



Identification of Optimum Maturity Index for Quality of Red Flesh Guava (*Psidium guajava* L.)

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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

This study conducted at Department of Postharvest Technology, Horticultural College and Research Institute, Periyakulam from 2015 – 2017, evaluated the optimal maturity stage for harvesting “Red flesh” guavas to maintain the postharvest quality. Four distinct maturity stages were identified: half maturity, green maturity, full maturity, and fully ripened based on day after fruit set (DAFS) and peel and pulp colour. Results indicate that “Red flesh” guavas reached half maturity at 91 days after fruit set, displaying characteristics like a deep green in peel and pale pink pulp, and showed largest fruit size measurements at green maturity (134 DAFS). At full maturity (147 DAFS),

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fruits achieved peak values in Total soluble solids (TSS) and TSS/acid ratio, with a decrease in firmness and acidity with changing peel in to yellowish green with bright pink pulp. The fully ripened stage (154 DAFS) was marked by the highest TSS content and maintained fruit size but slightly declines in specific gravity and firmness. Organoleptic evaluations rated guavas at fully maturity stage highest in terms of colour, texture, flavor, taste, and overall acceptability underscoring this stage as the most suitable for harvesting to ensure best quality.

Keywords: Guava; red flesh; maturity index; quality; fruit characters; organoleptic scores.

1. INTRODUCTION

“Guava (*Psidium guajava* L.) is an important tropical and sub-tropical fruit crop which is grown widely in India. The estimated guava production is about 5.59 million metric tons with the area of 359 thousand hectares in India for the fiscal year 2023” [1]. “The fruits are delicious, rich in vitamin ‘C’, pectin and minerals like calcium, phosphorous and iron. Guava fruits are used as fresh as well as for making jam, jelly, nectar, paste etc.” [2]. “There is a great demand of guava fruits in both domestic and international markets for fresh and processing purposes. Guava is a perishable fruit and highly prone to bruising and mechanical injuries. Due to such perishability, control of fruit ripening is fundamental and this generates the necessity to search for new technologies to increase shelf life, reach distant markets and thus improve the marketing process” [3].

“Maturity at harvest is the most important factor that determines storage-life and final fruit quality. Immature fruits are more subjected to shriveling and mechanical damage, and are of inferior flavour, quality when ripe. Overripe fruits are likely to become soft and mealy with insipid flavour soon after harvest. Fruits picked either too early or too late in their season are more susceptible to post-harvest physiological disorders than fruit picked at the proper maturity. The level of maturity actually helps in selection of storage methods, estimation of shelf-life, selection of processing operations for value addition etc. Guava fruits are picked at the mature-green stage (color change from dark- to light-green) in some countries where consumers eat them at that stage. In countries where consumers prefer ripe guava, the fruits are picked at the firm-yellow to half-ripe (softer) stage for long-distance transport or at the fully-ripe (yellow and soft) stage for local markets” [4].

Some fruits are usually picked mature but unripe so that they can withstand the post-harvest

handling system when shipped long distance. Most currently used maturity indices are based on a compromise between those indices that would ensure the best eating quality to the consumer and those that provide the needed flexibility in marketing. Skin colour is the best maturity index in guava [5,6,7] as it could be monitored non-destructively during fruit ripening and storage. Fruits attaining maturity shows signs of changing colour from pale green to yellowish green. If the fruit is to be shipped to distant markets it should be mature, full sized and of firm texture, but without an obvious colour break on the surface. Fruits for local market can be harvested in a more advanced stage of maturity [8]. However, harvesting fruits at appropriate stage of maturity is critical in maintaining the post-harvest quality of guava fruits [6,9,10].

“In post-harvest phase, the quality risks are highly associated with factors such as commodity, cultivar, harvest type, handling, storage and supply” [11]. Physico-chemical changes during maturity can be used as important criteria for determining the optimum stage of fruit harvesting for better quality and extended shelf life. With this background, comprehensive study was carried out to assess the optimum maturity stage for harvest.

2. MATERIALS AND METHODS

The study was conducted at Post Harvest Technology Laboratory, Horticultural College and Research Institute, Periyakulam, during 2015 - 2017. The experiment was laid out in randomized block design with three replications. Guava cv. Red flesh fruits were tagged after fruit set on each of the three selected plant in each replication. Ten fruits randomly selected tagged fruits from all directions of each plant at 7 days intervals after fruit set (DAFS) were taken and used for this study. Red flesh fruits of guava were assessed for various physical and biochemical changes at different stages of fruit maturity to determine the appropriate maturity

stage for harvest, better quality and desirable shelf life.

Fruit length, diameter and weight were measured from randomly selected fruit during study. The length and breadth were measured with the help of Vernier calipers in mm and calculated an average size. The specific gravity of fruit was recorded from the selected fruit by measuring their weight (g) in air by the volume of the fruit obtained by water displacement method. Fruit shape and colour of the actual fruit were visually observed and compared with the shape in the charted standard shapes and colour charts [12]. The quality parameters such as TSS, titratable acidity, TSS: acid ratio, fruit firmness and overall organoleptic rating were observed in this study. The data were subjected to statistical analysis [13]. The total soluble solids of the fruits were determined with the help of *Erma* hand refractometer. Fruit firmness was measured on opposite sides of the equatorial axis using mangnes penetrometer with a plunger of 6 mm diameter was used for the determination of rupture force and the readings were expressed as η . The acidity was recorded in terms of percent citric acid on fresh weight basis [14]. The TSS: acidity ratio was calculated by dividing the value of TSS by that of titratable acidity

Overall organoleptic rating of the fruits was done by a panel of five semi trained judges on the basis of nine-point hedonic scale (9 = Like Extremely; 8 = Like Very Much; 7 = Like Moderately; 6= Like Slightly; 5 = Neither Like Nor Dislike; 4 = Dislike Slightly; 3 = Dislike Moderately; 2 = Dislike Very Much; 1 = Dislike Extremely) for fruit appearance and colour, flavour, texture and taste [15].

3. RESULTS AND DISCUSSION

Investigations were done at different stages for 'Red flesh' Guava to identify the harvest index. Different maturity stages were identified: half maturity, green maturity, full maturity and fully ripened stages depends on the day after fruit set (DAFS), peel and pulp colour and fruit quality (Tables 1 & 2 and Plate 1). A significant variation in fruit weight and other characters of 'Red flesh' Guava was observed among the various stages of fruit maturity. The results were indicated the 'Red flesh' Guava reached half maturity at 91 days after fruit set displaying characteristics of deep green peel and pale pink with an increase in fruit size in length (63.3 mm) and breadth (67

mm), fruit weight (108 g), specific gravity (0.79 g/cm³), firmness (37.37 N), TSS (7.5 °Brix), acidity (1.96 g/lit of citric acid) and TSS/acid ratio (3.92) (FigS. 2, 3 & 4). The green maturity stage was found at 134 days after fruit set with largest fruit size with measurements as length (75.6 mm), breadth (79.3 mm), fruit weight (180 g), specific gravity (1.02 g/cm³), firmness (52.04 N), TSS (10.6 °Brix), acidity (0.64 g/lit of citric acid) and TSS/acid ratio (17.63) with mature green peel and pink pulp. The fully maturity was observed at 147 days after fruit set with increased in fruit size which was recorded in fruit length of 79 mm, breadth (81.3 mm), fruit weight (189.3 g), specific gravity (1.70). Fruits achieved peak values in TSS (11.3 °Brix), TSS/acid ratio (26.20) whereas decrease in firmness (31.58 N) and acidity (0.38 g/lit of citric acid). Fruit weight in Allahabad Safeda and Sardar rapidly increased upto 130 and 120 days, respectively, in the rainy season and up to 140 and 130 days, respectively in the winter season [16]. The increase in fruit weight could be attributed to an increase in the size of the cells and accumulation of food substances in the intercellular spaces in fruit [17,10,18]. The fully ripened stage was noticed at 154 days after fruit set without change in fruit length (79 mm) and breadth (81.3 mm), fruit weight (189.3 g) whereas increased TSS content (12.2 °Brix) and TSS/acid ratio (26.20) might be due to ripening of fruit due to depolymerisation of polysaccharides and conversion of fruit starch to sugar might be due to increasing in TSS and decreasing in acidity. The TSS: acid ratio was increased markedly towards the last growth stage of guava [19], while decrease in specific gravity (1.11 g/cm³), firmness (23.13 N) and acidity (0.35 g/lit of citric acid) with yellow peel and bright pink pulp. The increase in acidity might be attributed to increased bio-synthesis of organic acids during initial period of fruit growth [20]. The decrease in titratable acidity at the later stages of fruit maturity and ripening was considered to be due to conversion of organic acids into sugars [5,21,22,16,10]. Sensory attributes were taken in to consideration in making decision on fruit harvest time (Table 3). The results showed that all the sensory attributes were significantly difference in Red flesh guavas at different maturity stages. The organoleptic evaluations rated guavas at full maturity stage highest in terms of colour (8.2), texture (8.4), flavour (8.2), taste (8.3) and Overall acceptability (8.1) (Fig. 1) under scoring this stage is the most suitable for harvesting to ensure best quality.

Table 1. Periodic changes in the fruit characters of 'Red flesh' Guava (*Psidium guajava* L.)

Days after fruit set	Fruit size		Fruit weight (g)	Specific gravity (g/cm ³)	Fruit firmness (N)	TSS (°Brix)	Acidity (g/lit of citric acid)	TSS:acid ratio
	Length (mm)	Breadth (mm)						
0	2.6	5.6	2.3	0.42	17.79	0.2	0.21	0.94
7	2.3	7.3	2.3	0.42	20.02	0.2	0.21	0.97
14	3.3	7.3	3.3	0.47	22.69	0.3	0.52	0.55
21	4.3	10.3	9.3	0.50	22.69	0.5	2.12	0.24
28	5.3	11.3	24.3	0.53	23.58	0.5	2.19	0.23
35	13	17	34.7	0.57	24.02	0.7	3.43	0.28
42	14.3	18.3	36.7	0.57	27.58	2.0	4.12	0.49
49	22	24.6	49.3	0.65	27.58	3.0	4.15	0.72
56	24.3	30.3	52.7	0.66	31.58	4.1	4.19	0.97
63	29.6	34.3	65.3	0.68	31.58	5.3	3.92	1.35
70	45.3	50.6	72.7	0.74	33.81	5.7	3.55	1.60
77	56	59.6	80.7	0.73	35.14	6.3	3.54	1.78
84	62	65.3	91.0	0.75	35.59	7.0	2.49	2.81
91	63.3	67.0	108	0.79	37.37	7.5	1.96	3.92
98	65	72.0	110	0.79	37.37	8.2	1.74	4.74
105	70.6	71.7	131.3	0.79	37.80	8.6	1.69	5.06
112	71	74.7	142.7	0.81	40.92	9.5	1.60	5.95
119	71	73	152.0	0.81	44.93	10.3	1.55	6.69
126	75.6	78.3	160.0	0.86	44.93	10.4	1.03	9.49
133	75.6	79.3	180.0	1.02	52.04	10.9	0.64	17.63
140	78	81.0	192.0	1.70	43.15	11.0	0.63	17.19
147	79	81.3	189.3	1.70	31.58	11.3	0.38	26.20
154	79	81.3	188.0	1.11	23.13	12.2	0.35	35.23
Mean	44.02	47.89	90.34	0.79	32.47	5.90	2.01	6.31
SD	30.27	29.58	65.92	0.34	9.10	4.25	1.41	9.23

Table 2. Identification of different stages of maturity in guava cv. Red flesh

Days required for maturity	Stage of harvest	Peel colour	Pulp colour
91 days after fruit set	Half mature	Deep green	Pale pink
134 days after fruit set	Green mature	Mature green	Pink
147 days after fruit set	Full mature	Yellowish green	Bright pink
154 days after fruit set	Fully ripened	Yellow	Bright pink

Table 3. Organoleptic scores for guava cv. Red flesh at the time of different harvest stages

Sensory attributes	Half Maturity stage	Green Maturity stage	Full Maturity stage	Fully Ripened stage	SEd	CD (P=0.05 %)
Colour	6.5	6.7	8.2	7.9	0.265	0.620*
Texture	6.0	7.0	8.4	7.0	0.645	1.512*
Flavour	6.1	7.0	8.2	7.1	0.147	0.345*
Taste	5.0	6.8	8.3	8.0	0.512	1.198*
Overall acceptability	5.5	6.2	8.1	7.5	0.465	1.090*

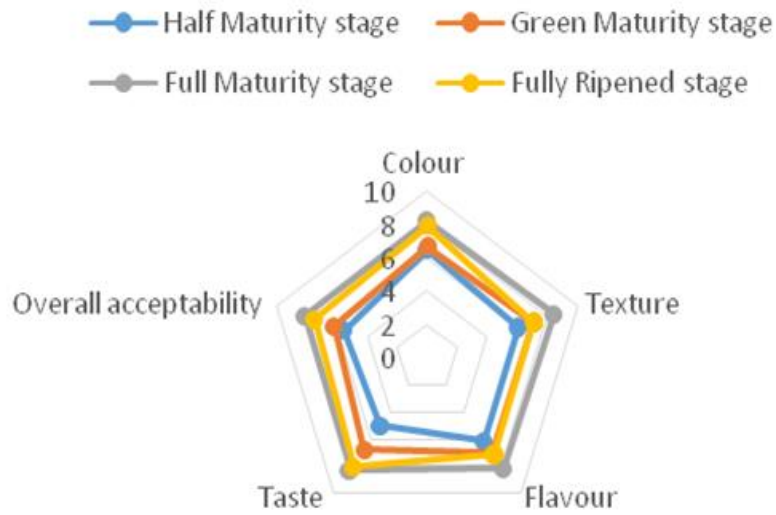


Fig. 1. Organoleptic scores for guava var. Red flesh at the time of different harvest stages



Plate 1. Changes in Peel and Pulp colour of guava cv. Red flesh at the time of different harvest stages

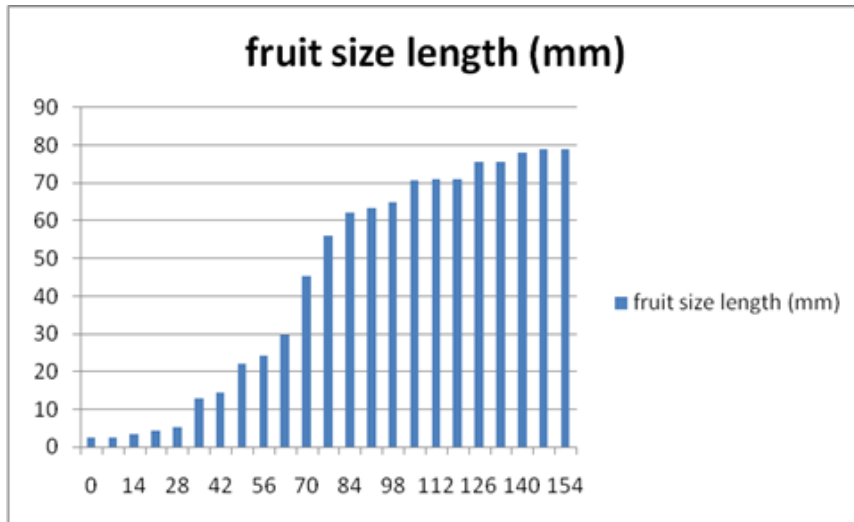


Fig. 2. Fruit size length (mm) of different days after the fruit set in guava var. Red flesh

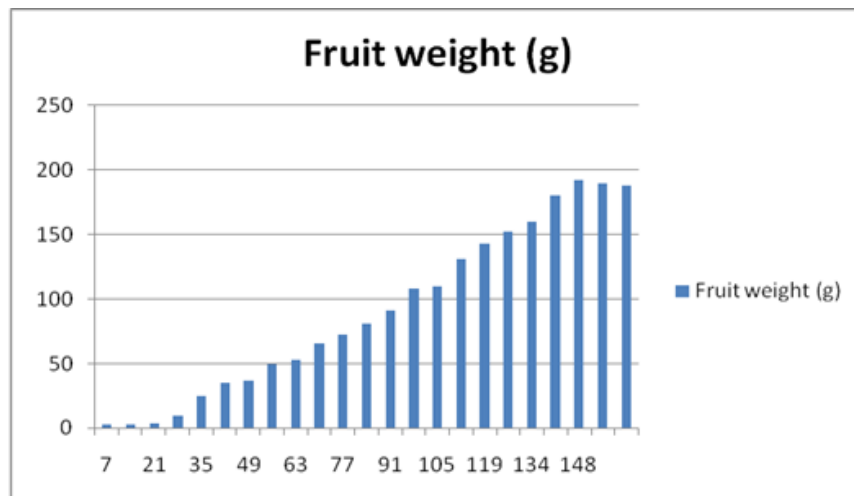


Fig. 3. Fruit weight of different days after the fruit set in guava var. Red flesh

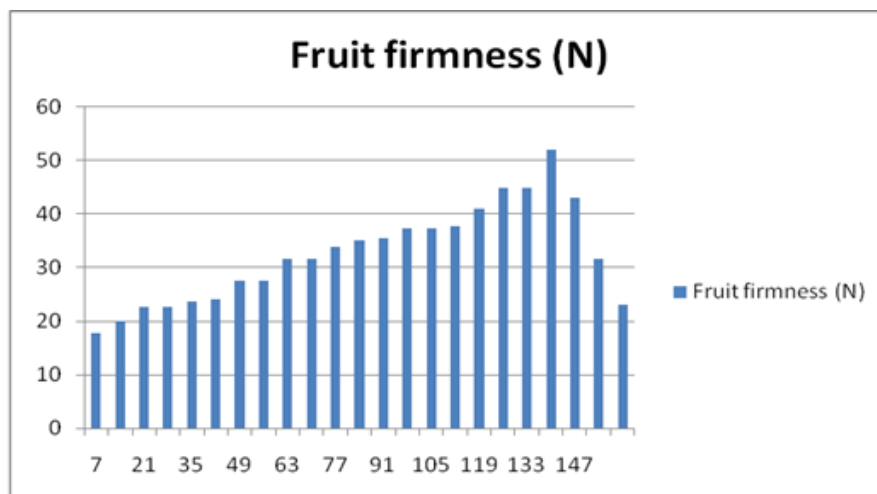


Fig. 4. Fruit firmness (N) of different days after the fruit set in guava var. Red flesh

4. CONCLUSION

In the present study it was concluded that the optimum green maturity stage was found 133 days after fruit set with mature green peel and pink pulp, and fruits were increased in size such as length and breadth, fruit weight, specific gravity, firmness, TSS, acidity and TSS/acid ratio. Regarding fully maturity stage was observed at 147 days after fruit set with changing peel in to yellowish green with bright pink pulp, whereas increased in fruit size which recorded highest length and breadth, fruit weight, specific gravity, TSS, TSS/acid ratio whereas decrease in firmness and acidity . In the case of fully ripened stage was observed that 154 days after fruit set without change in length and breadth, fruit weight whereas an increase in TSS and TSS/acid ratio while decrease in specific gravity, firmness and acidity. An increased trend in fruit weight and specific gravity was found with the days increased after fruit set and measured as maximum as 192 gm and 1.70 g/cm³ in 140 days after fruit set was decreased to 188 gm and 1.11 g/cm³ during 154 days after fruit set. The organoleptic scores of guava was recorded maximum for colour, texture, flavour, taste and overall acceptability at fully matured stage, which is most suitable for harvesting to ensure best quality.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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