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Conservation of Deglet Nour variety dates in syrup form and study of their quality*

Conservación de dátiles de la variedad Deglet Nour en forma de jarabe y estudio de su calidad

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Abstract

Introduction. Deglet Nour date syrup is gaining popularity due to its unique flavor and potential health benefits. Assessing its quality is crucial for both consumers and producers, as it directly influences its market value and health reputation. **Objective.** To evaluate the nutritional value, sensory quality, and antioxidant potential of Deglet Nour dates in syrup form. **Materials and methods.** The biological material was collected in Biskra, Algeria, in December 2019, during the maturation period of the plant material. To determine the various components of biological substances, quantitative analysis through color reactions was employed to measure total sugars, reducing sugars, non-reducing sugars, proteins, polyphenols, and flavonoids. The amounts of lipids and ash were recorded, and an atomic absorption spectrophotometer was applied to assess the variety of minerals. Testing for antioxidant activity was conducted through antiradical experiments. Furthermore, sensory evaluation included 45 individuals who assessed this syrup against others, concentrating on clarity, sweetness, and general flavor preference. **Results.** The chemical composition analysis revealed an average total sugar content (52 %), a moderate amount of protein (1.6 %), and low-fat content (0.09 %). The energy content was 215.6 kcal/100 g. The mineral analysis showed that the syrup is rich in essential minerals, particularly calcium, sodium, and magnesium. Flavonoids were identified as the predominant antioxidants, with anti-free radical activity estimated at 27.62 %. The sensory evaluation compared Deglet Nour syrup to Ghers and Degla-Beida varieties. The classification test showed that Deglet Nour syrup was perceived as the clearest. While it did not differ significantly in sweetness from Degla-Beida, it was preferred by tasters for its more pleasant taste. **Conclusions.** Dates of the Deglet Nour variety, which are highly sensitive to deterioration, yield after processing a natural syrup with the desired nutritional, therapeutic, and sensory properties.

Keywords: Antioxidant, *Phoenix dactylifera*, preference, robb, sensometry.

Resumen

Introducción. El jarabe de dátiles Deglet Nour está ganando popularidad por su sabor característico y sus posibles beneficios para la salud. Evaluar su calidad es esencial, ya que determina su valor comercial y su reputación nutricional. **Objetivo.** Este estudio tiene como objetivo analizar la composición nutricional, la calidad sensorial y la capacidad antioxidante de este jarabe. **Materiales y métodos**. El material biológico fue recolectado en Biskra, Argelia, en diciembre de 2019, durante el período de maduración del fruto. El análisis cuantitativo por reacciones de color se utilizó para medir proteínas, polifenoles y flavonoides. Se registraron las cantidades de lípidos y ceniza,s y se aplicó un espectrofotómetro de absorción atómica para evaluar la variedad de minerales. Las pruebas de actividad antioxidante se realizaron mediante experimentos antirradicales; además, la evaluación sensorial incluyó a 45 personas que compararon este jarabe con otros, concentrándose en la claridad, el dulzor y la preferencia general de sabor. **Resultados.** El análisis de composición química reveló un contenido promedio de azúcares totales (52 %), una cantidad moderada de proteínas (1,6 %) y un contenido bajo en grasas (0,09 %). El contenido energético fue de 215,6 kcal/100 g. El análisis mineral mostró que el jarabe es rico en minerales, especialmente calcio, sodio y magnesio. Los flavonoides fueron los antioxidantes más predominantes, con una actividad eliminadora de radicales libres del 27,62 %. Un análisis sensorial que comparó este jarabe con los de las variedades Ghers y Degla-Beida, reveló que se percibía como el más claro. Si bien su dulzor era similar al de Degla-Beida, los catadores lo preferían en general por su sabor superior. **Conclusiones.** Los dátiles de la variedad Deglet Nour, muy sensibles a la alteración, producen tras su transformación un jarabe natural con las propiedades nutricionales, terapéuticas y sensoriales deseadas.

Palabras clave: Antioxidante, *Phoenix dactylifera*, preferencia, robb, sensométrica.

Introduction

Dates (*Phoenix dactylifera* L.) are a highly nutritious food source, providing significant energy value. The predominant constituents are sugars, which account for 70 to 80 % of their composition (Siddiqi et al., 2020). They include additional nutrients such as proteins (2.3 to 5.6 %), lipids (0.2 to 0.5 %), minerals and trace elements (potassium, phosphorus, magnesium, calcium, manganese, iron and zinc) (1-1.9 %), fibers (6.4 to 11.5 %), vitamins (vitamin C, thiamine, riboflavin, niacin, vitamin A, etc.), carotenoids and polyphenols (Jaouhari et al., 2024). Furthermore, dates exhibit notable therapeutic benefits; they promote intestinal transit, prevent colorectal cancer thanks to their richness in dietary fiber, and have a pronounced antioxidant power mainly due to phenolic compounds, vitamin C and carotenoids (Mut et al., 2022).The Algerian phoenicicole heritage is characterized by an exceptional diversity, with more than 17 million palms and more than 800 cultivars. The varieties of dates are very numerous, but only a few are of commercial importance. They differ in flavor, consistency, shape, color, weight and dimensions. The most popular varieties are Deglet Nour, Ghars, Degla-Beida and Mech-Degla. The Deglet Nour variety, whose name means “fingers of light”, is highly valued on the market. It is naturally very sweet and contains sufficient inherent moisture, requiring no artificial enhancement. Unlike other date varieties that are harder and drier, Deglet Nour is soft and translucent (Blama Merzaia, 2014).

In Algeria, the flowering period of the date palm is from mid-March to mid-April, it lasts for a period of 30 to 50 days from which it is unavailable and expensive in spring. Its harvest and availability period is from September to December. The extra soft «Deglet Nour» variety cannot keep its attractive appearance for a long time under high temperature conditions. Hence, the need to keep it in the form of very energetic dates syrup.

Date syrup or robb is a product of considerable nutritional significance. It is rich in carbohydrates, mineral salts (in particular K, Ca and Mg), vitamins of group B and C, and antioxidants (Ben Mansour et al., 2022). It is a very

viscous and low humidity product. This property is important to preserve the quality of the product for two years and prevents the proliferation of microorganisms (Blama Merzaia, 2014).

The study aims to preserve dates of the Deglet-Nour variety, a variety sensitive to deterioration, in syrup form and to study their nutritional value, sensory quality and antioxidant potential.

Materials and methods

Sampling and preparation of syrup

The botanical material utilized comprises Deglet Nour dates that were harvested in Tolga oasis in Biskra (region located in the south of Algeria) during the maturation period of the plant material (in December 2019). The date syrup was prepared as follows: 2 L of water was added to 1 kg of washed and drained dates. The resulting mixture was cooked for two to three hours, stirring constantly, until the core changed color. The mixture was filtered through muslin, then was concentrated over low heat while stirring with a wooden spoon to avoid caramelization of the product. Cooking was stopped when the desired consistency was reached.

Determination of physicochemical parameters

The pH was recorded using a pH meter after immersing the probe in the heated and homogenized syrup. The acidity was determined by the acid-base dosage: 10 g of syrup were neutralized with sodium hydroxide solution (0.1 N) in the presence of a few drops of phenolphthalein, until the color changed to pale pink. Acidity was expressed in grams of citric acid per 10 g of syrup. The moisture content was determined by drying in an oven (105 °C) for 4 hours. Moisture content was determined by calculating the ratio of lost weight to fresh weight. The Brix value was determined directly on the refractometer scale at the point where the light and dark zones intersect. For this, 1 g of syrup was mixed with 50 ml of distilled water. The mixture was heated in a water bath for 20 min. The extract was then centrifuged at 1000 rpm and the soluble solids level was read directly on the refractometer (Lagha-Benamrouche et al., 2018).

Determination of chemical composition

The total sugar content was assessed in accordance with the method described by Lagha-Benamrouche et al. (2018). The reduction of the Fehling's solution by sugars facilitated the quantification of reducing sugars. Additionally, the hydrolysis of the clarified solution under acidic conditions and at elevated temperature allowed determination of total sugars (comprising both reducing and hydrolysable sugars) and to indirectly calculate the concentration of non-reducing sugars (total sugars minus reducing sugars) (Chidan Kumar et al., 2014). The protein content was quantified utilizing the Kjeldahl method described by Jean Constant et al. (2020), while the fat content was assessed using hexane as the organic solvent with a Soxhlet apparatus, following the method outlined by Jean Constant et al. (2020).

The ash content was evaluated through the incineration of organic matter at elevated temperatures (55 °C for a duration of 3 to 5 hours), resulting in a white or greyish-white residue. The analysis of mineral elements, including Na, Ca, Zn, Fe, Mn, Cd, Cu, and Mg, was performed by atomic absorption spectrophotometry following the method described by Guirrou et al. (2022). The extraction of phenolic compounds was carried out according to the methodology established by Lagha-Benamrouche et al. (2021). The quantification of total polyphenols was carried out as per the protocol described by Lagha-Benamrouche and Benkaci (2022).

The determination of hydrolyzable tannins was executed utilizing the vanillin method as described by Lagha-Benamrouche et al. (2018). The assessment of flavonoids was performed following the procedure delineated by Lagha-Benamrouche et al. (2021), which involved direct measurement using aluminum chloride.

Determination of the global energy value

The total energy value represents the energy released through the combustion of proteins, fats, and carbohydrates present in the diet, considering the digestibility of each macromolecule along with their respective Atwater coefficients. The Atwater coefficients are defined as the metabolizable energy expressed in kcal per 1 g of nutrient. For both carbohydrates and proteins, this coefficient is set at 4 kcal, which is equivalent to 17 kJ; whereas for lipids, it is measured at 9 kcal or 38 kJ (Lagha-Benamrouche et al., 2023). The comprehensive energy value was determined based on the equation 1.

$$E = (9XL) + (4XC) + (4XP) \quad (1)$$

Where: E: global energy value in kcal, L: total fat content in g per 100 g of sample, C: total carbohydrate content in g per 100 g of sample, P: total protein content in g per 100 g of sample and 9, 4 and 4: the Atwater coefficients of lipids, carbohydrates and proteins.

Antioxidant activity

In this study, the antioxidant activity was assessed utilizing both methods: the scavenging activity of the free radical 1,1-diphenyl-2-picrylhydrazyl (DPPH) and the reducing power (Lagha-Benamrouche et al., 2023).

Sensory evaluation

The sensory quality of Deglet Nour date syrup was compared with that of dates of less economic importance: Ghers and Degla-Beida (common varieties), prepared in the same way. For this, two tests were used: the classification test and the preference test. The classification test was used when it was suspected that the products differed on a specific organoleptic characteristic. The trained tasters (45 tasters) rated a series of labeled date syrups in order of color intensity and taste. All the variations between each sum of products taken two by two were calculated. Then the critical value, which corresponded to a risk of 5 %, was read from the table by Newell and Macfarlane. This value was taken at the intersection of the column (products) and the row (testers). Any calculated difference between products equal to or greater than this critical value means that the respective products can be considered different (Lagha-Benamrouche, 2021).

The preference test consisted of asking the tasters (34 tasters) to compare the syrups and choose one sample rather than another for which they had no preference (Lagha-Benamrouche, 2021; Lagha-Benamrouche and Benkaci, 2022).

Statistical analysis

Statistical analysis of the results was performed using STATISTICA 5.5 software and the degree of significance was assessed with a probability of $p \leq 0.05$. A one-way ANOVA followed by Tukey's test was performed. All data

represented the mean ± standard deviation of three experiments. For sensory evaluation, the pairwise comparison test of the sum of the ranks was used to determine which pairs of samples were different from each other. For the results of the preference test, the two-tailed binomial test table was used to interpret the results (Lagha-Benamrouche, 2021).

Results

Physicochemical analysis and chemical composition

Physicochemical analysis revealed a slightly acidic pH (pH 4.78, acidity 7.30 g CAE/10g), with notable soluble solids (76.7 %) and low relative humidity (16.7 %). Chemical composition analysis revealed a moderate protein content (1.6 g BSAE/100 g), low fat content (0.094 %), and high total sugar content (52.16 %). Reducing sugars represent 53.64 % of total sugars while non-reducing sugars represent 43.05 %. The energy value was estimated at 215.6 kcal/100 g. Mineral analysis detected a predominance of calcium, sodium, and magnesium. However, small amounts of iron, copper, zinc, and manganese were found (Table 1).

Table 1. Mineral composition of Deglet Nour date syrup harvested in Biskra, Algeria, 2019.

Cuadro 1 Composición mineral del jarabe de dátil Deglet Nour cosechado en Biskra, Argelia, 2019.

Minerals	Contents
Manganese (Mn)	8.292 ± 1.536 (μg/g)
Iron (Fe)	0.083 ± 0.003 (mg/g)
Cadmium (Cd)	Not determined.
Calcium (Ca)	1.644 ± 0.025 (mg/g)
Copper (Cu)	2.261 ± 1.589 (μg/g)
Magnesium (Mg)	1.047 ± 0.013 (mg/g)
Sodium (Na)	1.117 ± 0.003 (mg/g)
Zinc (Zn)	7.724 ± 0.177 (μg/g)

Antioxidant activity

The quantification of phenolic compounds showed a richness in total polyphenols (51.4 mg GAE/g) and a predominance of flavonoids (3.11 mg QE/g). The class of flavonols represents 4 % of total flavonoids. However, hydrolyzable tannins have not been determined.

The reducing power of the syrup at a concentration of 1 mg/ml showed an absorption range of 0.4 to 0.14. These absorbances are significantly lower ($p \leq 0.05$) than those of the other two standards (gallic acid and quercetin) tested at 20 g/ml. Quercetin indicated the greatest reducing power ($p \leq 0.05$) followed by gallic acid. The anti-radical activity of the extract analyzed (at a concentration of 1 mg/ml) was estimated at 27.62 %. The binding capacity of the latter is significantly lower ($p \leq 0.05$) compared to the standards tested at 40 g/ml [gallic acid (92 %) and quercetin (64 %)] (Figure 1).

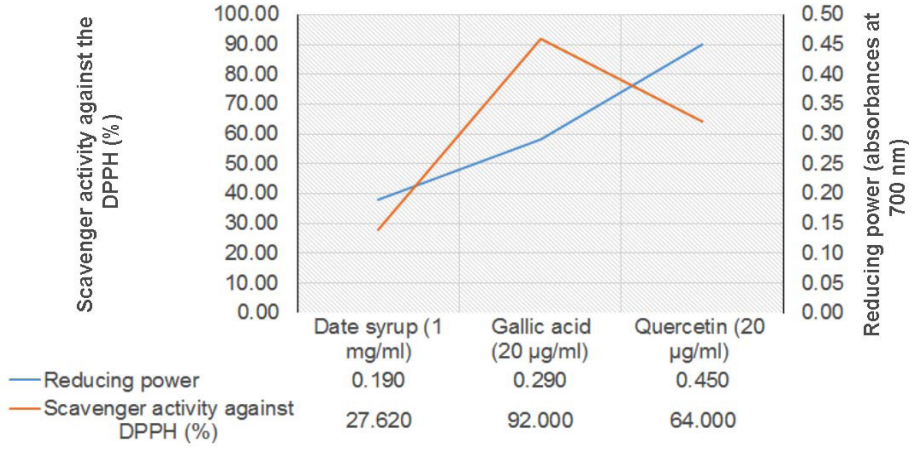

Figure 1. Reducing power and antioxidant activity against the DPPH radical of the standards (quercetin and gallic acid) and Deglet Nour date syrup harvested in Biskra, Algeria, 2019.

DPPH: 1.1-diphenyl 1-2-picrylhydrazyl.

Figura 1. Poder reductor y actividad antioxidante frente al radical DPPH de los estándares (quercetina y ácido gálico) y jarabe de dátiles Deglet Nour cosechados en Biskra, Argelia, 2019.

DPPH: 1.1-difenil 1-2-picrilhidrazilo.

Sensory evaluation

Deglet Nour syrup was categorized as belonging to group (A) instead of the others. The critical value was lower than the calculated value for the common variety syrup (Ghers and Degla Beida). The syrup of common varieties is perceived as more colorful ($p \leq 0.05$). It is concluded that the color difference between the two samples is significant and that both syrups are categorized into two groups (B) and (C) ($p \leq 0.05$) (Table 2).

Table 2. Multiple pairwise comparisons of row sums for the color intensity of the studied syrup, varieties harvested in Biskra, Algeria, 2019.

Cuadro 2. Comparaciones múltiples por pares de las sumas de las filas para la intensidad de color del almíbar estudiado, variedades cosechadas en Biskra, Argelia, 2019.

Samples	Effective (n)	Sum of ranks	Differences in ranks between possible pairs	Critical value for p ≤ 0.05 and Effective = 45 Number of products = 3	Groups
Deglet Nour (1)	45	56	(3)-(1) = 76*	23	A
Degla beida (2)	45	82	(2)-(1) = 26*	23	B
Ghers (3)	45	132	(3)-(2) = 52*	23	C

*: Significant at threshold $p \leq 0.05$. / *: Significativa en el umbral $p \leq 0,05$.

The calculated values, from several multiple comparisons, for the Ghers date syrup are higher than the critical value. According to the testers, the latter was considered less sweet ($p \leq 0.05$). As a result, Ghers syrup belongs to group (B) rather than the other groups.

For Deglet Nour and Degla Beida, the calculated value is lower than the critical value. These two syrups are placed in the same group (A). Tasters observed that these two syrups did not differ significantly in sweetness (Table 3).

Table 3. Multiple pairwise comparisons of row sums for sweetness intensity of the syrups studied, varieties harvested in Biskra, Algeria, 2019.

Cuadro 3. Comparaciones múltiples por pares de sumas de filas para la intensidad del dulzor de los jarabes estudiados, variedades cosechadas en Biskra, Argelia, 2019.

Samples	Effective (n)	Sum of ranks	Differences in ranks between possible pairs	Critical value for p ≤ 0.05 and Effective = 45 Number of products = 3	Groups
Deglet Nour (1)	45	56	(3)-(1) = 79*	23	A
Degla beida (2)	45	79	(2)-(1) = 23	23	A
Ghers (3)	45	135	(3)-(2) = 56*	23	B

*: Significant at threshold $p \leq 0.05$ / *: Significativa en el umbral $p \leq 0,05$.

Preference test

The results from the preference test were analyzed using the two tailed binomial test, checked against the two tailed table where $X = 11$, which shows how many testers mainly chose one of the two syrups (Deglet Nour or Degla Beida), and $n = 34$, representing the overall number of testers that participated in the study.

The results indicated that the value from the table at 0. 001 was less than the risk level ($\alpha \leq 5\%$). This suggests that the testers clearly preferred the Deglet Nour date syrup over the Degla Beida date syrup. They believed it had a better mix of sweetness and acidity, and they regarded it as the tastiest option.

Discussion

The physicochemical characteristics of the date syrup analyzed showed a slightly acidic pH, a high dissolved solids content and a low humidity. The values found are comparable to those of the bibliographic data. The pH of the syrup analyzed is comparable to the results found by Farahnaky et al. (2016), who reported pH values of 4.24 to 4.62 for date syrup of the Deglet Nour variety. Comparing the results obtained with those of Seddiki and Seddiki (2023) (12.43 to 13.15 g EAC/l), it is estimated that the titratable acidity of the analyzed sample is lower. Titratable acidity provides information about the concentration of organic acids presents in the sample, including acetic acid, citric acid, fumaric acid, lactic acid and malic acid (Bouhlali et al., 2020; Doukani & Tabak, 2015).

Dissolved solids content (or Brix index) refers to the sum of all solids dissolved in water including sugars, salts, carboxylic acids, etc. (Farahnaky et al., 2016). The Brix level of the studied syrup is similar to the values reported by Chouana et al. (2019) who found that the number of soluble solids for the same type of syrup was 76.0 %. The result obtained for moisture content is consistent with that of Chouana et al. (2019) (16.07 %) for syrup of the Deglet Nour variety. According to the latter, moisture content plays a crucial role in the shelf life of products. The longer a sample is stored, the lower its moisture content.

The protein content of the investigated syrup is comparable to those reported by Farahnaky et al. (2016) (1.23-1.63 %) for the Kabkab variety. However, it exceeds the value reported by Aleid and Haddadin (2023) (0.95-0.85 %) and Kadum et al. (2018) (2.4 %) for the syrups of the Deglet Nour and the Khalas varieties, respectively. The discrepancies noted in the results for syrups of the same variety can be attributed to genetic variations associated with the cultivar, differences in quantification methods, and alterations in protein composition resulting from heat treatment (Kadum et al., 2018).

Total sugars represented a significant portion of the syrup's composition. The level of total sugars and reducing sugars in the syrup studied was lower than those obtained by Chouana et al. (2019). The latter recorded contents of 63.83 % and 58.90 %, respectively, for the syrup of the Deglet Nour variety. The levels of reducing and non-reducing sugars in syrups vary depending on the nature of the fruit, its ripening rate, its acidity, and above all depending on the cooking conditions and their effects on the conversion of non-reducing sugars to reducing sugars under the influence of heat and acid (Lagha-Benamrouche et al., 2018). During fruit ripening, the contents of reducing and non-reducing sugars fluctuated due to starch hydrolysis, which contributes to the increase of reducing sugars (Liu et al., 2022). Cooking significantly affects sugar profiles through the conversion of starch to reducing sugars (Al-Qarni, 2020).

The amount of fat in the studied syrup is consistent with the findings of Aleid and Haddadin (2023) and Farahnaky et al. (2016), who recorded fat levels of less than 0.1 % for dates of the Khalas variety, and syrups from the Kabkab variety. Additionally, 15 different types of fatty acids were identified in date fruit oils. Approximately 50 % of the oil is composed of saturated fatty acids, with 40 % being monounsaturated fatty acids and 10 % polyunsaturated fatty acids. The most abundant saturated fatty acid is palmitic acid, with smaller amounts of myristic, arachidonic, pentadecanoic, heneicosanoic, and tricosanoic acids as observed by Ahmed et al. (2013).

The energy value of a food comes from the energy released by its nutrients during their metabolism. According to the work of Atwater, the energy released by metabolism is assumed to be 4 kcal/g or 17 kJ for carbohydrates and proteins; 9 kcal/g or 38 kJ for lipids, and 7 kcal/g for alcohols. The sum gives the overall energy value of the food (Lagha-Benamrouche et al., 2023). The estimated total energy value of date syrup is similar to that of other date syrups, with recent studies highlighting its nutritional profile. According to a study by Barakat and Alfheeaid (2023), date syrup contains approximately 270 kcal per 100 g. This value is consistent with findings from other studies which show date syrups are high in energy, primarily due to their high carbohydrate contents. Date syrups are recognized for their fast-acting energy and nutritional properties, with about 75-80 % of their composition being sugars, mainly fructose and glucose. They serve as a source of calories with about 78 % carbohydrates, 23 % proteins and 1 % fat (Ardali & Akbarian, 2014).

Ash content represents the total amount of mineral material present in a product. The ash content of foods must have a threshold that should not be exceeded for human and animal consumption (Lagha-Benamrouche et al., 2018). The determination of this rate sheds light on the nutritional quality of the sample to be analyzed. The Deglet Nour syrup analyzed was found to be less mineralized in comparison with the Kabkab variety syrup (2.18 %) tested by Farahnaky et al. (2016). The difference in the results obtained can be explained by several factors, mainly the variety of date used, but also the growth conditions, the stage of maturity, the geographical origin, the type of soil, the storage conditions of the fruit and the extraction conditions (Al-Karmadi & Okoh, 2024).

The mineralogical study shows the richness of date syrup in minerals, the most important of which are calcium, sodium and magnesium. Ahmed et al. (2013) report a predominance of potassium in date syrup. By comparing the results obtained with the bibliographical data, it can be seen that the calcium content of the syrup studied is slightly lower than those found by Ahmed et al. (2013) for the of the Deglet Nour variety syrup (179.6 to 181.4% mg/100 g). Various factors, such as variety, growing conditions, maturity stage, geographical origin, soil type, fruit storage conditions and the nature of the water used for the preparation of syrup, explain the difference in results (Aleid & Haddadin, 2023).

The results of the quantification of phenolic compounds indicate a lack of hydrolyzable tannins and a dominance of flavonoids. Consistent with the results obtained, Benmeddour et al. (2013) did not observe the presence of hydrolyzable tannins in ten varieties of dates, including the Deglet Nour variety. They indicate that the primary constituents of phenolic compounds in dates are condensed tannins, with a ratio (the ratio of condensed tannins to total phenols) ranging from 0.44 to 0.82, except for the Halwa cultivar, which exhibited a ratio of 0.14.

Upon comparing the antioxidant potential of the syrup under investigation with existing bibliographic data, it is observed that the date syrup exhibits a modest antioxidant activity in contrast to the fruit, demonstrating an efficacy of 27.62% compared to 60% for dates of the Deglet Nour variety, as reported by Benmeddour et al. (2013). Nevertheless, the scavenging power of the date molasses analyzed with regard to the DPPH radical remains close to that of the date of the "Thouri" variety estimated at 32 % by Benmeddour et al. (2013).

The antioxidant activity observed in the date syrup may be due to its content of phenolic compounds and flavonoids (Benouamane et al., 2022). This suggests the richness of dates and their syrups in secondary metabolites with the ability to scavenge free radicals. In this study, the results obtained were similar to those of Al-Mamary et al. (2014). The composition of the syrup and the interaction between phenol and other components of cell matrix can lead to these outcomes, as do the formation of synergistic or antagonistic complexes that can either enhance or inhibit antioxidant activity. The decrease in reducing capacity can also be explained by the loss or oxidation of antioxidant molecules during cooking of the fruit (vitamin C, polyphenols, carotenoids, etc.).

The sensory quality of Deglet Nour syrup has been compared to those of dates of common varieties: Ghers and Degla-Beida. Deglet Nour syrup is perceived to be the clearest. It does not differ significantly in sweetness from that of Degla-Beida; however, tasters preferred it and found its flavor more pleasant. This sensory study also shows that the testers prefer lighter colored syrups. This observation is similar to that of the panelists from southwestern Algeria; Seddiki and Seddiki (2023) report that consumers in southeastern Algeria prefer light-colored, slightly acidic and low-sweet date syrups.

Conclusions

Dates of the Deglet Nour variety were very sensitive to alteration; even so, after processing, they produced a natural syrup with the desired nutritional, therapeutic, and sensory properties. Deglet Nour date syrup demonstrated notable nutritional and sensory qualities, making it a valuable natural sweetener with promising market potential. Its richness in minerals and antioxidants makes it more attractive to both health-conscious consumers and producers seeking high-quality products.

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Conflict of interest

This work is an original work. It has not been published elsewhere (no portion of the manuscript has been previously published or posted in the internet) and that it has not been submitted simultaneously for publication elsewhere. The paper is not intended for a special issue and there is no conflict of interest.

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