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Berry quality of principal grapevines in the Oasis of El Jerid, Tunisia

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ABSTRACT

Purpose: A safeguard program was organized to prevent and protect the autochthon fruit species in El Jerid Oasis, Tunisia. In this context, this study aimed to evaluate the grapevine varieties in these oases. **Research method:** A survey was conducted to detect the existing grape varieties and to count their stock. Ampelographic characterization of the bunch and berry (length, width, weight) and organoleptic analyzes (juice percentage, pH, TSS, titratable acidity) were measured for the most frequent founded vines. **Findings:** The study revealed a genetic wealth of vines in El Jerid Oasis, Tunisia represented by local and introduced table grapevines such as Muscat d'Italia, Cardinal, Superior Seedless, etc. The ampelographic characterization revealed medium-sized bunches for local varieties Chetoui, Arbi and Kahla and larger bunches for Muscat d'Italie, Sfaxi and Guelb Sardouk. Indeed, our grapevines were characterized by low weighted bunches. The varieties Guelb sardouk, Muscat d'Italie and Sfaxi showed berries with higher calibers and weights. The other studied vines had medium-sized and low-weighted berries. The local vines Kahla and Guelb Sardouk revealed fine-tasting berries with low sugar and acidity. Arbi and Sfaxi berries were richer in sugar with low acidity. **Research limitations:** No limitations were founded. **Originality/Value:** This study valorized the autochthone vines of El Jerid Oasis, Tunisia, by highlighting their fruit qualities, especially the taste. Therefore, the plantation of these autochthone vines should be favorized for grape table consumptions.

INTRODUCTION

The grapevine is an arboreal plant endowed with capacities of adaptation and tolerance that allowed it to tolerate almost all the climates and to be cultivated in all the territories worldwide. Its fruit, grape berry, could be eaten fresh as a table grape or industrialized for making jam, wine, juice, jelly, grape seed extract, vinegar and grapeseed oil. Recently, grape berries were consumed in cosmetics and nutraceuticals (extracts of seeds and skin) since the pharmaceutical properties of resveratrol, 3, 5, 40-trihydroxy-trans-stilbene, were proven (Salehi et al., 2018). Consumer awareness the relationship between foods and health, together with environmental concerns, has increased the demand for foods with high nutritional qualities (Rahmani et al., 2015). Thus, the importance of the grape berry as fruit increased and its production reached 73 million tons in 2017 (OIV statistical report, 2018). The table grapes represented 42 % of the grape production in 2017 while the dried berries and wine grapes represented respectively 7 % and 52 % of the production (OIV statistical report, 2018).

In Tunisia, the grapevine showed flexibility to adapt to different Tunisian soil and climate conditions; thus, it is practically present on all the territory. Grapevines are grown throughout Tunisia, mainly for fruit production (Harbi Ben Slimane, 2001). The varietal assortment includes table grape, grape wine, spontaneous vines and rootstocks.

In 2017, the vineyards in Tunisia, vines of the table and wine grapes, extended on 20910 ha of which 50.11% occupied by table grapes (DGEDA, 2017). The grapevine is mainly cultivated in Ben Arous, Nabeul in the north-east and Sidi Bouzid in central Tunisia; these areas represent respectively, 25%, 11.2% and 7.8% from the total area of the table grape vineyard (DGEDA, 2017). The yield production was estimated at 133500 tons in 2016 (GIFruit, 2016). Despite the aridity of the climate, the grapevine was also present in the south of Tunisia, in Medenine and the oases of Gabes, Gafsa, Kebeli, and Tozeur.

Several previous studies had characterized the berry quality of the Tunisian grape varieties as well as the introduced varieties cultivated in different regions in Tunisia (Snoussi et al., 2004; Zemni 2007; Zemni et al.., 2007; Souid et al., 2008; Tounsi et al., 2009; Harbi et al., 2013; Trad et al., 2017).

Besides, the oasis of El Jerid, southwest of Tunisia, is well known its diverse genetic heritage of date palms and fruit tree species and the floor plantation. Date palms represent the first floor of the oasis and depending on the availability of irrigation water and the soil nature; and there are one or two other stages of cultivation. The fruit species such as apricot, peach, fig, pomegranate, vine, lemon tree, etc., and/or vegetable species such as parsley, pepper, okra, jute mallow (*Corchorus olitorius*), chard, etc., could constitute the other cultivation stage.

Otherwise, in El Jerid oasis, the grapevine was represented by local table grape genotypes (Harbi-Ben Slimane, 2001; Ben Maachia et al., 2014). The farmers induced new genotype to diversify oasis fruit yield and to try new tastes. These new plantations led to the substitution of the local grapevines thus to the reduction of their number. In this context, a safeguard program has been started to avoid the local grapevine genotypes genetic erosion in the oasis of El Jerid. Thereby, the present study was carried out to characterize the grape berries of principal grapevines in El Jerid oasis to better value these genetic resources and to encourage oasis farmers to replant these genotypes.

MATERIALS AND METHODS

The study area

The city of Tozeur is located northwest of Chott El Jerid, 450 km southwest of Tunis, Tunisia (Fig. 1). The geographical location of Tozeur, its dry and arid climate and the recorded rainfall explain its membership in the upper Saharan bioclimatic stage. It is one of the oases located at the doors of the Sahara and contains about 1096732 date palms, which is its main wealth (DGEDA, 2016).

In the oasis of El Jerid, the irrigation water was provided by the agricultural development groups with electric conductivity (ECe) from 2.57 to 4.29 dS m^{-1} and/or by wells of water (surface or deep) with ECe from 2.71 to 15.2 gl^{-1} dS m^{-1} (CRDA)

Plant material

The oases of El Jerid, Tozeur, Tunisia, were the subject of the present study (Fig. 1). Sixty farmers in Degache, Tozeur, Chamsa, Mrah Lahouar and Nefta were investigated. They were chosen for the vine's plantation (Fig. 1).

The most frequent grapevine genotypes in the oasis, according to the survey, were the subject of the following analyses. At harvest, bunches were collected from the oases in different dates according to their fully mature stage.

Fig. 1. The distribution map of the survey sites. Areas with dark color constitute the oases of each site. Numbers in parentheses represented the number of the prospected oasis in each site (Google earth, 2019)

Table 1. Descriptive characters codes (OIV, 2001)

Character	OIV code	IPGRI
Bunch: length	202	7.1.5
Bunch: width	203	
Bunch: weight	502	7.1.14
Berry: length	220	6.2.5
Berry: width	221	
Berry: weight	503	7.1.15

Pomology

The pomological parameters were measured according to the descriptive characters codes adopted by the International Organization of Vine and Wine (OIV, 2001). The length, width and weight of six bunches of each grape variety were determined (Table 1). Similarly, we were able to record the length, width and weight of 40 berries taken from 4 vines for each genotype.

Organoleptic parameters

The organoleptic characterization was carried out as previously described by Zemni et al. (2007) and Schreiner (2010). 100 g of grape berries for each genotype was crushed in a centrifuge for 1.30 min and then the percentage of juice was measured using the following formula (1):

$$J\% = (\text{juice weight (g)} / 100 \text{ g of berries}) \times 100 \quad (1)$$

The pH of juice was estimated using a pH meter calibrated with distilled water before each measurement. The value of total soluble solids (TSS) was determined on a handheld refractometer and expressed as °Brix correct at 20°C. The measurement of the juice titratable acidity (TA) was carried out by Metrohm titration by ion analysis; the apparatus stops the titration with sodium hydroxide (NaOH, 0.1N) as soon as the pH reaches 8.1. These analyses were quadruplicate.

Statistical analyzes

The vines for each genotype were chosen randomly; four vines per genotype were selected in the oasis and considered as replicate. A stat view ANOVA program was used for statistical analysis of the data. Values for different grape cultivars within each parameter were compared using the variance analysis (ANOVA) with repeated measures and Newman-Keuls test for differences between data if the ANOVA revealed significance ($p<0.05$). Means were tested by Newman-Keuls at the $P \leq 0.05$ level.

RESULTS AND DISCUSSION

Principal grape varieties found in the oasis of El Jerid

Numerous local and introduced grapevine genotypes were identified in the El Jerid oasis (Fig. 2). Their names are local, sometimes indicating the berry skin color (Kahla), the maturity season (Chetoui), the berry form (Guelb Sardouk). The grapevines present with the largest number of vines were the local genotypes Arbi, Kahla and Guelb Sardouk constituting respectively 63.3%, 43.3% and 21.4 % of the total vines prospected (Fig. 2). The introduced variety Muscat d'Italie also represented an important part, 36.7% of the vines found in the surveyed oases (Fig. 2). However, the local genotypes Chetoui and Sfaxi were present with low vines number in El Jerid oases, compared the other genotypes (Fig. 2).

Indeed, farmers introduced foreign varieties and little known in the oasis-like, Sultanine, Cardinal, Carignon and Superior Seedless (Fig. 2).

In addition to its importance in the number of vines, the local Arbi genotype was the most frequent genotype (39%) in the prospected oases, followed by the local genotype, despite its low number of vines, with a frequency of 23% in the oases (Fig. 3). The genotypes Kahla, Meski 1, Muscat d'Italie, Guelb Sardouk, Chetoui and Meski were the least frequent in the prospected oasis (Fig. 3).

Previous ampelographic analyses had identified 'Meski Abiadh' grown in Degache, Tozeur. This result was solicited by the genotypic analysis carried out by Snoussi et al. (2004). Snoussi et al. (2004) revealed the existence of two accessions known as 'Meski Abiadh' in Degache and Tozeur with different genotypes and similarly for two accessions known as 'Abri Abiadh' found in the oases of Degache and Tozeur.

These finding confirmed the genetic diversity of the grape varieties grown in the oases of El Jerid.

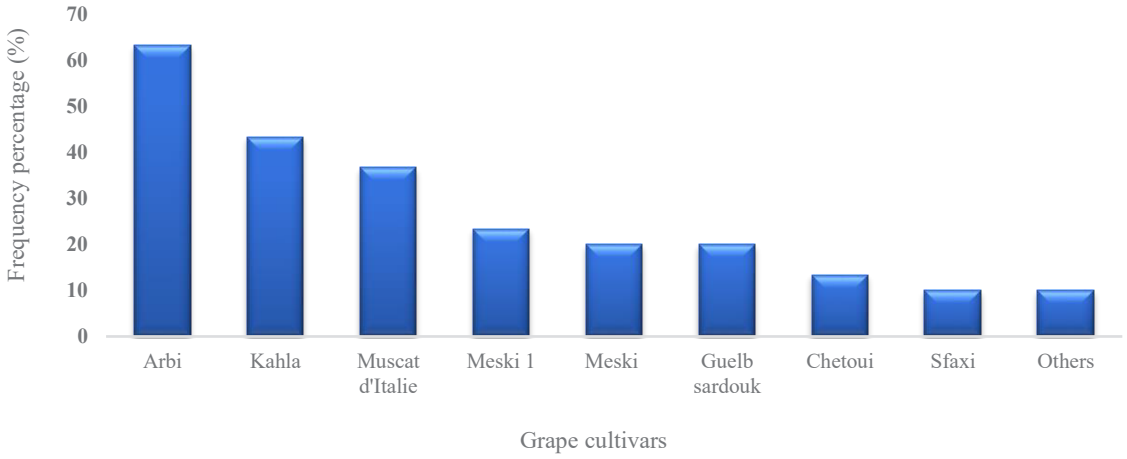

Fig. 2. The importance of each grapevine genotype according to the total vines number in El Jerid oasis

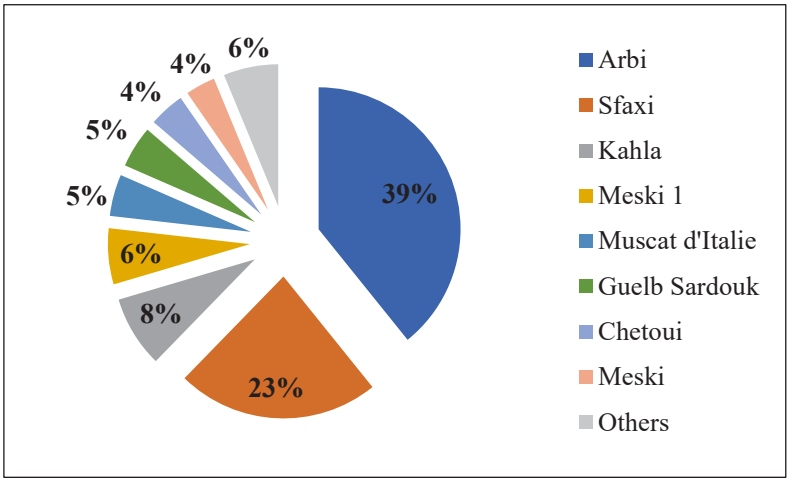

Fig. 3. The planting frequency of the present grapevine genotypes in the oasis of El Jerid

Bunches and berries characteristics of principal grape varieties

According to the survey, the grapevines Arbi, Chetoui, Guelb Sardouk, Kahla and Sfaxi, and Muscat d'Italie were the principal grape varieties planted in the investigated oases; these grape varieties were present at all irrigation water qualities according to the salt load, low with (ECe) from 2.57 to 4.29 dS m^{-1} and high with ECe from 4.28 to 8.02 dS m^{-1} (Fig. 4).

Our grapevines showed different maturity dates. The harvest of Arbi, Kahla, Guelb Sardouk and Muscat d'Italie grapes was throughout August. Later, the yields of Sfaxi and Chetwi were picked respectively in mid and late September (Fig. 4).

The pomological parameters allowed us to better distinguish the fruit characteristics of the principal vines in El Jerid oases (Fig. 4). According to the OIV descriptor (OIV, 2001), the local genotypes Chetoui, Arbi and Kahla had bunches with medium length (Table 2). The very long bunches were recorded by Sfaxi and Muscat d'Italie, respectively 24.55 and 25.7 cm (Table 2). However, our grapevines presented bunch with medium width, almost 12 cm (Table 2).

Else, according to the OIV descriptor (OIV, 2001), the local variety Guelb sardouk revealed long berries (2.46 cm) followed by Muscat d'Italie (2.03 cm) while the other grapevines had medium berry length, almost 1.6 cm (Table 2). The width of our grapevines' berries was medium almost 1.8 cm (Table 2). These results were comparable to those of Bazzoul Kalba Bidha, Bidh Hamem, Sakasly, Kahli, Khedhiri that were characterized by small bunches and medium-sized berries (Zemni, 2007).

Besides, our grapevines revealed low bunch weight according to OIV descriptor (OIV, 2001); the heavier bunch (272.7 g) was registered by the local genotype Sfaxi (Table 2). As for berries, the local genotypes Arbi, Chetoui and Kahla revealed low berry weight while the genotypes Guelb Sardouk, Muscat d'Italie and Sfaxi medium berry weight (OIV, 2001). Moreover, the statistical analyses revealed significant differences in the berry weight between the identified varieties (Table 2). The local grapevine Guelb Sardouk recorded the heaviest berry (4.97 g) while the genotype Arbi recorded the lowest berry weight (2.35 g). Our grape varieties bunches weights were comparable to those of Rafraf variety Bezzoul Lkhadem (270 g) and those of Asli (200 g) and Kahli (250 g) cultivated in Borj Cédria (Zemni, 2007). As for berries, their weights were comparable to those of the vine Muscat (from 3.12 g to 5.23 g), cultivated in baddar, Kélibia and Rafraf in Tunisia, and to those of Superior Seedless on its own roots and grafted on three rootstocks (3.58 g to 4.90 g) (Ahmad, 2016; Zemni, 2007).

Indeed, Muscat d'Italie known as 'Italia', cultivated vineyard of GOVPF of Belli-Grombalia, Tunisia, revealed high bunch weights that varied from 537.7 g to 747.7 g after leaf removal treatment for two years (Souid et al., 2008). Yet, under oasis conditions, Muscat d'Italie showed low bunch weight, 224.4 g (Table 2) that was slightly heavier than the bunch of Muscat d'Italie for two years grown in Rjim Maâtoug (191.3 g and 208.5 g), a similar condition to Tozeur oasis (Zemni et al., 2007). For Muscat d'Italie grown in Tunis (Zemni et al., 2007), the north of Tunisia, the bunch was slightly heavier than our Muscat d'Italie, especially in 2002 (281 g).

Compared to other Tunisian grapevines, Zemni (2007) revealed grapevines with heavier bunches than those of our grapevines, namely Muscat cultivated in three areas (from 330 g to 410 g), Mahdaoui cultivated in Borj Cédria (350 g), and Rafraf cultivars Ferrani (380 g), Rozaki (390 g), Masraoui (400 g), Bidh Hamem (420 g), Muscat rafraf (450 g) and Beldi (520 g). The Superior Seedless on its own roots and grafted on three rootstocks also showed heavier bunches (468.8 to 622.9 g) than those of our grapevines and varied from 468.8 to 622.9 g (Ahmad, 2016).

Table 2. The bunches and berries characteristics for the principal grapevines found in the oasis of El Jerid

	Bunch parameters			Berry parameters		
	Length (cm)	Width (cm)	Weight (g)	Length (cm)	Width (cm)	Weight (g)
Arbi	15.6±1.5 a	14±0.5 b	210.5 ± 19.3 a	1.52±0.0 a	1.54±0.0 a	2.35±0.0 a
Chetwi	14.75±0.8 a	11.17±0.4 a	232.5 ± 32.9 a	1.60±0.0 b	1.68±0.0 c	2.95±0.0 b
GuelbSardouk	21.2±0.4 b	10.53±0.4 a	225.4 ± 14.6 a	2.46±0.0 f	1.80±0.0 d	4.97±0.0 e
Kahla	15.9±1.3 a	11.93±0.6 a	195.6 ± 20.6 a	1.66±0.0 c	1.61±0.0 b	2.79±0.0 a
Sfaxi	25.7±1.4 c	13.85±1 b	272.7 ± 13.5 a	1.94±0.0 d	1.81±0.0 d	4.00±0.0 c
Muscat d'Italie	24.55±1.2 bc	11.6±0.5 a	224.4 ± 22.4 a	2.03±0.0 e	1.87±0.0 e	4.53±0.0 d

Data represent the mean ± SE of six repetitions for bunch parameters and forty repetitions for berry parameters. Different letters indicate statistical significance between the grape varieties for each parameter according to the Newman-Keuls test ($P < 0.05$).

Table 3. The juice's organoleptic parameters for the principal grapevines in the oasis of El Jerid

	Juice %	pH	TSS (%)	TA (meq / 100g of juice)
Arbi	61.2 a	3.72 a	20.26 b	3.82 a
Chetoui	66.1 a	3.85 a	19.96 a	5.19 a
GuelbSardouk	62.0 a	4.11 a	19.21 a	3.15 a
Kahla	60.3 a	3.90 a	17.80 a	4.21 a
Sfaxi	54.2 a	4.40 b	21.03 b	4.34 a
Muscat d'Italie	65.0 a	3.86 a	17.00 a	6.41 b

Data represent the mean ± SE of four repetitions. Different letters indicate statistical significance between the grape varieties for each parameter according to the Newman-Keuls test ($P < 0.05$).

Juice characteristics of principal grape varieties

To evaluate the berry juice of our grapevines, the organoleptic parameters, juice percentage, pH, TSS and titratable acidity (TA) were analyzed (Table 3). Table 3 showed significant differences in the juice's pH, TSS and TA at $p \leq 0.05$ while our grapevines revealed comparable juice percentage ($p > 0.05$). Except for the local genotype Sfaxi with low juice % (54.2 %), the tested grapevines were characterized by important juice percentage (>60 %); the higher percentages were recorded by the local genotype Chetoui (66.1 %) and the introduced genotype (65.0 %). Indeed, our grapevines' juices were characterized with acid pH (<7); the low pH was noted in the local genotype Arbi juice (3.72) while the highest pH (4.4) was observed in the local genotype Sfaxi juice (Table 3). Our data agreed with previous studies that recorded 3.31 and 3.29 as juice pH for Pinot Noir grown in two vineyards (Schreiner 2010) and 3.68 as pH for Shiraz's berry juice (Walker et al., 2003).

Besides, TSS and acidity play an important role in fruit quality improvement (Chanana & Gill, 2008). The tested grapevines revealed relatively low total soluble solids (TSS) levels; the local genotypes Arbi and Sfaxi recorded the greatest TSS levels, respectively 20.26 % and 21.03 % (Table 3). The Pinot Noir grapes, growing in two plots, and the Shiraz showed higher TSS levels (23.7%, 24% and 25.9%, respectively) than those observed in our grape varieties (Schreiner, 2010; Walker et al., 2003).

On the other hand, the titratable acidity analyses revealed a highest TA value in the juice of Muscat d'Italie; It reaches 6.41 meq/100g of juice as reported by Schreiner (2010) in the juice of Pinot Noir cultivars growing in two vineyards (6.7% and 7.52%). Zemni et al. (2007) reported Muscat d'Italie berries qualities cultivated in two different areas Tunis in the north and Rjim Maâtoug in the south in Tunisia. The juice pH and Brix of Muscat d'Italie from the El Jerid oasis (Table 3) was comparable to those from Rjim Maâtoug (3.95 and 16.8°, respectively) and Tunis (4.07 and 17.7°, respectively) while it was more acidic (Table 3). The berries of Muscat d'Italie from Rjim Maâtoug and Tunis were less acidic; almost 4 meq /

100g of juice (Zemni et al., 2007). Else, the local genotypes Arbi and Guelb Sardouk revealed the lowest acidities, respectively 3.82 and 3.15 meq / 100g of juice (Table 3). Shiraz also revealed low titratable acidity, around 3.78%, (Walker et al., 2003).

Zemni et al. (2007) reported that the high temperature and the low relative humidity in the Sahara (Rjim Maâtoug) decreased the photosynthetic activity and the vine growth sufficiently, which reduced bunches and berry weights and inhibited sugar accumulation, despite the use of irrigation. Since Tozeur belongs to the upper Saharan bioclimatic stage, this could explain the low yield qualities (bunch and berry weights and °Brix) of our grapevines compared to the grapevines cultivated in other areas in Tunisia (Souid et al., 2008; Zemni, 2007; Zemni et al., 2007).

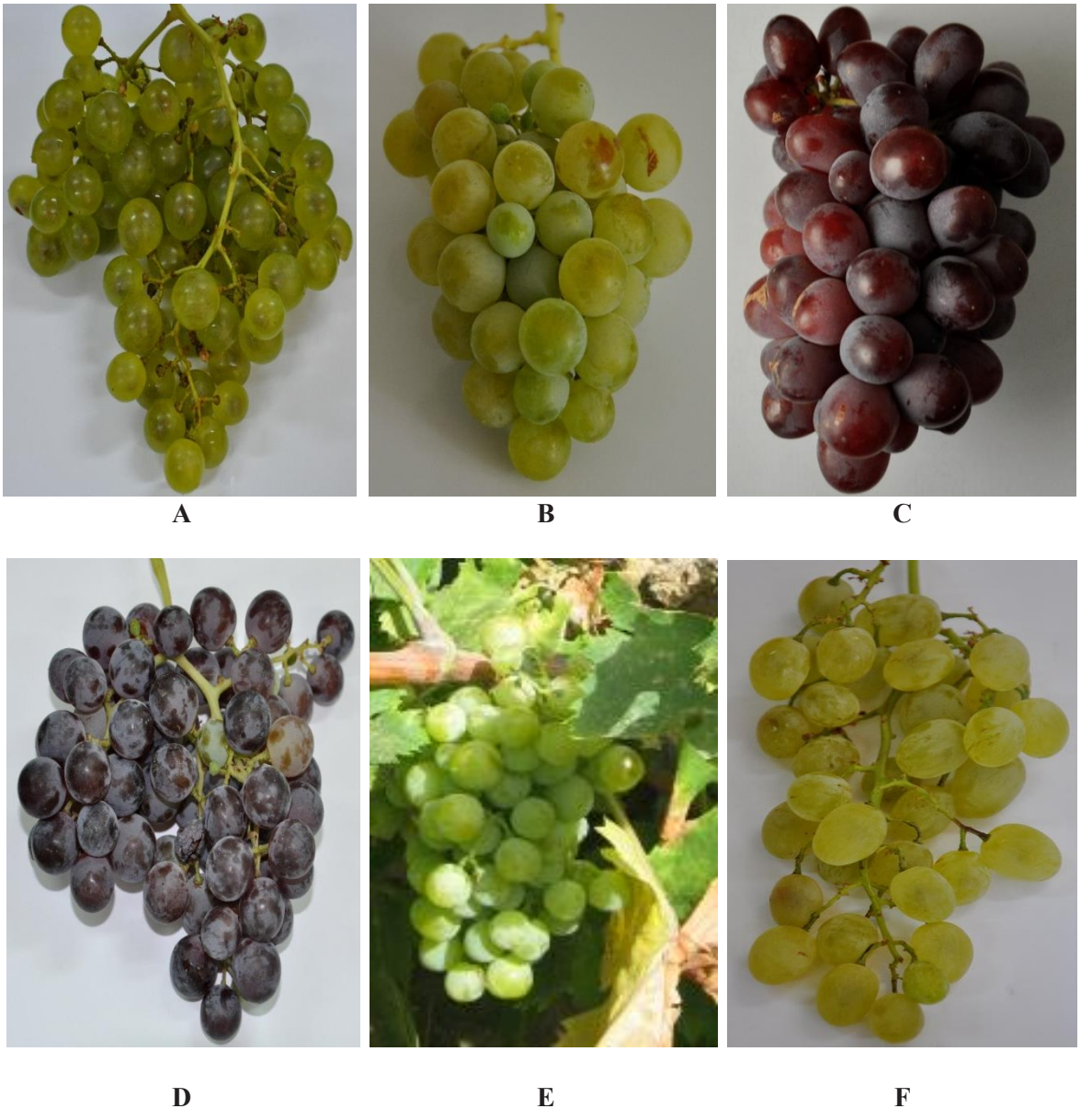

Fig. 4. The bunches of the studied grape varieties. A: Arbi, B: Chetoui, C: Guelb Sardouk, D: Kahla, E: Sfaxi, F: Muscat d'Italie.

Otherwise, the grapevines Kahla and Guelb Sardouk, with dark red-violet berries, were characterized by the lowest °Brix (17.8 and 19.21, respectively) and acidities (4.21 and 3.15 meq / 100g of juice, respectively) which made the berries not very sweet and not very acidic. Thus, Kahla and Guelb Sardouk could be considered for table grape production which agreed with the reported results for Kohli, grown in Kerkennah and Borj Cédria, Tunisia (Zemni, 2007). Yet, Arbi and Sfaxi berries were revealed rich by sugar (20.26 and 21.03 °Brix, respectively) with low acidity (3.82 and 4.34 meq/100g of juice, respectively) likely to be more suitable for drying (raisin). This constating confirmed the results of Zemni (2007) for the grapevine Asli.

CONCLUSION

El Jerid oases presented a large diversity of grapevine that was either local varieties planted for many years by farmers or from seedlings. In both cases, they were given the title of local or introduced varieties by farmers. The grapevines, grown under El Jerid oasis conditions, are characterized by low weighted bunches. The local genotypes Guelb Sardouk and Sfaxi and the introduced variety Muscat d'Italie revealed the higher bunch and berry calibers; their berries were heavier than the other studied genotypes' berries. Indeed, the local grapevine genotypes Kahla and Guelb Sardouk showed crunchy berries with fine taste while Arbi and Sfaxi berries were rich by sugar and not very acidic. Thus, we could encourage the area farmers for replanting the local grapevine genotypes Kahla and Guelb Sardouk, for dark red-violet berries production, Arbi and sfaxi for dried raisin production.

CONFLICT OF INTEREST

The authors have no conflict of interest to report.

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