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Studies on post harvest application of different chemicals on Plw, shelf life, ripening percent and spoilage percent 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 $CaCl_2$ 4% and $CaCl_2$ 2%, $CaCl_2$ 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 3^{rd}, 6^{th}, 9^{th} and 12^{th} days of storage period. During storage period, $CaCl_2$ 4% was effective in following characters, i.e. lowest PLW (1.86,2.83,9.94,19.18%) at 3^{rd}, 6^{th}, 9^{th} and 12^{th} days of storage period. Whereas maximum shelf life of sapota fruits was recorded in fruits treated with $CaCl_2$ 4% followed by $CaCl_2$ 4% i.e. 8 days. Among different treatments, $CaCl_2$ 4% (16.00) followed by $CaCl_2$ 2% (17.50%) at 12^{th} days of storage period were found most effective to extend the ripening of sapota fruits over control. The spoilage per cent of sapota fruits was increased as the storage period advanced irrespective of any treatment. $CaCl_2$ 4% (34.31%) treated fruits showed significantly lesser extend of spoilage.

Keywords: Sapota, GA3, Shelf life, $CaCl_2$, PLW, GA3, PLW, Ripening and Spoilage Percent

Introduction
Sapota also known as 'chiku' in India, is an evergreen fruit tree. It is a tropical American native, most likely hailing from southern Mexico or Central America (Jadhav, 2018).
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 100g. 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).
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.
One of the most important factors influencing the production and shelf life of sapota is calcium. It significantly improves firmness by thickening the middle lamella of fruit cells as a result of increased calcium pectate formation and deposition. Calcium has gotten a lot of press recently because of its beneficial effects on slowing ripening and senescence, increasing firmness, vitamin C and phenolic content, decreasing respiration, extending storage life and lowering the frequency of physiological disorders and storage rots. (Sharma *et al.*, 1996)
Fruit development necessitates the use of growth regulators. These regulators may be used as post-harvest treatments for fruits to enhance their physical and biochemical properties and thus improve their shelf life.

Gibberellic acid is best known for its anti-senescing effects, which allow fruits to ripen later. As a result, sapota fruits must be subjected to chemical and growth regulator treatments in order to determine their response on biochemical characteristics during storage at room temperature.

The shelf life of the sapota fruit degrades as soon as the fruits reach their climacteric height. Sapota in India has experienced heavy post-harvest losses of 20-30% (Salunkhe and Desai, 1984). According to Khurana and Kanawjia (2006), about 30-35 percent of sapota fruits perish as post-harvest losses during processing, storage, grading, transportation, packaging and distribution, resulting in a major loss in India.

As a result, an attempt has been made to conduct an experiment on "Studies on post harvest application of different chemicals on shelf life of sapota cv. "Kalipatti" with the aim of delaying ripening, plugging post harvest losses and improving the quality of sapota fruits cv. "Kalipatti" was carried out at laboratory, Department of Horticulture, VNMKV, Parbhani during the year 2020-21.

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 3^{rd}, 6^{th}, 9^{th} and 12^{th} days of storage period.

Treatment Details: 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, twokilogram 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 3 th, 6 th, 9^{th} and 12 th days of storage period.

Observation recorded

During the storage studies following observations were recorded.

Methodology adopted in recording observations

Physiological loss in weight (PLW)

Respiration and transpiration are the primary causes of physiological weight loss in fruit. Every fruit was labelled in order to research physiological weight loss. At a two-day period, the weight loss continued and the percent loss of weight was measured using a formula.

$$\text{PLW (\%)} = \frac{\text{Initial weight (g)} - \text{Final weight (g)}}{\text{Initial weight (g)}} \times 100$$

$$\text{Per cent of ripe fruits} = \frac{\text{Number of ripe fruits}}{\text{Total number of fruits}} \times 100$$

Spoilage (%)

At every alternate day of storage, the amount of clearly diseased and shrivelled fruits was counted and expressed as a percentage of the total number of fruits.

Results and discussion

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 physical parameters

Observation recorded on Physiological loss in weight (PLW), Shelf life (days), Ripening (%), Spoilage (%) during storage period are described here.

Effect on physiological loss in weight (PLW%)

Data pertaining to the influence of different chemical on PLW of sapota fruits as recorded at 3rd, 6th, 9th, 12th day interval are presented in Table 4.1 and also graphically depicted in Fig 4.1.

The data revealed that during storage period different post harvest treatment exerted their significant effects on PLW of fruits. On 3rd day of storage, significantly lowest (1.86) PLW was recorded with CaCl2 4% which was superior as compared to rest of treatments. On 6th day of storage, significantly lowest (2.83) PLW was recorded with CaCl2 4% which was superior as compared to among rest of treatments. On 9th day of storage, significantly lowest (9.94) PLW was recorded with Cacl2 4% which was superior among rest of treatments. On 12th day of storage, significantly lowest (19.18) PLW was recorded with $CaCl_2$ 4% which was superior as compared to rest of treatments.

The data revealed that different post harvest treatment exerted their significant effects on PLW during 3rd, 6th, 9th, 12th day of storage period. At 3rd, 6th, 9th, 12th day of storage period, Cacl2 4% recorded significantly lower PLW i.e. (1.86, 2.83, 9.94 and 19.18%) as compared to rest of treatments and highest PLW with control i.e. (5.18, 13.39, 21.20, 39.01%). In present investigation, the percent loss in weight of sapota fruits was increased as the storage period advanced irrespective of any treatment. This attributed to the general loss of water and partial desiccation of the fruits during storage Gautam and Chundawat (1990) [4]. Among all the treatments, CaCl2 4% could reduced the maximum PLW during the storage period.

The reduction in weight loss could be related to calcium maintaining the firmness of fruits by lowering the enzyme activity responsible for cellular disintegration, which reduced gaseous exchange. The PLW was significantly diminished by post harvest CaCl2 treatments. The present investigation is in conformity with the results reported by Bandhyopadhyay and Sen (1994) [1] in sapota fruits.

Table 4.1: Physiological loss in weight due to the effect of different levels of post-harvest treatments of chemicals on sapota fruits cv. Kalipatti

Sr. No.	Treatments	Physiological loss in weight (%)				
		No. of days (Storage period)				
		0 day	3rd day	6th day	9th day	12th day
1	Calcium chloride 1%	0	2.22	4.58	10.59	21.10
2	Calcium chloride 2%	0	2.04	3.71	10.30	20.10
3	Calcium chloride 4%	0	1.86	2.83	9.94	19.18
4	Gibberellic acid 100 ppm	0	4.23	7.09	11.71	30.10
5	Gibberellic acid 150 ppm	0	3.67	7.05	11.70	28.58
6	Gibberellic acid 200 ppm	0	3.11	7.01	11.70	27.40
7	Benzyl adenine 50 ppm	0	3.81	8.25	14.71	31.28
8	Benzyl adenine 75 ppm	0	3.54	7.76	14.20	30.01
9	Benzyl adenine 150 ppm	0	3.27	7.27	13.33	28.68
10	Control	0	5.18	13.39	21.20	39.01
S.Em.±		0	0.00	0.01	0.10	0.09
C.D. (0.05%)		0	0.01	0.04	0.30	0.27
C.V.%		0	0.30	0.40	1.38	0.57

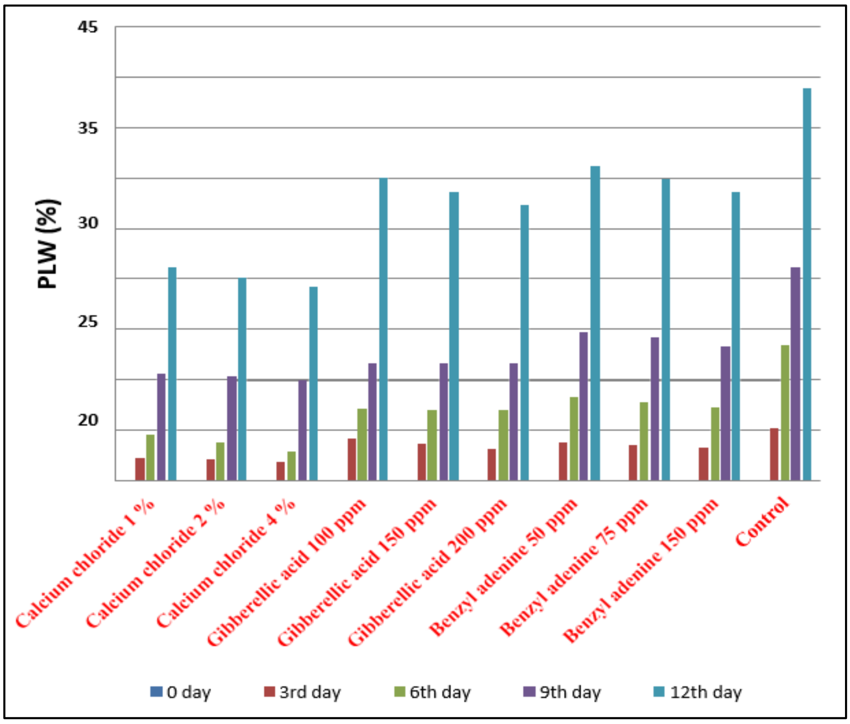

Fig. 4.1: Physiological loss in weight due to the effect of different levels of post harvest treatments of chemicals on sapota fruits cv. Kalipatti.

Effect on shelf life (days)

Data pertaining to the influence of different chemical on shelf life of sapota fruits as recorded at 3rd, 6th, 9th, 12th day interval are presented in Table 4.2 and also graphically depicted in Fig 4.2

The highest shelf life of sapota fruits (8 days) was recorded with $CaCl_2$ 4% and lowest shelf life of sapota fruits (5 days) was recorded with control as compared to rest of treatments.

The shelf life of fruits was significantly prolonged due to calcium chloride treatments over control. Among different treatments treatment $CaCl_2$ 4% followed by $CaCl_2$ 2% were found most effective to extend the shelf life of sapota fruits over control. The sapota fruits under treatments of calcium chloride were found to have better quality with extend shelf life.

Calcium helps in structural intergrity of both cell wall and plasma membrane thus delaying and extending storage life Ladaniya *et al.* (2008). Calcium chloride were treated on fruits like sapota (Vijayalaxmi *et al.*, 2004) [14], mango (Karemera *et al.*, 2014) [7] and concluded that calcium chloride were more effective extending shelf life.

Table 4.2: Effect of different levels of post harvest treatments of chemicals on shelf life (days) of sapota fruits cv. Kalipatti

Sr. No.	Treatments	Shelf life (days)
1	Calcium chloride 1%	8.0
2	Calcium chloride 2%	8.0
3	Calcium chloride 4%	8.0
4	Gibberellic acid 100 ppm	7.0
5	Gibberellic acid 150 ppm	7.0
6	Gibberellic acid 200 ppm	7.0
7	Benzyl adenine 50 ppm	6.0
8	Benzyl adenine 75 ppm	6.0
9	Benzyl adenine 150 ppm	6.0
10	Control	5.0
S.Em.±		0.58
C.D. (0.05%)		1.72
C.V.%		14.71

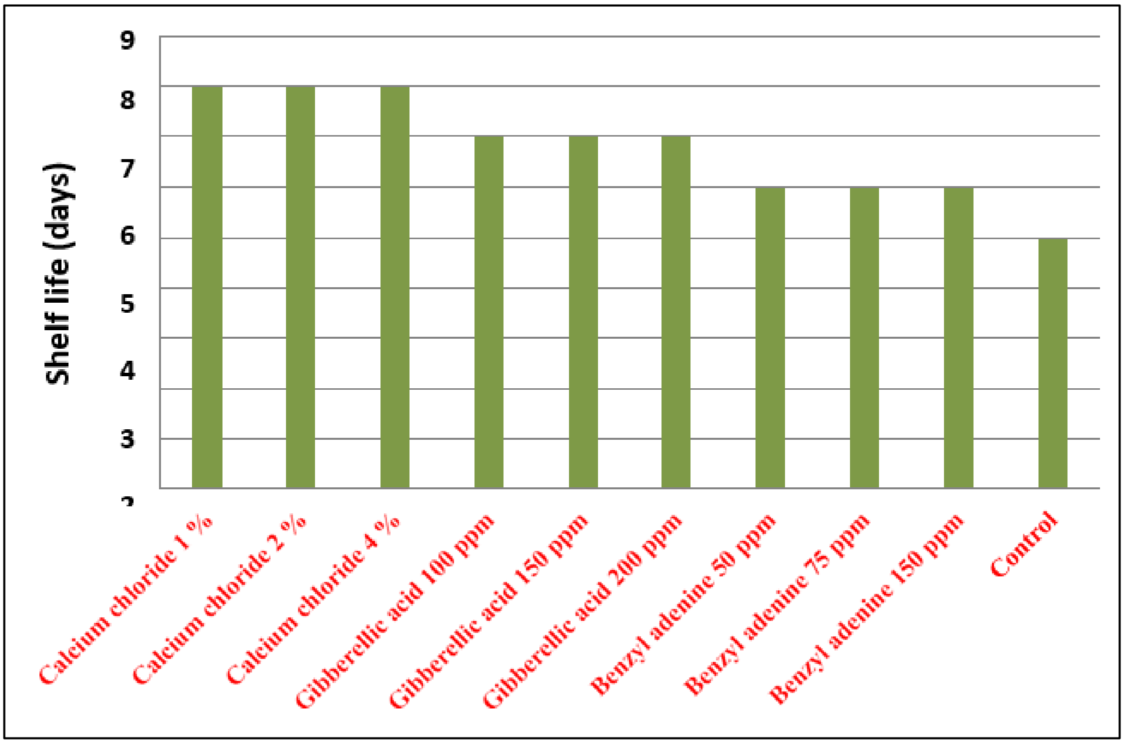

Fig. 4.2: Effect of different levels of post harvest treatments of chemicals on shelf life (days) of sapota fruits cv. Kalipatti**.**

Effect on spoilage (%)

Data pertaining to the influence of different chemical on spoilage of sapota fruits as recorded at 3rd, 6th, 9th, 12th day interval are presented in Table 4.3 and also graphically depicted in Fig 4.3.

At 0, 3 rd, 6 th there was no spoilage. On 9 th day of storage, significantly lower spoilage (0.34%) recorded with CaCl2 4% which was superior as compared to rest of treatments. On 12th day of storage, significantly lower spoilage (34.31%) recorded with CaCl2 4% which was superior as compared to rest of treatments. The highest spoilage was recorded with control i.e. (50.34 and 100.00%) at 9th and 12th days of storage period.

The spoilage percent of sapota fruits was increased as the storage period advanced irrespective of any treatment. Calcium treated fruits showed significantly lesser extend of rotting which may be due to the higher fruit flesh and skin calcium content which resulted in stronger intracellular organization and rigidified cell wall. Similar finding were reported by Sahay *et al.* (2015) [11] in banana.

Application of GA3 also helped to delay the ripening process and thus reduced spoilage. This might be due to GA3 treated fruits having thick skin which prevent the entry of microbes and maintained low rate of various metabolic processes which in trun increased the resistance to microbial activity. The present investigation is in conformity which results reported by Chattopadhyay *et al.* (1992) [3] in sweet orange and Jain *et al*. (2020) [6] in sapota.

Table 4.3: Effect of different levels of post-harvest treatments of chemicals on spoilage (%) of sapota fruits cv. Kalipatti

Sr. No.	Treatments	Spoilage (%)				
		No. of days (Storage period)				
		0 day	3rd day	6th day	9th day	12th day
1	Calcium chloride 1%	0	0	0	10.34	39.00
2	Calcium chloride 2%	0	0	0	5.34	36.66
3	Calcium chloride 4%	0	0	0	4.32	34.31
4	Gibberellic acid 100 ppm	0	0	0	12.02	65.32
5	Gibberellic acid 150 ppm	0	0	0	10.68	62.66
6	Gibberellic acid 200 ppm	0	0	0	9.34	53.00
7	Benzyl adenine 50 ppm	0	0	0	22.33	72.98
8	Benzyl adenine 75 ppm	0	0	0	21.34	70.66
9	Benzyl adenine 150 ppm	0	0	0	22.33	68.34
10	Control	0	0	0	50.34	100.00
S.Em. ±		0	0	0	0.00	0.25
C.D. (0.05%)		0	0	0	0.01	0.76
C.V.%		0	0	0	0.05	0.74

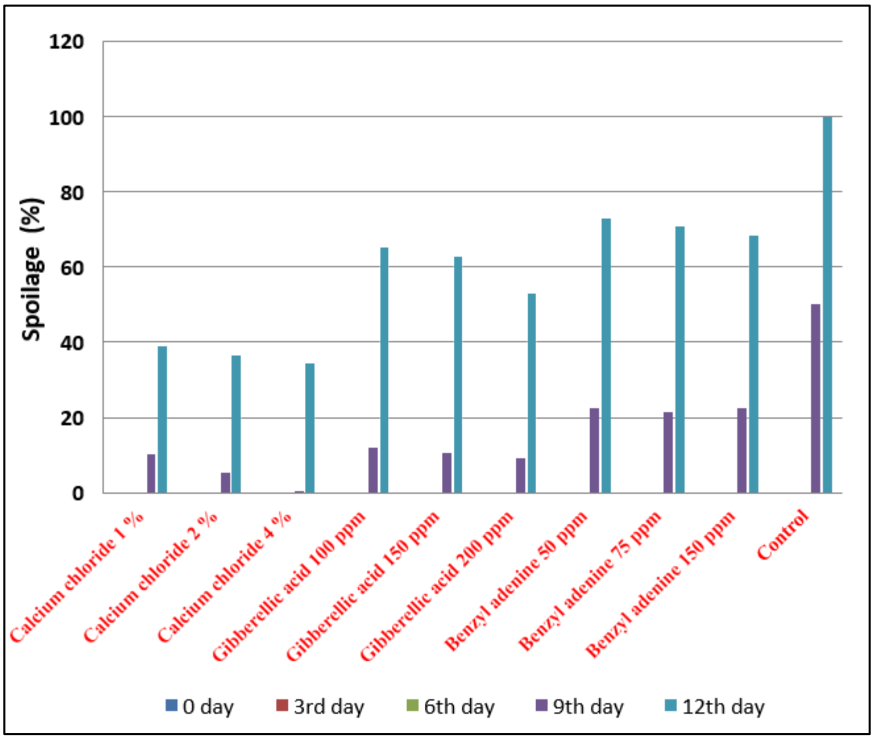

Fig 4.3: Effect of different levels of post-harvest treatments of chemicals on spoilage (%) of sapota fruits cv. Kalipatti.

Effect on ripening (%)

Data pertaining to the influence of different chemical on ripening of sapota fruits as recorded at 3rd, 6th, 9th, 12th day interval are presented in Table 4.4 and also graphically depicted in fig 4.4.

At 3rd day $CaCl_2$ 4% was lowest (0.00) ripening of fruits. At 6th day of storage, significantly lower ripening (8.32%) recorded with $CaCl_2$ 4% which was at par with $CaCl_2$ 2% (9.32) as compared to rest of treatments. On 9th day of storage, significantly lower ripening (11.00%) recorded with $CaCl_2$ 4% which was superior as compared to rest of treatments.

On 12th day of storage, significantly lower ripening (13.99%) recorded with BA 150 ppm which was superior as compared to rest of treatments. The highest ripening recorded with control i.e. (46.60 and 95.29%) at 3rd and 6th days of storage period.

The ripening percent of sapota fruits was increased as the storage period advanced irrespective of any treatment. Calcium treated fruits showed delay in ripening of the fruits which was due to fact that it slowed down the process of ripening by retarding the pre - climatic respiration rate and ethylene production.

These changes lead to reduced degradative metabolism in terms of catalase and PME activities and thus are helpful in extending shelf life of the fruits. The present investigation is in conformity with the results reported by Bharathi (2002) [2] and Nikam *et al*. (2010) [10] in sapota fruits.

Table 4.4: Effect of different levels of post-harvest treatments of chemicals on ripening (%) of sapota fruits cv. Kalipatti

Sr. No.	Treatments	Ripening (%)				
		No. of days (Storage period)				
		0 day	3rd day	6th day	9th day	12th day
1	Calcium chloride 1%	0	0.00	10.29	12.20	18.29
2	Calcium chloride 2%	0	0.00	9.32	11.29	17.50
3	Calcium chloride 4%	0	0.00	8.32	11.00	16.00
4	Gibberellic acid 100 ppm	0	35.50	71.61	83.52	85.61
5	Gibberellic acid 150 ppm	0	30.42	58.87	77.31	81.31
6	Gibberellic acid 200 ppm	0	25.10	45.10	71.11	77.19
7	Benzyl adenine 50 ppm	0	22.50	43.60	45.11	71.11
8	Benzyl adenine 75 ppm	0	14.11	21.09	33.08	57.21
9	Benzyl adenine 150 ppm	0	6.42	10.31	12.49	13.99
10	Control	0	46.60	95.29	0.00	0.00
S.Em. ±		0	0.04	0.09	0.18	0.27
C.D. (0.05%)		0	0.11	0.27	0.56	0.81
C.V.%		0	0.38	0.42	0.91	1.07

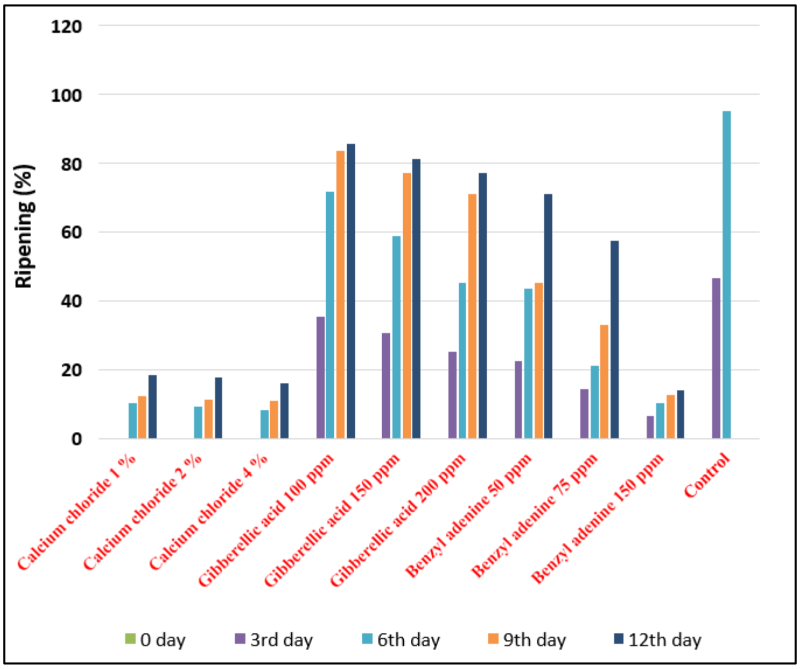

Fig 4.4: Effect of different levels of post-harvest treatments of chemicals on ripening (%) of sapota fruits cv. Kalipatti

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