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Full Length Research Paper

Study on morphologic variation of different Iranian melon cultivars (*Cucumis melo* L.)

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Information about the correlation and linkage among different horticultural characteristics is of primary importance in the field of crop improvement. In order to determine a morphologic variation of eleven native melon cultivars, a field trial conducted in completely randomized design at Torbat-e-Jam, Razavi Khorasan province, Iran, during 2010 and 2011 was carried out. Statistical parameters used included; mean traits, correlation and cluster traits analysis. The results showed that there was a wide diversity in melon cultivars. Correlation analysis between traits showed a significant positive relation between fruit length with sugar content and positive relation between fruit weight with fruit length, fruit diameter, flesh thickness, skin thickness, and sugar content. A negative relation that was observed was between fruit length with fruit diameter, flesh thickness and skin thickness. Significant negative relation was observed between fruit length and seed cavity width. Based on quantitative data, genotypes were divided into six groups. The sixth, fourth and third clusters had maximum flesh thickness, and the third cluster had the highest content sugar than other clusters. The sixth cluster had the strongest period of germination to ripening. Cluster four, and cluster three had less skin thickness than other clusters.

Key words: Cluster analysis, correlation, sugar content.

INTRODUCTION

Melon (*Cucumis melo* L.) is an economically important species of the Cucurbitaceae family. The origin of melon was in Africa (Kerge and Grum, 2000; Robinson and Decker-Walters, 1999) but the distribution of wild and cultivated melon types is worldwide currently (Pitrat, 1991). A high level of molecular and morphological variability in leaf plant and fruit characters has been described within these species (Monforte et al., 2003; Stepansky et al., 1999). Melons were divided into six groups namely; Cantaloupe, Inodorus, Flexuosus, Conomon, Chito, Dudaim, and Momordica (Munger and Robinson, 1991). In Iran, the Cantaloupensis and Inodorus groups are most important for commercial production. The cultivation of these crops in dry regions and desert fringes like Varamin, Garmsar, and Khorasan has a better qualitative and quantitative production. The number of fruits on each plant, average fruit weight, main stem length, number of nodes on main stem and internode length were correlated positively with yield, and these factors can be recommended as criteria for selection (Abdalla and Aboul-Naser, 2002; Lippert and Hall, 1982; Vijay, 1987).

Taha et al. (2003) evaluated 13 variable lines representing different melon types and reported a positive and significant association between the number of fruits/vine with the number of primary branches, and between fruit weight with plant length. Naroui et al. (2010) reported a significant positive relation between yield and fruit weight, and flesh diameter. Saberi et al. (2006) reported that there was a significant difference among agronomical characters for fruit yield, fruit number, and fruit length and these characters were very efficient in final yield.

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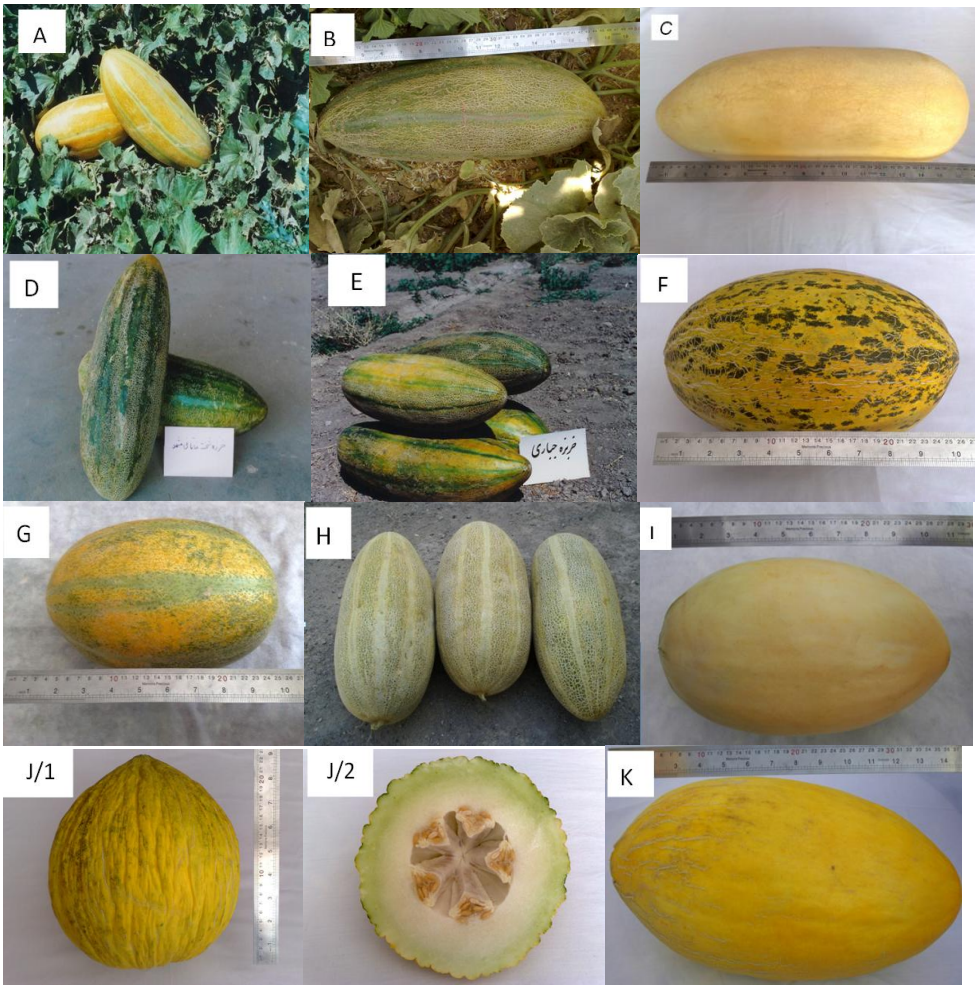

Figure 1. A; Khatooni, B; Ghasri, C; Jafarabadi, D; Khaghani, E; Jabari, F; Zard-e-Palangi, G; Ghenat-e-Boshrouyeh, H- Haji Mashallahi, I; Zin Abade, J/1 and J/2; Zemestani, K; Chah Paliz.

Information about the correlation and linkage among different horticultural characteristics is of primary importance in the field of crop improvement. Linkage relationships can be used to increase breeding efficiency by allowing earlier selection and reducing plant population size during selection. Study of genetic diversity not only organizes and protects plant material but is also important to the phenomenon of heterosis and hybrid seed production. The main objective of this research was to study native melon germplasm and to identify morphological characterization of melon cultivars to apply in growing or breeding programs.

MATERIALS AND METHODS

In order to identify and examine the characteristics of native melon varieties, the seeds of Khatooni, Ghasri, Jafarabadi, Khaghani, Jabari, Zard-e-Palangi, Ghenat-e-Boshrouyeh, Haji Mashallahi, Zin Abade, zemestani and Chah Paliz were collected (Figure 1). Different melon types were grown in replicated trials to evaluate some agronomical characters and the relationship by using a completely randomized design with four replications. This study was conducted in spring seasons of 2010 and 2011. Three seeds were planted per hole in each planted line with five holes and 80 cm spacing and spacing among cultivars was 3 m. Plants were thinned to two plants per whole at 15 days after sowing. Field`s experiments were conducted on a clay-loamy soil in the Torbat-e-Jam (Longitude: 60˚48', latitude: 35˚ 31', altitude: 928 m, with semi-arid climate, hot summers and cold winters). The experimental area was fertilized at rate of 110 kg N ha^{-1} and 85 kg P_2O_5 ha^{-1} before sowing. The crop was irrigated at an interval of seven days during growth. Hand weeding and chemical spraying against insect was done whenever necessary. Characters studied are shown in Table 1. Analysis of variance, and cluster analysis were carried out using Minitab software.

RESULTS AND DISCUSSION

Among of the cultivars collected; fruit shape, fruit skin color, skin texture and flesh color had high diversity (Table 2). Similar studies reported showed that great morphological variation existed in fruit characteristics, and *Cucumis melo* is therefore, considered the most

Table 1. Characters were studied.

Traits	Abbreviation	Description
Lateness	La.	Days (time of sowing to harvest)
Fruit shape	F.S	Determined on base of descriptor for melon
Skin color	Sk. Co	Determined on base of descriptor for melon
Fruit surface texture	F. S. T	Determined on base of descriptor for melon
Skin pattern	Sk. P	Determined on base of descriptor for melon
Flesh color	Fl. Co	Determined on base of descriptor for melon
Fruit weight	F. W	kg
Fruit length	F. L	cm
Fruit diameter	F. D	cm
Flesh thickness	Fl. T	mm
Skin thickness	Sk. T	mm
Seed cavity wide	S. C. W	mm
Number of placenta	N. P	
Sugar content	Su. C	Percentage (%)
Shape index	Sh. I	L/D (Fruit length divided to Fruit diameter)

Table 2. Morphological traits.

Cultivars	Qualitative traits (frequency %)										Quantitative trait
	F. S[a]		Sk. Co[b]		F. S. T[c]		Sk. P[d]		Fl. Co[e]		N. P (CV =1.58%)
Khatooni	3	(100)	1	(90)	2	(100)	3	(100)	1	(96)	3.08
Ghasri	3	(100)	2	(91)	2	(100)	3	(100)	3	(100)	3
Jafarabadi	3	(100)	1	(94)	2	(93)	1	(100)	1	(100)	3
Jabari	3	(92)	3	(96)	2	(100)	3	(100)	3	(100)	3
Khaghani	3	(100)	3	(97)	2	(100)	3	(100)	1	(97)	3
Chah Paliz	1	(93)	1	(100)	1	(93)	1	(100)	4	(95)	3
Zemestani	2	(98)	1	(90)	3	(100)	1	(100)	1	(100)	4.92
Ghenat-e-Boshrouyeh	1	(100)	3	(92)	2	(91)	3	(100)	1	(100)	3
Haji Mashallahi	1	(100)	2	(100)	2	(100)	3	(100)	3	(100)	3
Zin Abade	4	(95)	4	(91)	1	(100)	1	(100)	4	(98)	3
Zard-e-Palangi	1	(100)	1	(100)	1	(100)	2	(100)	2	(96)	3

[a]; Fruit shape, 1; elliptical 2; pyriform 3; elongated 4; ovate [b]; skin color: 1;yellow 2; green 3; green; yellow 4; cream [c]: fruit surface texture:1; smooth 2; netted 3; wrinkled d- skin pattern: 1; absent 2; spotted 3; stripped [e]; flesh color: 1; white 2' green 3' pale green 4; orange.

diverse species of the genus *Cucumis* (Stepansky et al., 1999; Jeffrey, 1980).

Results were almost the same for the two seasons with slight differences. Zemestani cultivar is a late ripening cultivar, and its fruits developed late than those of other cultivars, though Chah Paliz and Haji Mashallahi cultivars are also late ripening cultivars (Table 3). Jabari cultivar is an early ripening cultivar and its fruits developed earlier than those of other cultivars. Fruit length and diameter, respectively in the Jafarabadi, and Zemestani cultivars had the biggest size than other cultivars (Table 3). Results indicated that (Table 3) the minimum and maximum fruit length were respectively, 22.64 and 48.10 cm. Furthermore, the minimum and maximum fruit diameters were observed to be 15.15 and 19.56 cm, respectively (Table 3), but in other experiments, these ranges were 10 to 34.25 cm for fruit length and 8.75 to 16.25 for fruit diameter (Naroui et al., 2010). The highest weight and sugar content were recorded for Jafarabadi cultivar. The lowest fruit weights were recorded in the Zin Abad cultivar (2.30 kg) (Table 3). The highest sugar content was recorded for Jafarabadi cultivar. Similar observation was reported about the amount of sugar 4.25 to 8.25% (Naroui et al., 2010). Table 4 shows a simple correlation of coefficients. Lateness with fruit weight and flesh thickness had a positive relation, lateness with fruit diameter and skin thickness had a positive and significant relation, and lateness with sugar content had a negative relation. Since the late ripening melons have a dense texture, high durability and less sugar than early ripening

Table 3. Means comparison for traits (average of two years).

Cultivar	La. (days)	F.L (cm)	F.D (cm)	Sh.I (L/D)	Sk.T (mm)	Fl.T (mm)	S.C.W (mm)	F.W (kg)	Su.C (%)
Khatoni	84.96^{g}	40.55^{b}	16.34^{bcd}	2.48^{bc}	9.29^{c}	30.95^{d}	78.70^{fgh}	3.39^{c}	12.68^{bc}
Ghasri	88.42^{e}	37.98^{c}	15.80^{def}	2.43^{c}	8.75^{cd}	30.60^{d}	82.00^{def}	3.33^{cd}	13.00^{ab}
Jafarabadi	89.21^{e}	48.10^{a}	16.07^{cde}	2.99^{a}	7.09^{f}	32.58^{bc}	75.57^{h}	4.92^{a}	13.33^{a}
Jabari	80.08^{i}	39.70^{bc}	15.15^{f}	2.62^{b}	9.31^{c}	24.92^{f}	83.32^{de}	3.12^{cd}	12.13^{ef}
Zard-e- Palangi	91.08^{d}	28.30^{e}	18.78^{a}	1.51^{d}	9.14^{cd}	33.66^{b}	99.66^{a}	3.94^{b}	11.74^{g}
Khaghani	87.00^{f}	40.23^{bc}	16.27^{bcd}	2.47^{c}	8.40^{de}	25.22^{f}	82.63^{de}	3.09^{d}	12.26^{de}
Chah Paliz	102.23^{b}	33.16^{d}	15.39^{ef}	2.14^{d}	7.91^{e}	28.56^{e}	83.67^{d}	3.07^{d}	10.09^{j}
Zemestani	112.96^{a}	22.64^{f}	19.56^{a}	1.16^{h}	18.34^{a}	36.54^{a}	92.14^{c}	3.82^{b}	10.57^{i}
Ghenat-e- Boshrouyeh	85.83^{g}	28.22^{e}	16.62^{bc}	1.70^{f}	9.32^{c}	31.96^{d}	95.85^{b}	2.60^{e}	11.78^{fg}
Haji Mashallahi	98.42^{c}	32.38^{d}	16.95^{b}	1.96^{e}	11.03^{b}	31.99^{cd}	76.33^{gh}	3.98^{b}	12.57^{cd}
Zin Abade	81.42^{h}	26.22^{e}	15.23^{f}	1.73^{f}	6.01^{g}	33.15^{bc}	79.80^{efg}	2.30^{f}	11.22 ^{h}

Means in the same column with different letters differ significantly at 0.05 probability level according to LSD test.

Table 4. Simple **c**orrelation coefficients (r) between characteristics.

Variable	La. (day)	F.W (kg)	F.L (km)	F.D (mm)	Fl.T (mm)	Sk.T (mm)	S.C.W (mm)	Su.C (%)
La. (day)	1	0.32	-0.35	0.60*	0.46	0.70*	0.26	-0.43
F.W (kg)	0.39	1	0.45	0.43	0.36	0.21	-0.18	0.51
F.L (cm)	-0.49	0.36	1	-0.46	-0.46	-0.49	-0.70*	0.78**
F.D (mm)	0.68*	0.37	-0.59	1	0.60*	0.79**	0.65*	-0.22
Fl.T (mm)	0.52	0.32	-0.59	0.70*	1	0.45	0.24	-0.09
Sk.T (mm)	0.76**	0.27	-0.49	0.77**	0.44	1	0.41	-0.37
S.C.W (mm)	0.16	-0.12	-0.60*	0.59	0.27	0.31	1	-0.55
Su.C (%)	-0.55	0.39	0.84**	-0.47	-0.38	-0.42	-0.45	1

** and * are respectively significant at 1 and 5% level. Upper figures in the diagonal represent results of the second season, whereas, the lower figures represent results of the first season.

melons, it was effective to make a negative relation with the sugar content. In this study correlation between fruit weight and lateness (time of sowing to harvest) was found positive. This might be due to the increase in the rate of photosynthetic materials in fruit, because in the fruits of the late ripening cultivars, there are more time connections to the plant and more assimilation substances are absorbed than in early ripening cultivars. Results of this study indicated that the fruit weight with fruit length, fruit diameter, flesh thickness, skin thickness and sugar content had a positive relation, but had a negative relation with seed cavity. High fruit density was correlated with flesh thickness and small seed cavity wide in melon. The results were found to be similar with those of Naroui et al. (2010) and Taha et al. (2003) which were consistent. A positive and significant relation between fruit length and sugar content was recorded, but fruit length had a negative relation with fruit diameter, flesh thickness, and skin thickness, also had a negative and significant relation with seed cavity wide. Most Iranian land races in the Inodorus group have the potential to produce big fruits. In Iran, people prefer the heavy (over 3 kg) and elongated melon of the Inodorus group. Given the negative correlation between seed cavity wide and average fruit weight, the development of genotypes is capable of supporting fewer seed cavities wide, while simultaneously maintaining commercially acceptable fruit size for the Iranian market (3 to 4 kg) may come as a challenge. Analysis of variance revealed the melon cultivars that exhibited significant difference for all characters (Table 5).

According to the factor analysis (Table 5) and based on cluster analysis Ghasri, Chah Paliz, Jabari and Khaghani cultivars were in the first cluster. Khatooni and Haji Mashallahi were in the second cluster. Jafarabadi cultivar was in the third cluster. Zin Abad cultivar was in the fourth cluster. Zard-e-Palangi and Ghenat-e-Boshrouyeh were in the fifth cluster, and Zemestani was in the sixth cluster (Figure 2).

The fourth cluster had the lowest period of germination to ripening. Therefore, it can be modified to reduce the ripening period as a factor to enhance economic efficiency through increasing the harvest period and earlier access to market to be used (Figure 3A).

Table 5. Mean squares from the analysis of variance of traits.

S.V	DF	La.	F. L	F.D	Sh. I	Sk.T	Fl. T	S.C .W	F. W	Su.C
Year (A)	1	0.10^{ns}	2.91^{ns}	0.02^{ns}	0.01^{ns}	0.22^{ns}	0.75^{ns}	32.16^{ns}	0.02^{ns}	0.63^{ns}
Cultivar (B)	10	772.54**	466.92**	16.14**	2.40**	82.34**	97.58**	505.05**	4.32**	6.14**
A × B	10	2.88**	5.19^{ns}	0.19^{ns}	0.02^{ns}	0.12 ^{ns}	1.03^{ns}	18.88^{ns}	0.10^{ns}	0.15^{ns}
Error	66	0.81	5.42	0.62	0.02	0.62	1.96	12.88	0.09	0.13

** Significant at 1% level and ns no significant.

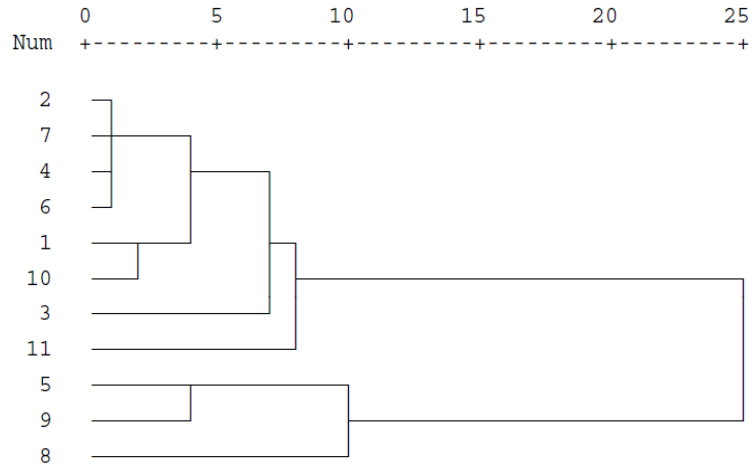

Figure 2. Dendrogram groupings of the various melons based on quantitative morphological data. (1; Khatooni, 2; Ghasri, 3; Jafarabadi, 4; Jabari, 5; Zard-e-Palangi, 6; Khaghani, 7; Chah Paliz, 8; Zemestani 9; Ghenat-e-Boshrouyeh 10; Haji Mashallahi 11; Zin Abad).

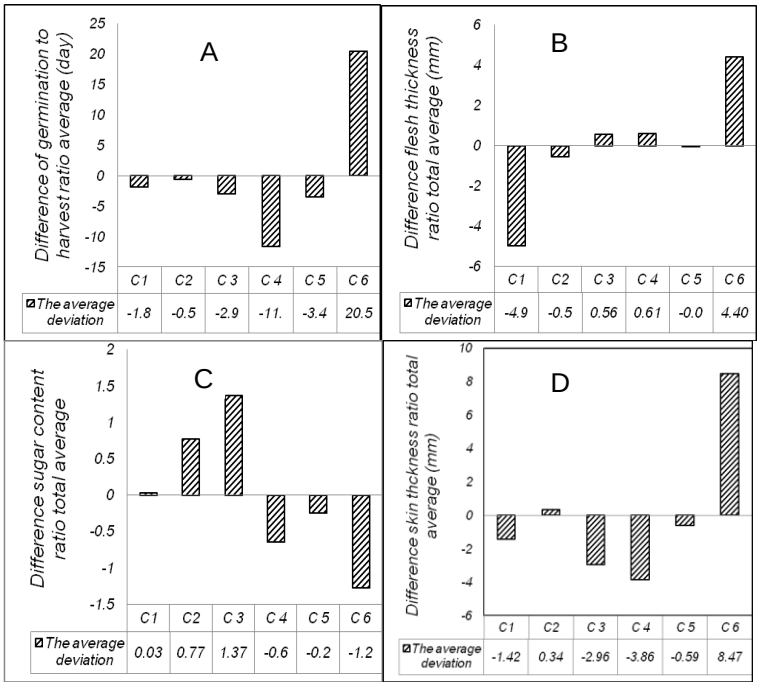

Figure 3. Changes traits studied ratio total average in different clusters, (C1; cluster 1, C2; cluster 2, C3; cluster 3, C4; cluster 4, C5; cluster 5 and C6; cluster 6).

The sixth, fourth and third clusters had maximum flesh thickness, as a result, selecting appropriate cultivars of these clusters can be used for economic yield (Figure 3B). Results indicated that the third and second clusters had the highest content sugar than other clusters (Figure 3C), cluster four, cluster three and cluster one had less skin thickness than other clusters (Figure 3D). These advantages can be used to improve the sugar level of cultivars and can result to less skin thickness. Variation and selection are two principals of each breeding program, and selection depends upon the existence of favorable diversity in population.

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