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Effect of calcium chloride treatment on post harvest quality of peach fruit during cold storage

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Abstract

This study was carried out on the effectiveness of calcium chloride ($CaCl_2$) treatments on the post harvest quality of peach fruits during cold storage at 10°C and 75 ± 5% RH. Different solutions of $CaCl_2$ such as 1% (T_1), 2% (T_2) and 3% (T_3) were prepared and the fruits were dipped for five minutes, while (T_0) was left with out calcium chloride treatment as control. The fruits were packed in corrugated soft board cartons (24″ x 12″ x 08″ dimension) and stored at 10°C. The physicochemical analysis such as weight loss, fruit firmness, Total Soluble Solids (TSS), decay index and ascorbic acid content were determined at an interval of four days. Statistical analysis showed that storage intervals and treatments have significant retention ($P < 0.05$) effects on the quality parameters of the peach fruits during cold storage. A significant decrease was observed in fruit firmness (1.9-0.6 kg) and ascorbic acid content (6.76-2.89 mg/100g), while a significant increase was observed in TSS (8.3-12.2°brix), decay index (0-43.83%) and % weight loss (0-11.92) during cold storage. Results showed that one and two percent calcium chloride treated fruits have little improvement while fruits treated with 3% calcium chloride were found to be most acceptable as per physicochemical analyses.

Introduction

Peach (*Prunus persica* L.) belongs to family Rossaceae, widely grown in temperate region of the world. It is one of the most important fruits grown in the Khyber Pakhtunkhwa (KPK) Province of Pakistan. Besides Peshawar region, peaches are also grown in South Waziristan and Northern areas of Pakistan like Swat, Hazara, Chitral, Gilgit and Hunza (Khattak *et al*., 2002). In KPK the post harvest losses of peach fruit recorded by Zeb and Khan (2008) were 30 to 40%, that's why it is marketed immediately after harvests.

Peaches are extremely perishable fruits and do not lend themselves to prolonged storage. If held too long at or near 0°C they are subjected to chilling injury. The onset of these symptoms determines the post harvest storage potential because chilling injury development reduces consumer acceptance (Crisosto *et al*., 1997). Several approaches like heat treatment, wax coating, vinyl resin plastic coating, fumigation with ethylene bromide, acid dipping and use of fungicides have been tried to control the post harvest losses of fresh fruits (Neo and Saikia, 2010).

Post harvest treatments can help in increasing fruit shelf life, thus reducing commercial losses for packaging houses. Post harvest application of calcium may delay senescence in fruits with no detrimental effects on consumer acceptance (Laster and Grusak, 2004). Exogenously applied calcium stabilizes the plant cell wall and protects it from cell wall degrading enzymes. It also reduces fruit softening and increases storage life as compared to untreated fruits (White and Broadley, 2003).

The purpose of this research work was to extend the shelf life of fresh peach fruit and to find an economical and effective control measure to minimize the post harvest losses so that it can be shipped to distant markets and thus generate larger revenues for all stake holders. The results of this work are not only highly useful for the farmers but also for the fruit processing industries.

Materials and Methods

Selection of fruits

Peach fruits cv. 'Earli Grande' (not fully matured) were harvested from 7 years old trees from

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a fruit orchard grown for the post harvest studies on identical soil and climatic condition in swat region of KPK, Pakistan. Immediately after harvest, they were transported to Food Technology Centre, Pakistan Council of Scientific and Industrial Research (PCSIR) Labs Complex in a refrigerated truck (Temp. 8°C ± 2, RH. 80 ± 5).

Preparation of sample

Randomly selected fruits were divided into four lots (T_o, T_1, T_2 and T_3). Each treatment contained 60 fruits. T_1, T_2 and T_3 were dipped in calcium chloride solution at 1%, 2% and 3% respectively for 5 minutes. One lot (T_o) was left with out calcium chloride treatment as control. The fruits were dried using a blotting paper (Hussain *et al*., 2012) and kept in cold storage (10°C and 75 ± 5% RH) in corrugated soft board cartons (24″ x 12″ x 08″ dimension).

Chemicals and reagents

All the chemicals and reagents used were of analytical grade except $CaCl_2$ which was food grade. Hydrochloric acid was from Merck (Damstadt, Germany) while $CaCl_2$ was from Sigma Chemicals Co. (St. Louis, USA).

Glass wares

All the glass wares used were of Pyrex, soaked in chromic acid for 24 hours before using and washed several times with tap water, rinsed with deionised water, oven dried and stored in dust free atmosphere without touching their insides.

Weight loss

Fruit weight loss was determined with the help of method described by Wang *et al.* (2005). Fruits were weighed after every 4 days and the percent weight loss was calculated by using the following formula:

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

Total soluble solids (°brix)

The Total Soluble Solids (TSS) was determined in the juice of ground peaches by means of digital refractometer (Atago Co. Ltd., Tokyo, Japan) at 20°C initially and after each 4 days (AOAC, 2005). Measurements were done in triplicate.

Fruit firmness

Fruit firmness was determined according to the method described by Hussain *et al*. (2012). After each four day interval five fruits were randomly selected from each lot and their firmness was determined using penetrometer with a 12 mm diameter plunger (Effegi FT-327, Milan, Italy) at two opposite points on the fruit's equator. To avoid the interference of skin, fruits were peeled at the points where firmness was to be measured. The average of these five fruits was the firmness of the whole lot expressed as kg.

Fruit decay index (%)

Fruit decay was visually evaluated initially and after four days storage interval. Any peach fruit with visible mold growth was considered as decayed. For this purpose first fruit decay rate was assessed by measuring the extent of decayed area on each fruit, and was termed as: 0, no decay; 1, less than 1/4 decay; 2, 1/4–1/2 decay; 3, 1/2–3/4 decay. The average extent of fruit decay was expressed as decay index and was determined using the following formula as described by Wang *et al*. (2005).

$$\text{\% Decay index} = [(1\times N_1+2\times N_2+3\times N_3) \times 100/ (3\times N)]$$

Where N is the total no. of fruits measured and N_1, N_2 and N_3 is the no. of fruits showing the different decay rates.

Ascorbic acid

Ascorbic acid was determined by the method described by Hans (1992). Briefly peach fruit pulp (5 g) from 10 fruits was blended with 5 mL of 1.0% hydrochloric acid (w/v) and centrifuged at 10,000 rpm for 10 minutes. The absorbance of the supernatant was measured at 243 nm using UV- Spectrophotometer model UNICO 2100 series Japan. Standard solutions were prepared in the same manner from 100 µg/ml ascorbic acid solution in 1% HCl. The Ascorbic acid content was calculated as mg /100g edible portion.

Statistical analysis

Data on the above parameters was taken in triplicate and analyzed statistically by using Randomized Complete Block Design (RCBD) while means were separated by Least Significant Difference (LSD) test at 5% level of significance as described by Steel and Torrie (1997).

Results and Discussion

Weight loss

Fruit weight loss is mainly associated with respiration and moisture evaporation through the skin. The delicate skin of peach fruits makes them susceptible to rapid water loss, resulting in deterioration of the fruits. Application of calcium chloride acts as a barrier, thereby restricting water

transfer and thus delaying dehydration. Figure 1 shows weight loss during cold storage (10°C and 75 ± 5% RH) of untreated fruits compared to fruits treated with 1%, 2% and 3% $CaCl_2$. All samples demonstrated a gradual loss of weight during storage. Throughout the storage, the weight loss of untreated fruits was significantly greater than that of treated fruits. At the end of the storage period, untreated peach fruits depicted 17.85% loss in weight, whereas the weight losses of samples treated with 1%, 2% and 3% calcium chloride dip were 13.52%, 10.47% and 5.82% respectively. Calcium applications are effective in terms of membrane functionality and integrity maintenance which may also be the reason for the lower weight loss found in calcium treated fruits. Sajid *et al.* (2014) reported that pear fruit treated with calcium chloride proved to be most effective in reducing weight loss compared to non treated fruit. The lower weight loss in samples treated with $CaCl_2$ dip may also be due to the effect of $CaCl_2$ on the delaying of natural physiological processes like respiration, onset of the climacteric, ripening process and senescence as reported by Hussain *et al.* (2012).

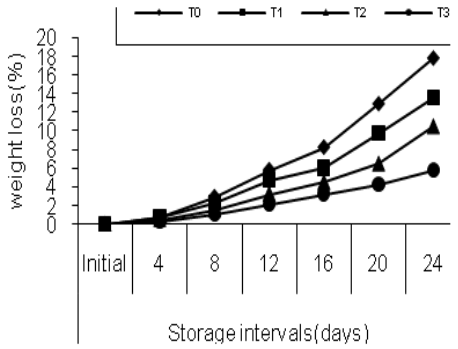

Figure 1. Effect of calcium chloride and storage at 10°C on weight loss

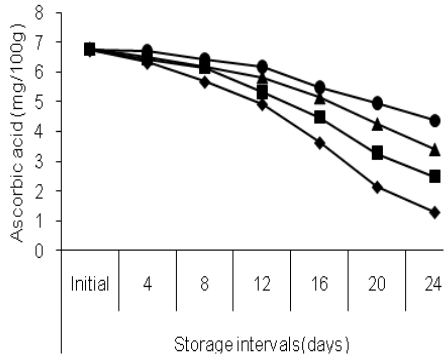

Figure 2. Effect of calcium chloride and storage at 10°C on ascorbic acid

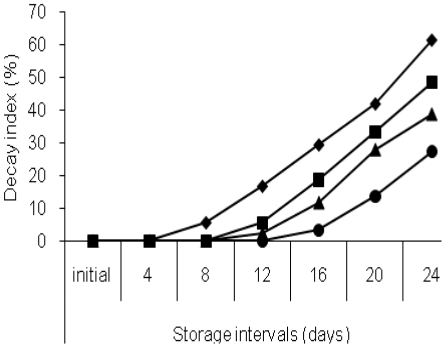

Figure 3. Effect of calcium chloride and storage at 10°C on decay index

Ascorbic acid content

The result of the ascorbic acid content is shown in Figure 2. Initially the ascorbic acid values for To, T_1, T_2 and T_3 were 6.73, 6.75, 6.78 and 6.76 mg/100g respectively. With the advancement of storage, ascorbic acid decreased significantly ($p \leq 0.05$) in all samples, and were decreased to 1.28, 2.49, 3.41 and 4.37 mg/100g respectively during 24 days clod storage. Among all the treatments, ascorbic acid was significantly ($p \leq 0.05$) higher in samples subjected to calcium chloride dip. Ascorbic acid is an important nutrient and is very sensitive to degradation due to its oxidation compared to other nutrients during food processing and storage (Veltman *et al*., 2000). These results showed that $CaCl_2$ treatments had a significant effect on retaining ascorbic acid content in peach fruits. This might be because higher concentrations of $CaCl_2$ delayed the rapid oxidation of ascorbic acid in samples T_2 and T_3. However the losses in ascorbic acid content may be due to light during storage. The ascorbic acid loss during storage is known to be due to its antioxidant activity especially under postharvest storage conditions (Davey *et al*., 2000).

Fruit decay index

The results pertaining to decay index is shown in Figure 3. In control fruits the decay was started after 4 days of cold storage and showed maximum decay at the end of the storage period. No decay was recorded in fruits treated with 1 and 2% $CaCl_2$ till 8 days of storage while the fruits dipped in 3% calcium chloride showed decay after 12th day of storage at 10°C. At the end of the storage period control, 1, 2 and 3% $CaCl_2$ treated fruits showed 61.22, 48.33, 38.55 and 27.22% decay respectively. Among $CaCl_2$ treated fruits, decay index was significantly ($P < 0.05$) different in samples treated at levels 2 and 3% after 24 days of storage. Since Ca is the major ingredient of middle lamella in cell walls and modifies cell wall rigidity by thickening the middle lamella of cell wall owing to increased formation and

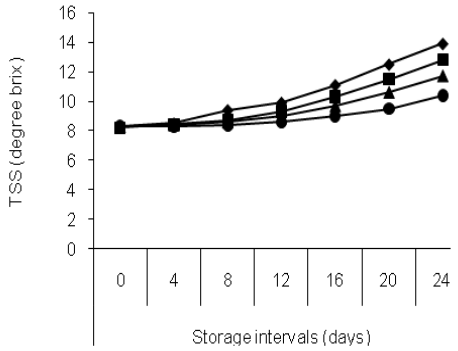

Figure 4. Effect of calcium chloride and storage at 10°C on TSS

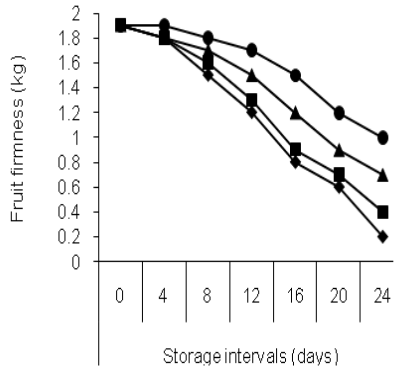

Figure 5. Effect of calcium chloride and storage at 10°C on fruit firmness

deposition of Ca-pectate and this reduced the rate of decay (Dey and Brinson, 1984). The incorporation of calcium ions in fruit tissue promotes new cross-links between anionic homogalacturonans, strengthening the cell wall and particularly the middle lamella which is responsible for holding cells together. Thus, increasing the stability of the cell wall and middle lamella of the fruits (Munoz *et al.*, 2008). Similar findings with decay of plum fruits at low temperature were reported by Mahajan *et al.* (2008). Therefore calcium dips raise the possibility of producing fruit less susceptible to decay during storage. While the higher decay content in untreated fruits was the result of lesser tissue strength and cellular disorganization.

Total soluble solids

Initially the total soluble solids of peach fruits were 8.3°brix (control), 8.2°brix (1%), 8.3°brix (2%) and 8.3°brix (3%) which showed an increasing trend irrespective of treatments (Figure 4). However after 24 days of storage, increase in TSS was significantly ($P \leq 0.05$) higher in control sample compared to $CaCl_2$ treated fruits. The increase in TSS was probably due to the hydrolysis of polysaccharides and concentrated juice content as a result of dehydration with the passage of storage time (Akhtar *et al*., 2010). The slower increase of TSS in 3% $CaCl_2$ might be due to the fact that more concentration of calcium chloride (3%) formed a thin layer on the surface of fruit which delayed degradation process. The increase in TSS is attributed to the enzymatic conversion of higher polysaccharides such as starches and pectins into simple sugars during ripening (Hussain *et al*., 2008). Therefore, the $CaCl_2$ dip resulted in delaying the increase in TSS in samples subjected to higher concentration of $CaCl_2$ even after 24 days of cold storage.

Fruit firmness

Effect of calcium chloride dip treatments on firmness of peach fruit is depicted in Figure 5. Statistical analysis of the data revealed that after 24 days of storage, firmness of control peach fruits was 0.2 kg and those treated with $CaCl_2$ at levels 1% (0.4 kg), 2% (0.7 kg) and 3% (1.0 kg) was statistically ($P<0.05$) different with respect to each others, After 24 days of storage, control fruits recorded a decrease of 89.47% in firmness as against the 78.95%, 63.16% and 47.37% in 1%, 2% and 3% $CaCl_2$ treated fruits respectively. As the fruit ripens the fruit softens. But application of calcium chloride helps in reducing the fruit respiration rate thus slows down the ripening process and maintained the fruit firmness (White and Broadly, 2003) The retention of firmness in samples calcified is due to fact that calcium plays an important role in maintaining cell wall structure by interaction with pectic acids in the cell walls to form calcium pectate (Conway and Sams, 1987). Cell wall integrity is also preserved when de-esterified pectic acid residues form cross-bridges between negatively charged carboxylic groups and divalent cations such as calcium, thus minimizing pectic substance solubilization (Krall and McFeeters, 1998).

Conclusion

On the basis of results obtained it is concluded that one percent calcium chloride treated fruits did not show any good results. Two percent calcium chloride treated fruits have little improvement, while 3% $CaCl_2$ retained maximum firmness, TSS, ascorbic acid content and reduced decay index and weight loss as compared to control.

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