Alqalam Journal of Medical and Applied Sciences. 2026;9(1):143-148
https://doi.org/10.54361/ajmas.269123

Original article

Comparative Evaluation of Extraction Methods on the Physicochemical Properties and Chemical Composition of *Pistacia Lentiscus* L. Oil

Lila Areibat*, Asma Al-Kareiwi

Department of Chemistry, Faculty of Arts and Sciences, University of Elmergib, Msallata, Libya.
Corresponding email. areibatlaila2020@yahoo.com

Abstract
This study explores the influence of three extraction techniques—hydrodistillation, cold pressing, and solvent maceration—on the physicochemical parameters and chemical composition of *Pistacia lentiscus* L. oil. The extracted oils were analyzed using gas chromatography with a flame ionization detector (GC-FID). The findings showed that, in comparison to the other extraction techniques, the cold-pressing approach produced higher density and refractive index values. The Brix value reached 69.3% for the cold-pressed sample, exceeding those produced via hydrodistillation and solvent maceration. GC-FID analysis identified six primary fatty acids in *Pistacia lentiscus* L. oil, with oleic acid (C18:1) being predominant—recording 48% in the cold-pressed oil, 45% in the hydrodistilled oil, and 32% in the alcoholic extraction. Thus, cold-pressing retained the most nutritious monounsaturated fatty acids. With measurements of 18% in the cold-pressed sample, 20% in the hydrodistilled sample, and 22% in the alcoholic extract, palmitic acid (C16:0) was the predominant saturated acid. This suggests that the use of organic solvents increases the number of saturated compounds. Linoleic acid (C18:2), a polyunsaturated fatty acid, revealed the largest percentage (16%) in the cold-pressed sample, compared with 13% and 8% for the hydrodistilled and alcoholic extracts, respectively. A balanced fatty acid profile was also found in trace levels of linolenic (C18:3), arachidic (C20:0), and stearic (C18:0) acids. These results highlight the advantages of cold pressing as a natural and effective way to maintain the nutritional integrity and quality of *Pistacia lentiscus* L. oil.
Keywords. *Pistacia Lentiscus* L., Extraction Methods, Physicochemical Properties.

Introduction

A medicinal plant, including one or more active chemical compounds in variable concentrations in certain areas, possesses the physiological ability to treat or even lessen the incidence of a particular ailment, whether provided as a fresh herb or as dried and extracted materials [1]. In Africa, 90% of the rural population relies on traditional herbal medicine as primary care. According to Yahya et al., there has been an increasing understanding to incorporate African medicine into healthcare, as recognized by the World Health Organization (WHO), which acknowledges its important role in offering alternative healthcare alternatives in Africa [2].

Pistacia lentiscus L. has historically been significant to the pharmaceutical, cosmetic, and traditional medical sectors. Numerous illnesses, such as hepatic and digestive diseases, oral and dental infections, and skin conditions like burns and wounds, have been treated with extracts and essential oils from its fruits and resin. The oil is also recognized for its antibacterial, anti-inflammatory, antioxidant, and circulatory benefits [3]. The plant's name changes throughout regions known as "Batm," "Batoum," or "Qadoum" in North Africa, and "Mastika" or "Mastic" in the Eastern Mediterranean. The Mediterranean region is home to the evergreen shrub or small tree *Pistacia lentiscus* L. It normally grows between 5 and 7 meters in height and is marked by its dense, spherical crown and inflexible, light-brown limbs. The plant is spread by seeds and exhibits pinnate leaves composed of 2-4 pairs of oval or lanceolate leaflets with smooth margins and blunt points. Its small, unisexual flowers emerge in clusters, while the spherical fruits (5-8 mm in diameter) change color from green to red and eventually to dark brown upon ripening [4].

The essential oil of *Pistacia lentiscus* L. is a viscous, fragrant liquid extracted largely from the plant's fruits. It has a characteristic odor and flavor evocative of olive oil and contains a complex blend of volatile and non-volatile chemicals, including fatty acids, terpenes, and phenolics. Owing to its biochemical diversity, this oil has been included in pharmaceutical formulations, aromatherapy, and functional foods [5]. Optimizing extraction techniques to maintain oil quality has been a primary research objective due to the growing interest in natural plant-based goods. Various processes are used to extract essential oils from plant sources, such as steam distillation, cold pressing, and solvent extraction; each approach impacts the purity and potency of the oil. The physicochemical characteristics and chemical makeup of oil are significantly impacted by extraction processes. Additionally, the efficiency and selectivity of the extracted chemicals may be impacted by variables including temperature, solvent polarity, and mechanical pressure. This study uses an analytical technique called gas chromatography-flame ionization detection (GC-FID) for chemical profiling to assess how various extraction methods—hydrodistillation, cold pressing, and solvent maceration-affect the physicochemical properties and fatty acid composition of *Pistacia lentiscus* L. oil.

Received*: 08-11-2025 -* ***Accepted****: 10-01-2026 -* ***Published****: 18-01-2026*

Materials and Methods

Plant Material and Chemicals

Mature fruits of *Pistacia lentiscus* L. were taken from the Al-Farjan region in Tarhuna, Northwestern Libya. The samples were cleansed to eliminate foreign elements such as stems, dust, and debris, then washed repeatedly with distilled water and shade-dried at ambient temperature for seven days. To improve the extraction efficiency, the fruits were crushed into fine particles after drying.

The analytical-grade chemicals and materials used included ethanol (as solvent), anhydrous sodium sulfate (Na_2SO_4), and distilled water. Further, a Clevenger-type hydrodistillation apparatus, a digital handheld refractometer (PAL-BX/RI), and agas chromatograph system (BK-GC 7820).

Extraction Techniques

Steam Distillation (Clevenger) (SD)

In a 500 mL glass flask, 10 gm of the dried and pulverized plant sample was combined with 100 mL of distilled water (1:10). The hydrodistillation was performed for three hours using a Clevenger device. The essential oil was extracted from the aqueous phase using ethyl alcohol in successive extractions. The organic phase was dried over anhydrous sodium sulfate and concentrated to a final volume of approximately 3 mL. The extracted oil was transferred into amber glass vials, tightly sealed, and refrigerated until further analysis.

Solvent Maceration (SM)

For solvent maceration, 10 gm of pulverized *Pistacia lentiscus* L. fruits were immersed in 100 mL of ethanol at room temperature. After an hour of constant stirring, the suspension was allowed to macerate for seven days. In several instances, light heating below the solvent's boiling point was utilized to boost the extraction yield. To get rid of any solid residue, the slurry was filtered through a fine mesh. The filtrate was then exposed to air or mild sunlight to allow solvent evaporation, providing the crude oil extract.

Cold Pressing Extraction (CPE)

In order to extract the oil without using heat, the cleaned and ground fruits were manually compressed using a screw or hydraulic press. A clean, cold-pressed sample fit for analysis was created by filtering the extracted oil through fine filters to exclude suspended particles.

Determination of the Physical Properties of Extracted Oils

Color and Odor

Odor was determined by short-range indirect inhalation, while oil color was visually examined in a transparent glass tube against a white background. The sensory qualities were described using standard vocabulary such as herbal, woody, citrus, fruity, or aromatic, reflecting the organoleptic quality and purity of the oil [6,7].

Density Determination (ρ)

Using a volumetric flask that had been previously weighed, the oil density (ρ) was determined gravimetrically. The mass of the empty flask was measured in grams, and the mass of the flask with 10 mL of oil was measured in grams [8]. The following formula is used to estimate the oil's mass:

$$m = m2 - m1$$

The density of oil (***ρ***) was calculated according to the following law:

$$\rho = m/V$$

Refractive Index (RI)

The refractive index of the *Pistacia lentiscus* L. oil samples was determined using a digital refractometer (Digital Hand-held "Pocket" PAL-BX/RI). Two drops of the sample were placed on a prism, held firmly in place, and the readings were recorded after the device had been allowed to stand at room temperature for 10 minutes [8].

Brix Weight % (w/w)

The dissolved solids concentration of liquids is ascertained using the Brix level, which is expressed as a percentage by weight (w/w %). In the context of oils, non-fat materials such as sugars, resins, waxes, gums, and a few other trace constituents are referred to as dissolved solids [9].

Gas Chromatography Analysis (GC-FID)

A BIOBASE GC (BK-GC7820) system with a flame ionization detector (FID) was used to examine the chemical makeup of *Pistacia lentiscus* L. oil samples. Samples were pumped straight into the gas chromatography inlet, where the flame ionization detector (FID) detected volatile substances after the carrier gas separated them. Peak retention periods and relative peak areas for the identification and quantification of fatty acids were obtained from the resultant chromatography.

Received*: 08-11-2025 -* ***Accepted****: 10-01-2026 -* ***Published****: 18-01-2026*

Results and Discussion

The findings from the examination of *Pistacia lentiscus* L. oil samples extracted by three techniques: hydrodistillation, ethyl alcohol maceration, and cold pressing, are shown in this section. Color, aroma, density, refractive index, and gas chromatography (GC-FID) analysis were among the physical and chemical tests used to evaluate the oil's quality. These findings are intended to analyze how various extraction techniques affect the content and characteristics of the oil, identify the best technique for producing high-quality oil, and relate the findings to scientific concepts.

Color and Odor Sensory Analysis

Three techniques were used to assess the color and smell of the oils derived from *Pistacia lentiscus* L. fruit. As seen in Table 1, the results demonstrated distinct variations in color and odor for each sample based on the extraction technique.

Table1. The sensory characteristics of Pistacia lentiscus L., oil extracted using various extraction techniques.

Extraction method	Color	Odor
Hydrodistillation (Clevenger apparatus)	Light golden yellow	A strong and pure aromatic scent
Cold pressing extraction	Dark yellow with a slight orange tint	A light, less intense scent with a subtle herbal note.
Solvent maceration extraction (alcoholic extract)	Light yellow with a slight greenish tint	A less pronounced scent with a slight alcoholic note.

The *Pistacia lentiscus* L. oil extracted by Clevenger showed a strong, clear, fragrant fragrance and a golden-yellow color with a hint of orange in this investigation. This is consistent with research by Çömlekçioğlu and Çırak (2021), who found that steam distillation aids in maintaining the full composition of volatile oils and aromatic chemicals, especially aldehydes and terpenes [10]. Cold-pressed pistachio oil is characterized by its dark yellow-orange color and mild, herbaceous aroma. These findings are consistent with those of Chandra S, et al. (2020) [11], and also with those of Roumaissa Bouras and Jahida Saoud (2019) [12], who confirmed that cold-pressing methods preserve pigment compounds (such as chlorophyll and carotenoids) while reducing volatile compounds responsible for the strong aroma.

In contrast, the oil extracted by soaking in ethyl alcohol exhibited a light-yellow color and a faint odor with a slight alcoholic note, reflecting the lower efficiency of this method in extracting aromatic compounds compared to distillation. This aligns with the findings of Kaya and Ozer (2015), who demonstrated that using alcohol as a solvent can led to the extraction of polar compounds at the expense of volatile essential oils, as well as the dissolution of pigments [13]. Furthermore, the sample may retain alcoholic residues that affect its sensory character. Based on these results, the findings highlight the importance of selecting the extraction method according to the study's objective. The Clevenger method proved superior in extracting aromatic properties, while the cold-pressing method preserved the overall botanical composition. The solvent leaching method (alcoholic extract) demonstrated that the type of solvent used in the extraction process affects the oil's quality (physical and chemical properties).

The density

At room temperature, the density of pistachio oil samples (*Pistacia lentiscus* L.) extracted using the three procedures under study was determined. The different chemical contents of the extraction procedures were reflected in the values, which clearly differed between them. (Table 2) displays the results.

Table 2. Density values of the extracted oils.

	Extraction method	Density (g/ml)
1	Hydrodistillation (Clevenger apparatus)	0.788
2	Cold pressing extraction	0.814
3	Solvent maceration extraction (alcoholic extract)	0.769

Compared to the ISO 3960:2007 specification for vegetable oils (0.900–0.930 g/mL) [14,15], all the values measured in this study were found to be lower than the internationally accepted standards. Furthermore, a comparison with the reported density values for pistachio oil in the studies by Boras and Soud (2019) [12] and Siaf (2022) [16] showed that all the studied samples exhibited lower density values. This difference is primarily attributed to the extraction method used [12–16]. The cold-pressed sample exhibited the highest density value, likely due to its retention of a higher proportion of heavier compounds, such as vegetable fats and non-volatile phenolic compounds. In contrast, the solvent-extracted (alcoholic extraction) sample recorded the lowest density, possibly due to partial loss of oil components during solvent evaporation and/or

Received*: 08-11-2025 -* ***Accepted****: 10-01-2026 -* ***Published****: 18-01-2026*

the presence of solvent residues mixed with the oil. The sample extracted by hydro distillation using a Clevenger apparatus showed an average density value, which may be attributed to the partial co-extraction of volatile compounds, while heavier compounds were extracted less efficiently. The comparison results are presented in (Figure 1). These findings highlight the substantial influence of the extraction technique on oil density, a metric intimately linked to purity, molecular makeup, and processing effectiveness.

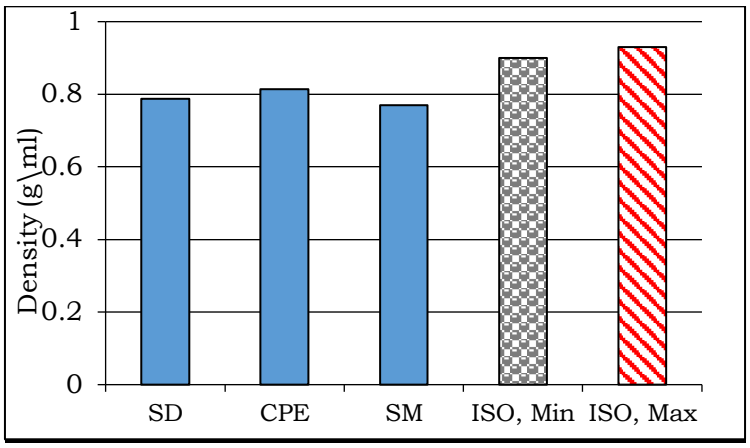

Figure 1. Comparison of the density values of the extracted oil samples with the (ISO) specifications.

Refractive Index (RI)

Oil quality is frequently assessed using the refractive index as a criterion. The refractive index values of *Pistacia lentiscus* L. oil samples were measured in this investigation, and the findings are shown in (Table 3).

Table 3. Refractive index (RI) values of the extracted oils.

	Extraction method	Refractive index
1	Hydrodistillation (Clevenger apparatus)	1.441
2	Cold pressing extraction	1.462
3	Solvent maceration extraction (alcoholic extract)	1.364

Compared to the International Organization for Standardization (ISO) specifications and compared to the reference values reported in previous studies, all samples exhibited a density lower than the stated range. This decrease is attributed to the extraction method: polar solvents, such as ethanol, may reduce the extraction of heavier compounds that contribute to higher density and refractive index, while hydrodistillation using a Clevenger apparatus primarily extracts volatile compounds, resulting in a lower refractive index. These observations are consistent with the findings of Patel et al. (2016) [17], who reported that the choice of extraction method directly affects the physicochemical properties of vegetable oils, particularly the retention of active fatty acids. (Figure 2) shows the comparison of the refractive index (RI) values of the extracted oil samples with the (ISO) specifications.

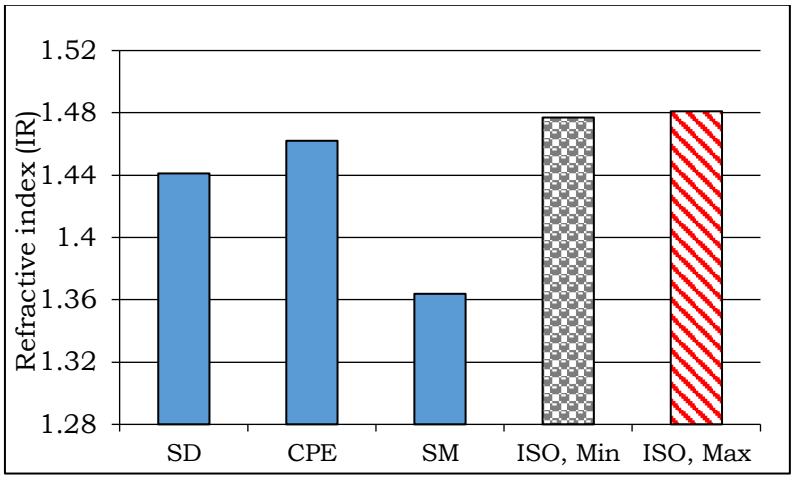

Figure 2. Comparison of the refractive index (RI) values of the extracted oil samples with the (ISO) specifications.

Received*: 08-11-2025 -* ***Accepted****: 10-01-2026 -* ***Published****: 18-01-2026*

Brix Weight (%)

Depending on the extraction technique, the oil samples' Brix levels differed considerably. The highest Brix value was found in the cold-pressed oil (69.3%), which was followed by the hydrodistilled oil (60.0%) and the solvent-extracted oil (20.6%). A review by Ebcim et al. (2018) [18] showed that cold-pressed oils retain higher amounts of active chemicals compared to other extraction processes, even though no research has directly linked Brix values in oils to the presence of waxes or resins. (Table 4) displayed the Brix weight values (%) for the current investigation. Consequently, higher preservation of secondary components, such as pigments, waxes, and resins, may account for the high weighted Brix value seen in cold-pressed samples, which enhances the oil's nutritional and physical qualities [18]. Table 4 displayed the Brix weight values (%) for the current investigation.

Table 4. Brix weight values (%) of the extracted oils.

	Extraction method	Brix Weight (%)
1	Hydrodistillation (Clevenger apparatus)	60.0
2	Cold pressing extraction	69.3
3	Solvent maceration extraction (alcoholic extract)	20.6

GC Analysis

According to the analysis, the highest percentage of fatty acids in all samples was oleic acid (C18:1). The findings also revealed that the cold-pressed sample had a higher percentage of unsaturated fatty acids than the other samples, including linoleic acid (C18:2). In contrast, the alcoholic extract sample had a greater percentage of palmitic acid than the cold-pressed sample. The results of the extracted oil samples' fatty acid composition are shown in Figure 3.

The analysis identified oleic acid (C18:1), palmitic acid (C16:0), and linoleic acid (C18:2) as the primary fatty acids present in *Pistacia lentiscus* L. oil, aligning with values previously reported in the literature [19]. Particularly for oleic acid (48%) and palmitic acid (18%), the cold-pressed oil in this investigation showed values that nearly matched those reported by Özcan M (2004) [19] and Belyagoubi-Benhammou et al. (2018) [20], and Derradji et al. (2025) [21]. This suggests that cold pressing successfully maintains the original fatty acid composition. On the other hand, hydrodistilled oil had somewhat lower quantities of linoleic acid (13%) and oleic acid (45%), perhaps as a result of the partial breakdown of unsaturated fatty acids at high temperatures during distillation. The alcoholic extract showed the lowest amounts of linoleic acid (8%) and oleic acid (32%), indicating that alcohol extraction may be less effective at keeping unsaturated fatty acids. Overall, our results demonstrate how important the extraction process is to preserving *Pistacia lentiscus* L. useful fatty acid content, and nutritional value.

Conclusions and Suggestions

The following conclusions and suggestions can be made in light of the study's findings on the impact of various extraction techniques on the physicochemical characteristics and fatty acid composition of *Pistacia lentiscus* L. oil:

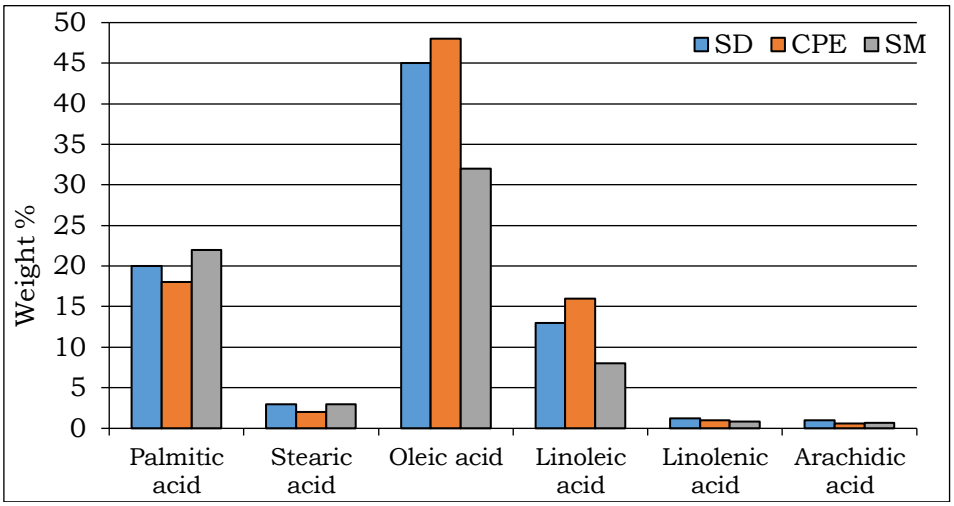

Figure 3. Fatty acid content in the extracted oil samples.

Conclusions

The physicochemical and chemical characteristics of *Pistacia lentiscus* L. oil are greatly influenced by the extraction process. The oil generated by cold pressing had the highest Brix value (69.3%), the highest unsaturated fatty acids (oleic acid 48%), and the best density (0.814 g/mL) and refractive index (1.424), all

Received*: 08-11-2025 -* ***Accepted****: 10-01-2026 -* ***Published****: 18-01-2026*

of which demonstrated outstanding natural constituent retention. Brix (20.6%), unsaturated fatty acids, density (0.769 g/mL), and refractive index (1.334) all significantly decreased in the alcoholic extract, indicating a partial loss of bioactive substances. Better retention of volatile aromatic chemicals and intermediate values was obtained using hydrodistillation. For the production of high-quality *Pistacia lentiscus* L. oil, cold pressing is recommended as the optimal extraction technique, particularly for nutritional or medicinal applications that require preservation of natural constituents. Volatile oils of *Pistacia lentiscus* L. with strong aromatic properties can be effectively obtained through hydrodistillation. Future research should focus on optimizing solvent extraction conditions to minimize the loss of bioactive compounds and on evaluating the impact of storage on the stability and quality of *Pistacia lentiscus* L. oil. In addition, to further support its application in the pharmaceutical and cosmetic industries, chemical investigations should be expanded to include secondary metabolites and aromatic compounds.

Conflict of interest. Nil

References

1. Al-Abed I. Study of the antibacterial and antioxidant activity of the crude alkaloid extract of Traganum nudatum T [master's thesis]. Ouargla (Algeria): University of Ouargla, Faculty of Sciences and Engineering Sciences, Department of Physics, Applied Organic Chemistry Division; 2011.
2. El-Shehat AZ. Essential oils. 1st ed. Egypt: Arabian House for Publishing and Distribution; 2000. p. 22.
3. Sahaki S, Julien N, Ayati F, Fernand F, Gentier E. A review of pistachio polyphenols: chemical diversity and pharmacological activities. Plants (Basel). 2023;12:279.
4. Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD). Atlas of medicinal and aromatic plants in the Arab world. League of Arab States; 2024.
5. Zitouni A, Chekroun-Bechlaghem N, Ghembaza N, Belyagoubi-Benhammou N. Lentisk fruits (Pistacia lentiscus L.) as sources of phytochemicals with potential health benefits: a review. J Nat Prod Res App. 2023;3(1):27–44.
6. Ben Khayal FA, Belgasim SM, Boubrig SY, Zaed MS, Ardia YK. Physical and chemical properties of fruit oil of Pistacia lentiscus L. growing wild in Libya. Alex Sci Exch J. 2025;46(2):279–289.
7. Mani-López E, Lorenzo-Leal AC, Palou E, López-Malo A. Principles of sensory evaluation in foods containing essential oils. In: Hashemi SMB, Khaneghah AM, de Souza Sant'Ana A, editors. Essential oils in food processing: chemistry, safety and applications. 1st ed. Hoboken (NJ): John Wiley & Sons; 2017. p. 293–325.
8. Edeh I, Okpo SO. Determining the physicochemical properties of lemongrass oil extract for suitability in various applications. J Nutr Food Process. 2023;6(2):1–6.
9. Kimball DA. Analyses of Brix, soluble solids, acids, oils, and pulp. In: Cameron RG, John MAC, editors. Citrus processing. 2nd ed. New York: Springer; 1999. p. 191–246.
10. Çömlekçioğlu N, Çırak R. Comparison of fatty acid composition and antioxidant contents of Tribulus terrestris L. collected from different localities. Turk J Agric Food Sci Technol. 2021;9(8):1448–1454.
11. Chandra S, Kumar M, Dwivedi P, Shinde LP. Functional and nutritional health benefit of cold-pressed oils: a review. J Agric Ecol. 2020;9:21–29.
12. Bouras R, Soud J. Study of the physicochemical properties of some vegetable oils [master's thesis]. Ouargla (Algeria): Kasdi Merbah University; 2019.
13. Kaya F, Özer A. Characterization of extracted oil from seeds of terebinth (Pistacia terebinthus L.) growing wild in Turkey. Turk J Sci Technol. 2015;10(1):49–57.
14. International Organization for Standardization. Animal and vegetable fats and oils. 4th ed. Geneva: ISO; 2007. (ISO 3960).
15. Kakhia TI. Analyses of oils, fats, and their raw and auxiliary materials. 2006. p. 1–339.
16. Siaf K. Valorization of Pistacia lentiscus L. in eastern Algeria [master's thesis]. Algeria: Faculty of Natural and Life Sciences, Department of Biological Sciences; 2022.
17. Patel VR, Dumancas GG, Viswanath LCK, Maples R, Subong BJJ. Castor oil: properties, uses, and optimization of processing parameters in commercial production. Lipid Insights. 2016;7:1–12.
18. Ebcim BÇ, Ozyurt VH, Otleş S. Cold press in oil extraction: a review. Ukr Food J. 2018;7(4):640–654.
19. Özcan M. Characteristics of fruit and oil of terebinth (Pistacia terebinthus L.) growing wild in Turkey. J Sci Food Agric. 2004;84:517–520.
20. Belyagoubi-Benhammou N, Belyagoubi L, El Zerey-Belaskri A, Zitouni A, Ghembaza N, Benhassaini H, et al. Fatty acid composition and antioxidant activity of Pistacia lentiscus L. fruit fatty oil from Algeria. J Food Meas Charact. 2018;12:1408–1412.
21. Derradji L, Benkhaled A, Yıldız K, Özbek ZA, Nouasri A, Ergönül PG. Influence of extraction method on physicochemical properties, fatty acid profile, and tocol content of Pistacia lentiscus oil from the Hodna subarid region (Algeria). Chem Biodivers. 2025;22(12):e01018.

Received: *08-11-2025* - ***Accepted***: *10-01-2026* - ***Published***: *18-01-2026*