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Screening of mango hybrid population for identifying nutritionally rich hybrids - A special focus on carotenoids

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ABSTRACT

In the present study 109 F_1 hybrids were evaluated for nutraceuticals such as total antioxidants, total phenols, total flavonoids and total carotenoids to identify nutritionally rich superior hybrids in mango. Genetic variability assessed for genetic parameters *viz*., genotypic variance, phenotypic variance, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability and genetic advance shown the presence of wide genetic variability in F_1 hybrid population of mango for nutritional compounds. The total phenol content varied from 22.78 to 170.14 mg $100g^{-1}$ of pulp, total flavonoids from 5.07- 37.33 mg $100g^{-1}$, total carotenoids ranged from 1.42 - 16.79 mg $100g^{-1}$ and the total antioxidants were in the range of 0.26-1.43 µmol Trolox $100g^{-1}$ of pulp. The narrow difference between phenotypic coefficient of variation and genotypic coefficient of variation for all the traits indicated the predominance of genotypic variability. The broad sense heritability (H^2) for all the compounds was high indicating that phenotype aptly reflects its genotype. In conclusion, the four carotenoids rich hybrids v*iz.* H-4509 H-3432 H-4252 and H-3946 were identified with 16.79 $100g^{-1}$, 11.37 $100g^{-1}$, 10.42 $100g^{-1}$ and 10.03 $100g^{-1}$ carotenoids content respectively. These hybrids could possibly serve as elite parents in crop improvement programme.

Key words: *Mangifera indica*, nutraceuticals, heritability, GCV, PCV.

INTRODUCTION

Mango is one the most important fruit of India and also known as "King of fruits". The wide range of variability exists in naturally grown population of mango for morphological and biochemical quality traits (Singh, 14). Currently, the demand for nutritionally rich fruits is increasing owing to its enormous health benefits. Mango is also well known for its nutritional quality due the rich source of dietary antioxidants, such as ascorbic acid, carotenoids and phenolic compounds (Ma *et al*., 10) which have demonstrated different health-promoting properties. The knowledge of relationship between the yield and other quality parameters is very much essential for crop improvement and in this connection; determination of correlation coefficients between the characters assumes significance in selecting breeding materials. The study of genotypic and phenotypic correlation among different characters are useful in planning, evaluating and setting selection criteria for the desired characters for selection in improvement program. Therefore, there is an urgent need for screening of mango hybrids for nutritional components to identify superior parents to develop nutritionally rich hybrids. In this context, the present study was carried out see the genetic variability in different hybrids of mango for important biochemical compounds such as total antioxidants, total phenols, total flavonoids and total carotenoids. This study helps to identify carotenoids rich hybrids in mango besides providing the information related to nutritional status of different hybrids for the identification of nutritional rich hybrids. The identified elite hybrids could possibly serve as parents in crop improvement programme.

MATERIALS AND METHODS

One hundred and nine hybrids at ICAR-CISH experimental farm were served as experimental materials. The age of the seedlings was ranged from eight to ten years and received common plant protection and crop management practices. Each hybrid was considered as treatment and fruits harvested from each tree served as replicates. Experimental site is located at 26.92°N latitude 80.72°E longitude with an average elevation of 128 meters (ICAR-CISH, Lucknow). The full matured fruits were randomly collected from mango orchard and fruits were washed with water to remove field heat as well as dirt on fruits. The fruits were stored at room temperature for uniform or complete ripening by considering softness and colour (Crisoto, 4). The pulp of mango hybrid fruits was extracted and used for analyses of different biochemical compounds *viz*., total antioxidants, total phenols, total flavonoids and total carotenoids.

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The total phenolics were estimated by standard protocol using Folin-ciocalteau reagent (Singleton *et al.*, 16). The total flavonoids content was determined by colorimetric method as described by Dewanto *et al.* (5). The total antioxidant activity of fruit pulp was determined by using CUPRAC (Cupric Reducing Antioxidant Capacity) assay as described by Apak *et al.* (1). Total carotenoids content was determined by using a modified method of Lichtenthaler (9) using acetone and petroleum ether as extracting solvents.

Phenotypic and genotypic components of variance were estimated by applying the formula suggested by Cochran and Cox (3). The co-efficient of variability both at phenotypic and genotypic levels for all the characters were computed by applying the formula suggested by Burton and De Vane (2). Heritability in broad sense for all the characters was computed as suggested by Lush (10). Genetic advance for each character was predicted by the formula given by Johnson *et al.* (7). Nutraceutical data were expressed as mean standard deviation of three replications. The experimental design followed for analysis was randomized completely block design (RCBD) with three replications. Analysis of variance was performed with SPSS version 16.0.

RESULTS AND DISCUSSION

One hundred nine hybrids were analysed for various biochemical parameters *viz*., Total antioxidants, Total phenols, Total flavonoids and Total carotenoids (Table 1). The analysis of variance indicated presence of ample amount of unpredictability for the characters under study indicating the usefulness of the hybrid population in selecting the superior hybrids for these characters.

The antioxidants content in the studied hybrids ranged from 0.26 to 1.43 µmolTrolox $100g^{-1}$ with a mean of 0.60 µmolTrolox. The hybrid H-2838 recorded the highest antioxidants (1.43 µmolTrolox $100g^{-1}$) while, the hybrid H-3669 showed the lowest (0.26 µmolTrolox $100g^{-1}$) antioxidants content. Another biochemical parameter, total phenols ranged from 22.78 to 170.14 mg $100g^{-1}$ with mean 52.70 mg $100g^{-1}$. Hybrid H-3669 recorded maximum amount of total phenols (170.14 mg $100g^{-1}$) while the minimum content was noticed in H-2154 (22.78 mg $100g^{-1}$). The total phenol content in hybrid H-3669 two times higher than the popular variety Alphonso (83 mg $100g^{-1}$) reported by Singh (15) and higher than Safeda Malgoa (148.33 mg $100g^{-1}$) as per Muralidhara *et al*. (12). Among the hybrids studied the average of 15.80 mg $100g^{-1}$ of total flavonoids were found even though total flavonoids ranged from 5.07 for H-3933 mg $100g^{-1}$ to 37.73 mg $100g^{-1}$ for H-3669. Carotenoids are the major bioactive compounds of the mango fruits. The carotenoids in the hybrids exhibited a wide range of variability as indicated by their range from 1.42 to 16.17 mg $100g^{-1}$ with an average of 4.70 mg $100g^{-1}$. The highest carotenoids content was recorded in hybrid H-4509 (16.17 mg $100g^{-1}$), while the lowest was recorded for the hybrid H-4065 (1.42 $100g^{-1}$). The hybrid H-4509 is having three times higher carotenoids content than commercial variety Dashehari (5.81 mg $100g^{-1}$) and forty times higher than the variety Aam Rupali (444.66 µg $100g^{-1}$) reported by Singh (14). Though, there are large numbers of antioxidant compounds in fruit pulp contributing to total antioxidant capacity nevertheless, total content of these bioactive substances in fruit gives an estimate of health promoting substances in mango fruits. Ma *et al.* (11) opined that polyphenols and flavonoids as the main constituents responsible for antioxidant capacity of mango with significant correlation.

The extent of variability is usually measured by genotypic coefficient of variance (GCV) and phenotypic coefficient of variance (PCV) and these estimates give information on relative amount of variation in different characters. As heritability is also influenced by various environmental factors, heritability estimates alone may not help in precise selection of the genotypes. But use of heritability estimates along with the predicted genetic gain will be more reliable (Johnson *et al.,* 7). The extent of variability for various traits available to the breeder determines the success that can be achieved in genetic improvement of the species. The coefficient of variation is used for comparing the variability of one character with another as it is independent of unit of measurement.

The genetic variability parameters such as genotypic co-efficient of variation (GCV), phenotypic co-efficient of variation (PCV), heritability in broad sense (H^2) and genetic advance (GA) were computed for various mango hybrids listed in Table 2. In the present study the phenotypic coefficient of variation and genotypic coefficient of variation were high for all the four nutraceuticals. The PCV values were greater than the GCV values for all the characters indicating influence of environment on the expression. However, genetic advance exhibited lot variability for the nutraceuticals under study. The genetic advance was low for total antioxidants (0.43) and total carotenoids (4.82), while it was moderate (15.38) to high (53.76) for total flavonoids and total phenolics respectively. The similar trend was noticed by Muralidhara *et al.* (12) for antioxidants (0.570), total phenols (54.49), total flavonoids (14.20) and total carotenoids (3.52) in fifty genotypes of mango. Though the PCV values were greater than GCV values but their narrow difference coupled with high heritability estimates for

Table 1. Variability for major nutraceuticals in various mango hybrids.

Hybrids	Parentage	Total antioxidants µmolTrolox/100g	Total phenols mg GAE/100g	Total flavonoids mg QE/100g	Total carotenoids mg/100g
H-4065	EC 95862 × Kurukan	0.57	53.06	16.67	1.42
H-4104	Dashehari × Eldon	0.34	29.86	15.33	2.59
H-3572	Dashehari × Vanraj	0.73	52.91	24.33	2.31
H-2659	Surkha Burma × Sharda Bhog	0.47	37.50	11.33	2.06
H-4109	Dashehari × Eldon	0.60	40.00	22.33	3.04
H-3805	Dashehari × Tommy Atkins	0.47	38.06	20.67	3.21
H-676	Amrapali × Surkha Burma	0.44	30.14	17.33	4.66
H-2609	Mallika × Ambika	0.62	51.95	11.00	3.90
H-2607	Eldon × Vanraj	0.44	33.75	14.00	2.80
H-2708	Surkha Burma × Sharda Bhog	0.31	36.11	10.67	3.44
H-2759	Dashehari × Janardhan Pasand	0.70	69.86	14.00	3.34
H-4097	Dashehari × Eldon	0.37	37.64	14.67	4.13
H-2836	Dashehari × Eldon	0.53	43.06	21.00	4.76
H-4448	Amrapali × Tommy Atkins	0.38	23.05	19.67	5.59
H-3073	Surkha Burma × Eldon	0.49	43.06	14.00	3.79
H-3071	Surkha Burma × Tommy Atkins	0.38	52.50	11.67	4.10
H-2999	Dashehari × Vanraj	0.54	48.33	21.67	4.86
H-4169	Dashehari × Eldon	0.76	68.47	20.00	2.68
H-3015	Dashehari × Ambika	0.70	49.59	22.00	2.75
H-3065	Surkha Burma × Eldon	0.43	32.64	15.00	3.83
H-2997	Dashehari × Elaichi	0.52	40.28	15.67	4.03
H-2800	Dashehari × Eldon	0.30	33.47	17.00	3.22
H-4530	Amrapali × Sensation	0.37	31.25	14.00	3.07
H-2791	Dashehari × Eldon	0.40	38.19	10.00	2.65
H-2831	Dashehari × Eldon	0.35	24.86	8.33	3.51
H-4477	Amrapali × Sharda Bhog	0.44	31.67	13.33	2.38
H-3022	Dashehari × Ambika	0.61	47.50	19.00	4.14
H-2768	Dashehari × Eldon	0.53	63.75	20.67	3.69
H-2765	Amrapali × Ambika	0.57	45.97	18.33	4.23
H-2653	Dashehari × Tommy Atkins	0.51	52.22	18.00	6.92
H-4509	Amrapali × Sensation	0.74	63.61	36.00	16.79
H-2722	Neelum × Elaichi	0.38	28.61	15.33	2.61
H-4108	Dashehari × Eldon	0.40	30.14	21.67	6.66
H-2591	Amrapali × Elaichi	1.01	83.19	19.00	3.20
H-2154	Dashehari × Vanraj	0.32	22.78	13.33	2.88
H-2650	Amrapali × Janardhan Pasand	0.91	89.86	23.00	5.80
H-2899	Dashehari × Elaichi	0.36	27.92	17.33	4.30
H-3998	Dashehari × Vanraj	0.51	31.11	19.00	2.10
H-4079	Starch × Kurukkan	1.08	100.14	22.00	6.39

Contd...

Table 1 contd...

Hybrids	Parentage	Total antioxidants μmolTrolox/100g	Total phenols mg GAE/100g	Total flavonoids mg QE/100g	Total carotenoids mg/100g
H-2866	Amrapali × Suvarna Rekha	0.38	25.97	18.00	5.90
H-2891	Amrapali × Eldon	0.62	59.59	19.67	9.05
H-2842	Dashehari × Eldon	0.35	35.69	15.33	2.21
H-2280	Amrapali × Tommy Atkins	0.54	44.03	17.00	5.65
H-2863	Amrapali × Suvarna Rekha	0.46	44.31	12.00	4.55
H-2620	Elaichi × Ambika	0.39	30.83	17.00	4.48
H-2844	Dashehari × Eldon	0.57	45.42	14.67	4.43
H-4053	Mallika × H-1739	0.60	53.33	18.33	5.81
H-2690	Neelum × Eldon	0.89	91.39	19.67	5.49
H-2742	Dashehari × Eldon	0.49	37.50	32.67	7.92
H-1882	Dashehari × Janardhan Pasand	0.54	51.25	18.67	4.55
H-4005	Dashehari × Vanraj	1.14	92.08	16.33	4.36
H-3991	Amrapali × Tommy Atkins	0.42	28.33	18.33	5.66
H-4241	Dashehari × Eldon	0.51	33.75	21.67	7.54
H-4189	Dashehari × Eldon	0.44	31.81	12.67	7.92
H-4159	Dashehari × Eldon	0.59	59.58	24.33	4.03
H-3651	Dashehari × Vanraj	0.37	27.78	15.00	6.81
H-3842	Dashehari × Eldon	0.61	80.00	5.87	8.35
H-3807	Dashehari × Eldon	0.72	59.86	7.53	4.42
H-4224	Dashehari × Eldon	0.71	65.97	16.93	3.61
H-4254	Dashehari × Eldon	1.20	105.69	23.73	2.68
H-4233	Dashehari × Eldon	0.80	64.44	33.07	5.63
H-4120	Dashehari × Eldon	0.31	25.42	16.07	5.32
H-4229	Dashehari × Eldon	0.63	41.94	32.20	7.45
H-4211	Dashehari × Eldon	0.69	71.67	12.87	4.45
H-2709	Amrapali × Tommy Atkins	0.86	94.17	19.33	10.00
H-3669	Amrapali × Tommy Atkins	1.43	170.14	37.73	8.55
H-2047	Amrapali × Tommy Atkins	0.63	50.28	25.47	6.77
H-3620	Amrapali × Tommy Atkins	0.90	75.42	7.53	3.14
H-3683	Amrapali × Tommy Atkins	0.57	41.81	9.13	2.62
H-4413	Amrapali × Tommy Atkins	0.59	56.67	19.07	3.17
H-4352	Amrapali × Tommy Atkins	0.39	50.56	7.80	4.85
H-4363	Amrapali × Tommy Atkins	0.67	50.56	5.40	6.96
H-4440	Amrapali × Tommy Atkins	0.61	51.25	6.87	5.73
H-4394	Amrapali × Tommy Atkins	0.65	40.83	6.07	5.26
H-4364	Amrapali × Tommy Atkins	0.73	41.67	8.20	3.39
H-4409	Amrapali × Tommy Atkins	0.66	46.81	8.47	3.83
H-3603	Dashehari × Tommy Atkins	0.54	54.58	7.27	3.78
H-3925	Dashehari × Tommy Atkins	0.55	41.39	8.20	6.51
H-3946	Dashehari × Tommy Atkins	0.63	48.75	5.93	10.03

Contd...

Table 1 contd...

Hybrids	Parentage	Total antioxidants µmolTrolox/100g	Total phenols mg GAE/100g	Total flavonoids mg QE/100g	Total carotenoids mg/100g
H-3949	Dashehari × Tommy Atkins	0.76	42.36	6.47	9.85
H-2256	Dashehari × Tommy Atkins	0.55	46.25	7.20	3.99
H-2015	Dashehari × Eldon	0.55	28.61	6.47	1.53
H-4250	Dashehari × Tommy Atkins	0.82	92.92	19.80	5.85
H-4264	Dashehari × Tommy Atkins	0.94	74.58	11.13	4.06
H-4252	Dashehari × Tommy Atkins	0.67	49.31	6.47	10.42
H-1739	Neelum × Tommy Atkins	0.84	63.89	7.00	1.90
H-4321	Neelum × Tommy Atkins	0.53	26.67	5.80	4.61
H-4015	Mallika × Tommy Atkins	0.63	55.83	5.80	1.53
H-4061	Ambika × Tommy Atkins	0.57	30.28	12.60	2.13
H-4301	Amrapali × Elaichi	0.41	47.92	8.40	3.85
H-4291	Elaichi × Amrapali	0.52	34.44	6.20	5.19
H-4292	Elaichi × Amrapali	0.58	33.47	7.13	3.52
H-4295	Elaichi × Amrapali	0.53	53.61	10.20	1.93
H-4280	Elaichi × Dashehari	0.82	166.94	26.13	3.44
H-4034	Elaichi × Dashehari	0.36	28.75	6.73	4.73
H-4490	Amrapali × Sharda Bhog	1.16	115.42	30.47	5.04
H-4501	Amrapali × Sharda Bhog	0.45	46.67	29.73	2.21
H-4482	Amrapali × Sharda Bhog	0.50	60.00	9.00	8.02
H-4534	Dashehari × Sensation	0.65	62.50	33.53	7.70
H-2563	Amrapali × Hurr	0.67	69.72	30.00	3.24
H-1914	Dashehari × Janardhan Pasand	0.71	59.31	15.40	2.09
H-2838	Dashehari × Janardhan Pasand	0.26	23.19	23.80	2.91
H-3432	Dashehari × Vanraj	0.39	27.64	23.27	11.37
H-3933	Mallika × Vanraj	0.48	43.47	5.07	3.14
H-1084	Amrapali × Janardhan Pasand	0.82	88.61	5.07	4.84
H-949	Amrapali × Vanraj	0.87	89.17	8.33	3.58
H-941	Amrapali × Tommy Atkins	0.72	49.44	9.13	3.53
H-4014	Mallika × Tommy Atkins	0.55	34.72	18.27	3.33
H-2603	Mallika × Elaichi	0.79	118.47	7.73	2.11
P=0.05		0.043	6.055	2.47	12.68

all the four nutraceuticals indicated that selection for these traits can yield positive results as they are less influence from environment. The parallel results were also reported by Muralidhara *et al*. (12) in different genotypes mango. The phenotypic selection can be relied upon for improvement of the traits as the traits are least influenced by the environment. Dinesh *et al.* (6) opined that when heritability in broad sense was higher for all the characters indicating the least influence of environmental alterations the expression of the traits would be precise. However, Lavi *et al.* (8) reported that parents should not be chosen entirely on the basis of phenotype since offspring performance is quite unpredictable.

Knowledge of correlation between different traits is necessary in fruit breeding. Estimation of genotypic and phenotypic correlations among characters is essential in planning appropriate breeding strategy for the crop plant. Correlation coefficient is also useful in indirect selection of a secondary trait along with the

Table 2. Estimates of genetic parameters for nutraceuticals in mango hybrids.

Genetic parameters		Total Antioxidants	Total Phenols	Total Flavonoids	Total Carotenoids
F-Value		181.38	149.85	73.07	49.85
Mean		0.60	52.70	15.80	4.70
Range	Minimum	0.26	22.78	5.07	1.42
	Maximum	1.43	170.14	37.73	16.79
CV (%)		4.52	7.09	9.83	12.68
σ^2 g		0.04	694.77	58.06	5.80
σ^2 e		0.00	14.00	2.42	0.36
σ^2 p		0.05	708.77	60.48	6.16
PCV		35.43	50.52	49.22	52.79
GCV		35.14	50.02	48.23	51.24
H^2		98.36	98.02	96.00	94.21
GA		0.43	53.76	15.38	4.82
GAM (%)		71.79	102.01	97.34	102.45

* GA=Genetic advance, H^2=Heritability in broad sense; σ^2 g=genotypic variance; σ^2 e=environment variance; σ^2 p= Phenotypic variance; CV=coefficient of variability

primary trait of interest. The genotypic and phenotypic correlation studies (Table 3 & 4) indicated different degrees of positive correlation between the traits under study but high degree of positive genotypic correlation (0.84) as well as phenotypic correlation (0.83) between Total phenols and Total antioxidants, indicating scope for simultaneous improvement of these two traits. Rashwan (13) indicated that if two traits are positively correlated then both traits can be improved simultaneously.

Role of balanced nutrition has shifted the focus from food grain to horticultural crops and fruit crops have assumed significance due to their rich health promoting bioactive compounds. Mango is a rich source of bioactive compounds and improved varieties of fruit are in great demand owing to shift in consumer preferences. In this scenario it is necessary to develop elite hybrids fulfilling the requirements of farmers and industry. The evaluation of hybrids revealed that hybrids differed significantly for all four indicating the presence of genetic variability for all the traits in the germplasm. The narrow difference between PCV GCV and high heritability coupled with high genetic advance as per cent of mean suggested the effectiveness of selection for the traits under study.

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Table 3. Genotypic correlation matrix for nutraceuticals in mango hybrids.

	Total Antioxidants	Total phenols	Total Flavonoids ants	Total Carotenoids
Total Antioxidants	1.00			
Total phenols	0.84	1.00		
Total Flavonoids	0.23	0.27	1.00	
Total Carotenoids	0.13	0.10	0.26	1.00

Table 4. Phenotypic correlation matrix for nutraceuticals in mango hybrids.

	Total Antioxidants	Total phenols	Total Flavonoids ants	Total Carotenoids
Total Antioxidants	1.00			
Total phenols	0.83	1.00		
Total Flavonoids	0.23	0.27	1.00	
Total Carotenoids	0.13	0.10	0.24	1.00

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