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Studies on the Variability in Biochemical Characters in F_1 Progenies of Peach (*Prunus persica* L.)

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ABSTRACT

Peach (*Prunus persica* L.) is an important fruit crop valued for its fresh and canned forms. There are a large number of cultivars, which are grown in different agro-climatic conditions in states like Jammu and Kashmir, Himachal Pradesh and North Eastern States. In the present study, some hybrids, evolved from crosses using six female parents (July Elberta, Alton, J. H. Hale, Kanto-5, Saharanpuri and Quetta) and one male parent (Kateroo, a local peach cultivar of Himachal Pradesh), were evaluated for some important biochemical parameters. The fruits harvested from these hybrids were evaluated in terms of titrable acidity, total soluble solid, reducing sugar, non-reducing sugar, total sugar and TSS/acid ratio. The mean values for titrable acidity for each cross varied between 0.50 to 0.75%, TSS from 11.53 to 12.90°B, reducing sugars from 2.33 to 2.88%, non-reducing sugars from 6.27 to 6.83%, total sugars from 9.24 to 10.05% and TSS/acid ratio between 14.47 to 23.90. The coefficient of variability varied from 11.07 to 31.50% for titratable acidity, 0.00 to 23.02% for TSS, 5.24 to 18.53% for reducing sugars, 2.09 to 15.14% for non-reducing sugars, 0.00 to 6.80% for total sugars and 18.23 to 156.51% for the TSS/acid ratio in these crosses. Significant variation with respect to biochemical parameters observed in different cross combinations showed the vast scope for improvement of this important fruit crop.

Key words: *Prunus persica*, F_1 progenies, variability, biochemical characters, acidity, sugar, TSS

INTRODUCTION

Peach (*Prunus persica* L.) is an important fruit crop valued for its fresh and canned fruits. It is native to China where its culture dates back to at least 3000 years. It has wider climatic adaptability, and now its cultivation has been successfully extended to various sub-tropical regions around the world. Peach is commercially grown in USA, Italy, France, England, Australia and China but in India, Pakistan, Turkey, Japan, Germany and USSR, its cultivation is on a small scale. In India, it is grown in the mid hills zone of Himalayas extending from Jammu & Kashmir to North Eastern States at an altitude of 1000-2000 m above MSL. The area and production of peaches and nectarines in the world during 2011 was 1.57 million ha 21.53 million tonnes, respectively (FAO 2013). India produced 90.8 thousand tonnes peach from an area of 20.3 thousand hectares during 2011-12 (NHB 2013). Most of the peach cultivars have been bred in various countries suitable to their agro-climatic conditions. In India, some attempts have also been made, and some good varieties have been developed. In the peach breeding programme initiated in 1997, crosses were made between July Elberta, Alton, J. H. Hale, Saharanpuri, Kanto-5 and Quetta with one local peach cultivar of Himachal Pradesh 'Kateroo' with an objective to evolve cultivars, which are suitable to local agro-climatic conditions, have different maturity period and varied qualitative characters. In the present study, some of the F_1 hybrids produced in the peach breeding programme were evaluated for a set of biochemical parameters considered important for fruit quality.

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MATERIALS AND METHODS

The experiment was carried out with the F_1 hybrids from seven different parents namely July Elberta, Alton, J. H. Hale, Kanto-5, Saharanpuri and Quetta as female and local cultivar 'Kateroo' as male. The experimental area is located at 30°86'N latitude and 77°17'E longitude at an elevation of 1220 m above mean sea level, having a mild temperate climate. The crosses made during the year 1997 resulted in 76 hybrid seedlings of six different combinations and all of them, grouped into crosses, were selected for the study. There were all total three replications (plants), and ten ripe fruits were selected from each replication for biochemical analysis. Standard biochemical procedure was followed for determination of different biochemical characters *viz.* titrable acidity, total soluble solids, reducing sugar, non-reducing sugar and TSS/acid ratio as given by Ranganna (2007). Based on the mean values observed, hybrids were categorized in to low, medium and high groups for each parameter and presented as percentage of individuals in that category. The coefficient of variation was calculated to know the extent of variability in each character of each cross. The t-test was applied to test the significance of differences between the means of different crosses. The methods were followed as suggested by Panse et al. (1985).

RESULTS AND DISCUSSION

The important biochemical characters *viz.* titratable acidity, total soluble solids, total sugars, reducing sugars, non-reducing sugars, TSS/acid ratios were analyzed for assessing the quality of peach hybrids obtained from different cross combinations. The experimental results showed significant differences between the hybrids for most of the biochemical parameters.

Titratable acidity : The perusal of the data (Table 1) revealed that in all the six crosses, a

Table1: Classification of peach hybrids in respect of titratable acidity

Crosses	Number of hybrids	Percentage of hybrids in different groups			Mean of the cross	Coefficient of variation (%)
		Low (<0.605%)	Medium (0.605-0.705%)	High (>0.705%)		
July Elberta x Kateroo	30	16.67	23.33	60.00	0.70	19.29
Alton x Kateroo	2	50.00	0.00	50.00	0.64	22.33
J. H. Hale x Kateroo	29	58.63	24.13	17.24	0.61	19.90
Kanto-5 x Kateroo	2	0.00	50.00	50.00	0.68	11.07
Saharanpuri x Kateroo	2	0.00	50.00	50.00	0.75	20.18
Quetta x Kateroo	11	45.46	27.27	27.27	0.50	31.55

Test of Significance

Mean of pairs	t-value
July Elberta x Kateroo and Alton x Kateroo	0.589
Julu Elberta x Kateroo and J.H.Hale x Kateroo	2.786*
July Elberta x Kateroo and Kanto-5 x Kateroo	9.903*
July Elberta x Kateroo and Saharanpuri x Kateroo	6.248*
July Elberta x Kateroo and Quetta x Kateroo	2.353*
Alton x Kateroo and J.H.Hale x Kateroo	0.296
Alton x Kateroo and Kanto-5 x Kateroo	0.351
Alton x Kateroo and Saharanpuri x Kateroo	0.758
Alton x Kateroo and Quetta x Kateroo	0.709
J.H.Hale x Kateroo and Kanto-5 x Kateroo	1.159
J.H.Hale x Kateroo and Saharanpuri x Kateroo	1.294
J.H.Hale x Kateroo and Quetta x Kateroo	0.858
Kanto-5 x Kateroo and Saharanpuri x Kateroo	0.582
Kanto-5 x Kateroo and Quetta x Kateroo	1.531
Saharanpuri x Kateroo and Quetta x Kateroo	1.595

*Significant at 5 per cent level

majority of the hybrids produced fruits with high acidity ranging between 17.24% in J. H. Hale x Kateroo to 60.00% in July Elberta x Kateroo. The proportions of hybrids with medium acidity ranged between 23.33% in July Elberta x Kateroo to 50.00% in Kanto-5 x Kateroo and Saharanpurix Kateroo; whereas, Alton x Kateroo crosses did not produce any hybrid with medium acidity. The proportions of hybrids with low acid the minimum in all the crosses. Kanto-5 x Kateroo and Saharanpuri x Kateroo crosses did not produce any hybrid with low acidity. The coefficient of variation was observed between 11.07% (Kanto-5 x Kateroo) to 31.55% (Quetta x Kateroo) for different cross combinations. Four means of pairs showed significant differences.

Total soluble solid (TSS) : In terms of the TSS (Table 2), majority of hybrids in all the cross combinations produced fruits with medium TSS. The proportions of such hybrids ranged between 50% in Kanto-5 x Kateroo to 100% Alton x Kateroo. Low TSS was found only in July Elberta x Kateroo (10.00%) and Saharanpuri x Kateroo (5.00%). The mean of the cross varied from 11.53 (Quetta x Kateroo) to 13.50 (Alton x Kateroo); whereas, the coefficient of variation ranged from 0.00% in Alton x Kateroo to 23.02% in Saharanpuri x Kateroo. Four mean pairs were found to have significant differences.

Reducing sugars : In all the crosses, the highest proportions of hybrids were medium for reducing sugars, which ranged between 27.27% in Quetta x Kateroo to 100.00% in Alton x Kateroo (Table 3). The hybrids with high reducing sugars content varied between 26.67% in July Elberta x Kateroo to 54.55% in Quetta x Kateroo; whereas, Alton x Kateroo and Saharanpuri x Kateroo crosses did not produce any hybrid with high reducing sugar. The percentage of hybrid individuals with low reducing sugar content varied between 10.00% (July Elberta

Table 2: Classification of peach hybrids in respect of total soluble solid

Crosses	Number of hybrids	Percentage of hybrids in different groups			Mean of the cross	Coefficient of variation (%)
		Low (<9.0%)	Medium (9.0-13.5%)	High (>13.5%)		
July Elberta x Kateroo	30	10.00	76.67	13.33	12.34	8.47
Alton x Kateroo	2	0.00	100.00	0.00	13.50	0.00
J. H. Hale x Kateroo	29	0.00	79.32	20.68	12.78	8.26
Kanto-5 x Kateroo	2	0.00	50.00	50.00	12.15	19.21
Saharanpuri x Kateroo	2	5.00	55.00	40.00	12.90	23.02
Quetta x Kateroo	11	0.00	90.91	9.09	11.53	13.14

Test of Significance

Mean of pairs	t-value
July Elberta x Kateroo and Alton x Kateroo	6.346*
Julu Elberta x Kateroo and J.H.Hale x Kateroo	1.681
July Elberta x Kateroo and Kanto-5 x Kateroo	0.115
July Elberta x Kateroo and Saharanpuri x Kateroo	0.266
July Elberta x Kateroo and Quetta x Kateroo	1.642
Alton x Kateroo and J.H.Hale x Kateroo	3.842*
Alton x Kateroo and Kanto-5 x Kateroo	0.819
Alton x Kateroo and Saharanpuri x Kateroo	0.286
Alton x Kateroo and Quetta x Kateroo	4.299*
J.H.Hale x Kateroo and Kanto-5 x Kateroo	0.380
J.H.Hale x Kateroo and Saharanpuri x Kateroo	0.057
J.H.Hale x Kateroo and Quetta x Kateroo	2.525*
Kanto-5 x Kateroo and Saharanpuri x Kateroo	0.281
Kanto-5 x Kateroo and Quetta x Kateroo	0.363
Saharanpuri x Kateroo and Quetta x Kateroo	0.637

*Significant at 5 per cent level

Table 3: Classification of peach hybrids in respect of reducing sugars

Crosses	Number of hybrids	Percentage of hybrids in different groups			Mean of the cross	Coefficient of variation (%)
		Low (<2.4%)	Medium (2.4-3%)	High (>3%)		
July Elberta x Kateroo	30	10.00	63.33	26.67	2.88	9.79
Alton x Kateroo	2	0.00	100.00	0.00	2.70	5.24
J. H. Hale x Kateroo	29	10.34	62.13	27.53	2.86	8.88
Kanto-5 x Kateroo	2	0.00	50.00	50.00	2.78	14.24
Saharanpuri x Kateroo	2	50.00	50.00	0.00	2.33	16.73
Quetta x Kateroo	11	18.18	27.27	54.55	2.77	18.53

Test of Significance

Mean of pairs	t-value
July Elberta x Kateroo and Alton x Kateroo	1.631
Julu Elberta x Kateroo and J.H.Hale x Kateroo	0.048
July Elberta x Kateroo and Kanto-5 x Kateroo	0.348
July Elberta x Kateroo and Saharanpuri x Kateroo	1.964
July Elberta x Kateroo and Quetta x Kateroo	0.682
Alton x Kateroo and J.H.Hale x Kateroo	1.476
Alton x Kateroo and Kanto-5 x Kateroo	0.267
Alton x Kateroo and Saharanpuri x Kateroo	1.263
Alton x Kateroo and Quetta x Kateroo	0.383
J.H.Hale x Kateroo and Kanto-5 x Kateroo	0.164
J.H.Hale x Kateroo and Saharanpuri x Kateroo	1.898
J.H.Hale x Kateroo and Quetta x Kateroo	0.563
Kanto-5 x Kateroo and Saharanpuri x Kateroo	1.139
Kanto-5 x Kateroo and Quetta x Kateroo	0.031
Saharanpuri x Kateroo and Quetta x Kateroo	1.394

x Kateroo) to 50.00% (Saharanpuri x Kateroo) in different crosses; however, Alton x Kateroo and Kanto-5 x Kateroo did not produce any hybrid with low reducing sugars content. The mean of the crosses varied between 2.33 to 2.88; whereas, coefficient of variation was between 5.24% (Alton x Kateroo) to 18.53% (Quetta x Kateroo) in different cross combinations.

Non-reducing sugar : In the present experiment, the progenies with high content of non-reducing sugars were in the highest proportions which ranged between 60.00% (July Elberta x Kateroo) to 90.00% (J. H. Hale x Kateroo) in different cross combinations. The medium content of non-reducing sugars varied from 10.00% of the hybrids between Kanto-5 x Kateroo to 32.00% of the hybrids between July Elberta x Kateroo. No hybrid of this category was obtained from J. H. Hale x Kateroo cross. The hybrids with low content of non-reducing sugars varied between 5.00% in Kanto-5 x Kateroo to 12.00% in Quetta x Kateroo; however, no hybrid was obtained with low non-reducing sugars content from the cross between Alton x Kateroo. The mean value of the crosses ranged between 6.14 to 6.83 and coefficient of variation ranged between 2.09% (Alton x Kateroo) to 15.14% (Kanto-5 x Kateroo). All the means of pairs between different crosses were non-significant (Table 4).

Total Sugars : It is clear from the data presented in Table 5 that majority of hybrids were with high content of total sugars which ranged between 70.00% in Alton x Kateroo to 100.00% in Quetta x Kateroo. The progenies with medium total sugars content varied between 10.00% to 20.00% in different crosses; however, Quetta x Kateroo cross did not produce any hybrid with medium total sugars content in their progenies. The low content of total sugars was found only in 10.00% and 5.00% progenies of crosses from Alton x Kateroo and J.

Table 4: Classification of peach hybrids in respect of non-reducing sugars

Crosses	Number of hybrids	Percentage of hybrids in different groups			Mean of the cross	Coefficient of variation (%)
		Low (>3.50%)	Medium (3.50-4.50%)	High (>4.50%)		
July Elberta x Kateroo	30	8.00	32.00	60.00	6.83	6.01
Alton x Kateroo	2	0.00	20.00	80.00	6.27	2.09
J. H. Hale x Kateroo	29	10.00	0.00	90.00	6.14	9.77
Kanto-5 x Kateroo	2	5.00	10.00	85.00	6.59	15.14
Saharanpuri x Kateroo	2	8.00	12.00	80.00	6.56	4.31
Quetta x Kateroo	11	12.00	18.00	70.00	6.55	10.78

Test of Significance

Mean of pairs	t-value
July Elberta x Kateroo and Alton x Kateroo	14.82
Julu Elberta x Kateroo and J.H.Hale x Kateroo	1.653
July Elberta x Kateroo and Kanto-5 x Kateroo	0.338
July Elberta x Kateroo and Saharanpuri x Kateroo	1.283
July Elberta x Kateroo and Quetta x Kateroo	1.241
Alton x Kateroo and J.H.Hale x Kateroo	0.926
Alton x Kateroo and Kanto-5 x Kateroo	0.449
Alton x Kateroo and Saharanpuri x Kateroo	0.563
Alton x Kateroo and Quetta x Kateroo	1.202
J.H.Hale x Kateroo and Kanto-5 x Kateroo	0.629
J.H.Hale x Kateroo and Saharanpuri x Kateroo	1.870
J.H.Hale x Kateroo and Quetta x Kateroo	1.716
Kanto-5 x Kateroo and Saharanpuri x Kateroo	0.041
Kanto-5 x Kateroo and Quetta x Kateroo	0.054
Saharanpuri x Kateroo and Quetta x Kateroo	0.034

H. Hale x Kateroo, respectively. Other crosses did not produce any hybrid with low total sugar content. The mean of the cross ranged between 0.00 to 6.80. The significant differences between mean of pairs were obtained in six cross combinations.

Total soluble solids/acid ratio : The TSS/acid ratio is one of the important biochemical parameters for qualitative characterization of peach. In the present study (Table 6), the proportions of hybrids with a low TSS/acid ratio varied between 3.45% J. H. Hale x Kateroo to 50.00% in both Kanto-5 x Kateroo and Saharanpuri x Kateroo. Low TSS/acid ratio was not recorded in the hybrids from the cross Alton x Kateroo. The progenies with a medium TSS/acid ratio varied between 27.27% (Quetta x Kateroo) to 56.67% (July Elberta x Kateroo); whereas, Kanto-5 x Kateroo did not produce any hybrid with a medium TSS/acid ratio. The progenies with a high TSS/acid ratio ranged between 20.00% in July Elberta x Kateroo to 65.52% in J. H. Hale x Kateroo. Saharanpuri x Kateroo cross did not produce any hybrid with a high TSS/acid ratio. The mean of the cross ranged between 14.47 to 23.90 and coefficient of variation ranged between 18.23% (Saharanpuri x Kateroo) to 156.51% (July Elberta x Kateroo). The significant differences were obtained only in case of two mean of pairs of different cross combinations.

Biochemical characters are important to assess the quality of a particular progeny of different crosses. In the present study, the mean values for titrable acidity ranged from 0.50 to 0.75 per cent, total soluble solids from 11.53 to 13.50 per cent, reducing sugars from 2.33 to 2.88 per cent, non-reducing sugars from 6.14 to 6.83 per cent, total sugars from 9.24 to 10.05 and total soluble solids/acid ratio from 14.47 to 23.90 in various cross combinations. The main factors responsible for variation in the fruit composition at a given stage of maturity of the same group of healthy trees over

Table 5: Classification of peach hybrids in respect of total sugars

Crosses	Number of hybrids	Percentage of hybrids in different groups			Mean of the cross	Coefficient of variation (%)
		Low (<6.55%)	Medium (6.55-7.55%)	High (>7.55%)		
July Elberta x Kateroo	30	0.00	10.00	90.00	10.05	3.79
Alton x Kateroo	2	10.00	20.00	70.00	9.30	0.00
J. H. Hale x Kateroo	29	5.00	10.00	85.00	9.32	6.80
Kanto-5 x Kateroo	2	0.00	10.00	90.00	9.72	6.77
Saharanpuri x Kateroo	2	0.00	20.00	80.00	9.24	1.00
Quetta x Kateroo	11	0.00	0.00	100.00	9.67	4.32
Test of Significance						
Mean of pairs						t-value
July Elberta x Kateroo and Alton x Kateroo						11.338*
Julu Elberta x Kateroo and J.H.Hale x Kateroo						1.749
July Elberta x Kateroo and Kanto-5 x Kateroo						0.700
July Elberta x Kateroo and Saharanpuri x Kateroo						8.824*
July Elberta x Kateroo and Quetta x Kateroo						2.660*
Alton x Kateroo and J.H.Hale x Kateroo						0.180
Alton x Kateroo and Kanto-5 x Kateroo						0.900
Alton x Kateroo and Saharanpuri x Kateroo						0.158
Alton x Kateroo and Quetta x Kateroo						2.922*
J.H.Hale x Kateroo and Kanto-5 x Kateroo						0.834
J.H.Hale x Kateroo and Saharanpuri x Kateroo						0.624
J.H.Hale x Kateroo and Quetta x Kateroo						2.075*
Kanto-5 x Kateroo and Saharanpuri x Kateroo						1.019
Kanto-5 x Kateroo and Quetta x Kateroo						0.103
Saharanpuri x Kateroo and Quetta x Kateroo						3.034s

*Significant at 5 per cent level

a series of years are climatic and nutritional conditions besides load of fruits on the trees. Atkinson et al. (1951) evaluated different peach cultivars and reported that acid content ranged from 0.50 to 1.33% with an average of 0.81% in all the varieties. There was less variation in all the varieties, but the variation due to maturity was more marked. They also observed that fruits which are higher in sugar contents were also higher in level of acidity and emphasized that more mature fruits contain more sugar and less acid than less mature fruits. Dabov and Zadgorski (1970) reported variation in acidity between 0.19 to 0.92% while evaluating 37 peach and 3 nectarine cultivars. Ahmed et al. (2002) observed TSS ranging from 2.23 to 13.37% tested over fifteen peach cultivars; whereas, Contreras et al. (1998) recorded 13.1 to 16.1°B in sixteen peach cultivars. Robertson et al. (1992) reported that acidity decreased with increasing maturity grade. The variation for biochemical traits has also been reported by many workers (Ninkovski et al. 1983; Khokhar and Agnihotri 1990; Yarilgac and Balta 2003) and the results of the present study are in good agreement with their findings. The hybrid of the cross July Elberta x Kateroo was found to be promising over other hybrids in terms of acidity, TSS, total sugar and TSS/acid ratio. However, hybrid of the crosses like Quetta x Kateroo and Alton x Kateroo can be used as donor parents for low acidity and high TSS respectively in future the breeding programme. Significant variation with respect to biochemical parameters observed in different cross combinations showed a vast scope for evolving better varieties of this important fruit crop with varied qualitative characters.

Table 6: Classification of peach hybrids in respect of total soluble solids/acid ratio

Crosses	Number of hybrids	Percentage of hybrids in different groups			Mean of the cross	Coefficient of variation (%)
		Low (<15.0%)	Medium (15.0-20.0%)	High (>20.0%)		
July Elberta x Kateroo	30	23.33	56.67	20.00	23.90	156.51
Alton x Kateroo	2	0.00	50.00	50.00	21.29	22.29
J. H. Hale x Kateroo	29	3.45	31.03	65.52	21.78	19.93
Kanto-5 x Kateroo	2	50.00	0.00	50.00	18.08	29.93
Saharanpuri x Kateroo	2	50.00	50.00	0.00	14.47	18.23
Quetta x Kateroo	11	27.27	27.27	45.46	22.05	40.54

Test of Significance

Mean of pairs	t-value
July Elberta x Kateroo and Alton x Kateroo	0.291
July Elberta x Kateroo and J.H.Hale x Kateroo	5.080*
July Elberta x Kateroo and Kanto-5 x Kateroo	0.771
July Elberta x Kateroo and Saharanpuri x Kateroo	1.392
July Elberta x Kateroo and Quetta x Kateroo	0.262
Alton x Kateroo and J.H.Hale x Kateroo	0.006
Alton x Kateroo and Kanto-5 x Kateroo	0.716
Alton x Kateroo and Saharanpuri x Kateroo	3.829
Alton x Kateroo and Quetta x Kateroo	0.066
J.H.Hale x Kateroo and Kanto-5 x Kateroo	0.948
J.H.Hale x Kateroo and Saharanpuri x Kateroo	3.622*
J.H.Hale x Kateroo and Quetta x Kateroo	0.096
Kanto-5 x Kateroo and Saharanpuri x Kateroo	0.848
Kanto-5 x Kateroo and Quetta x Kateroo	0.848
Saharanpuri x Kateroo and Quetta x Kateroo	2.310

*Significant at 5 per cent level

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