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Maturity indices and quality attributes during growth and development in guava cultivars 'shweta' and 'lalit'

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Abstract

Guava (*Psidium guajava* L.), grown in the northern plains of India differ in physico-chemical characteristics. However, their standard for maturity, storage and ripening lack specificity. Two cultivars 'Shweta' (white pulp) and 'Lalit' (pink pulp), were studied for maturity and quality changes from fruit set to and ripening. Two hundred flowers of each cultivars were tagged and 20 fruits were harvested at regular intervals during autumn-winter. Total chlorophyll content of peel and pulp decreased in both the cultivars from 62 to 132 days after fruit set. The total soluble solids (TSS) did not differ significantly. However, the titrable acidity and ascorbic acid content increased during fruit development period of 132 days. The anthocyanin content of peel was higher than that of pulp in both the cultivars. The Lycopene content in pulp of cv. Lalit increased from 62 days and attained maximum at maturity (122 days after fruit set). Higher ascorbic acid with lycopene and early maturing cultivar 'Lalit' has scope for fresh fruit consumption as well as for processing.

Keywords: psidium guajava; ascorbic acid; chlorophyll; lycopene; development; maturity

1. Introduction

Guava (*Psidium guajava* L.), the apple of the tropics, is one of the most common fruits in India. Guava fruit is a berry round in shape, ranging from 3 to 10 cm in diameter, has a yellow or pink peel at maturity. It is consumed fresh and also processed for its palatable flavour and taste. It is a rich source of dietary fibre, polyphenols and minerals. Guava fruits are highly nutritious in nature because it contains high levels of ascorbic acid (50 to 300mg/100g fresh weight), which is three to six times higher than oranges. Red-fleshed guava are rich source of carotenoids such as phytoflene, β -carotene, β -cryptoxanthin, γ -carotene, lycopene, rubixanthin, cryptoflavin, lutein and neochrome [1]. Previous studies on guava have demonstrated that physical and chemical changes such as appearance, hardness and chemical composition occurs during maturation. Knowledge about better understanding of chemical changes in fruit is important for a better understanding of metabolic processes such as maturity and ripening. Total soluble solids and ascorbic acid have been shown to significantly increase as fruit ripens. The substances responsible for the vitamin characteristic of the fruit reached their maximum values near 106 days from fruit set in guava [2]. The objective of the present study is to assess maturity indices and quality attributes during growth and development in guava cultivars 'Shweta' having white pulp and cv. 'Lalit' having pink pulp for better understanding of the compositional changes in different parts of fruits at growth and developmental stage to assign maturity and ripening in guava.

2. Materials and Methods

Eight year old guava trees of cultivars 'Shweta' and 'Lalit', grown at the Institute farm, were selected for the study. In each cultivar two hundred flowers were tagged on 28th August and fruit set was observed. Twenty fruits from each cultivar were harvested at 10 days intervals from 30th October to 4th January, i.e. for a period of 62 to 132 days after fruit set consisting of eight stages of fruit growth and development. The fruits were separated into peel, pulp and macerated to a fine paste and analysed for various compositional changes. Firmness of fruits were measured with the help of penetrometre (McIntosh, USA, 8mm probe) and expressed as kg/cm². Total soluble solids (TSS) was measured with help of digital refractometre (Atago) and expressed as degree brix (°B). The titratable acidity (TA) taking five gram of sample diluted to 50 ml of distilled water and titrated with 0.1 mol/L NaOH solution and results were expressed as per cent citric acid [10]. Ascorbic acid content in fruit pulp was estimated by titration using 2, 6 dichlorophenol indophenols dye [3]. For estimation of chlorophyll 2g of peel and pulp of guava fruits were weighed accurately and added 0.2g of sodium carbonate and small amount

of acid washed sand. This was followed by addition of 85% acetone and extracted 2 to 3 times. The volume was made up to 50ml in a volumetric flask. Spectrophotometric readings were noted at 600, 642.5 and 660 nm and expressed as mg/100g for chlorophyll 'a', 'b' and total chlorophyll [3]. The pulp and peel of guava fruits were used separately by weighing 2 gm each and dissolved in acetone solvent. Repeated extraction was carried with acetone in a pestle and mortar until the residue was colourless. The acetone extract was transferred to a separating funnel containing 10 to 15 ml of petroleum ether and mixed gently and collected in a 25 ml volumetric flask and the OD was read at 473 nm and lycopene was expressed as mg/100g of fresh weight [3]. For estimation of anthocyanin 2g of sample was dissolved in 20ml of ethanoic hydrochloride and stored overnight in a refrigerator at 4°C. Using a Buchnus funnel the extracts was filtered and volume was made to 25ml and stored in the dark for colour development and read at OD 535 nm and expressed as mg/100g of fresh weight [3]. All the analysis was carried out in triplicates and the data recorded during the course of investigation were subjected to statistical analysis by SAS 9.3 and CD at 0.05 level.

3. Results and Discussion

The fruit firmness at initial stage of growth and development was very high (Table.1 & 2.). The firmness in the fruits of cultivars 'Shweta' and 'Lalit' varied significantly ($p \leq 0.05$) during growth and development of 62 to 132 days. With the increase in growth and development of fruits, the firmness of the fruits exhibited a constant value and then decreased continuously. In cultivar 'Shweta' firmness was 12.13 Kg/Cm² while in cultivar 'Lalit' firmness was 11.93 Kg/Cm² up to 96 days after fruit set. The firmness was high 11.53 and 11.77 Kg/Cm² in cultivar 'Shweta' and 'Lalit' respectively, coinciding with the colour break stage of fruits 112 days. Thereafter, firmness decreased up to 6.77 Kg/Cm² in cultivar 'Shweta' and 6.60 Kg/Cm² in cultivar 'Lalit' on 132 day after fruit set indicating maturity and ripening of fruits. For both the cultivars, immature fruits were very firm, hard and dark green in colour. When the fruits were of 102 to 112 days old, there was colour break change in colour from dark green to light green in colour and fruits were moderately firm. Maturity of fruit was closely associated with firmness, the highest firmness was found in mature green fruits and the ripe fruits in guava had low firmness [4, 5]. Firmness for consumer is the significant quality aspects because it reflects the ripening stages of fruit in mango [6].

TSS and TA were measured on the edible portion of the fruit. The result showed a significant difference $p \leq 0.05$ in the TSS degree brix among the two cultivars of guava (Table.1 & 2.). At 62 days after fruit set the TSS were 10.07 °B and 10.80 °B in cultivars 'Shweta' and 'Lalit', respectively. With the increase in days after fruit set i.e. on the 122nd day the TSS was maximum 12.33 °B in cultivars 'Shweta' while in cv. 'Lalit' the TSS was maximum 14.07 °B on 112 days and decreased thereafter indicating fruit maturity and onset of ripening. The increase in TSS content may be attributed to the synthesis and fast translocation of sugars and other carbohydrates from the site of production to the site of accumulation i.e. fruits [7,8]. With the increase in days after fruit set cultivars 'Shweta' had maximum 0.73 per cent acidity on 96th day while that of cultivars 'Lalit' was 0.60 per cent on the 112th day. There was a significant variation $p \leq 0.05$ among the cultivars with regard to the per cent acidity indicating proper acid: sugar ratio for imparting flavour and

quality of fruits. Acidity or citric acid content decreased with the advancement of fruit growth. The decrease in acidity may be due to utilization in respiratory and other metabolic process during fruit growth and harvest maturity [9, 10]. The balance between TSS and acidity is useful method for determining the maturity indices of guava and it is also the best criteria in correlating fruit quality with consumer's acceptance. In our study, cultivars 'Lalit' matured 10 days earlier than cultivar 'Shweta'. The ascorbic acid content of the fruits was lowest at the initial period of growth and development (Table.1 & 2.). On the 112th day the ascorbic acid content was maximum in cultivar 'Shweta' 117.50 mg/100g while it was maximum 281.53 mg/100g in cultivar 'Lalit' on 102nd day and decreased thereafter indicating fruit maturity and ripening. Interestingly, the content of ascorbic acid increased progressively during fruit development. Small amounts of ascorbic acid accumulated during the first phase of fruit development 102 to 112 days after fruit set, and the level of ascorbic acid continued to rise throughout ripening as studied in grapes [11]. The amount of ascorbic acid content also increased variably with the advancement of growth and development of fruits. This may be due to more availability of derivatives of sugars i.e. glucose-6-phosphate which is the precursor of ascorbic acid [7, 8]. The chlorophyll content of the peel and pulp varied significantly $p \leq 0.05$ in cultivars 'Shweta' and 'Lalit' throughout the period of growth and development (Fig.1.). At the initial period i.e. 62 days after fruit set in cultivar 'Shweta' the chlorophyll content of peel was maximum 5.49 mg/g while that of pulp was 1.16 mg/g. There was a continuous decrease in the chlorophyll content in peel and pulp up to 102 day and remained constant up to 112 days. In cultivar 'Lalit' the chlorophyll content was similar to that of cultivars 'Shweta' and decreased continuously. The pulp chlorophyll content was maximum 1.94 mg/g on the 62nd day and decreased up to 102 days indicating maturity and ripening of fruits. Total chlorophyll content decreased. The loss in chlorophyll is likely due to increase in activities of chlorophyll degrading enzymes such as chlorophyllase, chlorophyll oxidase and peroxidase during ripening [12]. Decrease in chlorophyll and /or increase in carotenoids content is a normal phenomenon occurring during ripening of fruits. The visual discrimination of fruits at various stages of fruit ripening is done by changes in pigmentation of fruits [13]. Degradation of chlorophyll occurs due to chemical structural breakdown, caused by changes in pH, accumulation of organic acids and also due to chemical oxidizing systems [14, 15]. Lycopene content of peel and pulp of cultivars 'Shweta' and 'Lalit' significantly differed $p \leq 0.05$ during the entire period of fruit development of 132 days (Fig.2.) The peel lycopene content of cultivar 'Shweta' was 0.57 mg/100g while that of pulp was 0.42 mg/100g on the 62nd and 72nd day, respectively. In cultivar 'Lalit' lycopene content was maximum in peel on the 92nd day (0.47 mg/100g) and on the 122nd day after fruit set in pulp (0.34 mg/100g). There was a continuous increase in lycopene content of pulp and decrease in lycopene content of peel. The trend in the lycopene content of the pulp and peel was the inherent characteristics of the cultivar. Total lycopene concentrations were comparable to the contents reported in other guava [16] varieties ranging between 1.70-5.10 mg/100g. Various common tomato varieties contained lycopene from 1860 to 6498 microgram per 100g of fresh weight [17]. Lycopene contents of >2mg/100g is generally regarded as very high [18]. Therefore, cultivar 'Lalit' (pink pulp guava) is considered to be a good nutritional source of lycopene content. There was a

significant difference $p \leq 0.05$ in the anthocyanin content of the peel and pulp in both cultivars of guava (Fig.2.). The anthocyanin content was higher in cultivar 'Lalit' than that of cultivar 'Shweta'. The anthocyanin content of peel in cultivar 'Shweta' was higher than the pulp throughout the period of growth and development of 132 days. The anthocyanin content of peel in cultivar 'Shweta' was maximum 0.80 mg/100g on 112 days while that of pulp was maximum 0.16 mg/100g on the 102nd day. Peel anthocyanin content in cultivar 'Lalit' was maximum 1.14 mg/100g in the initial period of 62 days which decreased continuously and increased 0.83 mg/100g on the 112 day of growth and decreased thereafter. The anthocyanin content of pulp was less at the initial period of growth and development and attained maximum 0.45 mg/100g on 112 days and decreased thereafter. Anthocyanin colour is extremely unstable and overall stability may be affected by pH, light, heat, oxygen, ascorbic acid and co-pigmentation [19, 20]. Stability of anthocyanin is greatly reduced by presence of ascorbic acid resulting in hydro peroxide formation during oxidation of ascorbic acid [21]. With increase in ascorbic acid content there

is decrease in anthocyanin in fruits such as cranberry, strawberry, grapes and oranges [22]. The average temperature in degree centigrade and relative humidity per cent during the period of study are depicted in Fig.3 & 4.

4. Conclusion

From the above study that pink pulp colour guava cultivar 'Lalit' is early maturing in 112 days compare to cultivar 'Shweta' which attained maturity in 122 days after fruit set. Maturity of fruit was closely associated with firmness, the highest firmness was found in mature green fruits and ripe fruits had low firmness. Fruit maturity is accompanied by increase in TSS and decrease in citric acid content. There was a continuous decrease in the chlorophyll content in peel and pulp up to 102 day and remained constant up to 112 days indicating colour break stage of fruits or maturity. Guava cultivar 'Lalit' is early maturity enriched with lycopene besides having higher ascorbic acid content at the time of maturity and ripening has wider scope for processing as well as fresh-cut and table purpose.

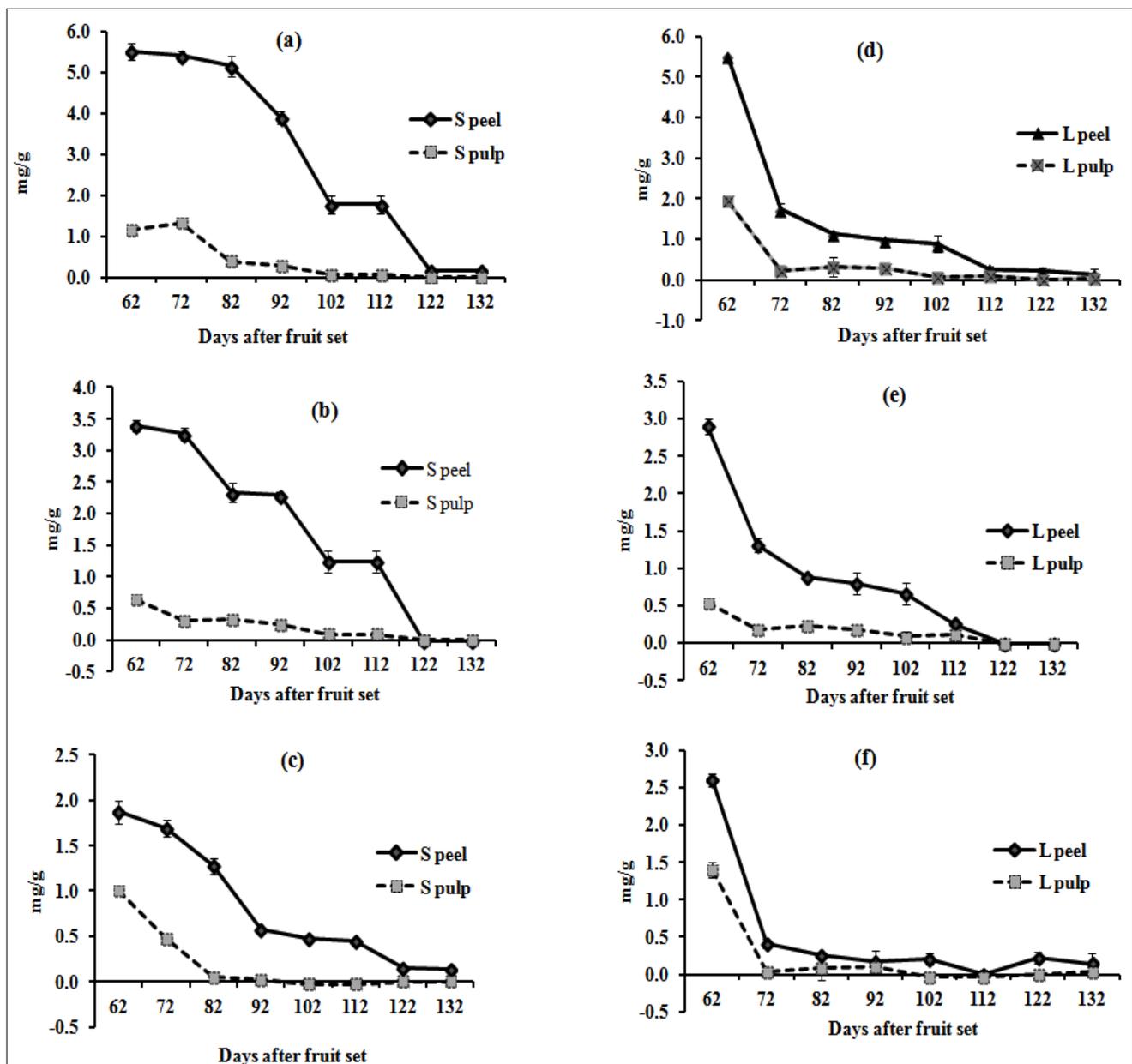


Fig 1: Chlorophyll 'a', 'b' and total chlorophyll content (mg/g) of guava in cultivars 'Shweta' ('a', 'b' and 'c') and 'Lalit' ('d', 'e' and 'f') fruits peel and pulp during growth and development

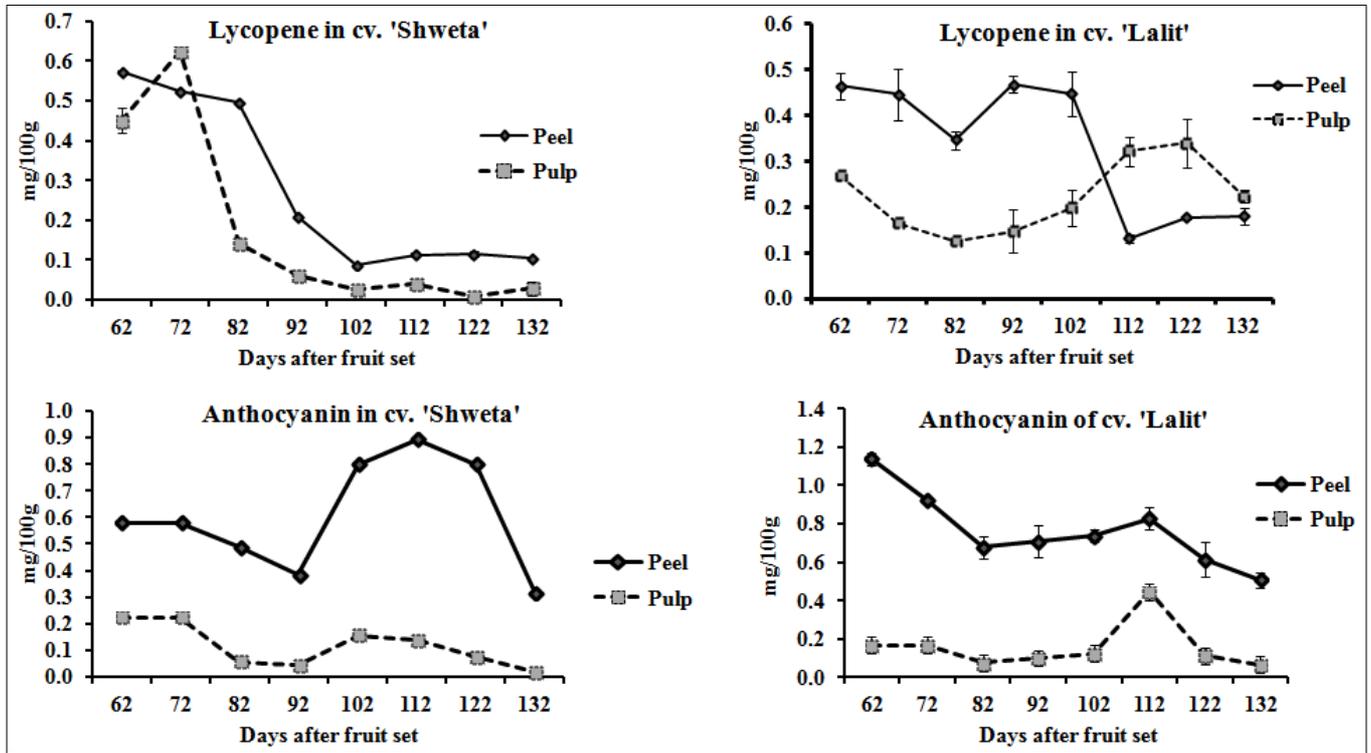


Fig 2: Lycopene and anthocyanin content (mg/100g) in cultivars 'Shweta' and 'Lalit' of guava fruit peel and pulp during growth and development

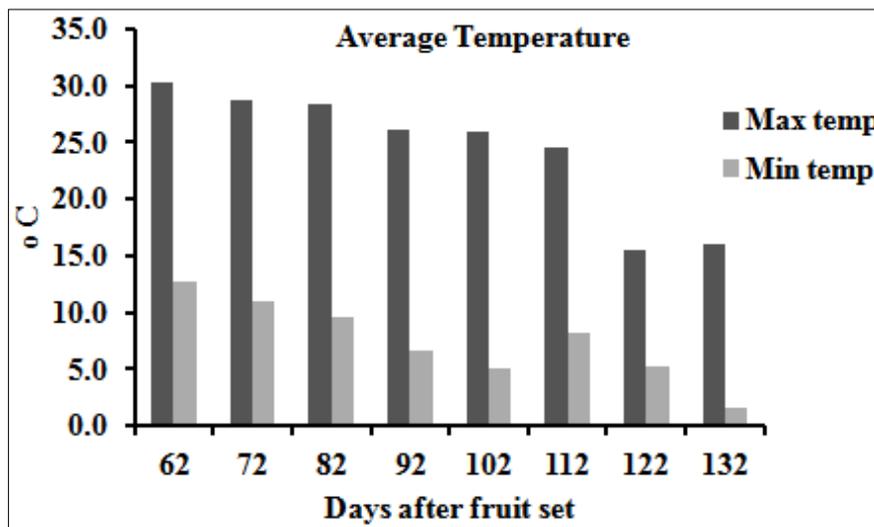


Fig 3: Average temperature (°C) during growth and development of guava fruits cultivars 'Shweta' and 'Lalit'

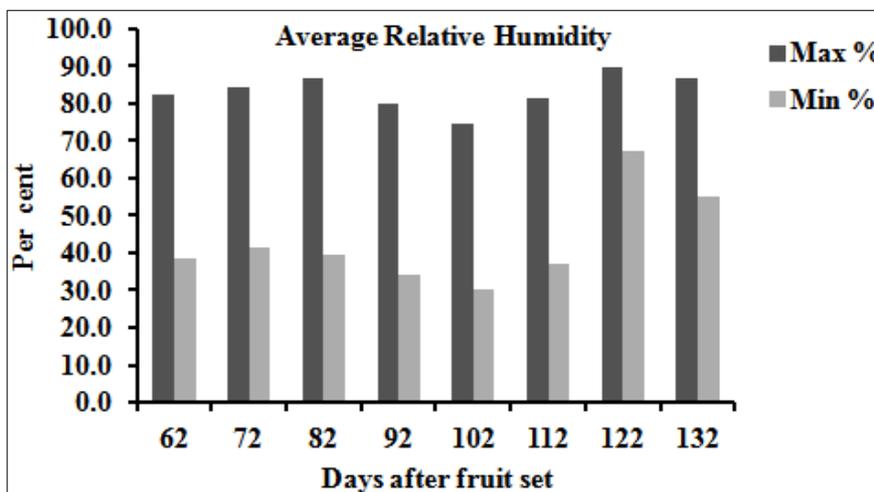


Fig 4: Average relative humidity (per cent) during growth and development of guava fruits cultivars 'Shweta' and 'Lalit'

Table 1: Physico-chemical parameters of guava cultivar 'Shweta' during growth and development (n=3).

Shweta	Firmness (Kg/cm ²)	TSS (°B)	Acidity (%)	Ascorbic acid (mg/100g)
62 days	12.47± 0.03	10.07± 0.07	0.64± 0.01	29.17± 0.83
72 days	12.47± 0.03	10.47± 0.07	0.54± 0.02	38.57± 1.56
82 days	12.47± 0.03	11.53± 0.07	0.64± 0.01	58.00± 0.79
92 days	12.13± 0.13	11.13± 0.07	0.73± 0.01	83.90± 1.41
102 days	11.53± 0.07	11.67± 0.07	0.55± 0.00	115.80± 1.96
112 days	10.73± 0.07	11.93± 0.07	0.57± 0.00	117.50± 0.49
122 days	8.73±0.07	12.33± 0.07	0.51± 0.01	117.50± 2.49
132 days	6.77± 0.03	12.07± 0.07	0.44± 0.01	79.94± 0.06
CD (0.05)	0.20	0.20	0.04	4.30

Table 2: Physico-chemical parameters of guava cultivar 'Lalit' during growth and development (n=3).

Lalit	Firmness (Kg/cm ²)	TSS (°B)	Acidity (%)	Ascorbic acid (mg/100g)
62 days	12.43±0.07	10.81±0.11	0.52±0.00	10.35±0.15
72 days	12.17± 0.17	10.17± 0.03	0.54± 0.02	86.70± 1.70
82 days	12.07± 0.07	11.53±0.06	0.54± 0.00	135.37± 1.54
92 days	11.93± 0.07	11.73± 0.07	0.54± 0.02	181.30± 0.52
102 days	11.77± 0.03	13.47± 0.07	0.55± 0.00	281.53±1.24
112 days	10.67± 0.09	14.07± 0.07	0.60± 0.00	266.23± 2.22
122 days	7.40± 0.10	11.07± 0.07	0.32± 0.01	106.17± 2.16
132 days	6.60± 0.20	11.27± 0.07	0.45± 0.01	86.67±1.33
CD (0.05)	0.34	0.22	0.04	4.61

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