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Effect of post-harvest application of different chemicals on quality parameters of sapota cv. Kalipatti

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Abstract
The investigation was conducted during 2020–21 at PG laboratory, Department of Horticulture, VNMKV, Parbhani (Maharashtra). Freshly harvested uniform sized sapota fruits were washed, cleaned and treated with CaCl2 4% and CaCl2 2%, CaCl2 1% for 5 minutes, GA3 200 ppm, GA3 150 ppm GA3 100 ppm for 5 minutes and BA 150 ppm, BA 75 ppm, BA 50 ppm for 5 minutes. Treated and untreated fruits were packed in card board cartoons of 30× 30 ×30 cm size with 6 vents each of 3 cm diameter equally on opposite sides and stored in PG laboratory. The experiment was framed in CRD with nine treatments and a control. The fruits were subjected to various quantitative and qualitative analyses on at 3rd, 6th, 9th and 12th days of storage period. By end of storage period, higher TSS (24.80%) was recorded by CaCl2 4%. Whereas, significantly higher reducing sugar (11.59%) and non –reducing sugar (11.09%) was recorded with the same treatment. By end of storage period, highest total sugar and ascorbic acid was recorded with CaCl2 4% (20.71% and 10.60 mg /100 g pulp). Whereas, lowest acidity (0.06%) and maximum TSS/acid was recorded with CaCl2 4% (412.10). From the present study it can be concluded that, CaCl2 4% was found best treatment which not only extended the shelf life of sapota fruits but also reduced the post – harvest losses and increased TSS, reducing sugar, non-reducing sugar, total sugar, ascorbic acid, TSS/acid ratio and decreasing trend with acidity.

Keywords: sapota, CRD, storage period, qualitative parmater, CaCl2, GA_3

Introduction
Sapota is a tropical fruit that is commercially grown in India and belongs to the Sapotaceae family. Due to its broad range of adaptability, sapota (*Manilkara achras* (Mill.) Fosberg) is one of the most popular fruits in the Southern and Western parts of the world and fair economic returns, as well as a low vulnerability to pests and diseases.

Sapota fruit is a berry with 3-5 black shiny seeds inside. The fruit is circular or globular in shape, with a length of 5.00 to 8.00 cm, a diameter of 3.5 to 7.00 cm, and a weight of 75 to 100 g. The fruit has a rusty brown scurfy skin that resembles that of an Irish potatoes, and the pulp is smooth, sweet, and crumbly with a granular texture that has an aroma. When fully ripe, a sweet sauce can be made from ripe fruits by pressing the flesh, adding orange juices, and topping with whipped cream, it can also be used as a dessert. Sapota, on the other hand is usually not cooked or preserved, but is sometimes fried (Peiris, 2007).

Sapota is not only delicious and sweet to eat, but also high nutritive fruit with an upscale source of vitamin A, proteins, carotenoids, phenols and minerals like Ca, P, Cu and Fe (Ugalat *et al.*, 2012). It's rich source of sugars (12–18%), proteins (0.7 g/100 g), vitamin C (6.0 mg/100 g), phenols (15.35 mg gallic acid equivalent/100 g), carotenoids (1.69 mg b-carotene/100 g) and minerals, for instance, phosphorous (27 mg/100 g), calcium (28 mg/100 g), iron (2.0 mg/100 g), potassium (193 mg/100 g), copper (0.086 mg/100 g) etc. (Ugalat *et al.*, 2012).

Since sapota fruits are climacteric, they ripen quickly after harvest and become softened due to a rapid increase in the activity of various oxidative enzymes, according to the original article published in the International Journal of Agricultural Science and Study (IJASR). As a result, proper post-harvest management is needed to keep sapota fruits fresh.

Various chemicals, such as calcium chloride, potassium permanganate, salicylic acid, and kinetin, have been used to slow down the metabolic activities of the fruit to delay ripening, minimize losses, and preserve colour and consistency (Tsomu and Patel, 2014). These chemicals inhibit the growth and spread of microorganisms by decreasing shrivelling, resulting in improved shelf life and fruit marketability for a longer period of time.

Materials and Methods

The details of materials and methods followed while conducting the present investigation are given in this heading: The present investigation entitled "Studies on post harvest application of different chemicals on shelf life of sapota cv. Kalipatti" conducted during 2020–21 at PG laboratory, Department of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (Maharashtra). Freshly harvested uniform sized sapota fruits were washed, cleaned and treated with CaCl2 4% and CaCl2 2%, CaCl2 1% for 5 minutes, GA3 200 ppm, GA3 150 ppm GA3 100 ppm for 5 minutes and BA 150 ppm, BA 75 ppm, BA 50 ppm for 5 minutes. Treated and untreated fruits were packed in card board cartoons of 30× 30 ×30 cm size with 6 vents each of 3 cm diameter equally on opposite sides and stored in PG laboratory. The experiment was framed in Completely Randomized Design with nine treatments and a control. The fruits were subjected to various quantitative and qualitative analysis on at 3rd, 6th, 9th and 12th days of storage period.

Treatment Details: Following post harvest treatments were imposed on matured fruits as soaking treatments.

Following post harvest treatments were imposed on matured fruits as soaking treatments.

Sr. No.	Treatment	Details
1	T1	Calcium chloride 1%
2	T2	Calcium chloride 2%
3	T3	Calcium chloride 4%
4	T4	Gibberellic acid 100ppm
5	T5	Gibberellic acid 150ppm
6	T6	Gibberellic acid 200ppm
7	T7	Benzyl adenine 50 ppm
8	T8	Benzyl adenine 75 ppm
9	T9	Benzyl adenine 150 ppm
10	T10	Control

Preparation for experiment

Selection of Fruits

The fresh and healthy fruits with uniform size and maturity, free from injuries, pest and diseases, blemishes were hand picked and collected from central nursery, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. Out of these fruits, two kilogram fruit having uniform size were randomly selected for each treatments.

Preparation of Chemical Solutions

Calcium Chloride (CaCl2)

For preparing solution of Cacl2 1%, 2%, 4%, 10 g, 20 g and 40 g were weighted and dissolved in 1 L acetone was added. 9 litre solution of each Cacl2 1%, 2%, 4% was prepared i.e. 3 litres per treatment per repetitions.

Gibberellic acid (GA_3)

For preparing solution of GA_3 100 ppm,150 ppm, 200 ppm, 100 mg,150 mg and 200 mg were weighted and dissolved in 1 L acetone was added. 9 litre solution of each GA3 100 ppm, 150 ppm, 200 ppm was prepared i.e. 3 litres per treatment per repetitions.

Benzyl Adenine

For preparing solution of BA 50 ppm,75 ppm, 150 ppm, 50 mg, 75 mg and 150 mg were weighted and and dissolved in 1 L acetone was added. 9 litre solution of each BA 50 ppm, 75 ppm, 150 ppm was prepared i.e. 3 litres per treatment per repetitions.

Method and time of fruit sampling

30 fruits from each treatment combination of each 3 repetitions were selected and marked for storage study. Different quantitative characters were then recorded from them and replaced the fruits in their respective boxes. One fruit was selected randomly from each repetition and used for chemical analysis. Oualitative characters were recorded on 3th, 6th, 9th and 12th days of storage period.

Observation recorded

During the storage studies following observations were recorded.

Methodology adopted in recording observations

Chemical parameters

Total Soluble Solids (%)

Total Soluble Solids of sapota fruits was recorded by using a hand refractometer (0- 32 ^{0}C). In each treatments two reading were taken and then average was worked out.

Reducing sugar (%)

The titrametric method of Lane and Eynon described by Ranganna (1979) was adopted for the estimation of reducing sugar.

Principle of the method

Invert sugar of reducing sugar reduced copper in Fehling's solution to red cuprous oxide. The sugars in a sample were estimated by determining the volume of unknown sugar required to completely reduce a measured volume of standard Fehling's solution.

25 g of homogenized pulp was taken and transferred to a 250 ml volumetric flask and 2 ml of 45 lead acetate solution was added for clarification. After 10 minutes the solution was made up adding potassium oxalate crystals in excess (5 to 10 g) and volume

as made up by the distilled water. The contents were then centrifuged for about 10 minutes. The clear supernatant solution was taken in a burette titrated with boiling Fehling's mixture (5 ml of Fehling's solution A and 5 ml of Fehling's solution B) till blue colour faded. At the stage 1 ml of 1 per cent methylene blue indicator was added and titration was continued till content attained was stopped and the titre value was noted from the burette. Percentage of reducing sugar was calculated from the following formula.

$$\text{Reducing sugar \%} = \frac{\text{Glucose equivalent} \times \text{Total volume made up}}{\text{Titre} \times \text{Weight of pulp}} \times 100$$

Non – Reducing Sugar (%)

Non - reducing sugar is calculated by following formula:

Non – reducing sugar (%) = Total sugars% - Reducing sugar (%)

Total sugar (%)

From the supernatant of above at 3.5.2 (reducing sugars), an aliquot of 50 ml was taken in a 250 ml volumetric flask to which 5 ml of dilute hydrochloric acid (1: 1) was added and then kept for inversion for 25 hours at room temperature. Then the solution was neutralized with 40 per cent sodium hydroxide till pink colour appeared using phenolphthalein as

indicator and the final volume was made up to 250 ml with distilled water. The solution was titrated against boiling Fehling's mixture as described earlier**.** The percentage of total.

$$\text{Total sugar \%} = \frac{\text{Glucose equivalent (0.052)} \times \text{Total volume made up} \times \text{volume made up after inversion}}{\text{Titre value} \times \text{Weight of sample} \times \text{Aliquot taken for inversion}} \times 100$$

Titratable acidity (%)

The method described by Ranganna (1979) was adopted. Five grams of the homogenized pulp was taken and transferred to 100 ml volumetric flask and the volume was made up with distilled water. The solution was centrifuged and clear supernatant aliquot was taken in a beaker and titrated against standard sodium hydroxide using phenolphthalein as a indicator, till pink colour obtained, which persists atleast 15 seconds, as an end point. The titrable acidity was expressed in terms of percentage malic acid equivalent by adopting following formula.

$$\text{Acidity \%} = \frac{\text{Titre} \times \text{Normality} \times \text{volume made up} \times \text{Eq. Weight of citric acid of alkali}}{\text{Volume of sample taken} \times \text{Weight of sample taken} \times 1000} \times 100$$

Ascorbic acid (mg /100 g pulp)

The method described by Ranganna (1986) was adopted for estimation of the ascorbic acid.

Ten grams of the homogenized pulp of sapota was blended with 3 per cent metaphosphoric acid and made up to 50 ml with 3 per cent HPO3.The contents was filtered through whatman No1 filter paper. 10 ml of the HPO3 extract was taken and titrate against standarad 2, 6 – dichlorophenol indophenols dye to a pink end point. The ascorbic acid content was calculated adopting the following formula.

$$\text{Ascorbic acid (mg / 100g pulp)} = \frac{\text{Titre} \times \text{Dye factor} \times \text{Total volume made up}}{\text{Aliquot of extract taken for estimation} \times \text{Weight of sample}} \times 100$$

TSS /Acid ratio

TSS: acid ratio was calculated by dividing the TSS value by acid value.

Results and Discussion

The present investigation entitled "Studies on post harvest application of different chemicals on shelf life of sapota cv. Kalipatti" conducted during 2020–21 at PG laboratory, Department of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (Maharashtra).

The statistically analysed results of the present investigations on various physical and biochemical parameters influenced due to different chemical treatments like calcium chloride, GA3, benzyl adenine and their scientific interpretations are presented in this chapter under appropriate headings and sub headings.

Effect of post harvest treatments on biochemical parameters

Observations recorded on total soluble solids (%), total sugars (%), reducing sugars (%), non- reducing sugars (%), total sugars (%), titrable acidity (%), ascorbic acid (mg/100 g) and TSS/ acid ratio are described below.

Effect on TSS (%)

Data pertaining to total soluble solids of sapota under influence of different chemical recorded at 3rd, 6th, 9th, 12th day interval are presented in Table 1 and also graphically depicted in Fig 1.

The data revealed that during storage period different post harvest treatment exerted their significant effects on TSS of fruits. On 0 day of storage, significantly higher (19.09%) TSS was recorded with GA_3 200 ppm which was superior as compared to rest of treatments and lowest TSS was recorded with $CaCl_2$ 1% (16.87%). On 3rd day of storage, significantly higher (21.43%) TSS was recorded with BA 150 ppm which was superior as compared to rest of treatments and lowest TSS was recorded with control (18.80). On 6th day of storage, significantly higher (23.48%) TSS was recorded with control and lowest TSS was recorded with CaCl2 4% (19.88). On 9th day of storage, significantly higher (25.61%) TSS was recorded with CaCl2 4% which was superior as compared to rest of treatments and lowest TSS was recorded with control (18.65). On 12th day of storage, significantly higher (24.80%) TSS was recorded with CaCl2 4% which was superior as compared to rest of treatments and lowest TSS was recorded with control (17.07). Upto 9th day of storage period, pace of accumulation of TSS increased with slight decrease at the end.

There was a significant variation in the TSS irrespective of treatment showed an increasing trend through-out the storage period. It was found highest in CaCl2 4% (24.80%) treated fruits at the subsequent days.

This may be due to the increase in soluble solids content and total soluble sugars caused by hydrolysis of polysaccharides like starch, cellulose and pectin substances into simpler substances. These results are in line with the finding of Jain *et al*. (2020) [4], who reported an increase in the TSS content of sapota fruits from harvest until ripening and later a decrease in TSS as the fruits started senescing.

Table 1: Effect of different levels of post harvest treatments of chemicals on TSS (%) of sapota fruits cv. Kalipatti

Sr. No.	Treatments	TSS (%)				
		No. of days (Storage period)				
		0 day	3rd day	6th day	9th day	12th day
1	Calcium chloride 1%	16.87	20.23	22.44	24.91	23.81
2	Calcium chloride 2%	17.61	20.57	21.16	25.26	23.34
3	Calcium chloride 4%	18.35	21.11	19.88	25.61	24.80
4	Gibberellic acid 100 ppm	18.64	20.42	19.97	23.12	20.45
5	Gibberellic acid 150 ppm	18.90	20.90	21.12	23.90	22.88
6	Gibberellic acid 200 ppm	19.09	21.33	21.17	24.05	23.94
7	Benzyl adenine 50 ppm	17.42	20.5	21.11	23.32	20.23
8	Benzyl adenine 75 ppm	17.64	20.70	20.89	23.74	20.11
9	Benzyl adenine 150 ppm	18.84	21.43	22.51	24.18	21.23
10	Control	16.98	18.80	23.48	18.65	17.07
S.Em. ±		0.00	0.10	0.00	0.00	0.00
C.D. (0.05%)		0.01	0.30	0.01	0.01	0.01

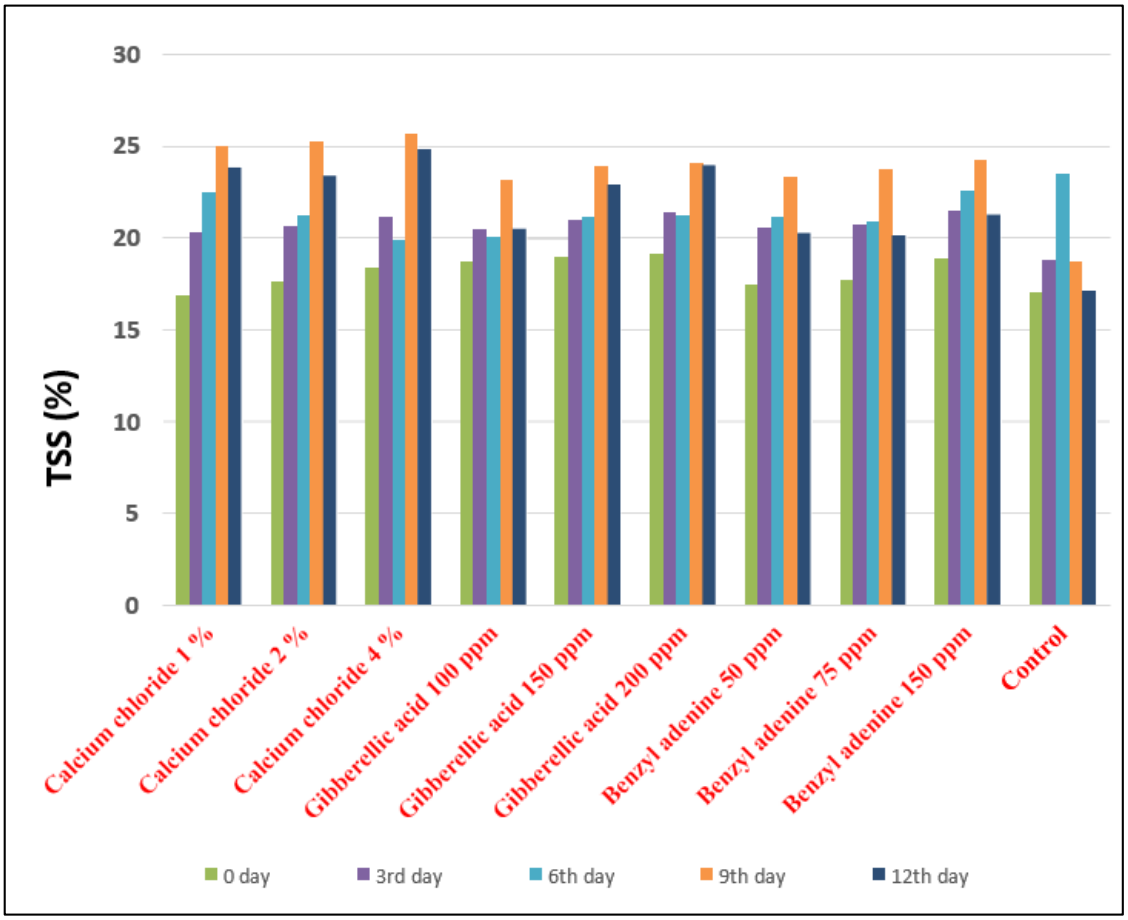

Fig 1: Effect of different levels of post harvest treatments of chemicals on TSS (%) of sapota fruits cv. Kalipatti.

Effect on reducing sugar (%)

Data pertaining to reducing sugar of sapota under influence of different chemical recorded at 3rd, 6th, 9th, 12th day interval are presented in Table 2 and also graphically depicted in Fig 2.

The data revealed that during storage period different post harvest treatment exerted their significant effects on reducing sugar of fruits. On 0 day of storage, significantly higher reducing sugar (7.81%) recorded with CaCl2 4% which was superior as compared to rest of treatments and lowest reducing sugar was recorded with control (5.82). On 3rd day of storage, significantly higher reducing sugar (13.03%) recorded with CaCl2 4% which was superior as compared to rest of treatments and lowest reducing sugar was recorded with control (7.97). On 6th day of storage, significantly higher reducing sugar (13.79%) recorded with CaCl2 4% which was superior as compared to rest of treatments and lowest reducing sugar was recorded with BA 50 ppm (9.47).

On 9th day of storage, significantly higher reducing sugar (12.79%) recorded with CaCl2 4% which was at par with CaCl2 2% (12.39%) as compared to rest of treatments. On 12th day of storage, significantly higher reducing sugar (11.59%) recorded with CaCl2 4% which was at par with CaCl2 1% (10.69%) as compared to rest of treatments. The lowest reducing sugar was recorded with control i.e. (8.91 and 7.55%) at 9th and 12th days of storage period. In all treatments, the pattern of accumulation of reducing sugar was increased from 0 to 6th days of storage period, being slightly declined 12th days of storage period.

In present study, accumulation of reducing sugar was gradually increased in fruits treated with chemical with a slight decline at the end of storage period, being significantly highest with CaCl2 4% (11.59%) as compared to rest of the

treatments.

The initial increase in reducing sugar might be due to the conversion of starch into reducing sugar and later on reduction could possibly might be due to utilization of sugar in the process of respiration.

The percentage of reducing sugar increased slowly during storage period upto 9th day and declined thereafter. The increase in reducing sugar might be due to increased rate of starch degradation by amylase activity. The present findings are in agreement with Jain *et al*. (2020) [4] in sapota.

The percentage of reducing sugar increased with advancement of storage period. This may be attributed to the inversion of non- reducing sugar into reducing –sugar caused by acids present in fruits. In all of the treatments, the rate of inversion was rapid at first, which could be related to the availability of more substrate for inversion in the early phases. The increase in the total reducing sugar contents is in line with the finding of Jain *et al*. (2020) [4] who reported an increase in reducing sugar content of sapota fruits during ripening. However, decrease in reducing sugar content (%) was observed due to over ripening of fruits which was utilized during respiration process.

Table 2: Effect of different levels of post harvest treatments of chemicals on reducing sugar (%) of sapota fruits cv. Kalipatti

Sr. No.	Treatments	Reducing sugar (%)				
		No. of days (Storage period)				
		0	3	6	9	12
1	Calcium chloride 1%	7.55	10.59	11.68	11.99	10.69
2	Calcium chloride 2%	7.68	11.99	12.70	12.39	10.29
3	Calcium chloride 4%	7.81	13.03	13.79	12.79	11.59
4	Gibberellic acid 100 ppm	6.65	8.55	9.91	11.10	9.33
5	Gibberellic acid 150 ppm	6.82	8.80	10.20	11.10	9.33
6	Gibberellic acid 200 ppm	6.69	9.05	10.51	11.20	9.66
7	Benzyl adenine 50 ppm	6.52	8.37	9.47	10.59	8.97
8	Benzyl adenine 75 ppm	6.66	8.66	9.64	10.78	9.19
9	Benzyl adenine 150 ppm	6.80	8.95	9.81	10.60	9.32
10	Control	5.82	7.97	11.58	8.91	7.55
S.Em.±		0.09	0.20	0.04	0.20	0.08
C.D. (0.05%)		0.27	0.59	0.13	0.61	0.24
C.V.%		2.34	3.61	0.72	3.19	1.50

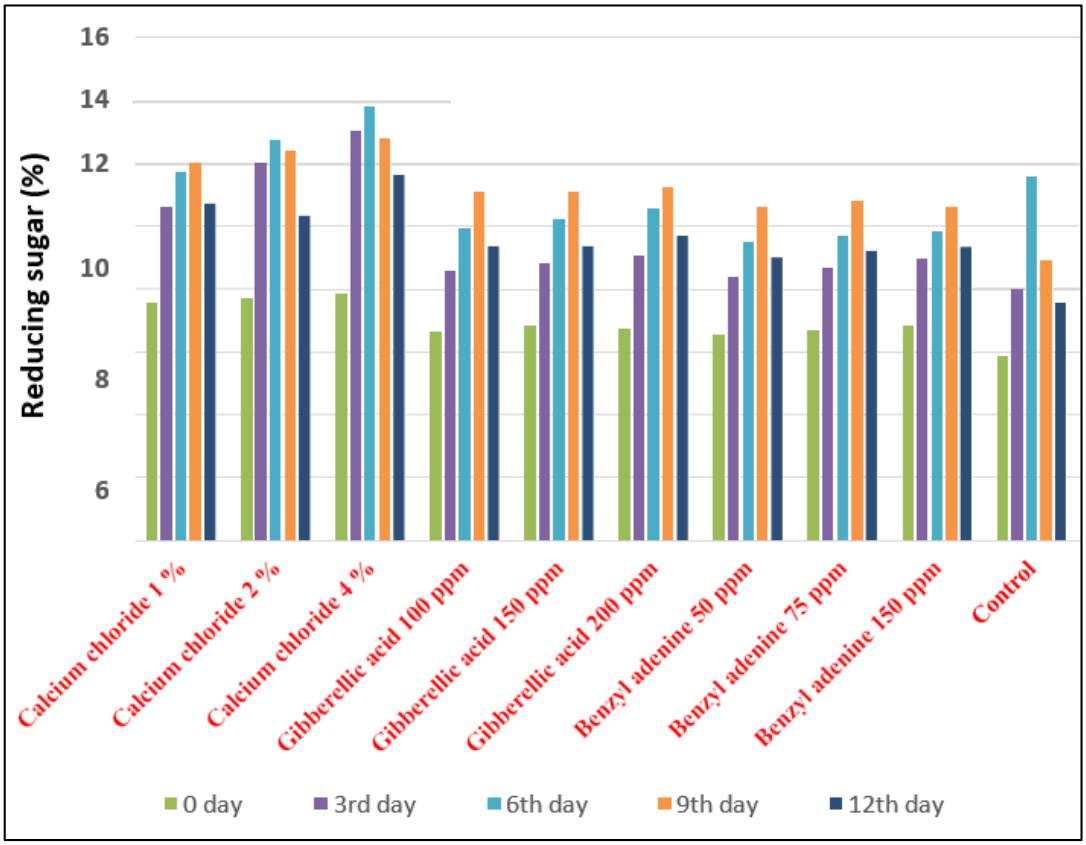

Fig 2: Effect of different levels of post harvest treatments of chemicals on reducing sugar (%) of sapota fruits cv. Kalipatti.

Effect on non - reducing sugar (%)

Data pertaining to non-reducing sugar of sapota under influence of different chemical recorded at 3rd, 6th, 9th, 12th day interval are presented in Table 3 and also graphically depicted in fig 3.

The data revealed that during storage period different post harvest treatment exerted their significant effects on non-reducing sugar of fruits. On 0 day of storage, significantly higher non - reducing sugar (7.92%) recorded with control which was superior as compared to rest of treatments and lowest reducing sugar was recorded with CaCl2 4% (4.32). On 3rd day of storage, significantly higher non - reducing sugar (8.08%) recorded with CaCl2 1% which was superior as compared to rest of treatments and lowest reducing sugar was recorded with BA 50 ppm (7.00). On 6th day of storage, significantly higher non - reducing sugar (9.03%) recorded with CaCl2 1% which superior as compared to rest of treatments and lowest non - reducing sugar was recorded with control (6.81).

On 9th day of storage, significantly higher non - reducing sugar (11.06%) recorded with CaCl2 4% which was superior as compared to rest of treatments At the end of storage period i.e. 12th day of storage, significantly higher non - reducing sugar (11.09%) recorded with CaCl2 4% which was superior

as compared to rest of treatments and lowest non - reducing sugar was recorded with control i.e. (6.90, 6.90) at 9th, 12th days of storage period.

In present study, accumulation of non - reducing sugar was gradually increased in fruits treated with chemical with a slight decline at the end of storage period, being significantly highest with CaCl2 4% (11.09%) as compared to rest of the treatments. This may be due to the increase in non - reducing sugar might be due to the hydrolysis of starch and pectin substances from water insoluble to water soluble fractions. These results with the finding of Somu *et al*. (2015) [7] and Jain *et al*. (2020) [4] in sapota.

Table 3: Effect of different levels of post harvest treatments of chemicals on non- reducing sugar (%) of sapota fruits cv. Kalipatti

Sr. No.	Treatments	Non- reducing sugar (%)				
		No. of days (Storage period)				
		0 day	3rd day	6th day	9th day	12th day
1	Calcium chloride 1%	7.06	8.08	9.03	9.78	9.78
2	Calcium chloride 2%	6.36	7.51	8.51	10.42	10.40
3	Calcium chloride 4%	4.32	5.88	8.00	11.06	11.09
4	Gibberellic acid 100 ppm	6.70	7.09	7.72	6.22	6.22
5	Gibberellic acid 150 ppm	6.96	7.05	8.17	7.29	7.28
6	Gibberellic acid 200 ppm	6.02	7.01	8.57	8.27	8.27
7	Benzyl adenine 50 ppm	6.35	7.00	8.41	7.98	7.98
8	Benzyl adenine 75 ppm	6.54	7.00	8.48	7.95	7.95
9	Benzyl adenine 150 ppm	6.50	6.71	8.55	7.82	7.82
10	Control	7.92	7.98	6.81	6.9	6.90
S.Em.±		0.17	0.00	0.01	0.01	0.03
C.D. (0.05%)		0.52	0.01	0.05	0.05	0.09
C.V.%		4.75	0.12	0.40	0.39	0.66

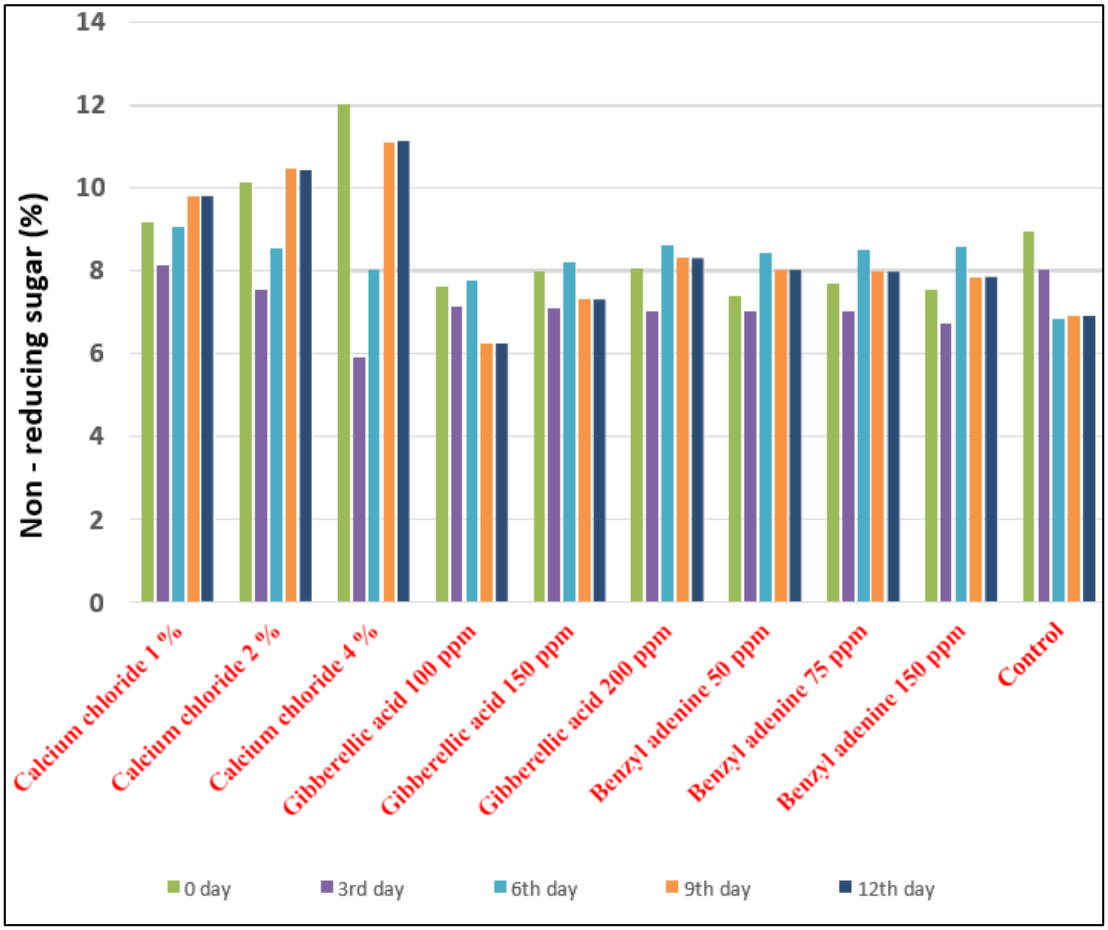

Fig 3: Effect of different levels of post harvest treatments of chemicals on non reducing sugar (%) of sapota fruits cv. Kalipatti.

Effect on total sugar (%)

Data pertaining to total sugar of sapota under influence of different chemical recorded at 3rd, 6th, 9th, 12th day interval are presented in Table 4 and also graphically depicted in Fig 3.

The data revealed that during storage period different post harvest treatment exerted their significant effects on total sugar of fruits. On 0 day of storage, significantly higher total sugar (18.79%) recorded with CaCl2 4% which was superior as compared to rest of treatments. On 3rd day of storage, significantly higher total sugar (19.50%) recorded with CaCl2 2% which was at par with 4% (18.99%) as compared to rest of treatments. On 6th day of storage, significantly higher total sugar (21.79%) recorded with CaCl2 4% which was superior as compared to rest of treatments. On 9th day of storage,

significantly higher total sugar (23.81%) recorded with CaCl2 4% which was superior as compared to rest of treatments. At the end of storage period i.e. 12th day of storage, significantly higher total sugar (20.71%) recorded with CaCl2 4% which was superior as compared to rest of treatments. It is also seen from table that by at the end of storage period, least total sugar was found in GA 100 ppm (6.22%) treated fruits. The lowest total sugar was recorded with control i.e. (13.40, 15.39, 15.80, 14.58) at 3rd, 6th, 9th, 12th day of storage period.

In present study, accumulation of total sugar was gradually increased in fruits treated with chemical with a slight decline at the end of storage period, being significantly highest with CaCl2 4% (20.71%) as compared to rest of the treatments. The starch, hemicellulose, and organic acids are converted into sugars in diverse ways as the fruit ripens. These changes are mostly determined by the storage conditions, such as temperature and time, as well as the physical state of the fruits. Generally, the total sugar content increases from harvest till ripening and declines as senescence approaches. Once the fruit ripens, the sugar undergo metabolic transformation, both quantitatively and qualitatively. These finding on total sugar are in line with report of Somu *et al*. (2015) [7] and Jain *et al*. (2020) [4] who noticed an increasing trend with respect to total sugar content with advancement of storage period in sapota cv. Kalipatti under ambient storage.

It was observed that total sugar content of sapota fruit at different stages of ripening increased significantly from mature to ripe stage with a slight decline at over ripe stage. The final level of total sugar was higher in treated fruits as compared to control. Lower levels of sugar in untreated fruits might be due to high levels of starch hydrolysis. The present investigation is in conformity with the results reported by Khanvilkar *et al*. (2018) [5] in sapota.

Table 4: Effect of different levels of post harvest treatments of chemicals on total sugar (%) of sapota fruits cv. Kalipatti

Sr. No.	Treatments	Total sugar (%)				
		No. of days (Storage period)				
		0 day	3rd day	6th day	9th day	12th day
1	Calcium chloride 1%	16.69	18.99	20.69	21.78	19.19
2	Calcium chloride 2%	17.78	19.50	21.21	22.80	18.98
3	Calcium chloride 4%	18.79	18.99	21.79	23.81	20.71
4	Gibberellic acid 100 ppm	14.58	15.61	17.69	17.31	16.68
5	Gibberellic acid 150 ppm	14.79	15.58	18.40	18.40	16.69
6	Gibberellic acid 200 ppm	15.00	16.08	19.10	19.49	17.08
7	Benzyl adenine 50 ppm	13.35	15.39	17.59	18.58	15.70
8	Benzyl adenine 75 ppm	14.30	15.68	17.10	18.70	16.40
9	Benzyl adenine 150 ppm	14.71	15.98	17.40	18.81	16.61
10	Control	11.40	13.40	15.39	15.80	14.58
S.Em.±		0.20	0.32	0.09	0.05	0.18
C.D. (0.05%)		0.61	0.97	0.28	0.17	0.55
C.V.%		2.36	3.44	0.89	0.51	1.88

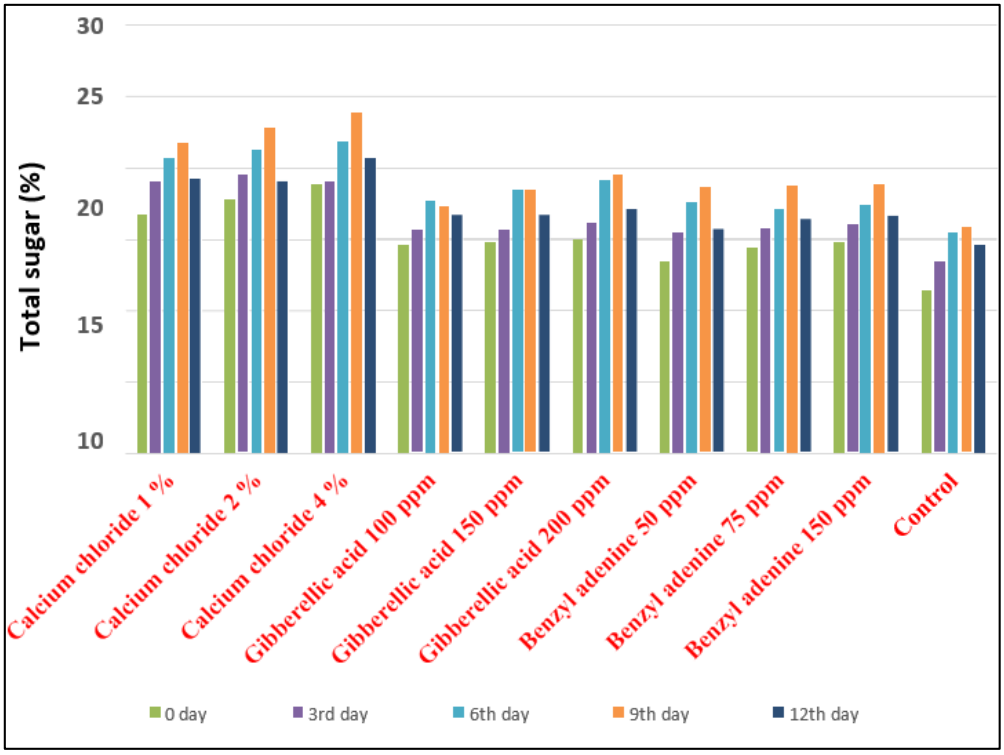

Fig 4: Effect of different levels of post harvest treatments of chemicals on total sugar (%) of sapota fruits cv. Kalipatti.

Effect on titratable acidity (%)

Data pertaining to titratable acidity of sapota under influence of different chemical recorded at 3rd, 6th, 9th, 12th day interval are presented in Table 5 and also graphically depicted in Fig

4.
The data revealed that titratable acidity during storage period different post harvest treatment exerted their significant effects on of fruits. On 0 day of storage, significantly lowest acidity (0.17%) recorded with CaCl2 4% which was superior as compared with CaCl2 2% (0.18%) as compared to rest of treatments. On 3rd day of storage, significantly lowest acidity (0.13%) recorded with CaCl2 4% which was superior as compared with CaCl2 2% (0.14%) as compared to rest of treatments. On 6th day of storage, significantly no difference between CaCl2 4% (0.12%) and CaCl2 2% (0.12%).
On 9th day of storage, significantly lowest acidity (0.10%) recorded with CaCl2 4% which was at par compared with CaCl2 2% (0.11%) as compared to rest of treatments. At the end of storage period i.e. 12th day of storage, significantly lowest acidity (0.06%) recorded with CaCl2 4% which was at par compared with CaCl2 2% (0.07%) as compared to rest of treatments.
The highest acidity was recorded with control i.e. (0.25, 0.21, 0.19, 0.18, 0.17%) at 3rd, 6th, 9th and 12th days of storage period. In all treatments, the pattern of accumulation of acidity (%) was decreased from 0 to 12th days of storage period.
Titrable acidity of sapota fruits declined with the advancement of ripening process of post
– harvest treatments. However, the trend of decline varied with the treatments being most rapid in CaCl2 4% (0.06%) and slowest in control. The decrease in the total titrable acidity might be due to increase in total sugar content of fruits. At the time of maturity, fruits were having higher amount of acidity, but as the fruits advance towards ripening acid content was decreases. These results are in line with finding of Jain *et al*. (2020) [4], who observed a decrease in acidity during ripening of sapota fruits.
The acidity of sapota fruits generally decreases with the advancement of storage period Vijayalaxmi *et al*. (2004) [8]. Decrease in acidity might be attributed to conversion of acids into sugars during respiration. These results elucidate the finding of Bharathi (2002) [2] in sapota fruits.

Table 5: Effect of different levels of post harvest treatments of chemicals on titratable acidity (%) of sapota fruits cv. Kalipatti

Sr. No.	Treatments	Titratable acidity (%)				
		No. of days (Storage period)				
		0 day	3rd day	6th day	9th day	12th day
1	Calcium chloride 1%	0.19	0.15	0.13	0.12	0.08
2	Calcium chloride 2%	0.18	0.14	0.12	0.11	0.07
3	Calcium chloride 4%	0.17	0.13	0.12	0.10	0.06
4	Gibberellic acid 100 ppm	0.21	0.14	0.17	0.16	0.14
5	Gibberellic acid 150 ppm	0.22	0.15	0.17	0.15	0.13
6	Gibberellic acid 200 ppm	0.22	0.17	0.15	0.14	0.12
7	Benzyl adenine 50 ppm	0.24	0.19	0.18	0.17	0.14
8	Benzyl adenine 75 ppm	0.23	0.18	0.17	0.16	0.13
9	Benzyl adenine 150 ppm	0.23	0.17	0.16	0.15	0.12
10	Control	0.25	0.21	0.19	0.18	0.17
S.Em.±		0.00	0.00	0.00	0.00	0.00
C.D. (0.05%)		0.01	0.01	0.01	0.02	0.01
C.V.%		4.67	6.13	6.41	0.02	7.98

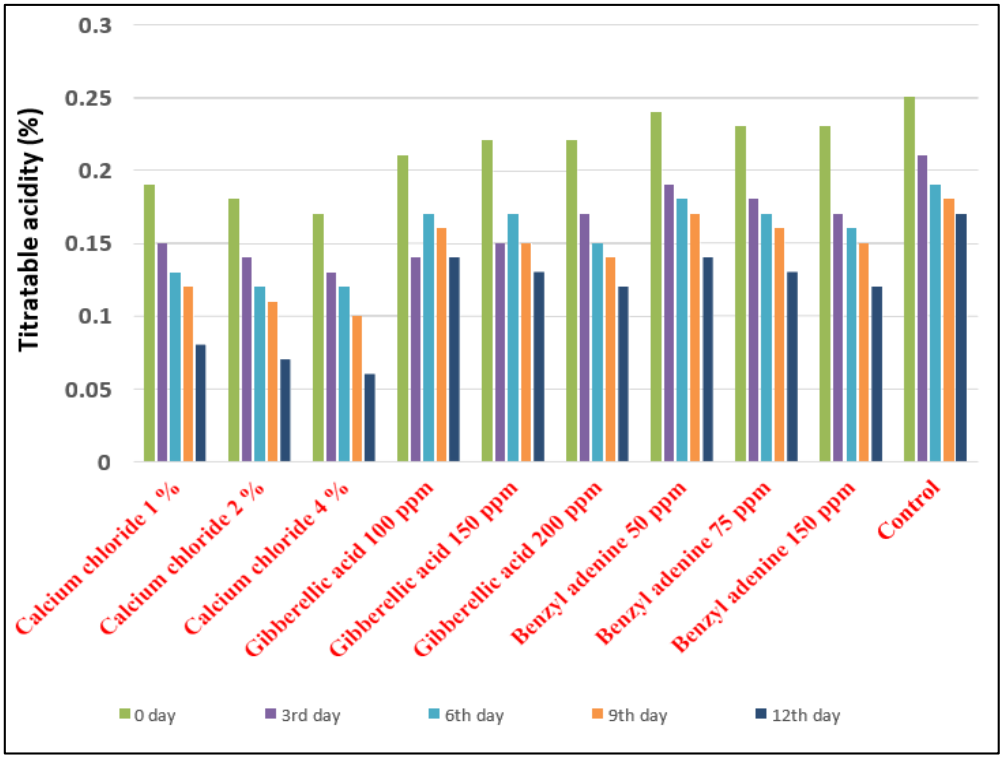

Fig 5: Effect of different levels of post harvest treatments of chemicals on titratable acidity (%) of sapota fruits cv. Kalipatti.

Effect on ascorbic acid (mg/100g pulp)

Data pertaining to ascorbic acid of sapota under influence of different chemical recorded at 3rd, 6th, 9th, 12th day interval are presented in Table 6 and also graphically depicted in fig 5.

The data revealed that during storage period different post harvest treatment exerted their significant effects on ascorbic acid of fruits.

On 0 day of storage, significantly higher ascorbic acid (24.75 mg/100g pulp) recorded with CaCl2 4% which was superior as compared to rest of treatments On 3rd day of storage, significantly higher ascorbic acid (22.50 mg/100g pulp) recorded with CaCl2 4% which was superior as compared to rest of treatments. On 6th day of storage, significantly higher ascorbic acid (19.31 mg/100g pulp) recorded with CaCl2 4% which was superior as compared to rest of treatments.

On 9th day of storage, significantly higher ascorbic acid (16.68 mg / 100g pulp) recorded with CaCl2 4% which was superior as compared to rest of treatments. At the end of storage period i.e. 12th day of storage, significantly higher ascorbic acid (10.60 mg / 100g pulp) recorded with CaCl2 4% which was superior as compared to rest of treatments.

It is also seen from table (6) that by at the end of storage period, least ascorbic acid (mg/100g pulp) was found in control (15.09, 12.69, 9.02, 6.98) at treated fruits 3rd, 6th, 9th, 12th day of storage period. During the end of storage, lowest ascorbic acid content was observed in control treated fruits followed by untreated fruits.

Decreased ascorbic acid content of control treated fruits may be due to the acceleration of ripening under the influence of ethylene. Identical observations during ripening was also reported by Ingle *et al.* (2001) [3] in Nagpur mandarin.

The results show that CaCl2 4% (10.60 mg/100g pulp) and CaCl2 2% (10.37 mg/100g pulp) treatments had a significant effect on retaining ascorbic acid content in sapota fruit.This might be as higher concentrations of CaCl2 delays oxidation of ascorbic acid. Ruoyi *et al.* (2005) [6] found that in peaches content of ascorbic acid was stable for fifty days storage period with the application of 0.5 per cent $CaCl_2$.

Table 6: Effect of different levels of post harvest treatments of chemicals on ascorbic acid (mg /100 g pulp) of sapota fruits cv. Kalipatti

Sr. No.	Treatments	Ascorbic acid (mg /100 g pulp) No. of days (Storage period)				
		0 day	3rd day	6th day	9th day	12th day
1	Calcium chloride 1%	23.17	20.80	17.11	14.49	10.05
2	Calcium chloride 2%	23.96	21.60	18.20	15.59	10.37
3	Calcium chloride 4%	24.75	22.50	19.31	16.68	10.60
4	Gibberellic acid 100 ppm	19.58	18.40	14.19	11.60	8.89
5	Gibberellic acid 150 ppm	20.60	18.69	14.78	12.19	8.91
6	Gibberellic acid 200 ppm	21.62	18.99	15.31	12.70	9.08
7	Benzyl adenine 50 ppm	20.47	17.81	14.00	11.18	8.48
8	Benzyl adenine 75 ppm	20.82	18.30	14.30	11.79	8.68
9	Benzyl adenine 150 ppm	21.17	18.80	14.60	12.39	8.88
10	Control	18.40	15.09	12.69	9.02	6.98
S.Em.±		0.02	0.19	0.19	0.05	0.02
C.D. (0.05%)		0.07	0.56	0.56	0.16	0.07
C.V.%		0.21	1.73	2.13	0.74	0.50

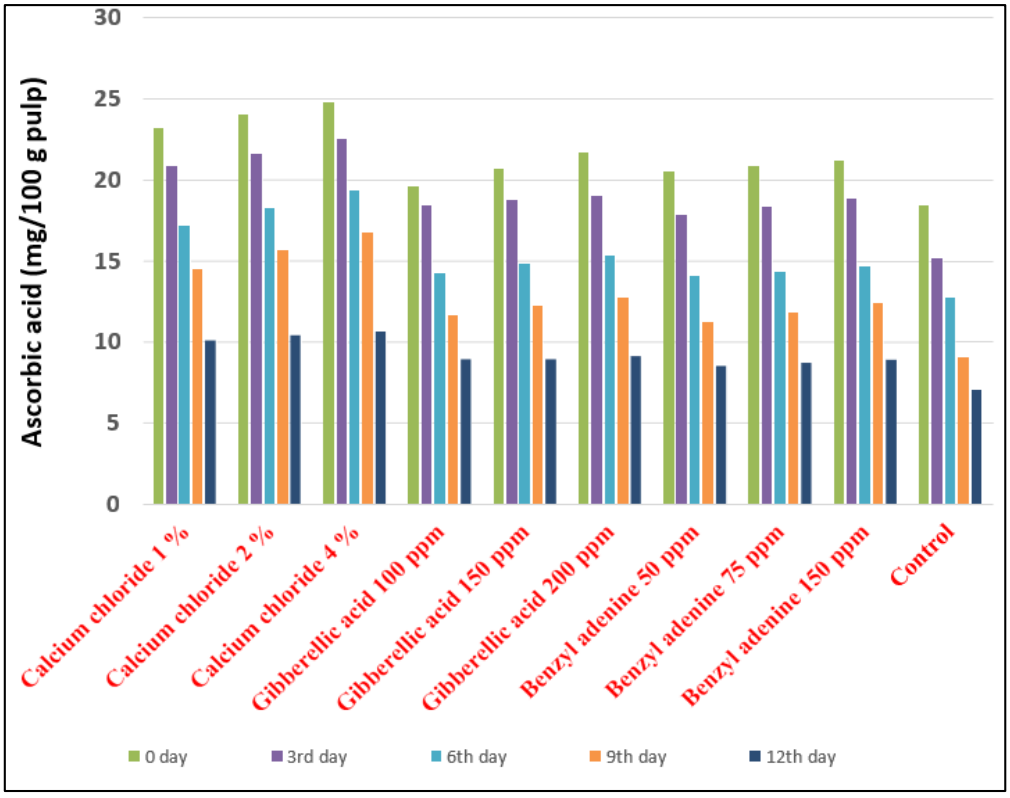

Fig 6: Effect of different levels of post harvest treatments of chemicals on ascorbic acid (mg /100 g pulp) of sapota fruits cv. Kalipatti.

Effect on TSS/Acid ratio

Data pertaining to TSS/Acid of sapota under influence of different chemical recorded at 3rd, 6th, 9th, 12th day interval are presented in Table 7 and also graphically depicted in Fig 6.

The data revealed that during storage period different post harvest treatment exerted their significant effects on TSS/acid ratio of fruits. On 0 day of storage, significantly higher TSS/acid ratio (107.98) recorded with CaCl2 4% which was superior as compared to rest of treatments. On 3rd day of storage, significantly higher TSS/acid ratio (161.12) recorded with CaCl2 4% which was superior as compared to rest of treatments. On 6th day of storage, significantly higher TSS/acid ratio (175.10) recorded with CaCl2 2% which was superior as compared to rest of treatments.

On 9th day of storage, significantly higher TSS/Acid ratio (256.00) recorded with CaCl2 4% which was superior as compared to rest of treatments. At the end of storage period i.e. 12th day of storage, significantly higher TSS/acid ratio (412.10) recorded with CaCl2 4% which was superior as compared to rest of treatments.

It is also seen from table (7) that by at the end of storage period, least TSS/Acid ratio was found in control (89.50, 123.85, 103.86 and 95.00) at treated fruits 3rd, 6th, 9th, 12th day of storage period, respectively.

In the present study, TSS and acid ratio of sapota fruits increased continuously throughout the storage period. Through TSS had shown initial increase, followed by decrease, the ratio was increased. This might is due to the magnitude of decrease in acidity is more compared to decrease in TSS in the later stages of storage. Similar trend of increase in TSS: acid ratio was observed by Jain *et al*. (2020) [4] in sapota. The highest TSS: acid ratio was recorded with CaCl2 4% (412.10%) and lowest (95.00%) recorded with control.

Table 7: Effect of different levels of post harvest treatments of chemicals on TSS/Acid ratio of sapota fruits cv. Kalipatti

Sr. No.	Treatments	TSS/Acid ratio				
		No. of days (Storage period)				
		0 day	3rd day	6th day	9th day	12th day
1	Calcium chloride 1%	88.79	134.95	172.87	207.85	297.75
2	Calcium chloride 2%	97.81	145.97	175.10	229.87	332.00
3	Calcium chloride 4%	107.98	161.12	164.88	256.00	412.10
4	Gibberellic acid 100 ppm	88.79	145.94	113.86	177.94	146.02
5	Gibberellic acid 150 ppm	85.60	139.10	123.05	183.94	176.00
6	Gibberellic acid 200 ppm	86.78	125.15	145.01	184.33	199.96
7	Benzyl adenine 50 ppm	72.59	106.11	117.08	145.91	174.95
8	Benzyl adenine 75 ppm	76.69	115.00	122.95	158.08	153.89
9	Benzyl adenine 150 ppm	81.60	126.01	140.89	172.90	176.96
10	Control	67.60	89.50	123.85	103.86	95.00
S.Em.±		0.23	0.56	0.57	0.62	0.56
C.D. (0.05%)		0.69	1.67	1.72	1.84	1.67
C.V.%		0.47	0.75	0.71	0.59	0.45

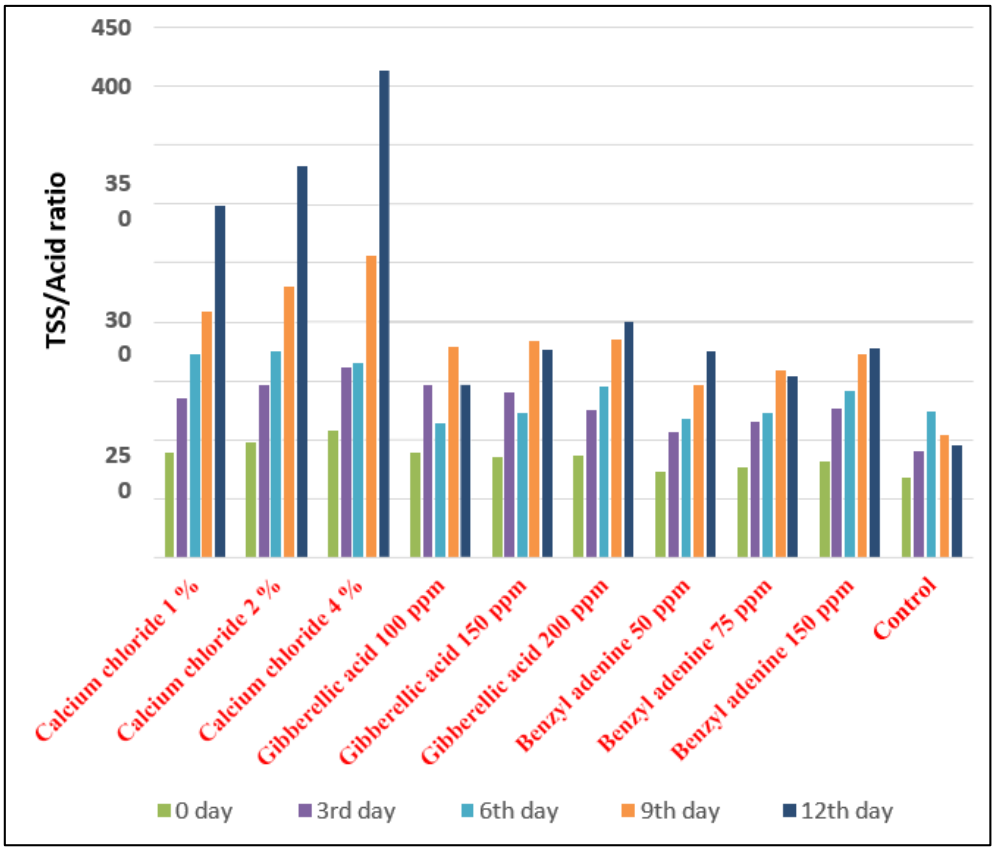

Fig 7: Effect of different levels of post harvest treatments of chemicals on TSS/Acid ratio of sapota fruits cv. Kalipatti

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