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HORTICULTURE

Interrelationship between fruit quality and pre-harvest calcium chloride treatment on peach Cv. 'Shan-I-Punjab'

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ABSTRACT

The effectiveness of pre-harvest calcium, chloride on post-harvest life and quality of peach fruits were studied. Calcium chloride viz. 0.5%, 1.0% and 1.5% was sprayed to peach plants at pit hardening stage, 10 and 20 days after pit hardening. Peach fruits harvested at physiological mature stage were sorted, washed, air dried and packed in CFB boxes before placing in cold store (temperature 0-10 and RH 85-90%). Changes in PLW, fruit firmness, sensory quality, pulp: stone, total sugars, total phenolics and calcium content were studied. Calcium chloride @ 1.5% (three sprays) resulted in **minimum PLW, total sugars and maximum** fruit firmness, sensory quality score, pulp: stone, total phenolics and calcium content during the stipulated storage period.

Highlights

- Three sprays of calcium chloride @ 1.5% was found effective in enhancing the storage life and maintaining fruit quality of Peach cv. Shan-i-Punjab.

Keywords: Cold Storage, Weight loss, Peach, Calcium chloride, Total Phenolics, Fruit quality

Peach (Prunus persica (L.) Batsch) is a drupaceous temperate fruit of excellent appearance and quality. The maturity of peach fruit coincides with extremely hot and dry environmental conditions. Since, peach is a climacteric fruit, and it continues to respire even after harvest, that lead to heavy post-harvest losses. These losses can be visualized in terms of shrinkage which renders the softening of the fruits. Mineral nutrition is reported to influence the storage quality of fruits in many ways. Of particular importance is calcium, a deficiency of which may induce a range of post-harvest disorders in several fruits and vegetables (Shear 1975). Calcium has been reported to maintain the cell wall structure in fruits by interacting with pectins in the cell wall to form calcium pectate which assists molecular bonding between constituent of the cell wall (Dong *et al.*, 2000), calcium also increases cell turgor pressure and stabilizes the cell membrane (Hernandiz and Munzo 2006). Calcium is known to strengthen the structure of cells by maintaining the fibrilar packaging in the cell walls thus reinforcing the cell to cell contact which is related to the formation of calcium pectate and counteracts the pectin methyl esterase, peroxidases and Catalases activity as observed in calcium treated apple pear fruits (Shirzadeh *et al.*, 2011 and Alandes *et al.*, 2009). It is also known to bind with the free carboxylic group released during degradation of cell wall

Table 1. Effect of pre-harvest calcium chloride treatments on physiochemical characteristics of peach fruits under cold storage.

Treatment	PLW				Sensory Quality					Pulp: stone					Total sugars				
	10	20	30	Mean	0	10	20	30	Mean	0	10	20	30	Mean	0	10	20	30	30
T1-Cacl2, 0.5% three Sprays	4.46	4.73	5.26	4.81	6.35	7.04	7.76	8.07	7.31	6.35	7.04	7.76	8.07	7.31	7.24	7.53	8.44	9.35	8.14
T2-CaCl2, 1.0% three sprays	4.35	4.61	5.11	4.69	6.22	6.82	7.89	8.40	7.33	6.22	6.82	7.89	8.40	7.33	7.13	7.40	8.34	9.22	8.02
T3-Cacl2 1.5% three sprays	4.32	4.58	5.06	4.65	6.19	6.77	7.95	8.51	7.36	6.19	6.77	7.95	8.51	7.36	7.08	7.36	8.29	9.18	7.98
T4-CaCl2 0.5% two sprays	4.50	4.77	5.33	4.88	6.41	7.16	7.73	7.95	7.31	6.41	7.16	7.73	7.95	7.31	7.26	7.57	8.49	9.39	8.18
T5-CaCl2 1% two sprays	4.43	4.68	5.18	4.77	6.30	7.00	7.80	8.16	7.32	6.30	7.00	7.80	8.16	7.32	7.19	7.47	8.42	9.30	8.10
T6-CaCl2 1.5%, two sprays	4.38	4.65	5.16	4.74	6.29	6.88	7.83	8.32	7.33	6.29	6.88	7.83	8.32	7.33	7.16	7.47	8.38	9.26	8.07
T7-CaCl2 0.5%, one spray	4.63	5.48	10.70	6.94	6.55	7.53	8.42	6.48	7.25	6.55	7.53	8.42	6.48	7.25	7.35	8.16	9.32	8.16	8.25
T8CaCl2 1.0%, one spray	4.54	5.39	10.56	6.83	6.48	7.48	8.49	6.63	7.27	6.48	7.48	8.49	6.63	7.27	7.33	8.09	9.20	8.25	8.22
T9-CaCl2 1.5%, one spray	4.54	5.34	10.46	6.78	6.45	7.40	8.54	6.70	7.27	6.45	7.40	8.54	6.70	7.27	7.30	8.00	8.00	8.30	7.90
T10-Control	4.69	5.59	11.83	7.37	6.59	7.65	8.28	6.04	7.14	6.59	7.65	8.28	6.04	7.14	7.24	7.53	8.44	9.35	8.14
Mean	4.50	4.98	7.47		6.38	7.17	8.07	7.53		6.38	7.17	8.07	7.53		7.13	7.40	8.34	9.22	8.02
CD (5%)																			
Treatments	0.027				0.024					0.025					0.021				
Storage	0.014				0.018					0.014					0.017				
interaction	0.046				0.042					0.042					0.045				

component (Degraeve *et al.*, 2003) by pectin methyl esterase and polygalacturanase and thus improves the fruit firmness. Keeping it in view, an experiment was conducted to study the effect of pre-harvest sprays of calcium chloride on storage life and fruit quality of peach cv. Shan-i-Punjab

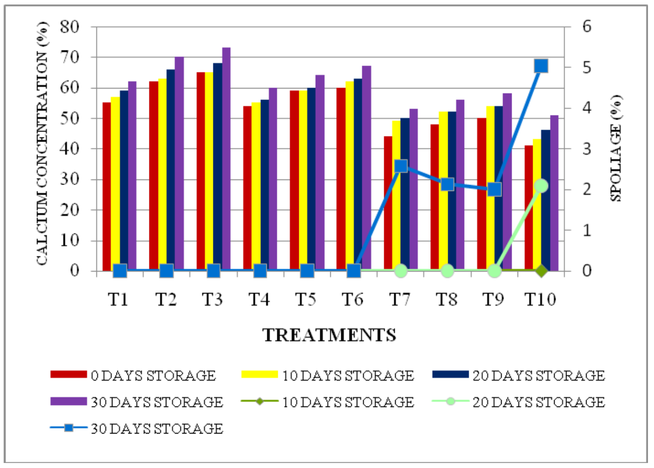

Figure I. Effect of calcium chloride treatments on spoilage (%) and calcium content (ppm FW) of peach fruits during cold storage

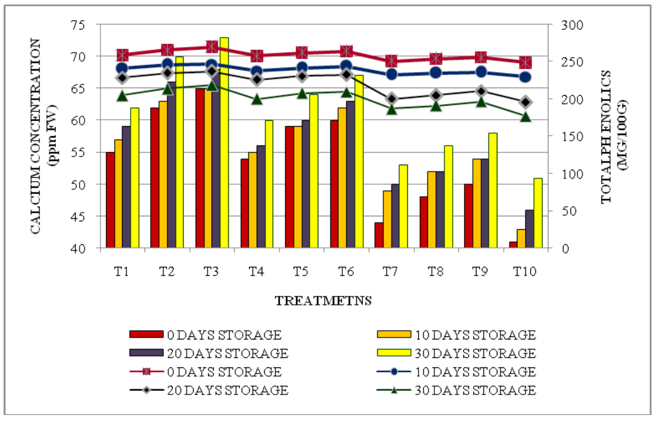

Figure 2. Relationship between calcium concentration (ppm FW) and Total Phenolics (mg/100g) of calcium chloride treated peach fruits during cold storage

Materials and Methods

The present investigation was carried at New Orchard of Punjab Agricultural University under sub-tropical environmental conditions. Thirty healthy and uniform plants of peach cv. Shan-i-Punjab were marked and sprayed with calcium chloride at three concentrations viz. 0.5 per cent, 1.0 per cent, 1.5 per cent at pit hardening stage, 10 and 20 days after pit hardening, in three different groups. The first group of plants were given three sprays of calcium chloride at pit hardening stage, 10 and 20 days after pit hardening, in second group of plants, two sprays of calcium chloride were given at 10 and 20 days after pit hardening and in the third group of plants one spray of calcium chloride was given at 20 days after pit hardening. A total of ten treatments were given comprising three replications in each treatment and the data was analyzed Factorial RBD using CPCS1 software. Fruits of uniform size were harvested from the treated plants with the help of a hand clipper in the early morning hours at physiological mature stage. The harvested fruits were immediately carried to the laboratory for sorting and packaging. The bruised and diseased fruits were sorted and the healthy fruits were washed and air dried at room temperature. After drying, the fruits were packed in one Kg CFB boxes in layers and subsequently placed in cold store (temperature 0-10C and RH 85-90%) For various Physico-chemical characteristics fruit samples were analyzed on the day of harvesting and after 10, 20 and 30 days of storage

Physiological loss in weight (PLW): It was worked out by subtracting final weight from the initial weight of the fruits and then converting into percentage value. The cumulative loss in weight was calculated on fresh weight basis.

Pulp: Stone ratio: The pulp and stone of individual fruits were separated and weighed. The ratio of pulp to stone was worked out and the mean of eighteen fruits for each treatment was reported.

Sensory quality: The fruits were rated for this character by a panel of five judges on the basis of external appearance of fruits, texture, taste and flavour using a nine point 'Hedonic scale' (Amerine *et al.*, 1965).

Spoilage: The spoilage percentage of fruits was calculated on number basis by counting the spoiled fruits in each replication and total number of fruits per replication.

Total Sugars (%): Total sugars were estimated by taking 10ml of juice and 5ml of lead acetate solution then potassium oxalate solution. The solution was again filtered with Whatman's filter No. 1 and the volume was made to 100 ml with distilled water. 25ml of volume was taken and 5ml of concentrated HCl (60%) was added to it and left for 24 hours at room temperature. On the next day, the solution was heated on water bath for 10 minutes at 680C. Then 2-3 drops of phenolphthalein indicator were added and it was first neutralized with 40% NaOH and then with 10% NaOH till light yellow colour appeared and the volume was made to 100ml with distilled water. The sugars were estimated by titrating the filtrate with fehling 1 and fehling 2 (5 ml each) using methylene blue as an indicator.

Total Phenolics (mg/100g): Total phenols were estimated by extracting the fruit samples in 80 per cent ethanol. The colour was developed with Folin-Denis reagent and the absorbance of the developed colour was recorded with a 'Spectronic-20' calorimeter at 650nm wavelength. Results were obtained by comparison with a standard curve, with tannic acid as a reference (Mahadevan and Sridhar, 1982). The results were expressed as mg/100g fresh fruit pulp.

Calcium content in fruits (ppm FW): Fruit samples (5g) including both peel and pulp were dried on various dates of observations and auto digested in 150ml titration flask to which 20ml of triacid (nitric acid, perchloric acid and sulphuric acid 9: 3: 1 ratio) was added. Calcium content was estimated by using flame photometer (Toth *et al.*, 1948).

Results and Discussion

Physiological loss in weight (PLW): Amongst all the treatments, the maximum weight loss was observed in reference fruits while the calcium chloride treatments considerably maintained the weight loss throughout the storage period (Table 1). The minimum physiological loss in weight was observed in peach fruits treated with calcium chloride @ 1.5% (three sprays), which was at par with fruits treated with calcium chloride @ 1.0% (three sprays) and the maximum physiological loss in weight was observed in control (untreated) fruits throughout the storage period. Weight loss is a consequence of fruit dehydration due to changes in surface transfer resistance to water vapor, in respiration rate and the occurrence of small fissures connecting the internal and external atmospheres (Woods 1990. Calcium applications have shown to be effective in terms of membrane functionality and integrity maintenance, with lower losses of phospholipids and proteins and reduced ion leakage (Lester and Grusak 1999), which could be responsible for the lower weight loss. Reduction in physiological loss in weight has also been observed in sapota cv. Kalipatti by post harvest dip of calcium chloride (Tsomu and Patel 2014). Our results are also in confirmation with Shirzadeh and Kazemi (2011) in apple and Navjot *et al.*, (2011) in peach

Sensory Quality: Sensory score of all the stored fruits increased upto 20 days of cold storage, after that it showed declining trend in fruits treated calcium chloride @ 0.5%, 1.0% and 1.5% (one spray) and in the reference fruits (Table 1). At the end of storage period, the maximum sensory quality score was observed in fruits treated with calcium chloride @ 1.5% (three sprays) followed by calcium chloride @ 1.0% (three sprays) treatment. The minimum sensory score was observed in untreated fruits. The higher sensory quality rating of calcium chloride treated fruits at the end of storage might be due to the retardation of ripening and softening processes of fruit that led to the development of better juiciness, texture, flavour and sweetness. These results are also in agreement with the findings of Shiri *et al.*, (2014) in Kiwi fruit tested with calcium chloride.

***Pulp to stone ratio*:** The pulp to stone ratio declined with advancement of storage period. However, this diminution was slower in calcium chloride treated fruits than the untreated ones (Table 1). The maximum pulp to stone ratio was observed in peach fruits treated with calcium chloride @ 1.5% (three sprays) and the minimum pulp to stone ratio was found in control fruits. The decrease in the pulp: stone ratio with the advancement of storage period may be due to the increase in moisture loss from the peach fruits. This decline was less in calcium chloride treated fruits, because of the role of calcium in maintaining cellular integrity. increase the pulp : stone ratio has also been observed by pre-harvest sprays of calcium chloridein peach fruits (Ali *et al.*, 2014). (Karemera and Habiman 2014) also reported higher pulp weight and lower stone weight with calcium treated mango fruits during storage.

Spoilage: Calcium chloride treatments significantly reduced the spoilage percentage in fruits under cold storage (Fig I). Peach fruits treated with calcium chloride @ 0.5%, 1.0% and 1.5% (two and three sprays) did not show any spoilage during the cold storage period. Among other treatments, maximum fruit spoilage was observed in control fruits, while the fruits treated with calcium chloride @ 0.5%, 1.0% and 1.5% (one spray) showed the average spoilage percentage at the tune 0.9, 0.7 and 0.6 respectively. Pre-harvest treatments of calcium chloride were found effective in checking the spoilage of fruits during cold storage. The reduced fungal infection in calcium chloride treated fruits was attributed to the increase in cell wall bound calcium (Chardonent et a.l 1999). While, Conway *et al.*, (1994) reported that pre-harvest calcium sprays on peach fruits stabilizes cell wall structure and protects it from pectinolytic enzymes, produced by the fungi. Calcium also increases the synthesis of phytoalexins and phenolic compounds which are involved in resisting the fungal attack and it also reduces the risk of micro cracks in the cuticle which is cracks in the cuticle which is known as the direct site of fungal infection (Elmer et al 2000. Reduced spoilage percentage was also reported with calcium chloride treatments in apple and plum fruits (Jan *et al.*, 2013 and Kirmani *et al.*, 2013).

Chemical characteristics

Total sugars: Calcium chloride treatments recorded significantly lower total sugars then the untreated ones (Table 1). Among the treatments minimum total sugars were estimated in fruits treated with calcium chloride @ 1.5% (three sprays) and the maximum total sugars were recorded in untreated fruits. Delay in increase of total sugars is mainly attributed to the role of calcium in regulating the cell biochemistry which delays the conversion of organic acids into free sugars and calcium also may have role in reducing the activity of enzymes involved in hydrolysis of starch into sugars. Similar results are obtained by Bhat *et al.*, (2011) in pear fruits treated with calcium chloride during cold storage.

Total Phenolics: The maximum total phenolics were estimated in fruits treated with calcium chloride @ 1.5% (three sprays) followed by fruits treated with calcium chloride @ 1.0% (three sprays) and the lowest value of total phenolics was observed in untreated fruits (Fig II). The decline in total phenolics may be due to higher activity of polyphenol oxidase enzyme during cold storage. The possible reason for higher total phenols with calcium treatments may be that, calcium does not allow the mixing of polyphenol oxidase and oxidisable polyphenols by maintaining the membrane stability (Akhtar *et al.*, 2010) which may also reduced the spoilage percentage in fruits. Similar observations were recorded by Kamal *et al.*, (2014) in peach, Sarrwy *et al.*, (2012) in date palm and Petkovsek *et al.*, (2009) in apples.

Calcium content in fruits: Fruits treated with calcium chloride @ 1.5% (three sprays) recorded maximum average calcium content followed by calcium chloride @ 1.0% (three sprays), whereas the minimum calcium content was observed in control fruits (Fig II). The difference between the treatments was also significant. The increase in calcium content was directly proportional to the concentration of calcium chloride applied at the time of spray and to the spray intensity. The higher level of calcium in treated fruits was due to active absorption and deposition of calcium in epicarp and mesocarp of fruits. Increased calcium content in treated fruits may be due to increased dehydration with prolongation of storage period. Increased level of calcium concentration has also been observed by foliar sprays of calcium salt in papaya (Madani *et al.*, 2014), apple (Lanauskas *et al.*, 2012) and pear (Hafez *et al.*, 2010) fruits.

Conclusion

Pre-harvest sprays of calcium chloride @ 1.5% (three sprays) proved to be safe and effective method in delaying the ripening of peach fruits and positively maintaining the post-harvest life and quality of peach fruits upto 30 days of cold storage.

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