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Influence of Maturity Stage on Post-harvest Quality of Guava Cultivars

Archit Singh [a*], B. K. Singh [a], Kalyan Barman [a] and Anand Kumar Singh [a]

[a] Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi-221005 (U.P.), India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The guava (*Psidium guajava* L.), a member of the Myrtaceae family and a native of tropical America, was brought to India by the Portuguese in the 17th century. The primary focus lies in comprehending the physiological and biochemical alterations within the fruit, which play a crucial role in understanding metabolic phenomena such as fruit ripening, softening, and overall aging. Additionally, these changes hold significance for shaping commercial procedures and meeting post-harvest demands. It is imperative for the post-harvest management system to strive to deliver the fruit to the market in the desired condition sought by consumers or importers. Guavas are highly perishable fruits, with fresh supplies to markets often lasting only a few days. In the Postharvest Laboratory of the Department of Horticulture, Banaras Hindu University, Varanasi, an experiment was carried out to investigate the influence of maturity stage on the post-harvest quality of guava cultivars under ambient conditions at 3-day intervals of storage. The guava cultivars, namely Lalit, Allahabad Safeda, and Shweta, were chosen at distinct stages of maturity, encompassing mature green, color break and ripe. The findings showed that the ripeness or stage of maturity at harvest had a substantial impact on the quality and storage life of guava fruits. In comparison to the colour-turning stage and the ripe stage of fruits, the mature green stage

**Corresponding author: E-mail: architsingh113@gmail.com;*

demonstrated promising results in maintaining post-harvest quality. Considering all the parameters, the best guava cultivars in terms of superior post-harvest quality, including total soluble solids, lycopene content, ascorbic acid content, and minimal acidity content, were found to be the Lalit cultivar.

Keywords: Cultivars; guava; maturity; post-harvest quality; storage.

1. INTRODUCTION

Guava (*Psidium guajava Linn*.), one of the most significant and varied commercial fruit crops grown in tropical and sub-tropical regions of the world and grown throughout the nation, is produced with relatively low inputs in comparison to other fruits. It is a great source of many minerals, including vitamin C. Its fragile nature, short post-harvest life, and susceptibility to chilling injury restrict its economic viability. After being harvested at room temperature, the highly perishable guava fruit swiftly ripens in a few days. Due to its delicate nature, guava cannot be preserved for a longer period Bashir et al. [1]. During the peak season for harvesting, the excess fruit goes to waste since it is not sold. Guava fruit preservation and post-harvest shelf life extension are necessary for India to use this significant fruit commodity economically and effectively. The ripeness of the fruit at harvest is the most important factor in determining shelf life and final fruit quality. Unripe fruits are more susceptible to shriveling and mechanical damage, whereas ripe fruits are of lower quality and flavour. Overripe guava fruits are prone to tasting bland and becoming limp and mealy soon after harvest. Fruit collected at the proper stages of ripeness is less likely to develop post-harvest physiological abnormalities than fruit picked too early or too late in the season. The maturity stage actually helps in the selection of storage techniques, the assessment of shelf life, the choice of processing procedures for value addition, etc. Guavas have a sweet, musky flavor, and the ripe fruit is quite fragrant. Guavas have a comparatively high dietary antioxidant value when compared to other plant foods because they are rich in the antioxidant pigments carotenoids and polyphenols. The process of ripening, which affects a fruit's color, flavor, and texture and makes it best suitable for consumption, is one of the most crucial ones. Several physiological, biochemical, and structural changes take place during fruit ripening, including the breakdown of starch or other storage polysaccharides, the formation of sugars, the synthesis of colors and volatile chemicals, and the partial solubilization of the cell wall [2]. Such obvious changes often take place in a coordinated manner. Understanding these ripening-related changes is crucial to preventing post-harvest losses and advancing methods for extending fruit's shelf life. These changes occur quickly in climacteric fruits, and the guava (*Psidium guajava* L.), which is climacteric, shows a typical increase in respiration and ethylene production during ripening. It is difficult to carry and store since it has a relatively limited shelf life and is easily softened. The best maturity indicator for guavas is skin color, since it can be checked non-destructively throughout ripening and storage. Fruits that are about to ripen show evidence of changing color from pale green to yellowish green. Fruit that will be delivered to far-off markets needs to be full-sized and firm in texture, but it shouldn't have a noticeable color break on the surface. Fruits for the neighborhood market might be collected when they are more advanced in their maturation [3]. However, maintaining the post-harvest quality of guava fruits depends on picking them at the right stage of ripeness. This article examines guava fruit maturity, post-harvest quality, and ripening broadly.

2. MATERIALS AND METHODS

The study was conducted in the post-harvest laboratory, Department of Horticulture, Banaras Hindu University, Varanasi. Its aim was to investigate how the maturity stage of guava cultivars affects their post-harvest quality under normal environmental conditions. In this study, we carefully selected uniform, medium-sized, and entirely green guava fruits from the Lalit, Allahabad Safeda, and Shweta cultivars, corresponding to their respective stages of maturity: mature green, color break, and ripe. These selected fruits were promptly transported in CFB (corrugated fiberboard) boxes to the postharvest laboratory immediately after harvesting. To ensure the fruits were in optimal condition for analysis, we meticulously removed any dirt or extraneous materials from them. Afterward, the fruits were carefully washed with tap water and allowed to air dry. Following the removal of fruits that displayed signs of disease,

spotting, or bruising, the remaining fruit was categorized into distinct groups. Subsequently, we conducted essential initial assessments of post-harvest quality by analyzing the fruits to record key parameters such as total soluble solids, titratable acidity, ascorbic acid content, lycopene content, and total phenolic content. The research was conducted using a factorial completely randomized design, with each treatment replicated 3 times at 3-day intervals during the storage period under ambient conditions. Analysis of variance (ANOVA) was used to analyze the experiment's outcomes with regard to several parameters that changed during storage, with treatments and the period of storage acting as sources of variation. The significance of the difference between the means was determined by HSD Tukey's test ($p \leq 0.05$) using IBM SPSS Statistics 26.

2.1 Analytical Methods

2.1.1 Total soluble solids

The measurement of guava fruit's total soluble solids (TSS) content throughout the storage period was performed using a digital refractometer (Atago, Tokyo, Japan). The results were quantified and reported as degrees Brix (ºBrix).

2.1.2 Titratable acidity

The determination of titratable acidity was carried out using the titration method as outlined in AOAC [4], guidelines. Initially, a 2.0 g fruit sample was blended with distilled water, and the sample volume was adjusted to 10 ml. Following homogenization, the sample was titrated against a 0.1 N sodium hydroxide solution with the addition of 2 to 3 drops of phenolphthalein solution until a pink color emerged. The titre value was then recorded, and the titratable acidity was calculated employing the subsequent formula. Ultimately, the findings were expressed as a percentage of citric acid.

Titratable acidity (%) = Titre value × Normality of alkali × Vol. made up × Equivalent wt. of citric acid × 100 / The volume of sample taken for estimation × Wt. or vol. of the sample taken × 1000

2.1.3 Ascorbic acid content

To determine the ascorbic acid content in guava fruit, we employed the method outlined by Jones and Hughes [5]. Initially, a 10 g sample of the fruit was crushed using a 3% metaphosphoric acid (HPO_3) solution. Subsequently, the sample volume was adjusted to 100 ml with a 3% metaphosphoric acid solution. From this mixture, a 10 ml sample was extracted and titrated against the 2,6-dichlorophenol indophenol dye until a persistent pink color appeared for 15 seconds. The titre value was then recorded, and the ascorbic acid content in the fruit was calculated using the formula provided. Finally, the results for the ascorbic acid content were expressed as milligrams per 100 grams of fresh weight (mg/100 g FW).

Dye factor = 0.5 / Titre value

Ascorbic acid content (mg/100 g FW) = Titre value × Dye factor × Volume made up x 100 / Aliquot of extract taken for estimation x Weight or volume of sample for estimation

2.1.4 Lycopene content

The lycopene content was assessed through the spectrophotometric method described by Ravelo-Perez et al. [6]. To assess lycopene content, we initiated the process by grinding 1.0 gram of pulp together with 50 ml of a hexane-ethanol-acetone mixture in a ratio of 2:1:1 (v/v). This resulting extract was transferred to a separating funnel, where 10 mL of distilled water was introduced. After allowing the phases to naturally separate for a duration of 5 minutes, the lower phase was discarded. Subsequent to filtration, we measured the absorbance of the upper phase at 503 nm using hexane as a reference, employing a UV-vis spectrophotometer. The outcome was expressed in micrograms per gram (µg/g). The final equation used for this calculation was derived as follows:

Lycopene (µg/g FW) = (A_{503} x 31.2) / mass of sample (g)

Where,

A_{503} is the absorbance at 503 nm and 31.2 is the extinction coefficient.

2.1.5 Total phenolic content

The determination of the total phenolic content in guava fruit followed the method established by Singleton et al. [7]. Initially, a 2.0-gram fruit sample was combined with 10 ml of 80% ethanol solution. Subsequently, the resulting mixture was subjected to centrifugation at 10,000 rpm for 10

minutes, and the supernatant was collected to assess the total phenolic content. In the next step, 100 µl of the sample extract was mixed with 2.9 ml of distilled water and 0.5 ml of 1 N Folin-ciocalteau reagent. After a 3-minute interval, 2 ml of a 20% sodium carbonate solution was introduced. The solution was then left undisturbed for a duration of 90 minutes, following which the absorbance was measured at 760 nm using a spectrophotometer. A standard calibration curve was created using gallic acid. Finally, the total phenolic content of guava fruit was expressed as milligrams of gallic acid equivalent per 100 grams of fresh weight (mg GAE/100 g FW).

Total phenols content (mg GAE/100 g FW) = OD_{760}× Volume made up (with 80% ethanol) × 100 / Aliquot taken × weight of sample × 1000

3. RESULTS AND DISCUSSION

The following headings have been used to present the findings of the current research and pertinent discussions:

3.1 Total Soluble Solids (°Brix)

Total soluble solids of guava fruits were found to increase initially during storage up to the 9th day except in the ripe stage (up to the 6th day), and later on decrease gradually with the increasing period of storage. However, during the initial days and onwards, a significant difference in total soluble solids was observed, but after 9 days of storage, no significant difference was found between various maturity stages in all the cultivars. After 6 days of storage, out of different cultivars, Lalit displayed the maximum total soluble solids (12.49, 12.82 and 13.12°Brix), followed by Shweta (12.03, 12.43 and 13.61°Brix), whereas the minimum total soluble solids were recorded in cultivar Allahabad Safeda (11.88, 12.24, and 12.53°Brix) at mature green, colour break, and ripe stages, respectively. However, after 12 days of storage, the highest value of total soluble solids was recorded in cultivar Lalit (12.56, 12.45 and 12.27°Brix), followed by Shweta (12.31, 12.25 and 13.19°Brix), while the lowest value was observed in Allahabad Safeda (12.23, 12.18 and 12.11°Brix) at mature green, colour break and ripe stages, respectively. However, total soluble solids in guava fruits at mature green, colour break and ripe stages in Lalit, Allahabad Safeda and Shweta, respectively, were statistically at par with each other at 12 days after storage. The total soluble solids content plays an important role in enhancing the quality of fruit and giving a rough idea of sweetness. Total soluble solids (°Brix) were significantly influenced by different parameters and storage periods. Total soluble solids in fruit refer to the organic compounds present in the fruit that are soluble in water. The major sugars found in guava are fructose, glucose, sucrose and inositol, in descending order [8]. The decrease in total soluble solids in the fruit may be caused by high fruit metabolism and senescence processes. Season, soil, and climatic conditions are only a few of the variables that might affect the total soluble solids content Lakade et al. [9]. As the fruit reaches the stage of ripening, an increase in TSS occurs. Polysaccharides or sucrose hydrolysis into reducing sugars (glucose and fructose) or the conversion of insoluble starches into soluble solids could be the reason for this increase [10]. However, the decline in TSS that occurred at later stages of ripening might be due to an increase in the rate of respiration, in which sugars are utilized as respiratory substrates.

3.2 Titratable Acidity (%)

It is evident from the data that the titratable acidity in guava fruits decreased gradually with the advancement of the storage period. There was a significant difference ($p<0.05$) in titratable acidity among mature green and ripe stage fruits, respectively, in all the cultivars up to the end of storage. After 3 days of storage, among the cultivars, Lalit recorded the minimum titratable acidity (0.48, 0.37 and 0.28%), followed by Shweta (0.51, 0.44 and 0.35%), whereas it was maximum in cultivar Allahabad Safeda (0.58, 0.53 and 0.41%) at mature green, colour break and ripe stages, respectively. Likewise, after 12 days of storage, lowest value of titratable acidity was recorded in cultivar Lalit (0.25, 0.20 and 0.17%), followed by Shweta (0.31, 0.28 and 0.22%), while the highest value was displayed in Allahabad Safeda (0.39, 0.35 and 0.26%) at mature green, colour break and ripe stages, respectively. However, titratable acidity in guava fruits at mature green and colour break stages in Lalit, Allahabad Safeda and Shweta, respectively, was statistically at par with each other at 12 days after storage. In all treatments during storage, substantial and gradual decreases in titratable acidity have been observed, and this gradual decrease may be due to the utilization of acid in metabolism. The loss in acidity could be attributed to the activity of

carboxylase and malic dehydrogenase, which are closely associated with the respiration rate, or might be due to the utilization of acid during respiration. A slower decrease in acidity in treated fruits compared to control could be due to delayed senescence and a lower respiration rate in the fruit. The titratable acidity was relatively high at harvest and then decreased during ripening, which is a natural phenomenon. This could be due to the rapid utilization of acids in guava fruits as a substrate during the respiration process. Similar results have been reported by Kumar et al. [11]; Hazarika et al. [12] in guava and strawberry fruits, respectively. Titratable acidity indicates the occurrence of total organic acids in fruits and plays an important role in determining the flavor of fruit. The flavor of fruit is related to its TSS: acid ratio [13]. According to Javed et al. [14], citric acid is the main organic acid found in guava. Fruits with a rapid decline in titratable acidity are ripening quickly and have significant metabolic activity, such as respiration, which uses organic acids as a substrate. The reduction of titratable acidity may also be caused by aging, the onset of degradation and increased ethylene production. The development of organic acid and a steady loss in pectin content may both be responsible for the change in acidity that occurs in distinct varieties after storage.

3.3 Ascorbic Acid Content (mg/100 g FW)

In this experiment, the ascorbic acid content of the guava fruits decreased in a linear pattern with the advancement of storage time up to 12 days. A significant difference in ascorbic acid content was recorded among mature green and ripe stage fruits, respectively, in all the cultivars during storage. However, different cultivars and maturity stages greatly influence the ascorbic acid content of guava fruits. Likewise, the rate of loss of ascorbic acid content in guava was faster at ripe stages as compared to other maturity stages during the storage period. Among various cultivars, after 3 days of storage, Lalit showed maximum ascorbic acid content (265.45, 253.32 and 239.23 mg/100 g FW), followed by Allahabad Safeda (251.58, 235.12 and 221.45 mg/100 g FW), whereas it was minimum in cultivar Shweta (240.35, 226.24 and 209.85 mg/100 g FW) at mature green, colour break and ripe stages, respectively. Likewise, after 12 days of storage, the highest value of ascorbic acid content was recorded in cultivar Lalit (228.82, 219.58 and 198.16 mg/100 g FW), followed by Allahabad Safeda (215.36, 201.65 and 191.87 mg/100 g FW), while the lowest value was noted in Shweta (195.84, 186.87 and 175.12 mg/100 g FW) at mature green, colour break and ripe stages, respectively. The loss of ascorbic acid in prolonged storage might be due to the rapid conversion of L-ascorbic acid to dehydro-ascorbic acid in the presence of the enzyme ascorbinase Wills et al. [15]. Ascorbic acid contributes to protecting the plant against oxidative damage due to its antioxidant property. However, due to its solubility in water, the vitamin undergoes rapid degradation due to oxidation during postharvest storage. The results are similar to the findings of Kumar et al. [16], who found that ascorbic acid decreased with increasing periods of storage in fruits of kinnow. According to Yaman and Bayoindirli [17], the concentration of oxygen in the storage environment affects the activity of the enzymes that oxidize ascorbic acid, such as ascorbic acid oxidase and phenol oxidase. Due to the low oxygen level, the activities of enzymes responsible for the oxidation were reduced, which in turn reduced the auto-oxidation of ascorbic acid in the presence of oxygen. Ascorbic acid is converted into dehydro-ascorbic acid by an enzyme called ascorbic acid oxidase, and it is further broken down by enzymes called peroxidase, catalase, and polyphenol oxidase [18]; Singh et al. [19].

3.4 Lycopene Content (mg/100 g FW)

In this experiment, the lycopene content of the guava fruits showed an increasing trend with an increase in storage period up to 12 days at ambient conditions. Among various cultivars, the lycopene content was only assessed in cultivar Lalit. The variety itself has been identified as a determining factor for the composition and content of plant pigments Siddiqui et al. [20]. There was a significant difference ($p < 0.05$) in lycopene content among mature green and ripe stage fruits, respectively. However, 3 days onwards, ripe stage fruits showed maximum lycopene content (0.46 mg/100 g FW), followed by colour break stage (0.24 mg/100 g FW) and the minimum lycopene content was observed at mature green stage (0.19 mg/100 g FW). Likewise, after 12 days of storage, the highest lycopene content (0.94 mg/100 g FW) was observed at ripe stage, followed by colour break stage (0.86 mg/100 g FW) and lowest lycopene content (0.78 mg/100 g FW) was observed at the mature green stage. Lycopene is a powerful natural antioxidant that imparts pink colouration to the fruit pulp in guava. Chandrika et al. [21] assessed the lycopene content of guava pulp in

Table 1. Effect of maturity stage on total soluble solids (°Brix) of guava cultivars during storage at ambient condition

		Total soluble solids (°Brix)				
	Maturity stages	**Days after storage (DAS)**				
		0 DAS	**3 DAS**	**6 DAS**	**9 DAS**	**12 DAS**
Lalit	Mature green stage	11.95 ± 0.33 b	12.28 ± 0.36 b	12.49 ± 0.18 b	12.78 ± 0.21 a	12.56 ± 0.30 a
	Colour break stage	12.41 ± 0.47 a	12.65 ± 0.42 a	12.82 ± 0.16 a	13.09 ± 0.18 a	12.45 ± 0.28 a
	Ripe stage	12.68 ± 0.25 a	12.86 ± 0.26 a	13.12 ± 0.27 a	12.55 ± 0.12 a	12.27 ± 0.16 a
Allahabad	Mature green stage	11.24 ± 0.05 c	11.49 ± 0.05 c	11.88 ± 0.57 c	12.29 ± 0.05 b	12.23 ± 0.05 a
Safeda	Colour break stage	11.55 ± 0.06 b	11.96 ± 0.32 b	12.24 ± 0.42 b	12.62 ± 0.03 b	12.18 ± 0.63 a
	Ripe stage	12.16 ± 0.18 a	12.28 ± 0.06 a	12.53 ± 0.07 a	12.35 ± 0.10 a	12.11 ± 0.48 a
Shweta	Mature green stage	11.39 ± 0.02 b	11.68 ± 0.03 b	12.03 ± 0.07 c	12.37 ± 0.66 b	12.31 ± 0.52 a
	Colour break stage	12.02 ± 0.07 a	12.27 ± 0.38 a	12.43 ± 0.26 b	12.79 ± 0.42 ab	12.25 ± 0.07 a
	Ripe stage	12.21 ± 0.05 a	12.36 ± 0.09 a	12.61 ± 0.35 a	12.46 ± 0.13 a	12.19 ± 0.24 a

Table 2. Effect of maturity stage on titratable acidity (%) of guava cultivars during storage at ambient condition

		Titratable acidity (%)				
	Maturity stages	**Days after storage (DAS)**				
		0 DAS	**3 DAS**	**6 DAS**	**9 DAS**	**12 DAS**
Lalit	Mature green stage	0.53 ± 0.05 a	0.48 ± 0.03 a	0.40 ± 0.03 a	0.33 ± 0.03 a	0.25 ± 0.02 a
	Colour break stage	0.44 ± 0.04 ab	0.37 ± 0.03 ab	0.31 ± 0.03 ab	0.26 ± 0.03 ab	0.20 ± 0.03 ab
	Ripe stage	0.35 ± 0.03 b	0.28 ± 0.02 b	0.24 ± 0.02 b	0.20 ± 0.01 b	0.17 ± 0.01 b
Allahabad	Mature green stage	0.62 ± 0.02 a	0.58 ± 0.02 a	0.52 ± 0.03 a	0.47 ± 0.01 a	0.39 ± 0.02 a
Safeda	Colour break stage	0.57 ± 0.05 a	0.53 ± 0.03 b	0.46 ± 0.03 a	0.42 ± 0.03 a	0.35 ± 0.03 ab
	Ripe stage	0.46 ± 0.04 b	0.41 ± 0.02 c	0.34 ± 0.05 b	0.29 ± 0.03 b	0.26 ± 0.03 c
Shweta	Mature green stage	0.59 ± 0.01 a	0.51 ± 0.07 a	0.42 ± 0.01 a	0.36 ± 0.05 a	0.31 ± 0.08 a
	Colour break stage	0.52 ± 0.03 b	0.44 ± 0.09 b	0.38 ± 0.04 a	0.32 ± 0.02 a	0.28 ± 0.03 a
	Ripe stage	0.41 ± 0.01 c	0.35 ± 0.05 c	0.29 ± 0.03 b	0.25 ± 0.03 b	0.22 ± 0.02 b

Values are mean ± standard error of three replicate determinations (n=3). According to HSD Tukey's test, values in the same column with different letters are significantly different ($p < 0.05$)

Table 3. Effect of maturity stage on ascorbic acid content (mg/100g FW) of guava cultivars during storage at ambient condition

		Ascorbic acid content (mg/100 g FW)				
	Maturity stages	**Days after storage (DAS)**				
		0 DAS	**3 DAS**	**6 DAS**	**9 DAS**	**12 DAS**
Lalit	Mature green stage	289.91 ± 7.25 a	265.45 ± 7.00 a	252.94 ± 8.31 a	245.41 ± 16.32 a	228.82 ± 3.92 a
	Colour break stage	268.65 ± 10.65 a	253.32 ± 6.88 a	241.35 ± 8.60 ab	233.58 ± 13.92 a	219.58 ± 13.92 ab
	Ripe stage	252.09 ± 10.21 a	239.23 ± 13.40 a	227.1 ± 16.95 b	212.31 ± 10.82 b	198.16 ± 8.62 b
Allahabad	Mature green stage	265.58 ± 4.71 a	251.58 ± 5.32 a	241.25 ± 7.21 a	229.34 ± 12.65 a	215.36 ± 4.78 a
Safeda	Colour break stage	248.12 ± 8.45 ab	235.12 ± 9.85 b	222.36 ± 4.68 ab	214.95 ± 8.37 b	201.65 ± 10.22 ab
	Ripe stage	232.54 ± 6.57 b	221.45 ± 11.51 b	210.49 ± 13.42 b	203.58 ± 5.31 b	191.87 ± 8.77 b
Shweta	Mature green stage	251.04 ± 6.35 a	240.35 ± 4.78 a	229.58 ± 9.12 a	211.26 ± 13.62 a	195.84 ± 2.89 a
	Colour break stage	237.65 ± 7.41 ab	226.24 ± 8.33 b	212.36 ± 7.25 ab	198.22 ± 8.53 a	186.87 ± 11.29 ab
	Ripe stage	224.18 ± 11.92 b	209.85 ± 10.38 c	191.67 ± 15.52 b	183.54 ± 5.76 b	175.12 ± 3.52 b

Table 4. Effect of maturity stage on lycopene content (mg/100g FW) of guava cultivars during storage at ambient condition

		Lycopene content (mg/100 g FW)				
	Maturity stages	**Days after storage (DAS)**				
		0 DAS	**3 DAS**	**6 DAS**	**9 DAS**	**12 DAS**
Lalit	Mature green stage	0.08 ± 0.00 c	0.19 ± 0.01 b	0.31 ± 0.02 b	0.57 ± 0.05 b	0.78 ± 0.07 b
	Colour break stage	0.15 ± 0.01 b	0.24 ± 0.08 b	0.42 ± 0.10 b	0.61 ± 0.04 b	0.86 ± 0.03 ab
	Ripe stage	0.29 ± 0.02 a	0.46 ± 0.03 a	0.64 ± 0.04 a	0.85 ± 0.03 a	0.94 ± 0.05 a
Allahabad	Mature green stage					
Safeda	Colour break stage	nd	nd	nd	nd	nd
	Ripe stage					
Shweta	Mature green stage					
	Colour break stage	nd	nd	nd	nd	nd
	Ripe stage					

** nd= not detectable*

Values are mean ± standard error of three replicate determinations (n=3). According to HSD Tukey's test, values in the same column with different letters are significantly different ($p < 0.05$)

Table 5. Effect of maturity stage on total phenolics content (mg GAE/100g FW) of guava cultivars during storage at ambient condition

	Maturity stages	Total phenolics content (mg GAE/100 g FW)				
		Days after storage (DAS)				
		0 DAS	3 DAS	6 DAS	9 DAS	12 DAS
Lalit	Mature green stage	405.80 ± 7.66 a	362.35 ± 15.88 a	339.62 ± 10.94 a	285.99 ±13.72 a	224.23 ± 9.67 a
	Colour break stage	377.56 ± 5.78 b	349.44 ± 8.91 ab	306.77 ± 8.30 ab	261.21 ± 3.98 ab	208.61 ± 5.53 b
	Ripe stage	351.86 ± 12.31 b	312.52 ± 11.51 b	264.24 ± 10.26 b	215.22 ± 11.70 b	169.33 ± 12.03 c
Allahabad Safeda	Mature green stage	381.52 ± 8.91. a	348.27 ± 18.79 a	321.89 ± 13.75 a	290.76 ± 8.26 a	246.19 ± 7.34 a
	Colour break stage	363.24 ± 11.56 ab	331.58 ± 7.83 ab	310.12 ± 4.47 a	265.13 ± 5.49 b	229.45 ± 9.14 b
	Ripe stage	346.17 ± 7.95 b	304.66 ± 10.17 b	281.38 ± 12.44 b	248.51 ± 14.20 c	208.27 ± 5.37 c
Shweta	Mature green stage	341.54 ± 5.87 a	319.21 ± 17.62 a	272.55 ± 11.23 a	257.71 ± 15.63 a	232.97 ± 4.31 a
	Colour break stage	328.61 ± 10.45 b	296.43 ± 5.96 b	261.67 ± 9.27 a	240.48 ± 6.82 a	219.75 ± 9.56 ab
	Ripe stage	302.38 ± 9.62 b	271.64 ± 10.26 b	245.38 ± 14.52 b	216.05 ± 8.37 b	185.41 ± 7.81 b

Values are mean ± standard error of three replicate determinations (n=3). According to HSD Tukey's test, values in the same column with different letters are significantly different ($p < 0.05$)

cv. Lalit, which was found to be 17.69 µg/100 g FW. This is in conformity with the findings of Lakade et al. [9]. Similar outcomes were also noted by Giovanelli et al. [22]. Maturation is directly related to the development of lycopene content. Additionally, it has been noted that the temperature range and respiration rate during storage affect lycopene formation [23].

3.5 Total Phenolics Content (mg GAE/100 g FW)

In this study, total phenolic content decreased significantly with the advancement of the storage period. There was a significant difference in total phenolic content between mature green and ripe stages, respectively, in all the cultivars. After 3 days of storage, mature green stage fruits showed the highest total phenolic content in comparison to other maturity stages. The similar pattern persisted until the 12 days of storage period, irrespective of cultivars and maturity stages. After 3 days of storage, among different cultivars, Lalit showed the maximum total phenolic content (362.35, 349.44 and 312.52 mg GAE/100 g FW), followed by Allahabad Safeda (348.27, 331.58 and 304.66 mg GAE/100 g FW), whereas it was the minimum in cultivar Shweta (319.21, 296.53 and 271.64 mg GAE /100 g FW) at mature green, colour break and ripe stages, respectively. Likewise, after 12 days of storage, the highest value of total phenolic content was recorded in cultivar Lalit (224.23, 208.61 and 169.33 mg GAE/100 g FW), followed by Allahabad Safeda (246.19, 229.45 and 208.27 mg GAE /100 g FW), while the lowest value was recorded in Shweta (232.97, 219.75 and 185.41 mg GAE /100 g FW) at mature green, colour break and ripe stages, respectively. However, total phenolic content in guava fruits at mature green and colour break stages in Lalit, Allahabad Safeda and Shweta, respectively, was statistically at par with each other at 12 days after storage. The breakdown of cellular structure during senescence may be responsible for the fall in phenolic content in fruit. Fruits are shielded by edible coatings from enzymatic oxidation of phenolic components by creating a barrier to oxygen and moisture. Increased activity of the enzymes polyphenol oxidase and peroxidase in guava fruits, which led to a quick decline in the total phenolic content of the fruits Serrano et al. [24]. Due to fruit ripening, the amount of phenolic compounds decreased as storage time increased Sharma et al. [25]. Gallic acid, ellagic acid, and quercetin are the main phenolic components found in guava Jiménez-Escrig et al. [26]. Both the pulp and peel contain significant amounts of phenolic chemicals Mahattanatawee et al. [27]. Due to their extreme instability, phenolic compounds alter significantly when they are stored Sharma et al. [25]; [28].

4. CONCLUSION

The experiment's findings demonstrated that the quality and storage life of guava fruits were significantly influenced by their ripening behavior or stage of development at harvest. When compared to the colour-turning stage and the ripe stage of fruits, the mature green stage demonstrated promising results in postponing the physico-chemical changes. The best guava cultivars in terms of post-harvest quality were determined to be Lalit excelled in terms of maximum total soluble solids, lycopene content, ascorbic acid content, and minimum acidity content.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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