# Mastic tree: past, present, future, and its potential importance for Turkey

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***Abstract***

**Mastic tree (*Pistacia lentiscus* var. *chia*) is known as a dioecious evergreen small tree, belonging to the Sumac family (*Anacardiaceae*). It has long been cultivated only in the south part of the Greek island of Chios, in the Aegean Sea. Mastic tree is the unique source of mastic gum, which is obtained by injuring the trunk and branches of the tree. The history of mastic dates back to the 5th century B.C., i.e., to the time of Herodotus. Hippocrates, Dioscorides and Galen mentioned about the pharmaceutical properties of mastic. Pliny gave detailed information about the mastic in his book of "Naturalis Historiae". Currently, about 140 t of mastic is being produced from 2,000,000 trees annually. The Chios Gum Mastic Growers Association having 4,850 members govern mastic production, processing, and trade. Mastic resin and mastic oil are widely used in medicine, pharmaceutical, cosmetic and food industry. However, some evidence showed that mastic tree was also cultivated in the adjacent western Anatolia in the past. Remnants of old plantations, particularly observed in former Greek Orthodox villages on the Çeşme Peninsula, pointed out the growing activities in the past. But probably lost its importance after the 1923 population exchange. Some efforts have been made on the protection, rehabilitation and propagation of the current genetic material since 1995. Also some experimental plots were established by some universities, related ministries and NGOs using different propagation methods in the last 20 years. In this paper, history and current status of mastic tree together with its development possibilities in Turkey are presented.**

**Keywords:** *Pistacia lentiscus* var. *chia*, gum mastic, history, Chios, Çeşme

## INTRODUCTION

Mastic tree (*Pistacia lentiscus* L.) is a dioecious evergreen shrub (rarely a small tree). It's a circum Mediterranean species and a leading component of maquis vegetation in the Mediterranean basin, extending to Madeira Island (Zohary, 1995). Mastic tree is the unique species evaluated for mastic gum which is obtained by wounding the trunk and thick branches of the tree. Mastic is a natural resin or more precisely an oleoresin obtained from *P. lentiscus* var. *chia* Duham which is different from the wild species mainly with leaf morphology (Browicz, 1987; Zakynthinos and Rouskas, 1998). Only male trees are used for mastic production (Belles, 2008). The oldest information on mastic goes back to Herodotus, i.e., the 5th century B.C. It has been used in traditional Greek medicine, mainly for gastrointestinal disorders. This gum was also mentioned by Hippocrates. The works of Greek physicians, such as Dioscorides and Galen include mastic as an important therapeutic factor, mention its properties, and recommend its use. Plinius emphasized the use of mastic and its superiority to other resins in his book of "Naturalis Historiae" (Browicz, 1987; Paraschos et al., 2012). Mastic oil was known to Romans as "mastichinum oleum" and used for various therapies (Belles, 2008). During the Ottoman administration, the mastic producing people of Chios had many privileges (Belles, 2008). Mastic tree and mastic gum have been associated with the Chios Island through the history. Fossils of mastic tree leaves found on the island proved its existence goes back to 6000 years ago suggesting that its origin comes from this island (Hagidimitriou, 2009). Attempts to grow the mastic tree on some adjacent islands failed

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(Browicz, 1987). Some climatic and edaphic factors seemed to limit the mastic tree growing (Belles, 2008). Mastic is exclusively produced in 24 villages known as mastic-villages (Mastichochora) at the southern part of Chios. About 140 t year$^{-1}$ mastic is being produced from nearly 2 million trees. Mastic production and trading activities have been administered by The Chios Gum Mastic Growers Association (CGMGA) that was founded in 1938 (Belles, 2008). Today, mastic resin and mastic oil are commercialized products due to their food, medicinal, cosmetic, pharmaceutical and industrial applications (Chadzopulu et al., 2011; Paraschos et al., 2012). Despite the lack of information, there is some evidence showed that cultivation of mastic tree was not uncommon in the adjacent Western Anatolia in the past. In some former Greek Orthodox villages on Çeşme Peninsula, remnants of old plantations were observed (Baytop, 1968; İsfendiyaroğlu, 2003). In recent years some innovative strategies on marketing through the development of a range of new products based on gum mastic by CGMGA on Chios (Matopoulos and Vlachopoulou, 2008). However, there is a danger of abandonment of mastic production due to the lack of interest by the new generation farmers (Theodoropoulos and Apostolopoulos, 2004; Belles, 2008). From this point of view, mastic culture might move the neighboring coasts of the Western Anatolia where the ecological conditions are nearly similar to southern part of Chios. In the last 20 years, some attempts have been started to protect and propagate the current genetic material of mastic tree governed by some institutions. Some small scale experimental plots were also established particularly on Çeşme peninsula and some other potential lands.

In this review, besides the historical background of mastic, current status and future prospects particularly in association with Turkey were exposed.

**MASTIC TREE AND GUM MASTIC**

Mastic tree (*Pistacia lentiscus* L.) is one of the most common plant species of coastal Mediterranean. It belongs to the Sumac family (*Anacardiaceae*) and is an evergreen shrub (rarely small trees) with leathery leaves and conspicuously winged rachis (Zohary, 1995). It is the unique species appreciated for gum mastic obtained by wounding the trunk and thick branches of the plant. Gum mastic is a natural resin or an oleoresin obtained from *P. lentiscus* var. *chia* Duham, differing from the wild species through its leaf morphology and tree-like growth (Baytop, 1968; Browicz, 1987; Paraschos et al., 2012). Mastic tree cultivation and gum mastic production have been associated with the island of Chios through the centuries. Mastic tree was not successfully grown anywhere else, either in continental or insular Greece. Besides the islands of Amorgos and Antiparos, attempts to transfer plantations to Rhodes and Lesvos were failed (Browicz, 1987). Interestingly, mastic tree was even introduced to the US in 1855 for experimental cultivation in California and the Gulf States (Kalças, 1992). Some climatic and edaphic factors are predictive on the mastic tree cultivation. The climate in mastic villages is temperate. The winter is short and mild, the temperature rarely falls down to 0°C. Mastic tree cannot withstand the temperatures below zero. Mastic tree may reach up to 500 m of altitude in southern slopes that are closed to the northeast wind. The soils are well-textured and rich in lime (20-50%) (Belles, 2008). Only male trees have been used for mastic production (Baytop, 1968; Browicz, 1987; Belles, 2008). The male tree gives the highest and best quality resin, starting on the 5-6$^{th}$ year. The regular production is reached in the 15$^{th}$ year (more than 320 g), but the highest production is among the 30-50 years (500 g and rarely 1 kg). And it lives over a hundred years (Belles, 2008; Zografou et al., 2010). Morphological characteristics suggest the existence of several male cultivated forms or genotypes that also differ in quantity and quality of the resin product (Browicz, 1987; Zografou et al., 2010). Based on the molecular results, four major male genotypes of mastic tree show genetic diversity (Zografou et al., 2010). Mastic tree is propagated clonally by the hardwood cuttings. Thick branches are cut and planted at their final place where the tree is grown. The propagation and planting activities have been regulated by the law No. 4381 of 1929 (Belles, 2008). Mastic is extracted after shallow incisions made on the trunk (needling) and the thicker branches of the plant. The resinous exudate flows out from the incisions in the form of tears (Belles, 2008). Macro-anatomical examinations showed that longitudinal resin ducts are locating only in the phloem tissue and consist of a few layers of epithelial cells. Mechanical injury to the bark

results with the exudation of resin in order to coat the wound surface (Sawidis et al., 2000). The process of mastic production takes place during the months from June to October. The Law No. 4381 was prohibited the production procedure before 15th July and after 15th October every year (Browicz, 1987; Belles, 2008). Steps of mastic production start with cleaning and compacting of ground under the trees. And then the ground is covered with a kind of white soil "asproi" that helps the mastic to dry more easily and quickly. The first needling begins on July 15. The needling injuries are the incisions (kentos) made on the trunk and particularly scaffold limbs, having 10-15 mm length and 4-5 mm depth. These incisions are made by using a tool called "kentitiri". A tree can receive 20-100 incisions totally, depending on its age. North winds and low temperatures help mastic to dry more quickly. The solidification of resin lasts about 14 days and finally collected by hand. Immediately after the drying of mastic, the first harvest begins after the mid-August. The growers detach mastic from the trunk, with a tool called "timitiri". After the second needling, the second harvest begins after September 15. When the mastic harvest ends (October), elaboration and sorting of mastic begin. Growers first sieved the mastic that has been collected. They separate the product from soil, leaves, etc. by sieving. Then mastic is washed with cold water repeatedly and laid in a cool place for drying. After the mastic dries, women using small knives clean mastic pieces one by one from any material stuck on them. This process is quite hard and elaborative. And then mastic is sorted according to the size of grains. After the first elaboration, a second process starts at the facility of CGMGA. In this process, a second cleaning is conducted through use of penknives by the competent young women workers (Belles, 2008; Hagidimitriou, 2009). Finally the cleaned mastic is categorized before packing as follows: large, medium, small, small No.3 and 5 and powder, respectively (Anonymous, 2018a). The chemical composition of mastic resin consists of a variety of organic ingredients including a natural polymer was identified as cis-1,4-poly-β-myrcene, volatile and aromatic ingredients that constituted the essential oil (approx. 2%), terpenic acids, phytosterols, polyphenolic molecules and a large number of potentially active secondary metabolites (Magiatis et al., 1999; Assimopoulou and Papageorgiou, 2005; Anonymous, 2015).

**HISTORICAL BACKGROUND AND USES**

The oldest historical reference about the use of mastic goes back to Herodotus (5th century B.C.) who informs us about chewing (mastication) of dried resinous fluid secreted from the bark of the mastic tree. Mastic was probably used by ancient Egyptians to spread over the sheets covering embalmed corpses was also mentioned by Herodotus (Paraschos et al., 2012). In fact, latest archeological findings confirmed to use of mastic for embalmment of Egyptians' mummies of the 7th century B.C. (Colombini et al., 2009). Gum mastic had been used in traditional Greek medicine for various gastrointestinal disorders for more than 2500 years. Ancient Greek physicians such as Hippocrates, Dioscorides and Galen mentioned its curing properties and recommended its use (Browicz, 1987; Belles, 2008; Paraschos et al., 2012). Dioscorides (1st century A.D.), one of the most famous medical authors of classical antiquity, gave detailed references to mastic and its numerous therapeutic effects on blood coagulation, chronic cough, stomach aches. And he also mentioned that the mastic is useful for cleaning the teeth and adoring the mouth when chewed. In his famous work "De Materia Medica", Dioscorides mentioned "mastichinon elaion (oleum)", probably prepared by mixing mastic with olive oil and its warming, astringent and emollient properties as well as its effects on inflammations of the stomach and intestinal disorders (Paraschos et al., 2012). Dioscorides was also a battlefield physician who served to the Roman army, wrote about the wound healing properties of an infusion prepared from mastic leaves (Belles, 2008). Galen of Pergamon (2nd century A.D.) who mentioned about the therapeutic properties of mastic based antidotes against baldness, mange and snake-bite (Belles, 2008). He also informed us the greatest of physicians Hippocrates believed the exceptional properties of mastic and he recommended it as a medicine for some "hysteric passions" (Belles, 2008). The Romans were also aware of the mastic and mastic oil. In fact, Roman women used toothpicks made from the mastic tree. Emperor Elagabalus (218-222 A.D.) was the first to prepare wine out of mastic oil, which has been named as "masticatum" (Belles, 2008). Plinius (1st century A.D.) is probably

the first author who reported the unique cultivation of mastic tree in the southern part of Chios (Paraschos et al., 2012). His reference about the use of mastic as an additive of grape must was confirmed by archeological findings of the 6th B.C. in Italy (Mizzoni and Cesaro, 2007). During the Byzantine Era, the trade and use of mastic was extended and very profitable for the imperial treasury (Paraschos et al., 2012). Its medicinal and cosmetic uses were mentioned by contemporary authors (Belles, 2008). Just after the start of the long administration of the Genoans (1346-1566 A.D.), the famous stock company "Maona", who was responsible for mastic monopoly, established. During this period, mastic exported all over the Europe and Islamic world (Belles, 2008; Ierapetritis, 2010; Paraschos et al., 2012). After the conquest by the Ottomans in 1566, Chios was administratively divided into two parts, as the villages that produce mastic and the others. Mastic villages had many privileges, more than the other residents of the island. These were as well as about the mastic production and also included the independency from the central administration; not submitting to drudgeries; reduced poll tax (jizya) and having the right to ring the bells of their churches (Belles, 2008). The administration of these villages was carried out by the Aga or Sakiz Emini, who was the collector of the mastic tax about 20.000 okas (26,000 kg) of mastic per year for the public treasury (Belles, 2008; Ierapetritis, 2010). Numerous European authors of the Ottoman period (16-18th centuries) also mentioned about the several therapeutic applications of the mastic. Furthermore, it was also present in many European pharmacopoeias of the 19th century with numerous prescriptions for ointments and pills containing mastic (Ierapetritis, 2010; Paraschos et al., 2012). In 1938, the Greek state brought the Compulsory Law Nr. 1390, and The Chios Gum Mastic Growers Association was officially established "for the purpose of protection of Chios mastic, by systemizing the production, collection, packing and its joint turnover" (Belles, 2008). This organization also helped to fortify the growers' income and gave the opportunity for a coordinated promotion of mastic at the international level (Paraschos et al., 2012). The therapeutic uses of mastic particularly on the gastrointestinal disorders are still conserved and being practiced in the East Mediterranean and Middle East societies (Paraschos et al., 2012). Healing effect of mastic on human duodenal ulcer and functional indigestion was proven in recent studies (Al-Habbal et al., 1984; Dabos et al., 2010a, b; Miyamoto et al., 2014). After the discovery of *Helicobacter pylori* and its correlation with gastric diseases (Warren and Marshall, 1983), investigations focus on the anti *H. pylori* properties of mastic and mastic oil (Paraschos et al., 2012). The discovery of anti-*H. pylori* effect of mastic, led to new studies on the antimicrobial activities of mastic and mastic oil (Paraschos et al., 2012; Anonymous, 2015). Mastic and mastic oil have been used for centuries as a preservative for fats and oils, and they could both be used as preservatives in pharmaceutical and cosmetic preparations, as well as functional foods (Assimopoulou et al., 2005). Results showed that mastic powder could have a hepatoprotective/cardioprotective role with its hypolipidemic activity if ingests daily at the proper amount (Triantafyllou et al., 2007). Investigations aiming on describing mastic's potential cardioprotective role brought new studies on its anti-inflammatory activity (Paraschos et al., 2012), particularly in order to assess the effects of mastic on patients with Crohn's disease (Kaliora et al., 2007). Findings provide the strong evidence that mastic might be an important regulator of immunity in Crohn's disease (Paraschos et al., 2012; Anonymous, 2015). Positive results were reported for the activity of mastic against prostate and colorectal cancers, as well as leukemia and lung carcinoma (Chadzopulu et al., 2011; Paraschos et al., 2012). For a long time, mastic has been esteemed for its aphrodisiac properties referred to in the past with the presence of zinc, because this trace element is important to male sex organ function and reproductive fluids. This might be the reason why the "Ottoman Sultan" preferred to have the mastic as an additive in his daily bread (Sawidis et al., 2010). Gum mastic provides an increased adhesiveness and low incidence of complications to closure tapes in surgery was reported (Yavuzer et al., 2005).

**MODERN TIMES**

Since 1997, gum mastic (Chios Mastiha) has been identified as Protected Designation of Origin product (PDO). And in 2008, Chios mastic became a part of the EU financially supported products (Anonymous, 2018a). In currency, more than 300 different end products are known

containing gum mastic consumed all over the world. Despite the majority of demand comes from Middle East countries where the gum mastic is a basic ingredient in their local cuisines, in the USA, Western Europe and Japan mastic is principally used in health and care formulations and products. In traditional confectionary and bakery products, Turkish delight, ice creams, chocolates and also chewing gums, mastic is used for its unique flavor. There are also numerous recipes of delicious Mediterranean delicacies based on mastic. Moreover, it is used in liqueurs and aperitifs such as the traditional "ouzo mastiha", beverages and refreshments, dietary supplements, cosmetics, tooth pastes, mouth washes, antiseptic/wound healing pastes and solutions, ointments for burns and skin treatments which are world-wide commercialized (Kartalis, 2006; Anonymous, 2018a). In 2015, according to European Medicines Agency (EMA) decision, mastic as a traditional herbal medicinal product is used against mild dyspeptic disorders, minor skin inflammations and minor wounds (Anonymous, 2018a). In 2002, Mediterra SA was founded by CMGA, who is particularly aiming on the establishment as a marketing tool for mastic under the brand name "mastihashop" and sale of mastic products world-wide. Up to now, 16 retail stores opened in Greece and different metropoles such as New York, Paris, Jeddah, Qatar, etc. (Anonymous, 2018a).

**FUTURE PROSPECTS AND TURKEY**

Today, mastic is produced in 24 mastic villages at the southern part of Chios. The latest figures pointed out the annual production may vary between 140 and 160 t. The production, turnover and export figures from 2011 to 2015 seemed to be quite stable. Production figures did not changed even after the large forest fire in 2012. But average net prices to grower slightly decreased (Table 1). Average selling price is 89 € $kg^{-1}$ nowadays. The first five importers are the Middle East countries (KSA, UAE, etc.) followed by Mauritania, USA, Turkey and Egypt (Anonymous, 2018a).

Table 1. The production, turnover, export and grower prices of mastic.

| Year | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|
| Production (t) | 147.0 | 152.0 | 147.3 | 145.2 | 125.9 |
| Turnover (€×1000) | 15.243 | 14.762 | 13.884 | 13.996 | 14.234 |
| Exported quantity (t) | 90.0 | 100.4 | 99.0 | 90.4 | 101.4 |
| Avg. net price to grower (€) | 72 | 68 | 66 | 65 | 64 |

Due to its widespread uses, mastic is an important agricultural product for the economy of the island. Mastic production is the main occupation of more than 2000 people in currency. Despite the global uniqueness, there is a present danger of abandonment of production due to the lack of interest by the new generation farmers. Because mastic farming is a family operation, and even though the selling price of mastic is high compared to other agricultural products, but producers are not satisfied since mastic production is labor intensive and the cost of production is very high. Moreover, the current subsidies for mastic production are not satisfactory. Demographic statistics showed that educational level of growers was mostly elementary school (45%) and 55% of them are middle aged (41-60). So, most of the growers do not want their children to involve in this occupation (Theodoropoulos and Apostolopoulos, 2004; Belles, 2008). For this reason, prospect for mastic production in the island of Chios is not optimistic.

On the other hand, presence of very old trees as in small groups particularly found in the former Greek Orthodox villages on the Çeşme Peninsula and its close periphery, pointed out the growing activities in the past (Baytop, 1968; İsfendiyaroğlu, 2003). Moreover, morphological characteristics of some old specimen trees correspond with some cultivated clones on Chios. After the 1923 population exchange, mastic tree growing entirely lost its importance. Some limited attempts in mid 60s like establishing a small experimental plantation in Çeşme was not long lived (Baytop, 1968). Attempts were restarted in 1994, aiming on the protection, rehabilitation and propagation of current genetic material on the Çeşme Peninsula under the leadership of Ege University and the related ministries. About 100

specimen trees have been legally registered and protected since 1995. In recent years, Turkey imported about 10 t gum mastic year$^{-1}$, valued at 1 million USD (Anonymous, 2018c). Nearly the same amount of mastic enters by the illegal ways is estimated. From this point of view, in 2008, one of the most important civil organizations (TEMA) started a project close to Çeşme, aiming at the grafting of naturally grown wild mastic trees, granted by an international chewing gum company. In the years 2010 and 2013, some separate projects initiated by the Ministry of Forestry and Water Affairs on propagation of mastic tree by cutting and grafting on the Çeşme Peninsula. A course of action (2014-2019) was also introduced by the same ministry, including to take inventory of alternative locations for establishing the new mastic tree forests by the various propagation methods, along with the coasts of İzmir, Muğla and Antalya provinces (Anonymous, 2018b). But in the mentioned projects, mastic tree has been considered as a forest species rather than a medicinal-aromatic plant. However, mastic production may constitute a risk of new forest clearings or over utilization of forests (Özden, 2016). A similar project has been conducted by the Ministry of Agriculture since 2016 aiming at the establishment of adaptation blocks in potential locations from Gökçeada to Marmaris districts. Determination of promising lands for mastic tree investments is quite important for Turkey. Because, mastic tree is always mentioned with the Çeşme district and surrounding villages. But the rapid development in tourism sector gave rise to a serious abandonment of agricultural activities particularly in the last 20 years in the Çeşme Peninsula. Tendency to give up the agricultural production is notable for young population living in the villages, related with nearly similar reasons observed as in Chios. In fact, the recent economic analyses conducted for Çeşme and close districts also proved that mastic production is not economically feasible due to the high land prices (Özden, 2016). In this respect, gum mastic production could only be encouraged in new alternative lands apart from the pressure of tourism. Moreover, high and long-termed subsidies should be needed due to the unique features of this production model. And intercropping particularly with the medicinal and aromatic plants seems to be quite important for early cash flow to growers. Agro-ecotourism activities including the mastic culture have to be organized.

Despite the long history and well organized structure of gum mastic production in Chios, if the magnitude of potential lands in the Aegean coasts of Anatolia is considered, mastic tree cultivation and mastic production in Turkey seems to be promising. A certain part of the domestic demand might be provided from new investments in the near future.

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