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Physiological changes and hydrolyzing enzyme activities during ripening of guava (*Psidium guajava*) fruits on-tree and in-storage

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ABSTRACT

An investigation was made to compare various physiological changes and hydrolyzing enzyme activities of guava (*Psidium guajava* L.) fruits of cv. Hisar Surkha and Hisar Safeda during ripening on-tree and in-storage. For studying on-tree ripening, fruits were harvested from both winter and rainy season crop at green mature, half ripe and full ripe stages. However for in storage ripening studies, fruits were harvested at green mature stage. Studies showed a progressive decrease of moisture content of fruits with advancement of ripening both on-tree and in-storage, whereas, specific gravity of fruits exhibited an inconsistent trend during ripening on-tree but followed a continuous decreasing trend during ripening in-storage. A continuous chlorophyll degradation and carotenoid synthesis was exhibited with the advancement of ripening on-tree as well as in-storage. Activities of enzyme PPO increased with advancement of ripening on-tree as well as in-storage. Catalase activity showed a sigmoidal trend during ripening of guava fruits both on-tree and in-storage, i.e. initially increased and thereafter followed a declining trend. Changes in the activities of both the enzymes were faster during ripening in-storage as compared to ripening on-tree. The changes were faster in cv. Hisar Surkha than Hisar Safeda. Activities of both the enzymes were higher in winter season crop as compared to rainy season crop.

Key words: Carotenoids, Catalase, Chlorophyll, Guava, In-storage ripening, Moisture, On-tree ripening, Polyphenol oxydase, Specific gravity

Guava (*Psidium guajava* L.) is a perishable fruit and is susceptible to bruising and mechanical injury. Even during winter seasons, it cannot be stored for more than 4-5 days. To reduce the percent losses in guava and to avoid glut, it becomes desirable to evolve technologies for prolonging its keeping quality through delaying softening process during ripening. Development of practical solution to the post-harvest problems requires detailed understanding of the biochemistry and molecular biology of fruit ripening process. Ripening is one of the most important process in the development of fruit, which involves complex metabolic and cellular changes. It render the fruit edible by bringing changes in colour, flavour, texture, aroma and biochemical composition of the fruit. The various physiological and biochemical changes taking place in guava during ripening in isolation have been studied by many workers (Selvaraj *et al.* 1999, Jain *et al.* 2003). It has been observed that ripening behavior of fruit while attached to the tree may not be the same as in detached fruit during storage (Sharma 1996, Nunes *et al.* 2006). In addition, the ripening behaviour of fruits is also not same winter season and rainy season.

Polyphenol oxidases (PPOs) are a group of copper containing enzymes that catalyze the o-hydroxylation of monophenols to o-diphenols (tyrosinase activity, EC 1.14.18.1) as well as the oxidation of o-diphenols to quinones (catecholase activity, EC 1.10.3.2) in the presence of oxygen (Araji *et al.* 2014) . Brown discoloration in fruits arising as a result of mechanical injury during storage or processing is caused by oxidation of monophenols or diphenols by enzyme polyphenol oxidase. A marked increase in polyphenol oxidase activity of guava fruit cv. Bapatla was noticed by Saroja *et al.* (1988). Selvaraj *et al.* (1998) observed that polyphenol oxidase activity increased from green stage to peel colour turning and yellow hard stages in Allahabad Safeda and L-49 guava, respectively. Polyphenol oxidase activity during different stages of growth, development and maturation were recorded in guava cv. L-49 during winter and rainy season by Hegde (2001). Like PPO, catalase also involved in autocatalytic synthesis of ethylene or may be relevant to the activities of senescent cells. Catalase activity was high at green mature stage in Allahabad Safeda and

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green stage in L-49 guava, decreased in peel colour turning stage and showed marginal changes in later ripening stages (Selvaraj *et al.* 1998). Hegde (2001) reported a continuous increase in activity of catalase enzyme in guava cv. L-49 from 30 days after fruit set to 135 days after fruit set in winter season.

To reduce the percent losses in guava and to avoid glut, it becomes desirable to evolve technologies for prolonging its keeping quality through delaying softening process during ripening. Development of practical solution to the post harvest problems requires detailed understanding of the biochemistry and molecular biology of fruit ripening. Thus the present investigation was undertaken with the objectives to study the physiological changes as well as hydrolyzing enzyme activities during ripening of guava fruits on-tree and in-storage.

MATERIALS AND METHODS

The present investigation was carried out on rainy season and winter season crop of guava fruits of cultivars Hisar Safeda and Hisar Surkha at Post-harvest Laboratory of Department of Horticulture, CCS HAU, Hisar, India. The fruits for the study were harvested with secateurs keeping small intact pedicel with each fruit from 10 year old trees. For studying ripening on-tree, fruits from tree were harvested on the basis of visual observation and firmness at three maturity stages, viz. Green mature stage (GMS): 100% green fruit; half ripe stage (HRS): 50% yellow and 50% green fruit and full ripe stage (FRS): 80% yellow and 20% green fruit.

For studying ripening in-storage, 10 kg uniform size fruits of both the cv. Hisar Safeda and Hisar Surkha were harvested at green mature stage from the trees of uniform size and age. Fruits of all the stages were replicated four times, each of 2.5 kg, packed separately in 2 % perforated polythene bags (200 gauge) and stored at room temperature. Activities of various physiological changes and hydrolyzing activities were recorded on respective stages for on-tree ripening and on alternate days for ripening in-storage. For measuring the moisture content of the fruits, 20 g of fruit pulp was taken and dried to a constant weight in oven at 70°C. The moisture content of fruit pulp was determined by drying it to a constant weight in oven at 70°C and using formula Moisture (%) = FW-DW/FW × 100 (FW = Fresh weight; DW= Dry weight). Water displacement method was followed to record specific gravity of fruits. Density of fruit in grams per cubic centimeter was worked out by dividing weight of individual fruit by its volume. Specific gravity was calculated using the following relationship, Specific gravity = density of fruit/density of water.

Total chlorophyll and carotenoids were estimated by the method given by Wellburn (1994), by using the following equations. Chlorphyll a (µg/ml) =12.19 A_{665} - 3.45A_{645}; Chlorphyll b (µg/ml) = 21.99A_{645} - 5.32$A_{665;}$ Total chlorphyll (µg/ml) = Chlorophyll a + Chlorophyll b. Carotenoids (µg/ml) = (1000A_{454} - 2.86 chl. a - 129.2 chl.b)/ 221. These values were then converted to express the contents in mg/100 cm^2 of peel. For enzyme activity estimation homogenized sample was obtained by extracting enzyme from fruit sample in chilled buffer specified for particular enzyme as per method adapted and then centrifuging in refrigerated centrifuge. Polyphenol oxidase activity (EC 1.10.3.1) was assayed by the method given by Okagami (1979) as described by Kaul and Farooq (1994) by using catechol and trichloro acetic acid (TCA) as reagents. The catalase activity (EC1.11.1.6) was assayed by the modified method of Euler and Josephson (1927) by using H_2O_2, H_2SO_4 and $KMnO_4$ as reagent.

RESULTS AND DISCUSSION

Pulp moisture content

It is revealed from the data presented in Table 1 that pulp moisture content of fruits showed a significant and progressive decrease with the advancement of storage in both the varieties irrespective of season. Pulp moisture content of the fruit also recorded a parallel decline during ripening on-tree from 87.09% to 84.33 % and to 82.27 % at GMS, HRS and FRS, respectively in rainy season and 86.16% to 81.81% from GMS to FRS in winter season. Hisar Safeda recorded higher pulp moisture content (85.56% and 84.94 % in rainy and winter season, respectively).

During ripening in-storage, pulp moisture content decreased from 87.09 % at 0 day of storage to 81.15% on 6th day of storage during rainy season (Table 2). During winter season pulp moisture content declined from 86.16% at 0 day of storage to 81.11% on 8th day of storage. Hisar Safeda maintained higher moisture content (85.24% and 84.49%) than Hisar Surkha (82.46% and 82.45%) in rainy and winter season, respectively.

Decrease in moisture could have resulted in reduced turgor which in turn resulted into loss of firmness. This decrease may be attributed either to the evapotranspirational loss of moisture from the fruits during ripening or its utilization in the hydrolysis of insoluble reserved metabolites into soluble metabolites. Decrease in moisture content of fruits with ripening has also been reported by Jain (1999) in guava cv. L-49 and Banarsi Surkha and by Dutta and Dhua (2004) in mango. On comparing seasons it was observed that loss of firmness of guava fruits was more in rainy season than winter season which may be attributed to higher temperature.

Specific gravity

The specific gravity of guava fruits was found to be differently affected during ripening on-tree and in-storage. During ripening on-tree, specific gravity showed a sigmoidal pattern of changes by increasing from GMS to HRS and declining at FRS, specific gravity measured while on-tree ripening during rainy season was 1.00 at GMS and increased significantly to 1.05 at HRS thereafter it declined significantly to 0.93 at FRS (Table 1). In winter season also specific gravity of guava hybrids showed a significant rise from 1.02 at GMS to 1.08 at HRS and then dropped significantly to 0.98 at FRS. Varietal differences

Table 1 Pulp moisture content, specific gravity, chlorophyll and carotenoids content in guava fruits during ripening on-tree

Stage of harvest	Pulp moisture (%)			Specific gravity			Chlorophyll (mg/100cm^2)			Carotenoids (mg/100cm^2)		
	Variety			Variety			Variety			Variety		
	Hisar Safeda	Hisar Surkha	Mean	Hisar Safeda	Hisar Surkha	Mean	Hisar Safeda	Hisar Surkha	Mean	Hisar Safeda	Hisar Surkha	Mean
Rainy season												
GMS	88.36	85.83	87.09	1.02	0.98	1.00	1.36	1.18	1.27	0.70	0.58	0.64
HRS	84.92	83.74	84.33	1.08	1.02	1.05	1.12	0.98	1.05	0.76	0.63	0.69
FRS	83.41	81.14	82.27	0.94	0.92	0.93	0.71	0.69	0.70	0.83	0.69	0.76
Mean	85.56	83.57		1.01	0.97		1.06	0.95		0.76	0.63	
CD (P = 0.05)												
Variety (A)			: 1.25			NS			0.10			0.03
Stage of harvest (B)			: 1.53			0.04			0.12			0.04
A × B			: NS			NS			NS			NS
Winter season												
GMS	87.30	85.03	86.16	1.03	1.02	1.02	1.53	1.29	1.41	0.74	0.61	0.67
HRS	84.61	83.20	83.90	1.10	1.06	1.08	1.34	1.04	1.19	0.82	0.67	0.74
FRS	82.91	80.72	81.81	0.99	0.97	0.98	1.01	0.82	0.91	0.87	0.71	0.79
Mean	84.94	82.98		1.04	1.01		1.29	1.05		0.81	0.66	
CD (P = 0.05)												
Variety (A)	1.13					NS			0.14			0.02
Stage of harvest (B)	1.38					0.03			0.12			0.03
A × B	NS					NS			NS			NS

GMS = Green mature stage, HRS = Half ripe stage, FRS = Full ripe stage

Table 2 Pulp moisture content, specific gravity, chlorophyll and carotenoid content in guava fruits during ripening in-storage

Days of storage	Pulp moisture (%)			Specific gravity			Chlorophyll (mg/100 cm^2)			Carotenoids (mg/100 cm^2)		
	Variety			Variety			Variety			Variety		
	Hisar Safeda	Hisar Surkha	Mean	Hisar Safeda	Hisar Surkha	Mean	Hisar Safeda	Hisar Surkha	Mean	Hisar Safeda	Hisar Surkha	Mean
						Rainy season						
0	88.36	85.83	87.09	1.02	0.98	1.00	1.36	1.18	1.27	0.70	0.58	0.64
2	86.33	83.26	84.79	0.96	0.91	0.93	1.21	0.88	1.04	0.74	0.62	0.68
4	83.51	81.32	82.41	0.93	0.88	0.90	0.95	0.62	0.78	0.78	0.66	0.72
6	82.79	79.46	81.12	0.89	0.68	0.78	0.67	0.32	0.49	0.80	0.80	0.80
Mean	85.24	82.46		0.95	0.86		1.04	0.75		0.75	0.66	
	CD (P = 0.05)											
	Variety (A) : 1.01					0.02			0.10			0.03
	Storage period (B) : 0.96					0.03			0.15			0.04
	A × B : NS					0.05			NS			0.06
						Winter season						
0	87.28	85.05	86.16	1.09	1.06	1.07	1.54	1.26	1.40	0.72	0.60	0.66
2	86.06	83.79	84.92	1.06	1.04	1.05	1.47	1.14	1.30	0.75	0.64	0.69
4	84.64	82.59	83.61	1.01	0.96	0.98	1.29	0.99	1.14	0.81	0.69	0.75
6	82.46	80.62	81.54	0.98	0.94	0.96	1.05	0.87	0.96	0.83	0.71	0.77
8	82.01	80.21	81.11	0.92	0.90	0.91	0.97	0.78	0.87	0.8	0.73	0.80
Mean	84.49	82.45		1.01	0.98		1.26	1.00		0.79	0.67	
CD (P=0.05)												
	Variety (A) 1.19					0.02			0.11			0.02
	Storage period (B) 1.23					0.03			0.15			0.03
	A × B NS					NS			NS			NS

as well interactions between varieties and stages of harvest were statistically non-significant. Initial increase in specific gravity during ripening may be due to less increase in fruit volume than that of fruit weight. However, at later ripening stages it decreased due to considerable increase in fruit volume and relatively slower increase in fruit weight. This increase in volume may be attributed to the increase in intercellular spaces with advancement of maturity (Baker and Davis 1951). These results corroborate the findings of Hegde and Chharia (2004) in guava cv. L-49 and in Kinnow by Lallanram and Godara (2005).

During ripening in storage, specific gravity followed a continuous decreasing trend throughout the storage period. On 0 day of storage, in rainy season, specific gravity was 1.02 and 0.98 in cv. Hisar Safeda and cv. Hisar Surkha, respectively, which declined progressively to 0.89 and 0.68 on 6th day of storage (Table 2). This decrease in specific gravity during storage has also been reported in ber (Godara and Sharma 1999) and Kinnow mandarin by Arya (2001). In winter season, maximum value of specific gravity (1.07) was measured on 0 day of storage which reduced to 1.05 on 2nd day of storage and obtained a minimum value of 0.91 on 8th day of storage. No variation was recorded in specific gravity of both the hybrids with respect to storage period in winter season. On comparing both the hybrids, higher value of specific gravity (0.95 and 1.01 in rainy and winter season, respectively) was recorded in cv. Hisar Safeda than cv. Hisar Surkha (0.86 and 0.98 in rainy and winter season, respectively).

Chlorophyll and carotenoids

Results of the present investigation revealed a progressive decline in chlorophyll content and simultaneous increase in carotenoids during ripening of guava fruits on-tree as well as in-storage. During ripening on-tree, chlorophyll content reduced from 1.27 mg/100 cm^2 at GMS to 1.05 mg/100 cm^2 at HRS and declined further to 0.70 mg/100 cm^2 during rainy season (Table 1). Similar trend was observed during winter season with chlorophyll content equivalent to 1.14, 1.19 and 0.91 mg/100 cm^2 at GMS, HRS and FRS, respectively, while the carotenoid content increased from 0.64 mg/100 cm^2 at GMS to 0.76 mg/100 cm^2 at HRS in rainy season and from 0.67 to 0.79 mg/100 cm^2 in winter season.

During ripening, in-storage, chlorophyll content declined significantly from 1.27 mg/100 cm^2 at 0 day of storage to 0.49 mg/100 cm^2 on 6th day of storage in rainy season and from 1.40 mg/100 cm^2 at 0 day to 0.87 mg/100 cm^2 on 8th day of storage in winter season, while carotenoid content increased from 0.64 mg/100 cm^2 to 0.80 mg/100 cm^2 from 0 days to 6th day of storage during rainy season and in winter season it increased from 0.66 to 0.80 mg/100 cm^2 from 0 to 8th day of storage respectively (Table 2). Cultivar Hisar Safeda maintained higher chlorophyll as well as carotenoid content throughout the experiment irrespective of harvesting stage or storage period.

This loss in chlorophyll content may be attributed to an increased chlorophyll degrading enzyme activities such as chlorophylase and peroxidase (Yamauchi and Hashinaga 1992, Yamauchi *et al.* 1997) during development and ripening. Similar results were also reported in guava by Selvaraj *et al.* (1998), Jain (1999) and Hegde (2001). During the entire investigation cv. Hisar Safeda maintained higher chlorophyll content than cv. Hisar Surkha. Kamboj (1997) have also reported higher chlorophyll content in cv. Hisar Safeda than cv. Hisar Surkha. Increase in carotenoid content in peel of guava fruits may be due to increased synthesis of carotenoids or unmasking of carotenoids by decrease in chlorophyll (Woodward 1972). In the present study, both these factors, i.e. synthesis of carotenoids and degradation of chlorophyll seem to be involved as there was significant increase in carotenoids content which means there was active synthesis of carotenoids during ripening of guava fruit and also a progressive decrease was observed in cholorophyll content which helped in unmasking the carotenoid pigments already present in fruits. These observations are in agreement with the results of Jain *et al.* (2003) in guava cv. Banarsi Surkha and Selvaraj and Raja (2000) in Kagzi lime. However these results are in contradiction to the findings of Selvaraj *et al.* (1999) who observed a decrease in carotenoid content of guava fruits of cv. Allahabad Safeda and Sardar with advancement of ripening. Cultivar Hisar Safeda had higher content of carotenoids than cv. Hisar Surkha. These results are in accordance with the findings of Kamboj (1997) who also observed higher carotenoids in cv. Hisar Safeda than cv. Hisar Surkha.

Polyphenol oxidase (PPO)

Polyphenol oxidase activity of the fruits followed a significant increasing trend with the advancement of ripening of guava fruits both on-tree and in-storage. During on-tree ripening, in rainy season, the PPO activity in cv. Hisar Safeda was recorded as 1.96 units/g FW/h at green mature stage which increased to 3.13 and 4.50 units/g FW/h at half ripe and full ripe stages, respectively, whereas PPO activity in cv. Hisar Surkha, during rainy season increased from 2.54 to 3.73 units/g FW/h from green mature to half ripe stage and attained maximum (5.35 units/g FW/h) at full ripe stage (Table 3). More or less similar pattern of chages in PPO activity was observed in winter season fruits. The PPO activity in cv. Hisar Safeda increased from 3.09 to 5.65 units/g FW/h from green mature stage to full ripe stage while in cv. Hisar Surkha this increase was from 3.72 to 6.49 units/g FW/h.

During ripening in storage, in rainy season, fruits of cv. Hisar Safeda exhibited PPO activity of 1.96 units/g FW/h on 0 day of storage and increased subsequently to 4.54 units/g FW/h on 6th day of storage (Table 4). In case of cv. Hisar Surkha, it increased from 2.54 to 5.0 units/g FW/h from 0 to 6th day of storage. In winter season activity of PPO in cv. Hisar Safeda was found to increase from 3.16 units/g FW/h on 0 day of storage to 5.31 units/g FW/h on 8th day of storage, whereas this increase in cv. Hisar Surkha was from 3.87 to 6.32 units/g FW/h.

Table 3 Polyphenol oxidase (PPO) and catalase activity in guava fruits during ripening on-tree

Stage of harvest	PPO (units*/ g FW /h)			Catalase (units*/ g FW /h)		
	Hisar Safeda	Hisar Surkha	Mean	Hisar Safeda	Hisar Surkha	Mean
			Rainy season			
GMS	1.96	2.54	2.25	596.33	602.53	599.43
HRS	3.13	3.73	3.43	704.16	712.53	708.34
FRS	4.50	5.35	4.92	681.08	644.09	712.58
Mean	3.20	3.87		660.52	653.05	
CD (P = 0.05)						
Variety (A)		0.11			14.01	
Storage period (B)		0.14			15.12	
A × B		0.17			16.2	
			Winter season			
GMS	3.09	3.72	3.40	694.48	700.18	697.34
HRS	4.48	5.45	4.96	799.94	808.18	804.06
FRS	5.65	6.49	6.07	782.90	787.80	785.35
Mean	4.41	5.22		759.11	765.38	
CD (P = 0.05)						
Variety (A)		0.12			14.36	
Storage period (B)		0.14			15.89	
A × B		0.16			17.68	

1 unit* of PPO = change in 1 OD at 430 nm, 1 unit* of catalase = 1 mmole of H_2O_2 splitted. GMS = Green mature stage, HRS = Half ripe stage, FRS = Full ripe stage.

This decrease in PPO activity results into decrease in astringency due to oxidation of phenols by PPO (Caldeira 1967). Furthermore, the PPO enzyme plays a vital role in the biochemical processes leading to maturation of fruits (Dilley 1970). Mowlah and Itoo (1982) reported a marked increase in PPO activity during ripening and disappearance of astringency due to decreased phenols in guava fruits. Similar observations have also been observed in guava by Selvaraj *et al.* (1998) and Hegde (2001).

Catalase

The results revealed a fluctuating trend in catalase activity during ripening of guava fruits. During ripening on-tree, in rainy season, it was 596.33 units/g FW/h at green mature stage which increased significantly 704.16 units/g FW/h at half ripe stages and reduced to 681.08 units/g FW/h at full ripe stage in cv. Hisar Safeda (Table 3). In cv. Hisar Surkha, catalase activity increased from 602.53 to 712.53 units/g FW/h from green mature to half ripe stage and there after declined significantly to 644.09 units/g FW/h at full ripe stage. At the same time, during winter season, a significant increase from 694.48 to 799.94 units/g FW/h from green mature stage to half ripe stage in cv. Hisar Safeda and 700.18 to 808.18 units/g f wt/h in cv Hisar Surkha was observed and it then showed a significant decline to 782.90 and 787.80 units/g FW/h in cv. Hisar Safeda and cv. Hisar Surkha, respectively.

During ripening in-storage in rainy season, initially catalase activity followed an increasing trend from 596.33 to 706.64 units/g FW/h from 0 to 4th day of storage in cv. Hisar Safeda and showed a significant reduction to 625.42 units/g FW/h on 6th day of storage (Table 4). In the same season, cv. Hisar Surkha recorded catalase activity of 602.53 units/g FW/h on 0 day of storage which increased significantly to 735.27 units/g FW/h on 2nd day of storage, thereafter in decreased significantly and reached a minimum value of 615.18 units/g FW/h on 6th day of storage.

In winter season, catalase activity in the fruits of cv. Hisar Safeda, increased significantly from 694.61 units/g FW/h to a maximum value of 800.51 units/g FW/h on 4th day of storage. Thereafter, it exhibited a declining trend and reduced to 727.28 and 624.64 units/g FW/h on 6th and 8th day of storage, respectively. In case of cv. Hisar Surkha, activity of catalase increased significantly from 700.41 units/g FW/h on 0 day to 814.14 units/g FW/h on 4th day of storage and then it decreased to 738.49 and 634.13 units/g FW/h on 6th and 8th day of storage respectively.

The findings of present investigations revealed that activity of enzyme catalase increased in the beginning and then decreased in later ripening stages of guava fruits on-tree as well as in-storage. Usually, catalase has been found to be involved in ethylene biosynthesis. Similar fluctuating trend in catalase activity has also been observed in guava by Selvaraj *et al.* (1998) and Hegde (2001) and in Kinnow mandarin by Lallanram and Godara (2005).

In the present investigation, both the cultivars viz. Hisar Safeda and Hisar Surkha maintained more or less same trend of catalase activity during ripening on-tree as well as in-storage. Catalase activity was found to be considerably high in winter season fruits, this may be explained due to slow degradation of H_2O_2 radicals at low temperature.

Conclusion

Fruit ripening is a complex, genetically programmed process that culminates in dramatic changes of colour, texture, flavor and aroma of fruit flesh. An understanding

Table 4 Polyphenol oxidase (PPO) and catalase activity in guava fruits during ripening in-storage

Days of storage	PPO (units*/g FW/h)			Catalase (units*/g FW/h)		
	Hisar Safeda	Hisar Surkha	Mean	Hisar Safeda	Hisar Surkha	Mean
			Rainy season			
0	1.96	2.54	2.25	596.33	602.53	599.43
2	2.50	3.73	3.11	681.08	735.27	708.17
4	3.52	4.91	4.21	706.64	721.42	714.03
6	4.54	5.01	4.77	625.42	615.18	620.30
Mean	3.13	4.04	652.42	668.60		
CD (P = 0.05)						
Variety (A)		0.10			16.44	
Storage period (B)		0.11			16.08	
A × B		0.13			17.25	
			Winter season			
0	3.16	3.87	3.52	694.61	700.41	697.51
2	3.85	4.75	4.30	770.51	778.56	744.54
4	4.32	5.32	4.82	800.51	814.14	807.32
6	4.83	5.84	5.34	727.28	738.49	732.88
8	5.31	6.32	5.82	624.64	634.13	629.38
Mean	4.29	5.22			723.51	733.15
CD (P = 0.05)						
Variety (A)		0.13			14.86	
Storage period (B)		0.15			15.57	
A × B		0.17			17.11	

1 unit* of PPO = change in 1 OD at 430 nm, 1 unit* of catalase = 1 mmole of $_{H2O2}$ splitted.

of these changes during ripening is of primary importance in checking post harvest losses and enhancing shelf life of fruits. In general, all the physical as well as physiological changes taking place during ripening of guava fruits were more pronounced during ripening in- storage as compared to ripening on-tree. Also the changes were rapid in rainy season than in winter season. Cultivar Hisar Surkha exhibited faster changes than cv. Hisar Safeda. Thus it can be concluded that physiological parameters, viz. moisture content, specific gravity, chlorophyll and carotenoid content and hydrolyzing enzymes catalase and PPO govern the ripening and shelf life of guava fruits and the information generated in the present study can be exploited to develop various post-harvest techniques to extend shelf life of guava fruits.

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