Research Article

# Effect of Postharvest Chemical Treatments on Fresh-Cut Pineapple Cubes

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**Abstract**

The present investigation was made to find out the best effect of postharvest treatments on fresh cut pineapple cubes at the departmental laboratory under the Department of Horticulture and Post Harvest Technology, Institute of Agriculture, Visva Bharati, Sriniketan during 2016-2017 which consisted of 12 treatments which includes the combination of sugar @ 100 and 200 gram/litre, citric acid @ 500, 750 and 1000 ppm and Na- benzoate @ 500 and 1000 ppm and one control. Changes in TSS, ascorbic acid, acidity, reducing sugar, non-reducing sugar, and total sugar were recorded at every 5 days of interval. Results indicate that the self life and quality of fresh cut pineapple cubes can be extended upto 20 days.

**Keywords:** Pineapple, Cubes, Quality, Postharvest

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## Introduction

Pineapple [*Ananas comosus* (L.) Merr.] is one of the commercially important fruit crop of India. Pineapple is known as 'golden queen' for its attractive golden yellow colour at ripening and its enticing sugar acid blending. Pineapple is a good source of carotene (vitamin A) and ascorbic acid (Vitamin C) and is fairly rich in vitamins B and $B_2$ [1]. It also contain minerals and fibres that can be contributed in daily diet, the consumption of pineapple has led to global economic growth [2]. Besides, it is also a source of bromelain, a digestive enzyme [3]. It provides adequate roughage to prevent constipation. Its fresh juice ha s a cooling and refreshing effect, especially in summer.

In India pineapple is also grown in Meghalaya, Tripura, Mizoram, Karnataka and Goa on a large scale and in Gujarat, Maharashtra, Tamil Nadu, Andhra Pradesh, Orissa, Bihar and Uttar Pradesh on the small scale.

Pineapple is one of the most important fruit crop of India tends to have high perishability coupled with poor transport networks and a long term chain for marketing intermediaries, that have failed to turn into profitable venture for farmers. Pineapple often faces several problems with its postharvest life than any other crop mainly with its physiologically active phase even after harvest and non-climacteric nature. So, an efficient postharvest system with scientific facts can tends to extend the shelf life by adopting suitable postharvest handling practices including proper packing and transportation. So in such sense, the reduction of postharvest product losses is a key issue to ensure the future global food security [4]. The bulk of the world production of pineapple is used by canning industry and the trade in fresh fruits is limited. Among all processed forms, canned slices and juice are in much demand in India, constituting roughly about 70% of the production. Considering the lengthy preparation of pineapple due to its morphological structures, which make immediate consumption difficult, there is an increasing interest in fresh-cut pineapple. Thick inedible skins and large crowns of pineapple also take up much storage space and result in higher transportation cost [5]. Therefore, processing pineapple into ready-to-eat products may be an alternative to meet consumers' demands. However, the storage life of fresh-cut pineapple is often limited only 2 - 3 days due to increased metabolic activity and delocalization of substrates and enzymes leading to rapid microbial growth, softening, enzymatic browning and off-flavour development [6]. However, the demand of fresh cut pineapple is very high though the recommendation of experimental finding is very few for marketing of fresh cut pineapple with proper postharvest treatments for better shelf life. With reference to the above said statement, this present investigation regarding the post harvest treatment of cut-fresh pineapple cubes was very much needed to know its keeping quality and market acceptance by using new technologies.

Therefore, the major objectives of the study are as follows:

- to know the combined effect of sugar, citric acid and Na-benzoate on the quality of fresh cut pineapple cubes
- to study the effect of treatment on the shelf-life of fresh cut pineapple cubes

## Material and Methods

The pineapple fruit of Kew variety at their optimum maturity were collected from the Horticultural Farm under Department of Horticulture and Post Harvest Technology, Palli Siksha Bhavana (Institute of Agriculture), VisvaBharati, Sriniketan. The fruits, immediately after harvest, were brought to the departmental laboratory. The whole fruits were disinfected by dipping them into 200ppm chlorinated water for 2 min before preparation. The fruits were peeled, cored and cut using a sharp stainless steel knife in a sanitized table top. The fruits for fresh-cut products were cut into cubes of size 2cm×2cm×2cm.

The treatment solutions were prepared by dissolving known weight of respective chemicals in a required volume of demineralized water. The solution to the fruit cubes ratio was maintained at 10:1 to avoid any dilution effect during treatment. The cubes were treated with respective treatment solutions by immersing the cubes for 1hour at room temperature. For Control treatment, samples were treated by immersing them in demineralized water for 1hour at room temperature. After the treatment duration is over, the samples were taken out from the treatment solution and were spread over an absorbent paper to remove any excess surface water. 200 g of treated sample were packed in zip-lock polypropylene pouch of 200 micron thickness. Two numbers of such pouches (400 g sample) were designated and appropriately marked for different intervals of observation under each replications of a particular treatment. The pouches were stored at lower compartment of refrigerators. The temperature of the refrigerators were monitored and maintained continuously at 10$^{o}$C. Whole experiment was done by using completely randomized design with three replications.

| Notation | Treatment components |
|---|---|
| $T_1$ | 100g/litre sugar + 500ppm citric acid + 500ppm Na-Benzoate |
| $T_2$ | 100g/litre sugar + 500ppm citric acid + 1000ppm Na-Benzoate |
| $T_3$ | 100g/litre sugar + 750ppm citric acid + 500ppm Na-Benzoate |
| $T_4$ | 100g/litre sugar + 750ppm citric acid + 1000ppm Na-Benzoate |
| $T_5$ | 100g/litre sugar + 1000ppm citric acid + 500ppm Na-Benzoate |
| $T_6$ | 100g/litre sugar + 1000ppm citric acid + 1000ppm Na-Benzoate |
| $T_7$ | 200g/litre sugar + 500ppm citric acid + 500ppm Na-Benzoate |
| $T_8$ | 200g/litre sugar + 500ppm citric acid + 1000ppm Na-Benzoate |
| $T_9$ | 200g/litre sugar + 750ppm citric acid + 500ppm Na-Benzoate |
| $T_{10}$ | 200g/litre sugar + 750ppm citric acid + 1000ppm Na-Benzoate |
| $T_{11}$ | 200g/litre sugar + 1000ppm citric acid + 500ppm Na-Benzoate |
| $T_{12}$ | 200g/litre sugar + 1000ppm citric acid + 1000ppm Na-Benzoate |
| $T_{13}$ | Control |

Various parameters related to the quality and shelf-life of fresh-cut pineapple products were studied in 5 days of interval upto 20th days of storage. Observation recorded was TSS ($^{o}$Brix), Acidity (%), TSS:Acidity, Total sugar, Reducing and Non-reducing sugar (%), Ascorbic acid (mg/100g) and Organoleptic score (out of 10). All the quality parameters were analyzed as per standards method given in A.O.A.C.

## Results

Data presented in the **Table 1** showed that the maximum TSS in 1$^{st}$ and 5$^{th}$ days of storage was recorded with the treatment $T_{11}$ (18.36$^{o}$B and 17.93$^{o}$B respectively). Whereas in 10$^{th}$ days of storage maximum TSS was recorded with the treatment $T_8$ (16.56$^{o}$B) and minimum was observed in $T_{13}$ (9.36$^{o}$B). However, in 15$^{th}$ and 20$^{th}$ days of storage highest TSS was retained with the treatment $T_9$ (13.44$^{o}$B and 12.36$^{o}$B respectively) and lowest TSS was recorded with the treatment $T_2$ (7.35$^{o}$B). It was clearly shown in same table, that treatment $T_{13}$ control has remain fresh and was able to retain its TSS only up to 15$^{th}$ days of storage.

It is also clear from the data presented in the Table 1 that the acidity was found non-significant among all the treatment.

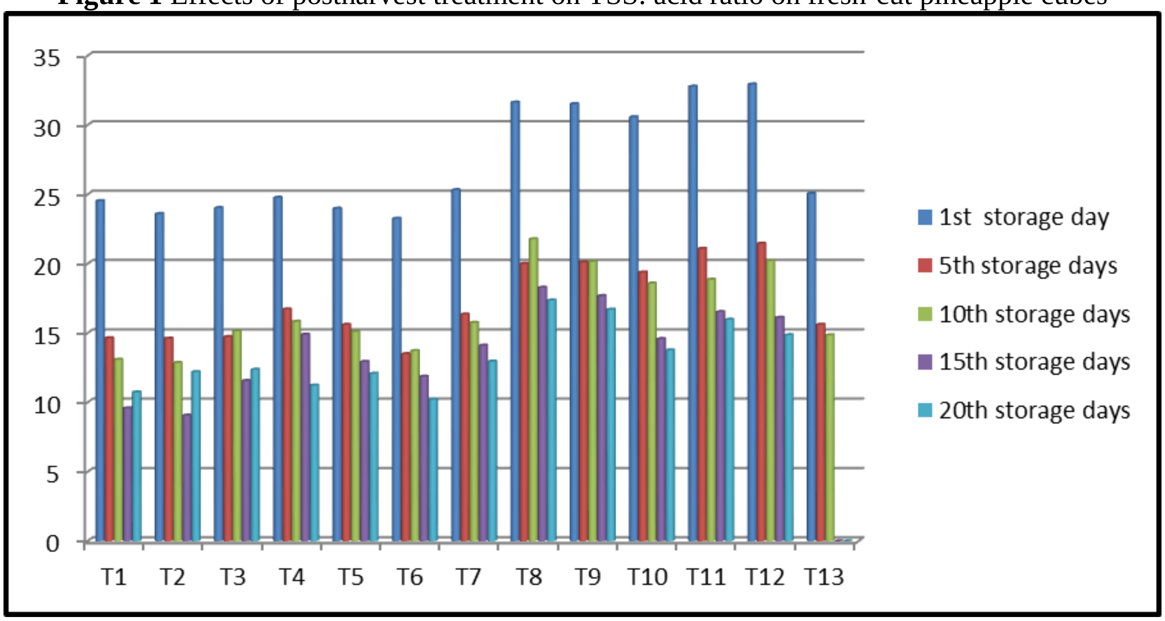
From the result presented in the **Figure 1** showed that the maximum TSS:Acidity ratio in 1$^{st}$ and 5$^{th}$ days of storage was recorded with the treatment $T_{12}$ (32.94 and 21.46 respectively). Whereas in 10$^{th}$ days of storage maximum TSS:Acidity ratio was recorded with the treatment $T_8$ (21.78) and minimum was observed in $T_2$ (12.87), $T_1$ (13.09) and $T_6$ (13.72) was found *at par* with each other. On the other hand, in 15$^{th}$ and 20$^{th}$ days of storage highest TSS:Acidity was retained with the treatment $T_8$ (18.28 and 17.36 respectively) which was found statistically *at par* with $T_9$ (17.68 and 16.70 respectively) and lowest TSS was recorded with the treatment $T_2$ (9.07).

**Table 1** Effect of postharvest treatment combination on TSS (°Brix) and acidity (%) of fresh-cut pineapple cubes

| Treatment | TSS (°Brix) | | | | | Acidity (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Storage days | | | | | Storage days | | | | |
| | 1 | 5 | 10 | 15 | 20 | 1 | 5 | 10 | 15 | 20 |
| $T_1$ | 13.74 | 12.45 | 11.13 | 8.25 | 7.63 | 0.56 | 0.85 | 0.85 | 0.86 | 0.71 |
| $T_2$ | 13.22 | 12.13 | 10.56 | 7.35 | 6.47 | 0.56 | 0.83 | 0.82 | 0.81 | 0.53 |
| $T_3$ | 13.46 | 12.38 | 11.36 | 8.21 | 6.93 | 0.56 | 0.84 | 0.75 | 0.71 | 0.56 |
| $T_4$ | 13.13 | 12.71 | 11.56 | 10.58 | 7.53 | 0.53 | 0.76 | 0.73 | 0.71 | 0.67 |
| $T_5$ | 13.43 | 12.65 | 11.33 | 9.31 | 8.46 | 0.56 | 0.81 | 0.75 | 0.72 | 0.70 |
| $T_6$ | 13.26 | 11.48 | 10.43 | 8.67 | 7.15 | 0.57 | 0.85 | 0.76 | 0.73 | 0.70 |
| $T_7$ | 13.42 | 12.57 | 11.50 | 9.46 | 8.43 | 0.53 | 0.76 | 0.73 | 0.67 | 0.65 |
| $T_8$ | 18.03 | 17.20 | 16.56 | 13.35 | 12.33 | 0.57 | 0.86 | 0.76 | 0.73 | 0.71 |
| $T_9$ | 17.66 | 17.11 | 16.13 | 13.44 | 12.36 | 0.56 | 0.85 | 0.80 | 0.76 | 0.74 |
| $T_{10}$ | 17.13 | 17.06 | 15.06 | 11.38 | 10.33 | 0.56 | 0.88 | 0.81 | 0.78 | 0.75 |
| $T_{11}$ | 18.36 | 17.93 | 15.66 | 12.73 | 11.5 | 0.56 | 0.85 | 0.83 | 0.77 | 0.72 |
| $T_{12}$ | 17.46 | 16.31 | 14.76 | 11.45 | 10.26 | 0.53 | 0.76 | 0.73 | 0.71 | 0.69 |
| $T_{13}$ | 13.28 | 10.93 | 9.36 | 0 | 0 | 0.53 | 0.70 | 0.63 | 0 | 0 |
| CD(P= 0.5% ) | 0.31 | 0.42 | 0.37 | 0.41 | 0.46 | NS | NS | NS | NS | NS |
| SEm± | 0.11 | 0.14 | 0.12 | 0.14 | 0.15 | NS | NS | NS | NS | NS |

**$T_1$**:100g/l sugar + 500ppm CA+ 500ppm Na-benzoate; **$T_2$:** 100g/l sugar + 500ppm CA + 1000ppm Na-benzoate ; **$T_3$:** 100g/l sugar + 750ppm CA+ 500ppm Na-benzoate ; **$T_4$**: 100g/l sugar + 750ppm CA+ 1000ppm Na-benzoate; **$T_5$**: 100g/l sugar + 1000ppm CA+ 500ppm Na-benzoate; **$T_6$:** 100g/l sugar + 1000ppm CA+ 1000ppm Na-benzoate: **$T_7$**: 200g/l sugar + 500ppm CA+ 500ppm Na-benzoate; **$T_8$:** 200g/l sugar + 500ppm CA + 1000ppm Na-Banzoate; **$T_9$**: 200g/l sugar + 750ppm CA+ 500ppm Na-Banzoate: **$T_{10}$:** 200g/l sugar + 750ppm CA+ 1000ppm Na-benzoate; **$T_{11}$:** 200g/l sugar + 1000ppm CA+ 500ppm Na-benzoate; **$T_{12}$:** 200g/l sugar + 1000ppm CA+ 1000ppm Na-benzoate; **$T_{13}$:** control

**Figure 1** Effects of postharvest treatment on TSS: acid ratio on fresh-cut pineapple cubes

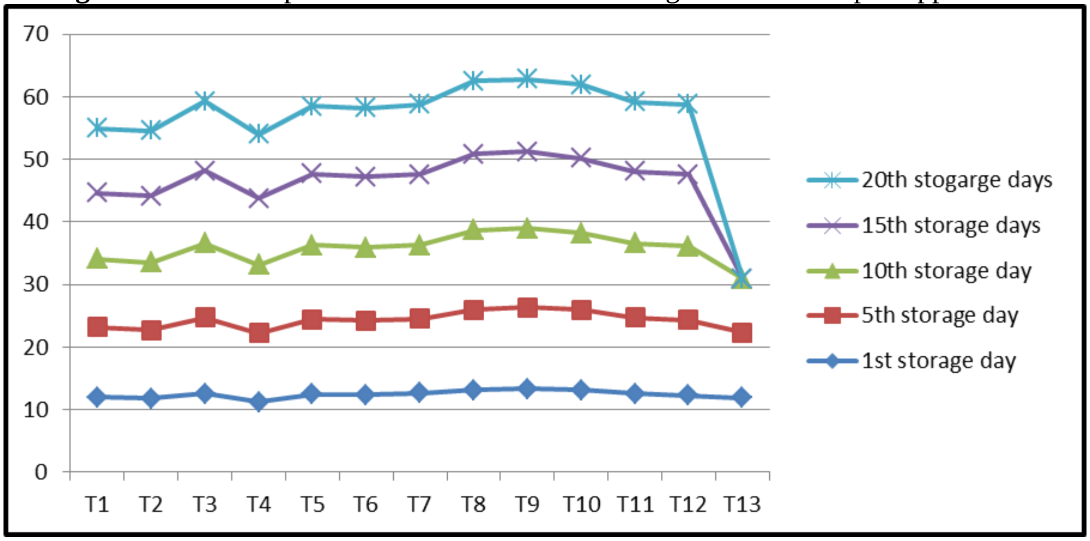



(**$T_1$**:100g/l sugar + 500ppm CA+ 500ppm Na-benzoate; **$T_2$:** 100g/l sugar + 500ppm CA + 1000ppm Na-benzoate ; **$T_3$:** 100g/l sugar + 750ppm CA+ 500ppm Na-benzoate ; **$T_4$**: 100g/l sugar + 750ppm CA+ 1000ppm Na-benzoate; **$T_5$**: 100g/l sugar + 1000ppm CA+ 500ppm Na-benzoate; **$T_6$:** 100g/l sugar + 1000ppm CA+ 1000ppm Na-benzoate: **$T_7$**: 200g/l sugar + 500ppm CA+ 500ppm Na-benzoate; **$T_8$:** 200g/l sugar + 500ppm CA + 1000ppm Na-Banzoate; **$T_9$**: 200g/l sugar + 750ppm CA+ 500ppm Na-Banzoate: **$T_{10}$:** 200g/l sugar + 750ppm CA+ 1000ppm Na-benzoate; **$T_{11}$:** 200g/l sugar + 1000ppm CA+ 500ppm Na-benzoate; **$T_{12}$:** 200g/l sugar + 1000ppm CA+ 1000ppm Na-benzoate; **$T_{13}$:** control)

**Figure 2** indicates that the treatment $T_9$ has shown consistency in retaining total sugar up to 20$^{th}$ days of storage and all other treatment varied significantly among each other.

It was observed from the **Table 2** that the reducing sugar was found non-significant during 1$^{st}$ to 5$^{th}$ days of storage while in 10$^{th}$ days of storage highest reducing sugar was recorded with the treatment $T_9$ (4.66%) and least was recorded with $T_4$ (3.27%). In last days of storage it was noted that the maximum reducing sugar was retained with the treatment $T_8$ (3.95%).

**Figure 2** Effects of postharvest treatment on total sugar of fresh-cut pineapple cubes




($T_1$:100g/l sugar + 500ppm CA+ 500ppm Na-benzoate; $T_2$: 100g/l sugar + 500ppm CA + 1000ppm Na-benzoate ; $T_3$: 100g/l sugar + 750ppm CA+ 500ppm Na-benzoate ; $T_4$: 100g/l sugar + 750ppm CA+ 1000ppm Na-benzoate; $T_5$: 100g/l sugar + 1000ppm CA+ 500ppm Na-benzoate; $T_6$: 100g/l sugar + 1000ppm CA+ 1000ppm Na-benzoate: $T_7$: 200g/l sugar + 500ppm CA+ 500ppm Na-benzoate; $T_8$: 200g/l sugar + 500ppm CA + 1000ppm Na-Banzoate; $T_9$: 200g/l sugar + 750ppm CA+ 500ppm Na-Banzoate: $T_{10}$: 200g/l sugar + 750ppm CA+ 1000ppm Na-benzoate; $T_{11}$: 200g/l sugar + 1000ppm CA+ 500ppm Na-benzoate; $T_{12}$: 200g/l sugar + 1000ppm CA+ 1000ppm Na-benzoate; $T_{13}$: control)

**Table 2** Effect of postharvest treatment combination on reducing sugar (%) and non-reducing sugar (%) of fresh-cut pineapple cubes

| **Treatment** | **Reducing sugar (%)** | | | | | **Non-reducing sugar (%)** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Storage days** | | | | | **Storage days** | | | | |
| | **1** | **5** | **10** | **15** | **20** | **1** | **5** | **10** | **15** | **20** |
| $T_1$ | 4.78 | 4.67 | 4.39 | 3.86 | 10.74 | 7.41 | 7.03 | 6.83 | 6.73 | 6.61 |
| $T_2$ | 4.69 | 4.33 | 3.90 | 3.56 | 12.20 | 7.57 | 7.50 | 7.35 | 7.23 | 7.12 |
| $T_3$ | 4.94 | 4.67 | 4.26 | 3.97 | 12.37 | 7.56 | 7.47 | 7.40 | 7.40 | 7.35 |
| $T_4$ | 3.96 | 3.43 | 3.27 | 3.15 | 11.23 | 7.63 | 7.52 | 7.40 | 7.32 | 7.16 |
| $T_5$ | 5.10 | 4.98 | 4.54 | 4.01 | 12.08 | 7.43 | 7.36 | 7.20 | 7.11 | 7.00 |
| $T_6$ | 5.21 | 4.76 | 4.23 | 3.87 | 10.21 | 7.33 | 7.26 | 7.20 | 7.15 | 7.11 |
| $T_7$ | 4.94 | 4.52 | 4.11 | 3.68 | 12.96 | 7.79 | 7.73 | 7.65 | 7.62 | 7.50 |
| $T_8$ | 5.12 | 4.78 | 4.45 | 4.12 | 17.36 | 8.16 | 8.02 | 7.91 | 7.76 | 7.60 |
| $T_9$ | 5.29 | 4.97 | 4.66 | 4.21 | 16.70 | 8.04 | 7.91 | 7.80 | 7.71 | 7.63 |
| $T_{10}$ | 5.53 | 4.75 | 4.54 | 4.17 | 13.77 | 8.13 | 8.02 | 7.93 | 7.82 | 7.71 |
| $T_{11}$ | 4.98 | 4.62 | 4.10 | 3.89 | 15.97 | 7.72 | 7.64 | 7.58 | 7.52 | 7.50 |
| $T_{12}$ | 4.30 | 3.87 | 3.54 | 3.31 | 14.86 | 8.31 | 8.19 | 8.03 | 7.85 | 7.67 |
| $T_{13}$ | 3.31 | 3.03 | 2.84 | 0 | 0 | 8.39 | 7.75 | 6.4 | 0 | 0 |
| CD(P= 0.5% ) | NS | NS | 0.46 | 0.51 | 0.64 | NS | NS | NS | 0.10 | 0.08 |
| SEm± | NS | NS | 0.15 | 0.17 | 0.21 | NS | NS | NS | 0.03 | 0.03 |

$\mathbf{T_1}$:100g/l sugar + 500ppm CA+ 500ppm Na-benzoate; $\mathbf{T_2}$**:** 100g/l sugar + 500ppm CA + 1000ppm Na-benzoate ; $\mathbf{T_3}$**:** 100g/l sugar + 750ppm CA+ 500ppm Na-benzoate ; $\mathbf{T_4}$: 100g/l sugar + 750ppm CA+ 1000ppm Na-benzoate; $\mathbf{T_5}$: 100g/l sugar + 1000ppm CA+ 500ppm Na-benzoate; $\mathbf{T_6}$**:** 100g/l sugar + 1000ppm CA+ 1000ppm Na-benzoate: $\mathbf{T_7}$: 200g/l sugar + 500ppm CA+ 500ppm Na-benzoate; $\mathbf{T_8}$**:** 200g/l sugar + 500ppm CA + 1000ppm Na-Banzoate; $\mathbf{T_9}$: 200g/l sugar + 750ppm CA+ 500ppm Na-Banzoate: $\mathbf{T_{10}}$**:** 200g/l sugar + 750ppm CA+ 1000ppm Na-benzoate; $\mathbf{T_{11}}$**:** 200g/l sugar + 1000ppm CA+ 500ppm Na-benzoate; $\mathbf{T_{12}}$**:** 200g/l sugar + 1000ppm CA+ 1000ppm Na-benzoate; $\mathbf{T_{13}}$**:** control

It has been revealed from the data presented in the **Table 2** showed that the non-reducing sugar was found non-significant initially from 1st to 10th days of storage. In 15th days of storage utmost non-reducing sugar was recorded with the treatment $T_{12}$ (7.85%) which was closely followed by the treatment $T_{10}$ (7.982%) and $T_8$ (7.76%). Furthermore, in 20th days of storage maximum retention of non-reducing sugar was noted with the treatment $T_{10}$ (7.71%) but $T_{12}$ (7.67%) and $T_9$ (7.63%) was also found *at par* with each other. At the same time in both 15th and 20th days of storage it was noted that the least amount of non-reducing sugar was retained by the treatment $T_1$ with 6.73% and 6.61% respectively.

Data pertaining to ascorbic acid was presented in the Table showed that, in 15th and 20th days of storage the highest ascorbic acid was maintained with the treatment $T_7$ (25.21 mg/100g) and $T_6$ (19.34 mg/100g) respectively but in 15th days of storage $T_6$ (24.98 mg/100g) was found *at par* with $T_7$. The least amount of ascorbic acid was maintained with the treatment $T_1$ with 20.44mg/100g (15th days of storage) and 13.67 mg/100g (20th days of storage).

Data represented in the **Table 3** clearly revealed that from initial days of storage to the 10th days of storage organoleptic score was found non-significant among different treatments but in 15th and 20th days of storage it was found that maximum organoleptic was score was with the treatment $T_8$ (6.59 and 5.78 respectively) while in 15th days of storage lowest organoleptic score was scored with the treatment $T_3$ (1.34) and $T_6$ (1.33) in 20th days of storage.

**Table 3** Effect of postharvest treatment combination on ascorbic acid (mg/100g) and organoleptic score (out of 10) of fresh-cut pineapple cubes

| Treatment | Ascorbic acid (mg/100g) | | | | | Organoleptic score (out of 10) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Storage days | | | | | Storage days | | | | |
| | 1 | 5 | 10 | 15 | 20 | 1 | 5 | 10 | 15 | 20 |
| $T_1$ | 31.87 | 27.87 | 23.77 | 20.44 | 13.67 | 9.66 | 7.33 | 6.33 | 0 | 0 |
| $T_2$ | 38.57 | 33.77 | 27.65 | 22.98 | 16.89 | 9.33 | 6.66 | 5.33 | 3.33 | 1.66 |
| $T_3$ | 39.98 | 33.45 | 27.12 | 22.12 | 16.47 | 9.33 | 3.33 | 2.25 | 1.34 | 0 |
| $T_4$ | 39.91 | 34.12 | 28.58 | 23.56 | 17.88 | 9.66 | 7.66 | 6.33 | 4.33 | 3.33 |
| $T_5$ | 40.42 | 34.67 | 29.23 | 23.23 | 17.56 | 9.66 | 6.33 | 4.33 | 3.33 | 2.33 |
| $T_6$ | 40.10 | 33.7 | 29.92 | 24.98 | 19.34 | 9.66 | 5.33 | 3.33 | 2.33 | 1.33 |
| $T_7$ | 40.52 | 34.45 | 29.99 | 25.21 | 18.9 | 9.33 | 5.32 | 3.66 | 2.66 | 1.66 |
| $T_8$ | 38.62 | 33.56 | 26.98 | 22.67 | 16.45 | 10.55 | 6.66 | 5.66 | 6.59 | 5.78 |
| $T_9$ | 38.98 | 33.67 | 27.23 | 22.9 | 16.52 | 9.33 | 8.66 | 6.66 | 5.66 | 4.66 |
| $T_{10}$ | 40.01 | 35.21 | 28.47 | 23.11 | 17.78 | 9.33 | 7.66 | 6.33 | 4.66 | 3.66 |
| $T_{11}$ | 39.9 | 34.93 | 28.86 | 23.78 | 17.66 | 9.66 | 5.66 | 4.66 | 2.66 | 1.66 |
| $T_{12}$ | 39.27 | 34.53 | 29.78 | 24.78 | 18.69 | 9.33 | 8.44 | 7.43 | 5.33 | 3.66 |
| $T_{13}$ | 30.90 | 24.66 | 19.66 | 0 | 0 | 9.33 | 3.34 | 1.02 | 0 | 0 |
| CD(P= 0.5% ) | NS | 0.58 | 0.46 | 0.42 | 0.40 | NS | NS | NS | 0.28 | 0.30 |
| SEm± | NS | 0.19 | 0.15 | 0.14 | 0.13 | NS | NS | NS | 0.09 | 0.10 |

**$T_1$**:100g/l sugar + 500ppm CA+ 500ppm Na-benzoate; **$T_2$:** 100g/l sugar + 500ppm CA + 1000ppm Na-benzoate ; **$T_3$:** 100g/l sugar + 750ppm CA+ 500ppm Na-benzoate ; **$T_4$**: 100g/l sugar + 750ppm CA+ 1000ppm Na-benzoate; **$T_5$**: 100g/l sugar + 1000ppm CA+ 500ppm Na-benzoate; **$T_6$:** 100g/l sugar + 1000ppm CA+ 1000ppm Na-benzoate: **$T_7$**: 200g/l sugar + 500ppm CA+ 500ppm Na-benzoate; **$T_8$:** 200g/l sugar + 500ppm CA + 1000ppm Na-Banzoate; **$T_9$**: 200g/l sugar + 750ppm CA+ 500ppm Na-Banzoate: **$T_{10}$:** 200g/l sugar + 750ppm CA+ 1000ppm Na-benzoate; **$T_{11}$:** 200g/l sugar + 1000ppm CA+ 500ppm Na-benzoate; **$T_{12}$:** 200g/l sugar + 1000ppm CA+ 1000ppm Na-benzoate; **$T_{13}$:** control

Picture of immersing the pineapple fresh-cut cubes in chemical treatment solution

## Discussion

Effect of postharvest treatments on shelf life and quality of fresh cut pineapple has shown positive effect on retaining its bio-chemical characteristic viz. TSS, acidity, TSS:Acidity ratio, total sugar, reducing sugar, ascorbic acid and organoleptic score, (Tables 1-3) and (Figures 1 and 2). Treated fresh cut pineapple cubes retained its quality up to 20 days and data was recorded accordingly. Treatments showed variation in results among each other, this is may be due to the fruits are divided into two groups according to their ripening mechanisms: climacteric and non-climacteric [7]. These differences in their biochemistry and ripening mechanisms result in different production of ethylene and respiration rates [8].

Effect of treatment ($T_8$) 200g/l sugar + 500ppm CA + 1000ppm Na-Benzoate and ($T_9$) 200g/l sugar + 750ppm CA+ 500ppm Na-Benzoate has showed better result in retaining the TSS and TSS:Acidity of fresh cut pineapple cubes but acidity was found non-significant throughout the storage days. It is may be due to when some technologies or chemicals are used to preserve the quality of fresh cut fruits than it could induce some mechanisms that affect the metabolic activity of the treated produce, such as triggering of the antioxidant mechanism [9]. In addition to that, fresh-cut fruits have a faster rate of softening and it measured perishable commodities due to its climacteric characteristic and higher metabolic process. The obtained results are confirmed with [10] in cut fresh guava.

In general, during minimal processing, the fruit tissues are damaged, and many cells are broken, releasing intracellular products such as phytochemicals and enzymes [11]. Nevertheless, the living tissues of fresh cut fruit need to transform their stored biomolecules to maintain its “energized state” [12]. However treating of fresh cut fruits with a combination of sugar, citric acid and Na-benzoate helps maintaining “energized state” which helps to overcome from rapid deterioration of fruits. It also helps to retain TSS and TSS:acidity ratio by reducing moisture and solute migration, gas exchange, respiration, and oxidative rates, as well as by reducing or even suppressing physiological disorders [13].

At $10^{th}$, $15^{th}$ and $20^{th}$ days of storage cut fresh pineapple cube treated with 100g/l sugar + 1000ppm CA+ 1000ppm Na-Benzoate exhibited significant less degradation and retained maximum ascorbic acid compared with the other treatments. Possible reason for ascorbic acid losses during storage are autoxidation, which occurs spontaneously when the ascorbic acid is combined with oxygen in the air. Present finding is also supported by [14]. [15] also stated that, chitosan at 2% + malic acid at 150 ppm + citric at 0.5% treatment resulted in significantly the highest vitamin C content of Valencia orange fruits during cold storage at 5°C. On the other hand [16] noticed that ascorbic acid content of pineapple gradually decreased with the increase in storage period.

At $15^{th}$ and $20^{th}$ days of storage treatment $T_9$, $T_{10}$ and $T_{11}$ has shown significant improvement in retaining total sugar and non-reducing sugar. It may be feasible that the minimal processes cause mechanical injury to the plant tissues and encouraged biochemical changes, microbial degradation, and the consequence is the loss of quality. However, the use of appropriate dose of sugar, citric acid and Na-benzoate may aid to avoid biochemical problems or pessimistic changes, due to mechanical injury (e.g. immersion therapy). Present study is also supported by [17]; [18]; [19]. Is possible may be due to cutting of pineapple cubes induces degradative changes associated with plant tissue senescence, and a consequently decrease in shelf life of fresh-cut product compared to the unprocessed product. As a part of defence mechanism, plant tissues frequently produced compounds such as phytoalexins, but synthesis of these naturally occurring compounds might be slow [20] and [9].

## Conclusion

On the basis of above findings it may be concluded that the treatments of sugar, citric acid and Na-benzoate have significant effect to increase shelf life and retaining quality of fresh cut pineapple cubes. As most of the important quality parameters recorded best in $T_8$(sugar 200g/l + citric acid @500ppm + Na-benzoate@1000ppm), thus this treatment combination has been found best for fresh cut pineapple cubes for maximum shelf-life with minimum lose of quality.

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