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Full Length Research Paper

Morphological and pomological characteristics of fig (*Ficus carica* L.) cultivars from Varamin, Iran

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In this study, physical characteristics and quality parameters of some local cultivars of fig (*Ficus carica* L.) grown in Varamin, Iran were determined. The main cultivars grown in Varamin were Bidaneh, Paizeh, Zard, Siah bolol riz, Siah zoodras, Siah diras, Morabaii, Hallavi riz and Hallavi dourosht. In the pomological characteristics, fresh fruit weight ranged from 8.0 to 43.5 g. Fruit diameter ranged from 21 to 45 mm, the total amount of sugar ranged from 9.8 to 18.9%, the amount of total soluble solid ranged from 13.3 to 28.50%. In addition also skin color, internal color and skin cracks were investigated. Results show that all of physical characteristics had statistically significant differences. This study suggests that Varamin fig germplasm is diverse. Cluster analysis also allowed to clustering of nine cultivars into two main groups at near 20 of dissimilarity level.

Key words: *Ficus carica L.*, cultivars, physical characteristics, quality parameters, cluster analysis.

INTRODUCTION

The fig (*Ficus carica* L.) is an economically important crop cultivated extensively in Iran. The total annual fig production of Iran was about 88,000 tonnes in 2007 (FAO, 2009). The fruit of *F. carica* L. are used commercially for jam, beverages, cake, chocolate, marmalade, dried fruit, fresh fruit, medicines and etc. (Babazadeh Darjazi, 2001). Fruits are mainly used fresh in Varamin. A small portion is sun dried and little quantities are used for jam production. All of the Varamin cultivars are common type (parthenocarpic). Up to now, numerous investigations have been performed aimed at identifying the morphological and pomological characteristics of cultivars in the *F. carica* L. (Babazadeh Darjazi, 2001, 2004, 2005; Caliskan and Polat, 2008; Gozlekci, 2010; Koyuncu, 1998; Kuden et al., 2008; Mahdavian et al., 2007; Mars et al., 1998; Messaoudi and Boughida, 2008; Messaoudi and Haddadi, 2008; Sabet, 1998). The quality of a fig fruit may be calculated from the quantity of sugar, total soluble solid (TSS), fruit weight, fruit shape, fruit size, and cultivars affect these traits (Babazadeh Darjazi, 2001). Fruit weight is considered as an important trait in the fresh consumption group; fruit shape is very important for packaging and transportation; the size of fruit is very important for canning industries; the quantity of sugar and TSS are very important for food industries (for jam, dried fig production) and cultivars affect these traits (Babazadeh Darjazi, 2001; Caliskan and Polat, 2008; Gozlekci, 2010; Koyuncu, 1998). It will be necessary to improve the quality and increase diversity. New planting necessitates the use of the best cultivars to satisfy the increasing demands of commercial requirements (Messaoudi and Haddadi, 2008). The importance of fresh fig production and exportation tended the researchers to finding good quality fig cultivars. (Kuden et al., 2008).

Phenotypic identification of plants has been used in the classification of genotypes and the study of taxonomic status. The basic identification of cultivar diversity by local farmers depends on botanical traits. In the absence of DNA markers, the most available tool for genetic diversity studies is morphological descriptors. These morphological traits sometimes are quite variable, and have been used by local farmers for basic identification of plant material. Morphological characterization has been used for various purposes including identification of duplicates, studies of genetic variation patterns, and correlation with characteristics of agronomic importance. Morphological traits are useful for preliminary evaluation, because they offer a fast and easy approach for assessing the extent of diversity (Asare et al., 2011).

To be useful for plant breeders, genetic resources must be characterized by morphological and agronomic traits. For this reason, there is need to collect, characterize and evaluate remnant local genotypes before they disappear. According to Aliyu et al. (2000), cluster analysis has the singular efficacy and ability to identify crop accessions with highest level of similarity using the dendrogram. These results of the classification of the cultivars can predict groups by discriminate analysis. The cluster analysis has can classify different genotypes on the basis of similarity and thus provides a hierarchical classification (Arslanoglu et al., 2011). The objective of this study was to evaluate physical characteristics and quality parameters of some local cultivars of fig grown in Varamin and to detect associations among genotypes. The main aim of our study was to identify the relationship between local fig cultivars.

MATERIALS AND METHODS

Experimental material

In 1989, fig cultivars were planted at 8x4 m^2 with three replication at Varamin research station (Latitude 35° 30' N, Longitude 51° 40' E); semi- desert climate (average rainfall 170 mm per year and average temperature 29°C); soil was classified as loam-clay; pH range 6.9 to 7.0. In this experiment, nine fig genotypes from Varamin regions were used as plant material (Table 2). They were Bidaneh, Paizeh, Zard, Siah bolol riz, Siah zoodras, Siah diras, Morabaii,Hallavi riz and Hallavi dourosht.

Identification and sampling of cultivars

In the last week of July 2001, at least 10 mature fruit and 10 mature leaves from each of fig cultivars were collected from many parts of the same trees located in Varamin Research Station. For the pomological analysis, fruits were analyzed according to some physical characteristics and quality parameters with three replications and 10 fruits in each replication.

Physical characteristics and quality parameters of cultivars are shown in Tables 1 and 2. Only morphological and chemical characteristics of the second crop were studied. Morphological and pomological characteristics of the samples were determined according to Fig Descriptors (IPGRI and CHIEAM, 2003).

Pomological characteristics of fig cultivars

10 fruits for each fig tree were randomly sampled for measurements and analyses. The characteristics were fruit weight (g), fruit length (mm), fruit diameter (mm), ostiol width (mm), fruit shape index, fruit skin (external), flesh color, total soluble solid content (%), sugar (%) and etc. Fruit width and fruit length were measured by using a digital caliper with a sensitivity of 0.01 mm. Fruit weight was measured using a digital balance with a sensitivity of 0.001 g. Fruit shape index was explained as the ratio of fruit width to fruit length. TSS and sugar were measured using a handel refrectometer. Fruit characteristics of the samples were determined according to Fig Descriptors (IPGRI and CHIEAM, 2003).

Leaf characteristics and plant growth characteristics

10 leaves for each fig tree were randomly sampled for measurements and analyses. The characteristics were leaf width (mm), leaf length (mm), petiole length (mm), number of leaf lobes and etc. Leaf characteristics of the samples were determined according to Fig Descriptors (IPGRI and CHIEAM, 2003).

Data analysis

Analysis of morphological variations was based on the measurements of 32 characters .Variations among and within populations were analyzed using analysis of variance (ANOVA)-one way. Correlation between pairs of morphological characters and altitude was evaluated using Pearson's correlation coefficient. We also examined overall variations of morphological characters among populations using cluster analysis using SPSS 18. This software was also used for the regression analysis of the data obtained from the experiments.

RESULTS

Pomological characteristics of fig cultivars

Some physical characteristic and quality parameters of nine cultivars are shown in Tables 1 and 2.

Physical characteristics of fruits

The fresh fruit weight ranged from 8.0 to 43.5 g. Among the nine cultivars examined, Paizeh showed the highest content of fresh fruit weight (Table 2). Fruit diameter ranged from 21 to 45 mm. Among the nine cultivars examined, Paizeh showed the highest content of fruit diameter. Fruit length varied from 20.00 to 36 mm.

Most of the cultivars analyzed had an oblate fruit shape (Table 2). Fruits of Siah bolbol riz and Morabaii were globose while those of Hallavi riz were oblong. Fruit stalk was long and slender for three cultivars (Siah bolbol riz, Zard and Hallavi riz) and it was short and thick for the remaining cultivars. Fruits ostiol width was changed between 0.0 (Morabaii) and 4.6 mm (Siah zoodras).

Total sugar and total soluble solids

While Hallavi riz cultivar gave the highest (18.9%) total amount of sugar, Paizeh cultivar gave the lowest (9.8%) (Table 2). The amount of TSS ranged from 13.3 to 28.50%. Among the nine cultivars examined, Siah bolbol riz showed the highest content of TSS (Table 2).

Fruit external characteristics

The fruit skin color varied from yellow to black. Paizeh and Morabaii cultivars had canary yellow colors. Zard cultivar was yellow-green and Bidaneh cultivar was light-

Table 1. The studied physical characteristics of nine local cultivars of fig (*Ficus carica L.*) grown in Varamin.

Physical characteristic		Physical characteristic	
X1	Fresh fruit weight [Ffw (g)]	X17	Petiole length (cm)
X2	Dried fruit weight [Dfw (g)]	X18	Petiole thickness (mm)
X3	Ffw /Dfw	X19	Depth of upper sinuses (cm)
X4	Fruit volume (cm^3)	X20	Leaf trace (mm)
X5	Fruit diameter (mm)	X21	Midvein length (cm)
X6	Fruit length (mm)	X22	Mid lobe base width (cm)
X7	Fruit shape index (Fd/Fl)	X23	Angle of central lobe tip
X8	Ostiole width (mm)	X24	Angle of lateral lobe tip
X9	Stalk length (mm)	X25	length of lateral lobe(cm)
X10	Stalk diameter (mm)	X26	Length of current season growth (cm)
X11	Sugar (%)	X27	Diameter of current season growth (mm)
X12	Total soluble solid (%)	X28	Terminal bud length [Tbl (mm)]
X13	Leaf length (cm)	X29	Terminal bud width [Tbw (mm)]
X14	Leaf width (cm)	X30	Tbl / Tbw
X15	Leaf area (LxW)(cm^2)	X31	Shoot internode length (mm)
X16	Length of central lobe(cm)	X32	Internode number

green, while Hallavi riz and Hallavi dourosht cultivars were light-brown, Siah bolbolriz cultivar was purplish-brown, Siah zoodras cultivar was purple and Siah diras cultivar was black.

The skin thickness was thin for five cultivars (Siah bolbol riz, Siah diras, Morabaii, Hallavi riz and Hallavi dourosht) and thick for the remaining cultivars. The skin ribs were Dark-brown (for Hallavi riz and Hallavi dourosht) and absent for the remaining cultivars. Zard showed some minute skin cracks.

Fruit internal characteristics

Fruit flesh color changed from white to light yellow. Fruit internal cavity was small for five fig cultivars (Zard, Siah bolbol riz, Siah zoodras, Siah diras and Hallavi riz) and medium for three remaining cultivars (Bidaneh, Paizeh and Hallavi dourosht). The number of seed per fruit was high (for Zard), medium (for Paizeh, Siah diras, Hallavi dourosht) and low for the remaining cultivars. Fruit of Bidaneh had the highest aromatic flavor.

Leaf characteristics

Leaf blade length of the genotypes changed between 12.00 to 26.50 cm, Leaf blade width was differed between 8.25 to 18.60 cm. Number of lobes per leaf was evaluated from three lobes (for Bidaneh, Paizeh, Siah bolol riz, Siah zoodras, Morabaii, Hallavi riz and Hallavi dourosht) to five lobes (for Zard, Siah diras).

Plant growth characteristics

The length of current season growth changed between 5.50 to 19.50 cm. while the diameter of current season growth changed between 6.25 to 9.50 mm. The highest of current season growth length was obtained from Bidaneh cultivar with 19.50 cm, while the lowest value was obtained from Hallavi dourosht with 5.50 cm.

Plant growth habits were obtained spreading (for Zard, Siah bolbol riz), erect (for Paizeh, Siah diras) and weeping habit (for Bidaneh, Siah zoodras, Morabaii, Hallavi riz and Hallavi dourosht). Tree vigor was found high (for Morabaii), medium (for Bidaneh, Paizeh, Siah zoodras, Hallavi riz and Hallavi dourosht) and low (for Zard, Siah bolbol riz and Siah diras).

Result of correlation

Correlations of the parameters were evaluated with Pearson correlation analysis. Relationships between all morphological traits were expressed in a correlation matrix in Table 3. According to this table, 32 different morphological traits are significantly correlated at 0.05 or 0.01 significant level. The highest positive values or r (correlation coefficient) were between [X4 and X1 (99%)]; [X25 and X24 (99%)]; [X4 and X2 (98%)]; [X2 and X1 (97%)]; [X5 and X2 (97%)]. The highest significant

Table 2. Statistical analysis of variation in physical characteristics of fig cultivars.

Traits	Cultivar								F value	
	Bidaneh	Paizeh	Zard	Siah bolbol riz	Siah zoodras	Siah diras	Morabaii	Hallavi riz	Hallavi dourosht	
Fruit trait										
Fresh fruit weight (g)	27.9	43.5	24.4	8	33.5	30.7	8.6	19.7	20.7	F**
Dried fruit weight (g)	5	7.4	4.1	1.6	4.9	4.9	1.6	3.4	4.4	F**
Ffw /Dfw	0.17	0.16	0.16	0.19	0.14	0.15	0.18	0.16	0.21	F**
Fruit volume (cm^3)	31.2	46.6	24.3	7.4	33.7	31.4	9.8	19.7	23.7	F**
Fruit diameter (mm)	38	45	35	21	40	38	24	32	37	F**
Fruit length (mm)	27	35	23	20	31	25	25	36	22	F**
Fruit shape index(Fd/Fl)	1.40	1.28	1.52	1.05	1.29	1.52	0.98	0.88	1.68	F**
Fruit shape	oblate	oblate	oblate	globose	oblate	oblate	globose	oblong	oblate	
Ostiole width (mm)	2.9	2.7	4.2	1.6	4.6	4.2	0	3.1	4	F**
Stalk length (mm)	7.00	6.00	11.5	15	4.00	5.00	5.80	11.0	12.0	F**
Stalk diameter (mm)	5.20	5.30	4.00	1.70	4.80	4.50	3.80	4.30	4.60	F**
Sugar (%)	15.3	9.8	16.2	16.5	15	16.8	16.5	18.9	17.9	F**
Total soluble solid (%)	18	13.3	18.4	28.5	20	22.5	28.2	24	17.1	F**
Fruit skin over color	Light-Green	Canary Yellow	Yellow-green	Purplish brown	Purple	Black	Canary Yellow	Light-brown	Light-brown	
Fruit ribs	None	None	None	None	None	None	None	Prominent	Prominent	
Bloom	Medium	None	None	None	None	None	None	None	None	
Fruit skin cracks	None	None	Minute	None	None	None	None	None	None	
Ease of peeling	Easy	Easy	Easy	Easy	Difficult	Easy	Difficult	Easy	Easy	
Fruit flesh color	Light yellow	Light yellow	Light yellow	White	White	White	Light yellow	Light yellow	Light yellow	
Pulp internal color	amber	Light strawbery red	Dark strawbery red	amber	amber	amber	amber	amber	amber	
Fruit cavity	Medium	Medium	Small	Small	Small	Small	None	Small	Medium	
Pulp juiciness	Juicy	Little juicy	Little juicy	Little juicy	Little juicy	Little juicy	Little juicy	Little juicy	Little juicy	
Shape of the fruit stalk	Short thick	Short thick	Long slender	Long slender	Short thick	Short thick	Short thick	Long slender	Short thick	
Pulp flavor	Aromatic	None	None	None	None	None	None	None	None	
Seed number	Low	Medium	High	Low	Low	Medium	Low	Low	Medium	
Neck length	None	None	None	None	None	None	Short	Short	None	
Scale color of eye	Light-orange	Purplish pink	Red with white margins	Light yellow- White	Dark- Purple with white margins	Dark- Purple	Canary Yellow	Light-brown	Light-brown	
Stalk color	green	Yellow-green	Yellow-green	Light-yellow	Dark-green	Dark-green	Light-yellow	Dark-green	Dark-green	
Number of fruit per node	1	1	1	1	1	1	2	1	1	
Breba crop	High	Low	Meduim	None	None	None	High	None	None	
skin thickness	medium	medium	medium	thin	medium	thin	thin	thin	thin	

Table 2. Contd.

Traits	Cultivar									F value
	Bidaneh	Paizeh	Zard	Siah bolbol riz	Siah zoodras	Siah diras	Morabaii	Hallavi riz	Hallavi dourosht	
Leaf trait										
Leaf length (cm)	18.75	20.50	17.00	12.00	25.20	26.50	25.00	24.00	21.50	F**
Leaf width (cm)	12.60	16.18	13.75	8.25	14.80	17.00	18.60	16.20	14.60	F**
Leaf area (LxW) (cm^2)	135	187	85	40	185	220	280	225	165	F**
Number of lobes	3	3	5	3	3	5	3	3	3	
Length of central lobe (cm)	8.5	9.8	9.5	5.5	11.3	12.50	13	11.9	10.51	F**
Leaf margin	Regular toothed	Regular toothed	Irregular toothed	Regular toothed	Irregular toothed	Irregular toothed	Regular toothed	Irregular toothed	Irregular toothed	
Leaf color	Light green	Dark green	Dark green	Dark green	Dark green	Dark green	Light green	Dark green	Dark green	
Petiole length (cm)	4.75	5.50	3.75	4.10	7.00	12.00	6.00	4.75	4.75	F**
Petiole thickness (mm)	2.60	3.60	2.75	3.25	3.75	3.50	3.40	3.60	2.80	F**
Depth of upper sinuses (cm)	2.40	3.20	3.75	2.25	3.50	4.70	4.40	2.80	2.80	F**
Leaf trace (mm)	4.25	4.70	3.90	3.45	4.40	4.25	5.30	4.10	3.10	F**
Midvein length (cm)	14	15	13	7.50	18.50	17.00	19.00	19.00	17.00	F**
Mid lobe base width (cm)	4.00	5.00	2.50	1.40	4.20	3.20	4.75	4.90	4.50	F**
Angle of central lobe tip	110	76	90	110	0	0	85	0	0	F**
Angle of lateral lobe tip	102	64	70	100	0	0	76	0	0	F**
length of lateral lobe (cm)	10.50	12.30	10.50	6.00	12.70	12.70	14.60	13.00	11.80	F**
Leaf blade surface	Soft	Soft	medium	Soft	Rough	Rough	Rough	medium	medium	
Leaf blade texture	Fragile	Flexible	Flexible	Fragile	Fragile	Fragile	Fragile	Fragile	Fragile	
Upper sinuses shape	U	U	V	U	V	U	U	V	V	
Density of hairs on leaf upper surface	None	Intermediate	None	Intermediate	None	None	None	None	None	
Bud trait										
Length of current season growth (cm)	19.50	12.00	7.40	6.25	9.50	9.50	11.00	18.75	5.50	F**
Diameter of current season growth (mm)	8.25	7.75	8.00	7.50	9.50	9.50	8.50	8.75	6.25	F**
Terminal bud length (mm)	9.50	11.90	10.30	6.40	10.80	9.50	12.50	8.30	8.50	F**
Terminal bud width (mm)	3.60	4.30	3.90	3.80	5.40	5.00	5.00	4.30	3.70	F**
Tbl / Tbw	2.63	2.76	2.64	1.68	2.00	1.90	2.50	1.93	2.29	F**
Shoot internode length (mm)	48	27	15	12	23	22	23	37	15	F**
Internode number	8	6	7	8	8	8	7	9	5	F**
Tree traits										
Tree growth habit	Weeping	Erect	Spreading	Spreading	Weeping	Erect	Weeping	Weeping	Weeping	
Tree Vigor	Medium	Medium	Low	Low	Medium	Low	High	Medium	Medium	

Mean is average of physical characteristics in different cultivars used with three replicates. F value is accompanied by its significance, indicated by: NS : not significant, * : significant at P = 0.05, **: significant at P = 0.01.

Table 3. Correlation matrix (numbers in this table correspond with physical characteristics mentioned in Tables1 and 2)

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15
X2	0.97**	-	-	-	-	-	-	-	-	-	-	-	-	-	-
X3	-0.48*	-0.31	-	-	-	-	-	-	-	-	-	-	-	-	-
X4	0.99**	0.98**	-0.41*	-	-	-	-	-	-	-	-	-	-	-	-
X5	0.95**	0.97**	-0.31	0.96**	-	-	-	-	-	-	-	-	-	-	-
X6	0.57**	0.52**	-0.44*	0.55**	0.51**	-	-	-	-	-	--	-	-	-	-
X7	0.44*	0.51**	0.16	0.46*	0.58 **	-0.37	-	-	-	-	-	-	-	-	-
X8	0.60**	0.58**	-0.30	0.56**	0.69**	0.13	0.67**	-	-	-	-	-	-	-	-
X9	-0.57**	-0.47*	0.56**	-0.57**	-0.51**	-0.43*	-0.07	-0.90	-	-	-	-	-	-	-
X10	0.78**	0.8**	-0.19	0.81**	0.88**	0.59**	0.41*	0.45*	-0.65**	-	-	-	-	-	-
X11	-0.62**	-0.62**	0.37	-0.64**	-0.47*	-0.30	-0.07	0.06	0.43*	-0.29	-	-	-	-	-
X12	-0.80**	-0.89**	0.12	-0.84**	-0.87**	-0.30	-0.63**	-0.57**	0.24	-0.72**	0.58**	-	-	-	-
X13	0.29	0.22	-0.24	0.29	0.36	0.47*	0.005	0.19	-0.71**	0.59**	0.16	-0.004	-	-	-
X14	0.27	0.24	-0.08	0.28	0.33	0.47*	-0.02	-0.01	-0.62**	0.60**	0.04	-0.06	0.88**	-	-
X15	0.12	0.08	-0.09	0.14	0.17	0.49**	-0.24	-0.18	-0.65**	0.49**	0.07	0.10	0.91**	0.91**	-
X16	0.16	0.11	-0.15	0.16	0.25	0.37	0.003	0.11	-0.59**	0.52**	0.22	0.01	0.94**	0.93**	0.91**
X17	0.32	0.22	-0.38	0.29	0.27	0.05	0.22	0.26	-0.62**	0.25	0.02	0.09	0.66**	0.47*	0.49**
X18	0.22	0.08	-0.36	0.16	0.07	0.59**	-0.49**	-0.05	-0.38*	0.05	-0.09	0.28	0.53**	0.45*	0.51**
X19	0.18	0.07	-0.28	0.15	0.14	0.03	0.13	0.03	0.59**	0.23	-0.01	0.11	0.66**	0.75**	0.60**
X20	0.19	0.09	-0.36	0.19	0.08	0.47*	-0.41*	-0.43*	-0.74**	0.34	-0.33	0.13	0.52**	0.66**	0.67**
X21	0.23	0.19	-0.08	0.23	0.34	0.53**	-0.04	0.15	-0.58**	0.64**	0.22	-0.06	0.94**	-0.89**	0.90**
X22	0.36	0.40*	0.07	0.41*	0.46*	0.70**	-0.11	-0.04	-0.51**	0.74**	-0.14	-0.33	0.69**	0.74**	0.79**
X23	0.28	0.24	-0.17	0.29	0.35	0.51**	-0.03	-0.03	-0.69**	0.66**	0.007	-0.13	0.91**	0. 95**	0.93**
X24	-0.24	-0.21	0.15	-0.22	-0.35	-0.31	-0.18	-0.57**	0.23	-0.34	-0.32	0.11	-0.70**	-0.43*	0.48*
X25	-0.27	-0.23	0.17	-0.24	-0.37	-0.31	-0.20	-0.61**	0.22	-0.35	-0.31	0.14	-0.69**	-0.45*	-0.47*
X26	0.19	0.18	-0.21	0.21	0.19	0.66**	-0.39*	-0.11	-0.27	-0.46*	0.02	-0.04	0.25	0.25	0.34
X27	0.24	0.05	-0.71**	0.18	0.12	0.41*	-0.27	0.14	-0.63**	0.20	0.06	0.27	0.56**	0.39*	0.43*
X28	0.41*	0.35	-0.26	0.42*	0.38*	0.36	0.02	-0.15	-0.75**	0.57**	-0.48*	-0.28	0.52**	0.72**	0.60**
X29	0.20	0.02	-0.45*	0.14	0.11	0.34	-0.22	0.03	0.69**	0.20	0.005	0.27	-0.76**	-0.63**	0.66**
X30	0.37	0.45*	0.18	0.43*	0.43*	0.17	0.29	-0.09	-0.26	0.58**	-0.43*	-0.55**	0.008	0.35	0.12
X31	0.29	0.30	-0.20	0.32	0.31	0.58**	0.21	-0.04	-0.37	0.56**	-0.06	-0.19	0.24	0.20	0.31
X32	-0.15	-0.30	-0.57**	-0.22	-0.28	-0.26	-0.55**	-0.02	-0.07	-0.22	0.30	0.51**	0.07	-0.14	0.008

Table 3. Contd.

	X16	X17	X18	X19	X20	X21	X22	X23	X24	X25	X26	X27	X28	X29	X30	X31
X17	0.53**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
X18	0.40*	0.44*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
X19	0.72**	0.69**	0.39*	-	-	-	-	-	-	-	-	-	-	-	-	-
X20	0.50**	0.29	0.48**	0.59**	-	-	-	-	-	-	-	-	-	-	-	-
X21	0.93**	0.39*	0.43*	0.51**	0.48*	-	-	-	-	-	-	-	-	-	-	-
X22	0.67**	0.05	0.30	0.16	0.48*	-0.82**	-	-	-	-	-	-	-	-	-	-
X23	0.95**	0.40*	0.38*	0.64**	0.63**	0.94**	0.82**	-	-	-	-	-	-	-	-	-
X24	-0.64**	-0.49**	-0.40*	-0.24	0.17	-0.65**	-0.39*	-0.50**	-	-	-	-	-	-	-	-
X25	-0.65**	-0.48*	-0.40*	-0.28	0.17	-0.65**	0.38*	-0.51**	0.99**	-	-	-	-	-	-	-
X26	0.16	-0.05	0.09	-0.18	0.41*	0.33	0.49**	0.29	0.07	0.10	-	-	-	-	-	-
X27	-0.44*	0.61**	0.58**	0.52**	0.58**	0.41*	0.09	0.39*	-0.25	-0.24	0.37	-	-	-	-	-
X28	0.57**	0.19	0.25	0.65**	0.82**	0.54**	0.57**	0.72**	0.07	0.04	0.12	0.30	-	-	-	-
X29	0.67**	0.66**	0.79**	0.73**	0.64**	0.63**	0.30	0.62**	-0.43*	-0.44*	-0.01	0.75**	0.53**	-	-	-
X30	0.10	-0.29	-0.32	0.16	0.40*	0.15	0.42*	0.31	0.43*	0.39*	0.23	-0.21	0.68**	-0.17	-	-
X31	0.13	-0.01	-0.03	-0.22	0.37	0.30	0.50**	0.28	0.07	0.11	0.96**	0.32	0.14	-0.06	0.28	-
X32	-0.03	0.19	0.30	-0.06	0.18	-0.01	-0.23	-0.11	-0.02	0.002	0.52**	0.70**	-0.28	0.25	-0.52**	0.42*

*Significant at 0.05;**,significant at 0.01.

negative correlations were between [X12 and X2 (89%)]; [X21 and X14] (89%)]

Result of cluster analysis

According to Aliyu et al. (2000), cluster analysis has the singular efficacy and ability to identify crop accessions with highest level of similarity using the dendrogram. Cluster analysis based on the morphological data assigned the populations into two groups A and B (Figure 1).

Cluster A, was divided into two subclusters; subcluster 1a consisting of four cultivars (Siah Dirras,Siah Zoodras, Halavi Riz,Halavi Dourosht) and subcluster 2a contained only one cultivar (Morabaii). Cluster B was divided into two subclusters; subcluster 1b consisting of two cultivars (Siah Bolbol Riz, Zard) and subcluster 2b consisting of two cultivars (Bidaneh, Paiezeh).

The phenotypic distance among populations ranged from 1.00 to 25.00. At 1.00 level of similarity, only four accessions into 2 two- accessions were similar to each other, while at 19 levels and above, larger numbers of the accessions were similar to each other. The cluster analysis separated the nine accessions as different genotypes with Euclidean similarity distance ranging from 1.00 to 25.00. At higher similarity levels, the above clusters were further divided into smaller sub-clusters

Statistical analyses

Differences for morphological characters among cultivars were analyzed by performing separate one-way ANOVA. The Duncan's Multiple Range test was used to separate the significant cultivars. Of the 32 physical characterististics analyzed, all showed statistically significant differences due to the influence of individual cultivars. These differences on the 1% level occurred in all of the studied physical characteristics (Table 2).

Regression analysis

SPSS 18 was used for the regression analysis of the data obtained from the experiments. The estimate value of Y (dependent variable) is based on a known X (independent variable) in the equation for the regression line ($Y = mX + b$). The regression modeling indicates that independent

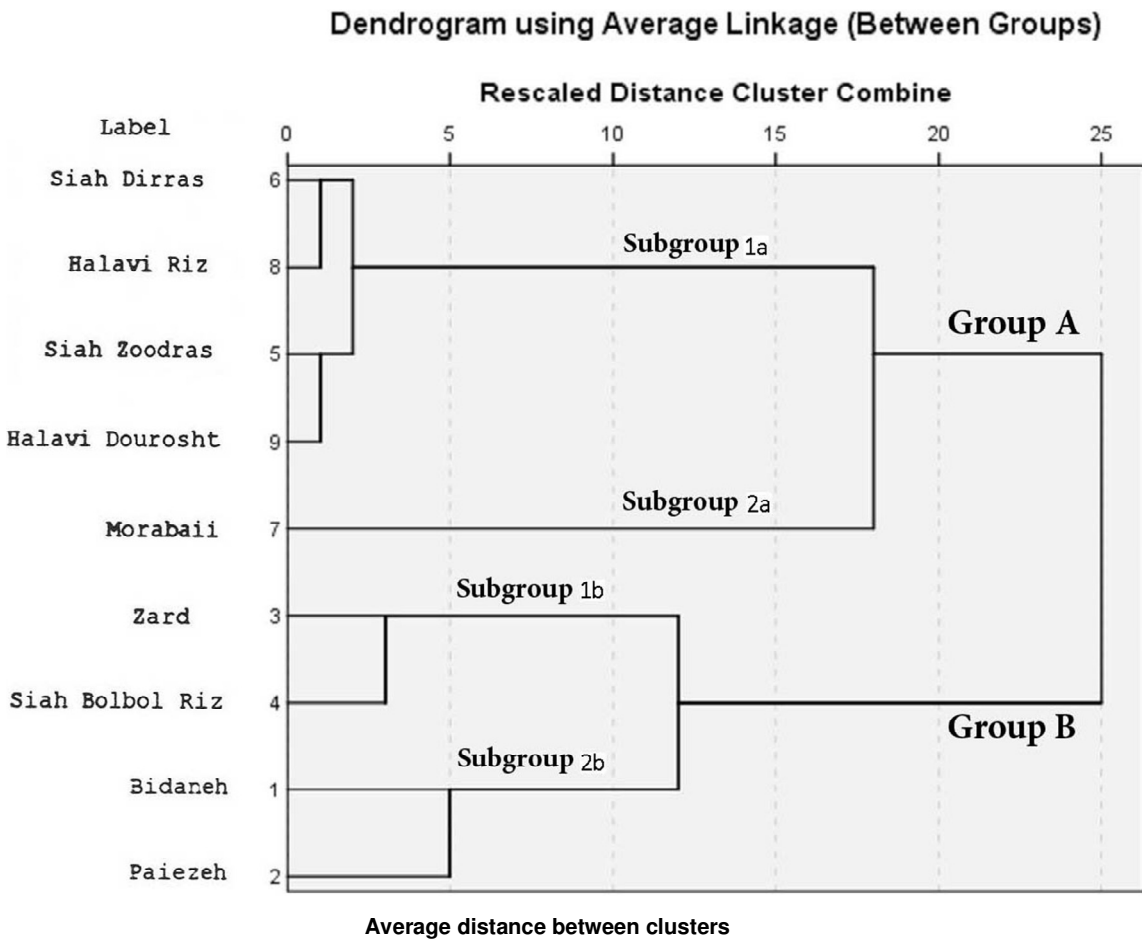

Figure 1. Clustering of all nine fig cultivars base on 32 physical characteristics in Table 1.

variables including fruit diameter, fruit stalk length and sugar (X), significantly influence the fresh fruit weight (Y) rate. Linear regression reveals a good correspondence between them. The result of this study reveals that increasing the fruit diameter (X5) improved the fresh fruit weight or yield (Y). The result of this study also shows that stalk length (X9) and sugar (X11) are negatively related with the fresh fruit weight or yield (Y).

The R^2 statistic is the percentage of variance in the data as explained by regression. It is a dimen-sionless index that ranges from 1.0 to 0.0 and measures how successfully the best fit line accounts for variation in the data. The quality of the polynomial model equation was determined by the determination coefficient R^2. The fit of the model was checked by the coefficient of determination R^2, which was calculated to be 0.91, indicating that about 91% of the variability in the response could be explained by this model. It was considered as very high correlation when the R^2-value was higher than 0.90

$Y = 1.42\ X5 - 2\ 5.11$; $R^2 = 0.91$;

$Y = 1.34\ X5 - 0.32\ X9 - 19.47$; $R^2 = 0.92$;

$Y = 1.24\ X5 - 0.16\ X9 - 0.89\ X11 - 3.07$; $R^2 = 0.95$..

DISCUSSION

Our observations that changing cultivars has an effect on some of the morphological characteristics of *F. carica* L. are in accord with other observations (Babazadeh Darjazi, 2001, 2004, 2005; Caliskan and Polat, 2008; Gozlekci, 2010; Koyuncu, 1998; Kuden et al., 2008; Mahdavian et al., 2007; Mars et al., 1998; Messaoudi and Boughida, 2008; Messaoudi and Haddadi , 2008; Sabet, 1998).

High positive correlations between two physical characteristics such as [X4 and X1 (99%)]; [X25 and X24 (99%)]; [X4 and X2 (98%)]; [X2 and X1 (97%)]; [X5 and X2 (97%)] suggest a genetic control (Scora et al., 1976). However, whether such a dependence between the two physical characteristics is not known. Similarly, high negative correlations observed between [X12 and X2 (89%)]; [X21 and X14] (89%)] suggest that one of the two physical characteristics is being increased at the decrease of the other. Non-significant negative and

positive correlations can imply genetic independence. However, without a thorough knowledge of the relationships between two physical characteristics, the true significance of these observed correlations is not clear. The highest positive value (correlation) were between [X4 and X1 (99%)]; [X25 and X24 (99%)]. This result indicates which of these physical characteristics were under the control of a single dominant gene (Scora et al., 1976) (Table 3). Knowledge of correlations among characters is useful in designing an effective breeding program for any crop.

Means for the consideration traits in cluster analysis revealed that there was significant similarity among some the cultivars. The existence of five cultivars (Siah Dirras, Siah Zoodras, Halavi Riz,Halavi Dourosht, Morabaii) in same subcluster of main cluster 'A' and 4 cultivars (Siah Bolbol Riz,Zard,Paiezeh,Bidaneh) in same subcluster of main cluster 'B' revealed that, the morphological behavior of these cultivars was similar and they may have same ancestors or same geographical origins or same genetic distance.

The maximum similarity was observed between (Siah Dirras, Halavi Riz) and (Siah Zoodras, Halavi Dourosht) belonging to main cluster 'A''. This may be due to same geographical origins or same growth conditions in years and centuries ago. The minimum similarity was observed between group A and group B. It showed that both groups belong to two different habitat that is why these cultivars were observed to join different clusters, A and B, respectively. Probable factors that may have played a role in high level of differentiation in some populations are breeding system and genetic drift (Gharibi et al., 2011). The distance between the two crop cultivars is an important parameter for designing a successful crossing or hybri-dization program. Clustering analysis is also conducted based on the distance between the cultivars. Therefore, based on the results from phenotypic data, intervarietal crossing activities may be more successful, if conducted between cultivars in different clusters and with high distance between one another (Fikiru et al., 2011). However, it should be kept in mind that cultivars used (in this study) were of common type (parthenocarpic) and cross between two cultivars was not possible. These diffe-rences among some cultivars may be due to the dissimilarity of materials and/or the fact that these cultivars are not originated from similar area.

Small leaf area, short trees and the existence of hairs on fruit, leaf and shoot in Siah Bolbol Riz suggested that, it may be belonging to dry and desert climate hence could be recommended for areas with short rainy season.

Fruit wet weight can be used for the development of high yield. According to the fact that yield is a polygene trait, and it is difficult to improve it directly, traits which have high correlation with the yield might prove helpful and indirectly improve the yield (Ojaghi and Akhundova, 2010). On the other hand, fresh fruit weight influence yield. Thus it was not surprising that positive and significant associations were observed between fresh fruit weight and yield. Therefore, we used fresh fruit weight as dependent variable and we also used other traits (fruit diameter, fruit stalk length, etc) as independent variable in regres-sion. Result of regression showed that fruit diameter influence fruit wet weight,

Conclusion

As a result of this present study, we can conclude that the use of physical characteristic and quality parameters is an adequate tool for identification of fig cultivars. In this present study, we found that the physical characteristics and quality parameters were significantly affected by cultivars. Some physical characteristic and quality parameters such as the quantity of sugar and TSS, fruit shape, fruit size are very important and widely used in food industries. Therefore, many studies, such as this study is very crucial in order to identify excellent traits in cultivars that we want to use, before fruits can be utilized in those industries. These results reveal that there are a lot of local fig cultivars that could contribute to further studies. We showed here that the use of morphological identification is a more appropriate alternative to determine the relationship between the different cultivars. Further research on the relationship between cultivars and quality parameters is necessary.

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