

# **Original Research Article**

## Identification of Palestinian colored-table-grape cultivars by means of morphological and pomological descriptors

### **ABSTRACT (ARIAL, BOLD, 11 FONT, LEFT ALIGNED, CAPS)**

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 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 disappeared. 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. MATERIAL 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, 2, 3, 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

### 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 1<sup>st</sup>, and five on May 1<sup>st</sup>. 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 revealed 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).

#### **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.

#### **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 (Figure 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".

**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 (cm <sup>2</sup> ) | 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  | <b>Mtartash-Fhesi</b>          | 01-Apr | Medium    | Circular     | Large      | Large      |
| 5  | <b>Halawani</b>                | 01-Apr | Absent    | Wedge-shaped | Small      | Medium     |
| 6  | <b>Shami</b>                   | 20-Mar | Very weak | Wedge-shaped | Medium     | Small      |
| 7  | <b>Mtartash</b>                | 01-Apr | Absent    | Circular     | Very Small | Small      |
| 8  | <b>Fhesi</b>                   | 01-Apr | Weak      | Circular     | Medium     | Medium     |
| 9  | <b>Baluti</b>                  | 01-May | Absent    | Wedge-shaped | Medium     | Small      |
| 10 | <b>Darawishi</b>               | 01-May | Absent    | Wedge-shaped | Medium     | Large      |
| 11 | <b>Shami-Mtartash</b>          | 20-Mar | Weak      | Wedge-shaped | Small      | Small      |
| 12 | <b>Halawani-Baladi-Mrazraz</b> | 01-Apr | Absent    | Wedge-shaped | Small      | Small      |
| 13 | <b>Shami-Aswad</b>             | 20-Mar | Weak      | Wedge-shaped | Medium     | Small      |
| 14 | <b>Roomi-Aswad</b>             | 01-May | Very weak | Wedge-shaped | Small      | Small      |
| 15 | <b>Halawani- Red-Club</b>      | 01-Apr | Weak      | Wedge-shaped | Large      | Medium     |
| 16 | <b>Aswad-Baladi</b>            | 01-May | Medium    | Wedge-shaped | Small      | Small      |
| 17 | <b>Dabuki-Aswad-Baladi</b>     | 01-May | Weak      | Wedge-shaped | Small      | Large      |
| 18 | <b>Halawani-Habe-Kabera</b>    | 01-Apr | Weak      | Wedge-shaped | Large      | Large      |
| 19 | <b>Roomi-Aswad-Haba-Tawela</b> | 01-May | Weak      | Wedge-shaped | Very large | Very large |

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

|   | <b>Genotype name</b>    | <b>Length of petiole compared to middle vein</b> | <b>Shape of upper lateral sinus</b> | <b>Depth of upper lateral sinus</b> | <b>General shape of petiole sinus</b> | <b>Shape of teeth</b> | <b>Length of teeth</b> | <b>Ratio length to width of teeth</b> |
|---|-------------------------|--------------------------------------------------|-------------------------------------|-------------------------------------|---------------------------------------|-----------------------|------------------------|---------------------------------------|
| 1 | <b>Sheukhi</b>          | Much shorter                                     | Slightly overlapping                | Medium                              | Half open                             | 1                     | Small                  | Medium                                |
| 2 | <b>Shabeh-El-Betoni</b> | Much shorter                                     | Slightly overlapping                | Very deep                           | Slightly overlapping                  | 1                     | Very large             | Large                                 |
| 3 | <b>Betoni</b>           | Much shorter                                     | Slightly overlapping,               | Shallow                             | Half overlapping                      | 1                     | Small                  | Medium                                |
| 4 | <b>Mtartash-Fhesi</b>   | Much shorter                                     | Strongly overlapping                | Medium                              | Half open                             | 1                     | Medium                 | Medium                                |
| 5 | <b>Halawani</b>         | Slightly                                         | Strongly                            | Shallow                             | Half open                             | 1                     | Very                   | Very                                  |

|    |                                |                  |                            |              |                      |   |            |            |
|----|--------------------------------|------------------|----------------------------|--------------|----------------------|---|------------|------------|
|    |                                | shorter          | overlapping                |              |                      |   | small      | small      |
| 6  | <b>Shami</b>                   | Much shorter     | Slightly overlapping       | Shallow      | Half open            | 1 | Small      | Small      |
| 7  | <b>Mtartash</b>                | Much shorter     | Slightly overlapping       | Very shallow | Strongly overlapping | 1 | Very small | Very small |
| 8  | <b>Fhesi</b>                   | Much shorter     | Slightly overlapping       | Shallow      | Half overlapping     | 1 | Small      | Small      |
| 9  | <b>Baluti</b>                  | Much shorter     | Strongly overlapping       | Deep         | Half open            | 1 | Large      | Large      |
| 10 | <b>Darawishi</b>               | Slightly shorter | Slightly overlapping       | Medium       | Half open            | 1 | Small      | Small      |
| 11 | <b>Shami-Mtartash</b>          | Much shorter     | Strongly overlapping       | Shallow      | Half open            | 1 | Small      | Medium     |
| 12 | <b>Halawani-Baladi-Mrazraz</b> | Slightly longer  | Strongly overlapping       | Very shallow | Half open            | 1 | Very small | Very small |
| 13 | <b>Shami-Aswad</b>             | Much shorter     | Strongly overlapping       | Shallow      | Half open            | 1 | Medium     | Large      |
| 14 | <b>Roomi-Aswad</b>             | Much shorter     | Lobes slightly overlapping | Medium       | Half open            | 1 | Very small | Large      |
| 15 | <b>Halawani- Red-Club</b>      | Slightly shorter | Strongly overlapping       | Very shallow | Half open            | 1 | Very small | Very small |
| 16 | <b>Aswad-Baladi</b>            | Much shorter     | Slightly overlapping       | Medium       | Half open            | 1 | Large      | Medium     |
| 17 | <b>Dabuki-Aswad-Baladi</b>     | Much shorter     | Slightly overlapping       | Medium       | Half open            | 1 | Large      | Medium     |
| 18 | <b>Halawani-Habe-Kabera</b>    | Slightly shorter | Strongly overlapping       | Very shallow | Half open            | 1 | Medium     | Very small |
| 19 | <b>Roomi-Aswad-Haba-Tawela</b> | Much shorter     | Strongly overlapping       | Shallow      | Half open            | 1 | Small      | Very small |

(1): Mixture of both sides straight and both sides convex

#### 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 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].

At the fruit level (Tables 3, 4, 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].

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

|    | Genotype name           | Bunch size (cm <sup>2</sup> ) | Bunch length (cm) | Length of peduncle (cm) | Density    | Single bunch weight (g) | Firmness  | Crahnness | Sweetness |
|----|-------------------------|-------------------------------|-------------------|-------------------------|------------|-------------------------|-----------|-----------|-----------|
| 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      | Medium    | 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      | Medium    | Medium    |

|    |                                |            |              |            |            |           |           |           |           |
|----|--------------------------------|------------|--------------|------------|------------|-----------|-----------|-----------|-----------|
| 15 | <b>Halawani- Red-Club</b>      | Large      | Intermediate | Very long  | Very loose | High      | Firm      | Medium    | High      |
| 16 | <b>Aswad-Baladi</b>            | Medium     | Intermediate | Very short | Very loose | Medium    | Medium    | Medium    | High      |
| 17 | <b>Dabuki-Aswad-Baladi</b>     | Medium     | Intermediate | Very short | Very loose | Medium    | Medium    | High      | Very high |
| 18 | <b>Halawani-Habe-Kabera</b>    | Very large | Long         | Very short | Very loose | Very high | Very firm | Very high | High      |
| 19 | <b>Roomi-Aswad-Haba-Tawela</b> | Small      | Short        | Short      | Very loose | Medium    | Very firm | Very high | High      |

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

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

|    |                                |                     |            |            |               |               |        |           |               |                       |
|----|--------------------------------|---------------------|------------|------------|---------------|---------------|--------|-----------|---------------|-----------------------|
|    | <b>Baladi</b>                  |                     |            |            |               |               |        |           |               |                       |
| 18 | <b>Halawani-Habe-Kabera</b>    | Late (15/10-15/11)  | Rose       | Very large | Round-obl ate | Intermedi ate | Firm   | Very high | Slightly easy | Very slightly colored |
| 19 | <b>Roomi-Aswad-Haba-Tawela</b> | Medium (15/9-15/10) | Blue-black | Large      | Obtuse-ovate  | Intermedi ate | Medium | High      | Difficult     | Very slightly colored |

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

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

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182 According to **UPGMA** Jaccard's similarity index (Table 6) and the constructed dendrogram of  
183 these morphological and pomological data (Fig 1), some cases of synonymies and  
184 homonymies clearly exists. A synonymy cases seems **to exist** between Aswad-Baladi and  
185 Dabuki-Aswad-Baladi genotypes as well as between Shami and Shami-Aswad genotypes  
186 which showed genetic distances of less than 0.32 and 0.35, respectively, suggesting their  
187 close relatedness, and possibly might be genetically identical, but with different local names.  
188 Similar studies were also reported in many Mediterranean countries that clearly showed the  
189 existence of confusion in grapevine nomenclature, such as Turkey [20], Tunisia [21] and  
190 Egypt [22]. On the other hand, homonym cases also occur in the following pairs of  
191 "Halawani, Betuni's, Fhesi, Roomi's and Shami's genotypes, in which each pair seems to be  
192 two distinctive genotypes (Table 6, Fig. 1). The occurrence of these cases might relate to the  
193 environmental influences on the expression of several phenotypic traits [23], as a  
194 mechanism of adaptation to local environmental conditions [24]. In addition, grapevine  
195 cultivars are often spread via vegetative propagation and this usually leads to the diffusion of  
196 numerous genetically identical copies of a specific plants. During this process, somatic  
197 mutation could occur and this results in a plant characterized by unique genomic traits that  
198 could lead to a unique phenotype [12].

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

201

**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-           | 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        |                   |              |                     |                      |

| Club                    |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|-------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 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 |

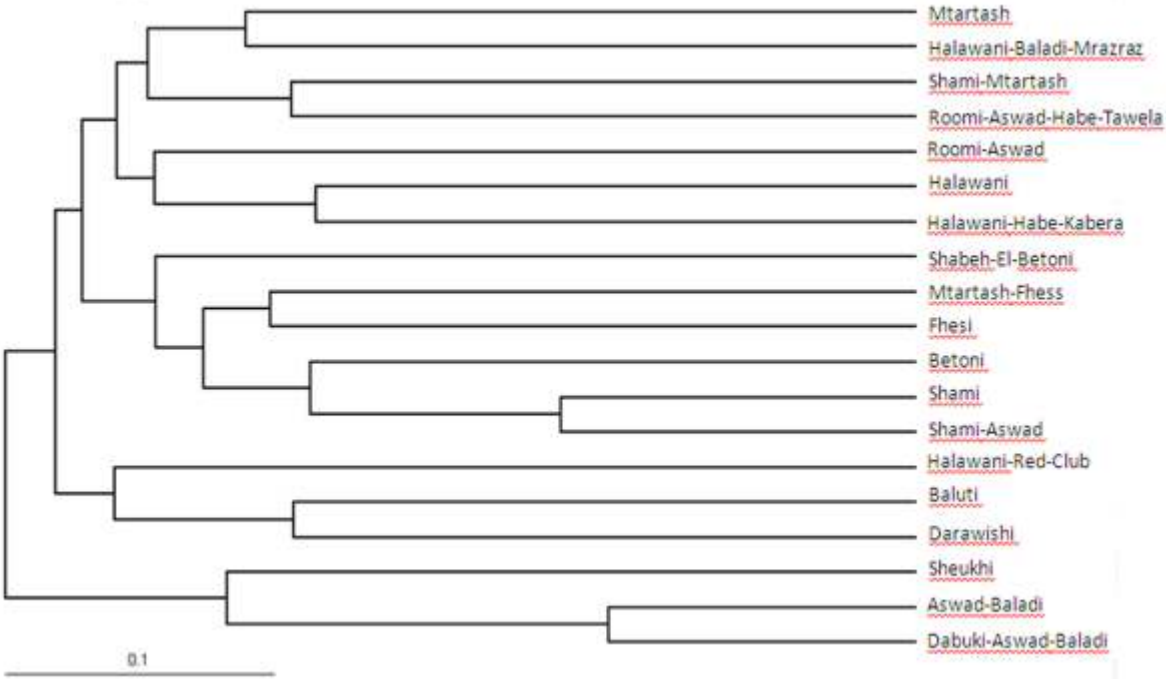


**Fig. 1: Dendrogram of 19 colored-table-grape genotypes constructed by UPGMA based on different morphological and pomological descriptors.**

### 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.

### REFERENCES

1. Schaal B, Beck J, Hsu SC, Beridze T, Gamkrelidze M, Gogniashvili M, Pipia I, Tabidze V, This P, Bacilieri R, Gotsiridze V, Glonti M.. Plastid DNA sequence diversity in a worldwide set of grapevine cultivars (*Vitis vinifera* L. subsp. *vinifera*). Proceeding of the 10th International Conference on Grapevine Breeding and Genetics, Geneva, New York, USA, 2010.
2. OIV. International Organization of Vine and Wine. Statistical report on world Viti-Vini-Culture, 2013.

- 224 3. Katula-Debreceni D, Szöke A, Veres A, Heszky L, Kiss E. Management and  
225 conservation of grapevine genetic resources and the Grape-Gen-06 project.  
226 Hungarian Agri. Research, 2010; P. 9-12.
- 227 4. Lacombe T, Audeguin L, Boselli M, Bucchetti B., Cabello F., Crespan M., D'Onofrio  
228 C., Eiras Dias J., Ercisli S., Gardiman M., Grando S, Imazio S, Jandurova O, Jung  
229 A, Kiss E, Kozma P, Maul E, Maghradze D, Martinez C, Muñoz G, Pátková JK, Pejic  
230 I., Peterlunger E Pitsoli D, Preiner D, Raimondi S, Regner F, Savin G, Savvides S,  
231 Schneider A, Spring JL, Szoke A, Veres A, Boursiquot JM, Bacilieri R, This P.  
232 European Grapevine Catalogue: Towards a Comprehensive List. Vitis Journal.  
233 2011; 50: 65-68 ([http://www1.montpellier.inra.fr/grapegen06/page\\_results/EU-](http://www1.montpellier.inra.fr/grapegen06/page_results/EU-catalogue.php)  
234 [catalogue.php](http://www1.montpellier.inra.fr/grapegen06/page_results/EU-catalogue.php)).
- 235 5. Basheer-Salimia R, Lorenzi S, Batarseh F, Moreno-Sanz P, Emanuelli F, Grando S.  
236 Molecular identification and genetic relationships of Palestinian grapevine cultivars.  
237 Mol. Biotech. 2014; 56(6): 546-56. (doi: 10.1007/s12033-013-9728-7).
- 238 6. Rout GR, Mohapatra A, Jain SM. Tissue culture of ornamental pot plant: a critical  
239 review on present scenario and future prospects. Biotechnol Adv. 2006; 24(6): 531–  
240 560.
- 241 7. Baraket G, Chatti K, Saddoud O, Abdelkarim A, Mars M, Trifi M, Hannachi A. Plant  
242 Molecular Biology Reporter. 2010 , <http://dx.doi.org/10.1007/s11105-010-0217-x>.
- 243 8. Zulini L, Fabro E and Peterlunger E. Characterization of the grapevine cultivar picolit  
244 by means of morphological descriptors and molecular markers. Vitis. 2005; 44: 35-  
245 38.
- 246 9. Cantini C, Cimato A, Sani G. Morphological evaluation of olive germplasm present in  
247 Tuscany region. Euphytica. 1999; 109:173–181.
- 248 10. IPGRI, UPOV, OIV. Descriptors for grapevine (*Vitis* spp.). International union for the  
249 protection of new varieties of plants, Geneva, Switzerland/office International de la  
250 Vigne et du Vin, Paris, France/International Plant Genetic Resources Institute,  
251 Rome, Italy, 1997
- 252 11. Schlüter PM, Harris SA. Analysis of multi-locus fingerprinting data sets containing  
253 missing data. Mol. Ecol. Notes. 2006; 6: 569-572.
- 254 12. Alba V, Anaclerio A, Gasparro M, Caputo AR, Montemurro C, Blanco A, Antonacci  
255 D. Ampelographic and molecular characterization of Aglianico accessions (*Vitis*  
256 *vinifera* L.) collected in southern Italy. South Afri J Enol Vitic. 2011; 32 (2): 165-173.
- 257 13. Bandelj D, Jakše J, Javornik B. DNA fingerprinting of olive varieties by microsatellite  
258 markers. Food Techn Biotech. 2002; 40(3): 185-190.
- 259 14. Borges RM, Alves EO, Gonçalves NP, Gomes AP, Andrade DC, Albuquerque TC.  
260 Phenotypic divergence among wine grape accessions in the semi-arid region of  
261 Brazil. Crop Breed. Appl. Biotechnol. 2010; 10: 260-265.
- 262 15. Johnson HB. Plant pubescence: An ecological perspective. Botanical Review.1975;  
263 41: 233-258.
- 264 16. Nobel PS. Biophysical plant physiology and ecology. Freeman. San Francisco, USA,  
265 1983.
- 266 17. Klich MG. Leaf variation in *Elaeagnus angustifolia* related to environmental  
267 heterogeneity. Environ. and Experimental Botany. 2000; 44: 171-183.
- 268 18. Karabourniotis G, Kotsabassidis D, Manetas Y. Trichome density and its protective  
269 potential against ultraviolet-B radiation damage during leaf development. Canadian  
270 J. of Botany. 1995; 73: 376-383.
- 271 19. Atak A, Kahraman KA. Breeding studies and new table grapes in Turkey. J. of Agri.  
272 Res. and Dev. 2012; 2(3): 80-85.

- 273 20. Cangi R, Çelik H, Köse B. Determination of ampelographic characters of some  
274 natural foxy grape (*Vitis labrusca* L.) types grown in northern Turkey (Ordu and  
275 Giresun Province). International J Botany. 2006; 2(2): 171-176.
- 276 21. Zoghalmi N, Riahi L, Laucou V, Lacombe T, Mliki A, Ghorbel A, This P. Origin and  
277 genetic diversity of Tunisian grapes as revealed by microsatellite markers. Sci.  
278 Hortic. 2009; 120: 479–486.
- 279 22. Hassan N, El-Homosany A, Gomma A, Shaheen M. Morphological and ISSR  
280 polymorphisms in some Egyptian grapes (*Vitis vinefera* L.) collection. World Applied  
281 Sci J. 2001; 15(10): 1369-1375.
- 282 23. Ghaffari S, Ferchichi A. Characterization of Tunisian grapevine (*Vitis vinifera* L.)  
283 cultivars using leaves morphological traits and mMineral composition. Romanian  
284 Biotech. Letters. 2011; 16(5): 6556-6563.
- 285 24. Ocete R, Lopez MA, Cantos M. Ecologia, ampelografia e estado sanitario de  
286 algumas populacoes de videria Silvestre do Alentejo. Enologia. 1999; 33(34): 8-17.
- 287  
288