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EFFECT OF CALCIUM CHLORIDE AND CALCIUM LACTATE ON QUALITY AND SHELF-LIFE OF FRESH-CUT GUAVA SLICES

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Present study was conducted to investigate the effectiveness of chemical treatments at low temperature on the quality of fresh-cut guava slices during 2011-12. Uniform sized guava slices were made free from seeds and treated with calcium chloride and calcium lactate with concentration 0.9%, 1.8%, 2.7% or 3.6%. After packing in plastic boxes, all treated samples were stored at $5^oC \pm 2^oC$ in a refrigerator for 24 days with 6 day interval between different removals. The results obtained from physico-chemical analysis showed decrease in firmness (111.67-12.67gf) and increase in browning (1.19-1.93nm) of guava slices compared to control with the passage of storage interval. Moreover, scores in taste (7.33-1.00), flavour (7.33-1.00), colour (7.50-1.00) and texture (7.67-1.00) of guava slices was also decreased with respect to interaction of treatments and storage period. Calcium chloride @ 2.7% showed significantly higher stability than other concentrations of calcium chloride and calcium lactate in delaying firmness and browning of fresh-cut guava slices along with maintaining their organoleptic properties for longer storage period. However, calcium chloride imparted undesirable bitterness to fresh-cut guava slices at the concentration of 3.6%. Based on the overall quality performance, 2.7% calcium chloride and 3.6% calcium lactate exhibited better results than other concentrations and control with storage life of 8 days at $5^oC \pm 2^oC$.
Keywords: Guava, fresh-cut technology, firming agents, sensory characteristic.

INTRODUCTION

Guava is commercially important fruit in more than fifty countries and Pakistan is third largest guava producing country after India and Mexico (Eipeson and Bhowmik, 1992). Guava is believed to be introduced in Indo-Pak during early 17th century. Several guava varieties are being cultivated in Pakistan and out of these *Gola* and *Surahi* are the most popular. Guava fruit is rich in dietary fibers, vitamins A, B and C along with some important minerals like phosphorous, potassium, calcium and iron. Fiber and calcium (Nadeem *et al*., 2009) are important in preventing heart diseases and colon cancer like problems, whereas vitamin C and iron play a role in reducing the problem of anemia (Hui, 2004). Moreover, guava has ability to produce a variety of food products like puree and paste, candies, juice concentrates, jams, jellies and squash. By virtue of its commercial and nutritional value, guava is considered a common man's fruit and can rightly be termed as "apple of the tropics" (Hui, 2004).

Guava fruit has a faster rate of softening due to its climacteric characteristic and higher metabolic process, which ultimately reduces its shelf-life (Mecrado- Silva *et al*., 1998; Jilani *et al*., 2010). There is a need to develop such techniques through which the supply as per consumer demand may be enhanced by maintaining the quality characteristics during storage and extending shelf-life of guava fruit. The shelf-life and post-cut quality of fresh-cut fruits depend mainly on cultivar, maturity or ripeness stage at harvesting, storage condition and processing technologies (Toivonen and Deel, 2002). Fresh-cut or minimally processed fruits and vegetables are products that are partially prepared; maintain a fresh-like state and no additional preparation is necessary prior to use and eating (Watada and Qi, 1999). Consumer demand for such foods is increasing for convenient, ready to use and ready to eat fruits with fresh-like quality (Lamikanra, 2002).

Calcium and its salts have been extensively reported for their potential role in maintaining postharvest quality to get reduce softening problem in fruits by decreasing the respiration and ripening processes along with reducing the senescence (Dong *et al*., 2000; Lamikanra, 2002; Durigan *et al*., 2005; Pereira *et al*., 2009; Bico *et al*., 2009). With the addition of calcium salts, cell wall structure could become stronger through strengthening the bond in between calcium and pectin (Gorny *et al*., 2002; Aguayo *et al*., 2006; Akhtar *et al*., 2010; Jilani *et al*., 2010).

The objective of this study was to extend the shelf-life of Pakistani guava (Surahi) slices by treating with different concentrations of calcium salts and to study their effects on quality attributes of fresh-cut guava produce packed in plastic boxes.

MATERIALS AND METHODS

The guava fruit was harvested at light green to yellow colour from a commercial orchard of Faisalabad. Fruits were transferred to laboratory of NIFSAT, UAF, where they were washed with sterilized water to minimize the contamination chances after grading on colour and size basis. Cleaned guava fruits were then graded, cut into uniform slices after removing their seed portion and dipped for 8 minutes in the solutions of calcium chloride or calcium lactate @ 0.9%, 1.8%, 2.7% or 3.6%. Treated slices were then air dried, packed in plastic boxes (120g/box with dimensions of L3.5" x W2" x D1.5") and stored at 5^{o}C $\pm$ 2^{o}C. The samples were analyzed on 0, 6, 12, 18 and 24 days after storage for firmness, browning and organoleptic attributes including taste, flavour, colour and texture. Samples were stored and analyzed in triplicate using CRD with factorial arrangement.

Firmness of each fresh-cut guava slice was determined by using needle probe/puncture (2mm needle) of TA.XT Plus texture analyzer (Texture Analyzer stable micro-system UK) through puncturing flesh up to 10mm with force (g) in to the cut surface of slices. Each slice was punctured thrice in each opposite side of three slices per replicate (Wang *et al.*, 2007).

Browning test was carried out by taking fresh-cut guava slices (20g) of each treatment in triplicate and homogenized (ULTRA TURRAX IKA T18 Basic) in the presence of 20ml sterilized water at speed of "22,000rpm" for 50 seconds. Then homogenized sample was centrifuged (@ 27600g at 5^{o}C for 15 min) and filtered (Whatman paper #4). To determine the browning intensity in the aliquot the absorption was noted form spectrophotometer (VARIAN Spectrophotometer AA240) at 340 nm (Moretti *et al.*, 2002).

Sensory evaluation (taste, flavour, colour and texture) was conducted using 9-point hedonic scale (1 = Dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neigther like nor dislike, 6 = like slightly, 7 = like moderately, 8 like very much and 9 = like extremely) as presented by Meilgaard *et al*. (2007).

Results were analyzed using one way ANOVA and LSD test was applied to the data to ascertain the statistical differences among mean values of different treatments.

RESULTS AND DISCUSSION

A significant (*P<0.01*) influence of chemicals (calcium chloride and calcium lactate), storage days and their interaction on the firmness and browning was observed during statistical evaluation. Regarding firmness (Table 1), application of 2.7% calcium chloride maintained the highest fruit firmness (95.53gf) followed by 3.6% calcium lactate (90.73gf) and 3.6% calcium chloride (87.67gf), while the control samples exhibited the lowest fruit firmness. The interaction of treatments and storage days also showed a decreasing trend in firmness during storage. But the maximum decrease in firmness (78.66gf) was recorded in untreated treatment followed by 0.9% calcium lactate (76.67gf) and 0.9% calcium chloride (69.34gf) while the lowest reduction in firmness (36.67g) was noted in slices treated with 2.7% calcium chloride. Similarly, Wongs-Aree and Kanlayanarat (2004) and Wong-Aree and Srilaong (2006) observed that the firmness in guava cuts increase with the increasing in concentrations of calcium chloride, but after certain level the firmness starts to decrease due to the development of some physiological disorders. Moreover, Pereira *et al.* (2009) found calcium lactate as a better chemical agent in delaying the firmness in guava peel through maintaining its hardness for longer time.

The results of browning (Table 2) showed the more absorption intensity in control (1.62) followed by 0.9% calcium lactate (1.58) and 3.6% calcium chloride (1.55) while the lowest browning intensity (1.36) was found in T_3

Table 1. Effect of calcium chloride and calcium lactate on firmness (g) of fresh-cut guava slices by different treatments and storage days

Treatments	Storage (Days)					Means
	0	6	12	18	24	
$T_{o\ (Control)}$	99.33 fg	83.33 j	54.67 p	34.33 r	20.67 t	58.47 i
Calcium chloride						
$T_{1\ (0.9\%)}$	103.67 de	93.33 h	73.67 l	56.67 p	34.33 r	72.33 g
$T_{2\ (1.8\%)}$	106.00 cd	100.00 fg	85.00 ij	70.67 m	56.67 p	83.67 e
$T_{3\ (2.7\%)}$	110.00 ab	111.67 a	97.67 g	85.00 ij	73.33 l	95.53 a
$T_{4\ (3.6\%)}$	109.67 ab	105.33 cd	93.33 h	73.33 l	56.67 p	87.67 c
Calcium lactate						
$T_{5\ (0.9\%)}$	101.67 ef	86.67 i	65.67 n	46.67 q	25.00 s	65.13 h
$T_{6\ (1.8\%)}$	102.67 e	91.00 h	78.33 k	61.00 o	46.67 q	75.93 f
$T_{7\ (2.7\%)}$	106.00 cd	99.00 g	91.00 h	75.33 l	54.67 p	85.20 d
$T_{8\ (3.6\%}$	107.67 bc	106.67 c	100.00 fg	78.33 k	61.00 o	90.73 b
Means	105.19 a	97.44 b	82.15 c	64.59 d	47.67 e	

Different letters in the same column show the means significantly different (P $\leq$ 0.05)

Table 2. Effect of calcium chloride and calcium lactate on browning of fresh-cut guava slices by different treatments and storage days

Treatments	**Storage (Days)**					**Means**
	0	**6**	**12**	**18**	**24**	
$T_{o(Control)}$	1.33 s-u	1.43 n-p	1.62 h-j	1.79 cd	1.93 a	1.62 a
Calcium chloride						
$T_{1\ (0.9\%)}$	1.31 t-v	1.35 q-t	1.46 m-o	1.64 g-i	1.84 bc	1.52 c
$T_{2\ (1.8\%)}$	1.27 u-w	1.32 s-u	1.40 o-r	1.53 k-m	1.73 de	1.45 d
$T_{3\ (2.7\%)}$	1.21 wx	1.19 x	1.30 t-v	1.47 l-n	1.64 gh	1.36 f
$T_{4\ (3.6\%)}$	1.30 t-v	1.39 p-s	1.54 kl	1.69 e-g	1.85 bc	1.55 b
Calcium lactate						
$T_{5\ (0.9\%)}$	1.32 s-u	1.41 n-q	1.57 i-k	1.72 d-f	1.87 ab	1.58 b
$T_{6\ (1.8\%)}$	1.27 u-w	1.34 r-t	1.47 l-n	1.63 g-i	1.78 cd	1.50 c
$T_{7\ (2.7\%)}$	1.25 v-x	1.31 t-v	1.43 n-p	1.55 jk	1.79 cd	1.47 d
$T_{8\ (3.6\%}$	1.25 v-x	1.25 v-x	1.34 r-t	1.51 k-m	1.66 f-h	1.40 e
Means	1.28 e	1.33 d	1.46 c	1.61 b	1.79 a	

Different letters in the same column show the means significantly different ($P \leq 0.05$)

which contain 2.7% calcium chloride. The results obtained in the present study are in line with the findings of Moretti *et al.* (2002) who found that the higher absorption is the indication of higher contents of phenolic contents, whereas it was also observed by Lee and Whitaker (1995) that the cut surface browning in fruit slices is caused by the action of polyphenol oxidase (PPO) in the presence of phenolic compounds and environmental oxygen. These findings indicate the better firmness with less browning was due to the fact that calcium chloride is known as better chemical agent in retarding the rate of respiration and ripening processes by decreasing the activity of responsible enzymes which are in fruits (Luna-Guzman and Barrett, 2000).

The results regarding the organoleptic evaluation indicate that the sensory attributes like taste, flavour, colour and texture were significantly influenced by the chemical treatments and storage period. For taste and flavour, the scores assigned to the guava samples have been presented in Figure 1 and 2. Figures show a decreasing trend in all of the samples during storage except 2.7% calcium chloride in which increasing trend in taste and flavour have been observed till 6th day of storage. T_3 (2.7% calcium chloride) was only treatment which showed slow decreasing trend till 18th day of storage followed by T_2 and T_1, while the least scores were given to the T_4. However, all the treatments (T_o – T_8) had the same score at the end of storage except T_3. Similarly Wang-Aree and Srilaong (2006) have observed with no changes in taste was found by using calcium chloride in the range of 1-2%. Bitterness problem started to increase, when its concentration was increased above 3%. Similarly, Mahmud *et al.* (2008) observed that with the use of 2.5% calcium contents, taste and flavour of papaya fruit were retained for longer storage period due to sustaining of their juice contents.

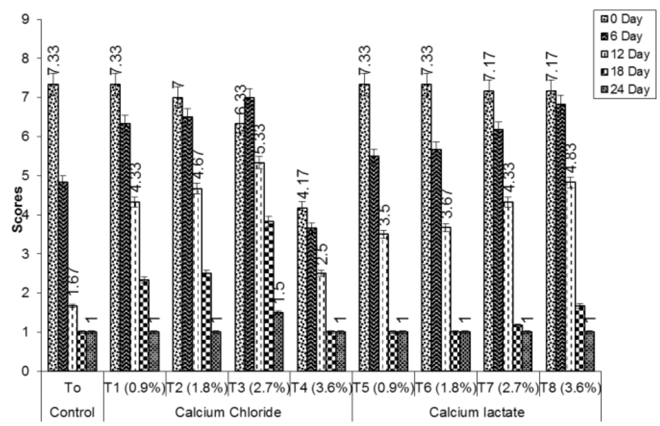

Figure 1. Effect of calcium chloride and calcium lactate on taste of fresh-cut guava slices by different treatments and storage days.

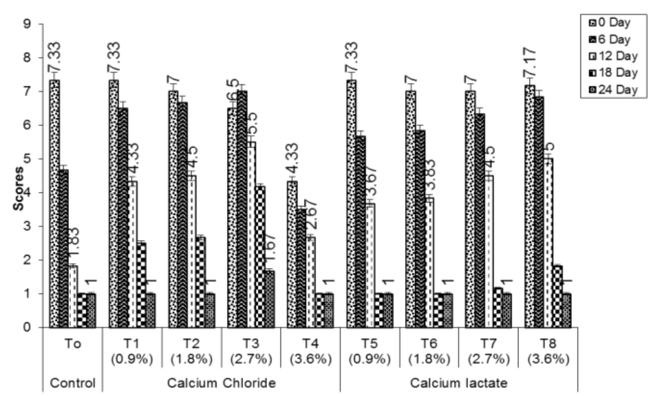

Figure 2. Effect of calcium chloride and calcium lactate on flavour of fresh-cut guava slices by different treatments and storage days.

The sensory score for colour and texture are presented in Figure 3 and 4. The score for colour and texture of the guava increased up to 6th day of storage in T_3 and T_8, after that a decrease trend was observed, while the other treatments showed decreasing trend throughout the storage period. The rate of decreasing in colour score was observed in T_3 followed by T_8, T_2 and T_7. The texture of T_3, T_8, T_2, T_7 and T_1 remained acceptable up to 18th day of storage, while in other treatments a clear reduction was observed. Results also showed that T_3 also remained more acceptable regarding, the texture as compared to other treatments. Likewise, Aguayo *et al.* (2006) found that the firmness in different fresh-cut fruits can be retained for longer period of time with the use of calcium chloride through dipping treatment. This might be attributed to maintaining the membrane integrity with the addition of calcium salt (Fan and Sokorai, 2005). Moreover, Wang *et al.* (2007) also observed that chemical treatment of calcium ascorbate treatment gave better result in maintaining the textural properties of fresh-cut apples than only packing fresh-cut apples in simple packaging material just after their sanitizing treatment.

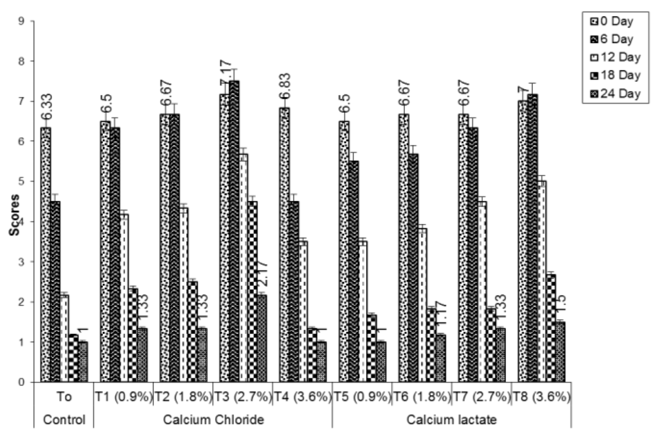

Figure 3. Effect of calcium chloride and calcium lactate on colour of fresh-cut guava slices by different treatments and storage days.

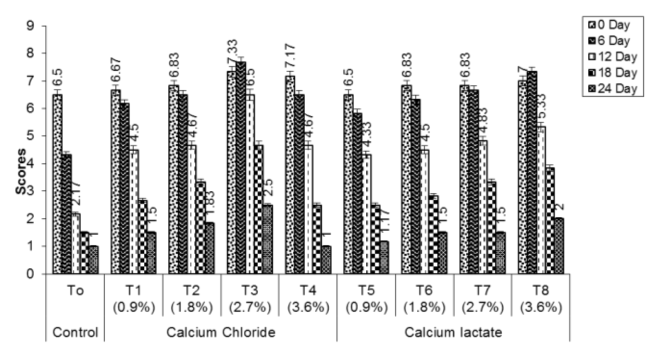

Figure 4. Effect of calcium chloride and calcium lactate on texture of fresh-cut guava slices by different treatments and storage days.

***Conclusion*:** Chemical dip with 2.7% calcium chloride presented the lowest rate of firmness loss and browning along with preserving the sensory attributes of fresh-cut guava slices up to 8 days of total shelf-life at 5°C after that there was a consistent deterioration in sensory attributes quality. Chemical dip might have reduced the respiration and ripening processes in fruits by controlling the activity of responsible enzymes and strengthening the cell-wall structure. From the result of present study, it was observed that the taste of fresh-cut guava slices reduced steadily with increase in storage period. Moreover, it was also found that bitterness in fresh-cut guava slices builds up if treated with higher concentrations of calcium chloride i.e. 3.6%.

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