Genetic Variability of some Palestinian Fig (*Ficus Carica* L.) Genotypes Based on Pomological and Morphological Descriptors

الإختلافات الوراثية لبعض الطرز الجينية للتين الفلسطيني بالإعتماد على الخصائص الثمرية والمورفولوجية

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Abstract

Characterization of fruit species is recognized as a primary and essential step towards protecting, conserving, maintaining, and conducting any future breeding program. The aim of this study is the genetic characterization of twelve fig genotypes (*Ficus carica* L.) from the southern region of the West Bank, Palestine, based on 41 pomological and morphological traits developed by IPGRI and CIHEAM (2003) with some minor modifications. Results showed a considerable diversity among all tested genotypes at both pomological and morphological levels. UPGMA dendrogram clustered the genotypes into four clusters (Fig. 1). The first (I) consisted of one genotype (Khdari). The second cluster (II) consisted of four genotypes (Ghzali, Bladi, Shhami and Hmari). The third cluster (III) consisted of four genotypes (Mwazi, Moozi, Ruzzi and Mouze). The fourth cluster (IV) consisted of three genotypes (Aswad, Swadi and Smari). Genetic distances ranged from 0.517 to 0.863 with a mean of 0.690. "Ruzzi and Mouze" were the most closely related genotypes, followed by "Ruzzi and Moozi"; "Moozi and Mouze"; "Mwazi and Ruzzi" and "Swadi and Smari". In contrary, "Khdari and Aswad" and Ghzali and Aswad" were the most distantly related ones.

Key words: *Ficus carica*, genotypes, genetic variability, pomological and morphological descriptors.

ملخص

يعتبر توصيف انواع اشجار الفاكهة من الخطوات الأساسية اللازمة لحماية وحفظ واستدامة هذه النباتات، وكذلك هي ضرورية نحو اجراء أي برنامج تحسين مستقبلي لهذه النباتات. هدفت هذه الدراسة الى توصيف اثنا عشر طراز وراثي من التين (*Ficus carica* L.)، جمعت من المنطقة الجنوبية للضفة الغربية في فلسطين وذلك بإستخدام ٤١ صفة شكلية للنبات والأوراق والثمار وفقاً للتوصيف العالمي المعتمد في التوصيف حسب IPGRI & CIHEAM (2003) مع بعض التعديلات البسيطة على هذه الصفات وفقاً لإحتياج الدراسة. اظهرت النتائج تنوعا كبيراً بين جميع الطرز الوراثية التي تم دراستها على المستوى الثمري والشكلي. وفقاً لشجرة UPGMA، انقسمت الانواع الوراثية الى اربعة مجموعات (Fig. 1). المجموعة الاولى (I) ضمت وراثي واحد هو خضاري في حين شملت المجموعة الثانية (II) اربعة طرز وراثية هي غزالي، بياضي، شامي وحماري. أما المجموعة الثالثة (III) فقد شملت هي الأخرى اربعة انواع وراثية هي موازي، مووزي، رزي وموزي. أما المجموعة الأخيرة (المجموعة الرابعة (IV)) فقد ضمت ثلاثة طرز وراثية هي اسود، سوادي وسماري. أما المسافات بين الطرز الوراثية، فقد تراوحت من 0.863 الى 0.517 بمعدل 0.690. ومن حيث القرابة بين الطرز الوراثية، فقد كان صنفي الرزي والموزي الأكثر قرابة فيما بينهما، تبعهما صنفي الرزي والمووزي، وصنفي المووزي والموزي، وصنفي الموازي والرزي وكذلك صنفي السوادي والسماري. في المقابل، فإن الأصناف "خضاري واسود" و"غزالي واسود" كانت اكثر الطرز الوراثية بعدا فيما بينها.

الكلمات المفتاحية: *Ficus carica*، الطراز الجيني، الاختلافات الوراثية، الصفات الثمرية والشكلية.

Introduction

During the last decades, fig (*Ficus carica* L.) rapidly increased in terms of both production volume and geographical spread. Statistically, figs are harvested from 427,000 ha, producing yearly over one million metric tons of figs around the world (FAO, 2009). The Mediterranean, around which most of the fig growing countries are located, has been the most important region of fig production from time immemorial (Aljane et al., 2008), representing more than 82 % of the total world annual production (FAO, 2009). From there, fig tree cultivation spread into many regions around the world with warm temperate climates (Papadopoulou et al., 2002). Palestine (one of the original countries) is characterized by a wide range of environmental conditions and rich natural biodiversity. The fig trees are grown all over the country and

mostly located on the marginal lands, in mixture with other fruit trees (mainly olive and grape), or scattered at the periphery of orchards, and in home gardens. In addition, fig names were mainly given based on skin ground color, internal color, country of origin, and maturity date (Aljane & Ferchichi, 2009). In such conditions, a large number of homonymous and synonymous designations and the occurrence of misnamed genotypes exist. However, these genotypes have not yet been investigated and their identity is unknown. Therefore, it is a crucial necessity for discrimination between these landraces for conservation of plant genetic resources and improvement purposes (Sadder & Ateyyeh, 2006; Rout & Mohapatra, 2008). Varietal discrimination and identification could be achieved either by morphological and/or molecular markers (Saddoud et al., 2008).

Morphological markers have been used for many years for identification and characterization of genotypes. In fig, several reports demonstrated the usefulness of these markers in documenting variability in their genotypes (Salhi-Hannachi et al., 2006; Saddoud et al., 2008; Padgornik et al., 2010). Moreover, morphological markers continue to be the first step for the description and classification of any germplasm as well as useful tools for screening the accessions of any collection (Cantini et al., 1999).

The present study is the first inventory aimed at characterizing the genetic diversity and detecting similarities of some fig genotypes grown in the southern region of the West Bank, Palestine using pomological and morphological descriptors.

Materials and Methods

Twelve fig genotypes, represented by adult trees, obtained from the southern region of West-Bank, Palestine were included in this study during the growing season of 2011. The genotypes includes: Shhami, Ghzali, Biadi, Khdari, Swadi, Smari, Aswad, Ruzzi, Hmari, Moozi, and Mouzi. Random samples of 20 mature fruits and 20 adult leaves were collected and studied from three trees / genotype.

Pomological and morphological traits

A total of 41 quantitative and qualitative traits (26 pomology and 15 leaf morphology) were determined according to the fig descriptors prepared by IPGRI and CIHEAM (2003); Aljane & Ferchichi (2009), with some minor modifications that showed high discrimination value depending on our study (Table 1).

Data Analysis

Each descriptor (quantitative and qualitative) was scored as 1 for presence and 0 for absence. Accordingly, the relatedness among genotypes was estimated based on Jaccard's similarity coefficient using the multilocus fingerprinting data sets containing missing data (FAMD) software version 1.108 beta. Consequently, cluster analysis was made using the un-weighted pair-group method with arithmetic averages (UPGMA) (Schluter & Harris, 2006) and the Tree view software (Win32, version 1.6.6).

Results

Pomological descriptors

Twenty-six quantitative and qualitative pomological traits are presented in Table 2.

Beginning of fruit ripening, fruit full ripening, and harvesting period

In terms of fruit maturation, the twelve genotypes studied were categorized as early (Biadi and Khdari), mid-season (Shhami, Ghzali, Mwazi, Ruzzi, Hmari, Moozi, and Mouze), or late (Swadi, Smari, and Aswad). However, no genotypes were present which would be categorized as either very early or very late in terms of this variable. The same trend was observed for fruit ripening for each genotype, with the exception of Swadi, Smari, and Aswad, where ripening extended beyond September (late). For all tested genotypes, the harvesting period was medium (21-40 days), with the exception of Shhami genotype where harvesting period was very long (>60 days).

Fruit external color and skin cracks

Fruit external color for all genotypes was green -purple, -yellow, -brown, except for Swadi, Smari, and Aswad genotypes, which was black-purple. Regarding skin cracks, Ghzali and Biadi genotypes presented scarce longitudinal cracks; Shhami, Khddari, and Hmari exhibited cracked skin; and the remaining genotypes categorized as minute.

Fruit shape, symmetry, size, uniformity, weight, firmness, neck and stalk traits:

In the studied twelve genotypes, the frequency of fruit shape observed was six (pyriformed) and six (ovoid); none of the genotypes was bell-shaped. In addition, all tested genotypes presented uniformity of size; however, only eight of them demonstrated symmetrical fruits.

Almost, all tested genotypes exhibited medium fruit weight (20-39 g), except Mouze genotype (56.30 g). In addition, three genotypes presented low fruit firmness; two were medium, and seven were firm. Similar trends were observed with fruit length and fruit width. Fruit neck length, neck width, stalk width, and stalk length varied among genotypes in our study.

Ostiole characteristics, skin peeling, fruit internal color and flesh thickness

Among all tested genotypes, eight presented opened ostiole type and four closed ostiole. Furthermore, transparent ostiole dew (drop) was observed in Mwazi, Swadi, Smari, Aswad, Ruzzi, Moozi, and Mouze genotypes. Additionally, most of the genotypes exhibited very large ostiole width except Hmari genotype which presented large ostiole width.

Eight genotypes presented easy skin peeling and the remainders (Ghzali, Khdari, Swadi, and Smari) were difficult to peel.

Internal fruit color was very variable in this study, ranging from amber to red.

Flesh thickness was large for Ruzzi and small for Hmari genotype; other genotypes were medium.

Pulp texture and flavor, and fruit total soluble solids (%):

Eight genotypes exhibited fine pulp texture, three (Swadi, Smari, Aswad) presented coarse, and Khdari had medium pulp texture. In addition, the strongest pulp aromatic flavor was observed in Ghzali, Biadi, Mwazi, Ruzzi, Moozi and Mouze genotypes.

Total soluble solids (TSS) content was either high (Shhami, Ghzali, Khdari, Mowazi, Swadi, Smari, and Moozi) or medium (Biadi, Aswad, Rozi, Mouzi) with the exception of Hmari, which had very high TSS.

Morphological descriptors

Fifteen quantitative and qualitative morphological traits are shown in Table 3.

Bud break:

Bud break of eleven genotypes was observed between March 15 to 30; however, Mouze genotype had a bud break between April 15-30.

Leaf color, shape, lopes, venation, apex shape, serration, and roughness

Among all genotypes tested, leaf color ranged from light green to dark green, leaf shape was always base chordate with lobes spatulate (except for Swadi, Aswad, and Ruzzi), lobe number was five (except for Swadi and Aswad), leaf venation was apparent, leaf apex shape was variable, leaf serration tended to be crenate (except for Mwazi and Swadi), leaf roughness was variable ranging from smooth to fairly rough.

Leaf area, length, width, and sinus depth

Aswad and Hmari genotypes presented the greatest value for leaf area, leaf limb length and width, whereas Shhami, Ghzali, Mwazi, and Smari genotypes tended to have the smallest values for each of these parameters.

Lateral sinus depth was small for Biadi, Swadi, Smari, and Aswad; whereas, the reminder genotypes had a medium category for this trait.

Petiole length and width, and leaf defoliation

Petiole length was long for genotypes Hmari, Moozi, and Mouze and it was medium for the Shhami, Biadi, Khdari, Aswad, and Ruzzi, however, the remaining genotypes presented short petiole length. Additionally, all genotypes showed small to medium petiole width, except for Ruzzi genotype which exhibited large size.

Defoliation was early (1-30 September) for the Biadi and Khdari genotypes, while it was late (1-31 December) for Mwazi, Ruzzi, and Moozi genotypes; and very late (> 1 January) for Mouze genotype; others were intermediate.

Dendrogram of relatedness among fig genotypes:

UPGMA dendrogram clustered the genotypes into two main clusters (Fig. 1). The first and largest cluster (I) consisted of two sub-clusters. Minor sub cluster (IA) composed of only one separated genotype "Khdari" and major sub cluster (IB) included eight genotypes divided into two small branches. The first branch (IBI) composed of "Ghzali and Biadi" and "Shhami and Hmari" genotypes, whereas, the second branch (IBII) consisted of "Mouze and Ruzzi" related to Moozi, in which the three genotypes were related to Mwazi.

The second and the smallest cluster (II) was composed of "Smari and Swadi" which were related to Aswad genotype.

Genetic distances ranged from 0.517 to 0.863 with a mean of 0.690 (Table 4). "Ruzzi and Mouze" were the most closely related genotypes, followed by "Ruzzi and Moozi"; "Moozi and Mouze"; "Mwazi and Ruzzi" and "Swadi and Smari". In contrary, "Khdari and Aswad" and Ghzali and Aswad" were the most distantly related ones.

Discussion

Fig cultivation in Palestine has a very long history (Kislev et al., 2006), and therefore we anticipate a promising future for breeding programs. The first step towards this end is identifying markers and

characterizing relevant traits that enable us to preserve, maintain, and establish breeding programs with the objective of increasing Palestinian fig production and improving fig fruit quality.

In this study, we selected 41 pomological and morphological traits in order to describe the genetic variability and relatedness among twelve Palestinian fig genotypes (Table 2, 3). Compared with other regional studies (Chalak et al., 2008 (11 traits); Papadopoulou et al., 2002 (16); Caliskan & Polat, 2008 (22); Simsek & Yildirim, 2010 (26), we evaluated a greater number of parameters, which were more informative for identifying fig genotypes. In fact, most of these characteristics are of economical interest and consequently could serve as target traits for selection by growers and breeders (Papadopoulou et al., 2002).

Among all examined genotypes, only early, mid-season, and late genotypes were recorded. However, the absence of very early or very late ones might be attributed to the harsh and long conditions in winter and the warm and dry climate in summer; respectively, which characterizes the region, might be the causes (Oukabli et al., 2003).

Regarding the fruit ripening variable, only Swadi, Smari, and Aswad genotypes were exceptional since their maturation extended beyond September which might be genetically controlled rather than environmentally. Therefore, these genotypes would be of great interest in any future breeding program looking for extending the ripening period.

It is well documented that extending the harvesting period is necessary for increasing fig production (Caliskan & Polat, 2008). Interestingly, Shhami genotype presented a very long harvesting period (more than 60 days), and thus this genotype is a promising one for inclusion in breeding programs.

Fruit external color was green -purple, -yellow, -brown for the majority of the examined genotypes. Oukabli et al. (2003) stated that fruit color has certainly constituted a criterion of selection of genotypes by farmers. Moreover, green fruits which give a white and attractive dry product have been favored by consumers.

An acceptable variation of fruit shape, symmetry, and uniformity was also observed, which might imply high genetic diversity of figs grown in Palestine and therefore promising global marketing.

Fig fruit weight is one of the most important components for determining the size of the fruit (Simsek, 2009), and is considered as a very important parameter in fig selection (Oukabli et al., 2003). Koyuncu et al. (1998) demonstrated that fruit weight, width and length are the most important characters affecting commercial value of fruits for fresh consumption. In our study, the largest fruit weight (56.30 g) was presented only in Mouze genotype. However, the medium fruit weight exhibited in the remaining genotypes might be related to the inherently smaller size of the selected genotypes (Caliskan & Polat, 2008).

Interestingly, seven genotypes presented firm fruits, which is a very important criterion in packing, transportation, and exporting purposes. On the contrary, the remaining ones could be recommended for dry consumption or other uses.

It is well known that the long fruit neck is an undesirable characteristic. Interestingly, our results revealed only one genotype with long neck length, even though; this character might be also changed according to the characteristics of the genotype, maintenance requirements, and the ecological conditions (Simsek, 2009).

Concerning the fruit stalk variable, Smari genotype exhibited the shortest fruit stalk length while, Aswad genotype showed the longest one. Since fig is a perishable fruit and short stalk length does not permit easy harvesting compared to longer stalks (Oukabli et al., 2003), therefore, the longest fruit stalk presented in Aswad genotype is an important quality character since the hard fruit detachment could damage the fruit, thus shortening its shelf life (Podgornik et al., 2010).

Among all tested genotypes, eight presented opened ostiole type which is of great interest because opened fruits ostiole enhance access of the pollinating insects to the inside of the fruit, thus resulting in greater seed set (Ozeker & Isfendiyaroglu, 1998). On the contrary, it may also

allow the entrance of different pests and pathogens to the fruits (Can, 1993), which can result in various damage.

Eight genotypes presented easy fruit skin peeling which is a promising trait since this trait is critical for local and global customer preference (Can, 1993; Ilgin, 1995).

A variable range of pulp texture (fine to coarse) and pulp flavor (little to aromatic) existed among our examined genotypes. The strongest flavor, exhibited in six genotypes, is probably linked to the emanation of approximately ten volatile compounds among which acetate-ethyl predominates and the concentration of this compound usually varies according to the genotype (Boling & King, 1980). This criterion constitutes an important parameter for fig fruit consumption (Saddoud et al., 2008). In fact, these genotypes are highly desired by Palestinian consumers.

For all examined genotypes, total soluble solid content (TSS) ranged from 13.03 % in Mouze genotype to 21.67 % in Hmari genotype. Indeed, high quality table figs are better if the TSS is between 13-25 % (Aksoy et al., 1992). A similar result was also reported by Koyuncu (1997) who determined the TSS ratio in different fig types under similar environmental conditions in the Sanliurfa region of Turkey.

In addition to different pomological descriptors, discussed above, leaf morphological and phenological characteristics are also very important for genotype selection by growers and breeders (Papadopoulou et al., 2002).

In this study, 15 morphological characteristics were quantitatively and qualitatively evaluated (Table 3). For all examined characteristics, large variability between genotypes was observed, with the exception for number of bud break (15-30 March), leaf lobes (3-5 lobes), leaf venation (apparent), limb length and width (short-medium and small- medium, respectively) variables. Because there are no differences in these traits among tested genotypes, these characters are insignificant for varietal identification and discrimination. The other ten variable morphological parameters are very effective and important to differentiate and compare

between the genotypes (Aljane, 2004; Saddoud et al., 2008), and might contribute to a large variability within fig accessions (Chalak et al., 2008).

According to UPGMA Jaccard's distance index (Table 4), Mouze, Moozi, Ruzzi, and Mwazi seem to be genetically identical with some homonymies "different local names". Similar results were also observed with "Aswad, Smari and Swadi genotypes. In fact, fig is usually propagated by vegetative means and therefore, mutations could have been engaged in developing these differentiated genotypes (Sadder & Ateyyeh, 2006) leading to such narrow variation.

Based on our similarity results, number of local fig genotypes were reduced which thereby, saving time and efforts for any future breeding program.

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Table (1): Pomological and morphological descriptors determined in some fig (*Ficus carica* L.) genotypes grown in the southern region of West-Bank, Palestine.

Fig Fruit and Leaf Descriptors					
A	**Fruit Descriptors**	**Abbreviation**	**Unit**	**Explanation**	**Method/ Reference**
1	Beginning of Ripening	BM	Notification	Very early <20 July	IPGRI and CIHEAM, 2003
				Early 20-31 July	
				Mid-season 1-15 August	
				Late 15-31 August	
				Very late >31 August	
2	Full Ripening	FM	Notification	Very early (end July)	IPGRI and CIHEAM, 2003
				Early (1-10 August)	
				Mid-season (11-31 Aug)	
				Late (1-30 September)	
				Very late (> 1 October)	
3	Harvesting Period	HP	Notification	Very short <15 days	IPGRI and CIHEAM, 2003
				Short 15-20 days	
				Medium 21-40 days	
				Long 41-60	
				very long >60	

4	Fruit External Color	EC	Notification	Green-purple Green-yellow Brown-green Black-purple	In this study
5	Skin Cracks	SC	Notification	Cracked skin Scarce Minute	IPGRI and CIHEAM, 2003
6	Fruit Shape	FS	Notification	Ovoid Bell-shaped Pyriformed	IPGRI and CIHEAM, 2003
7	Fruit Symmetry	FSy	Notification	Yes No	IPGRI and CIHEAM, 2003
8	Fruit Size Uniformity	SU	Notification	Uniform Variable	IPGRI and CIHEAM, 2003
9	Fruit Weight	FW	g	Large 40-60 Medium 20-39 Small <20	In this study
10	Fruit Firmness	FF	Notification	Soft <16 Medium 16-20 Firm >20	A digital hand-held firmness meter fitted with a 5mm probe (HPE-II: Qualitest; www.worldoftest.com)

11	Fruit Length	FL	mm	Short 29-46 Medium 46-54 Long 54-75 Very long > 75	IPGRI and CIHEAM, 2003
12	Fruit Width	FWth	mm	Small 28-38 Medium 38-49 Large 50-60 Very large >60	IPGRI and CIHEAM, 2003
13	Fruit Neck Length	NL	mm	Absent Short <5 Medium 5-15 Long >15	IPGRI and CIHEAM, 2003
14	Fruit Neck Width	NW	mm	Small <8 Medium 8-10 Large >10	In this study
15	Fruit Stalk Length	SL	mm	Short <4 Medium 4-8 Long >8	In this study
16	Fruit Stalk Width	SW	mm	Small <4 Medium 4-5 Long >5	In this study
17	Fruit Ostiole Type	OT	Notification	Closed Semi-open Open	Fateh A, Ali F, 2009
18	Ostiole Drop	OD	Notification	Present Absent	IPGRI and CIHEAM, 2003

19	Ostiole Drop Color	ODC	Notification	Transparent Pinkish Red Dark red	IPGRI and CIHEAM, 2003
20	Fruit Ostiole Width	OW	mm	Small <1 Medium 1-3 Large 4-5 Very large >5	IPGRI and CIHEAM, 2003
21	Skin Peeling	SP	Notification	Easy Medium Difficult	IPGRI and CIHEAM, 2003
22	Fruit Internal Color	IC	Notification	Amber Rosy Rosy-red Red White-red Pink	In this study
23	Fruit Flesh Thickness	FT	mm	Small <25 Medium 25-35 Large >35	In this study
24	Pulp Texture	PT	Notification	Fine Medium Coarse	IPGRI and CIHEAM, 2003

25	Pulp Flavor	PF	Notification	Neutral Little flavor Aromatic Strong	IPGRI and CIHEAM, 2003
26	Fruit Total Soluble Solids [%]	TSS	Notification	Low 10.0-13.0 Medium 13.1-16.0 High 16.1-20.0 Very high >20.0	A digital hand-held pocket refractometer (PAL-1; Atago, Itabashi-ku, Japan) IPGRI and CIHEAM, 2003
B	**Leaf descriptors**				
27	Bud Break	BB	Notification	March 1-15 March 15-30	IPGRI and CIHEAM, 2003/Date leaves shown on 50% of the terminal buds
28	Leaf Color	LC	Notification	Light green Green Dark green	IPGRI and CIHEAM, 2003
29	Leaf Shape	LS	Notification	A B C D E F G H	IPGRI and CIHEAM, 2003

30	Leaf Lobes Number	LN	Notification	Absent Three Five Seven More than seven	IPGRI and CIHEAM, 2003
31	Leaf Venation	LV	Notification	Unapparent Slightly apparent Apparent	IPGRI and CIHEAM, 2003
32	Leaf Apex Shape	AS	Notification	Triangle Sharp Obtuse Rounded	Fateh A, Ali F, 2009
33	Leaf Counter Serration	CS	Notification	Crenate Dentate Serrate Double serrate Undulate	IPGRI and CIHEAM, 2003
34	Leaf Roughness	LR	Notification	Rough Fairly rough Smooth	Fateh A, Ali F, 2009
35	Leaf Area	LA	cm^2	Small <160 Medium 160-200 Large >200	CI-202 Leaf area meter CID, Inc., USA.

36	Limb Length	LL	mm	Short <200	In this study
				Medium 200-220	
				Long >220	
37	Limb Width	LW	mm	Small <170	In this study
				Medium 170-190	
				Large >190	
38	Lateral Sinus Deep	LSD	mm	Small <30	(ACDSee Image Management Software (ACDSee 4.0 Trial Version)
				Medium 30-50	
				Long >50 long	
39	Petiole Length	PL	mm	Short <50	IPGRI and CIHEAM, 2003
				Medium 50-80	
				Long >80	
40	Petiole Width	PW	mm	Small <5	In this study
				Medium 5-6	
				Large >6	
41	Beginning of Leaf Drop	BD	Notification	< September-30 Very early	In this study
				01 - 31 Oct Early	
				01 - 30 Nov Medium	
				01 - 31 Dec Late	
				> 01 January. Very late	

A: Base calcarate, lobes linear
B: Base cordate, five lobed, lobes spatulate
C: Base calcarate, lobes lyrate
D: Base calcarate, lobes latate
E: Base cordate, three-lobed
F: Base truncate
G: Base decurrent
H: Leaf not lobed

Table (2): Pomological descriptors of some fig genotypes grown in the southern region of West-Bank, Palestine.

	Genotype Name	Shhami	Ghzali	Biadi	Khdari	Mwazi	Swadi	Smari	Aswad	Ruzzi	Hmari	Moozi	Mouze
A	Fruit Descriptors												
1	Beginning of Ripening	Mid-season	Mid-season	Early	Early	Mid-season	Late	Late	Late	Mid-season	Mid-season	Mid-season	Mid-season
2	Full Ripening	Mid-season	Mid-season	Early	Early	Mid-season	Late	Late	Late	Mid-season	Mid-season	Mid-season	Mid-season
3	Harvest Period	Very long	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
4	External Color	Brown-green	Green-yellow	Green-yellow	Green-yellow	Green-purple	Black-purple	Black-purple	Black-purple	Green-purple	Green-purple	Green-purple	Green-purple
5	Skin Cracks	Cracked skin	Scarce longitudinal cracks	Scarce longitudinal cracks	Cracked skin	Minute	Minute	Minute	Minute	Minute	Cracked skin	Minute	Minute

12	11	10	9	8	7	6
Fruit Width	**Fruit Length**	**Fruit Firmness**	**Fruit Weight**	**Fruit Size Uniformity**	**Fruit Symmetry**	**Fruit Shape**
Medium	Medium	Soft	Medium	Uniform	Yes	Ovoid
Medium	Medium	Firm	Medium	Uniform	Yes	Ovoid
Medium	Medium	Soft	Medium	Uniform	Yes	Ovoid
Medium	Short	Medium	Medium	Uniform	Yes	Ovoid
Medium	Medium	Firm	Medium	Uniform	No	Pyriformed
Medium	Short	Firm	Medium	Uniform	Yes	Ovoid
Medium	Short	Medium	Medium	Uniform	Yes	Pyriformed
Medium	Long	Firm	Medium	Uniform	Yes	Pyriformed
Medium	Long	Firm	Medium	Uniform	No	Pyriformed
Medium	Short	Firm	Medium	Uniform	Yes	Ovoid
Small	Medium	Soft	Medium	Uniform	No	Pyriformed
Medium	Long	Firm	Large	Uniform	No	Pyriformed

20	19	18	17	16	15	14	13
Ostiole Width	**Drop Color**	**Ostiole Drop**	**Ostiole Type**	**Stalk Width**	**Stalk Length**	**Neck Width**	**Neck Length**
Very large	Pinkish	Present	Open	Long	Medium	Medium	Medium
Very large	Pinkish	Present	Closed	Long	Medium	Medium	Medium
Very large	Pinkish	Present	Open	Long	Medium	Medium	Medium
Very large	-	Absent	Open	Long	Medium	Small	Short
Very large	Transparent	Present	Open	Long	Medium	Small	Short
Very large	Transparent	Present	Open	Long	Medium	Medium	Short
Very large	Transparent	Present	Closed	Long	Short	Medium	Medium
Very large	Transparent	Present	Open	Long	Long	Large	Short
Very large	Transparent	Present	Open	Long	Medium	Large	Medium
Large	Pinkish	Present	Closed	Long	Medium	Medium	Short
Very large	Transparent	Present	Open	Medium	Medium	Small	Medium
Very large	Transparent	Present	Closed	Long	Medium	Large	Long

21	**Skin Peeling**	Easy	Difficult	Easy	Difficult	Easy	Difficult	Difficult	Easy	Easy	Easy	Easy	Easy
22	**Internal Color**	Pink	Rosy	Rosy-red	White-red	Amber	Pink	Amber	Pink	White-red	Red	White-red	White-red
23	**Flesh Thickness**	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Large	Small	Medium	Medium
24	**Pulp Texture**	Fine	Fine	Fine	Medium	Fine	Coarse	Coarse	Coarse	Fine	Fine	Fine	Fine
25	**Pulp Flavor**	Little flavor	Aromatic	Aromatic	Little flavor	Aromatic	Neutral	Neutral	Neutral	Aromatic	Little flavor	Aromatic	Aromatic
26	**TSS [%]**	High	High	Medium	High	High	High	High	Medium	Medium	Very high	High	Medium

Table (3): Morphological descriptors studied of some fig genotypes grown in the southern region of West-Bank, Palestine.

	Genotype Name	Shhami	Ghzali	Biadi	Khdari	Mwazi	Swadi	Smari	Aswad	Ruzzi	Hmari	Moozi	Mouze
B	**Leaf Descriptors**												
1	**Bud Break**	Mar 15-30	Mar 15-30	Mar 15-30	Mar 15-30	Mar 15-30	Mar 15-30	Mar 15-30	Mar 15-30	Mar 15-30	Mar 15-30	Mar 15-30	Apr 15-30
2	**Leaf Color**	Dark green	Green	Light green-green	Light green-green	Dark green	Light green	Light green	Green-dark green	Green-dark green	Green-dark green	Dark green	Dark green
3	**Leaf Shape**	B	B	B	B	B	G-H	B	G-H	B-D	B	B	B
4	**Lobes Number**	Five	Five	Five	Five	Five	Three-five	Five	Three-five	Five	Five	Five	Five
5	**Leaf Veination**	Apparent	Apparent	Apparent	Apparent	Apparent	Apparent	Apparent	Apparent	Apparent	Apparent	Apparent	Apparent
6	**Apex Shape**	Obtuse	Triangle-obtuse	Triangle-obtuse	Triangle	Triangle-obtuse	Triangle	Triangle-obtuse	Triangle	Triangle-obtuse	Obtuse	Obtuse	Triangle-obtuse

7 Counter Serration	8 Leaf Roughness	9 Leaf Area	10 Limb Length	11 Limb Width	12 Leaf Sinus	13 Petiole Length	14 Petiole Width	15 Beginning of_Leaf
Crenate	Fairly rough-rough	Small	Short	Small	Medium	Medium	Medium	Nov
Crenate	Fairly rough-rough	Small	Short	Small	Medium	Short	Small	Nov
Crenate	Fairly rough	Medium	Short	Small	Small	Medium	Small	Oct
Crenate	Fairly rough	Medium	Short	Small	Medium	Medium	Medium	Oct
Dentate-serrate	Fairly rough	Small	Short	Small	Medium	Short	Medium	Dec
Crenate	Smooth	Medium	Short	Small	Small	Short	Small	Nov
Dentate	Smooth-fairly rough	Small	Short	Small	Small	Short	Small	Nov
Crenate	Smooth	Large	Medium	Small	Small	Medium	Medium	Nov
Crenate	Fairly rough	Medium	Short	Small	Medium	Medium	Large	Dec
Crenate	Fairly rough-rough	Large	Medium	Medium	Medium	Long	Medium	Nov
Crenate	Fairly rough-rough	Medium	Short	Small	Medium	Long	Small	Dec
Crenate	Fairly rough-rough	Medium	Medium	Medium	Medium	Long	Medium	Jan

Table (4): Jaccard's distance index generated for the 12 Palestinian fig genotypes based on some pomological and morphological descriptors.

	Shhami	Ghzali	Biadi	Khdari	Mwazi	Swadi	Smari	Aswad	Ruzzi	Hmari	Moozi
Ghzali	0.712										
Biadi	0.746	0.672									
Khdari	0.794	0.779	0.698								
Mwazi	0.803	0.716	0.768	0.797							
Swadi	0.783	0.803	0.800	0.677	0.803						
Smari	0.819	0.735	0.803	0.742	0.771	0.583					
Aswad	0.786	0.853	0.803	0.863	0.806	0.651	0.735				
Ruzzi	0.735	0.757	0.735	0.765	0.597	0.789	0.792	0.701			
Hmari	0.651	0.656	0.768	0.742	0.716	0.819	0.806	0.806	0.721		
Moozi	0.723	0.783	0.779	0.809	0.623	0.831	0.800	0.783	0.534	0.708	
Mouze	0.746	0.731	0.783	0.829	0.692	0.833	0.786	0.731	0.517	0.712	0.593

Fig. (1): Dendrogram of 12 Palestinian fig genotypes constructed by UPGMA based on some pomological and morphological descriptors.