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Effect of Pre-Harvest Calcium Chloride Treatments on Storage Life and Quality of Peach (*Prunus* persica Batsch.) Cv. Shan-I-Punjab

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ABSTRACT

Peach(*Prunus persica*)being a highly perishable fruit crop cannot be stored for a longer period under ambient conditions. To prolong the storage life, the plants of peach cv. “Shan-i-Punjab” were sprayed with calcium chloride viz. 0.5%, 1.0% and 1.5%, at pit hardening stage, 10 and 20 days after pit hardening stage 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. After harvesting the fruits were packed in CFB boxes and stored in cold store (temperature 0-1^{0}C and 85-90% RH) for 30 days. Fruits samples were analyzed at the time of harvesting 10, 20 and 30 days after storage for various physico-chemical characteristics. Fruits treated with three sprays of calcium chloride @ 1.5% showed better results with minimum physiological loss in weight, TSS, TSS: acid ratio, total sugars and maximum pulp: stone ratio, sensory quality and acidity throughout the storage period.

Keywords:

Calcium chloride, fruit quality, peach, Shan-i-Punjab, storage life

INTRODUCTION

Peach (*Prunus persica* (L.) Batsch) is a drupaceous temperate fruit of excellent appearance and quality. In India, peach occupies third rank after apple and pear in terms of area and production among temperate fruits. In Punjab, peach is grown throughout the state on an area of about 1583 ha with an annual production of 25,929 MT/ha (Anon 2009). Amongst, the recommended varieties Shan-i-Punjab is widely cultivated due to its high yield and superb 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.

Peaches from fresh eating, melting flesh varieties have short shelf-life due to the rapid softening of the fruit mesocarp at the end of the ripening process. After softening, fruit is susceptible to physical injury and pathogen attack and becomes unfit for storage (Nilo et al.2010). Mineral nutrition, particularly calcium is reported to influence the storage quality of fruits in many ways and a deficiency of which may induce a range of postharvest disorders in several fruits and vegetables (Shear 1975). Three principle roles of calcium in the plants are cation interaction, cell wall structure and membrane function and stability. In addition to this, role of calcium in mediating the transfer of extracellular signals into the intracellular biochemical reactions is also well accepted (Ferguson et al.1995). Application of calciumhas been found effective in decreasing respiration rate, protein breakdown, weight loss, ethylene synthesis as well as rotting in fruits (Hanson et al.1993). 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 activity as observed in calcium treated pear fruits (Alandes et al.2009). Calcium deficiency is normally overcome by spraying with calcium salts during fruit development or by post-harvest calcium dip/drench treatments of the fruit. Pre-harvest calcium chloride sprays seem to provide a means not only to extend the storage and market life but also considerably contribute in maintenance of quality (Gerasopoulos and Drogoudi 2005). Calcium sprays during fruit development provide a safe mode of supplementing endogenous calcium in a range of fresh fruits. Raese and Drake 2000). Keeping it in view, the study on effect of pre-harvest calcium chloride treatments on storage life and fruit quality of peach cv. Shan-i-Punjab was conducted with the aim to extend the post-harvest life of peach fruits under cold storage and to study the effect of pre-harvest calcium chloride treatments on the storage quality of peach fruit.

MATERIALS and METHODS

The experiment was carried out during the year 2010, a total of ten treatments were given comprising three replications in each treatment and the data was analysed using factorial RBD through CPCS1 software**.** 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. 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 0-1^{o}C and RH 85-90%) For various Physico-chemical characteristics fruit samples were analysed on the day of harvesting and after 10, 20 and 30 days of storage.

Physiological loss in weight (PLW) 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 was worked out and the mean of eighteen fruits for each treatment was reported. 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'for determining sensory quality (Amerine et al.1965). 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 soluble solids of fruit juice were determined with the help of hand refractometerand expressed as per cent total soluble solid.Titratable Acidity was determined by titrating 2 ml of juice against 0.1 N NaOH solution using phenolphthalein as an indicator. TSS to acid ratio was calculated by dividing the values of TSS and that of corresponding values of titratable acidity. Total sugars and phenolics were also estimated as per standard procedure.The treated peach plants were also visually examined using 20- 30 leaves per tree for salt toxicity symptoms.

RESULTS ANDDISCUSSION

All the fruits showed progressive increase in weight loss during storage (Table 1). Amongst all the treatments, the maximum weight loss was observed in control fruits while the calcium chloride treatments considerably maintained the weight loss throughout the storage period. 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 vapour, 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. Singh et al. (2010) also reported minimum physiological loss in weight in ber cv. Gola with calcium treatments during storage.

The sensory score of fruits stored under cold storage conditions indicated that sensory quality score of fruits increased continuously upto 20 days of storage in all the treatments (Table 1). Fruits treated with calcium chloride @ 1.5% (three sprays) showed maximum sensory quality score after 30 days of cold storage, while the untreated fruits registered maximum sensory score only after 20 days of storage and after then it recorded a declining tread.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 Kumar et al. (1994) in ber cv. Banarsi Pewandi trested with calcium chloride.

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. Bhat et al.(1997) also reported higher pulp: stone ratio with calcium treated loquat during storage.

Calcium chloride treatments significantly reduced the spoilage percentage in fruits under cold storage (Fig 1). 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% and1.5% (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 incell wall bound calcium (Chardonent et al.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). Naradisron et al. (2006) also reported reduced spoilage percentage with calcium chloride treatments in strawberry fruits.

Calcium chloride treatment had significant influence on TSS of fruits (Table 2). The minimum total soluble solids were observed in peach fruits treated with calcium chloride @ 1.5% (three sprays), followed by calcium chloride @ 1.0% (three sprays) and the maximum total soluble solids were recorded in untreated fruits. It may be possible that with the advancement of storage period, the starch content of the fruits was hydrolysed in the presence of enzyme -amylase, -amylase and starch phosphorylase resulting in general increase in total soluble solids. The effect of calcium in reducing total soluble solids content of fruits was probably due to slowing downthe respiration and metabolic activities, hence retarding the ripening process and use of metabolites, resulting in lowering total soluble solids in fruits (Mahmud et al. 2008). Our results are in conformity with those obtained with the findings of Singh and Tiwari (1994) in Guava and Shirzadeh (et al 2011) in apple cv. Jonagold.

Fruits treated with calcium chloride recorded higher acidity as compared to control (Table 2). It was maximum in calcium chloride @ 1.5% (three sprays) treated fruits followed by calcium chloride 1% (three sprays) treated fruits. The minimum acidity was noticed in untreated fruits. Reduction in titratable acidity with prolonged storage period may be due to the utilization of organic acid in respiration. Slow acid decline in calcium treated fruits is mainly due to reduced rate of respiration and accumulation of organic acids within the cells. Calcium is also known to maintain the cellular integrity and may not allow H^+ ions to loss through cell wall and thus maintain the acidity. The present findings are in agreement with Dris and Niskanen (1999) in apples and Shirzadeh (2011) in apple cv. Jonagold.

Pre-harvest treatments of calcium chloride significantly lowered TSS: acid ratio than the untreated ones. Fruits treated with calcium chloride@ 1.5% (three sprays) recorded minimum average TSS: acid ratio, followed by the fruits treated with calcium chloride @ 1.0% (three sprays), whereas maximum TSS: acid ratio was recorded in untreated fruits. This may be due to increased accumulation of organic acids in cells with calcium chloride treatments. The increase in TSS: acid ratio in control fruits was might be due to increase in TSS and decrease in acidity at faster rates. Shirzadeh (2011) also recorded slow decline in TSS: acid in calcium chloride treated jonagold apple fruits during cold storage.

Fruits subjected to calcium chloride treatments recorded significantly lower total sugars then the untreated ones (Table 2). 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

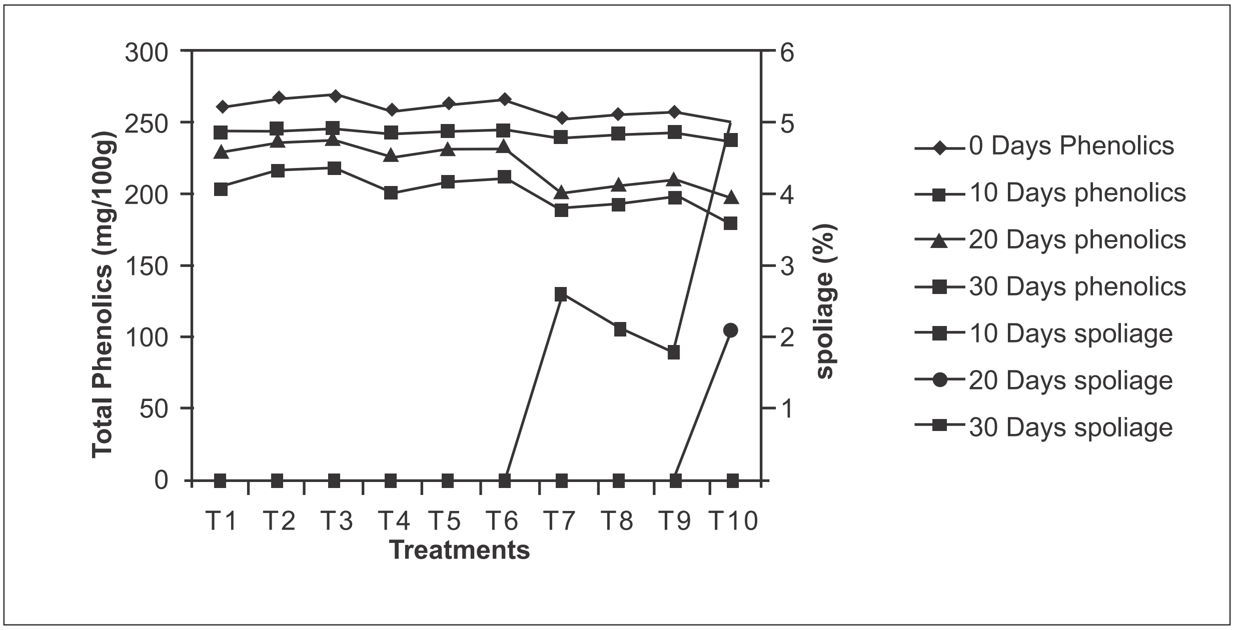

Fig. 1. Relationship between total phenolics and spoilage in the peach fruits treated with calcium chloride(n=3)

Table 1: Effect of pre-harvest calcium chloride treatments on Physical characteristics of peach fruits under cold storage (0-1°C) (n=3).

Treatment	PLW				Sensory Quality					Pulp:stone				
	10	20	30	Mean	0	10	20	30	Mean	0	10	20	30	Mean
T_1	4.45	4.75	5.25	4.82	6.33	6.84	7.65	7.98	7.20	8.83	7.95	7.10	6.65	7.63
T_2	4.37	4.60	5.09	4.69	6 .20	6.70	7.57	8.45	7.23	8.97	8.10	7.19	6.84	7.78
T_3	4.34	4.57	5.05	4.65	6.17	6.68	7.55	8.55	7.24	8.99	8.13	7.24	6.88	7.81
T_4	4.51	4.79	5.32	4.87	6.37	6.88	7.68	7.84	7.19	8.80	7.90	7.03	6.61	7.59
T_5	4.42	4.70	5.20	4.77	6.31	6.80	7.62	8.10	7.21	8.89	7.91	7.12	6.71	7.66
T_6	4.40	4.64	5.14	4.73	6.25	6.76	7.60	8.27	7.22	8.92	8.03	7.15	6.79	7.72
T7	4.60	5.47	10.72	6.93	6.53	7.55	8.10	6.34	7.13	8.69	7.74	6.72	5.68	7.21
T_8	4.57	5.40	10.57	6.85	6.49	7.49	8.03	6.61	7.16	8.73	7.81	6.76	5.71	7.25
T_9	4.53	5.35	10.45	6.78	6.44	7.41	7.97	6.85	7.17	8.77	7.85	6.82	5.76	7.30
T_{10}	4.70	5.61	11.84	7.38	6.57	7.66	8.10	6.02	7.09	8.66	7.42	6.12	4.76	6.74
Mean	4.49	5.00	7.46		6.37	7.08	7.79	7.50		8.83	7.88	6.93	6.24	
CD (5%)														
Treatment	0.026				0.023					0.022				
Storage	0.013				0.017					0.016				
Interaction	0.044				0.040					0.041				

Table 2: Effect of pre-harvest calcium chloride treatments on Chemical characteristics of peach fruits under cold storage (0-1^{0}C) (n=3).

Treatment	TSS					Titratable acidity					TSS: acid					Total sugars				
	0	10	20	30	Mean	0	10	20	30	Mean	0	10	20	30	Mean	0	10	20	30	Mean
T_1	10.0	10.3	11.6	11.9	12.34	0.7	0.7	0.7	0.6	0.72	13.3	15.7	17.0	19.6	16.42	7.2	7.5	8.4	9.3	8.13
T_2	10.1	10.1	11.4	11.7	12.19	0.8	0.8	0.7	0.7	0.76	12.4	14.4	15.6	17.4	14.99	7.1	7.3	8.3	9.2	8.01
T_3	10.1	10.0	11.4	11.7	12.15	0.83	0.8	0.7	0.7	0.79	12.1	14.0	15.0	16.4	14.40	7.1	7.3	8.3	9.2	7.97
T_4	10.3	10.3	11.6	12	12.35	0.76	0.73	0.69	0.60	0.70	13.6	15.9	17.4	20.6	16.85	7.3	7.5	8.5	9.4	8.17
T_5	10.2	10.2	11.6	11.9	12.32	0.79	0.76	0.72	0.65	0.73	12.9	15.2	16.5	19	15.90	7.2	7.3	8.4	9.3	8.09
T_6	10.1	10.1	11.5	11.8	12.26	0.80	0.77	0.74	0.67	0.75	12.7	15.0	16	18.3	15.50	7.1	7.4	8.4	9.3	8.05
T7	10.4	10.4	11.7	12.3	12.52	0.7	0.7	0.6	0.51	0.62	14.3	17.3	21.6	24.6	19.45	7.4	8.2	9.2	9.6	8.56
T_8	10.4	10.4	11.7	12.3	12.47	0.74	0.70	0.61	0.54	0.65	14.1	16.7	20.2	23.1	18.51	7.3	8.0	9.2	9.5	8.52
T_9	10.4	10.4	11.7	12.2	12.4	0.7	0.7	0.6	0.5	0.67	14.0	16.2	18.8	22.6	17.90	7.3	8	9.1	9.4	8.44
T_{10}	10.6	10.6	12	12.6	12.7	0.71	0.67	0.55	0.50	0.61	14.9	17.9	22.8	25.3	20.23	7.4	8.4	9.5	9.6	8.72
Mean	10.3	10.3	11.6	12.0	12.4	0.77	0.74	0.68	0.61		13.4	15.8	18.10	20.7		7.24	7.7	8.74	9.37	
CD (5%)																				
Treatment	0.016					0.024					0.020					0.01				
Storage	0.010					0.019					0.019					0.004				
Interaction	0.032					0.048					0.045					0.013				

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.(1997) in cherry treated with calcium chloride during cold storage.

Total phenolics decreased in all the treatments with advancement of storage (Fig I). 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. The decline in total phenolics may be due tohigher 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 Petkovsek et al. (2009) in apples. No visual effect of calcium chloride treatments was observed on peach leaves during the present study.

CONCLUSION

From the present study, it can be concluded that pre-harvest application of calcium chloride proved to be effective in delaying ripening of peach fruits under cold storage conditions. Calcium chloride @ 1.5% (three sprays) treatment was found most effective in decreasing the PLW, and maintaining sensory quality, pulp to peel ratio, TSS, acidity, TSS: acid and total sugars upto the 30 days of storage without any toxicity on leaves.

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