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Variability studies on selected taxa of *Capsicum* using morphological characters and SDS-Page profiles

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INTRODUCTION

Variety is the spice of life and basic characteristic of life in its unlimited diversity. The notion that no two individuals of a sexually reproducing population are 100% identical prevailed even when methods of scientific scrutiny were not available. Much of the variations in phenotype observed in natural populations of a species were earlier attributed to environmental influences[7]. Many botanists reasoned that distinct *intra* specific variations of plants were merely due to habitat modifications and adaptation to environment was by phenotypic plastic response. A wide spectrum of simple and overlapping variations is now documented in plants[8,10,12,20,23,27]. In general, all observed variations are broadly grouped into two categories, epigenetic and genetic. Genetic variations in plants are strictly hertable. Epigenetic changes in plants in general include morphological, chemical as well as physiological variations. Therefore a great deal of information morphology and genetic is necessary before the observed pattern of variation may be interpreted. Assessment of the extent and distribution of genetic variation in a crop species and its relatives is essential in understanding pattern of diversity and evolutionary relationships between accessions that help to sample genetic resources in a more systematic fashion for conservation and plant improvement. Traditionally, genetic diversity is assessed based on morphological features such as plant height, reproductive features, day length sensitivity, local adaptation etc, though such, characters exhibit enormous variation for the particular use of the crop. The genus *Capsicum* is a member of the 'Solanaceae' family. The genus *Capsicum* consists of approximately 22 wild species and five domesticated species[5]. Chellies types usually are classified by fruit characteristics, i.e. pungency, colour, shape, flavour, size and their use[4,22]. Despite their vast trait differences most Chellies cultivars commercially cultivated in the world belong to the species, *C.annum*. The *Tabasco* (*C.frutescens*) and *habanero* (*C.Chinese*), are the best-known exceptions. Several hundred Chellies pod-types are grown world wide. In the present study, it is considered important to carry out analysis of the variation pattern, of different cultivars of *Capsicum*. An attempt has been made to find out the similarities and differences among the different taxa and cultivars of *Capsicum*. It involves cladistical analysis of morphological characteristics and protein characteristics of leaf, such studies may be useful to find out the marker characteristics of the taxon, It may also be useful to find out the relative similarities of the taxa.

MATERIALS AND METHODS

Plants of Capsicum frutescens var. Fasciculatum (P_1), Capsicum breviatum (P2), Capsicum pubescens (P3), Capsicum frutescens longum var. Conides (P4), Capsicum baccatum (P5), Capsicum frutescens longum var. cerasiforme (P6), Capsicum frutescens longum var. baccatum (P7), Capsicum frutescens longum Var abbreviatum (P8), Capsicum Chinense (P9), Capsicum

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TABLE 1: Quantitative morphological characteristics selected taxa of *capsicum*

S.no.	Characters	Plant-1	Plant-2	Plant-3	Plant-4	Plant-5	Plant-6	Plant-7	Plant-8	Plant-9	Plant-10	Plant-11	Plant-12	Plant-13	Plant-14
1	P.H	38.8	50.4	13.4	58.2	54.6	53.8	54.2	57	58.8	23.6	44.2	48	51.6	47
2	No. of L	64	74	71	80	86	44	67	84	71	60	60	67	61	61
3	No. of B	8	9	12	15	15	11	13	14	14	13	12	8	12	12
4	L. L	4.0	4.0	2.5	6.2	5.6	5.3	5.0	5.8	6.6	2.6	5.2	5.3	5.5	5.8
5	L.B	2.1	1.7	1.1	2.8	2.5	2.5	2.6	2.4	2.7	1.6	2.4	2.45	2.7	2.5
6.	L . A	9.3	8.0	7.8	20.9	17.7	17.2	16.3	16.8	19.7	4.8	13.9	15.5	16.7	15.3
7.	P. L	1.1	1.2	1.0	2.6	2.0	2.9	3.0	2.0	2.7	1.2	2.1	2.3	2.4	1.6
8.	F. P.L.	1.5	1.6	1.5	2.4	2.1	2.0	2.0	1.9	2.0	1.3	2.3	2.4	2.4	2.1
9.	F.L	1.7	1.8	1.7	3.0	2.5	3.1	3.2	2.4	7.6	1.6	4.1	4.2	3.8	2.9
10.	I.N.L.	0.9	0.1	0.8	4.3	1.3	3.3	2.5	3.0	3.6	0.86	1.0	1.1	4.9	4.2

1. PH - Plant Height cm; 2. N.L. - No. of Leaves cm; 3. N.B.- No. of Branches cm; 4. L.L. - Leaf Length cm; 5. PH - Plant Height cm; 6. L.A.- Leaf Area cm^2; 2. N.L.- No. of Leaves cm; 7. P.L. - Petiole Length cm; 7. P.L. - Petiole Length cm ; 8.F.P.L. - Fruit Pedicil Length cm; 9. F.L. - Fruit Length cm; 10. I.N.L. - Internode Length cm

frutescens longum (P10), Capsicum baccatum var. Pendulum (P11), Capsicum baccatum var. melegueta (P12), Capsicum baccatum var. microcarpum (P13) and Capsicum annuum (P14), were collected from the Athmanilayam nursery garden, Marthandam, Kanaya kumari District. In each taxa 10 individuals were used to study the following morphological characteristics viz. plant height, number of leaves per plant, number of branches per plant, leaf length per plant, leaf breadth per plant, leaf area per plant, length of petiole per plant, length of pedicel per plant, length of fruit per plant and length of inter node per plant. Morphology characters were analysed using M.S.Excel® 2003 and NTSYS2. 02j software. For protein analysis, the fresh young leaves were harvested from the mother plants and washed once in de-ionized water and mashed in a pre-chilled mortar with 500µl of phosphate buffer (pH 7.0). The resultant slurry was centrifuged at 10000 rpm for 10min at 4^{0}C in a Micro 22 R centrifuge and the supernatant was stored at -70^{0}C before use. SDS- PAGE and PAGE was carried out by Anbalagan[1] method for protein and isoenzyme seprations. After electrophoresis the gel was observed using a Vilber Loubermat gel documentation system (Germany) and banding profiles of protein and isoenzyme of *Capsicum* cultivars compared by Biogene software analysis (Germany). The similarity and variation between the cultivars were estimated by Biogene software analysis and the dendrograms were documented.

RESULT AND DISCUSSION

Morphology

The quantitative and qualitative morphological characters revealed considerable diversity. Phenotypical variations among the plants raised under identical conditions of growth were not uncommon. They differed for plant height, branching, no of leaves, Fruit length, pedicel length, leaf length, leaf breadth and leaf area. Among the 14 taxa studied *Capsicum chinense* (TABLE 1) recorded maximum for plant height with a mean value of 58.8cm and *Capsicum pubescens* (TABLE 1) recorded the lowest height with a mean of 13.4cm. The number of leaves per plant in the selected taxa of *Capsicum* was found to be significantly variable. The leaf number was significantly higher than the others in *Capsicum baccatum* (86). Lowest numbers of leaves were observed in *Capsicum frutescens longum* var. *cerasiforme* (TABLE 1). The branch numbers of selected 14 taxa of *Capsicum* cultivars were significantly more similar. More number of branches were found in *Capsicum frutescens longum* var. *conides* and *Capsicum baccatum* with the mean of 15 (TABLE 1), Less number of branches were found in *Capsicum frutescens abbreviatum*, with 9 branches (TABLE 1).

Capsicum chinense recorded the highest value of leaf length with the mean of 6.6 cm (TABLE 1) and the lowest value in *Capsicum* pubescens with the mean of 2.5cm (TABLE 1). Breadth of the *Capsicum* cultivar taxa studies was significantly variable (TABLE 1) *Capsicum frutescens longum* var. *conides* showed the highest leaf breadth (2.8cm) and the lowest leaf breadth showed in *Capsicum pubsecens* (1.1cm). *Capsicum frutescens longum* var. *conides* showed the largest leaf area with the mean of 20.9cm^2 (TABLE 1). The lowest value was found in *Capsicum frutescens longum* with the mean of 4.8 cm^2. The petiole length of

TABLE 2: Ranking of morphological characteristics of each taxa of *Capsicum*

Point	Plant-1	Rank	Percent	Point	Plant-2	Rank	Percent	Point	Plant-3	Rank	Percent
2	64	1	100.00%	2	74	1	100.00%	2	71	1	100.00%
1	38.8	2	88.80%	1	50.4	2	88.80%	1	13.4	2	88.80%
6	9.30	3	77.70%	3	9	3	77.70%	3	12	3	77.70%
3	8	4	66.60%	6	8.01	4	66.60%	6	7.84	4	66.60%
4	4	5	55.50%	4	4	5	55.50%	4	2.5	5	55.50%
5	2.1	6	44.40%	9	1.8	6	44.40%	9	1.7	6	44.40%
9	1.7	7	33.30%	5	1.7	7	33.30%	8	1.5	7	33.30%
8	1.5	8	22.20%	8	1.6	8	22.20%	5	1.1	8	22.20%
7	1.1	9	11.10%	7	1.2	9	11.10%	7	1	9	11.10%
10	0.9	10	.00%	10	0.1	10	0.00%	10	0.8	10	0.00%
Point	**Plant-4**	**Rank**	**Percent**	**Point**	**Plant-5**	**Rank**	**Percent**	**Point**	**Plant-6**	**Rank**	**Percent**
2	80	1	100.00%	2	86	1	100.00%	1	53.8	1	100.00%
1	58.2	2	88.80%	1	54.6	2	88.80%	2	44	2	88.80%
6	20.98	3	77.70%	6	17.70	3	77.70%	6	17.22	3	77.70%
3	15	4	66.60%	3	15	4	66.60%	3	11	4	66.60%
4	6.2	5	55.50%	4	5.6	5	55.50%	4	5.3	5	55.50%
10	4.3	6	44.40%	5	2.5	6	33.30%	10	3.3	6	44.40%
9	3	7	33.30%	9	2.5	6	33.30%	9	3.1	7	33.30%
5	2.8	8	22.20%	8	2.1	8	22.20%	7	2.9	8	22.20%
7	2.6	9	11.10%	7	2	9	11.10%	5	2.5	9	11.10%
8	2.4	10	.00%	10	1.3	10	0.00%	8	2	10	0.00%
Point	**Plant-7**	**Rank**	**Percent**	**Point**	**Plant-8**	**Rank**	**Percent**	**Point**	**Plant-9**	**Rank**	**Percent**
2	67	1	100.00%	2	84	1	100.00%	2	71	1	100.00%
1	54.2	2	88.80%	1	57	2	88.80%	1	58.8	2	88.80%
6	16.30	3	77.70%	6	16.88	3	77.70%	6	19.73	3	77.70%
3	13	4	66.60%	3	14	4	66.60%	3	14	4	66.60%
4	5	5	55.50%	4	5.8	5	55.50%	9	7.6	5	55.50%
9	3.2	6	44.40%	10	3	6	44.40%	4	6.6	6	44.40%
7	3	7	33.30%	5	2.4	7	22.20%	10	3.6	7	33.30%
5	2.6	8	22.20%	9	2.4	7	22.20%	5	2.7	8	11.10%
10	2.5	9	11.10%	7	2	9	11.10%	7	2.7	8	11.10%
8	2	10	.00%	8	1.9	10	0.00%	8	2	10	0.00%
Point	**Plant-10**	**Rank**	**Percent**	**Point**	**Plant-11**	**Rank**	**Percent**	**Point**	**Plant-12**	**Rank**	**Percent**
2	60	1	100.00%	2	60	1	100.00%	2	67	1	100.00%
1	23.6	2	88.80%	1	44.2	2	88.80%	1	48	2	88.80%
3	13	3	77.70%	6	13.96	3	77.70%	6	15.48	3	77.70%
6	4.87	4	66.60%	3	12	4	66.60%	3	8	4	66.60%
4	2.6	5	55.50%	4	5.2	5	55.50%	4	5.3	5	55.50%
5	1.6	6	33.30%	9	4.1	6	44.40%	9	4.2	6	44.40%
9	1.6	6	33.30%	5	2.4	7	33.30%	5	2.45	7	33.30%
8	1.3	8	22.20%	8	2.3	8	22.20%	8	2.4	8	22.20%
7	1.2	9	11.10%	7	2.1	9	11.10%	7	2.3	9	11.10%
10	0.86	10	.00%	10	1	10	0.00%	10	1.1	10	0.00%
Point	**Plant-13**	**Rank**	**Percent**	**Point**	**Plant-14**	**Rank**	**Percent**				
2	61	1	100.00%	2	61	1	100.00%				
1	51.6	2	88.80%	1	47	2	88.80%				
6	16.72	3	77.70%	6	15.30	3	77.70%				
3	12	4	66.60%	3	12	4	66.60%				
4	5.5	5	55.50%	4	5.8	5	55.50%				
10	4.9	6	44.40%	10	4.2	6	44.40%				
9	3.8	7	33.30%	9	2.9	7	33.30%				
5	2.7	8	22.20%	5	2.5	8	22.20%				
7	2.4	9	0.00%	8	2.1	9	11.10%				
8	2.4	9	0.00%	7	1.6	10	0.00%				

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TABLE 3: Overall ranking of morphological characteristics of selected taxa of *Capsicum*

Point	P.H	Rank	Percent	Point	No.of leaves	Rank	Percent	Point	No.of brands	Rank	Percent
9	58.8	1	100.00%	5	86	1	100.00%	4	15	1	92.30%
4	58.2	2	92.30%	8	84	2	92.30%	5	15	1	92.30%
8	57	3	84.60%	4	80	3	84.60%	8	14	3	76.90%
5	54.6	4	76.90%	2	74	4	76.90%	9	14	3	76.90%
7	54.2	5	69.20%	3	71	5	61.50%	7	13	5	61.50%
6	53.8	6	61.50%	9	71	5	61.50%	10	13	5	61.50%
13	51.6	7	53.80%	7	67	7	46.10%	3	12	7	30.70%
2	50.4	8	46.10%	12	67	7	46.10%	11	12	7	30.70%
12	48	9	38.40%	1	64	9	38.40%	13	12	7	30.70%
14	47	10	30.70%	13	61	10	23.00%	14	12	7	30.70%
11	44.2	11	23.00%	14	61	10	23.00%	6	11	11	23.00%
1	38.8	12	15.30%	10	60	12	7.60%	2	9	12	15.30%
10	23.6	13	7.60%	11	60	12	7.60%	1	8	13	0.00%
3	13.4	14	0.00%	6	44	14	0.00%	12	8	13	0.00%
Point	**Lear length**	**Rank**	**Percent**	**Point**	**L.B**	**Rank**	**Percent**	**Point**	**L . Area**	**Rank**	**Percent**
9	6.6	1	100.00%	4	2.8	1	100.00%	4	20.948	1	100.00%
4	6.2	2	92.30%	9	2.7	2	84.60%	9	19.713	2	92.30%
8	5.8	3	76.90%	13	2.7	2	84.60%	5	17.7002	3	84.60%
14	5.8	3	76.90%	7	2.6	4	76.90%	6	17.2228	4	76.90%
5	5.6	5	69.20%	5	2.5	5	53.80%	8	16.8834	5	69.20%
13	5.5	6	61.50%	6	2.5	5	53.80%	13	16.7216	6	61.50%
6	5.3	7	46.10%	14	2.5	5	53.80%	7	16.3052	7	53.80%
12	5.3	7	46.10%	12	2.45	8	46.10%	12	15.4898	8	46.10%
11	5.2	9	38.40%	8	2.4	9	30.70%	14	15.3034	9	38.40%
7	5	10	30.70%	11	2.4	9	30.70%	11	13.9662	10	30.70%
1	4	11	15.30%	1	2.1	11	23.00%	1	9.3068	11	23.00%
2	4	11	15.30%	2	1.7	12	15.30%	2	8.0144	12	15.30%
10	2.6	13	7.60%	10	1.6	13	7.60%	3	7.8456	13	7.60%
3	2.5	14	0.00%	3	1.1	14	0.00%	10	4.8766	14	0.00%
Point	**Petiole. L**	**Rank**	**Percent**	**Point**	**Pedicel.L**	**Rank**	**Percent**	**Point**	**Fruit. L**	**Rank**	**Percent**
7											
6	3	1	100.00%	4	2.4	1	84.60%	9	7.6	1	100.00%
9	2.9	2	92.30%	12	2.4	1	84.60%	12	4.2	2	92.30%
4	2.7	3	84.60%	13	2.4	1	84.60%	11	4.1	3	84.60%
13	2.6	4	76.90%	11	2.3	4	76.90%	13	3.8	4	76.90%
12	2.4	5	69.20%	5	2.1	5	61.50%	7	3.2	5	69.20%
11	2.3	6	61.50%	14	2.1	5	61.50%	6	3.1	6	61.50%
5	2.1	7	53.80%	6	2	7	38.40%	4	3	7	53.80%
8	2	8	38.40%	7	2	7	38.40%	14	2.9	8	46.10%
14	2	8	38.40%	9	2	7	38.40%	5	2.5	9	38.40%
2	1.6	10	30.70%	8	1.9	10	30.70%	8	2.4	10	30.70%
10	1.2	11	15.30%	2	1.6	11	23.00%	2	1.8	11	23.00%
1	1.2	11	15.30%	1	1.5	12	7.60%	1	1.7	12	7.60%
3	1.1	13	7.60%	3	1.5	12	7.60%	3	1.7	12	7.60%
	1	14	.00%	10	1.3	14	.00%	10	1.6	14	0.00%
Point	**Inter node .L.**	**Rank**	**Percent**	**Point**	**Inter node .L.**	**Rank**	**Percent**				
13	4.9	1	100.00%	5	1.3	8	46.10%				
4	4.3	2	92.30%	12	1.1	9	38.40%				
14	4.2	3	84.60%	11	1	10	30.70%				
9	3.6	4	76.90%	1	0.9	11	23.00%				
6	3.3	5	69.20%	10	0.86	12	15.30%				
8	3	6	61.50%	3	0.8	13	7.60%				
7	2.5	7	53.80%	2	0.1	14	0.00%				

TABLE 4: Gross morphological variability (Covariance) of selected taxa of *Capsicum*

	Plant-1	Plant-2	Plant-3	Plant-4	Plant-5	Plant-6	Plant-7	Plant-8	Plant-9	Plant-10	Plant-11	Plant-12	Plant-13	Plant-14
Plant-1	405.2852													
Plant-2	486.9604	588.2769												
Plant-3	376.934	440.5689	416.694											
Plant-4	517.0909	623.1334	463.2005	671.7357										
Plant-5	545.8099	655.5887	504.7529	701.8719	738.5961									
Plant-6	328.5597	403.9417	250.4206	441.6237	450.2119	320.9252								
Plant-7	446.7944	541.188	389.1112	582.2967	606.5389	390.1903	507.323							
Plant-8	540.8174	651.2338	491.9622	697.2153	731.6378	452.2674	603.8017	726.1212						
Plant-9	469.5288	568.8043	406.3007	613.533	638.0053	413.1297	534.7251	635.3512	565.4643					
Plant-10	347.1749	412.5506	353.6833	434.3643	466.4332	256.2737	371.0661	458.447	388.0532	314.1445				
Plant-11	388.5233	469.0458	347.2979	503.3256	526.8472	331.3589	437.2192	523.155	460.9001	326.8214	378.4271			
Plant-12	434.6068	524.1031	388.4494	561.3195	587.6725	368.0117	487.0515	583.7758	513.6787	363.5	421.5159	471.9839		
Plant-13	406.027	492.2391	349.1104	531.331	551.6594	358.9868	463.141	549.9719	488.7673	334.6603	398.362	444.0163	423.7078	
Plant-14	397.913	480.7752	351.278	517.7112	539.9264	343.6102	449.7795	537.1619	474.1193	332.3544	388.173	432.6036	410.8118	399.7063

the selected fourteen taxa illustrated varied length (TABLE 1). *Capsicum frutescens longum* var. *baccatum* showed the longest length with the mean of 3cm, the lowest length was found in *Capsicum pubescens*. *Capsicum frutescens longum* var, *conides Capsicum baccatum* var. *melegueta*, *Capsicum baccatum* var. *microcarpum* were scored the longest pedicel length with the mean value of 2.4cm (TABLE 1) *Capsicum frutescens longum* showed the shortest pedicel length with the mean of 1.3cm (TABLE 1).

Fruit length was a highly variable characterstics, longest fruits were observed in *Capsicum chinense* (7.6cm) (TABLE 1) and the shortest fruit was found in *Capsicum pubescens* with the mean of 1.7 cm (TABLE 1). *Capsicum baccatum.* var. *microcarpum* showed the highest value for internode length with the mean of 4.9cm. (TABLE 1) and *Capsicum baccatum* var. *pendulum* showed the lowest value with the mean of 0.1cm (TABLE 1). The aforesaid said observations were substantiaties the over all ranking of all the morphological charactertics of all the taxa studied, it was shown in the (TABLE 2).

Rank

Morphological characterstics of each taxa of *Capsicum* were ranked using MS Excel® -2003 it was shown in (TABLE 3) High degrees of variability in the ranking of morphological characteristics were observed (TABLE 3). In all most all the taxa except P_6 the number of leaves was ranked I, followed by the height of the plant rank II. The remaining eight morphological charactestics got different ranks for different taxa of *Capsicum*. Ranking of morphological charactestics showed that the taxa may be placed under different groups. Hence all the morphological charactestics of all the taxa of *Capsicum* were analysed for their covariance. With respect to the morphological characterstics studied, all the selected taxa of *Capsicum* were consistently variable (TABLE 4) The highest level of consistency was found between P_3 and P_5 with the value of 701.8719 and the lowest level of consistency was found in P_6 and P_{10} (TABLE 4). Generally phenotypic variations give valuable due to the underlying genetic variations[3]. The variation of phenotypic characters, especially quantitative ones, differs greatly between varieties[19]. The present study largely confirms this reported observation as most of the quantitative morphological attributes varied greatly among the fourteen selected taxa of *Capsicum* cultivars. It was evident from the data present in TABLE 1. It appeared that the distinct morphological characteristics of the taxas may be due to certain combinations of genes which had become randomly fixed, as assumed by stephens and Rick[26]. Variation in morphological characterstics were earlier reported within populations and between ecotypes in *Angelica glauca*, *A.archangelica*[30] and *Ranunculs repens*[14]. Morphological markers had several disadvantages when used as markers in botanical studies, ie., they cannot be useful to distinguish homozygotes and heterozygotes from each other, if there is a dominance, Onus and Pickergill[17], As observed in *Capsicum*, morphological variability was observed in *Eucalyptus* cultivars[16] and *Actino cephalus*[2]. However morphological characteristics cannot be used as marker characteristics because they may not be useful to distinguish homo (or) hetero zygotes[17].

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TABLE 5: Morphological relationship of selected 14 taxa of *Capsicum*

	Part I	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1													
2	0.07936	1												
3	0.0634	0.0795	1											
4	0.01587	0.0793	0.03174	1										
5	0.01587	0.03174	0.01587	0.09523	1									
6	0.03174	0.03174	0.03174	0.06349	0.0793	1								
7	0.03174	0.01587	0.01587	0.0634	0.0793	0.0793	1							
8	0.03174	0.03174	0.03174	0.07930	0.11111	0.0952	0.077936	1						
9	0.03174	0.04761	0.04761	0.09523	0.06340	0.0952	0.04761	0.0793	1					
10	0.06349	0.0634	0.11111	0.01587	0.0158	0.01317	0.01587	0.0317	0.03174	1				
11	0.01587	0.01587	0.01587	0.0634	0.0952	0.0634	0.06349	0.0634	0.04761	0.03174	1			
12	0.3174	0.01587	0.031741	0.0634	0.0793	0.0793	0.07936	0.11111	0.06349	0.03174	0.07936	1		
13	0.03174	0.01587	0.01587	0.0952	0.0952	0.0952	0.11111	0.0793	0.06349	0.01587	0.07936	0.07936	1	
14	0.04761	0.01587	0.3174	0.0793	0.0793	0.0476	0.07936	0.0634	0.03174	0.03174	0.07936	0.09523	0.09523	1

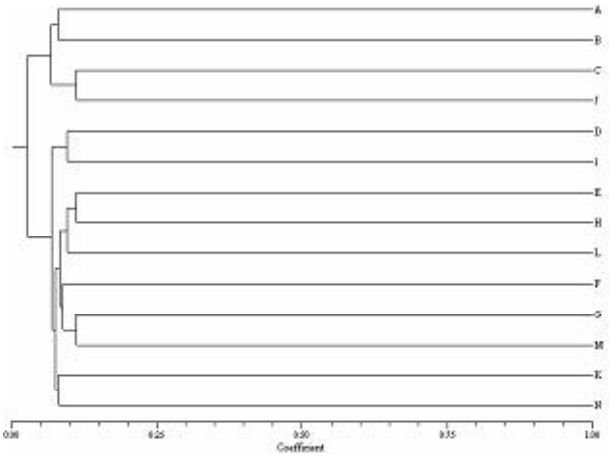

Figure : Dendrogram showing the marphological characteristics of selected taxa of *capsicum*

The dendrogram constructed using the UPGMA method, differentiated fourteen cultivars of *Capsicum* (TABLE 5; Figure 1) into two major clusters A and B Cluster A consists of four cultivars, *Capsicum frutescens* var *fasciculatum Capsicum frutescens abbreviatum Capsicum pubescens* and *Capsicum frutescens longum* (TABLE 5; Figure 1) cluster B consists of ten cultivars. *Capsicum frutescens longum* var. *conides Capsicum baccatum, Capsicum frutescens longum* var. *cerasiforme, Capsicum frutescens longum* var. *baccatum Capsicum frutescens longum* var. *baccatum Capsicum frutescens longum* var. *abbreviatum, Capsicum chinense, Capsicum baccatum* var. *pendulum, Capsicum baccatum* var, *melegueta Capsicum baccatum* var. *microcarpum, Capicum annuum*. Cluster 'B' (Figure 1) differentiated in to B_1 and B_2. B_1 consists of two taxa only *Capsicum frutescens longum* var. *conides and Capsicum chinense*. But B_2 (Figure 1)

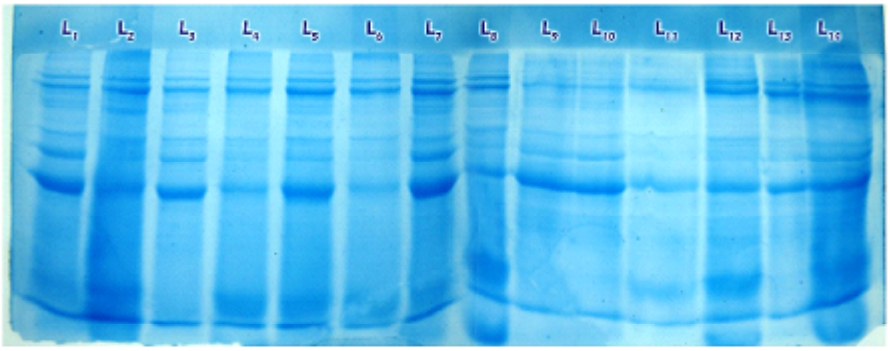

Figure 2 : SDS-PAGE protein profile of selected texa of Capsicum(Leaf)

includes the remaining eight cultivars Further B_2 divides into two more small clusters B_2^1 and B_2^2 (Figure 1) B_2^1 includes *Capsicum baccatum*, *Capsicum frutescens longum* var. *abbreviatum*, *Capsicum baccatum* var. *melegueta Capsicum frutescens longum* var. *Cerasiforme*, *Capsicum frutescens longum* var. *baccatum* and *Capsicum baccatum* var.*microcarpum.* B_2^2 (Figure 1) consists of *Capsicum baccatum* var. *pendulum* and *Capsicum annuum.* In B_2^1 cluster, relationship was observed among *Capsicum baccatum, Capsicum frutescens longum* var, *abbreviatum* and *Capsicum baccatum* var. *melegueta* . *Capsicum frutescens longum* var. c*erasiforme, Capsicum frutescens longum* var. *baccatum* and *Capsicum baccatum* var. *Microcarpum* expressed their closeness. As observed in the present investigation unrecorded and unweighed morphological characterstics were used to confirm the earlier *taxa*omic relationships in Gnetophytes (Tom et al., 2003) Lycophyta Sphenophyta, Pteridophyta[25] monocots and dicots[9] and 28 genera of flowering plants[6].

SDS-PAGE protein analysis

Multiple regions of activity were obtained for protein electrophoretic system P_1 to P_{10}, for fourteen ($Lane_1$ to $Lane_{14}$) cultivars (Figure 2) Region 1(Figure 2) contained thirty two bands, P_1^8 (0.028) was showed by *Capsicum frutescens longum* var. c*erasiforme* (L_6) and *Capicum annuum* (L_{14}); P_1^{10} (0.033) was showed by *Capsicum frutescens* var. *fasciculatum* (L_1) and *Capsicum pubescens* (L_3); P_1^{11} (0.034) was showed their presence in *Capsicum frutescens abbreviatum* (L_2) and *Capsicum baccatum* var. p*endulum* (L_{11}); P_1^{16} (0.051) was expressed in *Capsicum frutescens abbreviatum* (L_2) and *Capsicum baccatum* (L_5); P_1^{18} (0.056) was showed in *Capsicum baccatum* var. *pendulum* (L_{11}) and *Capsicum baccatum* var. *Microcarpum* (L_{13}); P_1^{22} (0..067) was shared by *Capsicum frutescens longum* var. *cerasiforme* (L_6) and *Capsicum frutescens longum* var. a*bbreviatum* (L_8). P_1^{25} (0.073) was showed in *Capsicum pubsecens* (L_3) and *Capsicum frutescens longum* (L_{10}); P_1^{29} (0.084) was showed in *Capsicum baccatum* var. m*icrocarpum* (L_5) and *Capsicum frutescens longum* (L_{10}) P_1^{26} (0.076) was showed their presence commonly in *Capsicum baccatum* (L_5) and *Capsicum chinense* (L_9). P_1^{17} (0.053) P_1^{24} (0.071) and P_1^{30} (0.087) were restricted to *Capsicum frutescens* var. f*asciculatum* (L_1); P_1 (0.015), P_1^{23} (0.070) were restricted to *Capsicum frutescens abbreviatum* (L_2). P_1^4 (0. 020), and P_1^{19} (0.058) were restricted to c*apppsicum frutescens longum* var. c*onides* (L_4). P_1^3 (0.019) and P_1^{13} (0.0420 were restricted to *Capsicum baccatum* (L_5). P_1^2 (0.016) and P_1^{28} (0.082) were restricted to *Cappsicum frutescens longum* var. *cerasiforme* (L6). P_1^6 (0.024), P_1^{14} (0.047) and P_1^{27} (0.081) were restricted to *Capsicum frutescens longum* var. *baccatum* (L_7). P_1^9 (0.031) was showed its unique presence in *Capsicum frutescens longum* var. a*bbreviatum* (L_8). P_1^7 (0.025) and P_1^{15} (0.048) were restricted to *Capsicum frutescens longum* (L10), P_1^5 (0.022) and P_1^{21} (0.062) were restricted to *Capsicum baccatum* var. *melegueta* (L_{12}). P_1^{12} (0.039) was showed its unique present in *Capsicum baccatum* var. *microcarpum* (L_{13}) similarly P_1^{20} (0.062) was showed unique present in *Capsicum annuum* (L_{14}). *Capsicum pubescens* (L_3) and *Capsicum chinense* (L_9) were failed to express their unique presence in this region. Region 2 showed twenty nine bands in different positions P_2^1 (0.101) was showed its presence jointly in *Capsicum baccatum* var. *pendulum* (L_{11}) and *Capsicum baccatum* var. *microcarpum* (L_{13}) P_2^3 (0.103) was showed its presence in *Capsicum pubescens* (L_3) and *Capsicum annuum* (L_{14}); P_2^{11} (0.124) was showed their presence commonly in *Capsicum frutescens* var. *fasciculatum* (L_1), *Capsicum frutescens longum* (L_{10}) and *Capsicum baccatum* var. p*endulum* (L_{11}). P_2^{12} (0.138) was shared by *Capsicum pubescens* (L_3) and *Capsicum baccatum* var. *melegueta* (L_{12}); P_2^{13} (0.140) was showed the presence in *Capsicum frutescens longum* var. c*onides*(L_4). And *Capsicum baccatum* (L_5); P_2^{14} (0.143) was showed jointely in *Capsicum frutescens abbreviatum* and *Capsicum annum* (L_{14}); P_2^{19} was shared by *Capsicum pubescens* (L_3) and *Capsicum frutescens longum* var. *abbreviatum* (L_8); P_2^{20}(0.163) the bands were similarly present in *Capsicum chinense* (L_9) and *Capsicum annuum* (L_{14}) ; P_2^{24} (0.185) was showed the presence in *Capsicum baccatum* (L_5) and *Capsicum frutescens longum* (L_{10}); P_2^{22}(0.177) was showed to the presence of *Capsicum chinense* (L_9) and *Capsicum annum* (L_{14}); P_2^{24}(0.185) was shared by *Capsicum baccatum* var. *pendulum* (L_{11}) and

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Capsicum baccatum var *melegueta* (L_{12}) and P_2^{27} (0.194) was showed its presence jointly in *Capsicum pubsescens* (L_3) and *Capsicum chinense* (L_9). Bands P_2^{16} (0.146). P_2^{18} (0.154) and P_2^{23} (0.183) was restricted to *Capsicum frutescens* var. f*asciculation* (L_1); P_2^{4} (0.105) was showed its unique present in *Capsicum frutescens abbreviatum* (L_2); Similarly P_2^{5} (0.107) was showed its unique present in *Capsicum baccatum* (L_5); Followed by P_2^{2} (0.103) was showed its unique present in *Capsicum frutescens longum* var. c*erasiforme* (L_6). P_2^{6} (0.109) and P_2^{28} (0.197) were restricted to *Capsicum frutescens longum* var. b*accatum* (L_7); P_2^{9} (0.118) and P_2^{25} (0.188) was restricted to *Capsicum frutescens longum* var. *abbreviatum* (L_8); P_2^{8} (0.115) was showed its unique present in *Capsicum Chinese* (L_9); P_2^{17} (0.149) and P_2^{26} (0.191) were restricted to *Capsicum frutescens longum* (L_{10}); similarly P_2^{7} (0.110) was showed its unique present in *Capsicum baccatum* var. m*elegueta* (42); Followed by P_2^{10} (0.12) was showed its unique present in *Capsicum annum* (L_{14}). *Capsicum pubescens* (L_3), *Capsicum baccatum* var. p*endulum* (L_{11}) and *Capsicum baccatum* var. m*icrocarpum* (L_{13}) were failed express their restricted expression in this region. Region 3 illustrated 19 bands in different positions in the banding profile. P_3^{3} (0.213) was observed in *Capsicum pubescens* (L_3) and *Capsicum frutescens longum* var.a*bbreviatum* (L_8); P_3^{10} (0.244) were showed its presence in *Capsicum frutescens longum* var. *baccatum* (L_7), *Capsicum baccatum* var.m*elegueta* (L_{12}) and *Capsicum baccatum* var. *microcarpum* (L_{13}). P_3^{17} (0.287) was showed by *Capsicum frutescens* var. f*asciculatum* (L_1) and *Capsicum frutescens longum* (L_{10}). P_3^{18} 90.292) was expressed jointly in *Capsicum baccatum* var. *pendulum* (L_{11}) and *Capsicum baccatum* var. melegueta (L_{12}). P_3^{1} (0.201) was showed it expression only in *Capsicum frutescens* var. *fasciculatum* (L_1). P_3^{5} (0.219) was restricted to *Capsicum frutescens abbreviation* (L_2); P_3^{7} (0.224) was showed its unique presence in *Capsicum baccatum* (L_5); P_3^{8} (0.225) was restricted to *Capsicum frutescens longum* var. *baccatum* (L_7). P_3^{12} (0.258), and P_3^{16} (0.278) were restricted to *Capsicum frutescens longum* var. a*bbreviatum* (L_8). P_3^{14} (0.270) was showed its expression only in *Capsicum chinense* (L_9); P_3^{4} (0.270), P_3^{9} (0.236) and P_3^{11} 90.256) were restricted to *Capsicum frutescens longum* (L_{10}). P_3^{2} (0.208) was restricted *to Capsicum baccatum* var. m*icrocarpum* (L_{13}); P_3^{6} (0.222) and P_3^{13} (0.261) were restricted to *Capsicum annum* (L_{14}). *Capsicum pubescens* (L_3), *Capsicum frutescens longum* var. *conides* (L_4), *Capsicum frutescens longum* var. c*arasiforme* (L_6), *Capsicum baccatum* var. *Pendulum* (L_{11}) and *Capsicum baccatum* var. m*elegueta* (L_{12}) were failed to express in this region. Region 4 contained twenty four bands in different positions. P_4^{3} (0.309) showed its presence jointly in *Capsicum pubescens* (L_3), *Capsicum baccatum* (L_5), *Capsicum frutescens longum* var. c*erasiforme* (L_6) and *Capsicum chinense* (L_9). P_4^{4} (0.312) was showed its expression in *Capsicum frutescens longum* var. c*onides* (L_4) and *Capsicum frutescens longum* var. *abbreviatum* (L_8). P_4^{5} (0.315) was shared by *Capsicum frutescens longum* var. b*accatum* (L_7) and *Capsicum baccatum* var. m*icrocarpum* (L_{13}). P_4^{6} (0.329) was showed its presence commonly in *Capsicum baccatum* var. pendulum (L_{11}) and *Capsicum baccatum* var. m*elegueta* (L_{12}). P_4^{12} (0.354) were showed its presence in *Capsicum frutescens* var. f*asciculatum*, *Capsicum frutescens longum* var. *abbreviatum* (L_8) and *Capsicum baccatum* var. p*endulum* (L_{11}). P_4^{18} (0.376) was shared by *Capsicum pubescens* (L_3) and *Capsicum baccatum* (L_5) and P_4^{20} (0.388) was showed its presence jointly in *Capsicum frutescens longum* var. *abbreviatum* (L_8) and restricted to *Capsicum frutescens abbreviatum* (L_2). P_4^{10} (0.349) was showed its expression only in *Capsicum frutescens longum* var. c*onides* (L_4). P_4^{16} (0.367) was showed its unique presence in *Capsicum frutescens longum* var. b*accatum* (L_6) P_4^{15} (0.365) was restricted to *Capsicum frutescens longum* var. *baccatum* (L_7). P_4^{7} (0.334) was demonstrated its expression in *Capsicum Chinese* (L_9). P_4^{13} (0.357) was restricted to *Capsicum frutescens longum* (L_{10}). P_4^{8} (0.337) and P_4^{23} (0.396) were expressed only in *Capsicum baccatum* var. p*endulum* (L_{11}). P_4^{14} (0.360) and P_4^{21} (0.390) were restricted to *Capsicum baccatum* var. *melegueta* (L_{12}). *Capsicum baccatum* var. microcarpum (L_{13}) showed its expression in P_4^{11} (0.351), P_4^{19} (0.385) and P_4^{22} (0.393). *Capsicum annum* (L_{14}) showed its expression in P_4^{1}, P_4^{9} and P_4^{24} and their Rf values respectively 0.303, 0.340 and 0.399. *Capsicum frutescens*

var. *fasciculatum* (L_1), *Capsicum pubescens* (L_3), *Capsicum baccatum* (L_5) and *Capsicum frutescens longum* var. abbreviatum (L_8) were failed to express in this region.

Region 5 obtained 18 bands in different positions. P_5^{11} (0.470) was showed its presence and expressed the similarity between *Capsicum frutescens* var. *fasciculatum* (L_1) and *Capsicum frutescens longum* var. *cerasiforme* (L_6). P_5^{16} (0.483) also showed the similarity between *Capsicum baccatum* (L_5), *Capsicum baccatum* var. m*icrocarpum* (L_{13}) and *Capsicum annum* (L_{14}). P_5^{18} (0.489) were expressed commonly in *Capsicum pubescens* (L_3); *Capsicum chinense* (L_9) and *Capsicum frutescens longum* (L_{10}). P_5^{13} (0.472) was present only in *Capsicum frutescens abbreviatum* (L_2). P_3^{13} (0.472) was showed its unique presence in *Capsicum frutescens longum* var. *conides* (L_4). P_5^{12} (0.471) was restricted to *Capsicum frutescens longum* var. b*accatum* (L_7). P_5^{17} (0.486) was showed its expression only in *Capsicum frutescens longum* var. *abbreviatum* (L_8). P_5^{5} (0.435) and P_5^{15} (0.478) were restricted to *Capsicum chinense* (L_9). P_5^{9} (0.452) was showed its unique presence in *Capsicum furtescens longum* (L_{10}). P_5^{1} (0.410) and P_5^{6} (0.438) were restricted to *Capsicum baccatum* var. p*endulum* (L_{11}). *Capsicum baccatum* var. m*elegueta* (L_{12}) showed its expression in P_5^{2} and P_5^{10} and their rf values respectively 0.413 and 0.461. P_5^{3} (0.416) and P_5^{7} (0.447) were restricted to *Capsicum baccatum* var. *microcarpum* (L_{13}). P_5^{4} (0.424) and P_5^{8} (0.449) was restricted to *Capsicum annum* (L_{14}). Region 6 showed 17 bands in different positions. P_6^{2} (0.503) was showed its presence and expressed the similarity between *Capsicum frutescens longum* (L_{10}) and *Capsicum baccatum* var. *melegueta* (L_{12}). P_6^{5} (0.520) was illustrated in *Capsicum chinense* (L_9), *Capsicum baccatum* var. *melegueta* (L_{12}) and *Capsicum annum* (L_{14}). P_6^{7} (0.534) was shared by *Capsicum frutescens longum* (L_{10}) and *Capsicum annum* (L_{14}). P_6^{15} (0.576) showed its presence jointly in *Capsicum baccatum* var. *microcarpum* (L_{13}) and *Capsicum annum* (L_{14}). *Capsicum frutescens longum* var. *abbreviatum* (L_8) showed its expression in $P_6^{1,}$ P_6^{6} and P_6^{16} and their Rf values respectively 0.500, 0.522 and 0.579. P_6^{8} (0.542) and P_6^{13} (0.570) were restricted to *Capsicum chinense* (L_9). P_6^{12} (0.567) was showed its presence only in *Capsicum frutescens longum* (L_{10}). P_6^{3} (0.506) and P_6^{4} (0.517) were restricted to *Capsicum baccatum* var. pendulum (L_{11}). *Capsicum baccatum* var. *melegueta* (L_{12}) showed its expression in P_6^{11}, P_6^{14} and P_6^{17} and their Rf values respectively 0.555, 0.573 and 0.593. *Capsicum frutescens* var. *fasciculatum* (L_1), *Capsicum frutescens abbreviatum* (L_2), *Capsicum pubescens* (L_3), *Capsicum frutescens longum* var. *conides* (L_4) *Capsicum baccatum* (L_5), *Capsicum frutescens longum* var. *cerasiflorme* (L_6), *Capsicum frutescens longum* var. *baccatum* (L_7), *Capsicum baccatum* var. *microcarpum* (L_{13}) and *capcisum annum* (L_{14}) were failed to express in this region. Region 7 contained Nine bands P_7^{8} (0.680) was shared by *Capsicum Chinense* (L_9) and *Capsicum baccatum* var. *meleguta* (L_{12}). P_7^{2} (0.618) and P_7^{9} (0.683) were restricted to *Capsicum frutescens longum* var. *abbreviatum* (L_8). P_7^{6} (0.663) was expressed only in *Capsicum frutescens longum* (L_{10}). P_7^{3} (0.621) was present only in *Capsicum baccatum* var. *pendulum* (L_{11}). P_7^{5} (0.640) was obtained only in *Capsicum baccatum var. melegueta* (L_{12}). P_7^{4} (0.626) was showed its unique presence in *Capsicum baccatum* var. *microcarpum* (L_{13}). P_7^{1} (0.612) and P_7^{7} (0.666) were restricted to *Capsicum annum* (L_{14}). *Capsicum frutescens* var. *fasciculatum* (L_1), *Capsicum frutescens abbreviatum* (L_2), *Capsicum pubescens* (L_3), *Capsicum frutescens longum* var. *conides* (L_4), *Capsicum baccatum* (L_5) *Capsicum furtescens longum* var. *cerasiforme* (L_6), *Capsicum frutescens longum* var. *baccatum* (L_7) and *Capsicum chinense* (L_9) were failed to express in this region.

Region 8 showed 11 bands in different positions. P_8^{1} (0.702) was showed their presence and similarity between *Capsicum frutescens longum* (L_{10}) and *Capsicum annum* (L_{14}) P_8^{9} (0.778) was showed its presence jointly in *Capsicum baccatum* var. *pendulum* (L_{11}) and *Capsicum baccatum* var. *melegueta* (L_{12}). P_8^{10} (0.792) was shared by *Capsicum Chinense* (L_9) and *Capsicum frutescens longum* (L_{10}). P_8^{2} (0.719) and P_8^{11} (0.795) were restricted to *Capsicum frutescens longum* var. *abbreviatum* (L_8). P_8^{3} (0.722) and P_8^{8} (0.775) were restricted to *Capsicum Chinense* (L_9). *Capsicum frutescens longum* (L_{10}) showed its expression in P_8^{4}, P_8^{5} and P_8^{7} and their Rf values respectively 0.730, 0.739 and 0.761. Region 9 illustrated

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with 10 bands in different positions. They failed to express the similarity between the cultivars. P_9^3 (0.838) was showed its expression only in *Capsicum frutescens* var. *abbreviatum* (L_2). P_9^8 (0.873) was obtained only in *Capsicum frutescens longum* var. *conides* (L_4). P_9^7 (0.868) was showed its expression only in *Capsicum baccatum* (L_5). P_9^{10} (0.884) was showed its unique presence in *Capsicum frutescens longum* var. *cerasiforme* (L_6). P_9^4 (0.846) was restricted to *Capsicum Chinense* (L_9). P_9^6 (0.865) was present only in *Capsicum frutescens longum* (L_{10}). *Capsicum baccatum* var. *melegueta* (L_{12}) showed its expression in P_9^1 and P_9^9 and their Rf values respectively 0.812 and 0.879. P_9^5 (0.862) was restricted to *Capsicum baccatum* var. *microcarpum* (L_{13}). P_9^2 (0.817) was showed its expression only in *Capsicum annum* (L_{14}). Region 10 showed nine bands in different positions. They failed to express the similarity between the cultivars. P_{10}^2 (0.913) was present only in *Capsicum frutescens* var. *fasciculatum* (L_1), P_{10}^5 (0.938) was showed its unique present in *Capsicum frutescens abbreviatum* (L_2). P_{10}^4 (0.935) was restricted to *Capsicum pubescens* (L_3). P_{10}^6 (0.940) was obtained only in *Capsicum frutescens longum* var. *conides* (L_4). P_{10}^8 (0.944) was showed its expression only in *Capsicum baccatum* (L_5). P_{10}^7 (0.941) was showed its unique presence in *Capsicum frutescens longum* var. *cerasiforme* (L_6). P_{10}^1 (0.908) was expressed only in *Capsicum frutescens longum* var. *baccatum* (L_7). P_{10}^3 (0.933) was present only in *Capsicum frutescens longum* var. *abbreviatum* (L_8) and P_{10}^9 (0.955) was restricted to *Capsicum baccatum* var. *melegueta* (L_{12}).

With reference to the morphological characters and protein profile the variability among the fourteen cultivars of *Capsicum* (Figure 2). The present study revealed that, the selected fourteen cultivars were easily distinguishable by SDS-PAGE protein pattern and morphological characters. Protein markers are practical, useful genetic and biochemical markers as well as good estimators of genetic variability in plant populations[11]. The present study also coincided with this, the presence or absence of chemical constituent has been found useful in the placement of the plant in taxaomic categories. Protein and isozymes (esterase, peroxidase) has been utilized to find the genetic line age of different plants and crops[13,17,18,24,28,29,31,32]. Protein variations are the important and powerful tool which has often used for this purpose. The present study confirmed the role of protein in species diversity variation, and similarity between the selected taxa. Each region is occupied by different protein in the form of band (s) and is representative of the expression of a particular gene.

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