

Physicochemical Properties of Oil Extracted from Two Date Palm Seed Cultivars Grown in Libyan

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الخصائص الفيزيائية والكيميائية للزيت المستخلص من بذور صنفين من نخيل التمر المزروع في ليبيا

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Abstract:

The objective of this study was to examine and analyze the physicochemical properties and fatty acid composition of oil extracted from date seeds of two Libyan date varieties:

Al-Brince (from northern Libya) and Al-Allig (from southern Libya). The physical properties of these oils indicated that refractive index of the oils was found to be between 1.3552 and 1.3554, and their specific gravity ranged from 0.898 to 0.965 g/cm³. Date seed oil showed high mean molecular mass about (274.96). The results revealed that the oil content of these seeds ranged from 12.8% to 17.2%. The chemical analysis showed acid values between 2 and 2.7 mg KOH/g. The saponification values were in the range of 199.7–203.66 mg KOH/g, while the iodine values ranged from 44.46 to 47.37 g iodine/100 g for Al-Allig and Al-Brince, respectively. The major fatty acids identified in the date seed oils included oleic acid (48.34%–49.12%), lauric acid (25.17%–28.89%), palmitic acid (6.64%–7.6%), myristic acid (8.56%–8.61%), linoleic acid (5.58%–7.59%), and stearic acid (1.93%–1.96%).

Keywords: Date seeds oil, Physical properties, Chemical properties, Fatty acids composition of the oil

الملخص:

كان الهدف من هذه الدراسة هو فحص وتحليل الخواص الفيزيائية والكيميائية وتركيب الأحماض الدهنية للزيت المستخرج من بذور التمر لصنفين من التمر الليبي (Phoenix dactylifera L). : البرنسي (من شمال ليبيا) والعليق (من جنوب ليبيا). حيث أشارت الخواص الفيزيائية لهذه الزيوت إلى أن معامل انكسار الزيوت يتراوح بين 1.3552 إلى 1.3554، وأن كثافتها النوعية تتراوح بين 0.898 إلى 0.965 جم/سم³. وأظهر زيت نوى التمر ارتفاع متوسط الكتلة الجزيئية حوالي (274.96). كما أظهرت النتائج أن المحتوى الزيتي لهذه البذور تراوح بين 12.8 % إلى 17.2 %. أظهر التحليل الكيميائي أن قيم الرقم

الحامض بين 2 و 2.7 ملجم KOH/جم. و تراوحت قيم رقم التصبن بين 199.7-203.66 ملجم KOH/جرام، في حين تراوحت قيم الرقم اليودي من 44.46 إلى 47.37 جرام يود/100 جرام للعقيق والبرنسي على التوالي. تشمل الأحماض الدهنية الرئيسية التي تم تحديدها في زيوت بذور التمر حمض الأوليك (48.34-49.12 %)، وحمض اللوريك (25.17 % - 28.89 %)، وحمض البالمتيك (6.64 % - 7.60 %)، وحمض الميريستيك (8.56 % - 8.61 %)، وحمض اللينوليك (5.58 % - 7.59 %)، وحمض الستريك (1.93%-1.96%).

الكلمات المفتاحية: زيت بذور التمر ، الخصائص الفيزيائية ، الخصائص الكيميائية ، تركيبة الاحماض الدهنية للزيت .

1-Introduction:

Date palm (*Phoenix dactylifera* L.) is one of the oldest cultivated fruit crops, with a cultivation history extending over 5,000 years, particularly in North Africa and the Middle East. In Libya, date palms are widely distributed across the coastal, central, and southern regions, with considerable cultivar diversity (Edongli et al., 1993). A notable byproduct of dates is their seeds, which serve as a rich source of oil, containing about 5% to 13% oil content. This oil is abundant in beneficial compounds such as phenolics, tocopherols, and phytosterols (Besbes et al., 2006; I. Nehdi et al., 2010; Rahman et al., 2007). The composition of date seed oil in terms of vitamins, minerals, and fatty acids has drawn attention for its potential use in food products (Habib et al., 2013; I. Nehdi et al., 2010). These seeds are particularly noted for their range of fatty acids, which include capric, lauric, myristic, pal`mitic, stearic, linoleic, linolenic, and arachidonic acids (Boukouada, 2009). Moreover. Date seed oil has attracted attention as a promising natural ingredient for cosmetic applications due to its antioxidant properties and potential protective effects on the skin. Its bioactive constituents, including phenolic compounds and tocopherols, may contribute to its ability to reduce oxidative damage, while its incorporation into cosmetic cream formulations further supports its potential use in skincare products (Dammak et al., 2007; Lecheb & Benamara, 2015).

2. Materials and methods:

2.1. Sample Preparation:

We randomly selected types of palm dates the (Al-Brince) and (Al-lilig) from the local market after that we removed the pits from the dates. Then the seeds were washed well with top water, after that washed with distilled water, then the samples were dried in the shade, with stirring from time to time for eight consecutive days.

2.2. Extraction of Date Seed Oils (Extraction Methods):

The seed oil of each variety were extracted in a soxhlet apparatus using toluene as a solvent for 8 h. The solvent was removed using a rotary evaporator at 40C°, and the lipids were weighed and

stored in a freezer at 4C, until analysis. The yield of the extracted oil was calculated according to the following expression:

$$\text{Oil Yield} = (\text{W}_{\text{oil}} / \text{W}_{\text{sample}}) \times 100$$

Where:

W oil : weight of oil obtained after extraction.

W sample : weight of dry sample (Ali & Tahseen, 2015)

2.3. Physicochemical characteristics of oils:

2.3.1. Chemical properties:

The acid value, saponification value and the iodine value of the seed oils were determined according to the ISO methods such as (Animal, 2009)) , (Mahdi et al., 2022) , (Standardization, 2013). respectively.

2.3.2. The physical properties:

Refractive index was determined by butyro refractometer: Place 1,2 drops of sample on the lower prism. Close prisms and adjust mirror until it gives sharpest reading. If reading is indistinct after running constant temperature water through instrument for some time, test sample is unevenly distributed on prism surfaces. As refractive index is greatly affected by temperature, use care to keep temperature constant (AOAC, 2000) .After that, the specific gravity was determined specific gravity increases as the molecular weight decreases and the unsaturation increases. Lund has the following equation:

$$\text{Specific gravity (g/cm}^3\text{)} = (\text{Iodine value} \times 0.00014) + (\text{Saponification value} \times 0.0003) + 0.8475$$

(Koman & Danielova, 1975).

The Higher Value (HHV), often referred to as the gross energy content, defines the total heat released during the complete combustion of a fuel in the presence of air. It reflects the maximum energy obtainable from the fuel under ideal combustion conditions.

In this study, the HHV of date seed oil was determined indirectly by correlation it with its iodine value (IV) and saponification value (SV) , following the empirical : (relationship proposed by

(Demirbas 1998)

$$(\text{HHV} = 49.43 - (.041 / \text{times SV}) - (0.015 / \text{times IV})$$

Furthermore, The calculated cetane index (CCI) was estimated from the saponification value (SV) and iodine value (IV) according to the equation proposed by Krisnangkura (1986):

$$(\text{CI} = 46.3 + \frac{5458}{\text{SV}} - (0.225 / \text{times IV})$$

where CCI is the calculated cetane index, SV is the saponification value (mg KOH/g), and IV is the iodine value (g I₂/100 g). Based on this equation, the calculated cetane indices were 62.45 for Al-Brince seed oil and 63.63 for Al-Allig seed oil.

The mean molecular mass (MMM) was calculated using the formula (560/saponification value) × 100, as outlined by (Ajiwe et al. 1996).

3.3. Fatty acid composition of date seeds oil:

Methyl ester of fatty acids: Dependent on the esterification of glycerides (the sample was prepared by reacting it with a solution of methylated potassium hydroxide 2 mN, was prepared by dissolving 11.2g in a small amount of pure methanol, concentration of 99.8% after which the volume was increased to 100 with methanol. The esterification process was performed by weighing 1 g of the oil sample and poured into a 10 ml tube and heated in a water bath at a temperature of 50 C°, until . dissolution. And then, add 5 ml of methyl potassium hydroxide solution, shake the tube well for 5 min. Then add 5 ml of methyl. Then 5 ml of pure hexane with a concentration of 99.9 % was added and the contents of the tube were mixed again well until FAME separation of materials into two layers, the upper layer slapping on methyl esters of fatty acids. Hexane and the lower layer contains the saponifications from the reaction after (FAME) in apparatus GC / Mass (AOAC, 2000). This test for the presence of fatty acids with more than two non conjugated double bonds is more reliable on fatty acids than on glycerides in which one of the three fatty acids in combination may be polyunsaturated.

3.Results and Discussion:

3.1. Physical Properties of Date Seed Oil:

The results presented in Table 1 highlight the refractive index and specific gravity of seed oils, measured at room temperature (25°C). The refractive index of the seed oils ranged from 1.3552 for Al-Brince seed oil to 1.3554 for Al-Allig seed oil. Similarly, the specific gravity of the oils varied between 0.965 g/cm³ for Al-Brince seed oil and 0.898 g/cm³ for Al-Allig seed oil. These findings are consistent with values previously reported by researchers such as Rehab S. M. A. et al. (2012) and Mortadah A. Ali et al. (2015). Specific gravity and refractive index are considered key indicators of oil purity and chemical composition, as specific gravity reflects molecular weight and fatty acid content, while refractive index is related to the degree of saturation of fatty acids and the extent of oxidation in the oil. however, It was found that the mean molecular mass (MMM) was higher in Al- Brince seed oil (274.96) . Whereas the Higher Heating Value (HHV) value were similar in oil extracted from date seeds. While The Higher Value (HHV), often referred to as the gross energy content, defines the total heat released during the complete combustion of a fuel in the presence of air. It reflects the maximum energy obtainable from the fuel under ideal combustion conditions. where HHV primarily depends on the elemental composition of the oil, particularly the carbon and hydrogen content. A higher concentration of carbon and hydrogen results in a higher HHV, while the presence of oxygen and values according to previous studies range between 39-41 MJ/Kg . The calculated cetane index was 62.45 for Al-Brince seed oil and 63.63 for Al-Allig seed oil. The slightly higher CCI observed for Al-Allig seed oil may be associated with its lower iodine value (44.46 g I₂/100 g) compared with Al-Brince seed oil (47.37 g I₂/100 g), together with its slightly lower saponification value (199.7 versus 203.6 mg KOH/g). According to the empirical relationship proposed by Krisnangkura (1986), both iodine value and saponification value contribute to the estimated cetane index. The calculated values therefore indicate relatively similar ignition-quality characteristics for the two seed oils. .Higher cetane

index are linked to increased combustibility, efficient ignition, and facilitate easy engine starting, even at low temperatures. They also contribute to lower ignition pressures and offer smoother operation with reduced knocking tendencies (Aminul Islam et al., 2012). And physical properties play an important role in assessing the quality of date seed in oil and determine of its potential applications.

Statistical analysis revealed no significant differences between Al–Brince and Al–Allig date seeds in refractive index ($P = 0.9993$), specific gravity ($P = 0.7648$), higher heating value (HHV) ($P = 0.8684$), or cetane Index (CI) ($P = 0.3771$). However, a highly significant difference was observed in mean molecular mass (MMM) ($P < 0.0001$), with higher values for Al–Brince (274.96 ± 1.00) than Al–Allig (208.42 ± 1.80).

Table 1. Physical Properties of Date Seed Oil

Parameter	Al –Brince seed	Al –Allig seed
Refractive Index	1.3552 ± 0.2000	1.3554 ± 0.3000
Specific gravity	0.96522 ± 0.20000	0.89856 ± 0.30000
Colour	Yellow- dark	Brown- light
State at Room temperature	Semi Liquid	Liquid
Mean molecular mass (MMM)	274.96 ± 1.00	208.42 ± 1.80
Fuel properties HHV (MJ/kg)	41.01 ± 1.00	41.22 ± 1.80
Cetane Index(CI)	62.45 ± 1.00	63.63 ± 1.80

Means with similar letters within the same columns are not significantly different ($p < 0.05$).

3.2. Chemical Properties of Date Seed Oil:

The chemical characteristics of date seed oils are summarized in Table 2. Among the studied varieties, the oil content was highest in Al-Allig at 17.2% and lowest in Al-Brince at 12.8%. The acid values of the oil samples ranged from 2.8 mg KOH/g in Al-Brince seeds to 2.4 mg KOH/g in Al-Allig seeds. These findings align with results previously reported by Soliman and Alobeed (2015) and Rehab et al. (2012). The iodine values of the examined seed oils were between 47.37 g iodine/100 g for Al-Brince seeds and 44.46 g iodine/100 g for Al-Allig seeds, which are consistent with the reported ranges for date palm seeds oil by (H. El-Din Tariq Bouhlali et al., 2015). Similarly, the saponification values of the analyzed oils ranged from 203.6 mg KOH/g of oil for Al-Brince seeds to 199.7 mg KOH/g of oil for Al-Allig seeds. These results are in agreement with findings from prior studies, such as those by Akbar et al. (2009). An independent-samples t-test showed significant differences between Al–Brince and Al–Allig seed oils in total oil content ($t = -5.389$, $P = 0.0057$), iodine value ($t = 3.564$, $P = 0.0235$), and saponification value ($t = 4.777$, $P = 0.0088$). Oil content was higher in Al–Allig ($17.20 \pm 1.00\%$) than in Al–Brince ($12.80 \pm 1.00\%$), whereas iodine and saponification values were higher in Al–Brince (47.37 ± 1.00 g iodine/100 g and 203.60 ± 1.00 mg KOH/g, respectively) than in Al–Allig (44.46 ± 1.00 g iodine/100 g and 199.70 ± 1.00 mg KOH/g, respectively). No significant difference was observed in acid value ($t = 0.490$, $P = 0.6499$), with values of 2.80 ± 1.00 and 2.40 ± 1.00 mg KOH/g for Al–Brince and Al–Allig, respectively.

Table 2. Chemical Properties of Date Seed Oil

Property	Al - Brince seed	Al - Allig seed
Total oil (%)	12.8 ± 1.00	17.2 ± 1.00
Acid value, mg KOH/g	2.8 ± 1.00	2.4 ± 1.00
Iodin value, g Iodine/100g	47.37 ± 1.00	44.46 ± 1.00
Saponification value, mg KOH/g	203.6 ± 1.00	199.7 ± 1.00

3.3. Fatty acid composition of date seeds oil:

The fatty acid composition of date seeds, which shows slight variation among the analyzed varieties, is presented in Table 3 and Figure (2).(3). Oleic acid was identified as the predominant fatty acid in these cultivars, ranging from 48.34% to 49.12%, followed by lauric acid at 25.17% to 28.89%. Other fatty acids, including linoleic acid (5.58% to 7.59%), myristic acid (8.56% to 8.61%), palmitic acid (6.64% to 7.60%), and stearic acid (1.93% to 1.96%), were found in smaller amounts. Together, these fatty acids accounted for approximately 90–95% of the total fatty acid content. Based on this composition, date seed oil can be classified as oleic-lauric oil, with oleic acid being the most abundant, followed by lauric acid. These findings align closely with the results reported by Devshony et al. (1992) and Bouhlali et al. (2017). Overall, the fatty acid profile of date seed oil may be influenced by factors such as varietal differences, agricultural practices, and climatic conditions. It has been proposed that date seeds could serve as a valuable source of edible oils for human consumption or medicinal applications, as suggested by Al-Shahib and Marshall (2003).

Table 3. Fatty acid composition of date seed oil.

compound	Al- Brince seed	Al-Allig seed
Lauric acid	25.17 %	28.89 %
Myristic acid	8.56 %	8.61 %
Palmitic acid	7.60 %	6.64 %
Stearic acid	1.96 %	1.93 %
Oleic acid	49.12 %	48.34 %
Linoleic acid	7.59 %	5.58 %

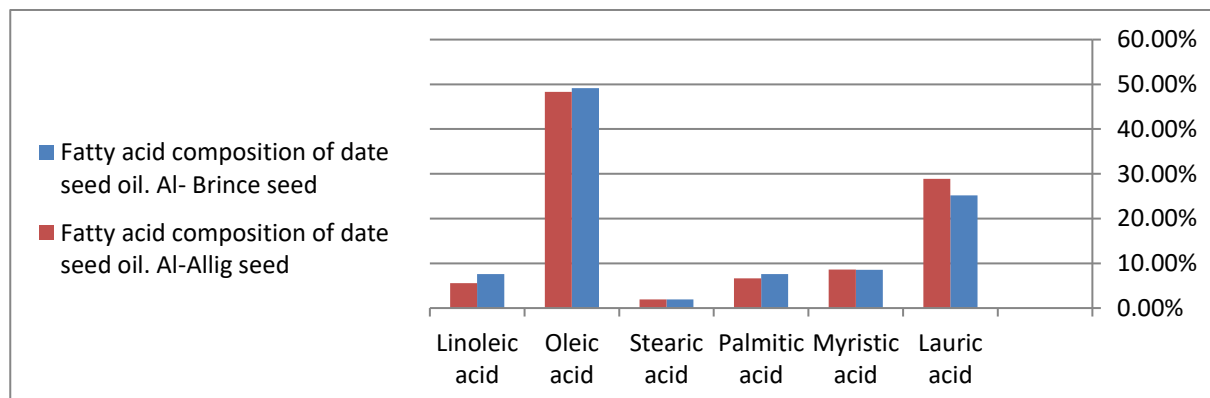


Fig. (1). Fatty Acid Profile of Date Seed Oil

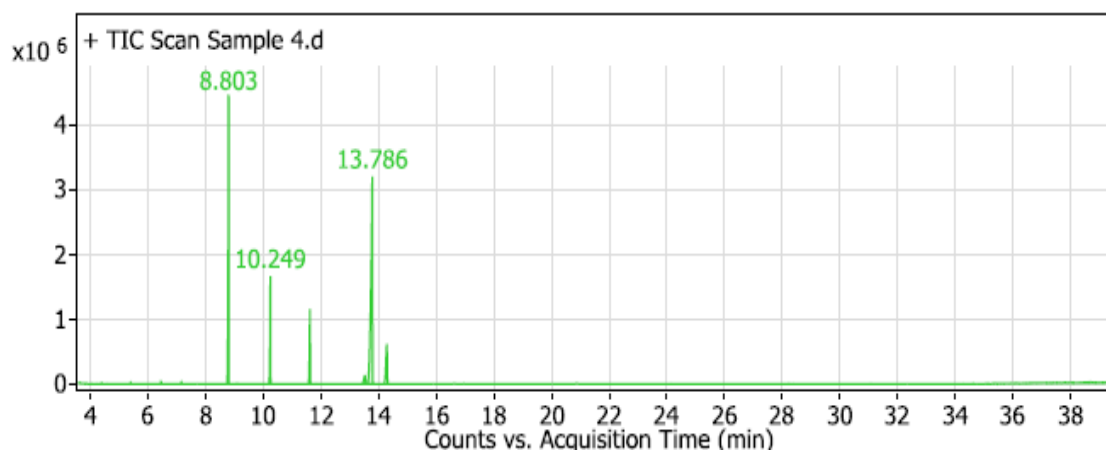


Fig.(2) : Chromatogram of the fatty acids composition of Al- Brince seed oil

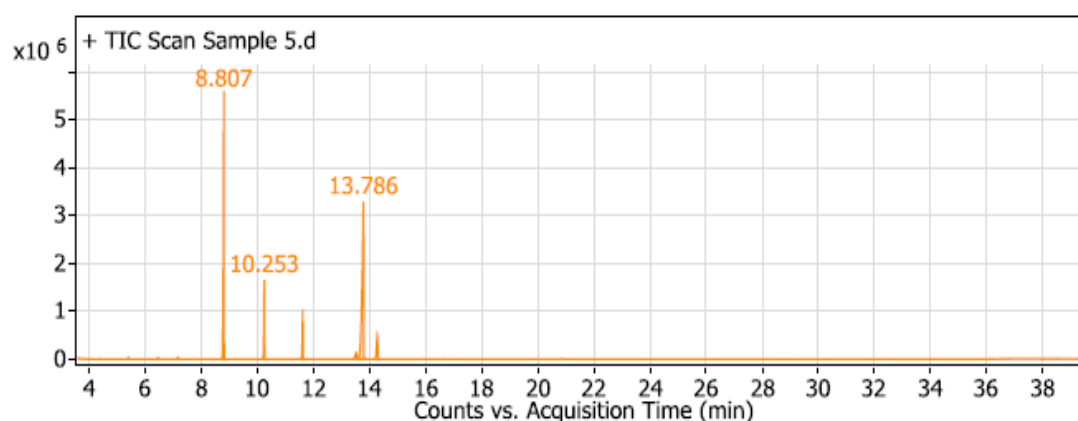


Fig.3: Chromatogram of the fatty acids composition of Al –Allig seed oil

4. Conclusion:

This study underscores the nutritional potential of oils extracted from two varieties of date seeds, demonstrating their suitability as a high-quality source. Crude oil derived from the seeds was assessed for its physicochemical properties, which align with the standards for edible vegetable oils. The analysis identified six types of fatty acids present in the oil, with lauric acid being the dominant saturated fatty acid and oleic acid serving as the main unsaturated fatty acid. Notably, the oil's moderate specific gravity and distinctive refractive index contribute to its excellent thermal stability and resistance to oxidation. These characteristics make it ideal for applications in the food, cosmetic and pharmaceutical industries. Moreover, the findings suggest that date seeds possess significant value as a by-product, that can be utilized in the food and the medicinal formulations. Additionally, this research contributes to the broader understanding of the benefits and diverse applications of using date seeds. However, further studies are needed to fully characterize the isolated components and bioactive compounds within date seeds and explore their extended health-promoting properties. Future research

efforts should also prioritize developing innovative, value-added products derived from date seeds to maximize their utility.

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