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Compositional analysis and sensory profile of five date varieties grown in south Algeria

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ABSTRACT

Morphological, physicochemical, biochemical, phytochemical and sensory characteristics of date fruits of cultivars Deglet Noor, Tamesrit, Ghars, Tinissine and H'mira were investigated. External and internal fruit quality was assessed by different parameters: fruits and cores weights and dimensions, pH, salt content, water, sugar, proteins, lipids, polyphenols and Flavonoids. Sensory quality was performed by panel tests of size, aroma, color, texture and sweet/acid taste of fruits. The studied varieties showed a low content in fat and proteins, but important amounts of sugars, dietary fiber, potassium and polyphenols. These results suggest that the five varieties are a good source of essential and important nutrients on health. The dates have significantly distinct characteristics; Tamesrit had the highest weight (14,66 g) compared to other varieties; Deglet Noor showed significantly ($p<0,05$) higher level of sugar (70%) particularly sucrose (29%) against 0% in Tamesrit and finally Tinissine contained significantly ($p<0,05$) higher levels of polyphenols. Differences in sensory scores of fruit were found between cultivars; showing a high preference score for Tamesrit cultivar.

Key words: date palm, compositional analysis, sensory quality.

INTRODUCTION

Dates, fruits of *Phoenix dactylifera*, are widely cultivated in arid and semi-arid areas in Algeria. The appreciation of the fruits by the population depends on a combination of several quality criteria that are associated with maturity, physicochemical (size, color, sugar content and consistency) and sensory properties (taste and flavor) [1].

Dates are important to human health due to their antioxidant capacity related to their high content of polyphenols; they are also rich in fiber and some minerals such as potassium, magnesium [2]. Date fruits are considered as a good source of sugars; it provides natural sugar in the form of glucose and fructose, which are easily absorbed by the human body [3]. Fruit quality is determined by sensory evaluation and physicochemical and biochemical measurements [4].

Algeria have a rich biodiversity of about 1900 date cultivars, but only some are evaluated for their fruit quality [5]. The aim of this study was the characterization of physicochemical, biochemical, phytochemical and a sensory evaluation of five Algerian date varieties. We try to discuss the health aspects of different components found in dates.

EXPERIMENTAL SECTION

1. Plant material

Five date palm cultivars grown in Algeria were used for this study. The dates in "*Tamr*" stage (maturity stage) are obtained from the farmers. Varieties *H'mira* and *Tinissine* originated from Adrar (south-west of Algeria); *Deglet*

Noor, *Ghars* and *Tamesrit* from Ghardaïa (600 km south of Algiers, south-central of Algeria). The samples were collected during 2013 season. 3 kg of each variety were used for experimentation. Each sample was cleaned and placed in polyethylene bags with labels, and stored in refrigerator until analysis.

2. Morphological Parameters

The samples consist of 20 dates randomly taken. Morphological measurements were realized on each fruit: weights of flesh, core and the whole date were determined using a precision scale, the length of the fruit was measured with a micrometer caliper.

3. Physicochemical and biochemical analysis of dates

For each date variety, pH measurement was performed using a pH meter of Karl Kolb trademark; total ash is obtained by incineration. Sample drying at 105°C during 24 hours is followed by calcination in muffle furnace for 5 hours at 500°C (% Ash= 100-% OM) (AFNOR, 1977: NF V 18-101). Potassium, sodium and magnesium assessment was carried out using an atomic absorption spectrophotometer; the contents are determined by the standard curves.

Total sugar has been identified by Dubois method and Bertrand method for reducing sugar; the sucrose content is obtained by the following formula: *% Sucrose = % Total sugar -% total reducing sugar* [6]. Proteins were measured by Kjeldahl method, according to AFNOR, 1977 (NF V 18-100) using a Kjelfoss automatic apparatus (Foss-Electric, Denmark) N×6,25; crude. Insoluble fiber was assessed by Weende method reported in AFNOR, 1993 (NF V 03-040) and soluble fiber by Kratchanova method [7]. water rate was evaluated by drying at 103± 2°C of ground sample until getting constant dried weight (% Humidity (H) = m_1-m_2/p×100) [6].

4. Phytochemical characterization

Phytochemical screening was carried out by colored reactions according to Ciulei [8]. The evaluation of total polyphenols rate is carried out by Folin-Ciocalteau reagent according to Singleton and Rossi method [9] using gallic acid as standard; the color produced is proportional to polyphenols amount in the plant extracts; absorbance is measured at 725-750 nm. Results are expressed in mg Gallic Acid Equivalent (GAE)/100g of fresh weight. Flavonoids content was evaluated according to the method described by Lamaison and Carnat [10] using quercetin as standard, the coloration produced is proportional to Flavonoids amount; absorbance is measured at 430 nm. Results are expressed in mg of Quercitrin Equivalent (QE)/100g of fresh weight.

5. Sensory evaluation

The sensory panel includes ten (10) individuals (6 women and 4 men, aged 23-45 years) having already consumed dates fruit. Fruit quality was assessed by comparing external aspect, color, flesh firmness, texture, astringency and sweet taste. For visual evaluation or flavor, the samples order was randomized. During flavor evaluation panelists rinsed their mouth with water at room temperature after intake of each variety of dates. The preference of dates (hedonic score) is evaluated by 60 volunteers, aged 18-55 years; the evaluation of the appreciation was expressed on a numerical scale ranging from 1 to 5 (1: unacceptable; 2: low; 3: fairly good; 4: good and 5: excellent).

6. Statistical analysis

Results are expressed as mean ± standard deviation; variability between cultivars of dates is determined by the ANOVA test, using STATISTICA software (STATISTICA V6).Significance was accepted at 0.05 level of probability ($p<0.05$).

RESULTS AND DISCUSSION

1. Morphological characterization

The measurement of length and weight of the entire date, flesh and cores have allowed some authors to evaluate the quality of Iraqi and Egyptian dates [11]. Morphological properties of dates are shown in Table 1. There were statistical differences among cultivars in the most of characteristics ($P<0.05$).

Table 1: Morphological characteristics of the five varieties grown at southern Algeria

	Ghars	*Tamesrit*	*H'mira*	*Deglet Noor*	*Tinissine*
Date length (cm)	4,10± 1,20^{a}	5,10±0,05^{b}	3,70±0,10^{c}	4,70±0,45^{b}	3,60 ±0,65^{c}
Date weight (g)	6,61±0,04^{a}	14,66±0,01^{b}	6,23±0,04^{d}	9,00±0,04^{e}	6,58±0,19^{a}
Flesh weight (g)	5,56 ±0,05^{a}	13,21±0,01^{b}	5 ,58±0,04^{a}	8,12±0,10^{c}	5,80± 0,24^{a}
Core weight (g)	0,65±0,02^{a}	1,45±0,01^{b}	0,65±0,01^{a}	0,97±0,06^{c}	0,78±0,01^{c}
Flesh Yield (%)	84,11	90,11	89,56	90,22	88,14

On same line, Means followed by the same letters are not statistically different.

1.1. Date length

Varieties length ranges from 3,60 cm to 5,10 cm. Cultivars *Deglet Noor* and *Tamesrit* are the longest dates; 4,70 cm and 5,10 cm respectively, while *H'mira* and *Tinissine* present the smallest date length; 3,70 cm and 3,60 cm respectively. These values are similar to those found for the same Algerian varieties from other regions [5]. Compared to those found for Tunisian varieties, ranging from 2, 75 to 3, 80 cm, these results prove higher dimensions. Munier [12] reported that fertilization and adequate irrigation of date palms provide dates with length, diameter and weight better than poorly maintained ones.

1.2. Date, core and flesh weights

- Date weight

Date fruit of *Tamesrit* cultivar had significantly the highest weight (14,66 g) compared to studied cultivars, followed by *Deglet Noor* (9 g) ($p<0,05$). Whereas the smallest date weights were observed in *Tinissine* and *H'mira* varieties i.e. 6,58 g and 6,23 g respectively. The obtained results are not in agreement with those reported by Acourene *et al.* [5] for the varieties *Tamesrit* and *H'mira*, which were 10,59 and 11 g respectively, this difference could be explained by climatic and cultural conditions. Compared to other studies, it was found that weights of different dates can change from one cultivar to another and from one region to another; dates weights of 54 Algerian cultivars studied by Acourene *et al.* [5] ranged from 3,88 g to 19,41 g.

- Core weight

The smallest core weight was observed in *Ghars* and *H'mira* cultivars; i.e. 0,65 g for each one. Whereas the highest core weight was recorded in *Tamesrit* cultivar; i.e. 1,45 g. These results are lower than those found by El Arem *et al.* [13] who reported that weights of cores ranged from 1.36 g to 1.89 g respectively, for some Tunisian varieties.

- Flesh yield

Results showed that dates flesh present 84 to 90 % depending on the studied cultivars, *Deglet Noor* and *Tamesrit* are the most fleshy varieties, with a yield of 90 % each one, these ones are the most profitable fruit compared to other cultivars. These results are in agreement with those found by El Arem *et al.* [13] for the Tunisian *Deglet Noor* cultivar which registered the highest yield at the "*Tamr*" stage. *Ghars*, *H'mira* and *Tinissine* have a low ratio of flesh weight / date weight, i.e. 84 to 89 % despite their low weights.

2. Physicochemical and biochemical analysis of dates

2.1. Physicochemical characteristics

In Table 2 are reported the values of the pH, water content, ash levels and mineral elements (K^+, Mg^{2+} and Na^+).

Table 2: physicochemical characteristics of the five studied dates

	Ghars	*Tamesrit*	*H'mira*	*Deglet Noor*	*Tinissine*
pH	6,40±0,03	6,00±0,1	5,46±0,09	5,42 ± 0,46	5,9±0,12
Moisture	26,35±2,1^{a}	21,50±0,98^{b}	14,48±0,8^{c}	20,83±0,39^{b}	18,69±1,1^{b}
Ash %	1,7±0,01^{a}	2,00±0,01^{a}	2,87±0,04^{b}	1,59±0,67^{a}	2,1±0,1^{a}
K^+ (mg/100g)	668,7±5,2 ^{a}	789,6±7,1^{b}	824±9^{bc}	665±8,4^{a}	916,5±5,8^{cd}
Mg^{2+} (mg/100g)	39,9±0,98^{a}	66±1,8^{b}	45,2±2^{a}	36,1±0,88^{a}	65,9±0,82^{b}
Na^+ (mg/100g)	3,3±0,02	**Not detected**	**Not detected**	2,9±0,01	**Not detected**

On same line, Means followed by the same letters are not statistically different.

- pH measurement

The pH values obtained for cultivars varied over a range of 5,42 ± 0,03 (*Deglet Noor*) to 6,40 ± 0,05 (*Ghars*); these results are in agreement with those of Barreveld [14], who showed that the most common pH values for the marketed dates range from 5,3 to 6.3; according to the same author, the pH can change during storage, result of some deterioration. Moreover, Ben Ismaïl *et al.* have found that pH of dates oscillate between 5 and 6,8 ; for Tunisian varieties [15]. However, different authors have shown higher pH (approximately 7) in certain varieties of high quality dates [16]; results registered of pH for *Tamesrit*, *Tinissine* and *H'mira* are lower than those found by Acourene *et al.* [5] for these varieties (6.57, 6.15 and 6.90 respectively).

- Water content

The water content is a basic parameter for the determination and rational conduct of harvesting, storage and conservation [11]. High water contents make varieties having a soft character, susceptible to microbial colonization, including that of the fungal flora. The water content of different varieties studied ranged from 14,48 ± 0,8 to 26,35 ± 2,1 %. Varieties *Tamesrit* and *Ghars* had the highest rates and *H'mira* variety showed the lowest rate. These values are in agreement with the studies conducted by Ahmed *et al.* [3] who showed that the moisture content ranged from 9,20% to 32,10 %. But these levels are significantly lower than that found in the *Aziza* variety reported by

Acourene *et al.* [17], this difference can be explained by the humidity of the storage and geographical distribution, as well as irrigation of each palm [17].

-Total ash

Dates analyzed in this study showed an ash content of the flesh ranging from 1,59 (*Deglet Noor*) to 2,87 % (*H'mira*). These differences between cultivars were recorded during a study conducted by Acourene *et al.* [17] on other Algerian varieties in the Zibans region with rates ranging between 1,1% to 3,7 %. Similarly, some authors [11, 18] reported changes in ash content of flesh; i.e. 2,15 to 3,46 % for Moroccan varieties, 2,53 % to 3,20 % for Sudanese varieties and 1,49 to 1,79 % for Omani ones respectively. These last contain the lowest levels.

-Mineral elements

Mineral composition of the flesh of dates showed, for all varieties, that potassium is the predominant element followed by magnesium; the same findings were observed by several authors with other varieties [18, 19]. However, sodium exists at very low concentrations. Moreover, for other Algerian varieties, the results were reversed to the obtained in this study showing overly high contents of Na^+ (30 mg/100 g) and very low levels of Mg^{2+} (1,2 mg/100 g) [20]. Mineral content and composition depend on the soil fertility status and realized amendments. Several studies have reported that the presence of Na^+, K^+ and Mg^{2+} in food can potentially affect blood pressure; an important input in k^+ and Mg^{2+} associated to a low intake of sodium (Na^+) is often as effective as antihypertensive agent in the treatment of high blood pressure [21].

2.2. Biochemical characterization

Results of the biochemical analysis of dates are shown in Table 3.

Table 3: Biochemical composition (%) of the five studied dates

	Ghars	*Tamesrit*	*H'mira*	*Deglet Noor*	*Tinissine*
Total sugars	57,21±0,21^{a}	58,6 ±0,81^{a}	67,04±0,73^{b}	75,21±0,69^{c}	54,30±0,19^{d}
Reducing sugars	55,00±0,1^{a}	58,6±0,14^{b}	63,23±0,39^{b}	46,2±0,21^{c}	53.4±0,09^{a}
Glucose	28,5±0,1^{a}	30,3±0,09^{a}	33±0,07^{a}	23±0,12^{b}	28,7±0,08^{a}
Fructose	26,5±0,08	28,1±0,06	33±0,3	23±0,07	24,7±0,18
Sucrose	2,20 ± 0,03^{a}	0^{b}	1,01±0,04^{c}	29±0,21^{d}	0,5±0,03^{e}
Soluble fibers	3,6±0.06^{a}	8,8±0,12^{b}	7,6±0,17^{b}	5,5±0,04^{c}	6±0,01^{c}
Insoluble fibers	4,31±0,04^{a}	9,1±0,01^{b}	6,2±0,05^{c}	7,7±0,12^{d}	6,5±0,9^{c}
Proteins	2,59± 0,05^{a}	1,88±0,12^{b}	2,2±0,09^{b}	2±0,74^{b}	1,65±0,23^{d}
Lipids	0,38± 0,02	0,18±0,02^{a}	0,53±0,03^{b}	0,52±0,11^{b}	0,66±0,08^{b}

On same line, Means followed by the same letters are not statistically different.

-Total sugars

Results obtained from analysis of total sugars of the five varieties of dates showed that sugars represent the major part of the flesh (Table 3) giving them an important energy value. *Deglet Noor* contains the highest content of total sugars (75%) and *Tinissine* shows the lowest level in sugar, less than 60 %. Similar observations on variability were reported by other authors on other varieties of dates. In Algeria, Acourene *et al.* [17] found very high levels of total sugars, greater than 80 % for some levels ranging from 61 % to 83 % for Moroccan varieties and Ben Ismail *et al.* [15] observed rates oscillating between 44 and 62,7 % for Tunisian varieties. Several studies conducted on Saudi, Emirati and Omani dates [3] showed that the varieties containing only glucose and fructose have low total sugar rates. This change in carbohydrate concentrations may be due to the variety, the nature of sugar, harvesting conditions, storage, geographical distribution of dates and other environmental factors.

-Reducing sugars

Reducing sugars are the principal sugars for the majority of the studied dates; *Ghars*, *H'mira*, *Tinissine* and *Tamesrit*; this could be attributed to high activity of invertase [14]. Reducing sugars are mainly composed of glucose and fructose. The presence of sugars provides the sweet taste to dates, especially fructose having a high sweetening power compared to glucose, therefore induces satiety which consequently leads to low weight gain [2].

-Sucrose

Results showed that *Deglet Noor* is the richest variety of sucrose, its level is 28 times higher than other studied varieties; other studies have shown that *Deglet Noor* is rich in non-reducing sugars [14] which is probably due to low activity of invertase compared to other varieties. Literature reported that dry dates are rich in sucrose, while soft and semi-soft dates are rich in reducing sugars [22].

-Proteins

Protein levels are low in the five studied varieties. A significant difference (p=0,004) was found between the varieties rates. These results are similar to those for two varieties of Pakistan (2,7±0,10% and 2,4±0,05%) [23]; this difference in proteins levels can be explained by the origin of cultivars and experimental conditions.

-Lipids

The lipid content of date flesh is very low for the different varieties, the values obtained ranged from 0,38 to 0,66 % for *Ghars* and *Tinissine* respectively. These levels are comparable to those reported for Emirati dates, i.e. 0,2 to 0,5% [24].

-Dietary fiber

The insoluble fiber content ranges from 4,31 to 9,1 % and that of soluble fiber oscillates between 3,6 and 8,8 %. *Ghars* variety is the poorest one in dietary fiber (8 %) and *Tamesrit* is the richest variety compared to other varieties (18%). These levels are high compared to 6,04 to 11,05 % found for other varieties [25]. However, the result obtained seems lower than that reported by Elleuch *et al.* [19] for two cultivars of Tunisian dates (14,4 and 18,4 %). This difference could be related to the maturity phase, where catalytic activity of enzymes is elevated. High levels of fiber may give to dates a beneficial impact on health and can classify this fruit among those containing important levels of indigestible carbohydrate; the high content of soluble dietary fiber slows digestion and absorption of glucose thereby moderating the increase of postprandial glycemia [26]. It has already been demonstrated that dietary fiber is significantly correlated to the glycemic index of food [27].

3. Phytochemical characterization of dates

3.1. Phytochemical screening

The phytochemical screening, presented in Table 4, showed the presence of certain chemical groups in the varieties studied at different proportions.

Table 4: Phytochemical screening results

Phytochemical compounds Cultivars	Alkaloids	Saponosids	Coumarins	Catechic tannins
Ghars	+	+++	++	++
H'mira	+	++	++	++
Tamesrit	-	+++	+++	+
Tinissine	-	+++	++	+++
Deglet Noor	+	+++	++	++

+++: Presence in high quantity; ++: Presence in average quantity; +: Presence in low quantity; -: Absence.

All the dates are rich in Saponosids, Coumarins and catechic Tannins; this result agrees with other studies reporting that date flesh is rich in phytochemical groups [23]. The abundance of Tannins in *Tinissine* variety could provide it a high degree of astringency.

3.2. Total polyphenols

The results obtained for the determination of total polyphenols, compounds which are known for their antioxidant properties, are shown in Figure 1.

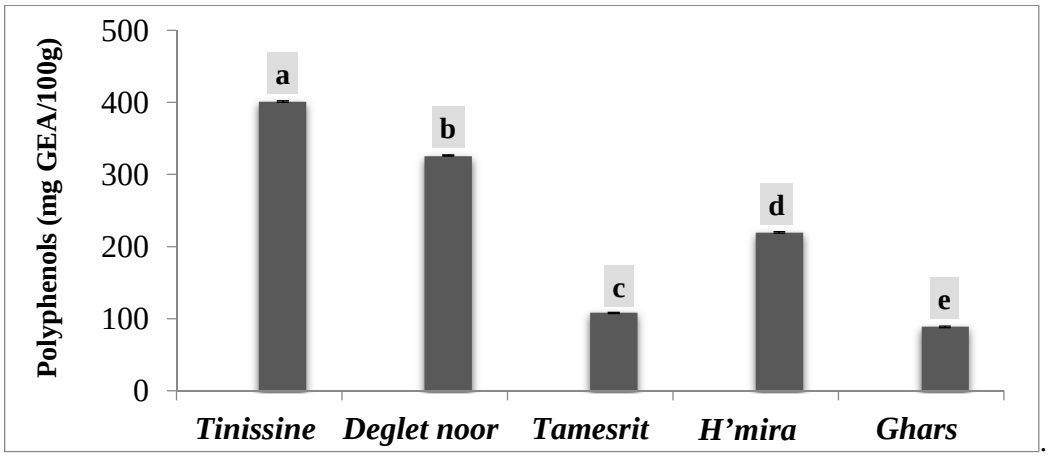

Figure 1: Rate of total polyphenols in five studied varieties of dates

a, b, c, d and e: homogeneous groups given by ANOVA (p <0,01)

The polyphenol content was significantly important in *Tinissine* compared to other varieties (p<0,01); contents in decreasing order are: *Tinissine>Deglet Noor>H'mira>Tamesrit>Ghars*; ie: 401; 326,2; 219,75; 108 and 88,75 mg EAG / 100 g of fresh matter (FM), respectively.

Polyphenol levels for *Tinissine*, *H'mira*, *Deglet Noor* ranged from 167 to 709 mg GAE/100 g FM in the study reported by Benmeddour *et al.* [28] for other Algerian varieties. Many factors can affect the polyphenol content: the geographical origin of the cultivar, maturity, season, soil fertilization, the time of exposure to sunlight, storage conditions, sampling and extraction methods [29].

3.3. Total flavonoids

Figure 2 shows the results of determination of total flavonoids in five varieties.

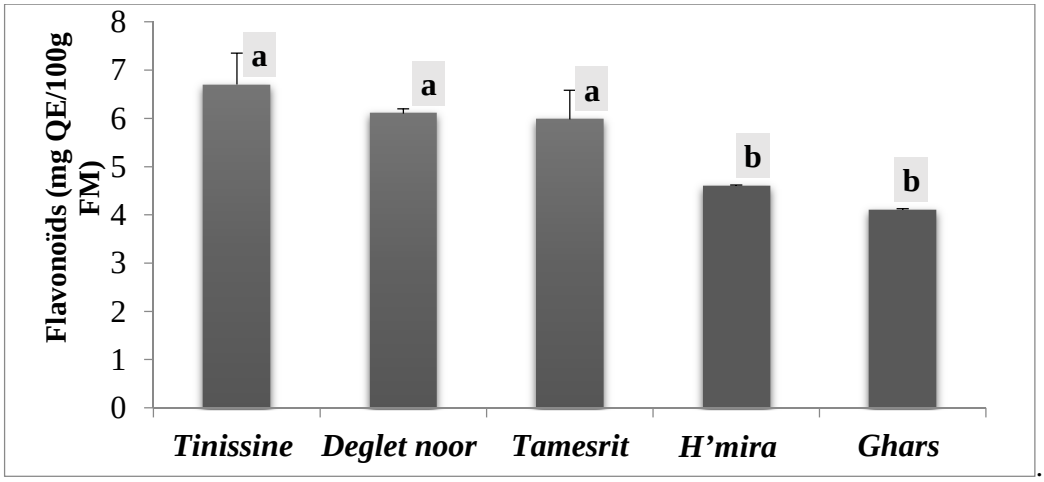

Figure 2: Rate of total Flavonoids in five studied varieties of dates
a and b: homogeneous groups given by ANOVA (p <0,01)

Flavonoids rates vary from 4,2 (for *Ghars*) 6,7 mg QE/100g (for *Tinissine*). Benmeddour *et al.* [28] report much higher contents than those found in this study (11,52 to 225,77 mg CE/100g FM). The differences in the levels between these studies could be due to the type of cultivar, environmental conditions, fruit maturity and extraction conditions.

4. Sensory evaluation

Table 5: Organoleptic characteristics of studied cultivars

Cultivars	*Deglet Noor*	*Ghars*	*Tamesrit*	*Tinissine*	*H'mira*
Couleur	Brown	Brown	Black/darkbrown	Black	Brown/reddish
Appearance of pericarp	Smooth, brillant	Smooth	Pleated	Embossed	pleated
Consistency	Semi-soft	Soft	Semi-soft	Semi-soft	Semi-soft
Texture	Fibrous	Fibrous	Fibrous	Fibrous	Fibrous
Taste	Very sweet	Sweet	Sweet	Slightly sweet, astringent	Sweet
Aroma	Slightly fragrant	fragrant	Slightly fragrant	fragrant	fragrant
Hedonic score	4,75 ±0, 33 Good	2,80±0,08 Low	4 ±0,19 Good	3,78±0,19 Fairly good	3±0,27 Fairly good

The results presented in Table 5 show that samples color is not homogeneous, however, the brown color predominates; this result is in agreement with Acourene *et al.* [5] who showed that from 54 varieties Algerian, 50 % are brown followed by 31 % yellow colored 16 % black and 3 % red. Color is an important factor in the appreciation of dates of which the choice is different from country to another; Algerian consumers are much more attracted by brown dates with glossy appearance (*Deglet Noor*), yellow colored for Saudi Arabia and the United Arab Emirates and red dates for Oman and Kuwait [30].

The appearance of the pericarp ranges from pleated for *H'mira, Tamesrit* and *Tinissine* cultivars to smooth for *Deglet Noor* and *Ghars* ones.

The consistency of dates of all varieties varies from semi-soft (*Deglet Noor, Tamesrit, Tinissine* and *H'mira*) to soft (*Ghars*) this consistency during chewing is related to their fibrous nature.

Dates are characterized by their sweet taste linked to their richness in carbohydrates, but perception of sweet taste depends on acidity; these last two characters can cover up each other [31], making sweet taste assessment difficult by sensory analysis.

The most appreciated varieties of dates by the volunteers (*Deglet Noor* and *Tamesrit*) are slightly fragrant than the other studied dates (*Ghars, Tinissine* and *H'mira*).

All date cultivars were appreciated by the whole population of study; volunteers preferred *Tamesrit* cultivar with a mean hedonic score preference of 4,75±0,33, followed by *Deglet Noor* (4±0,19), *Tinissine* (3,78±0,19), *H'mira* (3±0,27) respectively than *Ghars* the least preferred one with a score of 2,80±0,08 (Table 5).

Sensory analysis revealed that Algerian consumers are attracted by soft, sweet and fleshy cultivars with fibrous texture in the mouth and better appearance.

CONCLUSION

The outcome of the research was that the five varieties studied are rich in K^+ and Mg^{++}; glucose and fructose, dietary fiber and are poor in proteins and lipids. These dates may have beneficial effects on health due to the presence of bioactive constituents such as polyphenols and flavonoids.

The results of the compositional and hedonic analysis revealed that *Tamesrit* and *Deglet Noor* varieties have the best characteristics and are most appreciated by Algerian consumers who are attracted by soft, sweet and fleshy date fruits with fibrous texture in the mouth and better appearance. *Deglet Noor* is already very cultured and widely known, even abroad, where it is exported; whereas *Tamesrit*, an unknown variety, produced and consumed locally, is the most appreciated of all varieties and presents a wealth of fructose, sugar with a low glycemic index beneficial on health, an absence of sucrose very hyperglycemic, which would be recommended for diabetics. This variety of high nutritional quality and very well accepted by study volunteers, would deserve a better exploitation; it should be grown in other regions of southern Algeria.

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