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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. The oil was extracted from mature fruits by pressing. To assess the effects of temperature and light, the extracted oil was placed at 40°C and 25°C. At 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. Free fatty acids (FFA), peroxide value, and total phenol content were analyzed. Results showed that there was no increase in free fatty acid levels in any of the 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 decline in total phenol content during storage. The reduction of this parameter was more significant 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 [1]. These vegetable oils are subject to chemical reactions such as isomerization and oxidation of fatty acids [2].

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 can lead to the formation of toxic molecules.

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

Certain factors accelerate this oxidation but are not necessary or sufficient to trigger the oxidation phenomenon: oxygen, light (UV), contact with pro-oxidant metals (Iron or Copper), the presence of pigments such as chlorophyll, and the presence of enzymes (lipases…). Other factors will slow this phenomenon, particularly the contribution of the oil's natural vitamin E content.

For these reasons, it is essential to study the storage conditions of vegetable oils and select optimal conditions to minimize 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 in the acidity of lentisk oil under different storage conditions are shown in Figure 1.

Results showed minimal increases in free fatty acids across almost all oils studied. These results are in agreement with other studies on other vegetable oils [5,6]. 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 or storage, or from the action of lipolytic enzymes.

They are commonly found in edible oils, particularly when they degrade due to factors such as heat, moisture, and exposure to air [7].

The lowest trend for this parameter was observed for oils in semi-transparent glass, whereas in opaque glass the increase was higher.

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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].

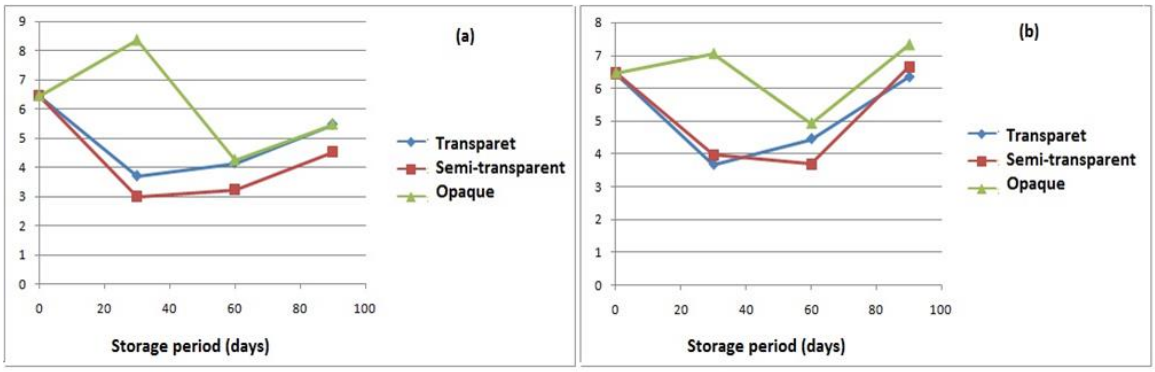

Figure 1. Effect of storage conditions on lentisk oil acidity; (a) at 25°C, (b) at 40°C

The peroxide index represents the oxidation state of fats. It can serve as an indicator of oxidative processes and, in turn, of 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 [11].

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, reaching a maximum before decreasing, so that a low peroxide index is no longer a reliable criterion for measuring oxidation at this stage [12].

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 [13].

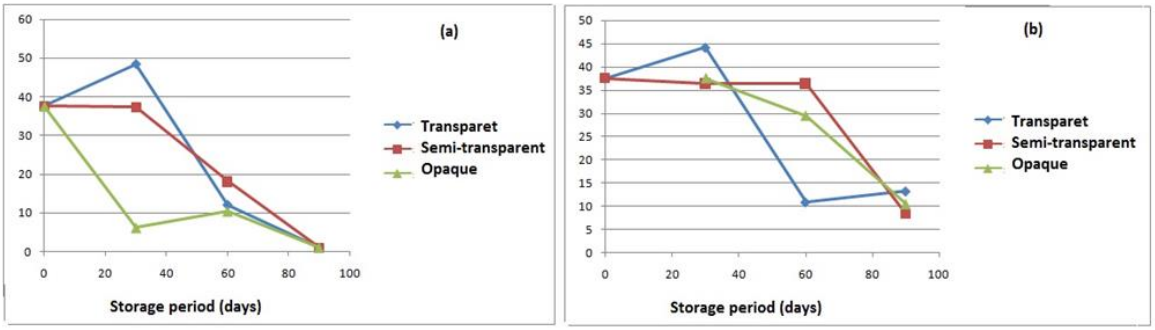

Figure 2. Effect of storage conditions on Peroxide value of lentisk oil; (a) at 25°C, (b) at 40°C

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°C.

The decrease in total phenol content during the storage of vegetable oils is a well-known phenomenon, especially in oils exposed to adverse conditions such as light, oxygen, and high temperatures. Phenolic compounds are natural antioxidants found in oils 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 [14-16]. This is due to oxidative degradation enhanced by high temperatures.

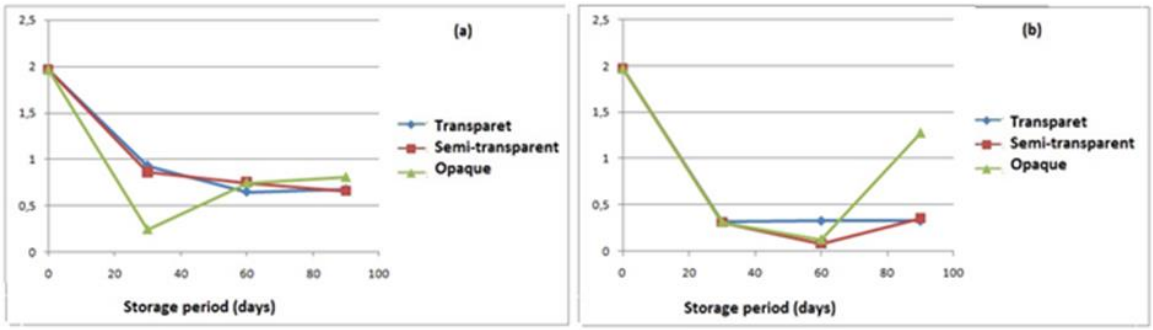

Figure 3. Variation of total phenol content according to storage conditions; (a) at 25°C, (b) at 40°C

The slight decrease in total phenols after 90 days of storage observed in the oil-packed in dark glass study was probably due to the high quality of the 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 significant variation under different storage conditions. Oil was sensitive to both temperature and light. The best results were obtained for oils stored in dark glass at 25°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 its chemical properties.

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 in the Herbarium of 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 the official analytical methods specified in NFE ISO 660[17]. 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:

$$FFA= (V \times C \times M \times 100) / 1000 \times m$$

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[17].
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 at 15-25°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 each flask, and titration with thiosulfate was continued 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:

$$\text{Peroxide Value (PV)} = (V-V0) / P\times10$$

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 each 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, followed by centrifugation 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 µl of the extracts from each sample was mixed with 100 µl 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 µL of 10% Folin-Ciocalteu reagent (diluted 10 times in distilled water) is added. After two minutes of incubation, 2 ml of 2% Na2CO3 is added. The tubes are then shaken and placed in the dark at room temperature for 30 minutes.

The absorbance of each solution was measured using a UV-visible spectrophotometer at 755 nm against a blank prepared in the same way, except that it did not contain gallic acid but instead distilled water. 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 in SAS, which yields an analysis of variance for the parameters studied. The most significant correlations between them are also noted.

The results are presented as the mean of three repetitions ± standard deviation.

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