.25%). It is apparent from the data that significantly highest TSS/acidity ratio was recorded in CITH-AP-19 (106.8), CITH-16 (102.0), Afhan (67.6), CITH AP- 3 (49.3) and New castle (40.20). In fresh fruits, ascorbic acid content in different varieties varied from 11.87 to 15.50 mg/100g, which is in agreement with Wenkam (1979) and Arthey and Philip (2003). Significantly highest ascorbic acid was recorded in CITH-AP-3(15.5mg/100g) closely followed by Afghan (15.2), Erani (15.0 mg/100g), CITH-2 (14.8 mg/100g). Variation in ascorbic acid content in different cultivars was also reported by Sharma *et al.* (2005) and Bhat *et al.* (2013). Significant variation in β carotene was recorded in different cultivars and maximum

Table 2 Chemical compositions of apricot genotypes grown under temperate ecosystem

Variety	TSS (°B)	Titrable acidity (%)	TSS/ acidity ratio	Ascorbic acid (mg/ 100g)	β-carotene (mg/ 100g)
CITH-AP-1	15.9	0.44	36.13	14.72	2.72
CITH-AP-6	21.7	0.75	28.10	14.18	2.18
Harcot	19.1	0.92	20.76	14.72	2.72
Afghan	16.9	0.25	67.6	15.20	3.2
CITH-AP-8	15.2	0.56	27.12	14.10	2.1
CITH-AP-19	23.5	0.22	106.8	14.10	2.1
Australian	15.9	0.56	28.39	14.18	2.18
CITH-AP-16	25.6	0.25	102.0	14.20	2.17
CITH-AP-18	22.8	0.36	63.33	14.72	2.72
CITH-AP-2	19.5	0.56	34.82	14.88	2.88
Erani	15.8	0.58	27.24	15.00	2.35
CITH-AP-3	15.98	0.32	49.93	15.50	2.89
Turkey	14.1	0.64	22.03	14.10	2.05
Heartly	15.98	0.44	36.31	11.87	1.87
New Castle	13.80	0.28	49.20	14.10	2.10
CD (P=0.05)	0.72	0.07	1.01	0.58	0.08

of 3.2 mg/100g was recorded in Afghan, CITH—AP-3, CITH-AP-2 (2.88 in each per 100g), CITH-AP-1, Heartly, CITH-18 (2.72 mg/100g). These observation are parallel to findings of Joshi *et al.* (1990), Bhat *et al.* (2013) and Leccese *et al.* (2010).Variation in different apricot cultivars grown in temperate regions were also reported by Lone (2013).

Post-harvest study of apricot cultivars

Physiological loss in weight (PLW %)

A significant difference of weight in apricot fruits was observed during storage (Fig 1). At the end of storage study,

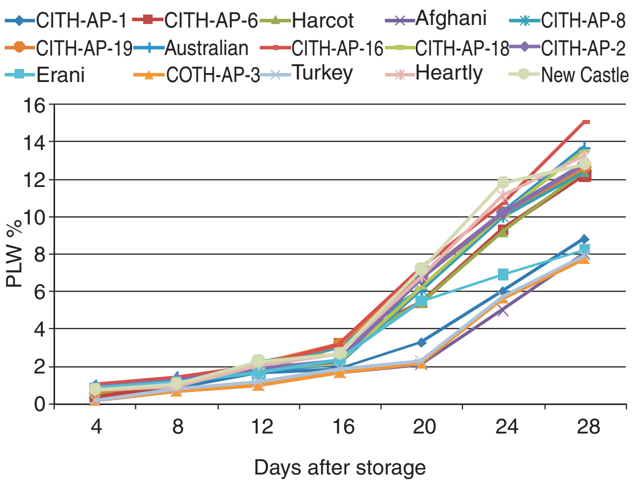

Fig 1 PLW (%) of apricot varieties stored at Low Temperature (LT).

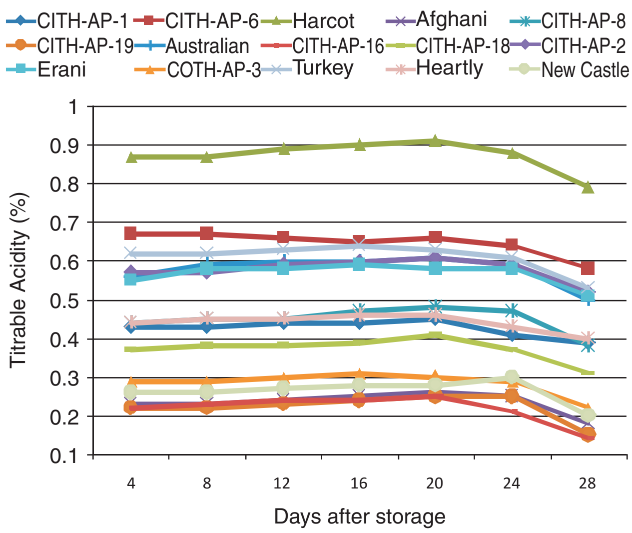

Fig 2 Titrable acidity % of apricot varieties stored at Low Temperature (LT).

minimum PLW (7.7%) was observed in variety CITH-AP-3 followed by Turkey (7.9%), Afghani (8.0%), Erani (8.2%) and CITH-AP-1 (8.8%), whereas maximum PLW was recorded in var. CITH-AP-16 (15.0%), Australian (13.7%), CITH-AP-18 (13.5%). Our data shows that there was increasing trend of weight loss with the passage of storage period. However, it was critically noticed that maximum weight loss occurred after 16th day of storage. The increasing trend of weight loss might be due to respiration, transpiration of water and other biological changes taking place during storage. These findings are corresponding with Agar and Polato (1995) and Ishaq *et al.* (2009) who have observed an increasing trend in weight loss in apricot varieties during storage. Water is the most abundant nutrient in fruits. However, maximum amount of water content varies between individual fruit of same kind because of various structural and growth features. It may be affected by cultural conditions, which influence structural differentiation (Salunkhe *et al,* 1991). Weight is of great importance because it can cause fruit shrivelling and advance senescence. It is mostly dependant on the relative humidity surrounding the fruit, but can also be associated with a slight reduction in flesh firmness (Antunes and Sfakiotakis 1997) and Harris and Ried 1981).

Total Soluble Solids

There was gradual increase in TSS with the passage of time during storage. Increasing trend was sustained up to 20-24 days of storage, whereas, after that TSS significantly decreased. Data indicates that minimum decrease of 1.19% was recorded in variety Afghan followed by Erani (1.85%), CITH-AP-3 (3.00%) and Turkey (3.44%), Australian (5.0%), CITH-AP-6 ((5.0%), CITH-AP-1 (5.05%), whereas, maximum decrease was recorded in CITH-AP-18 (15.1%),

Table 3 Quality of dehydrated apricot of different varieties grown under temperate ecosystem

Variety	Colour value		Firmness	TSS	Titrable	Ascorbic acid	β carotene	TSS/acidity
	L	a	(RI)	(°Brix)	acidity (%)	(mg/100g)	(mg/100g)	ratio
CITH-AP-1	40.6	29.6	44.1	19.2	0.97	9.5	1.71	19.79
CITH-AP-6	37.2	29.5	43.7	24.7	1.27	9.0	1.17	19.44
Harcot	43.2	31.2	45.5	23.2	1.20	10.3	1.72	19.33
Afghan	52.5	37.2	55.1	21.0	0.87	10.8	2.20	24.13
CITH-AP-8	39.5	27.5	43.2	20.0	1.00	9.00	1.10	20.00
CITH-AP-9	40.2	29.5	44.5	27.5	0.80	9.0	1.09	34.37
Australian	41.2	30.2	43.5	18.7	0.90	9.0	1.15	20.77
CITH-AP-6	40.2	29.5	44.5	28.8	0.70	9.0	1.15	41.14
CITH-AP-8	44.1	31.5	41.5	25.7	1.10	10.20	1.13	23.36
CITH-AP-2	45.5	37.5	47.5	24.3	1.17	10.10	1.73	20.76
Erani	53.2	38.2	56.1	19.2	0.77	9.90	1.90	24.93
CITH-AP-3	51.0	37.9	55.3	19.9	1.20	10.00	1.91	16.58
Turkey	52.1	38.5	56.2	19.7	0.99	9.72	1.15	19.89
Heartly	42.1	30.0	47.1	19.2	0.92	8.77	0.99	20.86
New Castle	40.1	30.2	45.2	17.7	0.77	9.00	1.10	22.98
CD (P=0.05)	0.58	0.09	0.10	0.80	0.07	0.08	0.05	1.02

CITH-AP-8 (13.0%), Heartly (13.00%) and New Castle (14.20%). The increase in TSS content of apricot might be due to conversion of carbohydrates in to sugars, organic acids, and other soluble materials by metabolic process during storage. These results are in line with other findings of Agar and Polate (1995) and Ishaq *et al*. (2009). First TSS increase and then decrease is due to hydrolytic change in starch and conversion of starch to sugar being an important index of ripening process in fruits (Arthey and Philip 2005). In apricot, main sugar is sucrose (Wills *et al,* 1983). Fruit contain starch, pectic material, disaccharides and mono saccharides, such as sugars like sucrose, fructose and glucose. The amount of each of these drastically increased during ripening of fruit, because all the starch is fully hydrolyzed.

Titratable acidity (%)

Results pertaining to acidity are given in Fig 2. The t*itratable* acidity increased in all the varieties up to 20-24 days of storage and there after decreased gradually with passage of storage time. The decreasing trend during storage was might be due to metabolic changes in fruits in advanced days of storage or due use of organic acid in respiration process that is to line with those of Echeverna and Valich (1989). The findings are also agreement with those of Agar and Polate (1995) who had observed that titratable acidity in apricot decreased in different varieties with passage of time with little different with our findings where in beginning it increased and gradually decreased after a particular period of storage under low temperature. Titratable acidity is directly related to the concentration of organic acids present in the fruit. Organic acid exist as free acids, anions (Malate) or combined as salt (potassium bitartarate) and esters such as Iso pentyle acetate (Kays 1991).

Ascorbic acid (mg/100g)

It was observed that ascorbic acid content in all the varieties showed reduced trend with the advancement of storage period. However retention of ascorbic acid varied significantly among the different cultivars (Fig 2). Minimum loss of ascorbic acid was recorded in variety Afghan (20.0%), Erani (20.75%), New Castle (22.35%), Turkey (28.57%), CITH-AP-3(25.9%), Whereas, maximum loss was noticed in CITH-AP- 8 (32.8%). Loss of ascorbic acid during storage may be due to conversion of dehydro ascorbic acid to diketogulunic acid by oxidation (Rai and Sexena 1988). These findings are also in line with (Lee and Kader 2000) who has reported that when the storage temperature or duration was increased, a gradual decrease in ascorbic acid content in those fruits was observed.

Evaluation of apricot varieties for drying

The studies were undertaken to evaluate the apricot varieties for drying purpose. The drying was carried out by standard method given in materials and methods uniformly to all the varieties tested. Quality characteristics of dried apricot for colour, firmness, TSS, titrable acidity, TSS/ acidity ratio, ascorbic acid and β carotene are given in Table

Table 4 Organoleptic evaluations of dehydrated apricot of different varieties grown under temperate ecosystem

Variety	Taste	Flavour	Colour	Overall acceptance
CITH-AP-1	7.0	7.0	7.5	7.3
CITH-AP-6	7.0	7.0	6.0	6.6
Harcot	7.0	6.5	7.5	7.0
Afghan	8.5	8.5	7.5	8.0
CITH-AP-8	7.0	6.0	6.0	6.3
CITH-AP-19	6.5	6.0	6.5	6.3
Australian	7.0	6.5	6.0	6.6
CITH-AP-16	7.0	7.0	6.0	6.6
CITH-AP-18	6.5	6.0	5.5	6.0
CITH-AP-2	7.5	7.0	7.0	7.3
Erani	8.0	7.5	7.5	7.8
CITH-AP-3	8.5	8.5	8.0	8.5
Turkey	8.0	7.5	8.8	8.0
Heartly	7.2	6.6	6.8	6.8
New Castle	6.5	6.6	6.0	6.36
CD (P=0.05)	0.20	0.17	0.18	0.09

4. Colour studies were conducted for (brightness) , L< and b, value indicating redness. Maximum brightness 'L' value was recorded in Turkey (38.5), Erani (38.2), CITH-AP-3 (37.9), CITH-AP-8 (37.2). Firmness of dried apricot measured as RI was recorded maximum in Var. Turkey (56.2), Erani (56.1), CITH-AP-3 (55.3), Afghan (55.1). TSS of the dried apricot varied significantly and maximum TSS was recorded in var. CITH-AP- 6 (28.8°B), CITH-AP-9 (27.5°B), CITH-AP-8 (25.7°B). Maximum acidity was recorded in var. CITH-AP-6 (1.27%) followed by CITH-AP-3 (1.20%), CITH-AP-2 (1.17%) and CITH-AP-8 (1.10), whereas, minimum was recorded in CITH-AP- 6 (0.7%), Erani (0.77%) and New Castle (0.77%). Maximum TSS/ acidity ratio was recorded in CITH-AP-6 (41.14), CITH-AP-9 (34.37), Erani (24.93). Maximum ascorbic acid was recorded in var. Afghani (10.8 mg/100g), CITH-AP-8 (10.2 mg/100g) and CITH-AP-2 (10.1 mg/100g). Maximum β-carotene was found in Afghan (2.20 mg/100g), CITH-AP-3 (1.91mg/100g) and Erani (1.90 mg/100g).

Organoleptic evaluation

Studies in organoleptic characteristics like colour, texture and aroma of dehydrated apricots reveals that maximum scores were recorded in var. CITH–AP-3 (8.5), Afghan (8.0), Erani (7.8), CITH-AP-1 (7.3), CITH-AP-2 (7.3) Shahnawaz and Khan 2005; Hussain *et al.* 2010 also compared the quality of dehydrated apricot and found some most suitable for dehydration purpose.

It is concluded that variety CITH-AP-1, CITH-AP-2, CITH-AP-6, Heartly, Turkey and New Castle were found suitable for table use having maximum quality attributes and maximum shelf life when stored at low temperature, whereas, variety CITH-AP-2, CITH-AP-3, Afghani, Turkey and Erani were found good for dehydration purpose and stored maximum with good quality, colour, texture and flavour.

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