



## SELECTION OF PROMISING GENOTYPES FOR QUALITATIVE TRAITS IN CHILLI (*CAPSICUM ANNUUM* L.)

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### Abstract

Sixty three genotypes of chilli (*Capsicum annum* L.) were evaluated at Horticultural Research Station, Lam, Guntur (Andhra Pradesh), India; to select the promising genotypes for qualitative traits viz. capsaicin content, total color value, oleoresin content, vitamin C, red carotenoids and yellow carotenoids. The analysis of variance revealed significant differences among the genotypes for all the six characters. Among sixty three genotypes, the highest ascorbic acid content was recorded for the genotype Aparna (223.22), while the lowest was observed in Phule Jyoti (43.99). The highest oleoresin content was recorded by the genotype LCA-724 (12.31) and the lowest in Pandava (5.17). The highest capsaicin content was recorded by the genotype Pusa Sadabahar (0.64), while the lowest was in G-4 (0.14). The maximum colour value was observed in the genotype LCA-713 (128) and the minimum in Aparna (20.58). The maximum per cent of red carotenoids was observed for genotypes LCA-357 and KT-1 (0.22), while the genotype Aparna had no red carotenoids. The maximum per cent of yellow carotenoids was observed for the genotype HC-28 (0.15) and the minimum for LCA-724 and LCA-620 (0.01).

**Key words :** *Capsicum annum*, ascorbic acid, capsaicin, oleoresin, red carotenoids, total color value, yellow carotenoids.

### Introduction

Chilli, known as the universal spice of India and has diverse utilities as a spice, condiment, culinary supplement, medicine, vegetable and ornamental plant. India is the largest producer, consumer and exporter of chilli in the world with production share of 36%. In India, Andhra Pradesh first in chilli production (49%) followed by Tamil Nadu (23%). In view of the changing of food habits and health conscious's, food quality particularly perishables like fruits and vegetables is gaining importance since improved quality not only facilitates remunerative market price for the producer and also improves health of the consumer. Thus, the attempts towards improvement of quality characters in crop plants have lot of significance which can increase the income of the farmer through premium price.

Chilli is known for its flavour, pungency and red ripe fruits are considered as rich source of vitamin C (Bosland and Votava, 2000). Capsicinoids and carotenoids, the major chemical constituents of chilli fruits add commercial value to the crop. The carotenoids which contribute fruit colour

act as dietary precursors of vitamin A and among carotenoids 'capsanthin and capsorubin' are important constituents. The pungency in fruit is due to capsaicin (8-methyl-N-vanillyl-6- enamide) and seven closely related alkyl vanillyl amides, collectively referred as "Capsaicinoids". Among capsicinoids, capsaicin and dihydrocapsaicin accounts for more than 80% and determine the pungency (Bosland and Votava, 2000). The degree of pungency varies widely with the genotypes (Kumar *et al.*, 2006). The 'capsaicin' is an alkaloid present in the placenta of the fruit, which can directly scavenge various free radicals (Reddy and Lokesh, 1992; Kogure *et al.*, 2002; Bhattacharya *et al.*, 2010) and has wide applications in the food, medicine and pharmaceutical industries. Chilli has also acquired a great importance because of the presence of 'oleoresin', which permits better colour distribution and flavor in foods. The fruits also contains flavonoids like quercetin, luteolin, apigenin, capsanthin, myristicin, hesperidin, scopoletin and phenolic compounds like esters of ferulic and sinapic acids, which have anti oxidant activity and can scavenge various free radicles.

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**Table 1** : Analysis of variance six qualitative characters in chilli (*Capsicum annuum* L.).

S.No.	Character	Mean sum of squares		
		Replications	Genotypes	Error
1.	Ascorbic acid (mg/100g)	4.371	4326.548**	100.724
2.	Oleoresin (%)	0.944	6.103**	0.572
3.	Capsaicin (%)	0.000007	0.022**	0.0006
4.	Total colour value (ASTA Units)	35.914	1234.578**	32.894
5.	Red carotenoids (%)	0.000096	0.0032**	0.000046
6.	Yellow carotenoids (%)	0.000179*	0.0020**	0.000032

\*: Significant at 5% level, \*\*: Significant at 1% level.

The availability of data on pungency and colour are important criteria for selection of genotypes from a genebank for use in crop improvement. However, data on pungency and carotenoids among the accessions in *Capsicum* genebanks are currently limited (Jarret *et al.*, 2003). Thus, the major objective of this study was to screen chilli genotypes for qualitative traits *viz.* ascorbic acid (vitamin C), capsaicin, oleoresin, total colour value, red and yellow carotenoids.

### Materials and Methods

The investigation was carried out during *kharif* 2012-13 at Horticultural Research Station, Lam, Guntur with 63 genotypes of chilli (*Capsicum annuum* L.) in a randomized block design with two replications. The nursery was raised during last week of July and the seedlings were transplanted at a spacing of 75 cm × 30 cm in a row of 4 m length during first fortnight of September. Each row consisted of 12 plants, of which five competitive plants were selected at random for collecting the fruit samples to estimate qualitative traits *viz.* ascorbic acid (mg/100g), oleoresin (%), capsaicin (%), total color value (ASTA units), red carotenoids (%) and yellow carotenoids (%).

Fruit samples were harvested at full ripe stage except for vitamin-C, for which mature green fruits were harvested. The red ripen fruits were sun dried and ground in an electronic grinder and passed through a 0.5 mm sieve. By using chilli powder the following biochemical constituents were measured. Total extractable colour of fruits (ASTA- American Spice Trade Association units) was estimated as per the procedure given by Rosebrook *et al.* (1968). Total red ( $C^R$ ; capsanthin, capsorubin and capsanthin-5, 6-epoxide) and yellow ( $C^Y$ ; zeaxanthin, violaxanthin, antheraxanthin,  $\beta$ -cryptoxanthin,  $\beta$ -carotene and cucurbitaxanthin A) carotenoid isochromic fractions were estimated following protocol of spectrophotometric

method (Hornero-Mendez and Minguéz-Mosquera, 2001). The capsaicin content was estimated by colorimetric method described by Balasubramanian *et al.* (1982). Ascorbic acid content of mature green fruits was estimated by volumetric (2, 6- dichlorophenol indophenol dye) method described by Sadasivam and Balasubramanian (1987). The oleoresin content was estimated as per the procedure given by Ranganna (1986). Analysis of variance was carried out as per the procedure given by Panse and Sukhatme (1957).

### Results and Discussion

The analysis of variance (table 1) revealed significant differences among the genotypes for all the six characters studied indicating the presence of genetic variability in the genotypes and considerable scope for their improvement. These results are in conformity with findings of Farhad *et al.* (2008), Gupta *et al.* (2009), Suryakumari *et al.* (2010), Arup *et al.* (2011), Kumar *et al.* (2012) and Naresh *et al.* (2013).

The ascorbic acid content of fruits ranged from 43.99 to 223.22 mg/100g (table 2) with a mean of 114.59 mg/100g. The highest ascorbic acid content was recorded for the genotype Aparna (223.22 mg/100g) followed by LCA-732 (221.71 mg/100g) while the lowest was observed in Phule Jyoti (43.99 mg/100g) preceded by LCA-742 (44.56 mg/100g). The range indicated that the variability in vitamin C content is higher between the genotypes studied. These results are in line with findings of Shirshat *et al.* (2007), Farhad *et al.* (2008), Arup *et al.* (2011) and Kumar *et al.* (2012).

The oleoresin ranged from 5.17 to 12.31 with a mean of 8.82 per cent (table 2). The highest oleoresin content was recorded by the genotype LCA-724 (12.31%) followed by LCA-714 (12.15%) while the lowest was observed in Pandava (5.17%) preceded by KT-1 (5.85 %) and Aparna (5.96 %). Manju and sreelathakumary

**Table 2 :** Mean performance of various qualitative characters in chilli (*Capsicum annuum* L.) genotypes.

Genotype	Source	AA	OC	CC	TCV	RC	YC
G-3	HRS, Lam	90.00	10.45	0.34	30.09	0.08	0.03
G-4	HRS, Lam	174.00	10.25	<b>0.14</b>	73.64	0.14	0.09
G-5	HRS, Lam	130.00	7.94	0.21	84.63	0.16	0.06
LCA-206	HRS, Lam	120.32	9.76	0.22	71.58	0.12	0.09
LCA-235	HRS, Lam	115.71	9.72	0.25	64.78	0.12	0.05
LCA-305	HRS, Lam	116.55	9.42	0.28	71.34	0.13	0.06
LCA-315	HRS, Lam	107.55	6.53	0.25	95.78	0.14	0.08
LCA-353	HRS, Lam	206.27	8.59	0.35	54.94	0.09	0.04
LCA-357	HRS, Lam	68.77	7.33	0.44	124.23	<b>0.22</b>	0.14
LCA-424	HRS, Lam	77.33	8.94	0.43	76.51	0.14	0.08
LCA-436	HRS, Lam	69.33	6.86	0.16	66.42	0.12	0.08
LCA-620	HRS, Lam	135.99	10.13	0.46	63.85	0.06	<b>0.01</b>
LCA-625	HRS, Lam	115.00	11.29	0.32	76.43	0.12	0.09
LCA-702	HRS, Lam	61.66	7.75	0.28	120.62	0.19	0.11
LCA-703	HRS, Lam	135.88	11.29	0.42	66.10	0.09	0.08
LCA-704	HRS, Lam	86.00	10.05	0.38	65.03	0.10	0.06
LCA-705	HRS, Lam	117.00	9.40	0.31	65.51	0.09	0.06
LCA-706	HRS, Lam	118.35	9.15	0.45	43.13	0.12	0.03
LCA-707	HRS, Lam	48.33	7.18	0.47	104.22	0.14	0.13
LCA-708	HRS, Lam	150.33	6.68	0.29	75.93	0.13	0.05
LCA-709	HRS, Lam	69.66	7.05	0.44	96.68	0.19	0.09
LCA-710	HRS, Lam	52.34	9.07	0.37	80.77	0.12	0.10
LCA-711	HRS, Lam	72.11	8.18	0.26	55.27	0.10	0.06
LCA-712	HRS, Lam	64.77	6.69	0.31	60.03	0.13	0.03
LCA-713	HRS, Lam	106.63	9.96	0.31	<b>128.00</b>	0.20	0.14
LCA-714	HRS, Lam	78.00	12.15	0.50	84.79	0.14	0.09
LCA-715	HRS, Lam	86.66	9.13	0.38	59.94	0.13	0.04
LCA-716	HRS, Lam	176.88	8.91	0.47	54.21	0.10	0.06
LCA-718	HRS, Lam	121.18	6.58	0.26	59.69	0.09	0.08
LCA-720	HRS, Lam	145.70	9.55	0.19	85.78	0.16	0.09
LCA-722	HRS, Lam	127.61	9.88	0.25	38.79	0.12	0.03
LCA-724	HRS, Lam	189.50	<b>12.31</b>	0.49	86.60	0.14	<b>0.01</b>
LCA-726	HRS, Lam	118.68	9.93	0.19	45.26	0.10	0.02
LCA-728	HRS, Lam	115.81	12.05	0.24	121.85	0.20	0.09
LCA-730	HRS, Lam	57.33	11.57	0.28	52.81	0.10	0.05
LCA-732	HRS, Lam	221.71	10.55	0.36	97.67	0.19	0.07
LCA-734	HRS, Lam	96.57	6.55	0.25	87.08	0.14	0.07
LCA-736	HRS, Lam	198.32	6.18	0.31	68.47	0.12	0.07
LCA-738	HRS, Lam	119.71	9.13	0.32	112.42	0.16	0.14
LCA-740	HRS, Lam	66.09	9.67	0.30	86.10	0.14	0.09
LCA-742	HRS, Lam	44.56	7.47	0.22	55.44	0.09	0.06
LCA-744	HRS, Lam	87.81	7.75	0.31	49.53	0.09	0.03
LCA-746	HRS, Lam	210.85	9.18	0.26	52.97	0.06	0.08
LCA-748	HRS, Lam	146.46	7.58	0.16	54.04	0.08	0.06
LCA-750	HRS, Lam	59.81	7.90	0.22	74.62	0.12	0.06
LCA-752	HRS, Lam	143.42	6.98	0.38	97.00	0.16	0.08
LCA-754	HRS, Lam	147.23	10.18	0.23	68.79	0.11	0.06
LCA-756	HRS, Lam	184.75	11.61	0.35	55.60	0.07	0.08

Table 2 continued....

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LCA-758	HRS, Lam	111.04	7.63	0.19	107.75	0.14	0.09
LCA-760	HRS, Lam	64.57	9.31	0.17	115.46	0.17	0.13
LCA-762	HRS, Lam	101.92	7.23	0.26	79.62	0.13	0.09
CA-960	HRS, Lam	71.25	7.96	0.25	33.21	0.07	0.05
HC-28	HAU, Hisar	62.88	9.49	0.50	103.81	0.14	<b>0.15</b>
KT-1	IARI, Katrain	75.00	5.85	0.28	121.14	<b>0.22</b>	0.09
Aparna	HRS, Lam	<b>223.22</b>	5.96	0.26	<b>20.58</b>	<b>0.00</b>	0.04
Pandava	Local collection, Guntur	182.65	<b>5.17</b>	0.26	86.02	0.14	0.10
Pant C-1	GBPUA&T, Pantnagar	140.83	7.68	0.43	78.56	0.11	0.12
Phule Jyoti	MPKV, Rahuri	<b>43.99</b>	11.55	0.46	71.50	0.12	0.06
Punjab Guchedar	PAU, Ludhiana	127.99	8.04	0.47	63.71	0.10	0.09
Pusa Sadabahar	IARI, New Delhi	131.99	7.22	<b>0.64</b>	73.96	0.13	0.06
Super-10	Local collection, Guntur	129.65	10.77	0.29	41.58	0.09	0.03
Warangal Chapatta	Local collection, Warangal	90.00	9.61	0.29	105.00	0.04	0.04
LCA-334	HRS, Lam	107.81	9.72	0.18	51.91	0.10	0.07
<b>Mean</b>		<b>114.59</b>	<b>8.82</b>	<b>0.32</b>	<b>74.90</b>	<b>0.12</b>	<b>0.07</b>
<b>F ratio</b>		42.95	10.66	35.96	37.53	70.21	63.95
<b>S.E.</b>		7.10	0.54	0.02	4.06	0.00	0.00
<b>C.V.</b>		8.76	8.58	7.88	7.66	5.54	7.89
<b>C.D. 5%</b>		20.06	1.51	0.05	11.46	0.01	0.01

Where,

**AA** - Ascorbic Acid (mg/100g), **OC** – Oleoresin Content (%), **CC** – Capsaicin Content (%), **TCV** – Total Colour Value (ASTA units), **RC** – Red Carotenoids (%), **YC** – Yellow Carotenoids (%).

(2002), Singh *et al.* (2009), Gupta *et al.* (2009), Suryakumari *et al.* (2010) and Arup *et al.* (2011) also reported variability in respect of oleoresin content.

The range of capsaicin varied from 0.14 to 0.64 with a mean of 0.31 per cent (table 2). The highest capsaicin content was recorded by the genotype Pusa Sadabahar (0.64%) followed by HC-28 and LCA-714 (0.50%) while the lowest was observed in G-4 (0.14%) preceded by LCA-436 and LCA-748 (0.16%). These findings suggest that it is possible to isolate superior genotypes during the selection process. Variability in capsaicin content of chilli accessions was earlier reported by Bharadwaj *et al.* (2007), Munshi *et al.* (2010), Shrilekha *et al.* (2011), Arup *et al.* (2011), Naresh *et al.* (2013).

The total colour value ranged from 20.58 to 128 with a mean of 74.90 ASTA units (table 2). The highest colour value was recorded for the genotype LCA-713 (128 ASTA units) followed by LCA-357 (124.23 ASTA units) and the lowest was observed by Aparna (20.58 ASTA units) preceded by G-3 (30.09 ASTA units) and CA-960 (33.21 ASTA units). The range of red carotenoids varied from 0.005 to 0.22 with a mean of 0.12 per cent. The maximum per cent of red carotenoids was observed for genotypes LCA-357 and KT-1 (0.22%) followed by LCA-728 and LCA-713 (0.20%) while the minimum per cent was

recorded for Aparna (0.00%) preceded by Warangal Chapatta (0.04%). The range of yellow carotenoids varied from 0.01 to 0.15 with a mean of 0.07 per cent. The maximum per cent of yellow carotenoids was observed for the genotype HC-28 (0.15%) closely followed by LCA-357, LCA-713 and LCA-738 (0.14%) while the minimum per cent was recorded for LCA-724 and LCA-620 (0.01%) preceded by LCA-726 (0.02%) (table 2).

The total colour value was highest in dark red lines followed by light red lines whereas yellow fruited lines recorded lower total colour value (Aparna-20.58 ASTA units). Because of, in yellow accessions the total carotenoid levels do not increase and remain low whereas in red chillies the levels of total carotenoids increases during the process of ripening due to synthesis of capsanthin, capsorubin,  $\beta$ -cryptoxanthin and zeaxanthin (Ha *et al.*, 2007). The accessions with yellow coloured fruits did not contain red carotenoids (Rodriguez-Burruezo *et al.*, 2009) as the deletion of the candidate gene *Capsanthin capsorubin synthase (Ccs)* gene (Thorup *et al.*, 2000) or structural changes in the gene such as mutation or deletion (Ha *et al.*, 2007) prevents the synthesis of red pigments capsanthin and capsorubin. Contrarily all the accessions including those with red

coloured fruits contained yellow carotenoids and the accessions with higher total carotenoids also contained higher levels of yellow carotenoids suggesting that enzymes like zeaxanthin epoxidase,  $\beta$ -ring carotene hydroxylase etc. required for yellow pigment production will be active in all the accessions including red fruited ones. These findings are in agreement with results of Naresh *et al.* (2013), who also reported higher variation among the genotypes for total carotenoids, red carotenoids and yellow carotenoids and also reported that red coloured fruits contained both red and yellow carotenoids while yellow coloured fruits contained only yellow carotenoids.

### Conclusion

In the investigation, a high range of variability was observed for all the characters. It was maximum for ascorbic acid content (43.99-223.22) and minimum for yellow carotenoids (0.01 to 0.15). The characters showing wide range of variation provide an ample scope for selecting superior types and the selected genotypes can be used in breeding programme for introgression of their desired genes into the high yielding varieties.

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