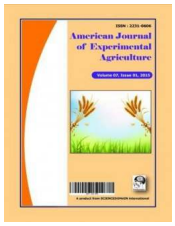

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Identification of Palestinian Colored-table-grape Cultivars by Means of Morphological and Pomological Descriptors

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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ABSTRACT

Palestine is a treasure chest of plant genetic diversity that hosts a large variety of plants including grapevines. Unfortunately, this diversity is challenged dramatically due to different biotic and abiotic stress resulted thereby in the disappearance of many local grapevine cultivars. The aim of this work was a multidisciplinary characterization, documentation and conservation of Palestinian colored-table-grapes. A detailed morphological and pomological (16 plant and leaf as well as 23 fruit) informative descriptors were used to assess genetic diversity and detect similarities and variations among 19 assumed cultivars collected from the southern region of West-Bank, Palestine. Examined different traits of plant, leaf and fruit (bunch, berry and panel) revealed various result patterns in which more than 80% of these traits presented great divergent genotypes and therefore, they could be potentially incorporated to both local and regional breeding programs. Based on the UBGMA Jaccard's similarity index and the constructed dendrogram, distinguishable genotypes as well as some cases of synonymies and homonymies clearly exist. A synonymy case seemed to be in two genotype-pairs which indeed showed genetic distances of less than 0.32 and 0.35 suggesting their close relatedness (possibly genetically identical). In addition, homonym cases also occur in the

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following pairs of "Halawani, Betuni's, Fhesi, Roomi's and Shami's genotypes, in which each pair seems to be two distinctive genotypes. Based on our similarity results, number of local colored-table-grape genotypes might reduce which thereby, saving time and efforts for any future breeding program.

Keywords: Table grapes; diversity; UPGMA; similarities; variations.

1. INTRODUCTION

Grape (*Vitis vinifera* L.) is one of the most ancient horticultural crops worldwide. Its domestication for food and drink is an event of tremendous cultural and economic importance [1]. The world vineyards reached a total area surface of 7.5 million hectares hence, the number of the world cultivars exceeds 13,000 representing relatively large grape diversity [2]. Due to the continuous selection of performing cultivars as well as different biotic and abiotic stresses, especially the climate change where temperature and drought is dramatically increased, severe genetic erosion for grape germplasm heritage occurred. To safeguard the still existing diversity and to promote its description and documentation, some international actions were undertaken mainly in Europe (e.g. the European Grape-Gen06 project) for the purpose of establishing a promising reservoir of biotic (drought, salinity, etc) and abiotic (insect and pathogen resistance, etc) resistance genes or of new qualitative traits [3-4].

In Palestine, the situation is even worse since many of our local cultivars had already dis-appeared. In addition to that, grape culture is still consisting of local and old cultivars (landraces), for which a large number of homonymous and synonymous designations, as well as the occurrence of cultivars misnaming may exist [5]. In fact, names of these cultivars have been traditionally given on the basis of several traits such as fruit skin color, local geographical origin, names of the vineyard owner, and cluster shape. Therefore, cultivars identification and description is an essential stage in the certification program, guaranteeing the trueness-to-type of the propagation materials, germplasm improvement and conservation, and monitoring of the genetic quality [6-7].

Despite the importance, accuracy, and efficiency of the molecular markers for varietal identification [8], methods based on morphological and pomological traits 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 [9].

The aim of this work was a multidisciplinary characterization and conservation of Palestinian colored-table-grapes using morphological and pomological descriptors.

2. MATERIALS AND METHODS

Nineteen colored-table-grapevine assumed genotypes were surveyed throughout West-Bank, Palestine (Table 1). From each assumed genotype (biotype), random samples of 15 adult leaves and 9 mature grape clusters were collected from three adult plants per assumed genotype. Sixteen leaf morphological and 23 grape fruit (bunch, berry, panel) descriptors or traits (Tables 1-4) were determined according to the grape descriptors [10], with some minor modifications that showed high discrimination values.

Each descriptor (from the 39 quantitative and qualitative traits) 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" [11] and the Tree view software (Win32, version 1.6.6).

3. RESULTS

3.1 Plant and Leaf Parameters

As shown in Tables 1 and 2, examined plant and leaf traits (descriptors) revealed various result patterns. Bud break of five genotypes was observed on March 20; eight on April 1st, and five on May 1st. Among all genotypes tested, anthocyanin coloration of main veins on upper side of blade ranged from absent to very weak, blade shape was either wedge-shaped or circular, number of lobes was always more than seven, size of blade fluctuated from very small (Sheukhi and Mtartash) to very large (Shabeh-El-Betoni and Roomi-Aswad-Habe-Tawela), leaf area was small, medium, or large (except for Roomi-Aswad-Habe-Tawela which presented

very large leaf areas), density of hairs between veins extended from absent to very dense, length of petiole compared to middle vein was slightly or much shorter with the exception of Halawani-Baladi-Mrazraz genotype which reveled slightly longer length, shape of the upper lateral sinus presented either slightly or strongly overlapping lobes. Depth of upper lateral sinus of four genotypes was very shallow, seven was shallow, six was medium, however, the reminder two genotypes were deep (Baluti) and very deep (Shabeh-El-Betoni).

The majority of the examined genotypes exhibited half-open shape of petiole sinus; however, Mtartash genotype revealed strongly overlapping lobes. The general shape of petiole sinus as well as sinus limited by veins variables were constantly absent, shape of teeth was mixture of both sides straightened both side convex, length of teeth was very small (4 genotypes), small (7 genotypes); medium (4 genotypes), large (3 genotypes), whereas Shabeh-El-Betoni genotype exceptionally revealed very large length of teeth. Finally, the ratio of length to width of teeth were very small (6 genotypes), small (3 genotypes), medium (6 genotypes), and large (4 genotypes).

3.2 Fruit Parameters

Regarding fruit traits, significant results were also presented as shown in Tables 3, 4 and 5. For all examined genotypes, bunch size generally ranged from small to large with the exception of Sheukhi and Halawani-Habe-Kabera genotypes which presented very small and very large bunch sizes respectively. Almost similar trend goes also with bunch length parameter. The length of the peduncle was very short to very long; bunch density was always very loose with the exception with Sheukhi genotype which revealed medium density. Single bunch weight was medium (5 genotypes) to very high (Halawani-Habe-Kabera); however the reminder genotypes were high.

For the different berry descriptors, most studied genotypes were categorized as early, medium and late ripened (maturated) ones except with Sheukhi genotype (very early) and Shami-Mtartash as well as Halawani-Baladi-Mrazraz (very late).

Skin color, berry shape, peduncle length, firmness of flesh, single berry weight, and ease of detachment of berries from peduncle presented a wide range of variation.

Anthocyanin coloration of flesh mostly very slightly colored with the exception of only two (Sheukhi and Darawishi) genotypes (slightly colored); presence of seeds was constantly well developed;

Descriptors of seed length, 100-seeds weight, juiciness, must yield, sugar content of must, firmness, crashness and sweetness showed a wide range of deviation.

3.3 Dendrogram of Relatedness among Colored-table-grape Genotypes

The similarity indexes (Table 6) were used to build a dendrogram by means of UPGMA analysis in order to determine the cluster of the genotypes (Fig. 1). As shown in the dendrogram, grapevine genotypes were classified into five clusters. The first cluster (I) was composed of four genotypes “Mtartash and Halawani-Baladi-Mrazraz” related to “Shami-Mtartash and Roomi-Aswad”. The second cluster (II) consisted of Roomi-Aswad-Habe-Tawela and Halawani associated with Halawani-Habe-Kabera. The third cluster (III) contained six genotypes including “Shami-Aswad and Shami” related to Betoni in which the three of them were linked to “Fhesi and Mtartash-Fhesi” as well as Shabeh-El-Betoni. The fourth cluster (V) consists of Darawishi and Baluti related to Halawani-Red-Club genotype. The fifth cluster (VI) composed of Dabuki-Aswad-Baladi and Aswad-Baladi associated to Sheukhi genotype.

Genetic distances ranged from 0.32 to 0.87 with a mean of 0.595 (Table 6). The most closely related genotypes were “Aswad-Baladi and Dabuki-Aswad-Baladi” followed by “Shami and Shami-Aswad”. On the contrary, the most distant genotypes were “Sheukhi and Mtartash-Fhesi” followed by “Sheukhi and Halawani-Habe-Kabera”.

4. DISCUSSION

Palestine is a treasure chest of plant genetic diversity that hosts a large variety of plants including grapevines. Unfortunately, this diversity is challenged dramatically due to different biotic and abiotic stress resulted thereby in the disappearance of many local grapevine cultivars. Moreover, the possibility of vegetative propagation and the intense movement of grape material between countries and has led to the diffusion numerous genetically identical copies of a specific and accordingly resulted in a great

Table 1. Plant and leaf descriptors (group-I: bud, anthocyanin, blade, lobes, leaf area, and hairs) of colored-table-grape cultivars

	Genotype name	Bud break	Anthocyanin coloration of main veins on upper side of blade	Shape of blade	Size of blade (cm2)	Leaf area
1	Sheukhi	20-Mar	Very weak	Wedge-shaped	Very small	Small
2	Shabeh-El-Betoni	01-Apr	Weak	Circular	Very Large	Large
3	Betoni	20-Mar	Very weak	Circular	Medium	Small
4	Mtartash-Fhesi	01-Apr	Medium	Circular	Large	Large
5	Halawani	01-Apr	Absent	Wedge-shaped	Small	Medium
6	Shami	20-Mar	Very weak	Wedge-shaped	Medium	Small
7	Mtartash	01-Apr	Absent	Circular	Very Small	Small
8	Fhesi	01-Apr	Weak	Circular	Medium	Medium
9	Baluti	01-May	Absent	Wedge-shaped	Medium	Small
10	Darawishi	01-May	Absent	Wedge-shaped	Medium	Large
11	Shami-Mtartash	20-Mar	Weak	Wedge-shaped	Small	Small
12	Halawani-Baladi-Mrazraz	01-Apr	Absent	Wedge-shaped	Small	Small
13	Shami-Aswad	20-Mar	Weak	Wedge-shaped	Medium	Small
14	Roomi-Aswad	01-May	Very weak	Wedge-shaped	Small	Small
15	Halawani- Red-Club	01-Apr	Weak	Wedge-shaped	Large	Medium
16	Aswad-Baladi	01-May	Medium	Wedge-shaped	Small	Small
17	Dabuki-Aswad-Baladi	01-May	Weak	Wedge-shaped	Small	Large
18	Halawani-Habe-Kabera	01-Apr	Weak	Wedge-shaped	Large	Large
19	Roomi-Aswad-Haba-Tawela	01-May	Weak	Wedge-shaped	Very large	Very large

genetic variability in germplasm that often allowed misidentification and cases of homonymy and synonymy [12].

Here, we reported a detailed morphological and pomological characterization as an important step to assess the genetic diversity among nineteen colored-table-grapes collected from the southern region of West-Bank for the purpose of documentation and conservation. Interestingly, more than 80% of the examined thirty-nine informative and economical traits presented satisfactory divergent genotypes and therefore, could be potentially incorporated to any future breeding programs [13-14].

At the plant and leaf levels (Tables 1, 2), except from three parameters (petiole sinus, tooth at petiole sinus, and shape of teeth), that were found to be constant, considerable variation among the reminder genotypes might be highly effective to differentiate and discriminate among the colored-table-grape genotypes. For example, the presence of dense hairs in the leaves of some cultivars might be attributed to the harsh conditions (long warm and dry climate in summer) which currently characterize the region. This criterion could be anticipated as a promising trait for any future breeding program, especially with respect to climate change. Similar results were also found with olive trees in which hairs found to be interpreted not only as a mechanical protection against biotic factors [15], but also as an additional retardation element in gas diffusion pathway [16], that indeed affects water loss by creating a zone of still air which reduces diffusion of water vapor from leaf interior to atmosphere [17]. Hairs also reflect radiation and reduce its absorption resulting thus in the reduction of leaf heating and consequently of leaf transpiration [18].

Table 2. Leaf descriptors (group-II: petiole-sinus-teeth) of colored-table-grape cultivars

	Genotype name	Length of petiole compared to middle vein	Shape of upper lateral sinus	Depth of upper lateral sinus	General shape of petiole sinus	Shape of teeth	Length of teeth	Ratio length to width of teeth
1	Sheukhi	Much shorter	Slightly overlapping	Medium	Half open	1	Small	Medium
2	Shabeh-El-Betoni	Much shorter	Slightly overlapping	Very deep	Slightly overlapping	1	Very large	Large
3	Betoni	Much shorter	Slightly overlapping,	Shallow	Half overlapping	1	Small	Medium
4	Mtartash-Fhesi	Much shorter	Strongly overlapping	Medium	Half open	1	Medium	Medium
5	Halawani	Slightly shorter	Strongly overlapping	Shallow	Half open	1	Very small	Very small
6	Shami	Much shorter	Slightly overlapping	Shallow	Half open	1	Small	Small
7	Mtartash	Much shorter	Slightly overlapping	Very shallow	Strongly overlapping	1	Very small	Very small
8	Fhesi	Much shorter	Slightly overlapping	Shallow	Half overlapping	1	Small	Small
9	Baluti	Much shorter	Strongly overlapping	Deep	Half open	1	Large	Large
10	Darawishi	Slightly shorter	Slightly overlapping	Medium	Half open	1	Small	Small
11	Shami-Mtartash	Much shorter	Strongly overlapping	Shallow	Half open	1	Small	Medium
12	Halawani-Baladi-Mrazraz	Slightly longer	Strongly overlapping	Very shallow	Half open	1	Very small	Very small
13	Shami-Aswad	Much shorter	Strongly overlapping	Shallow	Half open	1	Medium	Large
14	Roomi-Aswad	Much shorter	Lobes slightly overlapping	Medium	Half open	1	Very small	Large
15	Halawani- Red-Club	Slightly shorter	Strongly overlapping	Very shallow	Half open	1	Very small	Very small
16	Aswad-Baladi	Much shorter	Slightly overlapping	Medium	Half open	1	Large	Medium
17	Dabuki-Aswad-Baladi	Much shorter	Slightly overlapping	Medium	Half open	1	Large	Medium
18	Halawani-Habe-Kabera	Slightly shorter	Strongly overlapping	Very shallow	Half open	1	Medium	Very small
19	Roomi-Aswad-Haba-Tawela	Much shorter	Strongly overlapping	Shallow	Half open	1	Small	Very small

(1): Mixture of both sides straightand both sides convex

At the fruit level (Tables 3-5), a great diversity of bunch, berry, and panel parameters exhibited in our examined genotypes could be also potentially incorporated to both local and regional breeding programs. Such a high degree of variations in fruit characteristics could be utilized to interest farmers in diversifying grape genotypes, increasing grape production, stimulating attraction of consumers for fresh fruit consumption, and enhancing grape exporting. For example, the three genotypes which remarkably present very early and very late ripening time could be a useful source for future breeding program targeting early-late harvest. Similar results also reported by [19].

According to UPGMA Jaccard's similarity index above (Table 6) and the constructed dendrogram of these morphological and pomological data (Fig 1), some cases of synonymies and homonymies clearly exists. A synonymy cases seems to exist between Aswad-Baladi and Dabuki-Aswad-Baladi genotypes as well as between Shami and Shami-Aswad genotypes which showed genetic distances of less than 0.32 and 0.35, respectively, suggesting their close relatedness,

and possibly might be genetically identical, but with different local names. Similar studies were also reported in many Mediterranean countries that clearly showed the existence of confusion in grapevine nomenclature, such as Turkey [20], Tunisia [21] and Egypt [22]. On the other hand, homonym cases also occur in the following pairs of "Halawani, Betuni's, Fhesi, Roomi's and Shami's genotypes, in which each pair seems to be two distinctive genotypes (Table 6, Fig. 1). The occurrence of these cases might relate to the environmental influences on the expression of several phenotypic traits [23], as a mechanism of adaptation to local environmental conditions [24]. In addition, grapevine cultivars are often spread via vegetative propagation and this usually leads to the diffusion of numerous genetically identical copies of a specific plants. During this process, somatic mutation could occur and this results in a plant characterized by unique genomic traits that could lead to a unique phenotype [12].

Based on our similarity results, a number of local colored-table-grape genotypes might decrease, which, thereby, will save time and efforts for any future breeding program.

Table 3. Fruit (group-1: bunch and panel) descriptors of colored-table-grape cultivars

	Genotype name	Bunch size (cm2)	Bunch length (cm)	Length of peduncle (cm)	Density	Single bunch weight (g)	Firm-ness	Crah-ness	Sweet-ness
1	Sheukhi	Very small	Very short	Very short	Medium	Medium	Medium	High	High
2	Shabeh-El-Betoni	Medium	Intermediate	Very short	Very loose	High	Firm	High	High
3	Betoni	Medium	Intermediate	Long	Very loose	High	Firm	High	Very high
4	Mtartash-Fhesi	Large	Intermediate	Short	Very loose	High	Firm	High	Medium
5	Halawani	Large	Long	Medium	Very loose	High	Very firm	Very high	High
6	Shami	Large	Long	Long	Very loose	High	Firm	Small	Medium
7	Mtartash	Small	Short	Short	Very loose	Medium	Firm	High	Low
8	Fhesi	Large	Very long	Very long	Very loose	High	Firm	High	Very low
9	Baluti	Large	Long	Short	Very loose	High	Firm	High	high
10	Darawishi	Medium	Intermediate	Medium	Very loose	High	Firm	High	high
11	Shami-Mtartash	Medium	Short	Medium	Very loose	High	Firm	Mediu m	Low
12	Halawani-Baladi-Mrazraz	Small	Short	Short	Very dense	High	Medium	Small	Low
13	Shami-Aswad	Medium	Intermediate	Long	Very loose	High	Medium	Small	Medium
14	Roomi-Aswad	Medium	Intermediate	Medium	Very loose	High	Firm	Mediu m	Medium
15	Halawani-Red-Club	Large	Intermediate	Very long	Very loose	High	Firm	Mediu m	High
16	Aswad-Baladi	Medium	Intermediate	Very short	Very loose	Medium	Medium	Mediu m	High
17	Dabuki-Aswad-Baladi	Medium	Intermediate	Very short	Very loose	Medium	Medium	High	Very high
18	Halawani-Habe-Kabera	Very large	Long	Very short	Very loose	Very high	Very firm	Very high	High
19	Roomi-Aswad-Haba-Tawela	Small	Short	Short	Very loose	Medium	Very firm	Very high	High

Table 4. Some fruit descriptors (group-II) of colored-table-grape cultivars

	Genotype name	Time of berry ripening	Skin color	Berry size (mm^2)	Berry shape	Pedicel length (mm)	Firmness of flesh	Single berry weight (g)	Ease of detachment from pedicle	Anthocyanin coloration of flesh
1	Sheukhi	Very early (<15/8)	Blue-black	Medium	Ovate	Intermediate	Medium	Medium	Very easy	Slightly colored
2	Shabeh-El-Betoni	Medium (15/9-15/10)	Brown	Medium	Ovate	Long	Firm	Medium	Slightly easy	Very slightly colored
3	Betoni	Medium (15/9-15/10)	Blue-black	Small	Round	Short	Firm	Medium	Difficult	Very slightly colored
4	Mtartash-Fhesi	Late (15/10-15/11)	Radish-green	Large	Round	Short	Firm	High	Difficult	Very slightly colored
5	Halawani	Late (15/10-15/11)	Red	Very large	Round	Short	Firm	High	Slightly easy	Very slightly colored
6	Shami	Late (15/10-15/11)	Blue-black	Very large	Round	Intermediate	Firm	High	Difficult	Very slightly colored
7	Mtartash	Late (15/10-15/11)	Dark red-violet	Small	Obovate	Short	Firm	High	Difficult	Very slightly colored
8	Fhesi	Late (15/10-15/11)	Green-yellow	Large	Round	Short	Firm	High	Slightly easy	Very slightly colored
9	Baluti	Late (15/10-15/11)	Dark red-violet	Large	Elliptic	Short	Firm	High	Very easy	Very slightly colored
10	Darawishi	Late (15/10-15/11)	Dark red-violet	Very large	Elliptic	Short	Firm	High	Very easy	Slightly colored
11	Shami-Mtartash	Very late (15/11)	Greenish-black	Very large	Ovate	Intermediate	Firm	High	Difficult	Very slightly colored
12	Halawani-Baladi-Mrazraz	Very late (15/11)	Rose	Small	Round	Short	Medium	High	Difficult	Very slightly colored
13	Shami-Aswad	Late (15/10-15/11)	Blue-black	Large	Round	Intermediate	Medium	High	Difficult	Very slightly colored
14	Roomi-Aswad	Medium (15/9-15/10)	Dark red-violet	Medium	Narrow elliptic	Intermediate	Firm	High	Slightly easy	Very slightly colored
15	Halawani-Red-Club	Late (15/10-15/11)	Dark red-violet	Very large	Round	Intermediate	Firm	Very high	Difficult	Very slightly colored
16	Aswad-Baladi	Early (15/8-15/9)	Blue-black	Very small	Elliptic	Intermediate	Medium	Medium	very easy	Very slightly colored
17	Dabuki-Aswad-Baladi	Early (15/8-15/9)	Blue-black	Very small	Elliptic-obovate	Short	Soft	Medium	Very easy	Very slightly colored

18	Halawani-Habe-Kabera	Late (15/10-15/11)	Rose	Very large	Round-oblate	Intermediate	Firm	Very high	Slightly easy	Very slightly colored
19	Roomi-Aswad-Haba-Tawela	Medium (15/9-15/10)	Blue-black	Large	Obtuse-ovate	Intermediate	Medium	High	Difficult	Very slightly colored

Table 5. Fruit (group-III: berry) descriptors of colored-table-grape cultivars

	Genotype Name	Presence of seeds	Seed length (mm)	100 seed weight (g)	Juiciness	Must yield (ml)	Sugar content of must %
1	Sheukhi	Well developed	Medium	Very low	Slightly juicy	Medium	High
2	Shabeh-El-Betoni	Well developed	Medium	Low	Slightly juicy	High	High
3	Betoni	Well developed	Short	Low	Slightly juicy	High	High
4	Mtartash-Fhesi	Well developed	Medium	Very low	Very slightly	High	Low
5	Halawani	Well developed	Medium	Very low	Slightly juicy	High	Low
6	Shami	Well developed	Short	Low	Slightly juicy	High	Medium
7	Mtartash	Well developed	Medium	Low	Slightly juicy	Medium	Low
8	Fhesi	Well developed	Medium	Very low	Slightly juicy	High	Low
9	Baluti	Well developed	Medium	Medium	Very juicy	High	Low
10	Darawishi	Well developed	Long	Medium	Very Juicy	Medium	Low
11	Shami-Mtartash	Well developed	Medium	Low	Slightly juicy	High	Low
12	Halawani-Baladi-Mrazraz	Well developed	Medium	Low	Slightly juicy	High	Low
13	Shami-Aswad	Well developed	Short	Low	Slightly juicy	High	Low
14	Roomi-Aswad	Well developed	Medium	Low	Very slightly juicy	High	Low
15	Halawani- Red-Club	Well developed	Long	Medium	Very slightly juicy	Very high	Low
16	Aswad-Baladi	Well developed	Short	Low	Very juicy	High	Medium
17	Dabuki-Aswad-Baladi	Well developed	Short	Very low	Slightly juicy	High	High
18	Halawani-Habe-Kabera	Well developed	Long	Low	Very slightly juicy	High	Low
19	Roomi-Aswad-Haba-Tawela	Well developed	Medium	Medium	Very slightly juicy	High	Medium

Table 6. Jaccard's distance index generated for the 19 colored-table-grape genotypes

	Sheukhi	Shabeh-El-Betoni	Betoni	Mtartash-Fhesi	Halawani	Shami	Mtartash	Fhesi	Baluti	Darawishi	Shami-Mtartash	Halawani-Baladi-Mrazraz	Shami-Aswad	Roomi-Aswad	Halawani-Red-Club	Aswad-Baladi	Dabuki-Aswad-Baladi	Halawani-Habe-Kabera
Shabeh-El-Betoni	0.76																	
Betoni	0.76	0.62																
Mtartash-Fhesi	0.85	0.66	0.56															
Halawani	0.82	0.73	0.61	0.66														
Shami	0.74	0.73	0.54	0.70	0.63													
Mtartash	0.72	0.73	0.70	0.68	0.70	0.72												
Fhesi	0.80	0.63	0.60	0.57	0.69	0.60	0.64											
Baluti	0.78	0.75	0.67	0.62	0.60	0.71	0.71	0.76										
Darawishi	0.72	0.79	0.75	0.68	0.64	0.73	0.75	0.75	0.55									
Shami-Mtartash	0.74	0.68	0.64	0.70	0.63	0.56	0.68	0.64	0.71	0.75								
Halawani-Baladi-Mrazraz	0.82	0.75	0.73	0.73	0.59	0.68	0.59	0.73	0.73	0.84	0.59							
Shami-Aswad	0.72	0.71	0.55	0.66	0.61	0.35	0.75	0.67	0.65	0.77	0.56	0.67						
Roomi-Aswad	0.72	0.68	0.70	0.68	0.63	0.66	0.68	0.71	0.67	0.68	0.56	0.70	0.61					
Halawani-Red-Club	0.85	0.75	0.73	0.68	0.71	0.73	0.78	0.73	0.71	0.67	0.72	0.79	0.73	0.72				
Aswad-Baladi	0.60	0.70	0.70	0.76	0.76	0.68	0.78	0.81	0.71	0.73	0.63	0.75	0.64	0.66	0.75			
Dabuki-Aswad-Baladi	0.61	0.75	0.67	0.77	0.78	0.73	0.75	0.79	0.73	0.75	0.68	0.75	0.71	0.75	0.85	0.32		
Halawani-Habe-Kabera	0.87	0.79	0.77	0.68	0.54	0.75	0.77	0.79	0.69	0.75	0.73	0.69	0.71	0.77	0.71	0.80	0.84	
Roomi-Aswad-Haba-Tawela	0.74	0.73	0.75	0.72	0.63	0.68	0.72	0.77	0.67	0.75	0.66	0.68	0.68	0.68	0.75	0.70	0.78	0.68

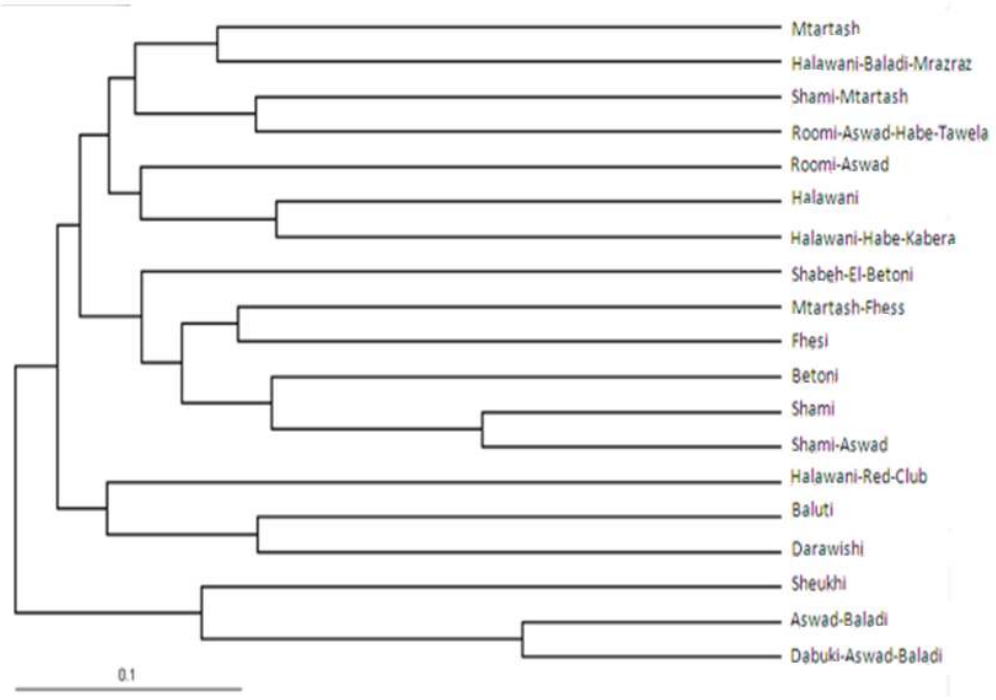

Fig. 1. Dendrogram of 19 colored-table-grape genotypes constructed by UPGMA based on different morphological and pomological descriptors

5. CONCLUSIONS

Morphological and pomological results proved to be very useful in characterizing and creating the first reference and catalogue of each considered local Palestinian colored-table-grape genotype and therefore, could be potentially incorporated to both local and regional breeding programs. The obtained synonymy cases might reduce the number of the local genotypes which thereby, saving time and efforts for any future breeding program.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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