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Effect of foliar spray of different chemicals on biochemical and organoleptic qualities of custard apple cv. Balanagar under ambient storage

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Abstract
The main aim of the study was to assess the "Effect of foliar spray of different chemicals on biochemical and organoleptic qualities of custard apple cv. Balanagar under ambient storage" was carried out in the KRC College of Horticulture, Arabhavi under University of Horticultural Sciences, Bagalkot during the year 2016 and 2017. The treatments involved foliar application of calcium chloride (1.0 and 2.0 %), borax (0.2 and 0.3 %), salicylic acid (0.40 and 0.60 %) and potassium silicate (0.40 and 0.60 %) at 30 days before harvesting to know their efficacy on improvement of quality and shelf life. The result showed that, the maximum retention of titratable acidity, ascorbic acid and minimum TSS and sugars were recorded with foliar spray of potassium silicate at 0.60 per cent which was closely followed by calcium chloride at 2.0 per cent.

Keywords: Custard apple, foliar, TSS, potassium silicate and calcium chloride

Introduction
Custard apple (*Annona squamosa* L.) is a semi-deciduous and exotic subtropical fruit. It has several synonymous such as Sithaphal, Sharifa, Sugar apple, Sweet sop etc. and more than 70 species come under the genus Annona of which only six of them produces edible fruits. In India, custard apple is grown in Andhra Pradesh, Assam, Bihar, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharastra, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. The plants are hardy and drought resistant and can thrive well on marginal and neglected soils. The main burning issue in this fruit is very short shelf life (3-4 days), when associated with inadequate handling, results in production loss and hinders custard apple commercialization and marketing. Hence, it is necessary to develop a technology which enables to extend the shelf life, reaching the consumer with good sensory qualities. The custard apple is climacteric in nature as they increase respiratory activity and production of ethylene during ripening. The increase of respiratory activity is accompanied by rapid modifications in its chemical composition, which alter the taste, aroma, firmness and skin colour. The softening and reduction of firmness of the fruit are the two main reasons for the decrease in quality and the major drawback to export of this fruit. To overcome this, study was carried out to retention of biochemical components and sensory character during storage.

Materials and Methods
This experiment was carried out in Horticultural Research Station, Tidagundi (Vijayapur) for two consecutive years during 2016 and 2017 to study the Effect of foliar application of different chemicals on biochemical and organoleptic qualities of custard apple cv. Balanagar under ambient storage. The fruits were harvested and brought to the laboratory of Department of Post-harvest technology, KRC College of Horticulture, Arabhavi, Gokak taluk, Belgaum district for further lab studies. The experiment was laid out in Completely Randomized Design (CRD) with three replications (5 tree/replication) and nine treatments. Selected trees were sprayed with different chemicals *viz*., $CaCl_2$ at 1 and 2 per cent, Borax at 0.2 and 0.3 per cent, Salicylic acid at 0.40 and 0.60 per cent and potassium silicate at 0.40 and 0.60 per cent. The pre-harvest sprays were applied to the trees at one month before harvesting during both the years (2016 and 2017).

The titratable acidity, ascorbic acid and sugars was determined by using method suggested by Ranganna (1986) [16] and total soluble solids was determined by using laboratory scale refractometer. The custard apple fruit was evaluated for its overall acceptability by using nine point hedonic scale.

Result

The data revealed that there was a significant difference among the pre-harvest treatments with respect to TSS, titratable acidity, ascorbic acid and sugars during storage intervals. The initial TSS content was recorded during 2016 and 2017 as 15.00 and 16.40 °B, respectively.

After 2 DAS, significantly minimum TSS was recorded in T_9 (18.30, 20.00 and 19.15 °B) which was on par with T_3 (18.30, 20.10 and 19.20 °B) while, significantly maximum TSS was noticed in the treatment T_1 (20.03, 21.83 and 20.93 °B) during 2016, 2017 and pooled data, respectively (Table 1). During 2016, significantly minimum TSS was recorded in T_9 (21.47 °B) which was in parity with T_3 (21.50 °B) at 4 DAS. On the contrary, significantly the maximum TSS was recorded in control fruits (24.00 °B). During 2017 and pooled data, the lowest TSS was significantly recorded in T_3 (22.67 and 22.08 °B) which was statistically closely associated with T_9 (22.73 and 22.10 °B) whereas, significantly highest TSS was recorded in the treatment T_1 (27.00 and 25.50 °B) at 4 DAS, respectively. Among 4 treatments, the highest TSS was recorded in T_9 (24.00, 27.50 and 25.75 °B), T_8 (24.00, 27.47 and 25.73 °B) and T_3 (24.00, 27.00 and 25.50 °B) while, lowest TSS was noticed in T_2 (23.80, 26.83 and 25.32 °B) during 2016, 2017 and pooled data at 6 DAS, respectively.

The titratable acidity was expressed in terms of citric acid as percentage on fresh pulp weight basis of custard apple fruits (Table 1). As evident from the treatment means, titratable acidity showed in decreasing trend with the increase in storage period with irrespective of the treatments. The initial titratable acidity was recorded during 2016 and 2017 as 0.424 and 0.443 per cent, respectively. After 2 DAS, significantly highest (0.410, 0.428 and 0.419 %) titratable acidity was found in foliar spray of 0.60 per cent potassium silicate (T_9) which was statistically on par with T_3 (0.407, 0.428 and 0.418 %) whereas, significantly lowest (0.303, 0.320 and 0.312 %) titratable acidity was observed in treatment T_1 (control) during 2016, 2017 and pooled data, respectively. In 2016, 2017 and pooled analysis, significantly maximum (0.355, 0.378 and 0.367 %) titratable acidity was observed in T_9 which was closely associated with T_8 (0.351, 0.376 and 0.364 %) and T_3 (0.348, 0.377 and 0.363 %) whereas, the minimum titratable acidity (0.272, 0.293 and 0.283 %) was noticed in T_1 (control) at 4 DAS, respectively. Among 4 treatments, highest titratable acidity was recorded in T_9 (0.286, 0.304 and 0.295 %) and T_3 (0.284, 0.302 and 0.293 %) whereas, lowest titratable acidity (0.278, 0.290 and 0.284 %) was noticed in T_2 (foliar spray of 1.0 % $CaCl_2$) during 2016, 2017 and pooled data at 6 DAS, respectively.

A gradual decrease in ascorbic acid content was observed in custard apple during storage period (Table 2). The initial ascorbic acid recorded in fruits during 2016 and 2017 was 8.26 and 10.12 mg/100 g, respectively. The treatment T_9 recorded significantly highest ascorbic acid (8.00 mg/100 g) than all other treatments during 2016 which was on par with T_3 (7.95 mg/100 g) whereas, lowest (7.41) was found in T_1 (control) at 2 DAS. For 2017 and pooled data, significantly highest ascorbic acid (9.33 and 8.67 mg/100 g) was found in foliar spray of 0.60 per cent potassium silicate (T_9) and it was statistically on par with T_3 (9.24 and 8.60 mg/100 g) whereas, lowest (8.50 and 7.95 mg/100 g) was noticed in control (T_1) at 2 DAS, respectively. After 4 DAS, significantly highest ascorbic acid (6.92 mg/100 g) was recorded in T_9 which was on par with T_3 (6.83 mg/100 g) whereas, lowest was recorded in T_1 (6.15 mg/100 g) during 2016. In 2017 and pooled data, T_9 treatment recorded significantly maximum ascorbic acid (8.21 and 7.56 mg/100 g) which was statistically similar with T_3 (8.17 and 7.50 mg/100 g) and minimum (7.28 and 6.72 mg/100 g) was found in T_1 (control) at 4 DAS, respectively.

After 6 days of storage, all treatments were spoiled except T_2 (foliar spray of 1.0 % $CaCl_2$), T_3 (foliar spray of 2.0 % $CaCl_2$), T_8 (foliar spray of 0.40 % potassium silicate) and T_9 (foliar spray of 0.60 % potassium silicate). Among 4 treatments, the highest ascorbic acid was recorded in T_9 (6.32, 7.40 and 6.86 mg/100 g) and T_3 (6.30, 7.34 and 6.82 mg/100 g) whereas, lowest (6.24, 7.17 and 6.70 mg/100 g) was noticed in T_2 during 2016, 2017 and pooled analysis, respectively.

The reducing sugar increased linearly as the storage period increased (Table 2). The initial value of reducing sugar was recorded in 2016 and 2017 as 3.44 and 4.54 per cent respectively. After 2 DAS, significantly lowest reducing sugar (4.41, 5.09 and 4.75 %) was recorded in T_9 which was parity with T_3 (4.49, 5.14 and 4.81 %) while, highest was found in T_1 (6.73, 7.79 and 7.26 %) during 2016, 2017 and pooled data, respectively. After 4 DAS, significantly lowest reducing sugar was observed in T_9 (9.20 %) and it was closely associated with T_3 (9.28 %) whereas, highest was noticed in T_1 (13.73 %) during 2017. Similarly, in 2016 and pooled data, T_9 (7.71 and 8.46 %) treatment registered significantly highest values which was on par with T_3 (7.82 and 8.55 %) whereas, highest reducing sugar was noticed in control fruits (11.73 and 12.70 %) at 4 DAS, respectively. Among 4 treatments, highest reducing sugar was recorded in T_9 (12.35, 14.31 and 13.33 %) followed by T_3 (12.01, 14.11 and 13.06 %) and lowest reducing sugar was noticed in T_2 (11.36, 13.79 and 12.57 %) during 2016, 2017 and pooled data, respectively at 6 DAS.

The study showed non-significant differences with respect to non-reducing sugar at 2 DAS and significant difference at 4 DAS (Table 3). At initial stage of observation, non-reducing sugars recorded during 2016 and 2017 was 2.74 and 4.00 per cent, respectively. In 2016, among the treatments, T_9 recorded maximum non reducing sugar (3.62 %) and it was closely followed by T_3 (3.58 %). However, minimum was recorded in T_1 (2.23 %) at 4 DAS. During 2017 and pooled data, maximum non reducing sugars was significantly recorded in T_9 (4.60 and 4.11 %) which was on par with T_3 (4.57 and 4.07 %) whereas, minimum was noticed in T_1 (3.27 and 2.75 %) at 4 DAS, respectively. Among 4 treatments, minimum non reducing sugars was recorded in T_9 (2.52, 3.06 and 2.79 %) followed by T_3 (2.74, 3.10 and 2.92 %) and maximum was noticed in T_2 (2.95, 3.27 and 3.11 %) during 2016, 2017 and pooled data, respectively at 6 DAS.

Total sugar content increased as the storage period progressed and then decreased (Table 3). At the initial stage, total sugars were recorded during 2016 and 2017 as 6.32 and 8.75 per cent, respectively. After 2 DAS, significantly lowest total sugar was recorded in T_9 (8.39, 10.00 and 9.20 %) which was on par with all the treatments except T_4, T_5, T_6, T_7 whereas, significantly highest total sugar was recorded in T_1 (10.35, 12.26 and 11.31 %) during 2016, 2017 and pooled data, respectively. After 4 DAS, significantly minimum total sugar was recorded in T_9 (11.52, 14.05 and 12.78 %) which was on par with all the treatments except T_4, T_5, T_6, T_7 whereas, significantly maximum was recorded in T_1 (14.08, 17.12 and 15.60 %) during 2016, 2017 and pooled data, respectively. Among 4 treatments, maximum total sugars were recorded in T_9 (15.00, 17.53 and 16.27 %) followed by T_3 (14.90, 17.37 and 16.13 %) and minimum was noticed in the treatment T_2 (14.47, 17.23 and 15.85 %) during 2016, 2017 and pooled data, respectively at 6 DAS.

Influence of different pre-harvest treatments on sensory attributes like colour and appearance, texture, flavour, taste and overall acceptability of custard apple fruits were assessed by the 10 semi-trained panel and the results are presented in Table 4. Organoleptic evaluation was done at 4 DAS.

In 2016, 2017 and pooled data, the maximum score for colour and appearance (8.30, 8.10 and 8.20) was noted in T_9 however, minimum score was noticed in T_1 (6.00, 5.80 and 5.90), respectively. The maximum score for texture was significantly found in T_3 (8.83, 8.90 and 8.87) while, minimum score was recorded in T_1 (6.00, 7.00 and 6.50) during 2016, 2017 and pooled data, respectively. Significantly highest score for taste and flavour was obtained in the treatment T_9 during 2016 (8.90), 2017 (8.70) as well as in pooled analysis (8.80). The lowest score (7.50, 7.00 and 7.25) was in control (T_1) during 2016, 2017 and pooled data, respectively. During 2016, 2017 and pooled data, highest score for overall acceptability was seen in T_9 (8.70, 9.00 and 8.85). However, T_1 (control) recorded minimum scores for overall acceptability (6.90, 7.00 and 6.95) at 4 DAS during 2016, 2017 and pooled data, respectively.

The treatments T_9, T_8, T_3 and T_2 recorded significantly the highest shelf life in 2016 (6 days each), 2017 (6.67, 6.00, 6.33 and 6.00 days) as well as in pooled analysis (6.33, 6.00, 6.17 and 6.00 days) when compared to all other treatments, respectively (Table 4). The minimum shelf life was in the control (T_1) fruits (4 days each) for 2016, 2017 and pooled data, respectively.

Discussion

The results obtained in this study are discussed below. The total soluble solids are approximate index of the amount of sugars present in fruits, as sugars constitute about 80-85 per cent of total soluble solids. There is increase in TSS and total sugars content in all the treatments as the storage period progressed. In the present experiment, irrespective of the treatments, there was a general increase in the TSS and sugars content of custard apple up to six days and then it was decreased. The increase in TSS and sugars during storage may be due to breakdown of complex organic metabolites into simple molecules or due to hydrolysis of starch into sugars.

The minimum TSS and sugars at all the days of storage was observed in the treatment T_9 and T_3 when compared to all other treatments (Table 1, 2 and 3). All these foliar sprayed fruits were found to have the lowest TSS, total sugars, reducing and non-reducing sugars as compared to others treatments at all the days of observation. The delayed increase of TSS and sugars was due to slow hydrolysis of starch associated with delayed ripening and antisenescence process of silicon due to low respiration rate as observed by Stamatakis *et al*., (2003) [25] in tomato. The results of this study are in accordance with Bhavya (2010) [1] in Bangalore Blue grapes, Toresano *et al*. (2012) [27] in water melon and Roshdy (2014) [18] in banana.

Comparatively, delayed increase in TSS and sugars over the storage period in the T_3 (calcium chloride @ 2.0 %) followed by T_9 (potassium silicate @ 0.60 %) sprayed fruits could be attributed to delayed conversion of starch to sugars which in turn was due to the effect of foliar spray. Higher calcium contents in fruit maintain membrane permeability and slow down the ripening process during storage. Similar findings were reported by Mahmad *et al.* (2008) [8] in papaya; Monica *et al.* (2013) [12] in litchi; Sharma *et al*., 2013 [20] in apple; Karemera and Habimana, 2014a and 2014b in Mango; who observed delayed increase in TSS and sugars in calcium sprayed fruits. The faster increase in TSS and sugars was observed in untreated control. The results indicated that the conversion of starch into sugars was rapid in control fruits than in sprayed fruits. This could be due to the rapid induction of pre-climacteric and climacteric phases and onset of climacteric peak in respiratory metabolic pathways in starch hydrolysis (Marriot, 1980) [11].

General declining trend in titratable acidity and ascorbic acid was noticed in custard apple in all the treatments with advancement in storage period (Table 1 and 2). The decrease in acidity in the fruits during the storage is because of the fact that organic acid might be utilized rapidly in respiration or conversion of acids into sugar. These results are parallel to the findings of Patel *et al.* (2011) [11] and Swati and Bisen (2012) [26] in custard apple, Lal *et al*., 2011 in apricot and Singh *et al*., 2017 in mango.

The maximum acidity and ascorbic acid was retained in T_9 (foliar spray of potassium silicate @ 0.60 %) and T_3 (foliar spray of calcium chloride @ 2.0 %) up to six days of storage. However, the control fruits recorded rapid decrease in titratable acidity and ascorbic acid at the end of 4 DAS. While, pre-harvest spray of potassium silicate and calcium chloride recorded minimum decreased in the titratable acidity and ascorbic acid. This was because of the slow ripening changes in the sprayed custard apple fruits during the storage. Similar results of slower decrease in acidity and ascorbic acid were recorded by foliar spray of potassium silicate during the storage by Lalithya *et al*., 2014 [7] in sapota; Roshdy (2014) [18] in banana and Kumbargire *et al*. (2015) [5] in banana. Similar result with respect calcium treatment during storage was recorded by Monica *et al.* (2013) [12] in litchi; Karemera and Habimana (2014a and 2014b) [2, 3] and Singh *et al*. (2017) [12] in mango. Faster decreasing of ascorbic acid and acidity in control fruits. This may be due to oxidative destruction of ascorbic acid in the presence of molecular oxygen by ascorbic acid oxidase enzymes (Mapson, 1970) [10].

Organoleptic evaluation of a product is an important tool for deciding the consumer acceptability. A human element plays an important role in evaluation of organoleptic characters of a product. For any new product, the consumer acceptability needs be evaluated first at the laboratory level. Hence, in the present investigation, ten semi-trained panellists evaluated different sensory attributes *viz.*, colour and appearance, texture, taste and flavour and overall acceptability. The fruits having organoleptic scores of more than 7.0 were considered to be most acceptable (Table 4).

Foliar spray with potassium silicate and calcium chloride obtained maximum organoleptic score for colour and appearance when compared to other treatments. The high scores for colour and appearance are due to pre-harvest sprays of potassium silicate effect which have already been reported by Shiarn *et al.* (2004) [22] in grapes and Ravishankar (2016) [17] in Banana. Similarly, the high score for colour and appearance in calcium chloride treatment have been reported by Karemera and Habimana (2014a) [4] in mango and Manasa (2015) [9] in mango.

Loss of texture is one of the main limiting factor on quality and post harvest shelf life of fruits (Table 4). The results of scores on texture were significantly influenced by the different pre harvest treatments. Similarly, the T_9 treatments had scored significantly higher for texture (Table 4). Maximum score for firmness of custard apple was observed in foliar spray of calcium chloride @ 2.0 and 1.0 per cent and potassium silicate @ 0.60 percent (8.87, 8.60 and 8.50, respectively). The lower scores for texture during ripening leads to lower quality and higher incidences of mechanical damage during handling and transportation. The loss of texture was associated with two processes. The first is the breakdown of starch to form sugar. The second is the breakdown of the cell walls or reduction in the middle lamella cohesion due to solubilization of pectic substances (Smith, 1989). Significantly maximum firmness of fruits under calcium chloride substantiates the maximum score for texture. The control fruits recorded lowest score for texture because faster fruit softening occurs considerably during ripening mainly as a result of degradation of the middle lamella of the cell wall of cortical parenchyma cells (Perkins *et al*. 2010) [15].

The scores for taste and flavour were significantly influenced by the treatments during the storage (Table 4). Sugar acid blend in the potassium silicate and calcium chloride sprayed fruits might have impressed the panel members resulting in higher sensory scores for taste and flavour (8.80 and 8.69, respectively). This may be due to the changes in acidity and sugars content during ripening. The accumulated starch was hydrolysed in the presence of amylase activity leading to the formation of sugars and thus reducing the organic acid content which gave a proper blend to taste of the fruit. Similar results were reported by Jaishankar (2015) [2] in sapota; Manasa (2015) [9] in mango and Ravishankar (2016) [17] in banana.

Foliar spray of potassium silicate (0.60 %) and calcium chloride (2.0 %) fruits recorded maximum scores for overall acceptability (8.85 and 8.60, respectively) when compared to other treatments (Table 4). However, untreated custard apple registered lower score for overall acceptability (6.95) during the storage. The highest overall acceptability of custard apple in foliar spray of potassium silicate (0.60 %) and calcium chloride (2.0 %) may be due to maintenance of freshness by delay in the physico-chemical changes in the custard apple during the storage. The overall acceptability of custard apple was judged by the panellists based on the perception of colour and appearance, texture, taste and flavour. The reason for high scores for overall acceptability may be due to maintenance of all the sensory attributes in the foliar sprayed (potassium silicate and calcium chloride) fruits during storage period. Similar results were reported by Jaishankar (2015) [2] in sapota, Manasa (2015) [9] in mango and Ravishankar (2016) [17] in banana. Control fruits were organoleptically inferior with respect to colour and appearance (5.90), texture (6.50), taste and flavour (7.25) and overall acceptability (6.95).

Once harvested, fruits are subject to the active process of senescence. Numerous biochemical processes continuously change the original composition of the fruit until it becomes unmarketable. The period during which consumption is considered acceptable is defined as the time of “post harvest shelf life”. From the above discussion, it can be concluded that custard apple plant sprayed with 0.60 per cent potassium silicate recorded 6.33 days shelf life followed by 2 per cent calcium chloride (6.17 days) before 30 days of harvesting enhance the shelf life with better physico-chemical parameters and sensory parameters during ambient storage (Table 4). The results are in conformity with report of Shi *et al*. (2012) [21] in Longan fruit and Ravishankar (2016) [17] in banana with respect to shelf life enhanced by potassium silicate. The effect of calcium chloride on shelf life was confirmed by report of Nagaraja *et al*. (2011) [13] in custard apple; Sahar (2014) [19] in guava; Jaishankar (2015) [2] in sapota and Manasa (2015) [9] in mango.

Table 1: Influence of different foliar sprays on TSS and titratable acidity of custard apple under ambient storage

Treatments	Total soluble solids (°B)									Titratable acidity (%)								
	Days after storage									Days after storage								
	2			4			6			2			4			6		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
T_1	20.03	21.83	20.93	24.00	27.00	25.50	*	*	*	0.303	0.320	0.312	0.272	0.293	0.283	*	*	*
T_2	18.37	20.17	19.27	21.77	22.73	22.25	23.80	26.83	25.32	0.400	0.416	0.408	0.345	0.362	0.354	0.278	0.290	0.284
T_3	18.30	20.10	19.20	21.50	22.67	22.08	24.00	27.00	25.50	0.407	0.428	0.418	0.348	0.377	0.363	0.284	0.302	0.293
T_4	20.00	21.83	20.92	24.00	27.00	25.50	*	*	*	0.310	0.322	0.316	0.272	0.294	0.283	*	*	*
T_5	19.95	21.67	20.81	24.00	26.97	25.48	*	*	*	0.322	0.330	0.326	0.292	0.300	0.296	*	*	*
T_6	19.52	21.83	20.68	24.00	27.00	25.50	*	*	*	0.384	0.409	0.397	0.295	0.311	0.303	*	*	*
T_7	19.50	21.50	20.50	23.93	26.80	25.37	*	*	*	0.387	0.412	0.400	0.300	0.316	0.308	*	*	*
T_8	18.33	20.17	19.25	21.73	22.80	22.26	24.00	27.47	25.73	0.400	0.418	0.409	0.351	0.376	0.364	0.281	0.297	0.289
T_9	18.30	20.00	19.15	21.47	22.73	22.10	24.00	27.50	25.75	0.410	0.428	0.419	0.355	0.378	0.367	0.286	0.304	0.295
Mean	19.14	21.01	20.08	22.93	25.08	24.01	23.95	27.20	25.58	0.369	0.387	0.378	0.314	0.334	0.324	0.282	0.298	0.290
S.Em±	0.22	0.32	0.17	0.38	0.29	0.30	-	-	-	0.005	0.004	0.004	0.005	0.004	0.004	-	-	-
C.D. @ 1 %	0.88	1.31	0.71	1.55	1.18	1.22	-	-	-	0.018	0.015	0.014	0.018	0.016	0.015	-	-	-

* No observation was recorded as the fruits lost their keeping quality.
Initial value of total soluble solids is 15.00 (2016) and 16.40 (2017) °B and titratable acidity is 0.424 (2016) and 0.443 (2017) per cent.

T_1 - Control; T_2 - $CaCl_2$ (1.0%); T_3 - $CaCl_2$ (2.0%)
T_4 - Borax (0.2%); T_5 - Borax (0.3%); T_6 - Salicylic acid (0.40%)
T_7 - Salicylic acid (0.60%); T_8 - Potassium silicate (0.40%); T_9 - Potassium silicate (0.60%)

Table 2: Influence of different foliar sprays on ascorbic acid and reducing sugar of custard apple under ambient storage

Treatments	Ascorbic acid (mg/100 g of sample)									Reducing sugar (%)								
	Days after storage									Days after storage								
	2			4			6			2			4			6		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
T_1	7.41	8.50	7.95	6.15	7.28	6.72	*	*	*	6.73	7.79	7.26	11.73	13.67	12.70	*	*	*
T_2	7.84	8.90	8.37	6.71	7.78	7.25	6.24	7.17	6.70	4.65	5.25	4.95	8.11	9.62	8.87	11.36	13.79	12.57
T_3	7.95	9.24	8.60	6.83	8.17	7.50	6.30	7.34	6.82	4.49	5.14	4.81	7.82	9.28	8.55	12.01	14.11	13.06
T_4	7.45	8.52	7.99	6.17	7.31	6.74	*	*	*	6.44	7.76	7.10	11.54	13.55	12.54	*	*	*
T_5	7.52	8.65	8.08	6.26	7.39	6.82	*	*	*	6.37	7.67	7.02	11.49	13.57	12.53	*	*	*
T_6	7.68	8.75	8.21	6.56	7.62	7.09	*	*	*	5.92	7.10	6.51	11.44	13.51	12.47	*	*	*
T_7	7.82	8.88	8.35	6.70	7.74	7.22	*	*	*	5.84	7.00	6.42	11.28	13.29	12.29	*	*	*
T_8	7.88	9.00	8.44	6.78	7.90	7.34	6.28	7.29	6.79	4.57	5.19	4.88	7.98	9.50	8.74	11.56	13.95	12.76
T_9	8.00	9.33	8.67	6.92	8.21	7.56	6.32	7.40	6.86	4.41	5.09	4.75	7.71	9.20	8.46	12.35	14.31	13.33
Mean	7.73	8.86	8.29	6.56	7.71	7.14	6.28	7.30	6.79	5.49	6.44	5.97	9.90	11.69	10.79	11.82	14.04	12.93
S.Em±	0.05	0.07	0.04	0.05	0.06	0.04	-	-	-	0.11	0.08	0.07	0.21	0.08	0.11	-	-	-
C.D. @ 1 %	0.22	0.27	0.18	0.22	0.25	0.17	-	-	-	0.44	0.34	0.27	0.85	0.31	0.44	-	-	-

* No observation was recorded as the fruits lost their keeping quality.
Initial value of ascorbic acid is 8.26 (2016) and 10.12 (2017) mg/100 g and reducing sugar is 3.44 (2016) and 4.54 (2017) per cent.

T_1 - Control; T_2 - $CaCl_2$ (1.0%); T_3 - $CaCl_2$ (2.0%)
T_4 - Borax (0.2%); T_5 - Borax (0.3%); T_6 - Salicylic acid (0.40%)
T_7 - Salicylic acid (0.60%); T_8 - Potassium silicate (0.40%); T_9 - Potassium silicate (0.60%)

Table 3: Influence of different foliar sprays on non-reducing sugar and total sugar of custard apple under ambient storage

Treatments	Non reducing sugar (%)									Total sugar (%)								
	Days after storage									Days after storage								
	2			4			6			2			4			6		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
T_1	3.44	4.25	3.84	2.23	3.27	2.75	*	*	*	10.35	12.26	11.31	14.08	17.12	15.60	*	*	*
T_2	3.62	4.75	4.18	3.54	4.37	3.96	2.95	3.27	3.11	8.46	10.25	9.35	11.84	14.22	13.03	14.47	17.23	15.85
T_3	3.74	4.78	4.26	3.58	4.57	4.07	2.74	3.10	2.92	8.42	10.17	9.30	11.58	14.08	12.83	14.90	17.37	16.13
T_4	3.47	4.03	3.75	2.39	3.33	2.86	*	*	*	10.10	12.01	11.05	14.06	17.05	15.56	*	*	*
T_5	3.48	4.02	3.75	2.43	3.30	2.86	*	*	*	10.03	11.90	10.97	14.05	17.04	15.55	*	*	*
T_6	3.51	4.38	3.95	2.49	3.37	2.93	*	*	*	9.62	11.71	10.67	14.06	17.05	15.56	*	*	*
T_7	3.55	4.33	3.94	2.57	3.40	2.99	*	*	*	9.58	11.56	10.57	13.99	16.87	15.43	*	*	*
T_8	3.64	4.79	4.21	3.56	4.42	3.99	2.79	3.17	2.98	8.41	10.23	9.32	11.73	14.15	12.94	14.50	17.29	15.90
T_9	3.78	4.67	4.23	3.62	4.60	4.11	2.52	3.06	2.79	8.39	10.00	9.20	11.52	14.05	12.78	15.00	17.53	16.27
Mean	3.58	4.45	4.01	2.93	3.85	3.39	2.75	3.15	2.95	9.26	11.12	10.19	12.99	15.74	14.36	14.72	17.36	16.04
S.Em±	0.19	0.25	0.16	0.29	0.22	0.22	-	-	-	0.17	0.29	0.17	0.37	0.21	0.26	-	-	-
C.D. @ 1 %	NS	NS	NS	1.20	0.90	0.91	-	-	-	0.68	1.18	0.69	1.52	0.86	1.04	-	-	-

* No observation was recorded as the fruits lost their keeping quality.
Initial value of non reducing sugar is 2.74 (2016) and 4.00 (2017) and total sugar is 6.32 (2016) and 8.75 (2017) per cent.
NS – Non significant

T_1 - Control; T_2 - $CaCl_2$ (1.0%); T_3 - $CaCl_2$ (2.0%)
T_4 - Borax (0.2%); T_5 - Borax (0.3%); T_6 - Salicylic acid (0.40%)
T_7 - Salicylic acid (0.60%); T_8 - Potassium silicate (0.40%); T_9 - Potassium silicate (0.60%)

Table 4: Influence of different foliar sprays on organoleptic evaluation (4DAS) and shelf life of custard apple fruit under ambient storage

Treatments	Score out of 9.0														
	Colour and appearance			Texture			Taste and flavour			Overall acceptability			Shelf life (Days)		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
T_1	6.00	5.80	5.90	6.00	7.00	6.50	7.50	7.00	7.25	6.90	7.00	6.95	4.00	4.00	4.00
T_2	8.00	7.85	7.93	8.50	8.70	8.60	8.50	8.40	8.45	8.30	8.13	8.22	6.00	6.00	6.00
T_3	8.23	8.10	8.17	8.83	8.90	8.87	8.73	8.65	8.69	8.70	8.50	8.60	6.00	6.33	6.17
T_4	6.70	6.50	6.60	6.67	7.00	6.83	7.50	7.20	7.35	7.00	7.50	7.25	4.00	4.00	4.00
T_5	7.40	7.00	7.20	7.00	7.40	7.20	7.75	7.50	7.63	7.80	7.50	7.65	4.00	4.00	4.00
T_6	7.40	7.00	7.20	7.00	8.00	7.50	7.75	8.00	7.88	7.80	7.50	7.65	4.33	4.67	4.50
T_7	8.00	7.50	7.75	8.00	8.50	8.25	8.00	8.20	8.10	8.00	8.00	8.00	5.00	5.00	5.00
T_8	8.17	8.00	8.08	8.17	8.55	8.36	8.57	8.40	8.48	8.40	8.25	8.33	6.00	6.00	6.00
T_9	8.30	8.10	8.20	8.40	8.60	8.50	8.90	8.70	8.80	8.70	9.00	8.85	6.00	6.67	6.33
Mean	7.58	7.32	7.45	7.62	8.07	7.85	8.13	8.01	8.07	7.96	7.93	7.94	5.04	5.19	5.11
S.Em±	0.29	0.26	0.15	0.31	0.18	0.20	0.24	0.18	0.15	0.21	0.14	0.09	0.11	0.19	0.12
C.D. @ 1 %	1.19	1.06	0.59	1.25	0.71	0.81	0.96	0.74	0.59	0.85	0.56	0.38	0.45	0.78	0.51

DAS – Days after storage

T_1 - Control	T_2 - $CaCl_2$ (1.0%)	T_3 - $CaCl_2$ (2.0%)
T_4 - Borax (0.2%)	T_5 - Borax (0.3%)	T_6 - Salicylic acid (0.40%)
T_7 - Salicylic acid (0.60%)	T_8 - Potassium silicate (0.40%)	T_9 - Potassium silicate (0.60%)

Conclusion

From the above discussion, it can be concluded that, foliar spray of potassium silicate (0.60 %) and calcium chloride (2.0 %) performed very well in ambient storage with respect to biochemical and sensory qualities of custard apple up to six days of storage.

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