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# Effects of packaging and storage temperature on the quality of *Pistacia lentiscus* seed oil

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**Abstract**: This study aimed to determine the effect of packaging and storage temperature on the chemical characteristics of Pistacia lentiscus seed oil. This work highlights the impact of environmental factors on the oxidative stability and nutritional composition of lentisk oil, which is relevant for food preservation strategies. The oil was extracted from mature fruits using a pressing method. To assess the effects of temperature and light, the extracted oil was placed at two different temperatures: 40°C and 25°C. At each temperature, three bottles were used: transparent, semi-transparent, and opaque. Three replicates for each treatment were removed after 30, 60, and 90 days of storage. Free fatty acids (FFA), Peroxide value, and total phenol content were analyzed. Results showed a minimum increase in free fatty acids in all oils studied. The results of changes in peroxide values of oils studied showed a slight increase over the first 40 days, followed by a decrease in all values. All studied oils showed a reduction in total phenol content during storage. The decrease of this parameter was more critical at 40°C.

Keywords: *Pistacia lentiscus*; packaging; seed oil; storage; temperature; quality.

# 1. Introduction

Vegetable oils are fats extracted from plant sources, typically from seeds, nuts, or fruits. It plays an essential role in our diet. They ensure several nutritional functions. Oils contribute to the supply of energy, are sources of essential fatty acids, and participate in the transport of fat-soluble vitamins and other constituents of nutritional value, such as phytosterols or phenolic compounds <sup>1</sup>. These vegetable oils are subject to chemical reactions such as isomerization and oxidation of fatty acids <sup>2</sup>.

Nutritionally, the oxidation of oils gradually leads to a loss of quality, mainly due to the partial degradation of essential fatty acids and vitamins E and A  $^3$ .

Generally, the more double bonds the fatty acid has, the faster its oxidation rate. The oxidation of fatty acids leads to their transformation into molecules that can be toxic to the body.

In practice, this oxidation phenomenon is easily identifiable because it is responsible for a change in the appearance of the vegetable oil (rancid smell, color change).

Certain factors accelerate this oxidation but are not necessary and sufficient elements to trigger the oxidation phenomenon: oxygen, light (UV), contact with pro-oxidant metals (Iron or Copper), the

\*Corresponding author: Faten Mezni Email address: <u>faten-mez@hotmail.com</u> DOI: <u>http://dx.doi.org/10.13171/mjc02504031817mezni</u> presence of pigments such as chlorophyll, the presence of enzymes (lipases...). Other factors will slow down this phenomenon, particularly the contribution or the natural richness of the oil in vitamin E.

For these reasons, it is essential to study the storage conditions of vegetable oils and select the optimal conditions for minimal degradation  $^4$ .

In this study, we determined, for the first time, the effect of packaging and storage temperature on the chemical characteristics of *Pistacia lentiscus* seed oil.

# 2. Results and Discussion

Variations of the acidity of lentisk oil according to storage conditions are presented in Figure 1.

Results showed a minimum increase in free fatty acids in almost all oils studied. These results are in agreement with other studies on other vegetable oils <sup>5.6</sup>. Free fatty acids are fatty acids that are not bound to glycerol in triglycerides. They are a class of organic compounds that can result from the hydrolysis of triglycerides during oil processing, storage, or due to the action of lipolytic enzymes.

They are commonly found in edible oils, significantly when they degrade due to factors like heat, moisture, and exposure to air  $^{7}$ .

Received January 2025 Accepted March 16, 2025 Published April 3, 2025 The level of free fatty acids (FFAs) in stored oils is significantly influenced by various storage

conditions, which can lead to quality degradation and reduced shelf life. Several studies reported the effect of temperature, light, and oxygen exposure on the quality of seed oils  $^{8-10}$ .



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Figure 1. Effect of storage conditions on lentisk oil acidity; (a) at 25°C, (b) at 40°C

The peroxide index represents the oxidation state of fats. It can serve as an indicator of the oxidative processes and in turn, of the oil quality. The oxidation of unsaturated fatty chains forms peroxides or hydroperoxides. These compounds are labile and break down into more stable compounds: aldehydes, ketones, and acids <sup>11</sup>.

The evaluation of PV is shown in Figure 2. The results of changes in peroxide values of oils studied showed a slight increase over the first 40 days, followed by a decrease in all values.

Several studies reported that the peroxide index changes over time, passing through a maximum before decreasing so that a low peroxide index is no longer a reliable criterion for measuring oxidation at this stage <sup>12</sup>.

In the transparent glass, this parameter showed an uptrend. This could be related to the effect of light on this parameter. The oil can be easily oxidized when displayed in stores in diffused light <sup>13</sup>.



Figure 2. Effect of storage conditions on Peroxide value of lentisk oil; (a) at 25°C, (b) at 40°C

The variations in total phenol content are summarized in Figure 3.

All studied oils showed a decrease in total phenol content during storage. The reduction of this parameter was more critical at  $40^{\circ}$ C.

The decrease in total phenol content during the storage of vegetable oils is a well-known phenomenon, especially in oils that are exposed to adverse storage conditions such as light, oxygen, and high temperatures. Phenolic compounds are natural

antioxidants found in oils and play a crucial role in protecting oils from oxidative degradation. However, during storage, these compounds can degrade, reducing the oil's antioxidant capacity and overall quality.

Many reports suggested significant losses in these components after storage <sup>14-16</sup>. This is due to oxidative degradation enhanced by high temperatures.



Figure 3. Variation of total phenol content according to storage conditions; (a) at 25°C, (b) at 40°C

The slight decrease in total phenols after 90 days of storage detected for oil packed in dark glass study was probably due to the high quality of fresh samples and favorable storage conditions. Even dark bottles protected the product from light and oxygen.

# 3. Conclusion

Chemical parameters of *Pistacia lentiscus* oil showed high variation according to storage conditions. Oil was sensitive to both temperature and light. The best results were obtained for oils stored in dark glass at  $25^{\circ}$ C.

This study determined the best storage conditions for this oil. As it is used for culinary and medicinal purposes, it is essential to preserve the chemical characteristics of this product.

# 4. Experimental

#### 4.1 Plant material

Mature fruits of *Pistacia lentiscus* were harvested from wild plants growing north of Tunisia (Bizerte). Dr. A. Khaldi identified the plant from I.N.R.G.R.E.F-Tunisia, and certified specimens (VS1-PL2009) were deposited at the Herbarium run by I.N.R.G.R.E.F.

# 4.2 Oil extraction

The oil was extracted using a pressing method. The fruits were first ground using an ordinary chopper. The resulting paste was mixed for 30 minutes in a water bath and was then placed in a hydraulic press to allow the liquid to separate from the meal. All floating oil was removed and stored in cold, dark conditions for subsequent chemical analyses.

#### 4.3 Storage conditions

To assess the effects of temperature and light, the extracted oil was placed in two different temperatures: 40°C and 25°C. In each temperature, three different bottles were used: transparent, semi-transparent, and opaque.

Three replicates for each treatment were removed after 30, 60, and 90 days of storage.

# 4.4 Free fatty acids (FFA)

Free fatty acids (FFA) were determined according to official analytical methods in NFEISO 660<sup>17</sup>. 10 g of oil were dissolved in 100 ml of chloroform in the presence of a few drops of phenolphthalein (1g/100 ml of ethanol). Titration was done with a solution of KOH in ethanol (0.5 mol/L).

The free fatty acid content is calculated according to the following formula:

Where:

C: KOH concentration in mol/L

V: volume of KOH in ml

m: mass of oil in g

M: molar mass of the fatty acid in g/mol (oleic acid 282 g/mol and palmitic acid 256 g/mol)

# 4.5 Peroxide value

The Peroxide value was determined according to European standards NFEISO 660<sup>17</sup>.

A given weight (1g) of the oils was introduced into 250ml Erlenmeyer, and then 10 ml of chloroform was added. 15 ml of acetic acid, then 1 ml of potassium iodide (KI) solution was added, and the mixture was shaken for 1 min. After 5 minutes of incubation in the dark and at a temperature between 15 and 25°C, 75 ml of distilled water was added.

Burettes were filled with 0.1N sodium thiosulphate. 1 ml of the starch indicator was added to every flask, and titration with the thiosulphate was done until the blue-grey color disappeared. Also, a blank titration was carried out with everything except the oil samples.

The peroxide values were calculated from the formula below:

Peroxide Value (PV) =  $(V-V0) / P \times 10$ 

Where:

V – Volume of thiosulphate used in the titration of the sample (ml).

V0 - Volume of thiosulphate used to titrate the blank (ml).

P– Mass of the tested oil (g).

Three replicates of every sample were analyzed to ensure the stability of the results.

### 4.6 Total phenol content

2 g of oil were weighed and mixed with 5 ml of methanol/water (80/20, v/v) for 1 min in a vortex device. The mixture was then separated in an ultrasonic bath for 15 min at room temperature and centrifuged at 5000 rpm for 25 min. The methanol phrase was removed and stored cold and in the dark. Total phenol content was measured using the Folin-Ciocalteu reagent, according to the method described

by Singleton and Ross18.  $500 \ \mu$ l of the extracts of each sample was mixed with

100  $\mu$ l of the Folin–Ciocalteu reagent (10 times diluted) and 2 ml of sodium carbonate Na2CO3. The whole is incubated at room temperature for 30 minutes, and the reading is carried out against a blank using a spectrophotometer at 755 nm.

From an aqueous stock solution of gallic acid with a concentration of 0.5 g/l, a standard range of solutions in an aqueous medium was prepared.

100  $\mu$ l of 10% Folin-Ciocalteu reagent (10 times diluted in distilled water) is added. After two minutes of incubation, 2 ml of 2% Na2CO3 sodium carbonate is added. The tubes are then shaken and placed in the dark for 30 minutes at room temperature.

The absorbance of each solution was read using a UV-visible spectrophotometer at a wavelength of 755 nm against a blank prepared in the same way, except that it does not contain gallic acid but distilled water instead of the test substance. The absorbance values of each concentration allowed us to plot the calibration curve for gallic acid.

#### 4.7 Statistical analysis

The statistical processing of the data is carried out using the GLM (General Linear Models) procedure of the SAS such that an analysis of variance relating to the parameters studied is carried out. The most significant correlations between them are also noted. The results are presented as the mean of three repetitions  $\pm$  standard deviation.

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