Indian Journal of Agricultural Sciences **87** (6): 796–800, June 2017/Article
https://doi.org/10.56093/ijas.v87i6.71001

Effect of various storage conditions and calcium treatments on physico-chemical properties of peach (*Prunus persica*) cv. Shan-e-Punjab

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Received: 03 October 2016; Accepted: 03 November 2016

ABSTRACT

Peach (*Prunus persica* L. Batsch) fruits of cv. Shan-e-Punjab were treated with various concentrations of $CaCl_2$ (2,4 and 6%), packed in poly bags and stored at 3$\pm$2 °C and 85–90% RH for 24 days followed by storage at ambient conditions (28 to 30 °C, 65–70% RH) for 6 days. The results showed that fruits treated with $CaCl_2$ (6%) reduced the physiological loss in weight (PLW) and maintained fruit firmness, acidity, TSS content and ascorbic acid activity during storage. The fruits stored under refrigerated conditions showed maximum PLW of 9.13 per cent in untreated fruits while it was minimum 6.22% in fruits treated with 6% $CaCl_2$ on 24thday of storage. The fruits treated with 6% $CaCl_2$ showed maximum firmness (13.28 lb/inch^2), acidity (0.71 %) and ascorbic acid (3.58 mg/100 g) content on 24th day under refrigerated conditions. Thus, 6 % $CaCl_2$ was found to be the best as it showed minimum PLW and maximum firmness and ascorbic acid under both ambient and refrigerated conditions.

Key words: Calcium chloride, Peach, PLW, Storage conditions, Total soluble solids

Peach (*Prunus persica* L. Batsch) is one of the most important stone fruits grown in the temperate zones of the world. In India, it is being grown in the mid hill zone of Himalaya extending from Jammu and Kashmir to Khasi hills, 1000-2000 m above mean sea level. The low chilling cultivars of peach are becoming popular in Jammu region as these come early in the market and growers get remunerative price for their produce. Among the low chilling cultivars, Shan-e-Punjab is one of the best that grows well under sub-tropical conditions of Jammu. The fruits of this variety are very attractive and possess captivating taste and aroma. It is delicious but highly perishable fruit and has a short shelf-life under ambient conditions. It attains physiological maturity in the months of May-June, when the atmospheric temperature is high, which leads to fruit softening, shrinkage, decay and heavy post harvest losses (Pongener *et al*. 2011).

Consumers consider firmness as a predictor of fruit storability and eating quality. Under normal storage conditions the life of fruit does not exceed 3 to 5 days (Tonini and Tura 1998). Different chemicals and growth regulators have been reported to extend the shelf life of many fruits (Ochel *et al*.1993). Post-harvest application of $CaCl_2$ reported to enhance the storage life of apples (Sams *et al*. 1993).Thus, the present investigations were undertaken to study the effect of storage conditions and calcium treatments on storage life and quality of peach fruit cv. Shan-e-Punjab.

MATERIALS AND METHODS

The fruits of peach cv. Shan-e-Punjab were harvested at colour break stage from the Research orchards of Division of Fruit Science, Udheywalla, SKUAST-J during 2014-15. Only mature and blemishes free fruits were selected for the study.Immediately after harvest, fruit samples were shifted to the laboratory to remove field heat before giving chemical dip treatment. The fruits were treated with different concentrations (2, 4 and 6 per cent) of calcium chloride ($CaCl_2$) for 15 minutes. The fruits kept under control conditions were dipped in water for same duration. The fruits were then allowed for air dry to remove the moisture from the fruit surface and packed in perforated poly-bags packing with 1% perforation at 3$\pm$2 °C and 85-90% RH. Prior to storage, these samples were treated with 1% $KMnO_4$ except fruits kept under control treatment.There were three replications for each treatment. The observations for various physico-chemical characteristics were made at an interval of 3 days.

Physiological loss in weight (PLW) of stored fruit was calculated by subtracting final weight from the initial weight of the fruits and expressed in per cent.

$$PLW (\%) = \frac{\text{Initial weight- Final weight}}{\text{Initial weight}} \times 100$$

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The fruit firmness was measured with the 'Magnes taylor Pressure Tester' (Plunger dia 7/inch). The plunger was held against the surface of the fruit and forced into the fruit with steady pressure to attain the force necessary for breaking the flesh. The fruit firmness was expressed in terms of lb/inch^2.

Total soluble solids (TSS) of fresh fruit was determined by using hand refractometer and readings were expressed as degree Brix (^{0}B) at 20^0 C using reference table (Ranganna 1986).

Titratable acidity was determined by titrating a known quantity of sample (10 ml) against standard solution of 0.1 N sodium hydroxide to a light pink colour using phenolphthalein as an indicator. The results were expressed as % citric acid (Ranganna 1986).

Ascorbic acid was determined using 2, 6-Dichlorophenol-indophenol visual titration method (AOAC. 1995).The data were subjected to statistical analysis by factorial completely randomized design outlined by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

The fruits stored under ambient condition in perforated polybags treated with 0, 2, 4, 6% $CaCl_2$ showed PLW of 21.50, 18.50, 16.50, and 14.43 %, respectively on 6th day

Table 1 Effect of different storage conditions and post-harvest treatments on physiological loss in weight (%) of peach cv. Shan-e-Punjab packed in perforated poly-bags

Treatment	Storage interval (days)									
	0	3	6	9	12	15	18	21	24	27
Ambient conditions										
T_0	0	2.10	21.50	F.N.A*						
T_1	0	1.90	18.50	F.N.A						
T_2	0	1.60	16.50	F.N.A						
T_3	0	1.50	14.43	F.N.A						
CD (P≤0.05) Storage intervals (S)= 5.43 Treatments (T)= 0.19 S×T= NS										
Refrigerated conditions										
T_0	0	1.20	2.21	3.46	4.88	6.15	7.19	8.09	9.13	FNA*
T_1	0	1.15	2.18	3.32	4.81	6.02	7.08	7.98	8.52	FNA
T_2	0	1.12	2.14	3.18	4.76	5.88	6.22	6.92	6.98	FNA
T_3	0	1.05	2.04	3.00	4.72	4.91	5.98	6.12	6.22	FNA
CD (P≤0.05) Storage intervals (S)= 0.66 Treatments (T)= 0.33 S×T= 0.74										

*FNA: Fruit Not Acceptable

Table 2 Effect of different storage conditions and post-harvest treatments on firmness (lb/inch^2) of peach cv. Shan-e-Punjab packed in perforated poly-bags

Treatment	Storage interval (days)									
	0	3	6	9	12	15	18	21	24	
Ambient conditions										
T_0	14.88	11.91	8.81	FNA*						
T_1	14.84	12.03	9.85	FNA						
T_2	14.82	12.09	10.13	FNA						
T_3	15.13	14.65	11.11	FNA						
CD (P≤0.05) Storage intervals (S)= 1.97 Treatments (T)= 0.36 S×T= NS										
Refrigerated conditions										
T_0	14.74	14.56	14.36	14.23	13.99	13.66	13.15	12.74	12.35	FNA*
T_1	14.77	14.52	14.38	14.29	14.05	13.83	13.35	12.98	12.63	FNA
T_2	14.86	14.61	14.49	14.41	14.11	14.01	13.76	13.44	13.13	FNA
T_3	14.84	14.71	14.51	14.46	14.15	14.05	13.8	13.47	13.28	FNA
CD (P≤0.05) Storage intervals (S)= 0.01 Treatments (T)= 0.01 S×T= 0.03										

*FNA: Fruit Not Acceptable

Table 3 Effect of different storage conditions and post-harvest treatments on TSS (ºbrix) of peach cv. Shan-e-Punjab packed in perforated poly-bags

Treatment	Storage interval (days)									
	0	3	6	9	12	15	18	21	24	
				Ambient conditions						
T_0	10.00	11.15	13.85	F.N.A*						
T_1	10.00	10.23	13.46	F.N.A						
T_2	10.00	10.22	13.03	F.N.A						
T_3	10.00	10.16	12.88	F.N.A						
CD(p≤0.05) Storage intervals (S)= 0.17 Treatments (T)= 0.21 S×T= NS										
	Refrigerated conditions									
T_0	10.00	10.55	10.83	11.01	11.21	11.75	12.31	13.07	11.92	FNA*
T_1	10.00	10.24	10.47	11.01	11.37	11.71	12.19	12.71	11.02	FNA
T_2	10.00	10.17	10.34	10.68	11.24	11.39	12.00	12.17	11.00	FNA
T_3	10.00	10.12	10.25	10.45	11.04	11.15	11.88	12.04	10.88	FNA
CD(p≤0.05) Storage intervals (S)= 0.06 Treatments (T)= 0.05 S×T= 0.08										

*FNA: Fruit Not Acceptable

Table 4 Effect of different storage conditions and post-harvest treatments on acidity (%) of peach cv. Shan-e-Punjab packed in perforated poly-bags

Treatment	Storage interval (days)									
	0	3	6	9	12	15	18	21	24	
				Ambient conditions						
T_0	0.86	0.74	0.54	FNA*						
T_1	0.86	0.82	0.57	FNA						
T_2	0.86	0.77	0.59	FNA						
T_3	0.86	0.79	0.66	FNA						
CD (P≤0.05) Storage intervals (S)= 0.11 Treatments (T)= 0.01 S×T= NS										
				Refrigerated conditions						
T_0	0.86	0.96	0.92	0.85	0.78	0.71	0.66	0.61	0.58	FNA*
T_1	0.86	0.98	0.94	0.87	0.79	0.73	0.69	0.63	0.61	FNA
T_2	0.86	0.98	0.95	0.89	0.83	0.77	0.72	0.66	0.63	FNA
T_3	0.86	0.99	0.97	0.91	0.87	0.81	0.77	0.74	0.71	FNA
CD (P≤0.05) Storage intervals (S)= 0.025 Treatments (T)= 0.013 S×T= 0.031										

*FNA: Fruit Not Acceptable

after storage, while the corresponding losses in those stored under refrigerated condition were 9.13, 8.52, 6.98 6.22 %, respectively, after 24 days of storage (Table 1). The reported effects of calcium on membrane functionality and integrity maintenance (Lester and Grusak 1999) may explain the lower weight loss observed in calcium treated fruits. Mahajan and Dhatt (2004) reported that pear fruit treated with $CaCl_2$ reduced weight loss compared to untreated fruits. It is possible that calcium delayed senescence and reduced the rate of transpiration and respiration. The results are also in accordance with the findings of Hussain *et al*. (2012), Sajid *et al.*(2014), Babu *et al.* (2015) and Sohail *et al.* (2015).

The data interpreted a decrease in firmness of fruit with the advancement of storage period and increase in firmness with increasing $CaCl_2$ concentration in cardboard boxes as well as polybags stored under ambient as well as refrigerated condition (Table 2). The retention of firmness in calcium treated fruits might be due to its accumulation in the cell walls leading to facilitation in the cross linking of the pectic polymers which increases wall strength and cell cohesion (White and Broadly 2003).

In general, TSS showed an increasing trend with the advancement in storage intervals whereas it showed a decreasing trend with the increase in concentration of $CaCl_2$in respective treatments stored under ambient as well as refrigerated storage conditions (Table 3).The maximum TSS was recorded in untreated fruits, while minimum was observed in fruits treated with 6 % $CaCl_2$ packed in polybags under both the storage conditions (ambient as well as refrigerated). The increase in TSS may also be due

Table 5 Effect of different storage conditions and post-harvest treatments on ascorbic acid (mg/100g) of peach cv. Shan-e-Punjab packed in perforated poly-bags

Treatment	Storage interval (days)									
	0	3	6	9	12	15	18	21	24	
Ambient conditions										
T_0	4.47	3.48	2.38	FNA*						
T_1	4.47	3.68	2.57	FNA						
T_2	4.47	3.88	2.90	FNA						
T_3	4.47	3.96	3.04	FNA						
CD (P≤0.05) Storage intervals (S)= 0.12 Treatments (T)= 0.16 S×T= NS										
Refrigerated conditions										
T_0	4.47	4.31	4.25	3.86	3.41	3.27	3.15	3.04	2.55	FNA*
T_1	4.47	4.41	4.31	3.94	3.42	3.22	3.16	3.15	3.13	FNA
T_2	4.47	4.43	4.35	4.04	3.65	3.42	3.32	3.25	3.18	FNA
T_3	4.47	4.45	4.39	4.21	3.92	3.77	3.65	3.61	3.58	FNA
CD (P≤0.05) Storage intervals (S)= 0.03 Treatments (T)=0.05 S×T=0.07										

*FNA: Fruit Not Acceptable

to higher PLW losses in apple fruits stored under ambient conditions, as a result of which there might be an increase in the concentration of sugars (Sharma *et al.,* 2010). An increase in TSS was also reported by Vanoli *et al*. (1995) and Bakshi and Masoodi (2009) during storage of peach fruits.

Titratable acidity showed gradual decline with the advancement in storage intervals under ambient as well as refrigerated conditions (Table 4). The fruits packed in polybags treated with 6% $CaCl_2$ showed highest titratable acidity, while as untreated fruits showed least value under both ambient as well as refrigerated conditions. Titratable acidity was found to increase with the increase in $CaCl_2$ concentration. Kakiuchi *et al.* (1981), Vanoli *et al.* (1995) and Bakshi and Masoodi (2009) also reported a decrease in overall acid level during storage of peach fruit.

The fruit ascorbic acid showed an increasing trend with the increase in $CaCl_2$ concentration under both storage conditions (ambient and refrigerated). Minimum (2.38 mg/100g) ascorbic acid was observed in fruits after 6 days which were untreated and packed in polybags, while it was maximum (3.58 mg/100g) in fruits treated with 6% $CaCl_2$ after 24 days of storage under ambient condition as well as refrigerated conditions (Table 5). Ascorbic acid is an important nutrient quality parameter and is very sensitive to degradation due to its oxidation (Veltman *et al*. 2000). The retention of ascorbic acid here may be because, the high concentration of $CaCl_2$ delayed the rapid oxidation of ascorbic acid. Ruoyi *et al*. (2005) reported that ascorbic acid content of peach was maintained during 50 days of storage in response to post harvest application of 0.5 % $CaCl_2$.

It is thus concluded that the fruits treated with 6 % calcium chloride in combination with 1% $KMnO_4$ packed in perforated polybags and stored under refrigerated conditions was found to be the best treatment for enhancing the quality and shelf life of peach cv. Shan-e-Punjab.

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