



## A review on *Pistacia lentiscus* seeds oil in Tunisia: Nutraceutical and economic potential

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### Abstract:

*Pistacia lentiscus* seed oil is a non-wood forest product commonly known for its nutritional and therapeutic value. In Tunisia, *P. lentiscus* fixed oil has high economic value considering its relatively high price, the increasing demand, and the expansion of such product may have an impact on the forestry area, creating employment opportunities and reducing poverty in forest areas. This work aims to highlight the importance of the nutritional and therapeutic values of this product and to demonstrate its economic importance. Such a study allows the identification of the main barriers encountered at different levels of the value chain. The paper aims also to identify the most relevant recommendations to commercialize the product and integrate international market and points out the underestimated potential that *Pistacia lentiscus* have in terms of unexploited surface area.

## 1. Introduction

In recent years, a growing interest in Non-Wood Forest Products (NWFP) can be observed. NWFP which are defined by FAO as “non-wood forest products consist of goods of biological origin other than wood, derived from forests, other wooded land and trees outside forests’ include a large range of products such as mushrooms, resins, berries, aromatic and medicinal plants (Muir *et al.*, 2020; Smith-Hall and Chamberlain, 2024). In Tunisia, NWFP are at the center of strategic orientations, this sector being able to play a leading role in economic diversification and the creation of new employment prospects in rural regions where professional alternatives are often rare. Due to its geographical position, Tunisia benefits from several factors of pedogenesis such as the climate and the soil, to which are added the water resources and the sunshine which are all favorable to the development of intensive cultivation (production) of the NWFP in general and aromatic and medicinal plants in particular of which the Tunisian flora is rich. Forests and woodlands cover around 8% of a surface area the country (1.3 million ha in 2015) with a local population representing 8% of the total population living inside these forests and getting an income from the extracted NWFP (Touhami *et al.*, 2023).

With a recent study highlighting the importance of the NWFP and showing a contribution of 32.30% to the local forest populations’ income as well as to the preservation of the environment through

reducing sedimentation and carbon sequestration (Taghouti and Daly-Hassen, 2018), an increasing interest is oriented to the investigation of these products considering the fact that 46% of the local population are below national poverty threshold defined by the National Institute of Statistics (INS., 2020).

The search on Scopus indicated that *Pistacia lentiscus* is largely studied (more than 1250 documents) and about 80 papers per year were published. The most cited paper belonged to (Krishnaiah *et al.*, 2011) summarizing the antioxidant potential of medicinal plant species (cited > 820 times). In Mediterranean region, It is commonly used in traditional medicine for the treatment of several diseases, including diabetes (Piccolella *et al.*, 2016, Floris *et al.*, 2024). This power of *Pistacia lentiscus* is due to the richness of the chemical composition in phenolic, flavonoid and other anti-oxidant components (Bouyahya *et al.*, 2018, Labhar *et al.*, 2024). Furthermore, the application of *Pistacia lentiscus* is also in corrosion protection of different metals in aggressive media (Haloui *et al.*, 2015, Salhi *et al.*, 2016, Barbouchi *et al.*, 2023).

Among the NWFP commonly studied, *Pistacia lentiscus* (Figure 1) is a particularly interesting aromatic and medicinal plant in terms of socioeconomic value but also nutritional and therapeutic value. Due to poor data on its collection and transformation and mainly potential, the *Pistacia lentiscus* is an underestimate species with a high potential.



**Figure 1.** *Pistacia lentiscus* seeds

The present study investigates the production of *Pistacia lentiscus* under different forms, its socio-economic, nutritional and therapeutic potential in Tunisia and in the international market.

In Tunisia, *Pistacia lentiscus* is an ancestral plant, well known by local populations for its nutritional and therapeutic vertus (Mezni *et al.*, 2012, Ait Mohand *et al.*, 2020). It was initially used as animal feed for wild raring besides a more recent use of the extracted fixed oil based on the discovery that the mastic tree's seeds are an important source of a fixed oil that is widely known for its wound healing and anti-ulcer potentials (Mezni *et al.*, 2020b). Such discovery allowed at the time the valorization and optimization of the fixed oil process, but also the generation of an additional important income to local populations.

The present paper, reviews the importance of the nutritional and therapeutic values of the *Pistacia lentiscus*' seed oil and shows its economic importance. It allows the identification of the main barriers encountered at different levels of the value chain. The paper aims also to identify the most relevant recommendations to commercialize the product and integrate international market.

## 2. Methodology

To prepare a review on the nutraceutical and therapeutic properties of *P. lentiscus* seed oil, existing knowledge was integrated. The corresponding data were collected by reviewing articles published in Elsevier, Google Scholar, MDPI, Taylor and Francis, and Springer databases.

The Economic data were obtained through a review of previous studies elaborated on the *Pistacia lentiscus* seeds oil. Data on production costs, labor, market prices, and revenue generation were collected through systematic review from the green and grey literature. The Economic Analysis was assessed by analyzing key indicators such as income generated per hectare, employment opportunities, and market demand for *Pistacia lentiscus* oil and price evolution.

## 3. Results and Discussion

### 3.1. *Pistacia lentiscus*: presentation and distribution

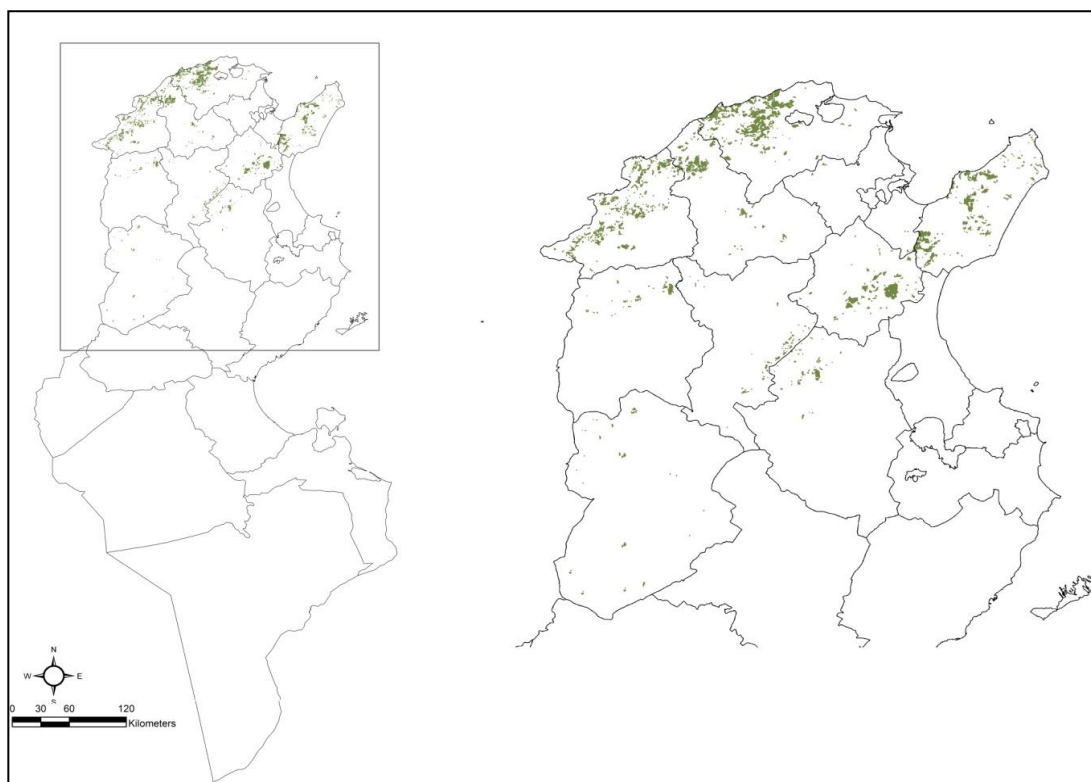
*Pistacia lentiscus* or Mastic Tree is an evergreen shrub growing in the scrubland and maquis of Mediterranean climates. It belongs to the Anacardiaceae family. The mastic tree is generally a shrub that can reach six meters (Diamantoglou and Kull 1988, Barazani *et al.*, 2003). The fruit is a small, rounded, edible drupe, about five millimeters in size. Initially red, it then becomes black at maturity (November-December).

*P. lentiscus* is one of the main components of low-altitude Mediterranean scrublands. It shows a circum-Mediterranean distribution and extends to North-East Africa and Madeira Island (Zohary, 1996). In the interior of the Iberian Peninsula, it grows at low altitudes (Garrigues) in shaded areas, avoiding places with cold winter (Castro-Díez *et al.*, 1998). Present all around the Mediterranean, *Pistacia lentiscus* is mainly confined to the thermo- and meso-Mediterranean levels; it hardly exceeds 400m in altitude, however it reaches the French coasts in places, particularly in the Alpes-Maritimes and in the Eastern Province. The mastic tree is found along the tell and in forest areas, in association with the Aleppo pine, the holm oak and the cork oak (Belhadj, 2007, More & White, 2013). According to (Chadefaud & Emberger, 1960), the mastic tree is likely to create real potential forest vegetation structures, on deep soil. In Tunisia, mastic trees cover a total surface area of 41796ha, distributed across the governorates of Nabeul, Zaghuan, Ben Arous, Beja, Bizerte, Jendouba, Kasserine, Kef, Kairouan and Seliana as shown in **Figure 2**.

### 3.2. *Lentisk oil production and nutraceutical value*

Seeds production varies to be between 600 and 2000kg/ha depending on the geographical region. Several external factors may also impact the quantities, such as the environmental conditions and the seasonality of the production. Lentisk oil is a yellow-green vegetable oil with an intense, herbaceous odor. It is extracted from the mature fruit of the lentisk tree. The oil is liquid at 32-34 C°; below this temperature crystallize (Leprieur 1860, Maarouf *et al.*, 2008).

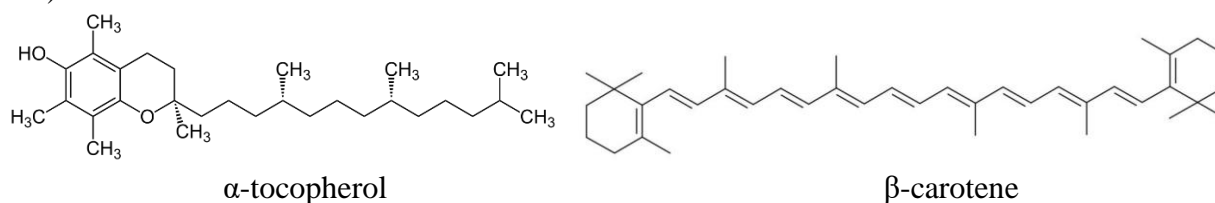
Like most vegetable oils, lentisk seed oil is composed of about 99% of fat. It contains 70% of unsaturated fatty acids. Oleic acid is the major fatty acid with a content of about 50%, followed by linoleic acid (20%) and palmitic acid (20%) (Mezni *et al.*, 2012, Ait Mohand *et al.*, 2020). The free fatty acid profile shows oleic acid as the prominent in terms of concentration (30%) followed by linoleic acid and palmitic acid at 18% and 6%, respectively. Lentisk oil is rich in phenols which are natural antioxidants. The phenolic profile of this oil showed that it is mainly composed of phenolic acids and flavones. The total amount of phenols present in the oil is around 4260.57 mg/kg oil (Mezni *et al.*, 2018, Siano *et al.*, 2020).



**Figure 2.** Geographical distribution of *P. lentiscus* in Tunisia

Oleic acid	linoleic acid	palmitic acid

The total tocopherol content was estimated to be 118.16 mg/kg oil. The  $\alpha$ -tocopherol (vitamin E) content is about 96.77 mg/kg oil. The total carotenoid content is about 10.57 mg/kg oil.  $\beta$ -carotene is the main specie identified in this oil representing 4.9 mg/kg oil (Karoui *et al.*, 2020, Mezni *et al.*, 2020a).



The vitamin E or  $\alpha$ -tocopherol has been found to be very effective in the prevention and reversal of various disease complications due to its function as an antioxidant, its role in anti-inflammatory processes, its inhibition of platelet aggregation and its immune-enhancing activity (Rizvi *et al.*, 2014; Loukili *et al.*, 2024; El Hassania *et al.*, 2024); while  $\beta$ -carotene is a precursor of the vitamin A widely used as an antioxidant with applications in the food industry as a natural colorant (Haddou *et al.*, 2023; Taibi *et al.*, 2023; Elbouzidi *et al.*, 2023).

Studies on the fixed oil of *Pistacia lentiscus* revealed its low toxicity. The high values of oral and intraperitoneal lethal doses of *Pistacia lentiscus* fixed oil confirmed a low acute toxicity (Boukeloua *et al.*, 2012). Showing that this oil is well tolerated. *P. lentiscus* seed oil exhibited several biological properties. The wound healing potential of this oil was reported by several studies (Aouinti *et al.*, 2014;

Khedir *et al.*, 2017, 2018; Mezni *et al.*, 2020b). The antimicrobial activity of lentisk oil against bacteria and yeasts, such as *Listeria innocua*, *Salmonella enterica*, *Enterococcus faecalis*, *Shigella flexneri*, *Candida parapsilosis*, *C. tropicalis* and *C. glabrata*, have been reported with some differences depending on the microorganism tested (Dhieb *et al.*, 2021; Milia *et al.*, 2023).

### 3.3. Tunisian market and value chain analysis

Seed oil is produced only in few Mediterranean countries (Tunisia, Algeria and Italy), presenting a high potential to integrate international market. Besides the specific characteristics the product presents, Tunisia presents a high production potential which can place the country in relatively high position in terms of exportation. Back to the literature, the actual production of the *Pistacia lentiscus* seed oil is obtained from the exploitation of around 14000ha surface area covered by *Pistacia lentiscus*. In order to expand the *Pistacia lentiscus* fixed oil to export, there is a need to move the production/extraction from its traditional and ancestral process to a more organized one. The Tunisian market is observing an exponential expansion of the seeds oil prices. Based on a review of the 10 past years, the market price is following a relatively rapid evolution bringing the prices to 220TND/L in 2024. The evolution can be explained by the increasing interest of the national and international communities to the product due to the previously explained nutritional and therapeutic virtues from one side but also to the important impact it has on the local population income (AIFM, 2022).



**Figure 3.** Description of the Value Chain of lentisk seed oil (GIZ, 2014)

At the collection level, collectors are mainly local inhabitants of rural areas, and the collection is regulated by the General Direction of Forestry as the legal representative of the public authorities (Figure 3). At this stage there is no legal framework that organizes the harvest and or collection of fruits. Local populations only benefit from usage rights that allow them to harvest fruits under conditions strictly limited to their personal needs (Code Forestier, 2017).

Such conditions present a real limitation to meet the real potential of the resource.

At the transformation level, an improvement of the transformation process was already performed through series of training and capacity buildings performed with the local populations. Such process improved the extraction performance and quality with 40% compared to the traditional methods (Mezni *et al.*, 2011). However, several gaps are still observed at this level such as; the lack of control and application of good hygiene practices and the use of a traditional process leading to the degradation of the quality of the oil. The commercialization level of the value chain can be described as the weakest link of the value chain. It mainly consists of wholesalers (or semi-wholesalers) who purchase the oil in bulk from the processors and ensures supply to retailers.

### 3.4. Highlight on the underestimated potential of *Pistacia lentiscus*

During the investigations on *Pistacia lentiscus*, the fact that the used surface area is much lower than the total surface area was raised. Actually, the total exploited area reported in the literature is around 14000ha all over the country, which represents only 20% of the total area reported by the forest

administration. Such observation points out the underestimated potential of the plant, considering a total production of 1.68 M l/an of fixed oil in 2016 with an average productivity of 120l/ha (AIFM, 2022). These results show the high-underutilized potential Tunisia have for the extraction and sales of *Pistacia lentiscus*'s fixed oil mainly that the country is among the only 3 countries that are reported producers. A social and an economic potential can be noted related to this product. Previous investigations have shown that the production of the fixed oil is exclusively made by local populations and small business initiatives and sold for a price that varied between 15 and 80dt/l in 2016 with a gross margin of more than 40%. An increasing demand of the product based on the medialization of its nutritional and medicinal value in the recent years led to an increase in its price reaching 220dt/l in 2023 (AIFM, 2022).

### 3.5. Recommendations

To encourage the production and the sales of the *Pistacia lentiscus* fixed oil to reach its potential, the present work emitted a list of recommendations to follow based on the different levels of the value chain:

At the collection level, recommendations go to both General Direction of Forestry being the official authorities managing the resource (considering the fact that the land is publicly owned) and to the local populations being the extractors/ collectors. For the General Direction of Forestry, it is highly recommended to review the specific rules and article of the forest code in order to facilitate the tender and encourage collectors to access the resource in order to increase the exploitation of *Pistacia lentiscus* surface area. From the collectors' side, the populations need to respect the regulation, protect the resource and avoid the overexploitation.

At the transformation and production side, it is advised to apply modern extraction method that allows a considerable yield (up to 12%) compared to the traditional extraction method (allowing a maximum yield of 7%) and a higher quality (Mezni et al., 2011). Also, it is suggested that the local population gets organized into Agricultural Development Groups (GDA) but also Small and Medium Enterprises (SME). Such initiatives are highly encouraged by the Tunisian government to support inclusive economic development and poverty reduction within the forest areas. An increase of market power can be reached through these organizational forms, leading to avoid the main market barriers namely: economies of scale, product differentiation, capital requirements, cost disadvantages, access to distribution channels and government policy (Taghouti & Daly-Hassen, 2018).

Several recommendations could be emitted for a better placement of the *Pistacia lentiscus* fixed oil on the market. To be effective, recommendations at this level are based on the origin of the product being an aromatic and medicinal plant and belonging to the wild food products category. Thus, policy recommendations suggest developing certification frameworks specific to wild food products, working with local populations to incorporate traditional knowledge, establishing clear legal frameworks, and providing technical support for certification infrastructure. Monitoring systems and public-private partnerships are encouraged to ensure the certification process is effective and sustainable. Additionally, clear labeling guidelines, traceability enhancements, and consumer education will help promote transparency, safety, and quality in wild food markets (Taghouti & Daly-Hassen, 2018).

## 4. Conclusion

*Pistacia lentiscus* fixed oil is a yellow-green vegetable oil with a high content of unsaturated fatty acids, predominantly oleic and linoleic acids. It also contains notable amounts of phenols and tocopherols, which contribute to its antioxidant properties. The oil has demonstrated low toxicity and

is known for its wound healing and antimicrobial effects against several bacteria and yeasts. Besides these attributes highlighting the therapeutic potential, making it valuable for various medicinal applications, in Tunisia, *Pistacia lentiscus* fixed oil has high economic value considering the its relatively high price (220tnd/l), the increasing demand, and the impact the expansion of such product may have on the forestry area, creating employment opportunities and reducing poverty in forest areas. The present paper points out the underestimated potential the *Pistacia lentiscus* have in terms of unexploited surface area and emit recommendations to support the different levels of production to overcome the gaps and barriers handicapping the expansion.

**Disclosure statement:** *Conflict of Interest:* The authors declare that there are no conflicts of interest.

*Compliance with Ethical Standards:* This article does not contain any studies involving human or animal subjects.

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