



## Research Note

# Studies on the improvement of chilli (*Capsicum annuum* L.) cv Co 4 for quality characters through hybridization

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### Abstract

Studies on hybridization were undertaken for the improvement of CO 4 by making direct and reciprocal crosses using CO 4 as one of the parents for quality aspects such as high capsaicin, oleoresin, capsanthin and ascorbic acid content at the Department of Vegetable Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during 2003-2005. The genotypes viz. Ujwala, Pusa Jwala, CHD 8, Arka Abir, Arka Lohit, Byadagi Kaddi, Punjab Lal, K 2 and PKM 1 were chosen for the investigation as parents. Capsaicin content was the highest in the hybrid, Punjab Lal x CO 4 (0.79 per cent). It also registered highly significant positive heterosis over mid parent, better parent and best parent for this trait. Other hybrids which also showed greater attributes in this aspect are Arka Lohit x CO 4, Ujwala x CO 4, CHD 8 x CO 4, CO 4 x Punjab Lal, CO 4 x Arka Lohit, Pusa Jwala x CO 4 and CO 4 x Pusa Jwala. In case oleoresin and capsanthin, CO 4 x Byadagi Kaddi exhibited the highest for both. It was comparatively higher than the oleoresin and capsanthin content of CO 4. It also registered significant positive heterosis over mid parent, better parent and best parent. Ascorbic acid content was the highest in K 2 among the parents. The hybrid PKM 1 x CO 4 recorded the highest ascorbic acid content. The cross combination PKM 1 x CO 4 also recorded the highest positive significant heterosis over mid parent, better parent and best parent.

**Key words :** Chilli , Hybrid, capsaicin, oleoresin, capsanthin

Chilli ( hot pepper ) was introduced into India from Brazil in the sixteenth century by the Portuguese. The average productivity in the country is around 1,112 kg ha<sup>-1</sup> while Andhra Pradesh tops with the highest productivity of 1,948 kg ha<sup>-1</sup> followed by Punjab (1,607 kg ha<sup>-1</sup>) (Kochi, 2005).

Chilli is mainly cultivated for three quality constituents namely, Capsaicinoides, Capsanthin and oleoresin. Pungency, one of the important quality attributes of *Capsicum species* is due to the presence of alkaloid compounds known as “capsaicinoids” in the fruit. The common profile for the capsaicinoids in chilli is capsaicin found in the higher proportions followed by dihydrocapsaicin. These two compounds account for 69 and 22 per cent of the total capsaicinoids, respectively (Bennett and Kirby, 1968). High standard heterosis were observed in the traits like capsaicin (202.38 per cent), oleoresin (21.83 per cent) and capsanthin content 33.03 per cent (Prasath and Ponnuswami, 2008). In case of ascorbic acid content, hybrid H27 (CA 25 x CA 10)

manifested highest per cent heterosis over mid parent (92.34 per cent) and better parent (79.32 per cent) respectively (Kumar and Tata, 2010).

The parent variety CO 4 was a pure line selection from an open pollinated type (CA 138) introduced from Srilanka. The plants were dwarf, the canopy resembled a small umbrella and the fruits were borne underneath the canopy. The fruits were stout, long dark green turning to capsicum red after ripening. It recorded a green fruit yield of 23.06 t ha<sup>-1</sup>, however the fruits were less pungent i.e. low capsaicin content. Capsaicin content in green chilli was recorded 0.29 per cent and in dry chilli it was 0.40 per cent. Oleoresin content in dry chilli was recorded as 14.00 per cent and capsanthin content was 44.00 ASTA units (Kanthaswamy *et al.*, 2000). CO 4 chilli had good combining ability with other varieties, so it was selected as parental line for direct and reciprocal crosses for improvement of characters. Hence, the present study was undertaken for the improvement of CO 4 variety of chilli for quality characters by



using it as both male and female parent in reciprocal and direct crosses.

The parents chosen for the investigation were of diverse origin maintained in the germplasm collection of Department of Vegetable Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore. The parents were raised in the field during November, Harvested red ripe fruits were dried in a hot air oven at 50°C, powdered to pass through a 100 mesh sieve. Two gram chilli powder was weighed, packed in filter paper and placed in a Soxhlet's apparatus. Two hundred ml of acetone was taken in the round bottom flask of the apparatus and heated in a water bath. The temperature was maintained at the boiling point of the solvent. After complete extraction (7-8 hours), the solvent was evaporated to dry under vacuum. Yield of oleoresin on dry weight basis was calculated using the formula

Biochemical observations

Capsaicin (Per cent):

Capsaicin content was determined by Folin Dennis method. The pungent principle reacts with Folin Dennis reagent to give a blue coloured complex which is estimated calorimetrically.

Reagents needed/required

1) Folin – Dennis reagent:

Preparation of Folin-Dennis reagent : Refluxed 750 ml distilled water, 100g Sodium tungstate, 20 g Phosphomolybdic acid and 50 ml Phosphoric acid for two hours. The contents were cooled and diluted to 1000 ml distilled water.

2) 25 per cent aqueous Sodium carbonate solution

3) Acetone

Procedure:

Red ripe fruits were dried in a hot air oven at 50°C and powdered finely. One gram in each of the sample was weighed in to the test tubes, added 10 ml acetone and kept overnight. Aliquot of 1 ml was pipetted into 100 ml conical flasks, added 25 ml of Folin Dennis reagent and allowed to stand for 30 minutes. Added 25 ml of freshly prepared sodium carbonate solution and was shaken vigorously. The volume was made up to 100 ml with distilled water and the optical density was determined after 30 minutes at 725 nm against reagent blank ( 1ml acetone + 25 ml Folin Dennis Reagent + 25 ml aqueous Sodium carbonate solution) using a UV spectrophotometer. To determine the EI per cent value for pure capsaicin, a stock solution of standard capsaicin (200 micro gram per millilitre) was prepared by dissolving five milligram in 25 ml acetone. From this, a series of solutions of concentrations

400 microgram, 600 microgram, 800 microgram and 1000 microgram were prepared and their optical density measured at 725 nm. Standard graph was prepared and calculated the content of capsaicin in the samples.

Oleoresin (per cent):

Oleoresin in chilli was extracted in a Soxhlet's apparatus using solvent acetone.

Procedure:

University, Coimbatore. The selected parents were Arka Abir, Arka Lohit, Byadagi Kaddi, CHD 8, K 2, Punjab Lal, Pusa Jwala, PKM 1, Ujwala and CO 4. Direct and reciprocal crosses were made to evolve eighteen hybrids involving CO 4 in all the crosses as either female or male parent .The hybrids along with the parents were raised in the field during November, Harvested red ripe fruits were dried in a hot air oven at 50°C, powdered to pass through a 100 mesh sieve. Two gram chilli powder was weighed, packed in filter paper and placed in a Soxhlet's apparatus. Two hundred ml of acetone was taken in the round bottom flask of the apparatus and heated in a water bath. The temperature was maintained at the boiling point of the solvent. After complete extraction (7-8 hours), the solvent was evaporated to dry under vacuum.

Yield of oleoresin on dry weight basis was calculated using the formula

$$\text{Oleoresin \%} = \frac{\text{weight of oleoresin}}{\text{weight of sample}} \times 100$$

Colour value estimation (dry chilli)

Colour value was estimated as per the standard procedure (Woodbury, 1997) and expressed in ASTA units.

Ascorbic acid estimation (green chilli)

Ascorbic acid was measured according to the procedure given by AOAC (1970).

Heterosis in F<sub>1</sub> hybrids was estimated for each trait based on the three mean values as detailed below.

$$\text{Relative heterosis (di)} = \frac{F_1 - MP}{MP} \times 100$$

$$\text{Heterobeltiosis (dii)} = \frac{F_1 - Br.P}{Br.P} \times 100$$

$$\text{Heterosis over best parent (diii)} = \frac{F_1 - Bt.P}{Bt.P} \times 100$$

Where,

F<sub>1</sub> - mean value of the F<sub>1</sub> hybrid

MP - mid parental value =

$$\frac{P_1 + P_2}{2}$$

Where, P<sub>1</sub> and P<sub>2</sub> are the mean values of the first and second parents respectively.

Br.P - mean value of the better of the two parents used in the respective cross combination and

Bt.P - mean value of the best parent. Test of significance



The standard errors for testing significance of heterosis were calculated as suggested by Snedecor and Cochran (1967).

$$SE_{MP} = \left[ \frac{3EMS}{2r} \right]^{1/2}$$
$$SE_{HP \text{ OR } BP} = \left[ \frac{2EMS}{r} \right]^{1/2}$$

Where,

EMS - Error mean square obtained in the combined analysis for parents and the crosses.

r - Number of replications

The 't' value was worked out as the deviation of  $F_1$  from the mid parent or better parent or the best parent by standard error and tested against the table 't' value at error degrees of freedom at 5 and 1 per cent levels of probability.

Capsaicin is one of the principal quality attributes in chilli. Capsaicin content was the highest in the hybrid, Punjab Lal x CO 4 (0.79 per cent) followed by Ujwala x CO 4 (0.67 per cent) and CHD 8 x CO 4 (0.62 per cent) and CO 4 x Punjab Lal (0.62 per cent). Among the parents, the value for this trait was high in Arka Lohit (0.72 per cent). Regarding heterosis, most of the hybrids showed positive significant heterosis over mid parent and better parent. But they showed negative significant heterosis over best parent except Punjab Lal x CO 4. This result has similarity with the result given by Sathiyamurthy (2001). Anandanayaki (1997) also observed positive heterosis for this trait. Significant negative heterobeltiosis was also reported by Doshi and Shukla (2000).

Oleoresin is another important quality trait in chilli. The highest oleoresin content was observed in Byadagi Kaddi followed by CHD 8. Among the hybrids, CO 4 x Byadagi Kaddi recorded the highest oleoresin content followed by CO 4 x Arka Abir (Table 1). The cross CO 4 x Ujwala exhibited highly significant positive heterosis over mid parent and better parent. Most of the hybrids showed negative heterosis over best parent (Table 2). Both positive and negative heterosis over mid parent and better parent and negative heterosis over best parent were reported by Muthuvel (2003). The result was similar with the findings of Anandanayaki (1997), whereas,

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Tanki (1999), Prasath and Ponnuswami (2008) recorded positive heterosis over mid, better and best parents.

For the trait of capsanthin, among the parents, Byadagi Kaddi recorded the highest capsanthin content followed by Arka Abir. Among the hybrids, CO 4 x Byadagi Kaddi exhibited the highest capsanthin. Most of the crosses showed positive heterosis over mid parent and both positive and negative heterosis over better parent and highly significant negative heterosis over best parent for this trait except four crosses. Result was similar with the finding of Prasath and Ponnuswami (2008).

Ascorbic acid content was the highest in K 2 among the parents. The hybrid PKM 1 x CO 4 recorded the highest ascorbic acid content. The cross combination PKM 1 x CO 4 also recorded the highest positive significant heterosis over mid parent, better parent and best parent. Most of the hybrids showed negative heterosis over best parent. Heterosis for this trait had also been reported by Kumar and Lal (2001), Kumar and Tata (2010).

The foregoing discussion revealed that the hybrids with high *per se* performance also registered high heterotic effects (Table 1). Based on these, hybrid Punjab Lal x CO 4 could be selected for capsaicin traits because it had higher capsaicin content of 0.79 per cent which was much higher than capsaicin content of parent variety CO 4 (0.39 per cent). It also registered highly significant positive heterosis over mid parent, better parent and best parent for this trait. Other hybrids which also showed greater attributes in this aspect were Arka Lohit x CO 4, Ujwala x CO 4, CHD 8 x CO 4, CO 4 x Punjab Lal, CO 4 x Arka Lohit, Pusa Jwala x CO 4 and CO 4 x Pusa Jwala (Table 1).

In case of traits *viz.* oleoresin and capsanthin, CO 4 x Byadagi Kaddi exhibited the highest for both. It was comparatively higher than the oleoresin and capsanthin content of CO 4. It also registered significant positive heterosis over mid parent, better parent and best parent (Table 3). The other two hybrids such as CO 4 x Arka Abir and Byadagi Kaddi x CO 4 were also promising for those traits. Based on the present result, the above hybrids could be selected and promoted for further study.

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**Table1. *Per se* performance of parents and hybrids for quality characters**

Parents and hybrids	Oleoresin (per cent)	Capsaicin (per cent)	Capsanthin (ASTA Unit)	Ascorbic acid (mg 100 g <sup>-1</sup> )
1. Ujwala x CO 4	14.36	0.67	44.24	127.75
2. Pusa Jwala x CO 4	12.29	0.59	38.22	99.89
3. CHD 8 x CO 4	15.73	0.62	40.88	112.19
4. K 2 x CO 4	12.37	0.50	38.85	72.76
5. Arka Lohit x CO 4	15.39	0.70	43.18	110.62
6. Byadagi Kaddi x CO 4	15.69	0.23	142.52	89.52
7. Punjab Lal x CO 4	14.12	0.79	44.29	120.14
8. Arka Abir x CO 4	15.49	0.22	131.03	127.56
9. PKM 1 x CO 4	13.22	0.58	40.18	185.56
10. CO 4 x Punjab Lal	14.56	0.62	45.52	73.89
11. CO 4 x Byadagi Kaddi	16.67	0.22	149.03	85.56
12. CO 4 x CHD 8	15.90	0.54	41.90	109.71
13. CO 4 x K 2	13.78	0.48	37.78	100.97
14. CO 4 x Arka Abir	16.28	0.21	133.43	91.13
15. CO 4 x Arka Lohit	15.72	0.59	45.04	100.03
16. CO 4 x Pusa Jwala	13.53	0.59	40.97	151.58
17. CO 4 x PKM 1	13.94	0.52	41.31	87.39
18. CO 4 x Ujwala	15.72	0.59	42.38	83.51
19. Punjab Lal	12.16	0.73	41.26	95.41
20. Ujwala	13.42	0.63	43.56	73.22
21. PKM 1	12.47	0.53	39.00	78.07
22. Arka Abir	15.64	0.19	126.40	136.75
23. CHD 8	15.43	0.58	38.56	109.66
24. K 2	13.33	0.51	32.38	141.56
25. Arka Lohit	14.48	0.72	42.45	122.01
26. Byadagi Kaddi	15.68	0.20	138.60	119.49
27. CO 4	14.10	0.39	42.13	70.47
28. Pusa Jwala	14.08	0.57	31.56	112.87
Mean				
Parents	14.08	0.50	57.59	105.91
Hybrids	14.71	0.51	63.38	107.21
SEd	0.19	0.01	0.49	0.51
CD (0.05)	0.38	0.02	1.01	1.03



**Table 2. Heterosis (per cent) over the mid parent (di), better parent (dii) and the best parent (diii) for capsaicin and oleoresin**

Hybrids	Capsaicin			Oleoresin		
	di	dii	diii	di	dii	diii
1. Ujwala x CO 4	18.51**	5.34**	-9.09**	4.36**	1.84	-8.42**
2. Pusa Jwala x CO 4	23.68**	4.15**	-18.68**	-12.90**	-12.96**	-21.62**
3. CHD 8 x CO 4	26.87**	6.09**	-15.71**	6.56**	1.97	0.34
4. K 2 x CO 4	12.15**	-1.05	-30.87**	-9.83**	-12.29**	-21.13**
5. Arka Lohit x CO 4	25.83**	-3.01*	-4.34**	7.72**	6.31**	-1.83
6. Byadagi Kaddi x CO 4	-21.13**	-40.34**	-68.13**	5.37**	0.06	0.06
7. Punjab Lal x CO 4	41.13**	8.26**	8.26**	7.51**	0.12	-9.97**
8. Arka Abir x CO 4	-24.02**	-43.50**	-69.82**	4.15**	-0.98	-1.23
9. PKM 1 x CO 4	26.16**	9.50**	-20.50**	-0.46	-6.22**	-15.67**
10. CO 4 x Punjab Lal	11.96**	-14.11**	-14.11**	10.92**	3.29	-7.12**
11. CO 4 x Byadagi Kaddi	-25.76**	-43.85**	-70.00**	11.95**	6.31**	6.31**
12. CO 4 x CHD 8	10.86**	-7.30**	-26.35**	7.71**	3.07*	1.42
13. CO 4 x K 2	6.81**	-5.75**	-34.16**	0.50	-2.25	-12.10**
14. CO 4 x Arka Abir	-27.47**	-46.07**	-71.19**	9.46**	4.07**	3.81**
15. CO 4 x Arka Lohit	6.55**	-17.87**	-19.00**	10.01**	8.56**	0.26
16. CO 4 x Pusa Jwala	22.85**	3.45*	-19.22**	-4.09**	-4.15**	-13.69**
17. CO 4 x PKM 1	13.19**	-1.76	-28.68**	4.96**	-1.11	-11.08**
18. CO 4 x Ujwala	14.97**	-6.93**	-19.68**	14.27**	11.51**	0.28

\*\* Significant at 0.01 level

\* Significant at 0.05 level



**Table 3. Heterosis (per cent) over the mid parent (di), better parent (dii) and the best parent (diii) for capsanthin and ascorbic acid**

Hybrids	Capsanthin			Ascorbic acid		
	di	dii	diii	di	dii	diii
1. Ujwala x CO 4	3.26*	1.56	-68.08**	77.82**	74.48**	-9.75*
2. Pusa Jwala x CO 4	3.74*	-9.27**	-72.42**	8.97**	-11.50**	-29.43**
3. CHD 8 x CO 4	1.33	-2.97	-70.51**	24.57**	2.31**	-20.75**
4. K 2 x CO 4	4.27**	-7.79**	-71.97**	-31.37**	-48.60**	-48.60**
5. Arka Lohit x CO 4	2.11	1.73	-68.84**	14.95**	-9.33**	-21.85**
6. Byadagi Kaddi x CO 4	57.72**	2.83**	2.83**	-5.75**	-25.08**	-36.76**
7. Punjab Lal x CO 4	6.22**	5.13**	-68.04**	44.85**	25.92**	15.13**
8. Arka Abir x CO 4	55.50**	3.66**	-5.46**	23.12**	-6.72**	-9.89**
9. PKM 1 x CO 4	-0.94	-4.62**	-71.01**	149.85**	137.68**	31.08**
10. CO 4 x Punjab Lal	9.17**	8.04**	-67.16**	-10.91**	-22.56**	-47.80**
11. CO 4 x Byadagi Kaddi	64.92**	7.53**	7.53**	-9.92**	-28.40**	-39.56**
12. CO 4 x CHD 8	3.85**	-0.55	-69.77**	21.81**	0.05	-22.50**
13. CO 4 x K 2	1.42	-10.32**	-72.74**	-4.76**	-28.67**	-28.67**
14. CO 4 x Arka Abir	58.35**	5.56**	-3.73**	12.04**	-33.36**	-35.62**
15. CO 4 x Arka Lohit	6.50**	6.10**	-67.50**	3.94**	-18.01**	-29.34**
16. CO 4 x Pusa Jwala	11.19*	-2.76	-70.44**	65.36**	34.30**	7.08**
17. CO 4 x PKM 1	1.83	-1.95	-70.20**	17.67**	11.94**	-38.27**
18. CO 4 x Ujwala	-1.08	-2.70	-69.42**	16.24**	14.06**	-41.00**

\*\* Significant at 0.01 level

\* Significant at 0.05 level