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Research Article

Effect of Anti-Browning Agents and Calcium Salts on Peach Slice Quality

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Abstract

Effects of four calcium salts (calcium chloride, calcium lactate, calcium citrate, calcium phosphate) on processed peach texture were determined. Peach slices were immersed in solutions containing dissolved calcium salts at levels of 0.5, 1 and 2 % for 1 minute then stored at 4 ˚C for 3 days. Peaches treated with calcium salts were firmer than non-calcium treated peach slices at all levels. Calcium lactate at 2 % level was best in terms of texture and overall appearance. Effect of calcium salts at 3 % level was also determined for three different varieties of peaches (Autumn Prince, Big Red, O'Henry) with a dipping time of 5 minutes. Calcium citrate and calcium phosphate treatments resulted in a poor texture as compared to non-calcium treated samples. Texture was improved with all calcium salts for Autumn Prince Variety as compared to other varieties. Increase in the level of calcium salts to 3 % did not generally improve the texture of peach slices. This study revealed that the form and concentration of calcium used to influence peach texture has differing effects. Furthermore, the Variety of peach responded differently to the calcium salt and anti-browning treatments. Calcium chloride was generally the best calcium salt for preventing peach deterioration and increasing calcium salt concentration to 2% from 1% did not improve the quality of stored peach slices.

Keywords: Peach Texture; Calcium Salts; Anti-browning; Peach Slices

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Introduction

Fresh cut fruits and vegetables are a strong and growing market in US estimated to be $27 billion annually [1]. A major problem associated with freshly cut fruits is their susceptibility to browning and textural defects. The reason for limited commercial success of fresh cut fruits like peaches and nectarines is the cut surface browning and loss of firmness [2]. Due to processing operations such as peeling and cutting, intermixing of polyphenol oxidase and phenolics causes enzymatic browning resulting in an undesirable appearance. In fresh cut fruit tissue, softening is a serious problem that decreases shelf life. Softening causes a loss of water and cell softening enzymes from plant cells will decrease turgor pressure [3].

Calcium Salts in Cut Fruit Preservation

Calcium salts have been widely used in the fresh cut produce industry to preserve the quality of minimally processed commodities. Calcium chloride is the most widely used firming agent for sliced fruits. The addition of calcium salts such as calcium chloride ($CaCl_2$), calcium lactate, and calcium citrate are used in cut fruits to reduce textural degradation during storage, especially in high-moisture fruits such as papaya [4]. Calcium ions play a significant role in maintaining cell wall integrity by interacting with pectin in plant cell walls, thereby enhancing fruit firmness. Studies have demonstrated that calcium chloride maintains the firmness of cut fruits like apple slices, reducing the rate of softening during storage [5]. Additionally, the calcium salt treatment has been associated with a reduction in water loss from cut fruit, which helps prevent dehydration and shriveling [6]. While it is beneficial for the texture retention, it is found to impart off flavors at higher concentrations [7]. Thus, various alternative calcium sources such as calcium lactate, calcium propionate have been tested with two studies reporting that the quality of fresh cut cantaloupe and melons improved with different calcium sources including calcium lactate, calcium chloride, calcium propionate and calcium amino acid chelate dips etc [2,8].

Calcium plays a very important role in fruit physiology particularly in relation with pectin with which it stabilizes cell membrane and turgor pressure. Because of the ability of calcium ions to form crosslinks between carboxyl groups of polyuronic chains present in the middle lamella pectin, they strengthen the plant cell wall [9,10]. Calcium also helps maintain the appearance of fruits and vegetables by inhibiting browning as it reduces the leakage of the enzyme polyphenol oxidase (PPO) and its substrates on the cut and exposed surfaces.

The literature reports levels of calcium chloride solutions in the range of 0.1 to 1 % with dipping times from 1 to 5 minutes [11-16]. Studies on melons reported a maximum level of up to 2.5 % [14]. In kiwifruit slices, no difference in treatments was found in levels between 1 % and 2 % [17]. Dipping has the added benefit of rinsing off enzymes and substrates, which can be released during the cutting operation from injured cells.

Enzymatic browning

Enzymatic browning can cause undesirable effects in fresh cut fruits and vegetables changing organoleptic properties and appearance decreasing shelf life and market value. Browning can be a desirable reaction in some foods such as in the production of tea, coffee, cocoa, prunes, cider contributing specific flavors and colors. Enzymatic browning occurs by oxidation of mono and diphenols in the presence of PPO. Polyphenol oxidase catalyses the hydroxylation of monophenols to diphenols and the oxidation of diphenols to o-quinones [18]. This PPO activity makes fruits and vegetables susceptible to the oxidative browning (e.g. fruits such as peaches, pears, apples, banana, apricots and vegetables such as mushrooms, potatoes, lettuce). Various factors affect enzymatic browning including the content and type of the phenolic substances present in fruits or vegetables, temperature and the presence of inhibitors. Browning, particularly enzymatic browning mediated by PPO, is a common problem with cut fruits like apples, bananas, and pears. This process leads to undesirable color changes and may reduce the nutritional value of the fruit. Anti-browning agents are commonly used to prevent or slow down enzymatic browning by either inhibiting the activity of PPO via copper ion chelation or by creating a physical barrier to oxygen, which is essential for the browning reaction [5].

Ascorbic acid (vitamin C) and citric acid are among the most common anti-browning agents used in cut fruit preservation. Ascorbic acid works by reducing the oxidized form of phenolic compounds, thus preventing the formation of brown pigments (Gómez et al., 2013). Citric acid acts as a pH adjuster, lowering the pH of the fruit's surface and making it less favorable for PPO activity. These agents have been found to significantly reduce browning in fruits like apples and pears during postharvest handling [6].

Another promising anti-browning agent is calcium ascorbate, a combination of calcium and ascorbic acid. This dual-purpose agent not only prevents browning but also enhances the firmness of cut fruit by providing the benefits of calcium salts while inhibiting PPO activity [5]. Other anti-browning treatments, such as the use of sulfur dioxide, have also been effective in reducing browning in fruits, though concerns about potential health risks have led to increased interest in more natural alternatives like calcium salts and ascorbic.

Synergistic Effects of Calcium Salts and Anti-browning Agents

Recent studies have explored the combined effect of calcium salts and anti-browning agents, suggesting that their synergistic use may provide superior quality retention in cut fruit. For instance, combining calcium chloride with ascorbic acid or citric acid has been shown to delay both textural changes and browning in fruits like apples (Gómez et al., 2013). The calcium ions enhance firmness by stabilizing cell walls, while the anti-browning agents inhibit the enzymatic browning process. This dual-action treatment has been particularly effective in improving the overall shelf life of cut fruits, reducing both softening and discoloration [4].

Wounding of tissues increases respiration rate and triggers texture deterioration [19]. Ascorbic acid, erythorbic acid, citric acid, and their combinations were found effective in preventing browning of apple slices [20]. Sapers and Hicks (1988) [21] found that sodium erythorbate and ascorbate are more effective than their respective acids for preventing browning of apple wedges. Erythorbate and ascorbate function to reduce undesirable oxidative products, change the redox potential of system and scavenge free radicals to prevent oxidation. Citric acid is an acidulant typically added in levels of 0.5 to 2 % in combination with other anti-browning agents. Citric acid reduces pH as well as chelate copper at the active site of PPO enzyme. The combination of reducing agents, acidulants and chelating agents are used because of their synergistic effect [18].

Objectives

The objectives of the current study were to determine the effects of:

1. Calcium salts at different levels on the texture of peach slices.
2. Calcium salts on the texture of different varieties of peaches.
3. Anti-browning agents on browning inhibition in peach slices.

Materials and Methods

Experiment 1. Peach slices dipped in 4 concentrations of 3 different calcium salts:

Flame Prince Variety peaches were stored overnight at 4 °C prior to the processing. On the day of processing, peaches were removed from cold storage and allowed to warm to room temperature. Peaches were peeled by submersion in 1% boiling NaOH (UNIVAR products Corp., Kirkland, WA 98033) solution for 30 seconds. After boiling, peaches were immediately cooled in ice cold water for 1 minute and lightly rubbed until and remaining peel was removed. Peeled peaches were submerged in 1% citric acid (Jungbunzlauer Canada, Ontario L3K5V4) solution for 30 seconds, cut in half to remove the pit and sliced in the sections approximately ½ inch in width. Slices were then dipped in one of four different calcium solutions at concentrations of 0.5, 1 and 2% for either calcium chloride, calcium phosphate (Fisher Scientific, Fair lawn, NJ 07410), calcium citrate (Sigma-Aldrich, Inc. St. Louis, MO 63103) or calcium lactate (Spectrum chemical mfg. Corp. Gardena, CA 90248) for 1 minute with control samples dipped in water. Samples were stored at 4 °C then texture was measured after 1 day of refrigerated storage (4 °C ± 2 °C) according to the method described below.

Texture analysis- Texture was measured using a TA-XT plus texture analyzer (Stable Micro Systems, Texture Technologies Corp, NY, USA) equipped with a 5 kg load cell. Peach slices were removed from refrigerated storage and a puncture test was conducted using a cylindrical probe TA-52 having a diameter of 2 mm driven through the slices at the test speed of 2.0 mm/sec. The force was recorded in kilogram of force to puncture for each of three slices per treatment.

Experiment 2 Effect of 3% calcium salt solutions on the texture of different peach varieties:

Peaches of the three different varieties Big Red, O'Henry and Autumn Prince were processed according to the method described in experiment 1. Briefly, this method involved peeling peaches by dipping in 1 % boiling NaOH for 30 seconds, cooling in ice water, submersion in 1 % citric acid, pit removal and slicing. Slices were then dipped in calcium chloride, calcium phosphate, calcium citrate and calcium lactate solutions at 3% concentration for 5 minutes. They were stored at 4 °C and texture was measured on 0, 1st, 2nd and 3rd day as previously described.

Experiment 3 Effect of different concentrations of anti-browning agents on visual browning.

Peaches of Autumn Prince Variety were purchased from a local market immediately after harvest and stored overnight at 4 °C prior to the processing. On the day of processing, peaches were removed from refrigeration and allowed to warm at room temperature for 1 hour. Peaches were hand peeled by knife, cut in a half to remove pit and sliced into six pieces with an approximate width of ½ inch. Slices were mixed with sodium erythorbate (PMP fermentation products, Inc., Milwaukee, WI), citric acid and their combinations. The following treatments were tested: (I) 0.5% sodium erythorbate (0.5S), (II) 1.0% sodium erythorbate (1S), (III) 0.5 % citric acid (0.5C), (IV) 1.0% citric acid (1C), (V) 0.5% sodium erythorbate + 0.5 % citric acid (0.5S,0.5C), (VI) 0.5 % sodium erythorbate +1.0% citric acid (0.5S,1C), (VII) 1.0% sodium erythorbate +0.5% citric acid (1S,0.5C) and (VIII) 1.0% sodium erythorbate +1.0% citric acid (1S,1C). Slices were held under refrigeration overnight at 4 °C and on the next day evaluated for surface darkness and overall darkness. The panel results for the four sets of peaches were recorded. A panel of 5 gave a visual score of the % darkening and overall degree of darkness (1-5 scale from least to most dark) of each set of 3 slices per treatment in three replications.

Statistical Analysis

All treatments were subject to analysis of variance (ANOVA) using SAS 9.2 to determine if there was a significant difference ($p > 0.05$) between treatments using proc glm and pdiff commands. For all experiments, Least Square Mean values were calculated.

Results and Discussion

Experiment 1 Peach slices dipped in 4 concentrations of 3 different calcium salts:

When all salt concentrations were averaged, calcium lactate (Ca-lac) increased puncture force of peach slices more than the other three calcium salts tested (Table 1). The % difference with respect to control (water dip) revealed that all calcium salts increased puncture force compared to control and calcium citrate (Ca-cit) was found to be least effective in improving texture among the calcium salts. Based on visual observations peach slices treated with calcium citrate were poorest in terms of color, appearance and texture followed by calcium phosphate (Ca-phos). Peach texture (puncture force) was found to be greater due to treatments in the following order:

Ca-lac> $CaCl_2$> Ca-phos> Ca-cit> Water.

When calcium salts were compared within their respective levels (0.5, 1, 2 %) the texture of peach slices was same for all levels of only calcium phosphate while the levels used for other salts resulted in significant interactions (Table 2). For calcium chloride, the 1% level was best for increasing firmness compared to 0.5 and 2 %. Garcia, Herrera and Morilla (1996) [22] reported similar results using treatments of calcium chloride at 1, 2, 4 % levels for strawberries and reported that the 1 % level at 25 °C and 45 °C was the most effective treatment for maintaining quality throughout the storage period of 3 days. However, an increase in calcium chloride concentration resulted in a decrease in firmness [22]. For calcium citrate, the 0.5 % level was best and puncture force decreased with an increase in calcium citrate levels and no difference was observed between the 1 and 2 % levels. For calcium lactate, the texture differed at all levels with the maximum texture obtained at 2 %. Luna-Guzman and Barrett (1999) [14] found similar results that calcium lactate and calcium chloride had a better firmness at 2. 5 % level compared to lower levels, with calcium lactate able to maintain the firmness of cantaloupe cylinders during storage [14]. In addition, parameters such as Total Soluble Solids (TSS), titratable acidity, sugar content, antioxidants, and phenolic compounds, were enhanced when dragon fruit was subjected to various concentrations of calcium chloride (1.0%, 2.0%, 3.0%, and 4.0%) through both spray and soak applications [23].

Table 1: Average texture effect of peaches dipped in calcium salt concentrations of 0.5, 1.0 and 2.0% compared to peaches dipped in water.

Treatment[1]	Puncture Force (kg)	% Difference from water dip
$CaCl_2$	0.1742[b]	37.007[b]
Ca-lac	0.2095[a]	64.608[a]
Ca-phos	0.1826[b]	41.483[b]
Ca-cit	0.1721[b]	1.922[c]
SEM	0.0067	7.795

[a-b]means within the columns with same subscript are not significantly different (P>0.05)

SEM=Standard error of mean for Puncture force=0.0067, % difference= 7.795

[1]Treatments consisted of calcium chloride ($CaCl_2$), calcium lactate (Ca-lac), calcium phosphate (Ca-phos), and calcium citrate (Ca-cit).

Table 2: Effect of Dipping Peaches in Different Calcium Salt Concentrations on Texture Compared to Peaches Dipped in Water.

Treatment	Level	Puncture Force (kg)	% Difference from water dip
$CaCl_2$	0.5	0.152[b]	20.92[b]
$CaCl_2$	1	0.203[a]	60.62[a]
$CaCl_2$	2	0.167[b]	29.48[a,b]
Ca-lac	0.5	0.137[c]	10.81[c]
Ca-lac	1	0.188[b]	54.28[b]
Ca-lac	2	0.302[a]	128.7[a]
Ca-phos	0.5	0.176[a]	40.67[a]
Ca-phos	1	0.187[a]	37.50[a]
Ca-phos	2	0.183[a]	46.28[a]
Ca-cit	0.5	0.247[a]	85.85[a]
Ca-cit	1	0.143[b]	7.362[b]
Ca-cit	2	0.125[b]	-87.44[c]

[a-c]means within the columns with same subscript are not significantly different (P>0.05)
SEM=Standard error of mean= 0.01174.
[1]Treatments consisted of calcium chloride ($CaCl_2$), calcium lactate (Ca-lac), calcium phosphate (Ca-phos), and calcium citrate (Ca-cit).

Peach puncture forces were also statistically compared for calcium salts among the same levels (Table 3). For 0.5 % calcium levels, calcium citrate resulted in the highest puncture force compared to other calcium salts followed by calcium phosphate. However, increase in the level for this salt resulted in decreased firmness. As a salt of an acid, citric acid may have affected pH decreasing firmness. Kluter and others (1996) [24] reported that rate of softening was higher at lower pH levels for peach slices packed in retort pouches. Calcium chloride and calcium lactate had similar effects on texture and were less effective than the other two salts improving firmness. For 1 % calcium levels (except for calcium citrate) the salts showed similar effects on texture and was found to be better than calcium citrate which differed from the results at the 0.5 % level. At the 2 % level, calcium lactate increased firmness more than other salts. At this level, calcium citrate was worst and calcium chloride and phosphate had a similar effect for improving texture. So, although calcium lactate gave the greatest increase in texture, the highest concentration i.e. 2 % was required to obtain these results.

Table 3. Effect of different calcium salts at different concentration on the texture of peaches compared to peaches dipped in water.

Treatment	Level	Puncture Force (kg)	% Difference from water dip
$CaCl_2$	0.5	0.152[b,c]	20.92[b]
Ca-lact	0.5	0.137[c]	10.81[b]
Ca-phos	0.5	0.176[b]	40.67[b]
Ca-cit	0.5	0.247[a]	85.85[a]
$CaCl_2$	1	0.203[a]	60.62[a]
Ca-lac	1	0.188[a]	54.28[a]
Ca-phos	1	0.187[a]	37.50[a,b]
Ca-cit	1	0.143[b]	7.362[b]
$CaCl_2$	2	0.167[b]	29.48[b]
Ca-lac	2	0.302[a]	128.7[a]
Ca-phos	2	0.183[b]	46.28[b]
Ca-cit	2	0.125[c]	87.44[c]

[a-d]means within the columns with same subscript are not significantly different (P>0.05); SEM=Standard error of mean= 0.01174
[1]Treatments consisted of calcium chloride ($CaCl_2$), calcium lactate (Ca-lac), calcium phosphate (Ca-phos), and calcium citrate (Ca-cit).

Peach texture after treatment with calcium salts were compared to control as the % difference. Calcium citrate was better as compared to the other three salts at 0.5 % level. However, at 1 % levels the other three salts were superior to calcium citrate. At the highest level of 2 % it was least effective compared to other salts. Calcium lactate showed the best results followed by calcium phosphate and calcium chloride. Overall, all calcium salts treatments resulted in better texture as compared to control (water dip). It was reported that calcium sources used in food industry resulted in significantly firmer samples than water dips [8]. Calcium ions will strengthen plant cell wall structure because of their ability to form crosslinks of carboxyl groups of polyuronic chains present in the middle lamella pectin [9,10]. Also, calcium ions contribute to the increased membrane integrity and cell turgor pressure.

Experiment 2 Effect of 3% calcium salt solutions on the texture of different peach varieties:

For Autumn Prince variety, treatment with calcium citrate and phosphate had same effect as the water dip and no dip (Table 4), and thus, there was no improvement in peach texture compared to control. Treatment with calcium chloride and lactate showed significant improvement in the texture of peach slices with respect to non-calcium treated as well as other salts. Overall, calcium lactate was retained texture to a greater extent than the rest of treatments for Autumn Prince and O'Henry varieties. However, for Big Red peaches, calcium chloride improved texture better than all other treatments and calcium lactate had similar effect on texture as no dip. Calcium citrate and phosphate showed a loss of firmness which was worst than non calcium treated samples for Autumn Prince and Big Red varieties. As a salt of acids, citric and phosphoric salts may have affected pH which resulted in the bad appearance as compared to other salts. In terms of solubility, these two salts were insoluble unlike calcium chloride and lactate. This may have resulted in less interaction of salt with the peach slices as compared to other two.

Table 4. Effect of different salts on the texture of different peach varieties in comparison to water dipping.

Variety	Treatment	Puncture force (kg)	% Difference from water dip
AP	$CaCl_2$	0.4185[a,b]	18.28[a,b]
AP	Ca-cit	0.3798[c]	8.095[b,c]
AP	Ca-lac	0.4513[a]	28.85[a]
AP	Ca-phos	0.3636[c]	5.680[b,d]
AP	No dip	0.3912[b,c]	11.68[a,c,d]
AP	Water dip	0.3688[c]	0.000[b,c]
BR	$CaCl_2$	0.2583[a]	57.88[a]
BR	Ca-cit	0.151[c,d]	-11.83[c,d]
BR	Ca-lac	0.2116[b]	25.12[b]

BR	Ca-phos	0.1193[d]	-28.05[d]
BR	No dip	0.1857[b,c]	8.170[b,c]
BR	Water dip	0.1723[c]	0.000[c]
OH	$CaCl_2$	0.2016[c]	1.016[c]
OH	Ca-cit	0.2707[b]	35.42[b]
OH	Ca-lac	0.3604[a]	76.91[a]
OH	Ca-phos	0.3035[b]	79.27[a]
OH	No dip	0.2267[c]	17.44[b,c]
OH	Water dip	0.2251[c]	0[c]

[a-d]means within the columns with same subscript are not significantly different (P>0.05); SEM=Standard error of mean= 0.0130; AP- Autumn prince, BR- Big Red, OH- O'Henry.
[1]Treatments consisted of calcium chloride ($CaCl_2$), calcium lactate (Ca-lac), calcium phosphate (Ca-phos), and calcium citrate (Ca-cit).

For the O'Henry variety, calcium chloride had same effect as non-calcium treated samples. Calcium lactate increased firmness the most with calcium citrate and phosphate being the second most effective firming agent tested at the 3% level. The overall texture was better for Autumn Prince peaches compared to the other two varieties which could be attributed to a better initial texture of that variety compared to others.

When % difference was observed with respect to control (water dip), it was found that for the Big Red variety, calcium citrate and phosphate resulted in peaches that were less firm than controls. For the same variety, calcium chloride had greater firmness followed by lactate as compared to control. For O'Henry and Autumn Prince variety however, calcium chloride had same effect as non-calcium treated samples. For O'Henry variety calcium lactate and phosphate were best as compared to other treatments.

When visual appearance was observed for all the varieties of peaches, treatment with calcium citrate showed a poor appearance among all treatments and calcium chloride was found to be best.

$CaCl_2$ > Ca-lac > Ca-phos > Ca-cit

When the texture effect of each salt was compared for the different varieties, no salt showed similar results for different varieties. For the Autumn Prince variety, all calcium salts showed better texture as compared to other varieties (Table 5).

Table 5. Effect of dipping different peach varieties in calcium salts on the puncture force and % difference in comparison to peaches dipped in water.

Variety	Treatment	Puncture force (kg)	% Difference from water dip
AP	$CaCl_2$	0.4185[a]	18.28[b]
BR	$CaCl_2$	0.2583[b]	57.88[a]
OH	$CaCl_2$	0.2016[c]	1.016[b]
AP	Ca-lac	0.4513[a]	28.85[b]
BR	Ca-lac	0.2116[c]	25.12[b]
OH	Ca-lac	0.3604[b]	76.91[a]
AP	Ca-phos	0.3636[a]	5.680[b]
BR	Ca-phos	0.1193[c]	-28.05[c]
OH	Ca-phos	0.3035[b]	79.27[a]
AP	Ca-cit	0.3798[a]	8.095[b]
BR	Ca-cit	0.1510[c]	-11.83[c]
OH	Ca-cit	0.2707[b]	35.42[a]

AP	No dip	0.3912[a]	11.68[a]
BR	No dip	0.1857[c]	8.170[a]
OH	No dip	0.2267[b]	18.44[a]
AP	water dip	0.3688[a]	0.000[a]
BR	water dip	0.1723[c]	0.000[a]
OH	water dip	0.2251[b]	0.000[a]

[a-d]means within the columns with same subscript are not significantly different (P>0.05); SEM=Standard error of mean= 0.0130; AP- Autumn prince, BR- Big red, OH- O'Henry.
[1]Treatments consisted of calcium chloride ($CaCl_2$), calcium lactate (Ca-lac), calcium phosphate (Ca-phos), and calcium citrate (Ca-cit).

Experiment 3 Effect of different concentrations of anti-browning agents on visual browning.

Citric acid was more effective than sodium erythrobate in preventing % and overall darkening in peach slices stored overnight under refrigeration (Table 6). There did not appear to be an overall synergism between sodium erythrobate and citric acid in reducing peach slice browning since 1.0% citric acid was most effect alone. Percent darkness and overall darkness was highest for treatment at 0.5 % odium erythorbate and lowest for 1 % CA.

Table 6. Effect of citric acid and sodium erythorbate alone and in combinations at 0.5 and 1.0% levels on the darkening of peach slices.

Treatment	% darkness	Degree of darkness
0.5 % Na erythorbate	52.1[a]	3.7[a]
1.0 % Na erythorbate	35.2[b]	2.3[b]
0.5% citric acid	34.4[b]	2.2[b]
1.0 % citric acid	19.1[d]	1.4[d]
0.5 % Na erythorbate/0.5 % citric @	48.6[a]	3.4[a]
0.5 % Na erythorbate/1.0 % citric @	28.5[c]	1.8[c]
1.0 % Na erythorbate/0.5 % citric @	41.2[a]	3.1[a]
1.0 % Na erythorbate/1.0 % citric @	29.1[c]	1.9[b,c]

[a-d]means within the columns with same subscript are not significantly different (P>0.05)
SEM=Standard error of mean= 0.130.

Peaches of Autumn Prince Variety were observed in terms of overall appearance. They were mixed with combinations of sodium erythorbate and citric acid as explained above with the addition of sugar (sugar: peach 1:5). Overall appearance of processed peach slices did not differ at the storage temperatures of -20 ˚C and -80 ˚C (data not shown).

Conclusion

Calcium chloride at 1 % was best at maintaining the texture of Autumn Prince Variety peach slices as compared to 0.5 and 2 %. For calcium lactate treated peaches, the puncture force increased incrementally through each level to 2 % however the level of calcium salts to 3 % did not increase the puncture force of peach slices. Overall, all calcium salts treatments resulted in better texture as compared to control. Also, there was no difference in peak force due to storage when all four calcium treatments were pooled. Peach slices treated with calcium citrate resulted in reduced quality in terms of color, appearance and texture followed by calcium phosphate. When effect of all salts was compared for the different varieties no salt showed consistent effect for all varieties. For the autumn prince variety, all calcium salts showed higher puncture force as compared to other varieties.

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