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Phenotypic diversity of date palm varieties (*Phoenix dactylifera* L.) from southwest Algeria estimated by fruit characteristics

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Phenotypic diversity of date palm varieties (*Phoenix dactylifera* L.) from southwest Algeria estimated by fruit characteristics

Abstract: This study aimed to identify the genetic diversity of date palm (*Phoenix dactylifera* L.) in the southwest of Algeria (wilaya of Adrar), as part of the Algerian date palm varieties conservation. The morphological characterization was adopted in terms of quality and quantity of 26 varieties. The main results showed a considerable genetic diversity of date palms in this agricultural territory. 7 cultivars counted in danger of extinction. The cluster analysis brought out significant differences between qualitative and quantitative traits. However, the cultivars of 'Deglet Talmine', 'Maatouk', and 'Timidouele' produced dates of high quantitative traits, however, of different qualitative traits. Also, some relationships were observed within clusters for other varieties. A variety named 'Khalt' was able to produce dates better than many cultivars. This work would help to know the focal traits of the plant genetic resources of date palm and preserve that are in extinction.

Key words: Adrar; cluster analysis; cultivar; dates; *Phoenix dactylifera* L.; qualitative characterization; quantitative characterization; variety

Fenotipska raznolikost sort dateljeve palme (*Phoenix dactylifera* L.) v jugozahodni Alžiriji, ocenjena na osnovi lastnosti plodov

Izvleček: Namen raziskave je bil določiti genetsko raznolikost dateljeve palme (*Phoenix dactylifera* L.) v jugozahodni Alžiriji (provinca Adrar), kot del programa ohranjanja alžirskih sort dateljeve palme. Morfološka opredelitev 26 sort je bila narejena na osnovi kakovostnih in količinskih parametrov. Glavni izsledki so pokazali, da je na tem kmetijskem območju precejšnja genetska raznolikost dateljeve palme. Sedem sort je bilo opredeljeno kot ogroženih pred izumrtjem. Klasterska analiza je pokazala značilne razlike med kakovostnimi in količinskimi lastnostmi sort. Sorte 'Deglet Talmine', 'Maatouk', in 'Timidouele' so bile najbolj rodovitne, a z različnimi kakovostnimi lastnostmi. Znotraj skupin sort so bile opažene še nekatere druge lastnosti. Tako je bila sorta 'Khalt' najrodovitnejša. Izsledki te raziskave bodo pomagali prepoznati ciljne lastnosti v naboru sort dateljeve palme za njihovo ohranjanje.

Ključne besede: Adrar; klasterska analiza; sorta; *Phoenix dactylifera* L.; kakovostna in količinska oznaka sort

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1 INTRODUCTION

The date palm (*Phoenix dactylifera* L.) is a centuries-old crop plant farmed in many desert regions of the world, particularly in West Asia and North Africa (Al-Yahyai & Mumtaz Khan, 2015).

Its culture is perennial and classified under the genus *Phoenix*, a monocotyledonous family Palmae with 36 chromosomes (*2n* = 36) (Chao & Krueger, 2007). *Phoenix* species are dioecious, with offshoots being the most common propagation method; however, tissue culture and seed are other viable options. Propagation via seeds produces new genotypes or forms of date palm, which are the primary source of date palm variety (Elhoumaizi et al., 2002).

Around 3000 date palm cultivars have been identified worldwide (Khierallah et al., 2015) in which 940 cultivars were recorded in Algeria (Hannachi et al., 1998).

However, Algeria is known for its noble variety 'Deglet Noor', which is considered a crop of nutritional quality (Debabeche et al., 2021) with great socio-economic importance 54 % of the total production. It occupies the largest cultivated areas in Ziban, Oued Souf, and Oued Righ (MARDF, 2021).

Adrar is the fourth-largest producer of dates in the country, with an annual production of 93568.1 tons in 2020, where there are a number of 3798579 date palms (MARDF, 2021).

This rank has decreased mainly due to the extension of the adverse biotic threats. The vascular attack of *Fusarium oxysporum* f.sp. *albedinis* W.L. Gordon, (1965) named the bayoud, which is considered the most dangerous, is widespread in multiple palm groves of the municipalities of the wilaya also, the anthropogenic and abiotic threats are well noted in this region. Drought is one of the most important environmental stresses causing a significant drop in crop productivity (Guettouchi et al., 2017; Sarwat & Tuteja, 2017). So, adopting a strategy to preserve and restore the plant genetic resources of the date palm is necessary for the state and scientists.

A previous survey on identifying genetic diversity of Algerian date palm female cultivars employing morphological description was done in the southeast Algerian territory. Simozrag et al.(2016) and Bedjaoui & Benbouza (2020) distinguished 96 cultivars in the wilaya of Biskra based on the morphological traits of the vegetative and the fruit part of the date palm. Another morphological identification was made on 175 cultivars in Oued Righ and 56 in Oued Souf (Acourene et al., 2007).Guettouchi et al. (2017) described 19 cultivars in the wilaya of Boussada and Simozrag & Laiadi (2020) characterized 80 minor cultivars in the wilayas of Biskra and Oued Righ using molecular traits.

The characterization combining the morphological, biochemical, and molecular traits of trees provides definite genetic information to species (Kameswara Rao, 2004) and preserve the genetic heritage of plants (Al-Yahyai & Mumtaz Khan, 2015). One of the most prevalent approaches for identifying date palm diversity is to use morphological criteria wherein the traits related to the vegetative or the fruit organs have been highly praised for date palm characterization (Elhoumaizi et al., 2002b).

In fact, phenotypic diversity is a visible sign of date palm variety. It depicts the interaction impact between genetic variation and the environment (Jaradat, 2011). Considering that this study has been engaged through the investigation and participation in the genetic identification of the endogenous female accessions of Southwest Algeria.

Therefore this work aimed to characterize some of the fruit morphological traits which are accessible to the observer being part of the diversity identification and conservation of the Algerian date palm varieties existing in the wilaya of Adrar and to enrich date palm germplasm and develop a suitable breeding strategy.

2 MATERIALS AND METHODS

2.1 PLANT MATERIAL

The research was conducted on the fruit of twenty six Algerian date palm varieties located in Algeria's southwest (wilaya of Adrar), between 27 ° 52 ′ 00 ″ N and 0 ° 17 ′ 00 ″ W, with an altitude estimated at 279 m. Adrar has a hot desert climate characterized by a mean annual temperature of 26.7 °C which means annual rainfall barely reached 16.26 mm in 2020.

Specific information on local names of date palm varieties, their type of reproduction, distribution, availability of their fruit in the market, and socio-economic value were carried out. A panel of expert provided it from Ben Abbes station of scientific and technical research center on arid regions and the farmers in the wilaya of Adrar (Table 1).

2.2 SAMPLING AND ANALYSIS

All the varieties are selected in palm groves of five municipalities of Adrar (Figure 1).The tree's sampling on each variety depended on their availability from one grove to another, and from 20 groves studied in each municipality at least 3 replicates were taken from each variety except for 'Khalt'. Twenty fruits from different bunches of each date palm tree were randomly sampled at the

Table 1: Identification data of the cultivars studied

Varieties	Code	Status of reproduction	Distribution	Harvest	Appreciation	Marketing
Abbad	ABB	Cultivated	Frequent	August	Excellent	Important
Abd Salam	ASA	Cultivated	Rare	October	Excellent	Important
Adam Bara	ABA	Cultivated	Rare	October	Excellent	Important
Adam Bola	ABO	Cultivated	Frequent	October	Excellent	Important
Adam Lebled	ALD	Cultivated	Frequent	August	Excellent	Important
Adam Mani	AMN	Cultivated	Frequent	October	Good	Medium
Adam Osalem	AOS	Cultivated	Infrequent	October	Medium	Medium
Cherka	CHE	Cultivated	Frequent	October	Good	Medium
DegletTalmine	DTN	Cultivated	Frequent	October	Medium	Important
El Mabrouka	ELM	Cultivated	Infrequent	October	Good	Medium
Feggous	FEG	Cultivated	Frequent	October	Excellent	Important
Hartane	HAR	Cultivated	Frequent	November	Excellent	Important
Hemira	HEM	Cultivated	Frequent	October	Good	Important
Hija	HIJ	Cultivated	Frequent	August	Excellent	Important
Khalt	KHL	Seedling	Unique	October	Low	Low
Maatouk	MAA	Cultivated	Frequent	October	Good	Important
Tademama	TDM	Cultivated	Frequent	October	Medium	Low
Takerbouchte	TKB	Cultivated	Frequent	December	Excellent	Important
Taorakhet	TAR	Cultivated	Rare	October	Low	Low
Tazerza	TZR	Cultivated	Abundant	October	Medium	Low
Timjohar	TMJ	Cultivated	Frequent	October	Good	Medium
Timebadda	TBD	Cultivated	Frequent	September-October	Good	Important
Timeliha	TML	Cultivated	Frequent	October	Medium	Medium
Timidouele	TMD	Cultivated	Frequent	October	Medium	Low
Tinaser	TNS	Cultivated	Frequent	October	Low	Important
Tinizioua	TNZ	Cultivated	Frequent	October	Medium	Low

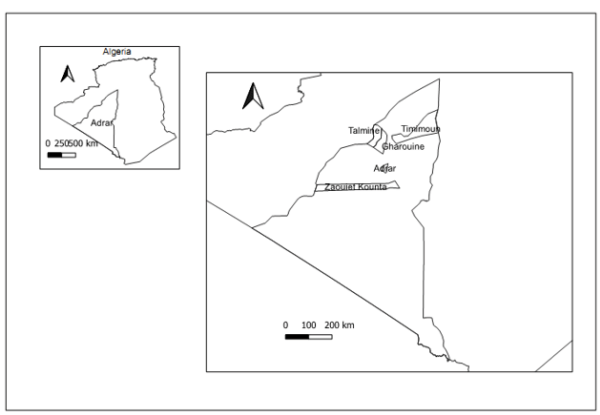

Figure 1: Location map showing the collected date palm varieties in the wilaya of Adrar

fully mature stage. The study was designed on different analyses on a phenotypic basis. The main traits were derived from the descriptor list for the date palm (IPGRI et al., 2005), concerning the fruit, including eight quantitative traits: fruit and seed sizes (cm), fruit and seed mass (g), and ratios of length and mass of the seed on their fruit also, the dates were identified by qualitative traits: the fruit shape, the fruit peel colour, the fruit consistency and the flesh texture.

2.3 STATISTICAL ANALYSIS

Correlations between qualitative and quantitative traits of the fruit were obtained with significance

$p < 0.05$. Cluster analysis was run for grouping cultivars that showed dissimilarity in several traits. Clustering was performed on eight quantitative fruit traits and four qualitative traits for everyone, using the Euclidean distance matrix and the un-weighted pair group method with arithmetic average (UPGMA). The qualitative traits were scored based on principal coordinates after doing Correspondence Analysis (CA). All statistical analyses were executed using PAST software (Hammer et al., 2001).

3 RESULTS

3.1 CORRELATION PLOT

The correlation plot confirmed that the most qualitative and quantitative traits studied are significantly correlated in the positive sense (Figure 2).

Fruit mass was positively and highly correlated with the fruit size (fruit length and diameter) and the fruit shape as fruit length had a positive correlation with seed length and fruit mass and peel colour of the fruit, and both were negatively correlated with the seed/fruit length and mass ratios. Fruit diameter was positively correlated with fruit's mass and shape and negatively correlated with the seed/fruit length and mass ratios. Otherwise fruit shape was negatively correlated with the seed/fruit mass ratio. Positive correlation was marked between fruit consistency and flesh texture and another positive correlation between seed size and seed mass.

3.2 QUALITATIVE PHENOTYPIC TRAITS

The visual observation traits are revealed in Table 2. Qualitative analysis of the dates showed remarkable phenotypic diversity in the shape, colour, consistency, and texture of dates. 65.38 % appeared of subcylindrical shape, 26.92 % were cylindrical, 11.54 % were triangular, 7.69 % were ovate elongated and subspherical, and 3.85 % was spherical. Most dates in maturity were dark in colour: 88.46 % pigmented red to black, and the rest were yellow to amber. Many dates were characterized by consistency from semi-dry to soft, 42.31 % for each one and 15.39 % were dry. However, 53.85 % of dates were of chewiness texture, followed by a cohesiveness texture with 30.77 % and hardiness with 15.38 %.

3.3 QUALITATIVE CLASSIFICATION OF DATE PALM FRUIT

Euclidean distance was used to estimate the phenotypic dissimilarity of the 26 varieties. Dissimilarity levels ranged from 0 to 2.50, determining the variety groups qualitatively related (Figure 3). The cluster analysis of qualitative traits resulted in two main clusters. The first

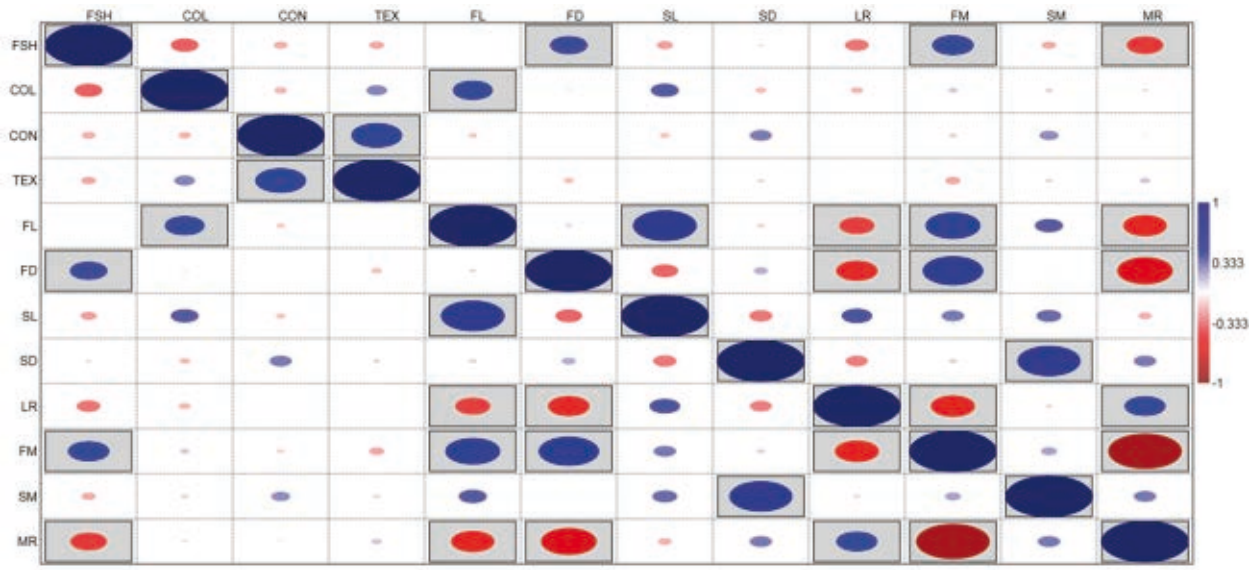

Figure 2: Correlation plot between qualitative and quantitative fruit traits. FSH - fruit shape, COL – peel colour, CON - fruit consistency, TEX - flesh texture, FL - fruit length, FD - fruit diameter, SL - seed length, SD - seed diameter, LR - seed/fruit length ratio, FM - fruit mass, SM- seed mass, MR - seed/fruit mass ratio

one is divided into three distinct sub-clusters: dates of 'Hartane', 'Maatouk', 'Timjohar', 'Tazerza', 'Feggous', 'Takerbouchte', 'Taorakhet', 'Tademama', 'El Mabrouka' and 'Adam Bola' grouped in a sub-cluster shared a dark colour of peel and soft consistency. They are characterized by an irregular shape and a chewiness and cohesiveness texture. The second sub-cluster contained 'Abbad', 'Tinizioua', 'Timidouele', 'Hija', 'Adam Lebled', 'Adam Bara', 'Timeliha', and 'Abd Salam' were very close, distinguished by the elongated shape of the fruit and colour shades from light to dark. They were similar in the semi-dry consistency and chewiness texture. The third sub-cluster recorded 'Timebadda', 'Cherka', 'Hemira' and 'Adam Mani', which had independence in fruit shape and peel colour between light and dark. Their dates were of semi-dry consistency and cohesiveness texture.

The second cluster was limited to only 'Adam Osalem', 'Khalt', 'Deglet Talmine', and 'Tinaser' entire of dry consistency and hardy texture compared to the other cluster. Their dates were not necessarily elongated, distinguished by the colour shades from light to dark.

3.4 QUANTITATIVE PHENOTYPIC TRAITS

The mean values and standard deviation of quantitative traits are reported in Tables 3 and 4.

Concerning the size, 61.54 % of dates seemed small

Table 2: Qualitative traits of fruit of date palm varieties

Varieties	Fruit shape	Colour of fruit peel	Fruit consistency	Flesh texture
Abbad	Subcylindrical and cylindrical	Amber-Brown	Semi-dry	Chewiness
Abd Salam	Subcylindrical	Yellowish orange-Dark orange-Garnet	Semi-dry	Chewiness
Adam Bara	Ovate elongated	Yellowish brown-Brown	Semi-dry	Chewiness
Adam Bola	Subcylindrical	Amber-Dark red	Soft	Cohesiveness
Adam Lebled	Subcylindrical	Brown	Semi-dry	Chewiness
Adam Mani	Subspherical	Brown	Semi-dry	Cohesiveness
Adam Osalem	Subcylindrical	Brown	Dry	Hardiness
Cherka	Triangular	Yellowish brown	Semi-dry	Cohesiveness
Deglet Talmine	Subcylindrical and triangular	Brown	Dry	Hardiness
El Mabrouka	Triangular	Reddish brown with mustard yellow	Soft	Chewiness
Feggous	Cylindrical	Garnet	Soft	Chewiness
Hartane	Cylindrical and subcylindrical	Red	Soft	Chewiness
Hemira	Subcylindrical	Dark red-Garnet	Semi-dry	Cohesiveness
Hija	Subcylindrical	Yellowish brown-Red	Semi-dry	Chewiness
Khalt	Subcylindrical	Blonde yellow-Brown	Dry	Hardiness
Maatouk	Ovate elongated and triangular	Garnet with dandelion yellow	Soft	Chewiness
Tademama	Cylindrical	Black	Soft	Cohesiveness
Takerbouchte	Spherical	Garnet	Soft	Cohesiveness
Taorakhet	Subcylindrical	Black	Soft	Cohesiveness
Tazerza	Subcylindrical	Garnet	Soft	Chewiness
Timjohar	Subcylindrical	Black	Soft	Chewiness
Timebadda	Subcylindrical and subspherical	Honey yellow	Semidry	Cohesiveness
Timeliha	Subcylindrical	Darkred–Darkbrown	Semi-dry	Chewiness
Timidouele	Cylindrical	Brown-Garnet	Semi-dry	Chewiness
Tinaser	Cylindrical and subcylindrical	Yellowish brown	Dry	Hardiness
Tinizioua	Cylindrical	Brown-Garnet	Semi-dry	Chewiness

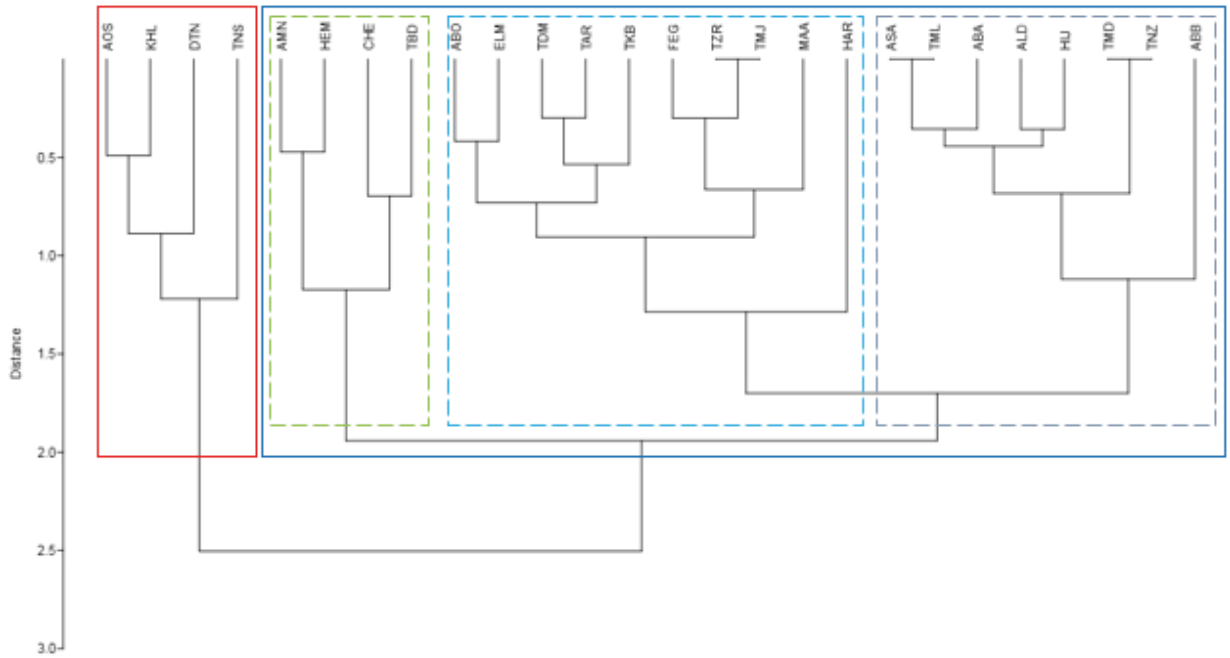

Figure 3: Hierarchical clustering of Algerian date palm fruit-based on four qualitative traits

(3 < *l* < 4 cm) as demonstrated by 'Abbad', 'Abd Salam', 'Adam Lebled', 'Adam Mani', 'Adam Osalem', 'Cherka', 'Feggous', 'Hija', 'Tademama', 'Takerbouchte', 'Timjohar', 'Timebadda', 'Timeliha', 'Tinaser', 'El Mabrouka' and 'Tazerza', followed by a rate of 34.61 % that were medium-sized (4.1 < *l* < 5 cm): 'Adam Bara', 'Adam Bola', 'Deglet Talmine', 'Hartane', 'Hemira', 'Khalt', 'Maatouk', 'Taorakhet', 'Tinizioua' and only 3.85 % represented by 'Timidouele' was large-sized (5.1 < *l* < 6cm). Traits in relation to fruit and seed length were shown that most dates represent a moderate size (0.5 < *r* < 0.67) except for 'Timidouele', which appears good (r < 0.5), and 'Timeliha' was bad (r > 0.67) (Table 3).

Table 4 revealed that 73.08 % of the dates had a good weight (*m* > 8 g) illustrated by 'Abd Salam', 'Adam Bara', 'Adam Bola', 'Adam Lebled', 'Adam Osalem', 'Cherka', 'Deglet Talmine', 'El Mabrouka', 'Feggous', 'Hartane', 'Hemira', 'Khalt', 'Maatouk', 'Takerbouchte', 'Taorakhet', 'Tazerza', 'Timebadda', 'Timidouele' and 'Tinizioua'. 23.08 % were moderate (6 < *m* < 8 g): 'Adam Mani', 'Hija', 'Tademama', 'Timjohar', 'Timeliha', 'Tinaser' and 3.85 % represented by 'Abbad' was of poor weight (*m* < 6 g). Traits concerning fruit and seed weight reported that 69.23% of the dates presented a ratio higher than 0.10, an indicator of a large seed volume relative to the fruit.

3.5 QUANTITATIVE CLASSIFICATION OF DATE PALM FRUIT

Euclidean distance was used to estimate the phenotypic dissimilarity of the 26 varieties. Dissimilarity levels ranged from 0.750 to 5.018, determining the accession groups quantitatively related (Figure 4). The cluster analysis of quantitative traits resulted in three main clusters. In the first cluster, close relationships were observed among 'Deglet Talmine', 'Maatouk' and 'Timidouele'. These dates record high traits of size and mass. However, 'Timeliha' in the second cluster was highly different from the two groups generated. Their dates presented very poor quantitative traits because of the high seed length. The third cluster was more grouped in distinct sub-clusters displaying the varieties with medium traits of fruit: 'Adam Bara', 'Adam Lebled', 'Hemira', 'Khalt', 'Hartane', 'Taorakhet', 'Adam Bola', which were very closely having the best quantitative traits in this sub-cluster. 'Tinizioua', 'Tazerza', 'Cherka', 'Timjohar', 'Tinaser' and 'Adam Osalem' were grouped in a sub-cluster, particular for dates of high seed mass, and 'Abbad', 'Tademama', 'Hija', 'Abd Salam', 'Takerbouchte', 'Timebadda' and 'Adam Mani' were grouped in another which seems poor. 'El Mabrouka' and 'Feggous' were clustered and appeared moderate due to their dates' high seed diameter and seed mass.

Table 3: Biometric traits of fruit of date palm varieties

Varieties	Fruit length (cm)	Fruit diameter (cm)	Seed length (cm)	Seed diameter (cm)	Seed / fruit length ratio
Abbad	3.59 ± 0.24	2.07 ± 0.11	2.09 ± 0.14	0.73 ± 0.02	0.58 ± 0.00
Abd Salam	3.78 ± 0.18	2.29 ± 0.06	1.95 ± 0.04	0.82 ± 0.01	0.52 ± 0.02
Adam Bara	4.27 ± 0.20	1.68 ± 0.67	2.71 ± 0.14	0.80 ± 0.03	0.64 ± 0.05
Adam Bola	4.47 ± 0.18	2.12 ± 0.10	2.62 ± 0.12	0.76 ± 0.03	0.59 ± 0.03
Adam Lebled	3.85 ± 0.04	2.38 ± 0.11	2.40 ± 0.03	0.83 ± 0.05	0.62 ± 0.01
Adam Mani	3.16 ± 0.14	2.16 ± 0.05	1.76 ± 0.07	0.92 ± 0.02	0.56 ± 0.04
Adam Osalem	3.94 ± 0.05	1.79 ± 0.03	2.33 ± 0.09	0.90 ± 0.08	0.59 ± 0.02
Cherka	3.74 ± 0.25	2.16 ± 0.10	2.04 ± 0.12	0.96 ± 0.05	0.55 ± 0.03
Deglet Talmine	4.52 ± 0.20	2.81 ± 0.17	2.30 ± 0.21	0.87 ± 0.04	0.51 ± 0.06
El Mabrouka	4.02 ± 0.27	2.17 ± 0.25	2.25 ± 0.13	1.18 ± 0.45	0.56 ± 0.01
Feggous	3.91 ± 0.28	2.27 ± 0.11	2.11 ± 0.09	1.08 ± 0.29	0.54 ± 0.02
Hartane	4.46 ± 0.13	2.09 ± 0.05	2.53 ± 0.03	0.84 ± 0.04	0.57 ± 0.01
Hemira	4.36 ± 0.19	2.13 ± 0.10	2.43 ± 0.17	0.89 ± 0.12	0.56 ± 0.06
Hija	3.49 ± 0.07	2.02 ± 0.15	2.06 ± 0.10	0.70 ± 0.04	0.59 ± 0.02
Khalt	4.45 ± 0.51	2.06 ± 0.23	2.61 ± 0.24	0.82 ± 0.08	0.59 ± 0.05
Maatouk	4.19 ± 0.06	2.33 ± 0.02	2.19 ± 0.10	0.88 ± 0.05	0.52 ± 0.02
Tademama	3.49 ± 0.08	2.08 ± 0.45	2.14 ± 0.02	0.82 ± 0.02	0.61 ± 0.02
Takerbouchte	3.10 ± 0.09	2.51 ± 0.17	1.90 ± 0.06	0.88 ± 0.02	0.61 ± 0.03
Taorakhet	4.37 ± 0.15	2.10 ± 0.10	2.54 ± 0.05	0.78 ± 0.04	0.58 ± 0.01
Tazerza	4.03 ± 0.03	2.02 ± 0.07	2.11 ± 0.09	0.89 ± 0.05	0.52 ± 0.03
Timjohar	3.85 ± 0.19	1.57 ± 0.57	2.23 ±0.13	0.90 ± 0.07	0.58 ± 0.03
Timebadda	3.32 ± 0.01	2.18 ± 0.16	1.88 ± 0.08	0.89 ± 0.04	0.57 ± 0.02
Timeliha	3.70 ± 0.43	1.85 ± 0.16	2.64 ± 0.06	0.82 ± 0.11	0.72 ± 0.08
Timidouele	5.10 ± 0.26	2.30 ± 0.10	2.42 ± 0.03	0.81 ± 0.01	0.47 ± 0.03
Tinaser	3.91 ± 0.19	1.86 ± 0.03	2.28 ± 0.05	0.80 ± 0.03	0.58 ± 0.02
Tinizioua	4.36 ± 0.16	2.14 ± 0.01	2.35 ± 0.09	0.88 ± 0.01	0.54 ± 0.02

4 DISCUSSION

The morphological traits of dates present the identity of date palms at the harvest moment. This research was conducted to discover more phenotypic diversity between qualitative and quantitative traits among the investigated varieties. Positive significant correlations were showed between date traits where distinction between varieties has been carried out. Previous similar results were found by Bedjaoui & Benbouza (2020) regarding the positive correlation between fruit mass and seed and fruit length.

Discrimination between varieties highly appeared in qualitative terms for the fruit consistency and texture. This diversity is due to plant material's ability to benefit from a significant genotypic heterogeneity especially as the study region is spread over a large area.

But it could also be due to environmental factors (Jaradat, 2011), which include differences in hydro-edaphic factors and crop management, affecting the physico-chemical contents and also the mechanical and rheological traits of the fruit (Ismail et al., 2006) as these factors have an influence on quantitative traits. It should be noted that since the mode of cultivation in the wilaya of Adrar is multi-variety, no special cultivation practice for any variety of date palm can be recorded.

Our findings appeared similar to those of Simozrag & Laiadi (2020) where they studied the genetic diversity based on nuclear microsatellite markers. Significant diversity was recorded between 'Cherka' and 'Taker-

Table 4: Mass traits of fruit of date palm varieties

Varieties	Fruit mass (g)	Seed mass (g)	Seed/fruit mass ratio
Abbad	5.99 ± 1.06	0.73 ± 0.13	0.12 ± 0.01
Abd Salam	8.90 ± 1.23	0.86 ± 0.11	0.10 ± 0.02
Adam Bara	10.38 ± 1.06	1.03 ± 0.22	0.10 ± 0.02
Adam Bola	11.85 ± 0.65	0.88 ± 0.12	0.07 ± 0.01
Adam Lebled	10.49 ± 0.28	0.92 ± 0.22	0.09 ± 0.02
Adam Mani	7.36 ± 0.59	0.93 ± 0.07	0.13 ± 0.00
Adam Osalem	8.31 ± 0.24	0.88 ± 0.10	0.11 ± 0.01
Cherka	8.47 ± 0.81	1.10 ± 0.19	0.13 ± 0.02
Deglet Talmine	22.08 ± 1.49	0.94 ± 0.18	0.04 ± 0.01
El Mabrouka	10.53 ± 2.21	1.23 ± 0.26	0.12 ± 0.01
Feggous	10.66 ± 2.45	1.17 ± 0.29	0.11 ± 0.00
Hartane	10.72 ± 0.92	1.15 ± 0.14	0.11 ± 0.00
Hemira	11.52 ± 0.80	1.02 ± 0.01	0.09 ± 0.01
Hija	7.96 ± 2.13	0.59 ± 0.12	0.08 ± 0.02
Khalt	9.90 ± 3.35	1.09 ± 0.26	0.11 ± 0.02
Maatouk	14.30 ± 0.88	0.93 ± 0.14	0.06 ± 0.01
Tademama	6.53 ± 0.43	0.81 ± 0.06	0.12 ± 0.00
Takerbouchte	9.74 ± 1.12	0.94 ± 0.05	0.10 ± 0.01
Taorakhet	11.74 ± 1.45	0.95 ± 0.11	0.08 ± 0.01
Tazerza	9.52 ± 0.32	1.04 ± 0.06	0.11 ± 0.00
Timjohar	6.15 ± 0.33	0.94 ± 0.06	0.15 ± 0.00
Timebadda	8.57 ± 1.37	0.87 ± 0.10	0.10 ± 0.00
Timeliha	6.60 ± 0.73	1.00 ± 0.23	0.15 ± 0.02
Timidouele	14.63 ± 1.61	0.87 ± 0.10	0.06 ± 0.00
Tinaser	6.66 ± 0.75	0.88 ± 0.09	0.13 ± 0.01
Tinizioua	9.02 ± 0.44	1.07 ± 0.13	0.12 ± 0.02

bouchte' varieties and a great diversity between 'Timeliha', 'Hartane', 'Tinaser', 'Deglet Talmine', 'Timidouele' and 'Hemira' varieties.

It is possible that this diversity may be owing to commercial consideration which is mainly due to the appreciating varieties at the expense of other varieties (Table 1). For some cases, soft consistency negatively affects the demand for the fruit and its cultivation. It is only because of the risk of damage to the fruit. It concerned mainly the dates of 'Tazerza', 'Tademama' and 'Taorakhet' varieties in addition, chewiness texture even in dates of semi-dry consistency has the same effect on the dates of 'Timidouele' and 'Tinizioua' varieties (Table 1),which are proved by Acourene et al.(2007) who indicated that 'Tazerza' variety threatened with erosion in Oued Righ.

However, the dry consistency and hardiness texture of the dates are less appreciated than other types but 'Deglet Talmine' and 'Tinaser' varieties are the most distinguished ones (Table 1) due to the demand from neighboring states.

Low production of young shoots throughout the date palm cycle for cultivars of 'Abd Salam' and 'Adam Bara' is considered a major factor in the genetic decline of date palm.

5 CONCLUSIONS

This study revealed an immense wealth of the date palm genetic resources in southwest Algeria. Biodiversity analyses using fruit qualitative and quantitative traits showed a high degree of diversity among date palm varieties.

The cultivars of 'Deglet Talmine', 'Maatouk' and 'Timidouele' produced dates of high quantitative traits despite different qualitative traits. Some relationships were also observed within clusters for the multitude of varieties. 'Khalt' variety produced dates of quantitative traits better than some cultivars.

Based on these phenotypic results, the breeder could have a primitive idea about the date palm's choice of plant genetic resources.

In this study, 7 cultivars counted in danger of extinction: 'Abd Salam', 'Adam Bara', 'Tazerza', 'Tademama', 'Taorakhet', 'Timidouele' and 'Tinizioua'.

Such work is an overview of the genetic identification of date palms. Further characterization of the date palm vegetative part is suggested, and biochemical and molecular analysis should be completed to allow precise identification.

In situ collections do not suffice with the extension of the adverse threats. There is an urgent need to establish field gene banks to preserve date palm genetic resources less frequented and less in demand, and to provide suitable germplasm for propagation.

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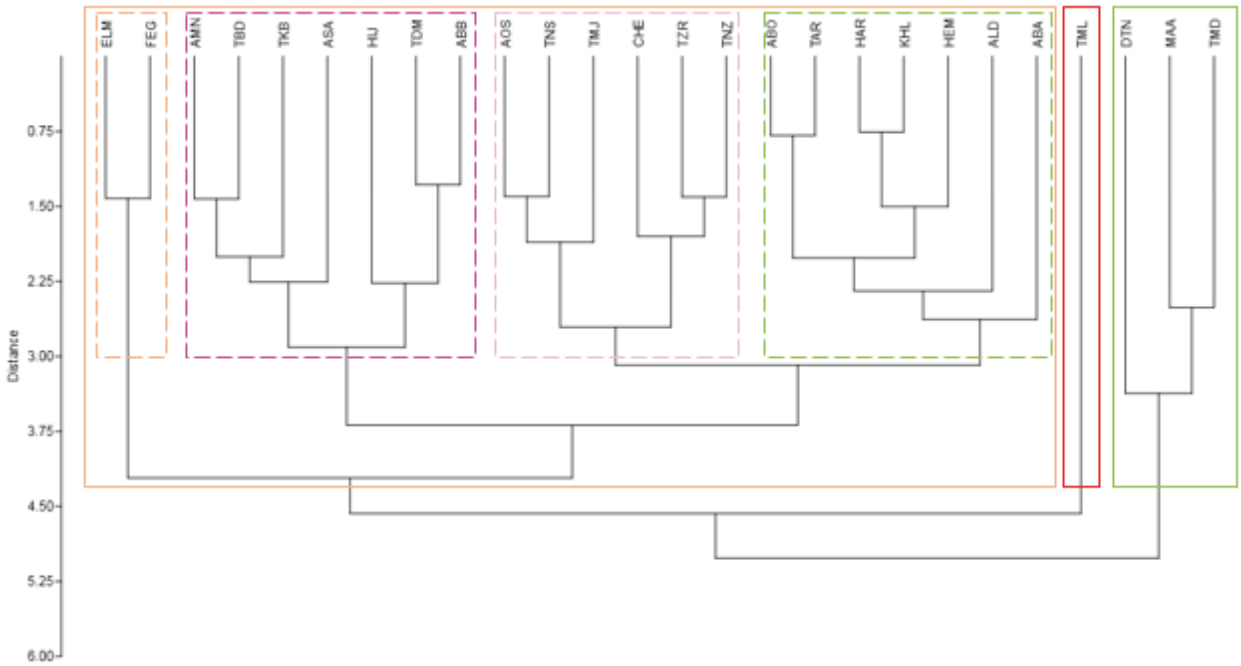

Figure 4: Hierarchical clustering of Algerian date palm fruit-based on eight quantitative traits

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