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Effect on colour, flavour, firmness and enzyme activities of peach (cv. TA 170) fruits harvested at different growth stages

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Abstract
Studies were conducted on Colour flavour, firmness and enzyme activities of peach (cv. TA 170) fruits harvested at different stages of growth for two years. The fruit firmness showed a declining trend from 65 DAFS till 80 DAFS, the sensory evaluation on flavour recorded the highest score on 70-75 DAFS, Light green colour of peach which indicates maturity was observed from 60 DAFS, a break in color towards yellow is the first definite indication of maturity and this colour break stage was reached at 65 DAFS, brightening of the red over-color of the skin was confirmed at 70 DAFS, the enzyme activity of pectin methyl esterase and polygalacturonase increased with the advancement of maturity and ripening of fruits. Cell-wall-degrading enzymes polygalacturonase became active during the final stages of ripening. For distant marketing fruits can be harvested at colour break stage *i.e* 60-65 DAFS, for local market when fruits attain reddish colour *i.e* 65-70 DAFS and for immediate consumption 70-75 DAFS when fruits attain complete maturity.

Keywords: Peach, growth stages, enzymes, firmness, colour

Introduction
The cultivar TA-170 is a low chilled peach variety, imported from U.S and was named as Partap in India, which require only 100-400 chilling hours during the year for proper flowering and fruiting. It is large fruited with average weight of 61.96 g and the fleshy mesocarp adheres to the stone (clingstone). The taste of the fruit is sweet, aromatic and rich in flavour (Singh *et al.*, 2007) [9].
The studies were conducted on seven years old peach plants cv. TA-170 for two years. The trees were selected on the basis of their uniform growth, vigour, productivity and free from insect and pest attack. These trees were grown under rainfed conditions and spaced at 4x4m distance and trained to open centre system. The research was laid out at Horticultural Research farm, ICAR Research Complex for NEH Region, Umiam (Meghalaya).

Fruit sample collection-The steps undertaken for collection of fruit samples:-
1. When plant came to flowering, the flowers of the same age group were tagged.
2. Regular observations were made on the growth and development of fruit.
3. Fruit samples were collected from these tagged plants.

Stages of harvesting
The fruits were harvested in the following Days after Fruit Set (DAFS)
1. 50 DAFS (D_1)
2. 55DAFS (D_2)
3. 60DAFS (D_3)
4. 65DAFS (D_4)
5. 70DAFS (D_5)
6. 75DAFS (D_6)
7. 80 DAFS (D_7)

The above DAFS represented the different stages of maturity of fruit *i.e* Mature green, Colour break, Half red and Full red stage according to visual observations.

Materials and Methods
CIELab parameters, *i.e.* 'L', 'a' and 'b' values were determined in a Hunter Lab Color Quest

XE Colorimeter. Hue, chroma and ΔE were calculated from the following equations

$$\text{Hue} = \text{Tan}^{-1}\, b/a$$

$$\text{Chroma}=\sqrt{a^2 + b^2}$$

Each sample was evaluated for various quality attributes *viz*. flavour/taste and overall acceptability by using nine-point Hedonic scale (Amerine *et al.*, 1965) [2]. (0- disliked extremely, 9- liked extremely).

Firmness values of each individual peach were measured at three points of the equatorial region by using the TA-XT2i Texture Analyser (Microstable Instruments, UK) with a 5 mm diameter flat probe. The probe descended toward the sample at 5.0 mm/sec and the maximum force (N) was defined as firmness. The firmness of each peach was measured three times on different sides. The results were expressed in Newton (N).

Pectinmethyl esterase (PME) activity was determined by the method described by Ranganna (1994).

$$\text{PE U/g}= \frac{\text{mlof 0.02 NNaOHconsumedx 3.1x1min}}{\text{mlofenzymepreparationxtotaltimeofdeterminationinmin}}$$

Polygalacturonase activity (PG) was determined by the method described by Mahadevan and Sridhar (1982) [5]. After holding the mixture at 30± 1^0 C for 16 hours its efflux time was recorded again and the per cent loss in viscosity was interpreted as being proportional to the PG activity.

$$\text{Per cent loss in viscosity of substrate V}= \frac{T_0 - T}{T_0 - TH_2O} \times 100$$

Where,

T_0 = Initial flow time

T= Flow time of reaction mixture after 16 hours

TH_2O = Flow time of distilled water

Results and Discussion

Colour reflectance of the peach fruits was measured as the Hunter colour values ('L', 'a' and 'b'). L is a measure of lightness on a scale ranging from '0' (black) to '100' (white), + 'a' denotes redness, -'a' indicates greenness when the values are negative, + 'b' denotes yellowness when the values are positive and –'b' indicates blue when the values are negative respectively. In the present study, the lightness of colour increased till 60 DAFS when fruit growth advanced towards maturity and then decreased. The ground color of a peach approaching maturity is light green. A break in color towards yellow is the first definite indication of maturity. 'b' value from the hunter reading indicated that this colour break stage was reached at 65 DAFS. Red color is typically dull prior to the green, turning to yellow break colour. When the underlying ground color breaks to yellow, the red brightens and can easily be selected. Brightening of the red over-colour of the skin was confirmed at 70 DAFS which was confirmed from the 'a' values obtained through hunter colour reading. Similar findings were also observed by Richard *et al*., (1991) [7].

'L' value

It is clear from table 1 and fig. 1 that 'L' value increased till 60 DAFS (52.15) in 1st year and (52.10) in 2nd year and then declined till 80 DAFS (40.87) in the first year and (40.81) in the later year of study.

There was a significant difference of 'a' value in the different stages or DAFS in both the years of study. During 1st year, significantly high values of 'a' was found from 75 DAFS (7.45) to 80 DAFS (8.00). Similar trend was observed during later year.

During 1st year, significantly high values of 'b' were found from 65 DAFS (4.50) till 80 DAFS (7.20). However, the data recorded on 80 DAFS was statistically at par with 75 DAFS (7.10). From table 1and fig. 1 it was also evident that similar trend in 'b' value was reflected in the later year of study.

Chroma also differed significantly in different stages of maturity and ripening during both the years of study. The highest value was recorded in 80 DAFS 1st year (59.84) and 2nd year (59.81).

Similarly the hue values showed a significantly declining trend with the advancement of stages or DAFS in both the years of study. The highest was recorded in 50 DAFS (57.63) and the lowest in 80 DAFS (31.89) in 1st year, similar results were obtained in the 2nd year also

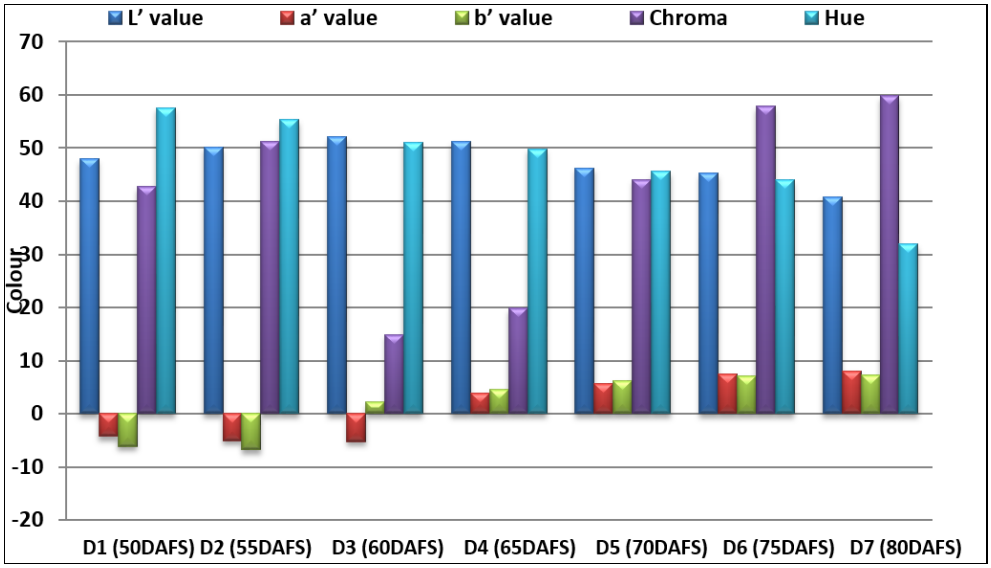

Fig 1: Changes in colour of peach (cv. TA-170) fruits harvested at different growth stages.

Organoleptic evaluation was carried out for flavour and the highest scores were obtained at 70-75 DAFS (8.01) and the scores decreases beyond this stage till 80 DAFS (7.80). The lowest score was obtained in 50 DAFS (5.10)

As fruits matures, fructose and glucose decrease and sucrose increases. Malic acid and citric acid are the predominant organic acids. The decline in total acids as the fruit matures results from a major loss of malic acid as reported by Ryall and Pentzer, (1982) [8] in peach.

Fruit firmness

The firmness of fruits at 50 DAFS was statistically at par till 65 DAFS (118.12 N in 1st year) and (118.10 N in 2nd year) and then declined significantly till 80 DAFS (86.52 N and 86.53 N respectively for both the years). The initial increase in fruit firmness upto 60 DAFS was nearly 2.50 per cent whereas the reduction thereafter from 65 to 80 DAFS was almost 27 per cent for both the years of study. Fruit enlarge rapidly due to cell enlargement and fruit firmness declines as cell wall becomes thin, as reported by Walsh *et al*., (1989) in peach. The decrease in the firmness of the peach var. TA-170 could also be due to increased levels of TSS and total sugars. This was in accordance with the findings of Crisosto (1994) [3] in peach fruits.

Pectin methyl esterase and polygalacturonase activity

It was observed that the enzyme activity of pectin methyl esterase and polygalacturonase increased with the advancement of maturity and ripening of fruits. The lowest PME was recorded at 50 DAFS (0.31 U/g pulp) and significantly rapid increasing trend was recorded from 70 DAFS (0.92 U/g) to 80 DAFS (1.11 U/g pulp). PME activity increased by 258 per cent at 80 DAFS over 50 DAFS during both the year of study.

Significantly increasing trend with the enhancement of fruit maturity was observed for polygalacturonase activity during both the years of study. The lowest polygalacturonase activity (9.83) was recorded at 50 DAFS and the maximum (15.21) at 80 DAFS in 1st year. Polygalacturonase activity increased by nearly 55 per cent at 80 DAFS as compared to only 9.83 per cent at 50 DAFS in both the years of observation, the increase of the enzyme activity was over 54 per cent at 80 DAFS as compared to 9.84 per cent at 50 DAFS.

The firmness decreased as the peach fruit became more tree ripe. However, there was no major relationship between PME activity alone and major changes in firmness. The on tree ripening and softening of fruits was not fully related to PME activity. The PME is responsible for initiation of pectin degradation which causes softening of fruits. Polygalacturonase cannot degrade pectin unless PME has de-esterified the pectin molecule. This was in accordance with the findings of Abu- Sarra *et al*., (1992) [1], Fischer *et al*., (1991) [4] and Nagar (1994) [6] in peach fruits. Softening of a harvested peach is prompted by cell-wall-degrading enzymes that become active during the final stages of ripening (Nagar, 1994) [6].

Table 1: Effect on colour of peach (cv. TA 170) fruits harvested at different growth stages

Treatments	L value		A value		B value		Chroma		Hue	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
D_1 (50 DAFS)	47.91	47.98	-4.32	-4.29	-6.20	-6.22	42.76	42.78	57.63	57.61
D_2 (55 DAFS)	50.22	50.30	-5.12	-5.10	-6.80	-6.81	51.35	51.32	55.34	55.32
D_3 (60 DAFS)	52.15	52.10	-5.27	-5.22	2.25	2.22	14.88	14.84	51.04	51.08
D_4 (65 DAFS)	51.19	51.15	3.92	3.96	4.50	4.51	19.86	19.82	49.84	49.80
D_5 (70 DAFS)	46.25	46.21	5.66	5.64	6.20	6.24	44.10	44.14	45.58	45.62
D_6 (75 DAFS)	45.25	45.25	7.45	7.42	7.10	7.15	57.86	57.81	43.96	43.91
D_7 (80 DAFS)	40.87	40.81	8.00	8.10	7.20	7.22	59.84	59.81	31.89	31.80
S.Ed.±	2.670	2.667	0.032	0.032	0.082	0.083	0.032	0.032	0.003	0.003
CD-5%	5.727	5.721	0.068	0.069	0.175	0.177	0.068	0.069	0.007	0.007
CD-1%	7.948	7.940	0.094	0.096	0.243	0.246	0.095	0.096	0.009	0.010

D_1 (50DAFS), D_2 (55DAFS), D_3 (60DAFS), D_4 (65DAFS), D_5 (70DAFS), D_6 (75DAFS), D_7 (80DAFS)

Table 2: Effect on flavor firmness and enzyme activities of peach (cv. TA 170) fruits harvested at different growth stages

Treatments	Flavour		Fruit Firmness (N)		PME activity (U/g)		PG activity	
	2008	2009	2008	2009	2008	2009	2008	2009
D_1 (50 DAFS)	5.10	5.10	115.93	115.94	0.31	0.32	9.83	9.84
D_2 (55 DAFS)	5.53	5.53	116.24	116.22	0.39	0.39	11.05	11.07
D_3 (60 DAFS)	6.88	6.88	118.83	118.85	0.54	0.54	11.89	11.90
D_4 (65 DAFS)	7.82	7.82	118.12	118.10	0.64	0.64	12.02	12.03
D_5 (70 DAFS)	8.01	8.01	110.61	110.63	0.92	0.93	13.51	13.51
D_6 (75 DAFS)	8.00	8.00	102.12	102.11	1.03	1.04	14.21	14.22
D_7 (80 DAFS)	7.80	7.80	86.52	86.53	1.11	1.12	15.21	15.20
S.Ed.±	0.036	0.037	1.759	1.760	0.007	0.008	0.019	0.021
CD-5%	0.077	0.079	3.773	3.775	0.016	0.017	0.042	0.045
CD-1%	0.108	0.110	5.236	5.239	0.022	0.024	0.058	0.062

D_1 (50DAFS), D_2 (55DAFS), D_3 (60DAFS), D_4 (65DAFS), D_5 (70DAFS), D_6 (75DAFS), D_7 (80DAFS)

Conclusion

Colour and firmness are the two easy non-destructive means of maturity indices, which can be used in selecting fruits for harvesting. Peaches are climacteric fruits, which mean they will continue to ripen even after harvest. For distant marketing fruits can be harvested at colour break stage *i.e* 60-65 DAFS, for local market when fruits attain reddish colour *i.e* 65-70 DAFS and for immediate consumption 70-75 DAFS when fruits attain complete maturity.

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