PHYSICOCHEMICAL CHARACTERISTICS AND NUTRITIONAL COMPOSITIONS OF SOME DATE (*PHOENIX DACTYLIFERA* L.) FRUIT CULTIVARS

– Research paper –

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Abstract: A comparative study was carried out for eight mature date fruit cultivars to assess physicochemical and nutritional values. Results showed that fruit and flesh weights and seed sizes indicated wide diversity among studied cultivars. The highest pH, acidity, and ash levels were obtained from *Tazizaout* and *Oukasaba* cultivars; protein contents varied from 0.47 (*Tazizaout*) to 0.31 g/100g DM (*Delat*), while free amino acids concentrations were found between 1.47 (*Oukasaba*) and 0.79 g/100g DM (*Tazarzeit*). Total carbohydrates were ranged from 96.28 to 84.51 g/100g DM. The date is low in fat, the highest concentration was 0.11 g/100g DM. Principal Component Analysis indicated that *Ourous* and *Delat* cultivars have specific characteristics and can be distinguished from the other cultivars.

Keywords: Date palm, cultivar, physicochemical characteristic, nutritional composition, biodiversity

INTRODUCTION

Date palm (*Phoenix dactylifera* L.) is considered among the oldest cultivable crop that was extensively grown in northern Africa and Middle East. This fruit is a berry including one-seeded that is surrounded by a relatively hard endocarp, then by fleshy mesocarp and finally by a thin epicarp (Ahmed et al., 1995). The date is considered to be an important subsistence crop in arid and semi-arid regions and plays an important socioeconomic strategy for many countries (Chandrasekaran and Bahkali, 2013). More than 2000 cultivars have been recorded around the world, but only a few of them have been used for their agricultural productivity and fruit quality (Mrabet et al., 2008). The Date plays an important role in the social life of the people both in their diet and medicinally. This fruit is well known for its numerous health properties; it is recommended for the prevention and treatment of several diseases such as coronary heart-related dysfunctions, constipation, cancer, etc. (Suliman et al., 2012).

The Date fruit is considered as the main crop produced in Algeria; with 1058559 tons harvested in 2017, it ranks the third worldwide (FAOSTAT, 2018). In addition to its leading economic place, dates are an integral part of Algeria diet and are

usually consumed either fresh or sun-dried as such or with milk. In order to elaborate processed products with high value-added, dates are consumed as syrup, jellies, pickles, paste, jams, and are used in many bakery or confectionery products together with chocolate, coconut, honey, vinegar, and others (Ghnimi et al., 2017).

This fruit considered as a good source of numerous nutrients (simple and complex sugars, minerals, antioxidants, etc.) and provide rapid energy due to their high carbohydrates content. The most are fructose and glucose, which are easily assimilated by the human body (Myhara et al., 1999). It is established that date composition can vary from cultivars depending on soil and climate conditions and agronomic practices (Al-Farsi et al., 2007).

M'zab oasis of Ghardaia department (southern Algeria) is among the highest date productivity with high biodiversity of date palm in Algeria. However, little scientific knowledge is available on the functional and biochemical composition of date fruits cultivars of this region. It was also revealed that differences in cultivars and locations might also affect the physicochemical characteristics of date fruits. Therefore, because of the growing importance of date fruits crop in Algeria, the current study was performed to evaluate physicochemical characteristics and nutritional

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compositions of date fruits of eight cultivars (“*Ourous*, *Tazizaout*, *Tazarzeit*, *Tazoughart*, *Ouaouchet*, *Oukasaba*, *Delat*, and *Tamezwert n'telet*” native to M’zab oasis) and assess the interrelationships between parameters, using the

Principal Component Analysis, allowing a precise characterization of studied cultivars. This would provide a description of characteristics, serving as a basis for the standardization of the fruit to promote its production and utilization.

MATERIALS AND METHODS

Plant material

Eight ripe cultivars of date palm fruits locally known as *Ourous*, *Tazizaout*, *Tazarzeit*, *Tazoughart*, *Ouaouchet*, *Oukasaba*, *Delat*, and *Tamezwert n'telet* were harvested in November 2016. Fruits were collected from M’zab oasis in the region of Ghardaia (Southern Algeria). They were selected with similar size, ripening stage, without infection and physical damage. Samples were cleaned, pitted, and crushed with hand grinding mill and kept in polyethylene boxes at 4°C.

Determination of morphological parameters

The physical characteristics were measured on 10 randomly harvested fruits. The investigated parameters were fruit size (weight, length, and width), measured using calliper. The length/width ratio was then calculated. Flesh and seed weight (in cm) of fruit were determined using an analytical balance (RADWAG model PS 600/C/2, Poland) and the seed/fruit, flesh/fruit and flesh/seed ratio were determined.

Determination of physicochemical characteristics and nutritional compositions

Hydrogen potential measurements were performed using a pH meter (Bante model 920, UK) at 20°C. Titratable acidity, expressed as a percentage of malic acid equivalent, was determined by titrating with NaOH solution (0.01N) to endpoint pH of 8.1 ± 0.20 (ISO 750, 1998). Total soluble solids (TSS) were measured with Abbe Refractometer (Optic system) and expressed as °Brix. Ash was obtained by combustion of dates in a muffle furnace (Nabertherm GmbH, Germany) at 550 °C for 6 hours. Moisture content was determined from 2 g of homogenized date fruits using a ventilated oven (WTB Binder, 120 Tuttlingen, Germany) at 105°C until constant weight. Lipids were extracted with a Soxhlet extractor (Behr Labor Technik, Germany) from 15 g of date pulp with 150 ml of petroleum ether; fat contents were calculated after the removal of the solvent by evaporation.

The HMF content was recorded as described by White (1979). The sample (0.5g) was homogenized with 10 ml of distilled water; 500µl of Carrez I (potassium ferricyanide 15%) and Carrez II (zinc

acetate 30%) reagents were added and the volume was completed to 15 ml with distilled water. The supernatant was paper filtered and a volume of 1 ml of filtrate is put in two test tubes to which 1 ml of distilled water as sample or bisulfite (0.2%) as reference are added. The HMF content was calculated according to the following equation: $\text{HMF (mg/100g)} = (A_{284} - A_{336}) \times 74.85$

A_{284} and A_{336} : absorbance values at 284 and 336nm, respectively.

74.85: Specific factor of dilution and conversion.

FAA content was estimated according to Yemm et al. (1955) method. FAA were extracted from date pulp with 10 ml of 80% ethanol, the mixture was incubated at 95°C for 20 min, then the extract was separated by centrifugation (Nuve NF 200, Ankara, Turkey). 1 ml of the extract was added to 0.5 ml of citrate buffer (0.2M, pH 5), 1 ml of potassium cyanide (0.01 M) and 200µl of ninhydrin (1%). After 15min of incubation at 100°C, 2.3 ml of 60% ethanol was added to the reaction mixture. The absorbance was measured at 570 nm and results were expressed as mg leucine equivalent per 100g of dry matter (DM) with reference to a calibration curve.

The proline content was determined by the spectrophotometric method described by Bates et al. (1973). 0.1 g of date pulp was stirred with 10 ml of sulfosalicylic acid (3%) for 30 min. The extract is recovered after filtration. 0.5 ml of the glacial acetic acid and 0.5 ml of the acid-ninhydrin are added to the assay. The mixture is heated for 60 min in a water bath at 95 °C (WB 22, Memmert, Osterode, Germany). After cooling, 1 ml of toluene is added and the mixture is centrifuged at 5000 rpm for 10 min. The absorbance of the organic phase is recorded at 520 nm. The total content of proline was determined based on a standard calibration curve prepared using proline.

The method of Bradford (1976) was used for protein determination. Bradford reagent (2.5 ml) was mixed with 0.1 ml of extract and the absorbance was measured at 595 nm after 5min of incubation. Protein concentrations were expressed as mg of bovine serum albumin (BSA) equivalent per 100g of DM using a calibration curve of BSA. Total carbohydrates were determined according to the phenol-sulfuric acid method according to

Dubois et al. (1956). The diluted sample (0.5 ml) was mixed with 0.5 ml phenol solution (5%) followed by addition of 2.5 ml concentrated sulfuric acid. The mixture was left at 105°C for 5 min prior to measuring absorbance at 490 nm using a spectrophotometer (Uvline 9400, Secomam, France). The total carbohydrate content was determined based on a standard calibration curve prepared using glucose.

Reducing sugars were determined by the dinitrosalicylic acid (DNS) method (Miller, 1959). DNS reagent (1 ml) was added to 1 ml of the extract, the mixture was heated for 15 min in a water bath at 95 °C. To stabilize the colour under these conditions, 1 ml of a 40% Rochelle salt was added to the mixture. The absorbance was measured at 575 nm and the results were expressed as g of glucose per 100g of DM with reference to a calibration curve using glucose as a standard.

Statistical Analysis

The results are expressed as the average values of three repetitions. To assess the significant differences of physicochemical characteristics among cultivars, analysis of variance with LSD test (Least Significant Difference) was performed using the Statistica software 8. A probability of 0.05 was considered significant.

To evaluate the relationship between different parameters and cultivars, a Principal Component Analysis (PCA) was conducted using the Statistica software. This statistical method was performed on the variance matrices for each group of parameters (morphological and physicochemical).

The significance of similarities between cultivars was tested to provide a set of weightings that allow studied date palm cultivars to be distinguished.

RESULTS AND DISCUSSION

Morphological characteristics

The physical properties of the eight date cultivars were presented in Table 1. *Delat* cultivar was the weightiest fruit (9.89 g), while *Tazarzeit* was significantly lower than the other cultivars (6.94 g). The weights of analyzed dates were lower than those reported by Sulieman et al. (2012) for five date palm cultivars grown in Sudan which showed that the highest value was 12.78 g. According to Saeed et al. (2015) study on five date cultivars grown under Sudanese conditions, the fruits *Ambrah* variety exceed 22 g that was classified as fruits with the heaviest weight.

Tazoughart had the highest value of seeds weight percentage (16%), followed by *Delat* and *Tamezwert n'telet* (15%) and the lowest was *Ouaouchet* cultivar (11%). Consequently, the flesh/seed ratio varied between cultivars, it was noted from table 1 that *Tazoughart* had the lowest ratio (5.32) and *Ourous* exhibited the highest ratio (9.14) and considered as the cultivar which highest edible portion.

Delat cultivar had the lengthen fruit (5.01 cm) followed by *Ourous* (4.79 cm), *Oukasaba* had the least fruit length (3.63 cm) which was statistically lower than all other cultivars. *Tazoughart* had the highest fruit diameter (2.17 cm) while *Tazarzeit* cultivar had the lowest one (1.81 cm).

The average fruit length was 4.21 cm which is higher than that reported by Singh et al. (2013) for Omani cultivars, which ranged between 2.70 and 4.07 cm. The average fruit diameter was 1.90 cm

which is lower than Iranian cultivars investigated by (Jahromi et al., 2007), which was in the range between 1.82 and 2.53 cm.

The flesh/fruit ratio was a criterion of date characterization. It indicated from the results of Table 1 that the flesh represents about 90-84% of the whole date weight. The *Ourous* cultivar seems the best one, followed by *Ouaouchet*. The flesh/date fruit ratio of these cultivars was very similar to the most well-known Tunisian cultivars *Deglet Nour* and *Horra*, which is equal to 90 and 88%, respectively (Amira et al., 2011).

The morphological parameters were important criteria for the differentiation between the studied cultivars. Variations of physical parameters proved significant differences of the fruit characteristics in some date cultivars (Shar et al., 2012).

Determination of physicochemical characteristics and nutritional compositions

The determination of physicochemical and nutritional compositions of dates is considered as important for storage, processing, and commercialization of dates.

Physicochemical characteristics (pH, TA, TSS, moisture, ash, lipids, HMF, FAA, proline, proteins, carbohydrates and reducing sugars) of eight date cultivars grown in M'zab oasis revealed statistical differences and the results were regrouped in Table 2.

Table 1. Physical characteristics of studied date cultivars

Parameter	<i>Ourous</i>	<i>Tazizaout</i>	<i>Tazarzeit</i>	<i>Tazoughart</i>	<i>Ouaouchet</i>	<i>Oukasaba</i>	<i>Delat</i>	<i>Tamezwert n'telet</i>
Fruit weight (g)	8.98 ± 0.63 ^b	8.31 ± 0.75 ^{bc}	6.94 ± 1.39 ^c	8.04 ± 0.88 ^c	7.79 ± 0.64 ^{cd}	7.97 ± 0.85 ^c	9.89 ± 1.06 ^a	7.19 ± 0.74 ^{de}
Flesh weight (g)	8.04 ± 0.53 ^a	7.02 ± 1.17 ^b	5.98 ± 1.39 ^c	6.78 ± 0.80 ^{bc}	6.87 ± 0.60 ^b	6.93 ± 0.79 ^b	8.31 ± 1.03 ^a	6.05 ± 0.58 ^c
Seed weight (g)	0.86 ± 0.14 ^{de}	1.04 ± 0.15 ^c	1.00 ± 0.20 ^{cd}	1.28 ± 0.16 ^b	0.86 ± 0.12 ^d	0.97 ± 0.12 ^{cde}	1.50 ± 0.20 ^a	1.09 ± 0.20 ^c
Fruit length (cm)	4.79 ± 1.74 ^b	3.99 ± 1.46 ^d	3.73 ± 2.28 ^e	4.04 ± 1.71 ^d	4.11 ± 2.92 ^d	3.63 ± 1.82 ^e	5.01 ± 3.37 ^a	4.37 ± 2.13 ^c
Fruit width (cm)	1.82 ± 0.75 ^c	1.84 ± 0.72 ^c	1.81 ± 1.11 ^c	2.17 ± 1.39 ^a	1.95 ± 1.37 ^b	1.87 ± 1.20 ^{bc}	1.9 ± 2.29 ^{bc}	1.9 ± 1.06 ^{bc}
Fruit Length/width	2.63	2.17	2.06	1.86	2.11	1.94	2.64	2.30
Seed/fruit weight	0.10	0.13	0.14	0.16	0.11	0.12	0.15	0.15
Flesh/fruit weight	0.90	0.84	0.86	0.84	0.88	0.87	0.84	0.84
Flesh/seed weight	9.14	6.75	5.96	5.32	8.03	7.11	5.53	5.57
Seed %	10	13	14	16	11	12	15	15

Each value represents the mean ± SE. Results within the same line with different letters are statistically different at $p < 0.05$ (ANOVA-LSD test)

Table 2. Proximate chemical composition of the studied date cultivars

Date variety	pH	Acidity (%)	TSS (%)	Ash (%)	Moisture (%)	Fat (%)	HMF (mg/100g)
<i>Ourous</i>	6.017 ± 0.007 ^d	0.16 ± 0.01 ^d	69.12 ± 0.62 ^c	1.85 ± 0.14 ^{ab}	11.34 ± 0.00 ^d	0.043 ± 0.005 ^c	0.24 ± 0.08 ^c
<i>Tazizaout</i>	6.73 ± 0.007 ^a	0.33 ± 0.02 ^a	71.88 ± 0.67 ^b	1.80 ± 0.49 ^{abc}	14.08 ± 0.16 ^{cd}	0.063 ± 0.033 ^{bc}	0.16 ± 0.05 ^{cd}
<i>Tazarzeit</i>	6.30 ± 0.019 ^b	0.23 ± 0.00 ^c	71.53 ± 0.87 ^b	1.25 ± 0.07 ^c	14.14 ± 0.00 ^{cd}	0.037 ± 0.024 ^c	0.07 ± 0.02 ^d
<i>Tazoughart</i>	6.05 ± 0.003 ^c	0.29 ± 0.01 ^b	64.90 ± 0.73 ^e	1.40 ± 0.15 ^{bc}	14.79 ± 0.46 ^{cd}	0.077 ± 0.024 ^{abc}	0.14 ± 0.08 ^{cd}
<i>Ouaouchet</i>	6.05 ± 0.011 ^c	0.16 ± 0.01 ^d	71.29 ± 0.75 ^b	1.47 ± 0.11 ^{abc}	13.24 ± 0.29 ^{cd}	0.103 ± 0.005 ^{ab}	0.62 ± 0.1 ^a
<i>Oukasaba</i>	5.53 ± 0.011 ^f	0.31 ± 0.01 ^{ab}	65.01 ± 0.16 ^c	1.99 ± 0.00 ^a	39.04 ± 3.92 ^a	0.09 ± 0.014 ^{ab}	0.15 ± 0.07 ^{cd}
<i>Delat</i>	5.98 ± 0.010 ^e	0.23 ± 0.00 ^c	67.06 ± 0.94 ^d	1.49 ± 0.14 ^{abc}	18.27 ± 0.44 ^c	0.113 ± 0.009 ^a	0.16 ± 0.05 ^{cd}
<i>Tamezwert n'telet</i>	5.49 ± 0.001 ^g	0.29 ± 0.02 ^b	73.22 ± 0.88 ^a	1.55 ± 0.42 ^{abc}	26.11 ± 2.33 ^b	0.067 ± 0.009 ^{bc}	0.39 ± 0.09 ^b

Each value represents the mean ± SE. Results within the same line with different letters are statistically different at $p < 0.05$ (ANOVA-LSD test)

pH value of studied cultivars was ranged between 5.49 and 6.73. Our results showed a similar trend to those reported in other date cultivars, who studied chemical compositions of Iranian date palm (Rastegar et al., 2012).

For titratable acidity, significant differences were observed among studied cultivars. The values of titratable acidity varied from 0.16% observed in *Ourous* and *Ouaouchet* to 0.33% obtained from *Tazizaout*. Our results were lower than those reported by Hesami and Abdi (2010), who obtained values ranged between 0.36 to 0.50% for date cultivars grown in Iran, but higher than those reported by Lemine et al. (2014) for Mauritanian cultivars (0.03 to 0.14 g malic acid/100g FW).

These results showed that *Tamezwert n'telet* had the highest TSS content (73.22 °Brix) followed by *Tazizaout* (71.88 °Brix) and the lowest level was recorded to *Tazoughart* (64.90 °Brix). The TSS values were in good agreement with those reported for the three Tunisian cultivars (Deglet Nour, Alligand, and Kentichi) values ranging between 65 and 75 °Brix (Abbès et al., 2011) and lower than with those measured by Al Tamim (2014) for Saudi and Egyptian date fruits (89 and 91 °Brix). Differences observed were principally due to the cultivar but other parameters can contribute such as climate conditions and harvesting period.

The eight studied cultivars present low percentages of ash (Table 2); the highest level was obtained

from *Oukasaba* cultivar (1.99%) and the lowest one was recorded to *Tazoughart* cultivar (1.25%). Moisture amount fluctuated between 11.34 and 39.04% for respectively *Oukasaba* and *Ourous* cultivars.

The date is a fruit with low content of fat; found results for the analyzed cultivars varied between 0.037 (*Tazarzeit* cultivar) and 0.113% (*Delat* cultivar). The level of lipid for *Ourous* and *Delat* cultivars was in agreement with those obtained by Al-Harrasi et al. (2014) for *Naghal* and *Qushbu Maan* of Omani date cultivars.

The 5-hydroxymethyl-2-furfural (HMF) is generally not present in fresh food, but it is naturally produced in food containing a high level of carbohydrates. HMF is the product of different reactions involving various precursors and intermediates such as carbohydrates, amino acids, vitamins, etc. (Anese and Suman, 2013). Analyzed cultivars exhibited large variations; *Ouaouchet* cultivar had relatively high HMF content (0.62 mg/100 g DM) that probably due to their richness in reducing sugars.

Previous studies have already determined high quantities of HMF in several types of dried fruits; Rahimzadeh et al. (2014) for example obtained contents ranged between 80 and 8569 mg/kg from numerous dried fruits including date (100 mg/kg), fig (159 mg/kg), apricot (838 mg/kg), etc. The differences between these results may be due to the species, cultivar, drying procedure, storage conditions.

About 500 variable amino acids exist in nature, but only 20 constitutes the building blocks of proteins (Oancea and Formaggio, 2008). The percentage of nitrogen varied in most from 0.1 to 1.5% in fruits of which 35 to 75% is represented by protein. The amino acid profile is typical and can be used for the characterization of a fruit product (Belitz et al., 2009). The free amino acid contents of date fruits are shown in Figure 1. ANOVA indicated significant differences ($p < 0.05$) between studied date cultivars. The contents ranged from 0.58 to 1.47 g/100g DM; *Oukasaba* contained a significantly high content of FAA. The determination of FAA contents in fruits and vegetables has been the subject of only a few investigations. The phytochemical screening studied by Birlangi (2016) has revealed the presence of eight essential amino acids and five non-essential amino acids in different cultivars of date palm fruits from the Middle-East region.

The analysis of proline content showed that the fruits *Oukasaba* cultivar contains a high concentration (0.23 g/100g DM). Comparing with our findings, Assirey (2015) obtained slightly lower proline contents for Sudanese dates (0.09-0.15 g/100g DM).

The dates are not concentrated on protein, but they contain more protein than other fruits. The average protein concentrations of the studied date cultivars determined with the Bradford method is given in Figure 1. The studied cultivars present the lowest percentages of protein in comparison with the data reported in previous studies. Significant variations were shown between cultivars. The highest protein content was recorded to *Tazizaout* cultivar (0.47 g/100 g DM) and the lowest one is attributed to *Delat* (0.31 g/100 g DM). The protein content of Tunisian date cultivars (Saafi et al., 2008) is higher than the values obtained in the present investigation. These results could be attributed to cultivar variations, environmental conditions and/or analysis methods.

Date fruit are characterized by a high content of carbohydrates, which represent the main components. These sugars are mainly reducing carbohydrates (glucose, fructose, mannose, and maltose), non-reducing sugars such as sucrose and small amounts of polysaccharides (Al-Shahib and Marshall, 2003). For date cultivars of our study, total sugars content varies from 84.51 to 96.28 g/100g DM (Figure 2), which are higher than to those found previously for dates of Saudi Arabia (71-81 g/100g DM) (Assirey, 2015).

Glucose and fructose were the predominant reducing sugars in studied date cultivars with the exception of *Ourous* cultivar, which had large non-reducing sugars content. The presence of high levels of reducing sugars could due to the presence of important invertase activity that liberates reducing sugars from sucrose (Fayadh and Al-Showiman, 1990).

Figure 2 shows that *Ouaouchet* has the highest content of reducing sugars (80.45 g/100 g DM). Moreover, the findings of this study were higher than values published by Thouri et al. (2017) for *Khorkobbi* and *Arechti* cultivars who reported that reducing sugar contents varied from 34.66 to 24.37%; Parvin et al. (2015) analyzed three date cultivars grown in Bangladesh and reported 42 to 48% of reducing sugars. The difference between physicochemical and nutritional parameters could mainly due to cultivar variations (Agomuo and Amadi, 2018; Jolayemi, 2019).

Figure 1. Free amino acid, proline, and protein contents of date fruits cultivars. For each parameter, results with different letters are statistically different at $p < 0.05$ (ANOVA-LSD test)

Figure 2. Total carbohydrates and reducing sugars contents of date fruits cultivars. For each parameter, results with different letters are statistically different at $p < 0.05$ (ANOVA-LSD test)

Principal component analysis (PCA)

The PCA was run using all measured physicochemical and morphological attributes in the objective to reduce the multivariate data to a two-dimensional presentation. Data exploration via Component matrix for attributes of date cultivars for the first two principal factors (PC) was showed in Table 3. For the two retained factors, the first one (PC1) explained 23% and had characteristics with a high contribution of seed % (-0.91), seed %/ fruit weight (-0.91), and flesh/seed weight (0.90). The second component (PC2) explained 20% and represented by fruits length (-0.89) and weight (-

PCA indicated specific and characteristic trends in different cultivars of date, which confirms the importance of multivariate analysis for the determination of possible grouping among the studied date cultivars.

0.80), proteins (0.74), and fruit length/ width (-0.72). The cumulative variance is approximately 42%, which indicates that the date fruit cultivars are not well distinguished by their nutritional value and morphological characteristics.

Table 3. Component matrix for chemical and morphological attributes of eight date cultivars for the first two principal components (PC) and the percentage variance accounted for each component.

Attribute	PC1	PC2
Hydroxymethylfurfural	0.380	0.055
Free amino acids	-0.443	0.241
Proline	-0.128	0.431
Proteins	0.240	0.735
Total carbohydrates	0.263	0.215
Reducing sugars	-0.609	0.278
Hydrogen potential	0.174	0.083
Titrateable acidity	-0.269	0.082
Total soluble solids	0.334	0.306
Ash	0.398	0.099
Lipids	-0.170	-0.406
Moisture	-0.314	0.269
Fruit weight	0.227	-0.804
Flesh weight	0.343	-0.692
Seed weight	-0.664	-0.690
Fruit length	0.309	-0.885
Fruit width	-0.466	-0.167
Seed %	-0.909	-0.165
Seed %/fruit weight	-0.910	-0.161
Flesh/fruit weight	0.139	0.131
Flesh/seed weight	0.896	0.161
Fruit length/width	0.479	-0.719
Variance explained (%)	22.650	19.506
Cumulative variance (%)	22.650	42.156

The graphical representation of eight date cultivars projected on the plane 1-2 of the principal component was showed in Figure 3. The

distribution and the dispersion of different cultivars through the plan formed by both principal axes based on the physicochemical and morphological parameters of fruits indicate characteristic variations of studied date cultivars. From the third group, *Tazarzeit* cultivar was relatively isolated from other cultivars.

The results reported by Elshibli and Korpelainen (2009) assessed the variation of fifteen cultivars in soft and dry types of the Sudanese date palm, PCA was performed on the basis of the chemical and morphological parameters of fruits and tree morphology. The results showed that the use of a combination of the different characters allows distinguishing the different cultivars. However, in our study, PCA applied for the studied date fruits revealed that only *Ourous* and *Delat* cultivars can be distinguished unlike to the other cultivars.

Figure 3. Dispersion of eight date fruits cultivars in the bi-plot of principal component analysis based on 22 marker systems of characterization, including fruit morphology and physicochemical characters of fruit

CONCLUSIONS

In overall, our findings provided insights into the composition and nutritional value of eight date cultivars growing in M'zab oasis (Algeria). Cultivar strongly induced variations on the different analyzed parameters; regarding the physicochemical and morphological characteristics, significant differences are recorded between the investigated date cultivars. Our results revealed that all date cultivars make an essential

nutrient and valuable richness food with great potential health benefits. The date cultivars contain a higher content of amino acids, carbohydrates and reducing sugars. The Principal component analysis revealed the relationships between different cultivars based on physicochemical and morphological parameters. PCA plot showed that the *Ourous* and *Delat* cultivars have specific characteristics that allowed their distinction from other cultivars.

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