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Estimation of phenotypic divergence in a collection of *Cucumis melo* from Kerala State, Southern India

Sunita Premnath Koli, Hosakatte Niranjana Murthy*

Department of Botany, Karnatak University, Dharwad, India; *Corresponding Author: nmurthy60@yahoo.co.in

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ABSTRACT

A collection of melon (*Cucumis melo* L.) from Kerala state, Southern India, consisting of thirty three accessions was evaluated for 22 quantitative and 14 qualitative characteristics to estimate the phenotypic diversity. The collection showed appreciable phenotypic diversity in fruit related traits. Principal component analysis (PCA) was performed to determine the relationships among the populations. The analysis revealed that the variations in stem hair length, number of nodes per plant on 60th day, fruit shape, fruit length, fruit weight, fruit colour at ripening, fruit rind hardness, flesh colour, flesh firmness, quality of flesh, shelf life, seed colour were the principle characters to discriminate melon accessions evaluated in the present study. When the 33 populations were plotted on the first two principal components, accounting for 49.97% of the total variation, three clusters were identified, accounting for 36 morphological attributes used in the study. The greater part of diversity was accounted for fruit diameter, fruit weight, fruit length and width, fruit cavity length and diameter, seed length and colour. Flesh area of fruit, flesh thickness, leaf size, seed weight, seed index did not account for variation in the first six principal components of the melon collection. Scatter diagram segregated the *acidulus* and *momordica* into different clusters. This evaluation of fruit trait variability can assist geneticists and breeders to identify populations with desirable characteristics for inclusion in various breeding programmes.

Keywords: *Cucumis melo*; Genetic Diversity; Phenotypic Traits; Principle Component Analysis

1. INTRODUCTION

Cucumis melo L. (2n = 2x = 24) is an economically important horticultural crop belonging to the family Cucurbitaceae. A great morphological variation exists in fruit characteristics such as size, shape, colour, texture, taste and composition. Therefore, *C. melo* is considered as the most diverse species of the genus *Cucumis* [1-3]. The cultivated varieties include sweet "dessert" melons as well as non-sweet forms that are consumed raw, pickled or cooked. Such a variation provides breeders with a rich genetic resource and thus there is an increased interest in understanding their genetic diversity.

The melon germplasm of the humid tropics of Southern India has been collected and assessed by Fergany *et al.* [4]. They reported that the collected populations belong to two groups: *C. melo* var. *acidulus* Naudin and *C. melo* var. *momordica* (Roxb.) Duthie et Fuller. They also recommended that additional collections of melon genetic resources should be made from Southern India as this could lead to the discovery of genetic diversity not present in the existing world collections of melon.

Poor keeping quality of some melon varieties which produce climacteric fruits limits their wide commercial acceptance and thus long shelf life has become an important character in modern cultivars of melon. Variation exists among *C. melo* varieties [5-8] and studies were carried out in few varieties including *inodorus*, *reticulatus*, *makuwa*, *sacharinus*, *cantalupensis*, *acidulus* and *momordica* [8-14]. Hence, the main objectives of present study were to evaluate the diversity among melon accessions collected from Kerala state, Southern India and to estimate the distribution of shelf life among these populations.

2. MATERIALS AND METHODS

2.1. Plant Materials and Bio-Agronomic Traits

The present study was carried out to assess the pheno-

typic diversity among thirty three landraces of *C. melo* collected in the Kerala state, Southern India (**Table 1**).

The landraces were evaluated in field trials using a randomized complete-block design in triplicates during December 2012 to March 2013. Each plot consisted of 1 row, 7.5 m long, spaced 2 m apart, with 1.5 m spacing between plants within the row. All characters (quantitative and qualitative characters) were measured in the field and at the normal harvest time for the estimation of phenotypic diversity. The characters selected for the analysis were pertaining mainly to *C. melo* breeding aims and were recorded for all genotypes in triplicates [1,15,16]. The fruit characters studied at maturity included length, diameter, shape, colour, skin and flesh

Table 1. Details of melon accessions used in the present study.

CmKc	Collection Area	Disrict	Fruit type	Shelf life	Cluster
1	Pilicode	Kasargode	*Acidulus*	Very good	I
2	Pilicode	Kasargode	*Acidulus*	Very good	I
3	Pilicode	Kasargode	*Acidulus*	Very good	I
4	Pilicode	Kasargode	*Acidulus*	Very good	I
5	Vylanthur	Thrissur	*Momordica*	Poor	III
6	Vylanthur	Thrissur	*Acidulus*	Very good	I
7	Kanhangad	Kasargode	*Acidulus*	Very good	I
8	Kanhangad	Kasargode	*Acidulus*	Very good	I
9	Kanhangad	Kasargode	*Acidulus*	Very good	Unclustered accession
10	Nidumbal	Thrissur	*Acidulus*	Very good	I
11	Amallor	Thrissur	*Acidulus*	Very good	I
12	Amallor	Thrissur	*Acidulus*	Very good	I
13	Kakkanad	Ernakulam	*Momordica*	Poor	III
14	Mattumal	Palakkad	*Acidulus*	Very good	I
15	Mattumal	Palakkad	*Acidulus*	Very good	I
16	Alathur	Palakkad	*Acidulus*	Very good	I
17	Chevayur	Kozhikode	*Acidulus*	Very good	I
18	Kottapadi	Malappuram	*Acidulus*	Very good	I
19	Changuvatti	Malappuram	*Acidulus*	Very good	I
20	Ettumunoor	Kottayam	*Acidulus*	Very good	I
21	Kamallur	Allapuzha	*Acidulus*	Very good	I
22	Pathanamthitta	Patanamthitta	*Acidulus*	Very good	I
23	Konni	Kollam	*Momordica*	Poor	II
24	Thiruvananthapuram	Thiruvananthapuram	*Momordica*	Poor	II
25	Thiruvananthapuram	Thiruvananthapuram	*Momordica*	Poor	II
26	Edacheri	Wayanad	*Acidulus*	Very good	I
27	Edacheri	Wayanad	*Acidulus*	Very good	I
28	Dharmadum	Kannur	*Acidulus*	Very good	I
29	Peravoor	Kannur	*Acidulus*	Very good	I
30	Kasargode	Kasargode	*Acidulus*	Very good	I
31	Pandalam	Patanamthitta	*Acidulus*	Very good	I
32	Kottarkara	Kollam	*Acidulus*	Very good	I
33	Thrissur	Thrissur	*Momordica*	Poor	III

thickness. Traits of fruit size and shape, such as flesh thickness, fruit length and width, placenta length were measured using the drawing ruler. Cotton blue in lacto phenol stain was used for the analysis of pollen viability. Finally, with an aim to compare together qualitative and quantitative data, a numerical transformation was applied to traits such as flesh and rind color (**Table 2**). A numerical value, ranging from 1 to k (k equal to number of

Table 2. Morphological characters measured in *Cucumis melo* collection.

Character Number	Character code	Character and descriptive values
1	Vl	Vine length at 60th day in cm
2	Sh	Stem hair: 1 (Soft), 2 (Intermediate), 3 (Hard)
3	Nb	Number of branches per plant at 60th day
4	Nn	Number of nodes per plant at 60th day
5	Ll	Leaf length in cm
6	Lw	Leaf width in cm
7	Lb	Leaf blade; 1 (Entire), 2 (Light lobed), 3 (Intermediate lobed)
8	Tl	Tendril length in cm
9	Pv	Pollen viability in %
10	Fp	Fruits per plant
11	Fsh	Fruit shape: 1 (globular), 2 (flattened), 3 (oblate), 4 (elliptical), 5 (pyriform), 6 (ovate), 7 (elongate)
12	Fl	Fruit length in cm
13	Fw	Fruit width in cm
14	Fd	Fruit diameter in cm
15	Fwt	Fruit weight in cm
16	Fcr	Fruit colour at ripening: 1 (white to green), 2 (white to orange), 3 (light green to yellow), 4 (yellow to orange), 5 (light green to orange)
17	Frc	Fruit rind colouration: 1 (monocloured), 2 (bicoloured with longitudinal strips from base to apex)
18	Frs	Fruit rind surface: 1 (smooth), 2 (cracked)
19	Frp	Fruit rind pattern: 1 (plane), 2 (strips), 3 (dotted)
20	Frh	Fruit rind hardness: 1(soft), 2 (intermediate), 3 (hard)
21	Fs	Fruit suture: 1 (suture), 2 (non suture)
22	Fth	Flesh thickness in cm
23	Flc	Flesh colour: 1(white), 2 (light orange), 3 (green), 4 (light orange), 5 (greenish orange), 6 (orange)
24	Ff	Flesh firmness: 1 (crispy), 2 (intermediate), 3 (grainy)
25	Qf	Quality of flesh: 1 (crispy), 2 (intermediate), 3 (soft)
26	FAF	Flesh area of fruit in %: $(a + b)^2 – (a'+ b') \times 100/(a + b)^2$ a = length of whole fruit, a' = length of fruit cavity b = diameter of whole fruit, b' = diameter of fruit cavity
27	Cl	Cavity length in cm
28	Cd	Cavity diameter in cm
29	Shl	Shelf life: 1, poor (1 - 2 months); 2,intermediate (3 months); 3, good (4 - 5 months); 4, very good (6 months)
30	Spf	Seeds per fruit
31	Sc	Seed colour: 1(white), 2 (cream), 3 (light brown)
32	Sl	Seed length in cm
33	Sw	Seed width in cm
34	Si	Seed index
35	Swt	Seed weight in grams
36	Gd	Growth duration: 1 (more than 120 days), 2 (90 to 120 days), 3 (less than 90 days)

classes), was assigned to each phenotrait, to indicate different degrees of expression. For seed characters, 10 measurements were averaged for each plant.

2.2. Statistical Analysis

All the original data were standardized to eliminate the difference in the variance of each character. Principal component analysis (PCA) was performed to generate a cluster diagram. Eigen values and contribution percentage of each principal component axis were calculated using the correlation matrix among thirty six characters for thirty three accessions [17]. All computations were performed using the unscrambler 10 software (CAMO Software India Pvt. Ltd., Bangalore, India) and SPSS 17.0 for MS Windows (SPSS Inc).

3. RESULTS AND DISCUSSION

Thirty three accessions of melons collected from Kerala state, Southern India were evaluated to estimate the genetic diversity among the melon populations. Thirty six selected qualitative and quantitative characters were assessed in the uniform field trials (**Table 2**). All the melon accessions used in the analysis were monoecious and substantial genetic diversity was observed. These accessions showed a large genetic variability with respect to fruit shape and size. Principal component analysis was used to assess the variability in melon accessions. The percentage of variation explained by the first six components was 35.07, 14.90, 9.10, 6.57, 5.79 and 5.33 respectively, and the principle characters with higher Eigen vectors that delineated the accessions into separate groups in the first six components are represented in the **Table 3**. The variations in stem hair length, number of nodes per plant on 60th day, fruit shape, fruit length, fruit weight, fruit colour at ripening, fruit rind hardness, flesh colour, flesh firmness, quality of flesh, shelf life, seed colour were the important characters for the formation of different clusters. **Figure 1** depicts the formation of three clusters with one un-clustered melon landrace. By these

Table 3. Contribution percentage and major characters associated with the first principle components of 33 melon accessions and their Eigen vector.

Principle component		1	2	3	4	5	6
Explained proportion of variation (%)		35.07	14.90	9.10	6.57	5.79	5.33
Cumulative proportion of variation (%)		35.07	49.97	59.07	65.64	71.43	76.76
	Eigen vector						
Vl	0.1941308	0.3854465	−0.6465489	0.1627286	0.09019072	−0.0867000	
Sh	−0.9686255	0.1757309	0.03016858	0.03681153	0.1206224	0.08627229	
Nb	0.2316808	0.2728379	0.2949748	0.2125249	0.3891021	−0.6061266	
Nn	0.01770082	0.2052537	0.3517672	−0.07458628	0.3291233	−0.7096581	
Ll	−0.1688125	−0.2735105	−0.5529157	0.4031258	0.232549	−0.1618984	
Lw	0.1007167	−0.3312536	−0.09961649	−0.005759506	0.4643296	−0.1944669	
Tl	0.2230351	0.28338	−0.4395817	0.03696718	0.5926297	−0.0230449	
Pv	0.2668421	0.2517732	0.0665976	−0.1027278	0.1960052	0.1466913	
Fp	−0.3765168	−0.3617526	0.3858287	0.394814	0.03369923	0.0822719	
Fsh	0.5391971	−0.0540669	−0.4160905	−0.1364919	0.3445447	0.09465964	
Fl	0.7227173	0.308144	0.3233948	−0.06559674	0.170721	0.3318942	
Fw	0.1537337	0.7595731	0.2415445	−0.2481305	0.01015097	−0.0214247	
Fd	0.04803415	0.8598647	−0.1049251	−0.1545179	0.07193942	0.06991526	
Fwt	0.2628347	0.7860266	0.1906711	−0.11744	−0.00634643	−0.0315025	
Fcr	−0.9686255	0.1757309	0.03016858	0.03681153	0.1206224	0.08627229	
Frh	−0.9686255	0.1757309	0.03016858	0.03681153	0.1206224	0.08627229	
Fth	0.05059452	0.1882358	−0.7923409	−0.06250334	−0.04250038	0.08531409	
Flc	0.9686255	−0.1757309	−0.03016858	−0.03681153	−0.1206224	−0.0862722	
Ff	0.9686255	−0.1757309	−0.03016858	−0.03681153	−0.1206224	−0.0862722	

Continued

Qf	0.9686255	−0.1757309	−0.03016858	−0.03681153	−0.1206224	−0.0862722
FAF	−0.3263147	0.1537797	−0.1432286	−0.5821441	−0.07895434	−0.210587
Cl	0.6670699	0.2680832	0.4493805	0.02985854	0.03566362	0.2570127
Cd	0.2118728	0.7323623	−0.08459914	−0.01454906	0.1111293	0.3136823
Shl	−0.9686255	0.1757309	0.03016858	0.03681153	0.1206224	0.08627229
Spf	0.1499597	0.384278	−0.3905573	0.5643572	−0.3008645	0.04569659
Sc	0.9051051	−0.1046764	−0.08269551	0.0444922	−0.02368167	−0.0326795
Sl	0.5496318	0.5316715	0.1352246	0.4556467	0.0162517	0.02770174
Sw	−0.0274061	0.6619	−0.00583967	0.3822937	−0.4315375	−0.315695
Si	0.5580416	−0.2469485	0.1362616	−0.000254083	0.5087599	0.3873413
Swt	0.1028545	−0.09773537	0.2895683	0.6930479	0.1978223	0.1617651
Gd	0.9686255	−0.1757309	−0.03016858	−0.03681153	−0.1206224	−0.0862722

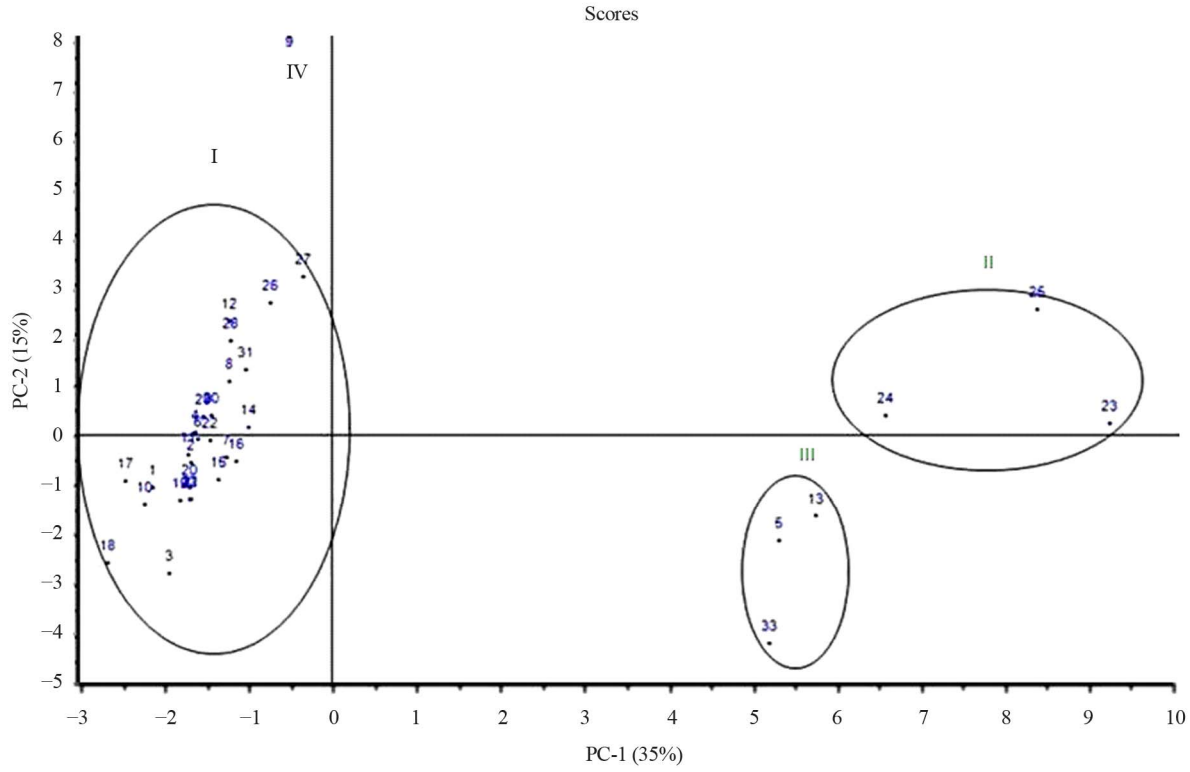

Figure 1. Cluster diagram constructed on the basis of the first two principle component axes, which contain 50% of the total variation.

components, accessions showing large variation in vine length (101 cm to 220 cm), number of branches on 60th day (12 to 20), number of nodes on 60th day (25 to 43), tendril length (24 cm to 51 cm), fruit shape (ovate to oblate), fruit length (15 cm to 43 cm), fruit width (7 cm to 12 cm), stem hair length, fruit colour at ripening, seed colour, larger fruit diameter with medium growth duration (within 120 days) were grouped into a larger cluster in the left and the collections in this cluster were mainly *acidulus* (**Figure 1**). Accessions with longer vine length and leaf length, larger fruit length, heavy fruit weight, light green to yellow fruit colour, soft rind, light orange flesh colour, grainy and intermediate flesh, poor shelf life (1 - 2 months), light brown seeds, short growth duration (within 90 days) were on the right of the scatter diagram, and these accessions on the right of the scatter diagram were *momordica* (**Figure 1**). Cluster 3 included landraces which showed almost similar characters as that of

the landraces grouped in cluster 2 with heavy fruit weight, light green to yellow fruit colour, soft rind, grainy and intermediate flesh, light orange flesh colour, moderate fruit length, poor shelf life (1 - 2 months), light brown seeds, short growth duration (within 90 days). These accessions on the right of the scatter diagram were *momordica* (**Figure 1**). The unclustered landrace CmKc-9 had long vein length, higher number of nodes on 60th day, smaller leaf size, higher fruit width, heavy fruit weight, medium growth duration (within 120 days). This landrace included the *acidulus*. The range for primary branches per plant was from twelve to twenty in *acidulus* which was almost similar to the branch profile of the *momordica*. The minimum and maximum vein length and number of nodes per plant was almost same in both the varieties. A detailed description of the melon fruits used in the study is given in **Table 4** and mean trait values of each cluster for their quantitative characters are mentioned in **Table 5**. The range of variability of phenoltypic characters in terms of minimum

Table 4. Fruit traits of melon accessions.

Analysis code number	Fruits/plant	Fruit colour	Fruit shape	Weight (g)	Aroma	Flesh colour
1	3	Light green to orange	Oblate	750	Mild but sweet	White
2	3	Light green to orange	Oblate	1000	Mild but sweet	White
3	4	Light green to orange	Ovate	550	Mild but sweet	White
4	3	Light green to orange	Oblate	1225	Mild but sweet	White
5	2	Light green to yellow	Elongate	1250	Strong	Light orange
6	3	Light green to orange	Oblate	800	Mild but sweet	White
7	2	Light green to orange	Elongate	1000	Mild but sweet	White
8	2	Light green to orange	Elliptical	1000	Mild but sweet	White
9	2	Light green to orange	Elliptical	2000	Mild but sweet	White
10	3	Light green to orange	Oblate	370	Mild but sweet	White
11	3	Light green to orange	Ovate	900	Mild but sweet	White
12	2	Light green to orange	Oblate	1500	Mild but sweet	White
13	2	Light green to yellow	Elongate	1000	Strong	Light orange
14	3	Light green to orange	Elongate	1225	Mild but sweet	White
15	2	Light green to orange	Elongate	755	Mild but sweet	White
16	3	Light green to orange	Elongate	900	Mild but sweet	White
17	3	Light green to orange	Oblate	570	Mild but sweet	White
18	4	Light green to orange	Oblate	750	Mild but sweet	White
19	2	Light green to orange	Elliptical	1000	Mild but sweet	White
20	2	Light green to orange	Oblate	1000	Mild but sweet	White
21	2	Light green to orange	Ovate	800	Mild but sweet	White
22	4	Light green to orange	Ovate	900	Mild but sweet	White
23	2	Light green to yellow	Elongate	1200	Strong	Light orange

Table 5. Mean trait values used in *Cucumis melo* cluster identification.

Traits	Cluster I	Cluster II	Cluster III	Unclustered accession
Vl	153.0 ± 41.46	44.75 ± 506.4	147.6 ± 34.195	210
Sh	3.00 ± 0.00	1.000 ± 0.000	1.000 ± 0.000	3
Nb	16.50 ± 2.68	313.7 ± 590.84	17.33 ± 2.08	21
Nn	33.65 ± 5.19	39.16 ± 8.207	32.66 ± 5.68	38
Ll	11.73 ± 2.28	26.20 ± 18.51	11.66 ± 2.19	9.8

Continued

Lw	17.84 ± 2.51	30.31 ± 14.38	18.20 ± 1.00	13.9
Tl	38.73 ± 8.21	42.00 ± 10.39	40.33 ± 9.60	49
Pv	96.69 ± 7.14	100.0 ± 0.000	100.0 ± 0.00	100
Fp	2.576 ± 0.757	2.000 ± 0.000	2.000 ± 0.000	2
Fsh	4.961 ± 1.611	7.000 ± 0.000	7.000 ± 0.000	4
Fl	21.80 ± 5.982	52.00 ± 7.810	23.16 ± 8.51	23
Fw	8.80 ± 1.288	10.73 ± 1.553	7.30 ± 2.13	12
Fd	30.68 ± 5.712	34.20 ± 2.662	25.26 ± 3.65	43.3
Fwt	814.6 ± 372.421	1335.0 ± 212.5	483.3 ± 448.14	2.000
Fcr	5.000 ± 0.000	3.000 ± 0.000	3.000 ± 0.000	5
Frs	2.000 ± 0.000	4.000 ± 0.000	3.000 ± 0.000	1
Frp	2.192 ± 0.401	2.000 ± 0.000	1.33 ± 0.57	2
Frh	2.000 ± 0.000	1.000 ± 0.000	1.000 ± 0.000	2
Fth	2.242 ± 0.441	2.300 ± 0.346	2.26 ± 0.40	2.5
Flc	1.000 ± 0.000	2.000 ± 0.000	2.000 ± 0.000	1
Ff	1.000 ± 0.000	3.000 ± 0.000	3.000 ± 0.000	1
Qf	1.000 ± 0.000	2.000 ± 0.000	2.000 ± 0.000	1
FAF	98.1 ± 0.988	96.14 ± 5.21	97.75 ± 0.88	96.55
Cl	19.65 ± 5.698	43.43 ± 14.165	22.86 ± 10.41	25
Cd	16.64 ± 2.319	492.0 ± 79.170	14.60 ± 0.87	22.6
Shl	4.000 ± 0.000	1.000 ± 0.000	1.000 ± 0.000	4
Spf	446.6 ± 123.7	492.0 ± 79.170	503.0 ± 136.96	848
Sc	2.000 ± 0.000	3.000 ± 0.000	2.66 ± 0.57	2
Sl	9.000 ± 0.000	0.966 ± 0.057	9.00 ± 0.00	1
Sw	4.000 ± 0.000	4.000 ± 0.000	4.000 ± 0.000	0.5
Si	2.250 ± 0.000	2.416 ± 0.144	2.250 ± 0.000	2
Swt	1151.1 ± 182.8	1224.0 ± 303.464	1142.6 ± 160.31	1202
Gd	2.000 ± 0.000	3.000 ± 0.000	3.000 ± 0.000	2

and maximum and mean values are presented in **Table 6**. Morphological variation was most apparent in fruit length which varied from 15 cm to 43 cm per fruit in *acidulus* whereas in *momordica* it was from 15 cm to 57 cm per fruit. Fruit colour was also quite similar ranging-from light green to yellow or orange (**Figure 2**). The fruit colour of the accessions, CmKc-5, CmKc-13, CmKc-23, CmKc-24, CmKc-25 and CmKc-33 was mainly light green to yellow which were grouped in cluster 2 and 3 which included mainly *momordica* (**Figure 3**). The fruits of *acidulus* were generally ovate to oblate in shape except in CmKc-8, but those of *momordica* were elongated except in CmKc-3 which was ovate. The average fruit weight of the collections varied greatly. The fruit weight varied from 420 g to 1250 g per fruit in *acidulus*, in *momordica* it varied from 200 g to 1580 g per fruit with CmKc-9 gaining the maximum fruit weight of 2000 g per fruit. The flesh of the fruits was generally white to light orange in color and crispy to grainy in nature. The flesh colour was white in *acidulus* and it was light orange in *momordica* (**Table 4**). Most of the *momordica* landraces had a strong odour at maturity except for CmKc-3 which had a mild and sweet odour. The fruits of *acidulus* were non climacteric, very firm and did not crack at maturity (**Figure 2**) and these fruits are used for cooking purpose in Kerala. The fruits of *momordica* were, climacteric, soft and cracked at maturity (**Figures 3(e)-(f)**), hence had very low shelf life and these fruits are also used for

Table 6. Variability in some quantitative characters of *acidulus* and *momordica* landraces.

Trait	*Cucumis melo* var. *acidilus*			*Cucumis melo* var. *momordica*		
	Cluster I			Cluster II		
	Minimum values	Maximum values	Mean ± SD	Minimum values	Maximum values	Mean ± SD
Vl	101	220	153 ± 41.46	176	210	187 ± 19.3
Sh	3	3	3.00 ± 0.00	1	1	1.00 ± 0.00
Nb	12	20	16.5 ± 2.68	14	23	18.3 ± 4.50
Nn	25	43	33.6 ± 5.19	30	42	36.3 ± 6.02
Ll	9.7	18.9	11.7 ± 2.28	10.1	10.8	10.4 ± 0.36
Lw	10.7	20.1	17.8 ± 0.49	18.2	18.9	18.6 ± 0.37
Tl	24	51	38.7 ± 8.21	30	48	42.0 ±10.3
Pv	75	100	96.6 ± 7.14	100	100	100.0±0.00
Fp	1	4	2.57 ± 0.75	2	2	2.00 ± 0.00
Fsh	3	7	4.96 ± 1.61	7	7	7.00 ± 0.00
Fl	15	43	21.8 ± 5.98	43	57	52.0 ± 7.81
Fw	7	12	8.80 ± 1.28	9	12	10.7 ±1.55
Fd	17	40	30.6 ± 5.71	31	34	34.2 ± 2.66
Fwt	370	1500	922 ± 285.2	1200	1580	1335 ± 212
Fcr	5	5	5.00 ± 0.00	3	3	3.00 ± 0.00
Frs	1	1	1.00 ± 0.00	4	4	4.00 ± 0.00
Frp	2	3	2.19 ± 0.40	2	2	2.00 ± 0.00
Frh	2	2	2.00 ± 0.00	1	1	1.00 ± 0.00
Fth	1.4	2.5	2.62 ± 2.06	1.9	2.5	2.30 ± 0.34
Flc	1	1	1.00 ± 0.00	2	2	2.00 ± 0.00
Ff	1	1	1.00 ± 0.00	3	3	3.00 ± 0.00
Qf	1	1	1.00 ± 0.00	2	2	2.00 ± 0.00
FAF	95	99	98.1 ± 0.98	90	99	96.1 ± 5.21
Cl	13	40	19.6 ± 5.69	31	59	43.3 ± 14.1
Cd	12	20	16.6 ± 2.31	15	26	20.1 ± 5.52
Shl	4	4	4.00 ± 0.00	1	1	1.00 ± 0.00
Spf	221	948	458 ± 153	410	568	492 ± 79.1
Sc	2	2	2.00 ± 0.00	3	3	3.00 ± 0.00
Sl	0.9	0.9	0.90 ± 0.00	0.9	1	0.96 ± 0.57
Sw	0.4	0.4	0.40 ± 0.00	0.4	0.4	0.40 ± 0.00
Si	0.25	2.25	2.17 ± 0.39	2.25	2.50	2.41 ± 0.14
Swt	100	158	1151 ± 182.	1003	1570	1224 ± 303
Gd	2	2	2.00 ± 0.00	3	3	3.00 ± 0.00

Figure 2. Variability in fruits of *Cucumis melo* var. *acidulus* landraces: (a) Tender oblate fruit of CmKc-3 landrace (Bar = 2.66 cm); (b) Ripe fruit of CmKc-3 landrace (Bar = 3.21 cm); (c) Tender fruit of CmKc-14 landrace (Bar = 4.92 cm); (d) Ripe fruit of CmKc-22 landrace (Bar = 5.04 cm); (e) Tender elongated fruit of CmKc-15 landrace (Bar = 3.5cm); (f) Ripe fruit of CmKc-27 landrace (Bar = 3.26 cm).

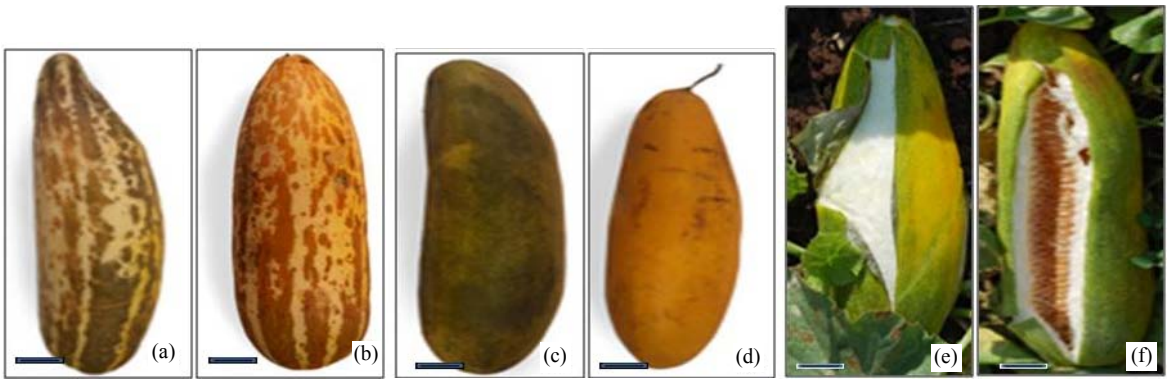

Figure 3. Variability in fruits of *Cucumis melo* var. *momordica* landraces: (a) Tender plane fruit of CmKc-5 landrace (Bar = 4.95 cm); (b) Ripe fruit of CmKc-13 landrace (Bar = 5.4 cm); (c) Tender fruit of CmKc-24 landrace (Bar = 5.07 cm); (d) Ripe fruit of CmKc-23 landrace (Bar = 5.78 cm); (e) Peeled fruit of CmKc-25 landrace (Bar = 3.17 cm); (f) Fruit cracking in CmKc-33 landrace (Bar = 3.4 cm).

cooking before maturity. The seeds of *acidulus* and *momordica* were medium sized, white in colour and maximum seed length was 0.9 and 1.0 cm respectively. The present survey of morpho-metric analysis of Kerala landraces of melon revealed considerable variability especially with fruit characteristics. The landraces belonged to two varieties, *acidulus and momordica* which possessed non sweet fruits which are consumed as cooked vegetables. These observations support the views of Fergany *et al.* [4], Manohar and Murthy [14] that South Indian melon landraces comprises of *acidulus* and *momordica*. The data on shelf-life and its correlation with other characteristics is presented in **Table 7**. Fruit shape, fruit weight, flesh colour, quality of flesh, flesh firmness were highly correlated with shelf-life of melon fruits. Accessions with good shelf-life belong to *acidulus* variety and these accessions were characterized by fruits possessing firm skin, non-climacteric, non-juicy, crisp with white flesh. The fruits of such accession could be stored more than six months without loss of quality. Assessment of shelf-life among melon accessions was carried

Table 7. Correlation coefficients between shelf life and other characters.

Character	Shelf life
Fruit shape	0.31087
Fruit colour	0.16896
Fruit weight	0.37343
Flesh colour	0.33142
Flesh thickness	0.18398
Quality of flesh	0.33142
Flesh firmness	0.57446
Rind hardness	0.21542
100 seed weight	0.15917
Growth duration	0.16923

out in *C. melo var. sacharinus* (Hami-melon) [18], and selected accessions have been used for breeding programme.

4. CONCLUSION

It was reported that melon germplasm (*acidulus* and *momordica*) of Southern India possess resistance to Cucumber mosaic virus, Zucchini yellow mosaic virus, Powdery mildew (races 1, 2, 3 and 5), *Fusarium* wilt (races 1 and 2), *Aphis gossypii* and leafminer [4]. The landraces collected from Kerala state showed increased shelf-life. However, these land races should be assessed for disease resistance characteristics by using molecular markers. These landraces need to be analyzed for their ability to be used as bred cultivars for commercial breeding purpose.

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APPENDIX

Abbreviations: CmKc-*Cucumis melo* Kerala collection, PCA-Principle Component Analysis

