International Journal Of Advance Research, Ideas And Innovations In Technology

ISSN: 2454-132X
Impact factor: 4.295
(Volume 4, Issue 5)
Available online at: www.ijariit.com

Postharvest application of calcium salts on fruit quality of guava during storage

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ABSTRACT

Guava is one of the most popular fruits grown in the tropical, sub-tropical and some parts of arid regions of India. Retailing of guava fruit in India is usually carried out without refrigeration. Therefore preservation of fruit at room temperature is highly desirable to reduce post-harvest loss and improve its commercialization. The post-harvest loss of guava in India is about 25-30%. Post-harvest dipping is one of the emerging technologies to increase the shelf life of fruits by retaining the fruit quality and control of the spoilage. The present investigation was carried out with this main objective to compare the efficacy of calcium chloride and calcium nitrate for shelf-life enhancement and fruit quality of guava. Fruits were treated with 1% of calcium chloride and calcium nitrate, 2% of calcium chloride and calcium nitrate and no treatment for control samples of guava. The physiological loss of weight, chemical parameters like TSS, ascorbic acid, and reducing and total sugar content were observed and compared with untreated guava fruits. In the current study, it was observed that the reduction in PLW and retention of ascorbic acid was more in 2% $ca(No_3)_2$ treated samples than the other samples. However, TSS, reducing sugars and total sugars were retained more in 1% $cacl_2$ treated samples than the other treated samples when compared with control samples of guava. The application of 2% $ca(No_3)_2$ and 1%$cacl_2$ recorded a potential shelf life of guavas during storage.

Keywords— *Guava, Post-harvest, Calcium Chloride ($cacl_2$), Calcium Nitrate ($ca(No_3)_2$), Storage*

1. INTRODUCTION

Guava (*Psidium guajava L.*) is also known as the apple of the tropics. It is one of the most popular fruits grown in the tropical, sub-tropical and some parts of arid regions of India. Guava is one of the common and important fruit crops in India and leading producer of guava with approximately 40% of guava production in the world. Guava is the fourth most important fruit in India which occupies approximately 6.5% of the area under fruit cultivation. Guava is also known as the apple of the tropics. It is one of the most popular fruits grown in the tropical, sub-tropical and some parts of arid regions of India. Guavas are rich in dietary fiber and vitamin C, with moderate levels of folic acid. Having low-calorie profile of essential nutrients, a single common guava fruit contains about four times the amount of vitamin C as an orange. However, nutrient content varies across guava cultivars.

Guava being a climacteric fruit ripens rapidly and is highly perishable; a shelf-life period ranges from 3-4 days at room temperatures. So, it makes transportation and storage difficult (Bassetto *et al.*, 2005). During storage fruit ripening is characterized by green color loss, rot development, fruit softening, wilting, loss of brightness and undesirable biochemical changes (Jacomino *et al.*, 2001). Retailing of guava fruit in India is usually carried out without refrigeration and therefore, the preservation of fruit at room temperature is highly desirable to reduce post-harvest loss and improve its commercialization. The post-harvest loss of guava in India is about 25-30% i.e. 4.5 lakh tonnes, worth rupees180 crores (Patel *et al.*, 2014). The post-harvest losses can be minimized by checking the rate of transpiration and respiration, microbial infection and protecting membranes from disorganization (Bisen and Pandey, 2008). The post-harvest losses not only reduce the availability of fruits but also result in an increase in per unit cost of transport and marketing, it affects both producer’s income and consumer welfare.

Traditionally, fruit coatings have been applied to improve appearance and reduce moisture loss in storage. All films also offer some resistance to gas exchange, depending on their composition and thickness. Guava fruit is highly susceptible to chilling injury and mechanical damage. Removing of field heat and store at room temperature reduces the decay of fruits. Proper covering, postharvest treatment with a chemical, hot water, and long-term refrigeration was applied for improving the fruit resistance to chilling injury and diseases. Postharvest applications with calcium chloride during ripening stage have been used to delay aging or ripening, efficiently reducing postharvest decay and controlling many diseases in fruits and vegetables (El-Gamal et al., 2007).

Calcium salts are exhibited a distinct role in sustaining cell wall integrity in fruits by interrelating with the pectic acid of the cell wall to form calcium pectate which facilitates cross-linkage of pectic compounds of the cell wall. $CaCl_2$ is being used as a firming agent and preservative in the fruit industry for fresh-cut and whole produces. $CaCl_2$ pre-treatments exhibited increased shelf life and firmness of fruits (Akhtar et al., 2010).

Post-harvest dipping treatment increases the shelf life of fruits by retaining their firmness and control of the decaying organism (Ahmed *et al.,* 2009). These chemicals control the transpiration, respiration, ripening of fruits by regulating the biochemical changes in fruits, this will delay in internal ethylene synthesis in fruits and extend the period of availability of fruits in the market. This will further reduce the wastage of fruits and minimize postharvest loss. The post-harvest treatment of guava fruits with suitable chemicals like calcium chloride and calcium nitrate has a positive impact to enhance shelf-life without a drastic loss in nutrients. Hence, the present investigation was carried out to assess the effect of the postharvest application of calcium chloride and calcium nitrate on physicochemical changes during storage guava.

2. METHODOLOGY

The Freshly harvested mature, green, unripe, sound, uniform size guavas free from diseases or damages were purchased to the current study. The guavas were cleaned and air dried for experimentation. Guavas were dipped in different chemicals with different concentrations like 1% $cacl_2$, 2% $cacl_2$, 1% $ca(No_3)_2$, 2% $ca(No_3)_2$ and control samples for 30 minutes. After dipping the fruits were exposed in air for few minutes for drying at ambient temperature. Observations were recorded at 2, 4, 6, 8, 10 and 12 days of storage and effectiveness were compared in all the five samples of guava.

The impact of postharvest treatment of guava fruits with different concentrations of 1% $cacl_2$, 2% $cacl_2$, 1% $ca(No_3)_2$, 2% $ca(No_3)_2$ and control samples on physical parameters like a physiological loss in weight (PLW) has been observed. The chemical analysis includes Total Soluble solids (TSS), ascorbic acid, reducing sugars and total sugars were analyzed in guava fruits during shelf life period.

3. PHYSICAL PARAMETERS OF FRUITS

3.1 The physiological loss in weight (PLW %)

For determining the physiological loss in weight, guavas were weighed individually. It was expressed as a percentage of the original fresh weights of the fruit.

$$PLW\ (\%) = \frac{Initial\ fruit\ weight - final\ weight\ of\ the\ fruit}{Initial\ fruit\ weight} \times 100$$

3.2 Colour

The color of guava gradually changes from green to light green and then from yellowish green to light yellow. The color changes were observed using scorecard by sensory evaluation.

3.3 Fruit firmness

Firmness was detected by touch. The observation of the firmness of the fruit was recorded periodically using the scorecard by sensory evaluation.

3.4 Chemical Analysis

- **Total soluble solids (^{0}Brix) -** TSS value of the fruit was determined by 'Erma' hand refractometer.
- **Ascorbic acid (mg/100g) - A**scorbic acid was estimated by the method described by Ranganna (1986).
- **Reducing and Total Sugars** -Reducing and total sugars were estimated by using the Lane and Eynon method.

3.5 Shelf life

The physical characteristics such as color, firmness, ripening, and spoilage were considered to assess the shelf life of the fruits. Scores were given to each characteristic of the fruit and shelf life was calculated for all the chemical treatments and control.

4. RESULTS AND DISCUSSION

Coatings and waxes are applied to fruits and vegetables as part of the postharvest treatment of fresh fruits and vegetables as a method of preservation. It does not affect the fruit quality during the storage period, this helps to reduce the post-harvest losses by increasing the shelf life of fruits. Coating guavas do not affect all aspects of ripeness at the same rate. These coatings also make cold-stored guavas prone to a blackening of the peel after their removal to a ripening temperature. Cold-stored guavas may not be amenable to the modified atmospheres induced within fruit by these particular coatings. Oxygen may become too severely limited and CO_2 concentrations too high within fruit at a time when they not only must undergo metabolic changes induced by the onset of ripening but also adapt to cold temperatures. Coating cold-stored guavas with any film may not be advisable if the quality is to be maintained. In the present study, $cacl_2$, $ca(No_3)_2$ was applied in the preservation of guavas and the results obtained are presented.

4.1 The physiological loss in weight % (PLW)

The results of the study reveal that the decrease in PLW was noticed in all the samples of guavas during storage. In experimental samples, the PLW loss % was less when compared to the control samples of guavas during storage. The table 1 shows the values of PLW in guava fruits treated with 1% $cacl_2$, 2% $cacl_2$, 1% $ca(No_3)_2$, 2% $ca(No_3)_2$ and control samples from 2nd day to 12th-day storage.

Table 1: Effect of Postharvest application of calcium salts on PLW in Guava

Treatment	2nd Day	4th Day	6th Day	8th Day	10th Day	12th Day
1% $cacl_2$	93.19	89.28	85.97	81.91	80.29	76.42
2% $cacl_2$	108.58	104.5	101.42	98.57	96.04	91.90
1% $ca(No_3)_2$	98.77	94.20	93.23	91.30	88.72	86.50
2% $ca(No_3)_2$	89.54	89.35	84.36	82.47	80.76	78.69
Control	89.35	84.16	79.98	79.98	74.11	71.68

The current research results are in support with many findings calcium application has been reported to be effective in terms of membrane functionality and integrity maintenance with lower losses of phospholipids and proteins with reduced ion leakage (Lester and Grusak, 1999), which perhaps might be responsible for the lower weight loss in calcium-treated fruits in the present study.

Martinez et al. (2009), stated that the loss of fresh mass during fruit development is a normal response to increased transpiration and respiration, so it is important to minimize these losses (Rawat et al., 2010). Loss of water from the surface of fruits, cell wall degradation, rapid respiration, and ethylene concentration results in weight loss of fruits (Zhu et. al., 2008). Storage of guava fruits period increased with the increase of Cumulative Physiological Loss in Weight (CPL). It might be due to an increase in ethylene, respiration, and loss of moisture from the surface of fruits cause a significant loss in fruit weight of guava.

4.2 Total Soluble Solids (TSS %)

The data pertaining to the TSS of guava fruit was shown in fig.1. The data shows that the TSS increased significantly from 2nd to 8th day of storage with different treatments of $cacl_2$, $ca(No_3)_2$ of guavas when compared to control samples. The decrease of TSS% was observed among 10th and 12th day in all the samples of guava during storage.

Calcium treatments (nitrate and chloride) did not considerably affect the TSS content of guava fruit, rather had some preserving effect on TSS due to retardation of ripening. However, the TSS was higher for a period of 20 days with calcium nitrate treatments (1% and 2%) suggesting the use of either of the concentrations to record more TSS than in control fruits during low-temperature storage and the results are in correlated with the findings of Goutam et. al., (2010) in guava and Mahajan et.al., (2008) in Plum.

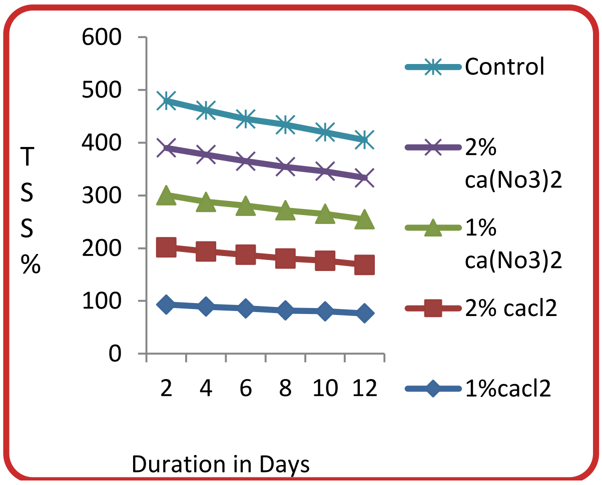

Fig. 1: Effect of Postharvest application of calcium salts on TSS in Guava

TSS during ripening was affected mainly in the conversion of starch into simple sugars such as glucose, fructose, and sucrose that causing in the flavor (Chitarra, 2005).

4.3 Ascorbic acid (mg)

The ascorbic acid content was gradually decreased in all the treated samples including a control sample (Table 2). The ascorbic acid content was less in control sample than the treated samples from initial to 12 days storage. Among treated samples 2% $ca(No_3)_2$ guavas retain more ascorbic acid content followed by 1% $ca(No_3)_2$, 2%$cacl_2$ and1% $cacl_2$. The guavas treated with 1&2% $ca(No_3)_2$ retain more ascorbic content in guavas when compared to other samples.

Table 2: Effect of Postharvest application of calcium salts in Ascorbic Acid content of Guava

Treatment	2nd Day	4th Day	6th Day	8th Day	10th Day	12th Day
1% $cacl_2$	226.40	186.18	165.54	144.46	107.46	85.45
2% $cacl_2$	226.07	194.40	169.26	149.23	112.23	90.67
1% $ca(No_3)_2$	249.70	219.20	191.10	160.35	114.92	100.02
2% $ca(No_3)_2$	261.90	223.64	181.15	165.75	122.21	104.14
Control	196.58	165.90	139.90	132.40	101.40	75.92

The decrease in ascorbic acid during storage of guava fruits is associated with the activity of ascorbic acid oxidase which catalyzes the oxidation of ascorbic acid into 2-dehydroascorbic acid as proposed by Ohkawa (1989). It was found that guava fruits treated with calcium nitrate and calcium chloride were significantly better in the retention of ascorbic acid compared to control, might be attributed to the slow rate of oxidation in the respiration process. The results are in similarity with the findings of Jain and Mukherjee (2011) in mango and Goutam et. al., (2010) in guava.

4.4 Reducing sugars and total sugars

Reducing sugars and Total Sugars in the samples of guava fruit was shown in fig.2&3. The data shows that the reducing sugars and total sugars increased significantly from 2nd to 8th day of storage with different treatments of $cacl_2$ and $ca(No_3)_2$ of guavas when compared to control samples. Whereas the decrease of reducing sugars and total sugars was noticed in 10th and 12th-day storage when compared to 8 days of storage in all the samples of guava. 1%$cacl_2$ treated guavas contain a high amount of reducing sugars and total sugars than the other treated samples when compared to the control sample. As the storage period extended the total soluble solids content also increased, the rate of increase was faster in control samples.

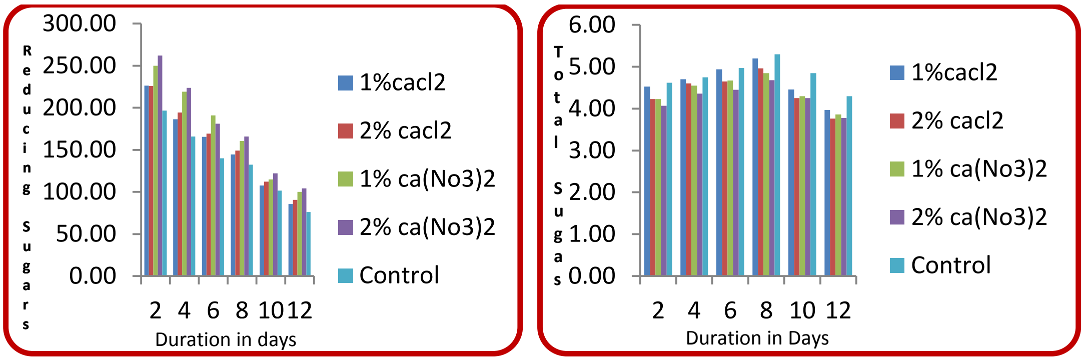

Fig. 2, 3: Effect of postharvest application of calcium salts on reducing and total sugars of guava

In all treatments reducing and total sugar has shown a rise up to 8 days of storage which might be due to the breakdown of polysaccharides into monosaccharides and disaccharides but at 12 days of storage the sugar content was significantly reduced due to respiratory break down of monosaccharides as confirmed by Jayachandran et .al., (2005). The reason for the hike of reducing sugars may be due to the fact that certain cell wall materials such as pectin and hemicelluloses can be converted into reducing sugars during storage leading to enhancement of reducing sugars.

The fruit is a rich source of Vitamin C and pectin. It is also a good source of calcium, phosphorous, pantothenic acid, riboflavin, thiamine, niacin and vitamin A (Paul and Goo, 1983). The application of chemicals control the transpiration, respiration, ripening of fruits by regulating the biochemical changes in fruits, this will delay in internal ethylene synthesis in fruits and extend the period of availability of fruits in the market. This will further reduce the wastage of fruits and minimize postharvest loss. The post-harvest losses not only reduce the availability of fruits but also result in an increase in per unit cost of transport and marketing (Stephan et. al., 2016).

5. CONCLUSION

The stage of maturity or ripeness at harvest and postharvest treatments with calcium salts had a significant effect on fruit quality and shelf life of guava fruits during storage. The fruit maturity is strongly influenced the ripening behavior of guava fruits as evidenced by changes in PLW, ascorbic acid, and sugar content. It is concluded that freshly harvested guava fruits treated with 2% $ca(No_3)_2$ and 1%$cacl_2$ retain maximum shelf life with less nutrient loss, these treatments are suitable to extend the shelf life of guavas. These chemicals control the transpiration, respiration, ripening of fruits by regulating the biochemical changes in fruits; and extend the period of availability of fruits in the market.

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