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# Effect of post-harvest treatments of various chemical and plant growth regulators on chemical characteristics of sapota fruits cv. Kalipatti

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**Abstract**
The mature fruits of sapota cv. Kalipatti were subjected to various post harvest chemical and growth regulator treatments viz. calcium chloride (5000 and 10000 ppm), calcium nitrate (2 and 4 %), gibberellic acid (200 and 400 ppm), benzyl adenine (75 and 150 ppm) and control (distilled water) and stored at ambient temperature. The level of acidity and ascorbic acid decreased with advancement of storage period and titratable acidity was found maximum (0.18 %) in control i.e. fruits treated with distilled water. The TSS, reducing sugars and total sugars were found to be increased up to 9$^{th}$ day of storage and then decreased at 12$^{th}$ day of storage. $CaCl_2$ (10000 ppm) was found to be best since they have the highest amount of TSS (23.81 $^0$Brix), reducing sugars (10.69 %), total sugars (19.18 %) and ascorbic acid (10.08 %).

**Keywords:** sapota, calcium chloride, calcium nitrate, gibberellic acid, benzyl adenine, storage

## Introduction
Sapota (*Manilkara achras* (Mill) Forsberg), popularly known as *Chiku* is native to tropical America. It is a tropical fruit belongs to family Sapotaceae. India is considered to be the largest producer of sapota in the world. Various chemicals have been used to improve and maintain quality by slowing down the metabolic activities of fruits. Among various chemicals, calcium has received considerable attention in recent years due to its desirable effect in delaying ripening and senescence, increase firmness, vitamin C and phenolic contents, reduced respiration, extending storage life and reducing the incidence of physiological disorders and storage rots (Sharma *et al.* 1996) [7]. Growth regulators are an integral component of fruit production. These regulators can be used as post harvest treatments for fruits to increase various physical and biochemical properties so as to enhance its keeping quality. Generally, gibberellic acid is known for its anti senescing properties which results in delaying ripening of fruits. In sapota kinetin regulated ripening was reported by Chundawat and Rao (1981) [1]. Therefore, it is necessary to subject sapota fruits to chemical and growth regulator treatments to evaluate their response on biochemical characteristics during storage under ambient temperature.

## Materials and Methods
The research work was carried out at Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli during the year 2015-16 and 2016-17 after registering under Ph. D. Programme at Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India. Fruits of uniform size, colour and free from injuries were selected for the study. The fruits of sapota cv. Kalipatti were dipped for 10 min. in solution of calcium nitrate (2 and 4 %), calcium chloride (5000 and 10000 ppm) gibberellin acid (200 and 400 ppm), benzyl adenine (75 and 150 ppm) and in absolute control the fruits were dipped in distilled water.
The experimental data was analysed in Completely Randomized Design (CRD) with three replications. The fruits were then air dried and kept at ambient temperature during storage. Data were recorded periodically and analysed statistically following the CRD design as outlined by Panse and Sukhatme (1967) [5]. Total soluble solids were determined by hand referactometer and expressed in $^0$ brix, acidity, reducing sugars, total sugars and ascorbic acid

content of fruits were recorded by a method as suggested by Ranganna (1977) [6] and the observations were recorded at two days interval.

## Result and Discussion

From the investigation it was recorded that total soluble solids (TSS) of fruit as influenced by different treatments of chemical and growth regulators during storage studies was found to be increased steadily during storage up to 9th day, followed by decline towards the end of storage, irrespective of treatments. While fruits treated with distilled water i.e. control showed steady increase in TSS up to 6th day (23.48 $^0$Brix) and thereafter it starts declining (Table 1).

At the end of storage the maximum TSS was found in fruits treated with calcium chloride 10000 ppm (23.81 $^0$B) which was at par with the treatments in which fruits were treated with $CaCl_2$ 5000 ppm and $GA_3$ 400 ppm. Increase in TSS during storage may be due to increase in soluble solids content and total soluble sugar content due to hydrolysis of polysaccharides like starch, cellulose and pectin substances in to simpler substances. These results are in line with the findings of Ingle *et al.* (1982), Madhavi *et al.* (2005) [4] who reported an increase in TSS content of sapota fruits from harvest until ripening and later a decrease in TSS as the fruit started senescing.

**Table 1:** Effect of post harvest treatments of different chemicals and plant growth regulators on total soluble solids–TSS ($^0$Btrix) of sapota fruits cv. Kalipatti.

| Treatments | Days of storage | | | | |
|---|---|---|---|---|---|
| | 0 | 3 | 6 | 9 | 12 |
| Control (Distilled water) | 16.98 | 18.80 | 23.48 | 18.65 | 17.07 |
| Calcium nitrate 2 per cent | 17.30 | 18.19 | 21.75 | 22.25 | 19.84 |
| Calcium nitrate 4 per cent | 16.39 | 18.22 | 20.48 | 23.07 | 20.12 |
| Calcium chloride 5000 ppm | 16.13 | 19.49 | 23.72 | 24.56 | 21.81 |
| Calcium chloride 10000 ppm | 16.87 | 20.03 | 22.44 | 24.91 | 23.81 |
| Gibberellic acid 200 ppm | 19.09 | 21.33 | 21.76 | 24.05 | 20.94 |
| Gibberellic acid 400 ppm | 19.54 | 22.24 | 24.02 | 24.98 | 22.00 |
| Benzyl adenine 75 ppm | 17.64 | 20.70 | 20.89 | 23.74 | 20.79 |
| Benzyl adenine 150 ppm | 18.84 | 21.43 | 22.51 | 24.18 | 21.23 |
| Mean | 17.64 | 20.05 | 22.34 | 23.37 | 20.84 |
| SEm±1 | 0.62 | 0.72 | 0.71 | 0.79 | 0.75 |
| CD (P=0.05) | 1.79 | 2.07 | 2.03 | 2.26 | 2.16 |

The data regarding the effect of various post harvest treatments of chemicals and growth regulators on titratable acidity in sapota cv. Kalipatti fruits is presented in Table 2. The statistical analysis of the data indicated that the titratable acidity of sapota fruits significantly declined with the advancement of storage. However, the trend of decline varied. The average titratable acidity in at the initial day of storage recorded 0.22 per cent and it steadily declined throughout the storage period and minimum was recorded at 12th day of storage (0.13 %), irrespective of treatments. At the end of storage the maximum titratable acidity (0.18 %) was found in control i.e. fruits treated with distilled water. The minimum titratable acidity was recorded in fruits treated with $CaCl_2$ 10000 ppm (0.08 %). The results are in line with Ingle *et al.* (1982) who observed a decrease in acidity during ripening of sapota fruits. The acidity of sapota fruits generally decreases with advancement of storage period (Vijayalakshmi *et al*., 2004) [9]. Decrease in acidity might be attributed to conversion of acids in to sugar during respiration.

**Table 2:** Effect of post harvest treatments of different chemicals and plant growth regulators on titratable acidity (%) of sapota fruits cv. Kalipatti.

| Treatments | Days of storage | | | | |
|---|---|---|---|---|---|
| | 0 | 3 | 6 | 9 | 12 |
| Control (Distilled water) | 0.25 | 0.21 | 0.19 | 0.18 | 0.18 |
| Calcium nitrate 2 per cent | 0.24 | 0.20 | 0.18 | 0.17 | 0.15 |
| Calcium nitrate 4 per cent | 0.23 | 0.19 | 0.18 | 0.16 | 0.14 |
| Calcium chloride 5000 ppm | 0.20 | 0.16 | 0.15 | 0.13 | 0.11 |
| Calcium chloride 10000 ppm | 0.19 | 0.15 | 0.13 | 0.12 | 0.08 |
| Gibberellic acid 200 ppm | 0.22 | 0.17 | 0.15 | 0.14 | 0.13 |
| Gibberellic acid 400 ppm | 0.22 | 0.17 | 0.15 | 0.14 | 0.12 |
| Benzyl adenine 75 ppm | 0.23 | 0.18 | 0.17 | 0.15 | 0.14 |
| Benzyl adenine 150 ppm | 0.23 | 0.17 | 0.16 | 0.14 | 0.13 |
| Mean | 0.22 | 0.18 | 0.16 | 0.15 | 0.13 |
| SEm±1 | 0.004 | 0.003 | 0.003 | 0.002 | 0.002 |
| CD (P=0.05) | 0.012 | 0.008 | 0.008 | 0.006 | 0.006 |

Reducing sugars was gradually increased in fruits with a slight decline at the end of storage period, being significantly highest with $CaCl_2$ 10000 ppm (10.69 %) followed by $CaCl_2$ 5000 ppm and $GA_3$ 400 ppm which were at par as compared to rest of the treatments (Table 3). The initial increase in reducing sugars might be due to the conversion of starch in to reducing sugars and starch degradation by amylase activity, later on reduction possibly might be due to utilization of sugar in the process of respiration. The increase in reducing sugar content is in line with the findings of Ingle *et al.* (1982) who reported an increase in reducing sugar content of sapota fruit during ripening. However, decrease in reducing sugar content (%) was also observed due to over ripening of fruits which was utilize during respiration process. Similar view was also shared by Gautam and Chundawat (1990) [2] and Tsomu *et al.* (2015) [8] in sapota.

**Table 3:** Effect of post harvest treatments of different chemicals and plant growth regulators on reducing sugars (%) of sapota fruits cv. Kalipatti.

| Treatments | Days of storage | | | | |
|---|---|---|---|---|---|
| | 0 | 3 | 6 | 9 | 12 |
| Control (Distilled water) | 5.82 | 7.97 | 11.55 | 8.91 | 7.55 |
| Calcium nitrate 2 per cent | 6.16 | 8.45 | 9.18 | 10.55 | 8.26 |
| Calcium nitrate 4 per cent | 6.47 | 8.59 | 9.37 | 10.24 | 8.83 |
| Calcium chloride 5000 ppm | 7.42 | 9.79 | 10.58 | 11.58 | 10.09 |
| Calcium chloride 10000 ppm | 7.55 | 10.89 | 11.65 | 11.98 | 10.69 |
| Gibberellic acid 200 ppm | 6.99 | 9.05 | 10.53 | 11.21 | 9.66 |
| Gibberellic acid 400 ppm | 7.16 | 9.30 | 10.84 | 11.30 | 9.99 |
| Benzyl adenine 75 ppm | 6.66 | 8.66 | 9.64 | 10.75 | 9.19 |
| Benzyl adenine 150 ppm | 6.80 | 8.95 | 9.81 | 10.92 | 9.41 |
| Mean | 6.78 | 9.07 | 10.35 | 10.82 | 9.29 |
| SEm±1 | 0.23 | 0.34 | 0.38 | 0.39 | 0.35 |
| CD (P=0.05) | 0.67 | 0.98 | 1.09 | 1.11 | 1.02 |

The accumulation of total sugars during the process of ripening is a consequence of starch hydrolysis. In present investigation the accumulation of total sugars was gradually increased up to 9th day of storage and decreased at the end of storage, irrespective of treatments. The total sugars content was increased up to 9th day of storage and then declined at the end of storage except in control treatment which showed decrease in total sugars from 9th day of storage (Table 4). The average total sugars content at initial stage of storage was 14.47 per cent which showed gradual increase up to 9th day (19.21 %) and at the end of storage it was found to be 16.73

per cent, irrespective of treatments. At the 12th day storage the significantly maximum total sugars were recorded in the fruits treated with $CaCl_2$ 10000 ppm (19.18 %) which was statistically at par with $CaCl_2$ 5000 ppm and $GA_3$ 400 ppm. As the fruits advances towards ripening starch, hemi cellulose and organic acids get converted in to various forms of sugar. These changes are largely dependent upon the condition of storage such as temperature, time and physical status of fruits. Similar finding was revealed by Tosmu *et al.* (2015) in sapota cv. Kalipatti under ambient storage conditions.

**Table 4:** Effect of post harvest treatments of different chemicals and plant growth regulators on total sugars (%) of sapota fruits cv. Kalipatti.

| Treatments | Days of storage | | | | |
|---|---|---|---|---|---|
| | 0 | 3 | 6 | 9 | 12 |
| Control (Distilled water) | 11.41 | 13.40 | 15.37 | 15.81 | 14.55 |
| Calcium nitrate 2 per cent | 13.52 | 15.53 | 17.20 | 18.50 | 15.39 |
| Calcium nitrate 4 per cent | 13.76 | 15.15 | 17.76 | 18.54 | 15.49 |
| Calcium chloride 5000 ppm | 15.62 | 18.44 | 20.14 | 20.72 | 18.40 |
| Calcium chloride 10000 ppm | 16.67 | 18.97 | 20.69 | 21.76 | 19.18 |
| Gibberellic acid 200 ppm | 15.01 | 16.06 | 19.11 | 19.48 | 17.05 |
| Gibberellic acid 400 ppm | 15.24 | 16.27 | 19.82 | 20.55 | 17.42 |
| Benzyl adenine 75 ppm | 14.30 | 15.66 | 18.13 | 18.70 | 16.42 |
| Benzyl adenine 150 ppm | 14.73 | 15.95 | 18.37 | 18.84 | 16.72 |
| Mean | 14.47 | 16.16 | 18.51 | 19.21 | 16.73 |
| SEm±1 | 0.52 | 0.59 | 0.64 | 0.73 | 0.64 |
| CD (P=0.05) | 1.48 | 1.69 | 1.82 | 2.11 | 1.84 |

Table 5 revealed that the ascorbic acid was decreased during storage period and the mean ascorbic acid content of sapota fruits at the initial day of storage was 21.04 mg $100g^{-1}$ which was decreased towards the end of storage and at the 12th day of storage it was 8.74 mg $100g^{-1}$, irrespective of treatments. The fruits treated with $CaCl_2$ 10000 ppm recorded significantly maximum ascorbic acid content (10.8 mg $100g^{-1}$) which was at par with $CaCl_2$ 5000 ppm and GA3 400 ppm, while the minimum ascorbic acid (6.98 mg $100g^{-1}$) content was noticed in control treatment. This might be because of higher concentration of calcium chloride delayed the rapid oxidation of ascorbic acid. The results are in line with the report of Tsomu *et al.* (2015) [8] in sapota cv. Kalipatti

**Table 5:** Effect of post harvest treatments of different chemicals and plant growth regulators on ascorbic acid (mg100g-1) of sapota fruits cv. Kalipatti

| Treatments | Days of storage | | | | |
|---|---|---|---|---|---|
| | 0 | 3 | 6 | 9 | 12 |
| Control (Distilled water) | 18.40 | 15.08 | 12.68 | 9.02 | 6.98 |
| Calcium nitrate 2 per cent | 19.40 | 17.49 | 13.78 | 10.04 | 7.47 |
| Calcium nitrate 4 per cent | 19.73 | 17.74 | 13.92 | 10.73 | 8.31 |
| Calcium chloride 5000 ppm | 22.38 | 20.11 | 16.06 | 13.39 | 9.81 |
| Calcium chloride 10000 ppm | 23.17 | 20.91 | 17.13 | 14.48 | 10.08 |
| Gibberellic acid 200 ppm | 21.62 | 18.98 | 15.33 | 12.70 | 9.08 |
| Gibberellic acid 400 ppm | 22.64 | 19.27 | 15.90 | 13.25 | 9.39 |
| Benzyl adenine 75 ppm | 20.82 | 18.32 | 14.30 | 11.77 | 8.68 |
| Benzyl adenine 150 ppm | 21.17 | 18.81 | 14.60 | 12.38 | 8.88 |
| Mean | 21.04 | 18.52 | 14.85 | 11.97 | 8.74 |
| SEm±1 | 0.71 | 0.71 | 0.53 | 0.46 | 0.32 |
| CD (P=0.05) | 2.04 | 2.04 | 1.53 | 1.33 | 0.92 |

## Conclusion

From the present study it is concluded that the post harvest treatment to sapota fruits with $CaCl_2$ 10000 ppm resulted in good maintenance of quality such as TSS, reducing sugars, total sugars, ascorbic acid content up to 12th days of storage as compared to control.

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