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Review Article

# Mastagi (*Pistacia lentiscus*): A Comprehensive Evidence-Based Review of Traditional Uses and Modern Pharmacological Perspectives

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## Abstract

**Background:** *Pistacia lentiscus* L. (Mastagi) is an aromatic medicinal plant traditionally used in Unani medicine, particularly for gastrointestinal disorders, wounds, and ulcers. **Objective:** To review the traditional uses, phytochemical constituents, and pharmacological activities of *P. lentiscus*. **Methods:** Information was compiled from classical Unani literature and published experimental and clinical studies concerning the botanical characteristics, traditional uses, Phytochemistry, and pharmacological properties of *P. lentiscus*. **Results:** *P. lentiscus* contains diverse bioactive constituents, including monoterpenes, triterpenes, phenolics, flavonoids, fatty acids, tocopherols, and sterols. Experimental studies have reported antimicrobial, antioxidant, anti-inflammatory, gastroprotective, Hepatoprotective, hypolipidaemic, antidiabetic, anticancer, neuroprotective, and wound-healing activities. **Conclusion:** The available evidence supports several traditional uses of *P. lentiscus* and indicates considerable pharmacological potential. However, evidence is predominantly preclinical, and further well-designed clinical and safety studies are required to establish its therapeutic efficacy.

**Keywords:** *Pistacia lentiscus*; Mastagi; mastic gum; Unani medicine; Phytochemistry; pharmacological activity.



## 1. Introduction

*Pistacia lentiscus* L. (Mastagi), commonly known as the mastic tree, is an aromatic medicinal plant that grows to a height of 1–5 m[1]. It is an evergreen perennial shrub belonging to the family Anacardiaceous[1]. The tree bears bright red globose berries, and mastic gum is the natural resin obtained from its stem[2,3]. Mastic is a resin or more correctly an oleoresin containing little oil obtained from a cultivated variety of Pistacia lentiscus in the Greek Island of Chios[4]. Mastic comes in peppercorn-sized, rigid, microscopic rips. Most are pear-shaped, avoid globular, or almost globular, and occasionally, but infrequently, they are elongated. The medicine has a mildly acceptable taste and an agreeable, slightly aromatic odour, both of which are characteristics[5]. The resin occurs as small, hard, pear-shaped, ovoid or nearly globular, sometimes elongated tears, about 2–8 mm in diameter. The tears are pale yellow and brittle, break with a clear, glossy fracture, are transparent inside and crush to a sandy powder. The taste is slightly agreeable and the odour aromatic[6,7].

**Table: - 1-** Kingdom, division, class, order, genus, species and family of *Pistacia. Lentiscus*[7]

| | |
|---|---|
| **Kingdom** | Plantae |
| **Subkingdom** | Viridiplantae |
| **Division** | Tracheophyta |
| **Class** | Magnoliopsida |
| **Order** | Sapindales |
| **Family** | Anacardiaceae |
| **Genus** | *Pistacia* |
| **Species** | *P. lentiscus* |

### Vernacular names[8]

**Table: - 2 –** Vernacular names, Mizaj, Part used and Miqdar-e-Khurak of *Pistacia. Lentiscus*[8]

| | |
|---|---|
| **Arabic** | Mastake, Ilk-ur-Roomi, Mastagi |
| **Urdu** | Mastagi |
| **English** | Mastic tree, Mastic |
| **Hindi** | Rumi Mastagi, Rumi Mastaki, Mastagi |
| **Tamil** | Ponnuikan, Kungiliyam |
| **Persian** | Kundur Roomi |
| **Bengali** | Rumi-Mastungi |
| **Marathi** | Ruma Mastakee, Roomi Mastakhi |
| **Gujarati** | Rumi Mastagee |
| **Mizaj (temperament)** | Har wa Yabis (hot and dry) in the second degree[9] |
| **Parts used** | Resin obtained from the stem of *P. lentiscus* |
| **Miqdar-e-Khurak (dose)** | 2–7 g[10] |

## 2. Habitat and Distribution

Native to the Mediterranean region (France, Spain, Portugal, Greece, Turkey) and also found in North Africa. Mostly mastic is produced on the Greek Island of Chios, some is also produced in Algeria, Morocco and the Canary Island[11]. Growing in countries bordering on the Mediterranean, its resin is called the mastiche and obtained by incisions made in the bark, is imported into India from Asia Minor through Persia and Afghanistan[11,12].

## 3. Ethnobotanical description

*P. lentiscus* L. is widely distributed in Mediterranean countries such as Morocco and the Iberian Peninsula, and is cultivated in France, Turkey, Iraq, Iran and England. Its resin is imported into India from Asia Minor through Iran and Afghanistan[7]. The aromatic, ivory-coloured resin, known as mastic, is harvested as a spice from cultivated mastic trees on the Greek island of Chios, where it is also known as 'Chios tears'. The resin is originally liquid and dries in the sun into hard, brittle, translucent drops; when chewed, it softens and becomes a bright white, opaque gum[13].

### Mahiyat (Unani morphology)

In Unani literature, Mastagi is a resin popularly known as 'Alakur-rome' and is imported from foreign countries. It resembles Kundur but is more effective and lighter. Two varieties are described. The first, *Mastagi Romi*, is white, transparent, fragrant, sweet, very soft and sticky; the resin exudes naturally from the bark of the tree. This variety is of superior quality and has a shelf life of about 20 years. The second, *Qabti*, is black, less transparent, bitter and hard[14].

### Afal (Pharmacological actions)

Mastagi has various important pharmacological actions like Muhallil-e-Auram (Anti-inflammatory), Kasir-e-Riyah (Carminative), Mushtahi (Appetizer), Mujaffif-e-Rutoobat (Siccative), Musakhkhin (Calorific), Mulayyin (Laxative agent), Qabiz (Astrigent), Mulattif (Demulcent), Jali (Detergent), Muqawwi-e-Aam (General tonic), Muqawwi-e-Meda (Stomach Tonic), Muqawwi-e-Aza-e-Raisa (Tonic to Vital organs), Mufatteh-e-Sudad (Deobstruent), Mufarreh Qalb (Exhillarant), Musakkin-e-Alam (Analgesic), Mundamil-e-Qurooh, (Cicatrizant), Munaffis-e-Balgham (Expectorant), Mudirr-e-Baul (Diuretic), Jazib-e-Rutoobat (Absorbant), Habis-e-Dam (Heamostatic), Habis-e-Ishal (Anti-diarrhoeal)[14,15].

### Mahall-e-Istemal (Therapeutic uses)

Mastagi has numerous beneficial therapeutic indications based on their actions *Jarah waqurooh*(Wound and Ulcers), *Zof-e-Hazam* (Indigestion), *Zof-e-Jigar* (Weakness of Liver), *Nafakh-e-Shikam* (Flatulence), *Zof-e-Badan* (General Weakness), *Suda-e-Barid* (Headache), *Qarha-e-Am'a* (Intestinal ulcer), *Zof-e-Ishtiha* (Anorexia), *Jarb* (Scabies), *Sailan-e-Dam-e-Rahem* (Uterine bleeding), *Razz (Contusion), Zarba wa Saqta* (Strain and Sprain), *Ehtibas-e-Baul* (Urine Retention), *Nafs-ud-Dam* (Heamoptysis)[14,15].

## 4. Chemical constituents

The mastic gum of Pistacia lentiscus contains approximately 2% essential oil. Essential oil obtained from samples originating from Spain has been reported to contain about 90% monoterpene hydrocarbons, with α-pinene (79%) as the predominant constituent, followed by myrcene (3%). The resin is primarily composed of triterpenes, including mastic acid, isomastic acid, oleanolic acid, and tirucallol. A lyophilized aqueous extract of the aerial parts has also been reported to contain steroid-triterpenes, catechin tannins, flavonoids, saponins, resins, and sugars[7]. The resin contains a diverse range of terpenoids and related derivatives, including 1,8-cineole, isoterpinolene, α-cubebene, α-ylangene, α-copaene, β-bourbonene, valencene, germacrene D, β-caryophyllene, α-longipinene, γ-gurjunene, α-amorphene, α-humulene, isocaryophyllene, β-cubebene, β-patchoulene, α-muurolene, γ-muurolene, guaiene, β-selinene, γ-elemene, cyclostivene, 17-(acetyloxy)kauran-19-al, pyrethrin I, (−)-spathulenol, ledol, megastigmatriene, allethrin, cubenol, and 16-kaurene, together with several other terpenoid derivatives. The essential oil of P. lentiscus is characterized predominantly by α-pinene, β-myrcene, β-pinene, limonene, and β-caryophyllene[4]. The fixed oil obtained from ripe seeds is rich in monounsaturated fatty acids (52.4%), with oleic acid (51.06%) being the major fatty acid, followed by linoleic acid (20.71%). The seed oil is also particularly rich in α-tocopherol, which accounts for approximately 97% of the total tocopherol content, while β-sitosterol has been reported as the predominant sterol[16]. The leaves are rich in phenolic compounds. Galloyl quinic acid derivatives, quercetin and kaempferol glucosides, luteolin and neo-rehmannioside have been identified by UHPLC–HRMS[17], and the flavonol glycosides myricetin-3-*O*-rhamnoside, quercetin-3-*O*-rhamnoside and kaempferol-3-*O*-rhamnoside have been isolated from distilled leaves[18,19]. Gallic acid is the predominant compound in both leaf and fruit extracts, and luteolin was reported for the first time in the fruits[20]. The berries contain phenolics and flavonoids as well as anthocyanins, tannins, saponins, terpenoids, proteins and mucilage[21,22]. Among the bioactive triterpenoids, oleanolic acid and 24Z-isomasticadienolic acid have been reported from *P. lentiscus*[23]. The phytochemical content varies with altitude: in leaves from Morocco, lower altitudes increased polyphenol and flavonoid yields, whereas higher sites favoured ascorbic acid, chlorophylls and tannins[24].

Microwave-assisted extraction (MAE) of phenolic compounds from *P. lentiscus* leaves was optimized using response surface methodology with a Box Behnken design. The optimum conditions (46% ethanol, 60 s extraction time, 17.86 W/mL power density and a 28:1 liquid-to-solid ratio) yielded 185.69 ± 18.35 mg GAE/g dry weight of total phenolic. Compared with ultrasound-assisted and conventional solvent extraction, the optimized MAE produced higher levels of total phenolic, flavonoids and tannins, with comparable antioxidant activity in the ABTS assay[17,25].

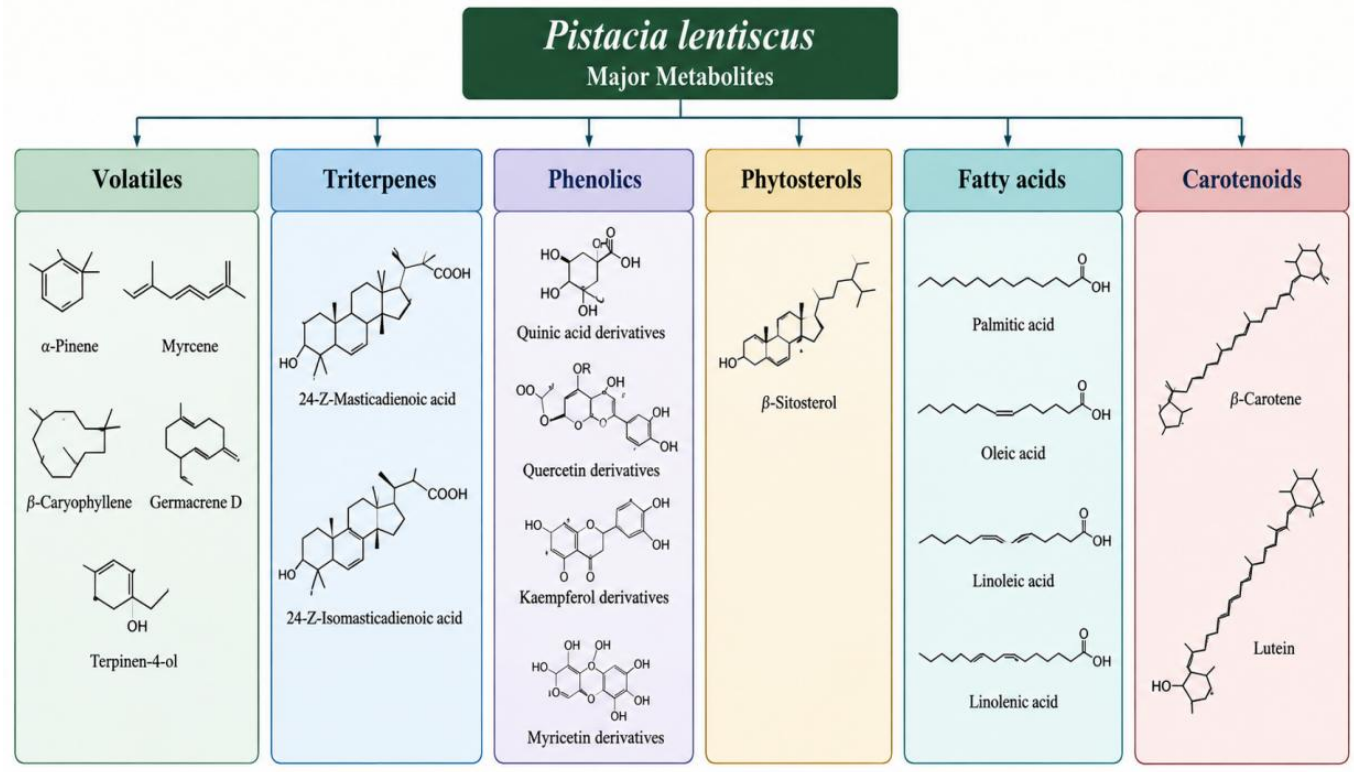



**Figure 2.** Major classes of metabolites reported from *Pistacia lentiscus*: volatiles, triterpenes, phenolics, phytosterols, fatty acids and carotenoids, with representative structures.

## 5. Evidence-based pharmacological actions

### Anti-atherogenic and hypolipidaemic activity

Dedoussis et al.[26] investigated the molecular mechanisms through which the total polar extract of *P. lentiscus* var. *chia* resin inhibits the cytotoxic effect of oxidized low-density lipoprotein (ox LDL) on peripheral blood mononuclear cells (PBMCs). Cells exposed to ox LDL underwent apoptosis and necrosis, depending on the duration of exposure, and concurrent culture with the polar extract inhibited both phenomena. Ox LDL decreased glutathione (GSH) levels and upregulated CD36 expression, whereas the extract restored GSH levels and downregulated CD36 expression, even at the mRNA level, thus exhibiting antiatherogenic efficacy. The triterpenoid fraction showed particularly strong GSH-restoring activity.

In hypercholesterolaemic animals given 200 mg/kg for 30 days, an ethanolic leaf extract with a higher flavonoid content significantly reduced total cholesterol, triglycerides and LDL-cholesterol, whereas the aqueous extract significantly lowered total cholesterol and triglycerides[27].

### Antimicrobial activity

*Antibacterial activity.* Mezni et al.[28] studied oil extracted from mature fruits collected in northern Tunisia, using a traditional method practised by women in forest areas and a pressing method. Gas chromatography mass spectrometry showed that oleic acid was the main fatty acid (more than 56%), followed by palmitic acid (27%). Pressing improved antioxidant activity. Antibacterial activity was tested against *Escherichia coli*, *Salmonella typhimurium* and *Clostridium perfringens*: a significant bactericidal effect was observed against *C. perfringens*, particularly with pressed oil from Bizerte, but not against *E. coli* or *S. typhimurium*.

In an in vitro study, extracts of *P. lentiscus* were tested against the bacteria *Sarcina lutea*, *Staphylococcus aureus* and *E. coli* and the fungi *Candida albicans*, *Candida parapsilosis*, *Torulopsis glabrata* and *Cryptococcus neoformans*. Decoctions showed the best antibacterial activity, but the activity against fungal cells appeared much more interesting[29].

Aqueous and flavonoid enriched extracts and the essential oil obtained from the leaves were assessed against six bacterial strains. A significant effect was observed against *S. typhimurium*, whereas lower activity was seen against *S. aureus*, *Pseudomonas aeruginosa* and *Salmonella enteritidis*. The essential oil showed significant inhibitory effects against *S. typhimurium*, *S. enteritidis* and *S. aureus*[30]. In a comparison against antibiotic-resistant strains, the methanolic leaf extract, which was richer in phenolics and flavonoids than the aqueous extract, showed stronger antibacterial and antioxidant effects, with notable activity against *P. aeruginosa*[31]. The essential oil of var. *chia* was active against *E. coli*, *S. aureus* and *Bacillus subtilis*, and minor constituents such as verbenone, α-terpineol and linalool contributed substantially to this effect, suggesting synergistic interactions among its components[4]. *Activity against* Helicobacter pylori. Mastic resin was bactericidal against all tested *H. pylori* strains, including metronidazole-resistant strains, at 0.06 mg/mL within 24 hours; lower concentrations suppressed bacterial growth and produced a post-antibiotic effect[32]. In a microdilution assay on clinical isolates, mastic gum killed 50% of strains at 125 µg/mL and 90% at 500 µg/mL. Transmission electron microscopy of cells exposed to sub-bactericidal concentrations showed blebbing, morphological abnormalities and cellular fragmentation[33]. In a randomized pilot clinical study, mastic gum eradicated *H. pylori* in 4/13 and 5/13 patients at two different doses; this was less effective than standard triple therapy (10/13 patients), but mastic gum was well tolerated[34]. *Oral pathogens.* Mastic gum produced clear growth-inhibition zones against *Streptococcus mutans* and other mutans streptococci and was non-cytotoxic to HEp-2 cells at the concentrations used. In 25 healthy volunteers, chewing mastic gum significantly reduced salivary mutans streptococci compared with placebo gum ($p < 0.001$), and the effect persisted for more than two hours[35]. In orthodontic patients with fixed appliances, a 15-minute chewing period significantly reduced salivary *S. mutans* and total bacterial counts; after 135 minutes, *S. mutans*, lactobacilli and total viable bacteria were all significantly lower than with placebo gum ($p < 0.001$)[36]. In a three-week study of 42 adults, pure, xylitol-containing and probiotic mastic gums all significantly reduced salivary mutans streptococci ($p < 0.001$); pure and xylitol mastic raised salivary pH, whereas probiotic mastic lowered it, which may be unfavourable for dental health[37]. Among the compounds tested against oral pathogens and *C. albicans*, oleanolic acid from *P. lentiscus* showed the strongest broad-spectrum activity, particularly against *Porphyromonas gingivalis* and other anaerobes[23]. A narrative review concluded that polyphenol-rich *P. lentiscus* extracts show stronger antimicrobial activity than other plant derivatives, particularly against periodontal pathogens and *C. albicans*, and may be useful in toothpastes and mouthwashes[38].

*Antifungal activity.* Crude leaf extracts of *P. lentiscus*, *P. vera* and *P. terebinthus* significantly inhibited the growth of the plant pathogens *Pythium ultimum* and *Rhizoctonia solani*, but no appreciable activity was seen against *Fusarium sambucinum*[39].

### Antimutagenic and antigenotoxic activity

Hayder et al.[30] demonstrated the antimutagenic activity of different extracts against aflatoxin B1 (AFB1) and sodium azide using the *Salmonella typhimurium* assay. The number of revertants per plate decreased significantly when the plant extracts were added to the assay system using strains TA100, TA98 and TA1535. Fruit extracts showed no genotoxicity in the SOS chromotest with *E. coli* PQ37, with or without microsomal activation; the ethyl acetate fraction and the total oligomeric flavonoids significantly reduced AFB1- and nifuroxazide-induced genotoxicity and showed strong DPPH radical-scavenging activity[40].

**Antioxidant activity**

Many herbal therapies are used to treat liver disease, jaundice or diabetes, conditions in which oxidative stress is prominent. Ljubuncic et al.[41] selected eight plants used to treat these conditions in traditional Arab medicine and assessed their antioxidant potential by measuring their ability to suppress iron-induced lipid peroxidation in rat liver homogenates. Their potential toxicity was evaluated through effects on mitochondrial respiration and cell-membrane integrity in cultured PC12 and HepG2 cells. All the extracts suppressed iron-induced lipid peroxidation and none was toxic; the extracts of *Teucrium polium* and *P. lentiscus* were the most effective.

The antioxidant properties of galloyl quinic acid derivatives isolated from *P. lentiscus* leaves have been investigated by electron paramagnetic resonance (EPR) spectroscopy and UV–Vis spectrophotometry, and estimated using the biologically relevant LDL oxidation test. The scavenging activities of gallic acid and the 5-*O*-galloyl, 3,5-*O*-digalloyl and 3,4,5-*O*-trigalloylquinic acid derivatives were estimated against the 1,1-diphenyl-2-picrylhydrazyl (DPPH), superoxide and hydroxyl radicals. Scavenging activity increased with the number of galloyl groups on the quinic acid skeleton, and the half-inhibition concentrations ($IC_{50}$) of the di- and tri-galloyl derivatives did not exceed 30 μM for any of the radicals tested. All the tested metabolites strongly reduced LDL oxidation, following a trend similar to that observed for hydroxyl radical scavenging[42].

Other studies have confirmed the antioxidant potential of the leaves. Ethanolic leaf extracts showed higher antiradical activity than those of *Pistacia atlantica*, although lower than ascorbic acid[43]. The ethyl acetate leaf extract showed the strongest DPPH and hydroxyl radical scavenging and reducing activity, while the methanolic extract showed the highest inhibition of β-carotene bleaching (94%); both showed anti-lipid peroxidation activity, closely associated with their phenolic and flavonoid contents[44]. Methanolic extracts of leaves and fruits showed DPPH scavenging above 73%, with $IC_{50}$ values of 0.121 ± 0.001 mg/mL for leaves and 0.26 ± 0.0002 mg/mL for fruits[45]. Among nine Mediterranean medicinal plants, the leaves of *P. lentiscus* and *Myrtus communis* showed the highest DPPH-scavenging activity, and *P. lentiscus* leaves also inhibited β-carotene bleaching by 43.02%[46]. In Tunisian plants, the methanol/water (8:2) leaf extract had the highest phenolic content (124.1 mg GAE/g dry weight) and a DPPH-scavenging potency exceeding that of BHT[47]. Leaf and fruit extracts also showed strong ORAC activity and protected cells against $H_2O_2$-induced oxidative stress, with maximum protection at 100 μg/mL[48]. In Moroccan leaves, DPPH-scavenging activity correlated positively with total polyphenol content, and total antioxidant capacity with flavonoid concentration[24].

The berries, oil and resin are also antioxidant. The ethanolic berry extract showed strong DPPH and ABTS radical-scavenging activity and notable reducing power, attributed mainly to its phenolic and flavonoid content[21]. The vegetable oil contained phenolics (122.72 ± 1.16 mg GAE/g) and flavonoids (18.41 ± 0.43 mg QE/g) and scavenged DPPH radicals ($IC_{50}$ = 37.38 μg/mL), although less effectively than ascorbic acid ($IC_{50}$ = 27.20 μg/mL)[49]. In oil substrates, the resin of var. *chia* showed significant antioxidant effects, particularly in virgin olive oil and lard, and acted synergistically with citric acid in sunflower and corn oils, suggesting possible applications as a natural antioxidant in functional foods, pharmaceuticals and cosmetics[50].

**Neuroprotective activity**

Co-administration of the leaf extract (150 and 300 ppm) for two months in male mice significantly improved anxiety-related behaviour and memory performance and attenuated aluminium-induced histopathological changes. In vitro, the extract and its phenolic constituents, particularly myricetin rhamnoside, quercetin rhamnoside, gallic acid, myricetin and quercetin, reduced lipid peroxidation in synaptosomal membranes, with myricetin rhamnoside the most active ($IC_{50}$ = 0.04 mM)[51]. In addition, *P. lentiscus* leaves showed 73.84% acetylcholinesterase inhibition in an enzyme-inhibition screen of nine Mediterranean plants[46].

**Anticancer activity**

Balan et al.[52] reported that a 50% ethanol extract of Chios mastic gum (CMG) contains compounds that inhibit proliferation and induce death of HCT116 human colon cancer cells in vitro. CMG treatment induced cell-cycle arrest at G1, detachment of the cells from the substrate, activation of pro-caspases-8, -9 and -3, and several morphological changes typical of apoptosis in cell organelles. These events were time- and dose-dependent but p53- and p21-independent. Apoptosis induction was not inhibited in HCT116 clones expressing high levels of the anti-apoptotic protein Bcl-2 or dominant-negative FADD, indicating that CMG induces cell death through a yet-to-be-identified pathway unrelated to the death-receptor and mitochondrion-dependent pathways. The findings suggest that CMG induces an anoikis form of cell death involving caspase-dependent events and might be developed into a chemotherapeutic agent for colon and other cancers.

In vivo, intraperitoneal administration of a hexane extract of mastic gum (200 mg/kg for four consecutive days, followed by a three-day treatment-free interval) reduced the growth of HCT116 xenografts in SCID mice by approximately 35% over 35 days without significant toxicity[53]. Dietary mastic oil from var. *chia* inhibited the proliferation and migration of colon carcinoma cells and reduced survivin expression; oral administration suppressed tumour growth in mice, with decreased Ki-67 and survivin levels. The complete mastic oil (67.7% α-pinene and 18.8% myrcene) showed significant antitumour activity, whereas the individual compounds or their combination did not, suggesting a synergistic effect of its terpene constituents[54]. Mastic oil also inhibited the proliferation of K562 leukaemia cells and promoted apoptosis, while reducing VEGF release, endothelial cell proliferation and microvessel formation

in vitro and in vivo; these effects were associated with suppression of Erk1/2 activation in leukaemia cells and of RhoA signalling in endothelial cells[55].

Leaf and fruit extracts have also shown antiproliferative activity. The methanol/water (8:2) leaf extract was cytotoxic to CaCo-2 and AGS cells ($IC_{50}$ = 135.67 ± 2.5 and 250.45 ± 1.96 µg/mL, respectively), whereas infusion extracts were inactive[47], and leaf and fruit extracts inhibited the growth of B16F10 melanoma cells ($IC_{50}$ = 56.40 and 58.04 µg/mL, respectively)[48].

**Hepatoprotective effect**

The boiled and non-boiled aqueous extracts of *P. lentiscus*, *Phillyrea latifolia* and *Nicotiana glauca* were evaluated in carbon tetrachloride ($CCl_4$)-intoxicated rats. The extracts were administered orally at a dose of 4 mL/kg body weight and contained various amounts of solid matter. Only the non-boiled aqueous extract of *N. glauca* leaves reduced total serum bilirubin, while the boiled and non-boiled extracts of *N. glauca* flowers were ineffective. Bilirubin and alkaline phosphatase (ALP) activity were both reduced by the boiled aqueous extract of *P. latifolia*, without reducing alanine aminotransferase (ALT) and aspartate aminotransferase (AST) activity. Both aqueous extracts of *P. lentiscus* showed marked antihepatotoxic activity against $CCl_4$, reducing the activity of all three enzymes and the bilirubin level, and the effect of the non-boiled extract was more pronounced than that of the boiled extract[56].

Leaf and fruit extracts also protected mice against paracetamol-induced liver injury, improving hepatic biochemical markers and reducing histological damage; the leaf extract showed the stronger overall activity, which was attributed to its higher phenolic content[20].

The evidence is, however, not uniform. An aqueous leaf extract with proven in vitro antioxidant activity induced hepatic fibrosis, inflammation, mild cholestasis and glutathione depletion when administered for a prolonged period to healthy rats, and it aggravated these effects in thioacetamide-treated animals[57]. This finding highlights the need for caution regarding prolonged use of aqueous leaf extracts.

**Gastrointestinal protective and anti-ulcer activity**

The effect of mastic obtained from the stem of *P. lentiscus* was studied in experimentally induced gastric and duodenal ulcers in rats. Mastic at an oral dose of 500 mg/kg significantly reduced the intensity of gastric mucosal damage induced by pyloric ligation, aspirin, phenylbutazone, reserpine and restraint plus cold stress. It significantly decreased free acidity in 6-h pylorus-ligated rats and had a marked cytoprotective effect against 50% ethanol, which was reversed by prior treatment with indomethacin. The protective effect was not seen when mastic was given intraperitoneally in the phenylbutazone and restraint plus cold stress models, and the reduction in ulceration in cysteamine-induced duodenal ulcers was not statistically significant in mastic-pretreated rats. The results imply that a mild antisecretory action and a localized adaptive cytoprotective action may be responsible for its anti-ulcer activity[58].

In a clinical study of benign gastric ulcers, oral mastic gum gave significant symptomatic relief and accelerated endoscopic healing without side effects[59]. Its activity against *H. pylori*, including metronidazole-resistant strains, may also contribute to its anti-ulcer effects[32]. Leaf extracts have shown similar protection: chloroform, ethyl acetate and methanolic leaf extracts significantly reduced HCl/ethanol-induced gastric lesions in rats in a dose-dependent manner after oral administration[60], and an aqueous leaf extract dose-dependently attenuated colonic tissue damage, oxidative stress and inflammatory changes in acetic acid-induced colitis in rats[61].

**Anti-inflammatory activity**

The alcoholic leaf extract reduced croton oil-induced ear oedema by 65% and vascular permeability by 46%, compared with 51% and 28%, respectively, for the aqueous extract. Both extracts significantly suppressed carrageenan-induced pleurisy and inhibited neutrophil chemotaxis and elastase activity in vitro[62]. Intraperitoneal administration of aqueous, chloroform, ethyl acetate and methanolic leaf extracts produced dose-dependent anti-inflammatory effects in carrageenan-induced paw oedema in rats[60], and the leaf extract also showed significant anti-inflammatory activity in cell-based assays[48]. The acetonic extract of the fruits has been evaluated for topical and oral anti-inflammatory activity in the croton oil-induced ear oedema model in mice, in comparison with indomethacin[63].

**Hypotensive activity**

A lyophilized aqueous extract of *P. lentiscus* caused a dose-dependent decrease in systemic arterial blood pressure in normotensive, urethane-anaesthetized Wistar rats[22].

**Antiarthritic and antigout activity**

The total phenolic contents of the leaves and bark of *Fraxinus angustifolia* and of the leaves and seeds of *P. lentiscus* were estimated. The aqueous fractions of *P. lentiscus* obtained from hexane and chloroform extractions and the aqueous fraction of *F. angustifolia* obtained from ethyl acetate extraction inhibited xanthine oxidase (XO) activity by 72.74 ± 2.63% ($IC_{50}$ = 27.52 µg/mL), 68.97 ± 3.89% ($IC_{50}$ = 42.46 µg/mL) and 53.92 ± 3.17% ($IC_{50}$ = 58.84 µg/mL), respectively, at 100 µg/mL, compared with 98.18% ($IC_{50}$ = 6.34 µg/mL) for the reference drug allopurinol. At 50 µg/mL, both *P. lentiscus* extracts showed inhibition rates above 50%, whereas *F. angustifolia* leaf extracts showed only mild inhibition. Lineweaver–Burk analysis showed that the inhibition by the aqueous extracts of *F. angustifolia* bark and *P. lentiscus* was of mixed type, whereas *F. angustifolia* leaf extracts inhibited XO non-competitively. XO inhibition correlated positively with total phenols (r = 0.89) and flavonoids (r = 0.93) for *P. lentiscus*, and with total phenols (r = 0.72) and tannins (r = 0.54) for *F. angustifolia*[64].

### Antidiabetic activity

*P. lentiscus* is a Mediterranean shrub rich in phenolic and flavonoid compounds. Evidence from in vitro and in vivo studies indicates that it exerts antidiabetic effects through multiple therapeutic targets, highlighting its potential as a multitarget natural agent for the management of type 2 diabetes[65]. The fruit extract has also shown antidiabetic activity and α-amylase inhibition[20].

### Wound healing and dermatological activity

Boulebda et al.[66] evaluated the effect of *P. lentiscus* fruit fatty oil on cutaneous wound healing in rats and compared it with that of its saponifiable and unsaponifiable oily fractions. Full-thickness excision wounds were made on the back of anaesthetized rats. The fruit oil and the two fractions were assessed together with a conventional drug, Madecassol®. The preparations were applied topically to the wounded area once a day and assessed over 26 days, during which wound area was measured and photographically documented. Wound contraction was significantly enhanced ($p < 0.05$) by *P. lentiscus* oil, the unsaponifiable oily fraction and Madecassol compared with untreated control animals, and the effect was most pronounced in the group treated with the unsaponifiable fraction.

Flavonol glycosides from distilled leaves (myricetin-3-*O*-rhamnoside and quercetin-3-*O*-rhamnoside) permeated the cutaneous membrane in transdermal diffusion tests, and these compounds and the crude extract significantly inhibited tyrosinase and elastase at non-cytotoxic concentrations in B16 melanoma cells, indicating potential as a cosmeceutical ingredient for skin pigmentation and loss of elasticity[18].

## 6. Conclusion

Mastagi (*P. lentiscus*) has a long history of use in Unani medicine, and a broad body of experimental evidence supports its antimicrobial, antioxidant, anti-inflammatory, gastroprotective, hepatoprotective, hypolipidaemic, antidiabetic and anticancer effects. Most of this evidence, however, comes from in vitro and animal studies, and clinical data are limited to small studies on *H. pylori* eradication, gastric ulcers and oral health. The conflicting hepatic findings with aqueous leaf extract underline the need for rigorous safety and dose-finding studies before clinical use can be recommended.

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