

Review Article

Five *Pistacia* species (*P. vera*, *P. atlantica*, *P. terebinthus*, *P. khinjuk*, and *P. lentiscus*): A Review of Their Traditional Uses, Phytochemistry, and Pharmacology

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Pistacia, a genus of flowering plants from the family Anacardiaceae, contains about twenty species, among them five are more popular including *P. vera*, *P. atlantica*, *P. terebinthus*, *P. khinjuk*, and *P. lentiscus*. Different parts of these species have been used in traditional medicine for various purposes like tonic, aphrodisiac, antiseptic, antihypertensive and management of dental, gastrointestinal, liver, urinary tract, and respiratory tract disorders. Scientific findings also revealed the wide pharmacological activities from various parts of these species, such as antioxidant, antimicrobial, antiviral, anticholinesterase, anti-inflammatory, antinociceptive, antidiabetic, antitumor, antihyperlipidemic, antiatherosclerotic, and hepatoprotective activities and also their beneficial effects in gastrointestinal disorders. Various types of phytochemical constituents like terpenoids, phenolic compounds, fatty acids, and sterols have also been isolated and identified from different parts of *Pistacia* species. The present review summarizes comprehensive information concerning ethnomedicinal uses, phytochemistry, and pharmacological activities of the five mentioned *Pistacia* species.

1. Introduction

The genus *Pistacia* belongs to the Anacardiaceae, a cosmopolitan family that comprise about 70 genera and over 600 species. The species of the genus *Pistacia* are evergreen or deciduous resin-bearing shrubs and trees which are characterized as xerophytic trees and growing to 8–10 m tall. *Pistacia lentiscus* L., *P. atlantica* Desf., *P. terebinthus* L., *P. vera* L., and *P. khinjuk* Stocks. are distributed from the Mediterranean basin to central Asia [1, 2]. Three *Pistacia* species naturally occur in Iran: *P. vera* L., *P. khinjuk* Stocks., and *P. atlantica* Desf.; *P. atlantica* has three subspecies or varieties which have been described as *cabulica*, *kurdica*, and *mutica* [3]. *P. vera* is the only species of the genus cultivated commercially, and the rest of the species are mostly used as rootstocks for *P. vera* [1, 2].

Different parts of *Pistacia* species have been investigated for various pharmacological activities. Most of the papers are devoted to the resin of *P. lentiscus* that is known as mastic. In addition to their therapeutic effects, *Pistacia* species are used in food industry, for example, consumption of pistachio (*P. vera*) nut as food additive [4], *P. terebinthus* fruit as snack food or in making coffee-like drink [5, 6], and the anthocyanin composition of *P. lentiscus* fruit as food colorants [7].

Chemical studies on *Pistacia* genus have led to discovering diverse secondary metabolites in addition to high level of vitamins and minerals.

Our review presents a comprehensive report on phytochemical aspects, pharmacological activities, and toxicity of the genus *Pistacia* by focusing on the data reported since

the year 2000 via papers on databases including PubMed, Scopus, Google Scholar, and Web of Science.

2. Traditional Uses

Traditional uses, plant part used, and pharmacological activities of *Pistacia lentiscus*, *P. atlantica*, *P. terebinthus*, *P. vera*, and *P. khinjuk* from different regions are listed in Table 1.

Different parts of *Pistacia* species including resin, leave, fruit, and aerial part have been traditionally used for a wide range of purposes. Among them, *P. lentiscus* is the most commonly used in different regions and resin of that has been utilized for as long as 5000 years. Resin of *P. lentiscus* has been used for variety of gastric ailments in the Mediterranean and Middle East countries for the last 3000 years [8]. It was used in ancient Egypt as incense; it has also been used as a preservative and breath sweetener [4]. Most of the traditional uses reports for resin of *P. atlantica* are from Iran and have been used for the treatment of digestive, hepatic, and kidney diseases [9]. Fruit of *P. vera* (pistachio) is used all over the world. Records of the consumption of pistachio as a food date to 7000 BC [4]. Pistachio is cultivated in the Middle East, United States, and Mediterranean countries. Iran is one of the biggest producers and exporters of pistachio nuts [10]. In traditional Iranian medicine (TIM), different parts of *P. vera*, *P. atlantica*, *P. khinjuk*, *P. terebinthus*, and *P. lentiscus* have been used for a long time as useful remedies for different diseases, for example, the fruit kernel of *P. vera* as a cardiac, stomach, hepatic, and brain tonic; the fruits of *P. atlantica*, *P. khinjuk*, and *P. terebinthus* for their aphrodisiac activity and treatment of liver, kidney, heart, and respiratory system disorders, and the gum resin of *P. lentiscus*, *P. atlantica*, *P. khinjuk*, and *P. terebinthus* for their wound healing activity, and treatment of brain and gastrointestinal disorders [9, 11].

3. Phytochemical Studies

Various compounds from different phytochemical groups were identified in *Pistacia* species. These are summarized below and also in Table 2 based on the structure of finding components.

3.1. Terpenoids

3.1.1. Monoterpeneoids, Sesquiterpenoids, and Volatile Oil. Essential oil is one of the main components reported from different parts of *Pistacia* species including leaves, resin, ripe and unripe fruits, galls, leaf-buds, twigs, and flowers. Analysis of essential oils is mostly performed by means of gas-chromatography (GC) based techniques. There are many qualitative and quantitative variations between the content of essential oils. These variations are related to several parameters like plant species and part, sex of cultivars, harvesting time, geographical origin, and climatic conditions [12, 13]. Hydrocarbon and oxygenated monoterpenes are the major chemical constituents in essential oil and among hydrocarbon monoterpenes, α -pinene (1) has been reported as the main compound of some samples like *P. vera* [12, 14, 15],

P. terebinthus [16–18], *P. lentiscus* [19–24], and *P. atlantica* [25–27]. In addition to α -pinene, other major components isolated from different parts of *Pistacia* species are as follows: limonene (2), α -terpinolene, and ocimene (3,4) from fruits and leaves of *P. vera* [28]; (E)- β -Ocimene (5) and limonene in fruits [18, 28, 29]; (E)- β -Ocimene and terpinen-4-ol (6) in leaves and *p*-cymen, (7) in young shoots of *P. terebinthus* [28–30]; bornyl acetate (8), terpinen-4-ol, sabinene (9), and myrcene (10) in fruits, terpinen-4-ol, myrcene, *p*-mentha-1(7),8 diene (11), and ocimene from leaves [27, 28, 31], sabinene and *p*-mentha-1(7),8 diene in leaf buds, and Δ^3 -carene (12) in unripe galls of *P. atlantica* [31, 32]. Monoterpens are also detected in mastic water which was separated from the mastic oil during steam distillation. Verbenone (13), α -terpineol (14), linalool (15), and *trans*-pinocarveol (16) are the main constituents of mastic water [33]. β -pinene (17) in oleoresin, β -myrcene and sabinene in fruits [28, 30, 34], terpinen-4-ol in aerial parts [22], and limonene, myrcene, sabinene, and terpinen-4-ol in leaves of *P. lentiscus* were determined as the main composition [28, 30, 35, 36].

Some of the other monoterpenes identified as effective antibacterial components of these essential oils are camphene (18), limonene, and carvacrol (19) from *P. vera* resin [12].

Sesquiterpenes isolated in lower amount compared with monoterpenes. Germacrene-D (20) and β -caryophyllene (21) were identified in *P. lentiscus* and *P. terebinthus* leaves with higher concentration in comparison with other sesquiterpenes [28]. Spathulenol (22), an azulenic sesquiterpene alcohol, is the predominant component of leaves of *P. atlantica* and *P. khinjuk* [37, 38]. Congiu et. al. [34] recovered Caryophyllene with the highest amount from *P. lentiscus* leaves by means of supercritical CO_2 extraction. Germacrene-D in *P. terebinthus* flowers, β -caryophyllene in *P. lentiscus* galls, and Longifolene (23) in aerial parts of *P. lentiscus* are dominant [24, 29, 39].

3.1.2. Diterpenoids. Trace amounts of Diterpenoids were isolated from the essential oil of these species. Abietadiene (24) and abietatriene (25) were detected in essential oil of *P. vera* resin [12].

3.1.3. Triterpenoids. Resin of these species has been characterized by penta and tetracyclic triterpenes. Triterpenes such as masticadienonic acid (26), masticadienolic acid (27), morolic acid (28), oleanolic acid (29), ursonic acid (30) and their derivatives have been detected in acidic fractions of *P. lentiscus*, *P. terebinthus*, and *P. atlantica* resins [40–42]. Several triterpenoid compounds were isolated from neutral fraction of *P. lentiscus* and *P. terebinthus* resins like tirucallol (31), dammaradienone (32), β -Amyrin (33), lupeol (34), oleanolic aldehyde, and 28-norolean-12-en-3-one. Quantitative and qualitative varieties in chemical composition of resins according to the method of collection were reported [40, 41].

Anti-inflammatory properties have been reported from masticadienolic acid, masticadienonic acid, and morolic acid isolated from *P. terebinthus* [43]. Among triterpenes isolated from the resin of three sub-species of *P. atlantica* (*kurdica*,

TABLE 1: Ethnomedicinal uses of selected *Pistacia* species.

Species	Regions	Plant part(s) used	Traditional uses and ethnobotanical reports	Reference(s)
<i>Pistacia lentiscus</i>	Algeria	Leaf	Appetizer and astringent	[75]
	Greece	Resin	Stomach ache, dyspepsia, stomach ulcer, intestinal disorders, hepatic inflammation, tooth disease, diabetes, hypercholesterolemia, and diuretic	[33, 128, 129]
		Aerial part	Stimulant, diuretic, hypertension, kidney stones, jaundice, cough, sore throat, eczema, and stomach ache	[88]
	Iraq	Resin	Abdominal pain	[130]
	Iran	Resin	Gum tissue strengthener, breath deodorizer, brain and liver tonic, and gastrointestinal ailments	[11, 100, 102]
	Italy	Leaf	Toothache, mycosis, herpes, abdominal and intestinal pain, rheumatism, antiseptic, cicatrizant, emollient, expectorant, and astringent	[131, 132]
	Jordan	Leaf	Jaundice	[121, 133]
	Morocco	Resin	Heart burn and stomach ache	
		Leaf	Digestive disease, evil eye	[134]
		Leaf, bark	Gastric analgesic	[135]
	Portugal	Root	Antiseptic and antiodontalgic	[135]
		Seeds	Antirheumatic	[135]
		Stem	Buccal antiseptic	[135]
		Aerial part	Hypertension	[136]
<i>Pistacia lentiscus</i>	Spain	Fruit	Influenza	[71]
		Leaf	Dermatophytosis in cows	[72]
		Tender bud	Warts	[73]
	Tunisia	Fruit	Edible usage, condiment, scabies, Rheumatism, and antidiarrheal	[60]
	Turkey	leaf	Eczema, diarrhea, throat infections, paralysis, kidney stones, Jaundice, asthma, stomach ache, astringent, anti-inflammatory, antipyretic, and stimulant	[96]
<i>Pistacia atlantica</i>	Algeria	Fruit	Stomach ache, cough, stress, tonic, and antidiarrheal	[20, 63]
	Greek	Fruit	Mouth flavouring, tanning, and as fodder	[31]
		Aerial part	Veterinary	[31]
		Fruit	Antidiarrheal	[11]
			Peptic ulcer, mouth freshener, antiseptic, gum tissue strengthener, as chewing gum, appetizer, phlegm dissolver, astringent, laxative, demulcent, diuretic, emmenagogue, carminative, visceral inflammation, scabies, stomach, liver and kidneys tonic, gastrointestinal disorders, and motion sickness	[9]
	Iran	Resin		
		Resin, bark	Joint pains, toothache, wound healing	[137]
	Jordan	Fruit	Stomach ache	[133]
		leaf	Antidiabetic	[109]
	Morocco	Leaf	Eye infection	[134]
		Resin	Gum tissue strengthener, breath deodorizer, cough, chill, and stomach disease	[27]
	Turkey	Fruit	Mouth disease	[138]
		leaf	As vegetables and food	[127]
		Resin	Wound healing	[138]

TABLE 1: Continued.

Species	Regions	Plant part(s) used	Traditional uses and ethnobotanical reports	Reference(s)
<i>Pistacia terebinthus</i>	Greece	Resin	Antidote, aphrodisiac, expectorant, and treatment of leprosy	[139]
		Resin	Smoke of it as air purifier and antiseptic	[140]
	Iran	Leaf, bark	Astringent and antidiarrhea	[11]
		Resin	Diuretic, laxative, stimulant, and aphrodisiac	[18]
	Jordan	Leaf	Diuretic, antihypertensive, and treatment of jaundice	[18]
		Aerial part	Hypotensive and cephalalgeic	[141]
	Spain	Branch	Antiseptic	[141]
		Flower, leaf	Odontalgia and Dislocated joint	[142]
	Turkey	Fruit	Antiprostatitis	[141]
		Fruit	Cold, flu, diuretic, stomach ache, rheumatism, stimulant, antitussive, appetizer, as coffee, urinary inflammations, and soap production	[29, 53, 138, 143]
	Turkey	Leaf	Stomach ache, mycosis, and antidiabetic	[29, 53, 144, 145]
		Resin	Urinary and respiratory antiseptic, asthma, antipyretic, and anti-inflammatory	[53]
<i>Pistacia vera</i>	Iran	Nut shell	Tonic, sedative, and antidiarrhea	[11]
		Fruit	Food	[10]
	Jordan	Oil	Facial skin cleanser	[133]
	Turkey	Resin	Asthma, stomach ache, and hemorrhoids	[146]
<i>Pistacia khinjuk</i>	Iran	Aerial part	Veterinary use	[147]
		Resin	Stomach discomfort, nausea, vomiting, and motion sickness	[148]

cabulica and *mutica*), 3-O-acetyl-3-epiisomasticadienolic acid (35) has been identified as the most effective antimicrobial agent [42].

3.2. Phenolic Compounds. Gallic acid (36), catechin (37), epicatechin (38), and gallic acid methyl ester were identified in *P. vera* seed and skin, leaves of *P. lentiscus* and leaves and galls of *P. atlantica* [44–46]. Bhouri et al. [47] demonstrated that digallic acid (39) from fruits of *P. lentiscus* has antimutagenic properties. Monounsaturated, diunsaturated, and saturated cardanols have been detected in *P. vera* kernel. 3-(8-Pentadecenyl)-phenol (40) was the dominating cardanol in *P. vera* [48]. Trans and cis isomers of phytoalexin, resveratrol (3,5,4'-trihydroxystilbene) (41–42), and trans-resveratrol-3-O-β-glucoside (trans-piceid) were quantified in *P. vera* kernel [49–51]. *P. lentiscus* leaf is a rich source of polyphenol compounds (7/5% of leaf dry weight) especially galloyl derivatives like mono, di, and tri-O-galloyl quinic acid (43) and monogalloyl glucose (44) [45].

1,2,3,4,6-Pentagalloyl glucose (45) and gallic acid from fruits of *P. lentiscus* were introduced as antioxidant and antimutagenic compounds [52].

Flavonoid compounds have been detected in different parts of these species. Naringenin (46), eriodictyol (47), daizein (48), genistein (49), quercetin (50), kaempferol (51), apigenin (52), and luteolin (53) were isolated from *P. vera* fruit, and quercetin-3-O-rutinoside (54) is the main constituent of seed [44]. Decrease in flavonoid content

of *P. vera* has been reported during the fruit ripening [51]. In addition to some known flavonoids isolated from *P. terebinthus* and *P. atlantica* fruits, 6'-hydroxyhypolaetin 3'-methyl ether (55) has been identified in fruits of *P. terebinthus* [46, 53]. Flavonoids were also isolated from aerial parts of *P. atlantica* and *P. lentiscus*, and quercetin-3-glucoside (56) was reported as the most abundant one [54]. 3-Methoxycarpachromene (57), a flavone with antiplasmodial activity, was isolated from aerial parts of *P. atlantica* [55].

Myricetin-3-glucoside (58), myricetin-3-galactoside (59), and myricetin-3-rutinoside (60) are the major flavonoid glycosides from *P. khinjuk* [54]. Myricetin derivatives also were determined as 20% of the total polyphenol amount of *P. lentiscus* leaves [45].

Anthocyanins have been reported from some *Pistacia* species. Cyanidin-3-O-glucoside (61), cyanidin-3-galactoside (62), and quercetin-3-O-rutinoside are the main anthocyanins of *P. vera* fruit [44, 56, 57]. Cyanidin-3-O-glucoside and delphinidin-3-O-glucoside (63) have been detected in *P. lentiscus* berries and leaves [7, 45].

3.3. Fatty Acids and Sterols. *Pistacia* species have oleaginous fruits considered by several researchers. The oil content in *P. vera* kernel and seed is about 50–60% [58, 59] and in ripe fruits of *P. lentiscus*, *P. terebinthus*, and *P. atlantica* is 32.8–45% [60–63]. The main fatty acid in seed and kernel of *P. vera* is oleic acid [58, 64, 65]. Oleic acid has been also determined

TABLE 2: Chemical compounds isolated from selected *Pistacia* species.

Name of compound	Structure	Species	Plant part	References
Monoterpenoids, sesquiterpenoids, and volatile oil				
1 α -pinene		<i>P. vera</i>	Leaf and unripe fruit Resin	[14] [12, 15]
		<i>P. terebinthus</i>	Fruit Aerial part	[16] [17]
		<i>P. terebinthus</i> var. <i>palaestina</i>	Leaf and gall	[18]
		<i>P. lentiscus</i> var. <i>chia</i>	Resin	[19]
		<i>P. lentiscus</i>	Leaf Fruit Aerial part	[20] [21] [22–24]
		<i>P. atlantica</i>	Leaf, fruit, and gall Resin	[25] [26, 27]
2 Limonene		<i>P. vera</i>	Leaf	[28]
			Fruit	[28]
			Resin	[12]
		<i>P. terebinthus</i>	Unripe and ripe fruits	[29]
		<i>P. lentiscus</i>	Fruit Leaf	[28] [28, 36]
3 Terpinolene		<i>P. vera</i> <i>P. atlantica</i>	Leaf Leaf	[28] [28]
4 α -Ocimene				
5 β -Ocimene		<i>P. vera</i> <i>P. terebinthus</i>	Leaf Unripe and ripe fruits Leaf	[28] [18] [28]

TABLE 2: Continued.

Name of compound	Structure	Species	Plant part	References
6 Terpinen-4-ol		<i>P. terebinthus</i>	Leaf	[30]
		<i>P. atlantica</i>	Unripe fruits	[31]
			Leaf	[27, 31]
		<i>P. lentiscus</i>	Aerial parts	[22]
			Leaf	[30, 35]
7 <i>p</i> -Cymene		<i>P. terebinthus</i>	Young shoots	[29]
8 Bornyl acetate		<i>P. atlantica</i>	Fruits	[27]
9 Sabinene		<i>P. atlantica</i>	Fruits	[28]
			Unripe fruits	[31]
		<i>P. lentiscus</i>	Leaf buds	[31]
			Fruits	[28]
			Leaf	
10 Myrcene		<i>P. atlantica</i>	Unripe fruits	[31]
			Leaf	[31]
		<i>P. lentiscus</i>	Fruits	[34, 36]
			Leaf	
11 <i>p</i> -Mentha-1(7),8 diene		<i>P. atlantica</i>	Leaf Leaf buds	[31] [31]
12 Δ^3 -carene		<i>P. atlantica</i>	Unripe galls	[32]

TABLE 2: Continued.

Name of compound	Structure	Species	Plant part	References
13 Verbenone		<i>P. lentiscus</i>	Mastic water Mastic oil	[33] [19]
14 α -terpineol		<i>P. lentiscus</i>	Mastic water Mastic oil	[33] [19]
15 Linalool		<i>P. lentiscus</i>	Mastic water	[33]
16 Trans-pinocarveol		<i>P. lentiscus</i>	Mastic water	[33]
17 β -pinene		<i>P. lentiscus</i>	Resin	[30]
18 Camphene		<i>P. vera</i>	Resin	[12]
19 Carvacrol		<i>P. vera</i>	Resin	[12]
20 Germacrene-D		<i>P. lentiscus</i> <i>P. terebinthus</i>	Leaf Flowers	[28] [29]
21 β -caryophyllene		<i>P. terebinthus</i> <i>P. lentiscus</i>	Leaf Galls	[28] [34] [24]

TABLE 2: Continued.

Name of compound	Structure	Species	Plant part	References
22 Spathulenol		<i>P. atlantica</i> <i>P. khinjuk</i>	Leaf Leaf	[37] [38]
23 Longifolene		<i>P. lentiscus</i>	Aerial parts	[39]
Diterpenoids				
24 Abietadiene		<i>P. vera</i>	Resin	[12]
25 Abietatriene		<i>P. vera</i>	Resin	[12]
Triterpenoids				
26 Masticadienonic acid		<i>P. lentiscus</i> <i>P. terebinthus</i> <i>P. atlantica</i>	Resin Resin Resin	[40] [41] [42]
27 Masticadienolic acid		<i>P. lentiscus</i> <i>P. terebinthus</i> <i>P. atlantica</i>	Resin Resin Resin	[40] [41] [42]

TABLE 2: Continued.

Name of compound	Structure	Species	Plant part	References
28 Morolic acid		<i>P. lentiscus</i> <i>P. terebinthus</i> <i>P. atlantica</i>	Resin	[40] [41] [42]
29 Oleanolic acid		<i>P. lentiscus</i> <i>P. terebinthus</i> <i>P. atlantica</i>	Resin	[40] [41] [42]
30 Ursomic acid		<i>P. atlantica</i>	Resin	[42]
31 Tirucallol		<i>P. lentiscus</i> <i>P. terebinthus</i>	Resin	[40] [41]
32 Dammaradienone		<i>P. lentiscus</i> <i>P. terebinthus</i>	Resin	[40] [41]
33 β -Amyrin		<i>P. lentiscus</i> <i>P. terebinthus</i>	Resin	[40] [41]
34 Lupeol		<i>P. lentiscus</i> <i>P. terebinthus</i>	Resin	[40] [41]

TABLE 2: Continued.

Name of compound	Structure	Species	Plant part	References
3-O-acetyl-3- 35 epiisomasticadienolic acid		<i>P. atlantica</i>	Resin	[42]
36 Gallic acid		<i>P. vera</i> <i>P. lentiscus</i> <i>P. atlantica</i>	Seed and skin Leaf Fruit Gall and Leaf	[44] [45] [52] [46]
37 Catechin		<i>P. vera</i> <i>P. lentiscus</i>	Seed and skin Leaf	[44] [45]
38 Epicatechin		<i>P. vera</i>	Seed and skin	[44]
39 Digallic acid		<i>P. lentiscus</i>	Fruits	[47]
40 3-(8-Pentadecenyl)- phenol		<i>P. vera</i>	Kernel	[48]

TABLE 2: Continued.

Name of compound	Structure	Species	Plant part	References
41 <i>Trans</i> -resveratrol		<i>P. vera</i>	Kernel	[49–51]
42 <i>Cis</i> -resveratrol		<i>P. vera</i>	Kernel	[49]
43 3,4,5-Tri-O-galloyl quinic acid		<i>P. lentiscus</i>	Leaf	[45]
44 Monogalloyl glucose		<i>P. lentiscus</i>	Leaf	[45]
45 1,2,3,4,6-Pentagalloyl glucose		<i>P. lentiscus</i>	Fruit	[52]

TABLE 2: Continued.

Name of compound	Structure	Species	Plant part	References
46 Naringenin		<i>P. vera</i>	Seed and skin	[44]
47 Eriodictyol		<i>P. vera</i>	Seed and skin	[44]
48 Daidzein		<i>P. vera</i>	Seed and skin	[44]
49 Genistein		<i>P. vera</i>	Seed and skin	[44]
50 Quercetin		<i>P. vera</i>	Seed and skin	[44]
51 Kaempferol		<i>P. vera</i>	Seed and skin	[44]
52 Apigenin		<i>P. vera</i>	Seed and skin	[44]

TABLE 2: Continued.

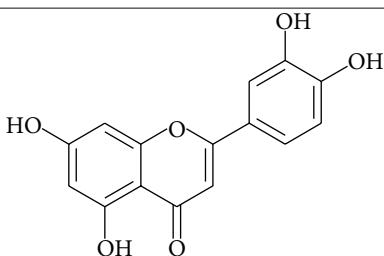
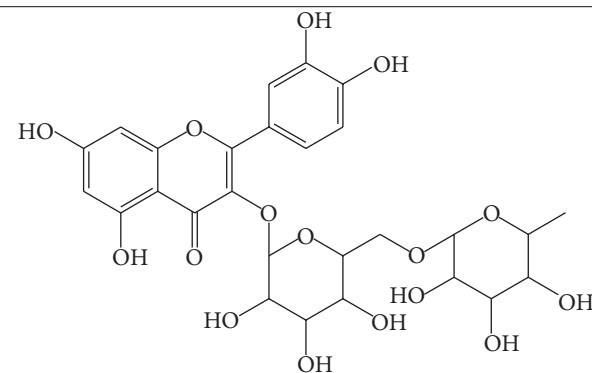
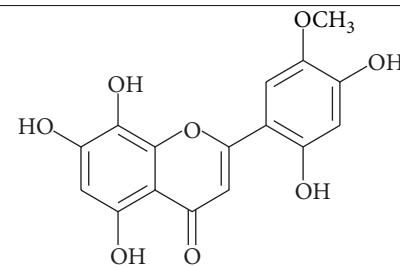
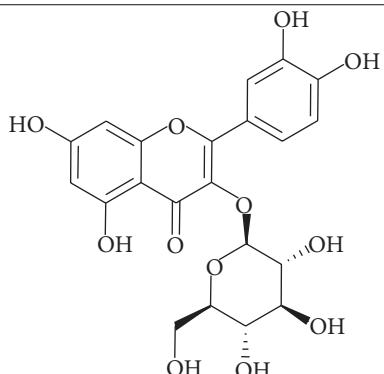
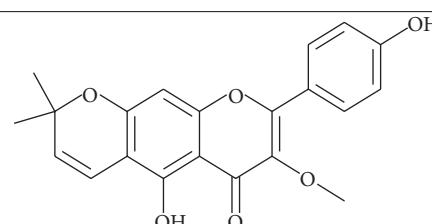
Name of compound	Structure	Species	Plant part	References
53 Luteolin		<i>P. vera</i>	Seed and skin	[44]
54 Quercetin-3-O-rutinoside		<i>P. vera</i>	Seed and skin	[44]
55 6'-Hydroxyhypolaetin 3'-methyl ether		<i>P. terebinthus</i>	Fruits	[53]
56 Quercetin-3-glucoside		<i>P. atlantica</i> <i>P. lentiscus</i>	Aerial parts	[54]
57 3-Methoxycarpachromene		<i>P. atlantica</i>	Aerial parts	[55]

TABLE 2: Continued.

Name of compound	Structure	Species	Plant part	References
58 Myricetin-3-glucoside		<i>P. khinjuk</i>	Aerial parts	[54]
59 Myricetin-3-galactoside		<i>P. khinjuk</i>	Aerial parts	[54]
60 Myricetin-3-rutinoside		<i>P. khinjuk</i>	Aerial parts	[54]
61 Cyanidin-3-O-glucoside		<i>P. vera</i>	Skin Nuts	[44] [56] [57]
		<i>P. lentiscus</i>	Berries leaves	[7] [45]

TABLE 2: Continued.

Name of compound	Structure	Species	Plant part	References
62 Cyanidin-3-galactoside		<i>P. vera</i>	Skin Nuts	[44, 56] [57]
63 Delphinidin-3-O-glucoside		<i>P. lentiscus</i>	Berries Leaves	[7] [45]

as the most abundant fatty acid in oil of *P. atlantica* and *P. terebinthus* fruits [62, 66, 67]. Increase of oleic acid and decrease of linoleic acid have been recorded during ripening of *P. lentiscus* fruits [60]. Other fatty acids identified in these species are linolenic, palmitic, palmitoleic, stearic, myristic, eicosanoic, behenic, lignoceric, arachidonic, pentadecanoic, hexadecanoic, octadecanoic, and margaric acid [58, 66, 68].

The most abundant sterol reported in fruits of *P. vera*, *P. atlantica*, *P. lentiscus*, and *P. terebinthus* is β -sitosterol followed by campesterol, Δ^5 -avenasterol, stigmasterol, brassicasterol, and cholesterol [59, 60, 69, 70].

The oil from fruits of *P. atlantica*, *P. lentiscus*, and *P. terebinthus*, in addition to its desirable odor and taste, has been recommended as a new source for production of vegetable oils concerning the high amount of mono-unsaturated and omega-3 fatty acids like oleic acid and linolenic acid and high quantity of phytosterols like β -sitosterol [60, 68].

3.4. Miscellaneous. Chlorophylls *a* and *b* and lutein are the major colored components of *P. vera* nuts [56]. Pheophytin, β -carotene, neoxanthin, luteoxanthin, and violaxanthin were also determined in different samples of *P. vera* nuts [71]. α -tocopherol was determined in leaves of *P. lentiscus*, *P. lentiscus*

var. *chia*, and *P. terebinthus* [72]. Tocopherols and tocotrienols are the most abundant constituents of unsaponifiable matter of *P. atlantica* hull oil [73]. Different isomers of tocopherol, tocotrienol, and plastoehromanol-8 have been identified in seed oil of *P. terebinthus* [70]. Evaluating the nutritional composition of *P. terebinthus* fruits illustrates the richness of this fruit in protein, oil, minerals, and fiber [62, 68].

4. Pharmacological Aspects

Different pharmacological activities of five mentioned *Pistacia* species have been described in detail in Table 3.

4.1. Antioxidant Activity. Different parts and constituents from *P. lentiscus* have been shown in vitro radical scavenging properties [23, 47, 52, 74–76]. *Pistacia lentiscus* var. *chia* and *P. terebinthus* var. *chia* resins were effective in protecting human LDL from oxidation in vitro [77]. *P. atlantica* leaf and fruit have shown antioxidant activity similar to or significantly higher than those of standard antioxidant compounds in different in vitro antioxidant assays [78–80]. However, the essential oil from *P. atlantica* leaf showed weak antioxidant activity in DPPH test compared to synthetic antioxidants

TABLE 3: Pharmacological activities of selected *Pistacia* species.

Pharmacological activity	Plant	Plant part	Assay	Extract/essential oil/isolated component	Dose or concentration	Observations	Ref.
			In vitro DPPH method	1, 3, 10, 30, and 100 $\mu\text{g/mL}$		Dose dependent radical scavenging activity of GA (IC50: 2 $\mu\text{g/mL}$) and PGA (IC50: 1 $\mu\text{g/mL}$)	
Fruits			Xanthine oxidase inhibition Inhibition of lipid peroxidation induced by H_2O_2 in K562 cell line	Polyphenols: galic acid (GA) and 1,2,3,4,6 pentagallyl-glucose (PGA)	100, 200, and 300 $\mu\text{g/mL}$ 200, 400, and 800 $\mu\text{g/mL}$ for GA and 100, 200, and 400 $\mu\text{g/mL}$ for PGA	[formation of uric acid and superoxide anions (O_2^-) by increasing concentrations of both GA and PGA Dose dependent inhibition by GA (IC50: 220 $\mu\text{g/mL}$) and PGA (IC50: 200 $\mu\text{g/mL}$)]	[52]
			Reducing power	Seven different extracts (1) Ethanol, (2) Ethyl acetate, (3) Aqueous/ethyl acetate, (4) Hexane, (5) Aqueous/hexane, (6) Chloroform, (7) Aqueous/chloroform	100 $\mu\text{g/mL}$	Higher activity of aqueous fractions from hexane and chloroform than standards (BHA and α -tocopherol) Inhibition of linoleic acid peroxidation by aqueous extracts from chloroform and hexane comparable to those of the standard (BHA)	
			Linoleic acid peroxidation	Essential oil Methanolic extracts	100 $\mu\text{g/mL}$ 0.2, 0.4, 1.0, 2.0, and 4.0 mM 100, 80, 50, 30, 20, 10, and 5 mg/L	High scavenging activity (90%) equivalent to that of the standard BHA (89%) by all extracts except chloroform High scavenging capacity against H_2O_2 comparable to standards (α -tocopherol and BHA)	[75]
<i>P. lentiscus</i>	Leaf		DPPH method Scavenging activity against hydrogen peroxide		10–100 $\mu\text{g/mL}$	Antioxidant activity ranged between 0.52 and 4.61 mmol/L IC50 ranged between 5.09 and 11.0 mg/L	[74]
			DPPH method		5000 mg/L	Activity ranged between 84.6 and 131.4 mmol Fe^{2+}/L plant extract; IC50: 5.09–11.0 (mg/L)	[23]
		Aerial parts	DPPH method		0.05, 0.1, and 0.15% w/v	Significant antioxidant activity	
<i>P. lentiscus</i> var. <i>chia</i>	Resin		FRAP assay Oil oxidation assay by the oven test	Resin solution in dichloromethane	0.05, 0.1, 0.15, and 0.2 mg/mL	Free radical scavenging activity towards the ABTS + radical was 99% at 0.2 mg/mL	[149]
Antioxidant			ABTS			21% XO inhibitory activity at 150 $\mu\text{g/mL}$; 28% reduction of superoxide anion activity	
			Xanthine oxidase (XO) inhibition and superoxide scavenging activity	Digallic acid	50, 100, and 150 $\mu\text{g/mL}$	1 lipid peroxidation (IC50: 178 $\mu\text{g/mL}$)	[47]
			TBARS		200, 400, and 800 $\mu\text{g/mL}$		
			Electron-spin resonance Spectroscopy for the determination of hydroxyl radical by Fenton reaction	Mastic in water	ND	Effectively scavenged hydroxyl radical generated by the Fenton reaction	[76]
		Gum	Nitrate/nitrite colorimetric assay		0–3 mg/mL	No nitric oxide scavenging activity	

TABLE 3: Continued.

Pharmacological activity	Plant	Plant part	Assay	Extract/essential oil/isolated component	Dose or concentration	Observations	Ref.
<i>P. lentiscus</i> var. <i>chia</i> , <i>P. terebinthus</i> var. <i>chia</i>	Gum	Copper-induced LDL oxidation	Hexane and methanol/water extracts	2.5, 5, 10, 25, and 50 mg/2 mL	LDL protective activity; methanol/water extract of <i>P. lentiscus</i> showed the most LDL [77]		[88]
<i>P. lentiscus</i>	Leaf	Reduction power activity Pyrogallol autoxidation method	Ethanolic extract	0.25; 0.5; 0.75; 1; 2; 3 mg/mL ND	Reducing power comparable to ascorbic acid		[88]
<i>P. atlantica</i>	Leaf	Reduction power activity Pyrogallol autoxidation method	Ethanolic extracts	0.25; 0.5; 0.75; 1; 2; 3 mg/mL ND	Superoxide anions scavenging activity		[88]
<i>P. atlantica</i> subsp. <i>mutica</i>	Hull	FRAP test DPPH radical-scavenging assay Oven test	The unsaponifiable matter (USM) of fruit's hull oil	100 mg in 10 mL of <i>n</i> -hexane ND ND	Reducing power close to values observed by ascorbic acid Superoxide anions scavenger at a concentration as low as 0.0625 mg/mL		[80]
<i>P. atlantica</i> subsp. <i>mutica</i>	Fruit hull	(1) Reducing power (2) Chelating abilities on metallic ions (3) Radical scavenging Activity (DPPH) (4) The total antioxidant activity (thiocyanate method in linoleic acid emulsion) (5) Hydrogen peroxide scavenging activity	Rancimat test DPPH test FRAP test	(1) 20–100 μ g/mL (2) 0.25, 0.50, 0.75, and 1.0 mg/mL (3) 5–25 μ g/mL (4) 100 μ g/mL (5) 100 μ g/mL	Significant reducing power; the highest reducing power amongst the USM fractions belonged to the tocopherols and tocotrienols and linear and triterpenic alcohols respectively EC50 value significantly lower than α -tocopherol		[80]
<i>P. atlantica</i> subsp. <i>mutica</i>	Fruit hull	ABTS radical cation decolorization assay Lipid peroxidation (TBARS assay) Copper-mediated LDL oxidation DPPH assay	<i>n</i> -Hexane extract Essential oil Water and methanol extracts Methanol/water or Dichloromethane Hydrophilic extract Hydrophilic extract	Different percentages (up to 15%) 50 μ L ND 0.02%, 0.04%, and 0.06% in soybean oil ND	Significant stabilizing effect (1) Reducing power of significantly higher than α -tocopherol and BHT and nearly similar to BHA (2) The chelating activity of 1.0 mg/mL was nearly fourfold less than EDTA at 0.037 mg/mL and has slightly effective capacity for iron binding (3) 85% inhibition rate at 15 μ g/mL, nearly similar to ascorbic acid and BHA (4) Higher antioxidant activity than α -tocopherol and similar to BHA, BHT, and trolox (5) Concentration-dependent scavenging compared to BHA, BHT, and α -tocopherol		[79]
<i>P. atlantica</i> subsp. <i>mutica</i>	Fruit hull	Rancimat test DPPH test FRAP test			The antioxidant activity of hull oil was exactly the same as that of TPHQ at low concentrations		[79]
<i>P. atlantica</i>	Leaf	Oven test	Water and methanol extracts	ND	Weak radical scavenging activity Higher antioxidant capacity relative to ascorbic acid		[32]
<i>P. vera</i>	Fruit hull	Oven test			Effective in retarding oil deterioration at 60°C, at concentration of 0.06%, similar to BHA and BHT added at 0.02%.		[81]
<i>P. vera</i> L., var. <i>Bronte</i>	Kernel	ABTS radical cation decolorization assay Lipid peroxidation (TBARS assay) Copper-mediated LDL oxidation DPPH assay	Methanol/water or Dichloromethane Hydrophilic extract Hydrophilic extract	0.25, 0.5, or 1.0 mg/mL Extracts from 30, 60, or 100 μ g of nut 0.050–12.00 mg/mL	The antioxidant activity of the lipophilic extract was much lower than hydrophilic one		[82]
<i>P. vera</i> L., var. <i>Bronte</i>	Seed and skin (hull)	Trolox equivalent antioxidant capacity (TEAC) assay (ABTS radical) Scavenging activity against the superoxide anion	Methanol/water extract	ND ND	Radical scavenging activity in a dose-dependent manner Inhibition of LDL oxidation		[44]
					Antioxidant power: 0.015 \pm 0.001 and 2.19 \pm 0.14 mmol Trolox/g of seeds and skins, respectively IC50 of 3.25 \pm 0.19 and 0.25 \pm 0.02 mg for seeds and skins, respectively		

TABLE 3: Continued.

Pharmacological activity	Plant	Plant part	Assay	Extract/essential oil/isolated component	Dose or concentration	Observations	Ref.
<i>P. vera</i>	Gum	TBARS and FRAP in rat	Extract	0.1–0.5 g/kg	↓ brain MDA level by 63% and ↑ antioxidant power of brain by 235%	[83]	
		DPPH assay		1, 1.5, 2.5, 3.5 and 4 µg/mL	Concentration-dependent radical scavenging activity	[150]	
		ABTS assay	Aqueous	ND	Scavenging capacity of crude and purified extracts was higher than standards compounds (TBHQ and BHT)	[84]	
		β-carotene bleaching method		0.48–9.5 µg/mL	Concentration-dependent antioxidant capacity	[84]	
		Trolox equivalent antioxidant capacity assay (ABTS/K2S8C2 method)	Ethanol-water extract	ND	Considerably higher antioxidant activity compared with BHA and ascorbic acid	[84]	
	Fruits	DPPH test		25, 50 and 100 µg/mL	High radical scavenging activity	[53]	
		Total antioxidant activity in β-carotene-linoleic acid system	Acetone and methanol extracts	25, 50 and 100 µg	Isolated pure 60-hydroxyhypolaeltin-30-methyl BHT showed higher antioxidant activity than both extracts and BHT	[53]	
		Superoxide anion scavenging activity		50 µg	Both extracts had scavenging activity near to ascorbic acid; higher activity of methanol extract than acetone extract	[53]	
		FRAP		0.2–1 µg/mL	Higher reducing power of methanol extract than α-tocopherol; acetone extract reducing power was equal to that of α-tocopherol	[53]	
		Metal chelating activity		1000–4000 µg/mL	Methanol extract had higher activity than acetone extract	[53]	
<i>P. terebinthus</i>	Fruits and 4 terebinth coffee brands	DPPH radical scavenging activity		250, 500, 1000 and 2000 µg/mL	High scavenging effect especially at 2000 µg/mL	[85]	
		DMPD radical scavenging activity	Ethyl acetate and methanol extracts		Scavenging effect lower than that of quercetin	[85]	
		H ₂ O ₂ radical scavenging activity			Inactive in scavenging H ₂ O ₂ radical	[85]	
		Metal-chelation effect			Remarkable metal-chelation properties as compared to EDTA	[85]	
		FRAP assay			High reducing power	[85]	
	Antimutagenic	FRAP assay			High reducing power	[85]	
		Aflatoxin B1 (AFB1)-induced mutagenicity in <i>S. typhimurium</i> TA 100	Essential oil	250, 500 and 1000 µg/plate	Mutagenic inhibition of 76.7% by 250, 82.8% by 500, and 96.5% by 1000 µg/plate	[86]	
		(AFB1)-induced mutagenicity in <i>S. typhimurium</i> TA100 or TA98		0.3, 250, 500, 1000 µg/plate	In TA100: 76, 82.8, and 96.5%, mutagenic inhibition rate for 250, 500, and 1000 µg/plate, respectively; in TA98: 99 and 100%, mutagenic inhibition rate with 250 and 500 µg/plate 50 µg/plate: 23% inhibition in TA100 and 52.2% in TA98;	[87]	
		Aqueous extract	0.3, 50, 300, 600 µg/plate	300 and 600 µg/plate: 67.7 and 87.8% for TA100 and 58–76.8% for TA98	TA100: 47.75, 3, and 88.6% inhibition by 50, 300, and 600 µg/plate, respectively; TA98: 62.5, 77, and 93.5% inhibition by 50, 300, and 600 µg/plate, respectively	[87]	
		Flavonoid-enriched extract extracts	50, 300, 600 µg/plate				

TABLE 3: Continued.

Pharmacological activity	Plant	Plant part	Assay	Extract/essential oil/isolated component	Dose or concentration	Observations	Ref.
<i>P. lentiscus</i>	<i>P. lentiscus</i> Leaf	Sodium azide-induced mutagenicity in <i>S. typhimurium</i> TA1535 and TA100	Disc diffusion	Essential oil	1.5, 10, 15, 30 µg/Plate	TA100: 79, 83, and 94% inhibition by 10, 15, and 30 µg/plate, respectively; TA1535: 62, 76, and 93% inhibition by 10, 15, and 30 µg/plate, respectively	[86]
		Aqueous extract	Disc diffusion	1.5, 50, 300, 600 µg/plate	TA100: 92, 96, and 98% inhibition by 50, 300, and 600 µg, respectively; TA1535: 62, 80, and 94% for the same concentrations		
		Flavonoid-enriched extract extracts	Disc diffusion	50, 300, 600 µg/plate	50 and 300 µg/plate: from 54 to 68% inhibition in TA1535 and from 84 to 93% in TA100		
		Essential oil	Disc diffusion	0.03, 0.15, 0.62, 2.5, 10, 40.0 mg/mL	Noticeable activity against <i>S. enteritidis</i> (MIC: 30 µg/mL) and <i>S. aureus</i> (30 µg/mL); less important activity against <i>S. typhimurium</i> , (MIC: 150 µg/mL);		
		Ethanolic extract	Disc diffusion	5 and 10 µL	No significant inhibitory activity towards <i>Escherichia coli</i> , <i>Pseudomonas aeruginosa</i> , and <i>Enterococcus faecalis</i>		
		Aqueous extract	Disc diffusion	ND	No effect on <i>Klebsiella pneumoniae</i> and <i>Escherichia coli</i> .		
		Ethanolic extract	Disc diffusion	50, 100, 500 µL, and 1 mL	Significant inhibition against <i>Candida albicans</i> , <i>Staphylococcus aureus</i> , and <i>Salmonella typhi</i>		
		Essential oil	Disc diffusion	ND	Inhibiting activity on <i>Trichoderma</i> sp and <i>Fusarium</i> sp		
		Total oligomer flavonoid-enriched extract	Disc diffusion	ND	Most active against <i>S. typhimurium</i> , (MIC: 4 µg/mL), significant inhibitory activity towards <i>P. aeruginosa</i> and <i>S. enteritidis</i> (MIC: 40 µg/mL), and no activity against <i>S. aureus</i> , <i>E. coli</i> , and <i>Ent. faecalis</i> up to 1000 µg/mL		
		Microdilution agar	Disc diffusion	ND	TOF extract exhibited antibacterial activity only against <i>S. typhimurium</i> (MIC: 100 µg/mL)		
<i>P. lentiscus</i> var. <i>chria</i>	<i>P. lentiscus</i> var. <i>chria</i>	Anitmicrobial and antiviral	Microdilution	Essential oil and its fractions and components	Activity against <i>S. enteritidis</i> , <i>S. typhimurium</i> , and <i>S. aureus</i> (MICs between 30 and 620 µg/mL). No effect on <i>Ent. faecalis</i> , <i>P. aeruginosa</i> , and <i>E. coli</i> up to 1000 µg/mL		
		Gum	Disc diffusion	ND	<i>Escherichia coli</i> , <i>Staphylococcus aureus</i> , and <i>Bacillus subtilis</i> were resistant to α-pinene. <i>E. coli</i> is resistant to β-myrcene, <i>S. aureus</i> showed an intermediate response, and <i>B. subtilis</i> is sensitive to it. <i>p</i> -Cymene, β-caryophyllene, methyl isoeugenol, limonene, γ-terpinene, and <i>trans</i> -anethole showed moderate antibacterial activity, and in some cases, the bacteria were resistant to them. <i>E. coli</i> and <i>S. aureus</i> were resistant to β-pinene, slightly inhibited <i>B. subtilis</i> . Verbenone, R-terpineol, and linalool showed higher antibacterial activity than other components		
		Gum	Disc diffusion	ND	MWR (58 mg/mL), (-)-trans-pinoconeol (13 mg/mL), (-)-linalool (37.6 mg/mL), (+)-linalool (36.6 mg/mL), (-)-verbenone (29.5 mg/mL), and (+)-α-terpineol (29.2 mg/mL)		
		Mastic gum water (MWR)	Disc diffusion	ND	The broadest average inhibition zones were for <i>E. coli</i> and <i>S. aureus</i> by (+)-α-terpineol and (+)-linalool compared to the positive control gentamicin (10 µg); significant antifungal activity against <i>Candida albicans</i> by MWR		
		Gum	Disc diffusion	ND	Microdilution		

TABLE 3: Continued.

Pharmacological activity	Plant	Plant part	Assay	Extract/essential oil/isolated component	Dose or concentration	Observations	Ref.
<i>P. lentiscus</i>	Gum	ND	Human T-cell leukemia MT-4 cells infected with HIV-1 _{LB} ; viable cell number determination by MTT assay	Liquid mastic	2% liquid mastic	Activity against <i>Porphyromonas gingivalis</i> and <i>Prevotella melanogenum</i>	[76]
<i>Pistacia lentiscus</i> var. <i>chia</i>	Gum	Microdilution	In vivo administration of extract in infected mice with <i>H. pylori</i>	Solid and liquid mastic Total mastic extract without polymer (TMEWP), acidic and neutral fractions	Solid mastic: 0–200 µg/mL; liquid mastic: 0–0.0006%	Neither solid nor liquid mastic had any anti-HIV activity compared to positive controls	[33]
<i>P. lentiscus</i> , <i>P. atlantica</i> (sp. <i>cabulica</i> , <i>kurdica</i> , and <i>mutica</i>)	Gum	Broth microdilution	Isolated components of the acidic fractions of the gum	MEWP: 0.049 to 1.560 mg/mL, fractions: 0.060 to 1.920 mg/mL	Moderately reduced <i>H. pylori</i> colonization in the antrum and corpus of the mice stomach. Visible reduction in <i>H. pylori</i> colonization observed in histopathology evaluations	The acid fraction exhibited the highest activity against <i>Helicobacter pylori</i> followed by the TMEWP and neutral fraction	[33]
<i>P. atlantica</i> (sp. <i>kurdica</i>)	Gum	ND	Modified [³ H]-hypoxanthine incorporation assay	ND	The MIC values for the components ranged from 0.1 to 50 µg/mL against the strains of <i>H. pylori</i> and all Gram-negative bacteria including <i>Escherichia coli</i> , <i>Salmonella typhimurium</i> , <i>Serratia marcescens</i> , <i>Pseudomonas aeruginosa</i> , <i>Alcaligenes faecalis</i> , <i>Enterobacter aerogenes</i> , <i>Pseudomonas fluorescens</i> , <i>Porphyromonas gingivalis</i> , and <i>Proteus vulgaris</i> and ranged from 2 to 100 µg/mL against Gram-positive bacteria including <i>Bacillus cereus</i> , <i>Staphylococcus aureus</i> , <i>Streptococcus faecalis</i> , <i>Staphylococcus epidermidis</i> , <i>Bacillus subtilis</i> , and <i>Corynebacterium sp</i>	Against all tested bacteria mentioned in previous row, MIC values for essential oil and pure α-pinene ranged 500–1000 mg/mL	[152]
<i>P. atlantica</i>	Leaf	Leaf and twig	Leaf and fruit derm	Essential oil, α-pinene Flavone 3-methoxyarpachromene from ethyl acetate extract Methanol, ethanol, ethanol + water, and water extracts	ND 0.8 and 4.9 µg/mL 25, 50 and 75 mg/mL	IC50 of 3.4 µM against <i>P. falcatum</i> KI strain where the positive controls artemisinin and chloroquine had IC50s of 3.6 and 89 nM, respectively	[55]
<i>P. atlantica</i>	Leaf	Disc diffusion	Disc diffusion	Ethanolic extract	5 and 10 µL	Dose dependent activity against <i>E. coli</i> , <i>Staphylococcus aureus</i> , and <i>Staphylococcus epidermidis</i> ; less activity in comparison with gentamicin (10 µg/disk), tobramycin (10 µg/disk), and kanamycin (30 µg/disk), <i>Klebsiella pneumoniae</i> and <i>Escherichia coli</i> were not sensitive to the extract. <i>Candida albicans</i> , <i>Staphylococcus aureus</i> , and <i>Salmonella typhi</i> showed a sensitizing effect at the 5 µL and a very significant effect at 10 µL	[88]
	Gall	Disc diffusion	Disc diffusion	Ethanolic extract	(50, 100, 500 µL, and 1 mL) of ethanolic extract (0.338 g/mL)	No inhibiting activity was observed against <i>Aspergillus flavus</i> , <i>Rhizopus stolonifer</i> , <i>Trichoderma sp</i> , <i>Fusarium sp</i> and <i>Aspergillus flavus</i>	[91]
	Leaf and gall	Disc diffusion	Disc diffusion	Aqueous extract	4.9 mg	Activity against the <i>Bacillus</i> species and <i>Pseudomonas aeruginosa</i>	[92]
				Essential oils	Final 0.1% v/v	Delayed not block fungal growth in <i>Fomitiopsis pinicola</i> and <i>Penicillium sp</i> . by volatile constituents of galls; volatile constituents of leaf inhibited only the growth of <i>Penicillium sp</i>	[92]

TABLE 3: Continued.

Pharmacological activity	Plant	Plant part	Assay	Extract/essential oil/isolated component	Dose or concentration	Observations	Ref.
<i>P. atlantica</i> var. <i>kurdica</i>	Gum	Agar disc diffusion Inhibitory quantity (MIQ) method	Essential oil	$10^{-1}, 10^{-2}, 10^{-3}$, and $10^{-4} \mu\text{g/mL}$	Most active against <i>E. coli</i> followed by <i>S. aureus</i> and <i>S. Pyogenes</i> .	[90]	
		Maruzzella method		0.5, 1.5, and $2 \mu\text{g/mL}$	<i>S. aureus</i> and <i>S. Pyogenes</i> were susceptible to $0.5 \mu\text{g/mL}$, and <i>E. coli</i> was tolerant to this concentration		
		Mice infected with <i>Leishmania major</i>	Gum	$10^{-1}, 10^{-2}, 10^{-3} \mu\text{g/mL}$	<i>E. coli</i> , <i>Staphylococcus aureus</i> , and <i>Streptococcus pyogenes</i> were sensitive to $10^{-1} \mu\text{g/mL}$.	[93]	
<i>P. terebinthus</i>	Leaf	Microdilution		Locally rubbed on lesions	↓Skin lesion size in mice infected with <i>L. major</i> compared with control ($P < 0.01$); ↓number of parasitologically positive mice ($P < 0.05$)	[84]	
			Hydroalcoholic extract (for <i>S. aureus</i>)	0.024, 0.049, 0.097, 0.19, 0.78, 1.56, and $25 \mu\text{g/mL}$	Activity against <i>S. aureus</i> with a MIC: $\leq 1.56 \mu\text{g/mL}$. No antimicrobial effect on <i>E. coli</i> .	[84]	
<i>P. khinjuk</i>	Gum	Disc diffusion, microdilution	Essential oil and gum smoke	ND	Activity of essential oil against all tested bacteria including <i>Bacillus subtilis</i> , <i>Salmonella typhi</i> , <i>Escherichia coli</i> , <i>Staphylococcus epidermidis</i> , and <i>Pseudomonas aeruginosa</i> ; activity of nonpolar smoke fraction on all of strains especially on <i>S. dysenteriae</i> , <i>E. coli</i> , <i>B. subtilis</i> , and <i>P. aeruginosa</i>	[140]	
	Not mentioned	Disc diffusion, microdilution	Ethanolic extract and its fractions	ND	Active against Gram-positive and Gram-negative bacteria especially <i>n</i> -butanolic fraction	[153]	
<i>P. vera</i>	Leaf	Microdilution	Chloroform, ethyl acetate, ethyl alcohol, and diethyl ether extracts	ND	Activity against bacteria including <i>Bacillus subtilis</i> , <i>Enterococcus faecalis</i> , <i>Staphylococcus aureus</i> , <i>Staphylococcus epidermidis</i> , <i>Escherichia coli</i> , and <i>Klebsiella pneumoniae</i> (MIC = 0.02–0.5 mg/mL) and fungi including <i>Candida albicans</i> and <i>Saccharomyces cerevisiae</i> (MIC = 0.06–0.4 mg/mL). Chloroform extract inhibited growth of fungi more than others	[38]	
	Leaf fruits derm	Disc diffusion	Methanolic extract	25, 50, 75 mg/mL	Hydroalcoholic extract of fruits derm on <i>E. coli</i> , water extract on <i>S. epidermidis</i> , and methanolic extract on <i>S. aureus</i> (all in 75 mg/mL) had higher antibacterial activity than tobramycin and same as gentamicin and kanamycin No inhibitory activity against <i>Trypanosoma brucei rhodesiense</i>	[91]	
	Leaf branch, stem, seed	In vitro study on four parasitic protozoa	Lipophytic extracts	0.8 to $9.7 \mu\text{g/mL}$	Not any significant inhibitory potential against <i>Trypanosoma cruzi</i>	[94]	
					Remarkable activity of branches extract at $4.8 \mu\text{g/mL}$ against <i>Leishmania donovani</i> . Dried leaf extract displayed notable activity against <i>Plasmoidium falciparum</i> at $4.8 \mu\text{g/mL}$.		
	Gum	Hole-plate, agar dilution	Essential oil	1/10, 1/20, 1/40, 1/80, and 1/100 v/v	All isolates of <i>Helicobacter pylori</i> were sensitive to the essential oil (MIC: $1.55 \mu\text{g/mL}$)	[15]	
		Agar-disc diffusion, broth microdilution, and broth susceptibility	Essential oil	of 2 and 4 μL	Dose dependent activities against <i>Corynebacterium xerosis</i> , <i>Bacillus brevis</i> , <i>B. megaterium</i> , <i>Mycobacterium smegmatis</i> , <i>St. aureus</i> , <i>Klebsiella oxytoca</i> , <i>Enterococcus faecalis</i> , <i>Micrococcus luteus</i> , <i>Escherichia coli</i> , <i>Versinia enterocolitica</i> , <i>Kluveromyces fragilis</i> , <i>Rhodotorula rubra</i> , and <i>Candida albicans</i>	[12]	

TABLE 3: Continued.

Pharmacological activity	Plant	Plant part	Assay	Extract/essential oil/isolated component	Dose or concentration	Observations	Ref.
	Hull	Disk diffusion test Agar dilution method	Aqueous	1200 $\mu\text{g}/\text{plate}$ 0.5 to 10 mg/mL	Gram positive bacteria were the most sensitive	[150]	
	Leaf, branch, stem, kernel, shell skins, and seeds	Microdilution In vitro antiviral assay	Lipophytic extracts	256 and 512 mg/mL	Greater activity against Gram positive bacteria than Gram-negative; remarkable antifungal activity against <i>C. albicans</i> and <i>C. parapsilosis</i>	[89]	
					Extracts of shell skin and fresh kernel had significant activity against <i>Parainfluenza virus</i> and <i>Herpes simplex virus</i> same as the cyclovir		
		Phospholipase A2 (PLA2) induced hind-paw mouse edema		200 mg/kg	Inhibition of edema		
		Ethyl phenylpropionate (EPP) induced mouse ear edema		1 mg/ear	Inhibition of edema by 44%.	[95]	
		12-O-Tetradecanoylphorbol- 13-acetate (TPA)-induced mouse ear edema	Methanolic extract	1 mg/ear	Nonsignificant effect		
		Mouse ear edema induced by multiple topical applications of TPA		1 mg/ear	58% inhibition of chronic inflammatory swelling		
		In vitro phospholipase A2 activity assay		ND	↓activity of the enzyme by 75%		
		Myeloperoxidase assay		ND	↓activity of the enzyme by 73%		
		Phospholipase A2 (PLA2)-induced hind-paw mouse edema		30 mg/kg	Inhibition of edema by all triterpenes		
		Ethyl phenylpropionate (EPP) induced mouse ear edema		1 mg/ear	31% and 38% nonsignificant inhibition of edema by masticadienonic acid and morolic acid, whereas masticadienonic acid was inactive	[95]	
		Mouse ear edema induced by multiple topical applications of TPA	Masticadienonic acid, masticadienonic acid, and morolic acid from methanolic extract	0.3 mg/ear	Inhibition of swelling and neutrophil infiltration by all compounds		
		Myeloperoxidase assay		10–100 $\mu\text{g}/\text{mL}$	80% inhibition of enzyme activity by all the compounds		
		Inhibition of the production of LTB4 from rat Polymorphonuclear leukocytes (PMNL)		12.5–100 μM	Inhibition of leukotriene B4 production in rat PMNL by all compounds		
		Ethyl phenylpropionate-induced mouse ear oedema	Oleanolic acid and its semisynthetic 3-oxo-analogue	1 mg/ear	No activity on the edema		
		Mouse ear edema induced by TPA		0.5 mg/ear	A nonsignificant 28% inhibition		
		Mouse edema induced by DPP		0.5 mg/ear	↓swelling by 40% similar to standard (carbamazepine)	[95]	
		Delayed type hypersensitivity induced by fluorobenzene in mouse ear	Oleanolic and oleanonic acids	0.5 mg/ear	Oleanonic acid: ineffective at both 24 and 96 h; oleanolic acid: ↓edema nonsignificantly at 96 h by 32%		
		Mouse ear inflammation induced by multiple topical applications of TPA		0.3 mg/ear	Oleanonic acid: significant effect with 45% inhibition; oleanolic acid: inactive		

TABLE 3: Continued.

Pharmacological activity	Plant	Plant part	Assay	Extract/essential oil/isolated component	Dose or concentration	Observations	Ref.
<i>P. vera</i>	<i>P. vera</i>	Fruits, leaf, branches, peduncles, and oleoresin	Myeloperoxidase assay	ND		Inhibition of neutrophil infiltration by oleanolic acid	
			Phospholipase A2-induced hind paw mouse edema	30 mg/kg		oleanolic 84% and 67%, respectively	
			Bradykinin-induced mouse Paw edema	Oleanonic acid	30 mg/kg	↓edema by both compounds	[146]
			Inhibition of leukotriene B4 production from rat polymorphonuclear leukocytes	ND		↓edema by 61%	
			Carrageenan-induced hind Paw edema	Ethanolic and aqueous extracts	250, 500 mg/kg	Among all extracts, only the oleoresin exhibited a dose-dependent anti-inflammatory activity	
			P-Benzooquinone-induced abdominal constriction test in mice	Aqueous extract, ethanolic extract	250, 500 mg/kg	Among all extracts, only the oleoresin displayed antinociceptive activity with 32.1% inhibition at 500 mg/kg and 21.7% inhibition at 250 mg/kg	
			Hot plate test	Aqueous extract, ethanolic extract	0.4 and 0.5 g/Kg	Dose-dependent antinociceptive activity after 30–60 min of treatment	
			Xylene-induced ear edema	Aqueous extract, ethanolic extract	0.4, 0.16, 0.28 g/kg	Significant anti-inflammatory activities	
			Chronic anti-inflammatory activity (granuloma pouch method)	Aqueous extract, ethanolic extract	0.4 g/Kg 0.35, 0.5 g/Kg	Significant and dose-dependent anti-inflammatory activity	[97]
			Writhing test	Aqueous extract, ethanolic extract	0.4, 0.28 g/kg 0.35, 0.5 g/kg	↓number of mouse abdominal constrictions induced by acetic acid	
<i>P. lentiscus</i> var. <i>chia</i>	<i>P. lentiscus</i> var. <i>chia</i>	Gum	Modification of VCAM-1 and ICAMI expression by ELISA	Neutral extract and isolated phytosterol tricucallol	Extract: 25, 50, 100, 200 μg/ml Tricucallol: 0.1, 1, 10, 100 μM	↓significance dose-dependent ↓ in vascular adhesion molecule 1 (VCAM-1) and intracellular adhesion molecule 1 (ICAM-1) expression ↓adhesion of U937 cells to TNF-α-stimulated human aortic endothelial cells	[98]
			U937 cell adhesion assay			↓phosphorylation of NFκB p65	
			Measurement of NFκB P65 Phosphorylation by ELISA				
			Pyloric ligation, Aspirin-, phenylbutazone-, and reserpine-induced and cold-restraint stress ulcer in rat	Powder finely suspended in corn oil	An oral dose of 500 mg/kg	↓intensity of gastric mucosal damage in all models	[103]
Effects on Gastrointestinal disorders	<i>P. lentiscus</i>	Resin	TNBS-induced colitis in rats	Powder in polyherbal formulation	50, 100, and 200 mg/kg of formula with 4% <i>P. lentiscus</i> resin	↓macroscopic and microscopic colonic damage; ↓TNF-α, IL-1β, MPO, and lipid peroxidation; not significantly increase in antioxidant power of colon	[106]
	<i>P. lentiscus</i> var. <i>chia</i>	Resin	3-week double-blind randomised placebo controlled study on patients with functional dyspepsia	Powder	350 mg TID	Improved the feeling of symptoms significantly	[104]
	<i>P. lentiscus</i> var. <i>chia</i>	Resin	Dextran-sulfate sodium (DSS) model of colitis in mice	Powder	0.20 g/kg chow (0.02%) 2.0 g/kg chow (0.20%)	Delayed the onset and progression of acute colitis and weight loss caused by the disease	[105]
<i>P. lentiscus</i> var. <i>chia</i>	<i>P. lentiscus</i> var. <i>chia</i>	Resin	4-week pilot study on 10 patients with Crohn's disease and 8 controls	Capsules of fine powder	2.22 g/day (6 caps/d, 0.37 g/cap)	↓Crohn's disease activity index and plasma inflammatory mediators such as C-reactive protein, interleukin-6 (IL-6) without any side effects; immunomodulatory effect by ↓ tumor necrosis factor-alpha (TNF-α) and ↑macrophage migration inhibitory factor	[107]

TABLE 3: Continued.

Pharmacological activity	Plant	Plant part	Assay	Extract/essential oil/isolated component	Dose or concentration	Observations	Ref.
	<i>P. lentiscus</i> var. <i>chia</i>	Resin	4-week pilot study on 10 patients with crohn's disease and 8 controls	Capsules of fine powder	2.22 g/day (6 caps/d, 0.37 g/cap)	Immunomodulatory activity ↓TNF- α and ↑macrophage migration inhibitory factor (MIF) in these patients	[108]
Antidiabetic	<i>P. atlantica</i>	Leaf	In vitro and in vivo (normoglycemic and streptozocin-induced hyperglycemic rats)	Aqueous extract	2 mL plant extract equivalent to 200 mg of starting material	Significant inhibitory effect on α -amylase in vitro; no significant hypoglycemic activity in normoglycemic and hyperglycemic rats	[109]
			In vitro enzymatic starch digestion and rat model	Aqueous extract	1.5, 10, 12.5, 25, 50, and 100 mg/mL	In vitro: significant dose dependent dual inhibition of α -amylase and α -glucosidase comparable to acarbose	[110]
	<i>P. lentiscus</i> var. <i>chia</i>	Resin	Human study	Powder diluted in 250 mL of water	0.7 g per day	In vivo: significant acute postprandial antihyperglycemic activity comparable to metformin and glipizide and improved glucose intolerance in oral starch tolerance test	[111]
	<i>P. lentiscus</i> var. <i>chia</i>	Resin	In vitro study on human colon cancer cells (HCT116)	Ethanol extract	ND	Significantly decrease (3.1 mg/dL per month, $P = 0.003$) in serum glucose level among male subjects	[111]
			In vitro study on human leukemic cell line	Liquid and solid resin	0–200 μ g/mL (solid mastic) or 0–2 (v/v)% of liquid mastic	Inhibited proliferation and induced apoptosis of human colorectal tumor cells	[112]
			In vivo human colon cancer/immunodeficient mouse model	Hexane extract	200 mg/kg administered daily for 4 consecutive days (followed by 3 days without treatment)	The most cytotoxic effect against promyelocytic leukemia HL-60 among 13 human cell types; inhibition of natural apoptosis of oral polymorphonuclear leukocytes	[76]
			Human cell line (androgen-responsive prostate cancer cell line)	ND	2, 4, 6, 8, 10, and 12 μ g/mL	Anticancer activity via its delay effect on the growth of colorectal tumors developed from HCT116 xenografted into mice	[8]
	<i>P. lentiscus</i>	Resin	Human prostate cancer cell lines (LNCaP and DU-145), RT-PCR, and Western blotting were used to detect maspin expression	ND	2, 4, 6, and 8 μ g/mL	Remarkable potency to decrease the expression and function of the androgen receptor in androgen-responsive prostate cancer cell line (LNCaP)	[154]
Antitumor			The human prostate cancer cell lines (PC-3), MTT assay, gene assay, RT-PCR, and Western blotting	ND	10, 20, and 30 μ g/mL	Increased maspin expression in LNCaP cells	[113]
			Lewis lung carcinoma cells	Essential oil	0.01% v/v	Inhibited proliferation and blocked the cell cycle progression in androgen-independent prostate cancer PC-3 cells by suppressing NF- κ B activity and the NF- κ B signal pathway	[114]
			Immunocompetent mice	Essential oil	45 mg/kg intraperitoneally, 3 times a week for 3 weeks	A time-dependent modification in the expression of 925 genes and phenomena in Lewis lung carcinoma cells by its antiproliferative, proapoptotic, and anti-inflammatory activities	[115]
	<i>P. atlantica</i> sub. <i>kurdica</i>	Fruit	Cells line and the in vivo chicken embryo CAM angiogenesis model	Essential oil	0.01–0.1% v/v	Significant inhibition on tumor growth without signs of toxicity related to apoptosis induction, reduced neovascularization, and inhibiting chemokine expression	[116]
						Antiproliferative and proapoptotic effect on K562 human leukemia cells; inhibited the release of vascular endothelial growth factor from K562 and B16 mouse melanoma cell; concentration-dependent inhibition of endothelial cell proliferation without affecting cell survival; significant decrease of microvessel formation	

TABLE 3: Continued.

Pharmacological activity	Plant	Plant part	Assay	Extract/essential oil/isolated component	Dose or concentration	Observations	Ref.
	<i>P. vera</i>	Rat liver medium-term carcinogenesis bioassay (Ito-test) human colon carcinoma HT129 cells	Rat liver medium-term carcinogenesis bioassay (Ito-test) human colon carcinoma HT129 cells	Powder in diet Ethanol : H ₂ O (70 : 30)	0, 0.01, 0.1 and 1% 0.7 mg/mL	Promoted the preneoplastic lesions development in rat liver with increasing liver relative weight	[117]
			In vitro cytotoxic activity against human cell lines	Crude methanolic extract fractionated against petroleum ether, chloroform, and <i>n</i> -butanol	ND	50% growth inhibition similar to 500 nM of doxorubicin	[119]
						Moderate cytotoxic effect against breast cancer cell line (MCF7), hepatocellular carcinoma cell line (HEPG2), cervix cancer cell line (HELA), and normal melanocytes (HFB4); n-hexane fraction showed strong cytotoxic effect (IC50: 3.15–4.17 µg/mL) against all of the tested cell lines, except for MCF7 (IC50: 13.5 µg/mL)	[120]
	<i>P. lentiscus</i>		Rat model using Carbon tetrachloride	Aqueous extract	4 mL/kg (contained 1.946 g of solid matter)	Bilirubin and activity of 3 enzymes including alkaline phosphatase (ALP), alanine aminotransferase (ALT), and aspartate aminotransferase (AST)	[121]
		Leaf	Rat model using Thioacetamide	Aqueous extract	15 mg/kg and 75 mg/kg	Hepatic fibrosis, an inflammatory response, mild cholestasis, and depletion of reduced glutathione associated with an increase in its oxidized form for five weeks administration in healthy rats; in thioacetamide-induced rat liver lesions, it aggravated the inflammatory, fibrotic, and glutathione depleting responses without affecting the extent of lipid peroxidation	[122]
Effects on liver and serum biochemical parameters	<i>P. lentiscus</i> var. <i>chia</i>	Resin	Human model	Powder diluted in one glass (250 mL) of water	5 g	Serum total cholesterol, LDL, total cholesterol/HDL ratio, lipoprotein, apolipoprotein A-1, apolipoprotein B, AST, ALP, and gamma-GT were reduced in human subjects	[111]
	<i>P. lentiscus</i>	Seeds oil	Rabbit model, mercury induced toxicity	<i>Pistacia</i> oil	5%	Mercury induced toxicity in rabbits caused increase in the level of ALP, AST, and urea serum, while it was reported that <i>P. lentiscus</i> oil-treated rabbits showed none of those changes	[156]
	<i>P. vera</i>	Fruit (roasted, unsalted pistachio nuts)	Human model (10 patients with moderate hypercholesterolemia)	Nut	20% in diet	↓ total cholesterol, total cholesterol/HDL ratio, and LDL/HDL ratio and ↑ HDL after 3 weeks use	[124]
	<i>P. terebinthus</i>	Fruit	Rabbit model	Fruit	1 g/kg	Inhibited the development of hydropic degeneration and fatty changes in the liver and demonstrated hypolipidemic effect	[125]
	<i>P. vera</i>	Fruit	Rabbit model	Methanolic and cyclohexane extracts	Methanolic extract (1% v/w) cyclohexane extract (5% v/w)	Beneficial effects on HDL, LDL, and aortic intimal thickness. The methanolic extract additionally showed an antioxidant activity and remarkable decrease in aortic surface lesions	[123]
Effects on atherosclerosis	<i>P. terebinthus</i>	Fruit	Rabbit model	Fruit	1 g/kg	Inhibited the development of the atherosclerotic lesions in the thoracic artery	[125]
	<i>P. lentiscus</i>	Resin	Cell culture (peripheral blood mononuclear cell, PBMC); cell viability assessed via MTT assay	Total polar extract	2.7, 27, and 270 µg/mL	Restored intracellular antioxidant glutathione (GSH) levels and downregulated CD36 mRNA expression resulted in antioxidant and antiatherogenic effects	[126]
	<i>P. atlantica</i>	leaf	TLC bioautography assay, Ellman's colorimetric method	Aqueous extract	5, 10, 15, 20, and 25 µg/mL	Strong acetylcholinesterase (AChE) inhibition	[13]
Anticholinesterase activity	<i>P. atlantica</i>	Leaf	Ellman's colorimetric method	Methanol and ethyl acetate extracts	0.1 mg/mL	Relatively weak AChE inhibitory activity	[127]
	<i>P. terebinthus</i>	Fruit	Ellman's colorimetric method and the modified dopachrome method	Ethyl acetate and methanol extracts	25, 50, 100, and 200 µg/mL	No inhibitory activity against AChE and tyrosinase while selectively inhibited butyryl/cholinesterase (BChE) at moderate levels (below 50%) at the tested concentrations	[85]

[32]. *P. vera* fruit revealed significant antioxidant activity similar to the synthetic antioxidant [81]. Lipophilic extract from *P. vera* nuts showed lower antioxidant potential than that of hydrophilic extract [82]. One survey showed *P. vera* skins had a better antioxidant activity compared to seeds by means of four different assays because of higher content of antioxidant phenolic compounds in skins [44]. Antioxidant activity has been also reported from other parts of *P. vera* [83].

In one study, the extract from *P. terebinthus* leaf had nearly 12-fold higher antioxidant capacity than those of BHA and ascorbic acid [84]. *P. terebinthus* fruits showed noticeable metal-chelation properties as compared to EDTA and high radical scavenging activity similar to the standards. Antioxidant activity of the fruits may be elevated by roasting process [85].

4.2. Antimutagenic Activity. Essential oil and different extracts from *P. lentiscus* leaves indicated significant inhibitory effect on mutagenicity in vitro [86, 87]. Gallic acid, digallic acid, and 1,2,3,4,6-pentagalloylglucose, polyphenols isolated from the fruits of *P. lentiscus*, induced an inhibitory activity against mutagenicity and genotoxicity in in vitro assays [47, 52].

4.3. Antimicrobial and Antiviral Activities. *Pistacia* species have demonstrated significant antibacterial activity against various Gram positive and Gram negative bacteria as shown in Table 3. Antimicrobial activity of *Pistacia lentiscus* resin, the essential oil and gum from *P. atlantica* var. *kurdica* and its major constituent α -pinene and *P. vera* gum against *Helicobacter pylori* were recorded [15, 33]. A study indicated that antibacterial activity of *P. lentiscus* gum oil can be attributed to combination of several components rather than to one particular compound. Verbenone, R-terpineol, and linalool showed high antibacterial activity against *Escherichia coli*, *Staphylococcus aureus*, and *Bacillus subtilis* which is comparable to that of mastic oil itself [19]. *P. lentiscus* gum revealed selective antibacterial activity against *Porphyromonas gingivalis* and *Prevotella melaninogenica* and had antiplaque activity on teeth by inhibiting bacterial growth in saliva [76].

Significant antifungal activity was seen from essential oil of *P. lentiscus* leaf and gum, different extracts of *P. khinjuk* leaf, and essential oil of *P. vera* gum [15, 19, 38, 88]. Evaluating the effect of *P. vera* gum essential oil on growth of 13 bacteria and 3 yeasts demonstrated inhibitory effect on all of them except *Bacillus cereus*, *Pseudomonas aeruginosa*, and *Klebsiella pneumoniae* and more effective yeasticide than nystatin. Carvacrol was found to be the most effective constituent [12, 15]. Lipophylic extracts from different parts of *P. vera* showed a little antibacterial activity and noticeable antifungal one against *C. albicans* and *C. parapsilosis*. Kernel and seed extracts showed significant antiviral activity [89].

Some active constituents of essential oil from the aerial parts of *P. khinjuk* responsible for its antibacterial and antifungal activity are α -pinene, β -pinene, myrcene, beta-caryophyllene, Germacrene B, and Spathulenol [38].

Organic fraction of mastic water obtained during the steam distillation of resin from *Pistacia lentiscus* var. *chia*

indicated acceptable antifungal activity but moderate antibacterial effect. Among some of its major compounds, (\pm)-linalool and α -terpineol had the highest antimicrobial effect [33].

Essential oil from leaf and gum of *P. atlantica* showed acceptable antibacterial and antifungal activities [90–92]. However, leaf ethanolic extract had no distinct antimicrobial activity [88].

A remarkable inhibitory activity of different extracts and essential oil from *P. lentiscus* leaves was observed against *Salmonella typhimurium*; additionally, essential oil showed significant inhibitory effects against *S. enteritidis* and *Staphylococcus aureus* [86, 87].

As reported by Adams et al. [55], the leaves and twigs of *P. atlantica* and its active substance 3-methoxycarpachromene showed antiprotozoal activity against *Plasmodium falciparum*. *P. atlantica* var. *kurdica* gum controlled cutaneous leishmaniasis in mice infected with *Leishmania major* [93]. Extract from *P. vera* branch had significant inhibitory activity against *Leishmania donovani* and leaf extract inhibited *Plasmodium falciparum* without cytotoxicity on mammalian cells [94].

4.4. Anti-Inflammatory and Antinociceptive Activity. Anti-inflammatory and antinociceptive activity of five mentioned *Pistacia* species have been shown in Table 3.

P. terebinthus gall showed anti-inflammatory activity in different in vivo models of acute and chronic inflammation [95]. Masticadienonic acid (26), masticadienolic acid (27), and morolic acid (28), three triterpene isolated from *P. terebinthus* gall, seem to be responsible for its anti-inflammatory activity [43]. Additionally, oleanonic acid (29) from the galls of *P. terebinthus*, reduced the production of leukotriene B4 from rat peritoneal leukocytes and showed antiedematous activity in mice [96]. Oleoresin and leaf extract from *P. vera* showed significant anti-inflammatory and antinociceptive activity [97].

Extract of the resin of *P. lentiscus* var. *Chia* and its isolated phytosterol tirucallol (31) showed anti-inflammatory activity on human aortic endothelial cells and had significant inhibitory activity on adhesion molecules expression in TNF- α -stimulated human aortic endothelial cells [98]. It was proposed that the anti-inflammatory effect of *P. lentiscus* var. *chia* gum may be related to inhibition of protein kinase C which leads to decrease in superoxide and H₂O₂ production by NADPH oxidase [99].

4.5. Effects on Gastrointestinal Disorders. One of the most important traditional uses of gums from *Pistacia* species is for management of gastrointestinal disorders. Moreover, there are several scientific studies that confirm this property [100–102]. Resin of *P. lentiscus* significantly reduced the intensity of gastric mucosal damage induced by pyloric ligation, aspirin, phenylbutazone, reserpine, and restraint with cold stress via its antisecretory and cytoprotective activities [103]. In one double-blind placebo controlled trial, *P. lentiscus* gum improved the feeling of symptoms significantly in patients with functional dyspepsia [104]. Moreover, *Pistacia* species exerted significant antibacterial activity on *Helicobacter pylori*

[15, 33]. Supplementation with *P. lentiscus* oil in experimental model of colitis delayed the onset and progression of acute colitis and led to decrease weight loss caused by the disease [105]. A polyherbal formula that contains *P. lentiscus* gum caused significant decrease in colonic damage and biochemical markers related to pathophysiology of IBS in rat model of colitis [106]. Administration of *P. lentiscus* var. *chia* resin to patients with established mild to moderate active crohn's disease (CD) for 4 weeks caused significant reduction in CD activity index and plasma inflammatory mediators without any side effects and also as an immunomodulator resulted in significantly reduction in tumor necrosis factor-alpha (TNF- α) and enhanced macrophage migration inhibitory factor in these patients [107, 108].

4.6. Antidiabetic Activity. Aqueous leaf extract from *P. atlantica* showed significant inhibitory effect on α -amylase and α -glucosidase in vitro [109, 110]. It demonstrated significant acute postprandial antihyperglycemic activity comparable to metformin and glipizide in starch-fed rats. It also improved glucose intolerance [110]. However, another study on this extract did not show significant hypoglycemic activity when tested in normoglycemic and streptozocin-induced hyperglycemic rats [109]. Administration of *P. lentiscus* var. *chia* gum to human subjects for 12 months caused significantly decrease in serum glucose level among male subjects. Serum glucose in women was not affected [111].

4.7. Antitumor Activity. Among mentioned species of *Pistacia*, *P. lentiscus* is the most investigated for antitumor activity (Table 3). *P. lentiscus* var. *chia* gum inhibited proliferation and induced apoptosis of human colorectal tumor cells in vitro [112]. The resin exerted the most cytotoxic effect against promyelocytic leukemia among 13 human cell types and also inhibited the natural apoptosis of oral polymorphonuclear leukocytes [76]. The gum demonstrated anticancer activity via delaying the growth of colorectal tumors developed from human colon cancer cells xenografted into mice [8]. It also increased maspin (a mammary serine protease inhibitor with tumor suppressive activity for prostate cancers) expression in responsive prostate cancer cells and inhibited cell proliferation and blocked the cell cycle progression [113, 114]. Essential oil of *P. lentiscus* demonstrated significant inhibition on tumor growth in immunocompetent mice without signs of toxicity, related to apoptosis induction, reduced neovascularization, and inhibiting chemokine expression [115]. In addition, it had antiproliferative and proapoptotic effect on human leukemia cells and inhibited the release of vascular endothelial growth factor from these cells [116]. Despite many reports on antitumor activities of *P. lentiscus*, one in vivo study showed that the high dose of *P. lentiscus* gum promoted the preneoplastic lesions development in rat liver with increasing liver relative weight which proposed that desirable anticarcinogenic effects of mastic could be obtained at relatively low doses [117]. In one recent study, the current data on the anticancer activities of gum, oil, and extracts of *P. lentiscus* L. and its major constituent, have

been reviewed comprehensively with special attention to the probable anticancer mechanisms [118].

The fruit extract of *P. atlantica* sub. *kurdica* showed growth inhibition in human colon carcinoma cells similar to Doxorubicin [119]. *P. vera* oleoresin demonstrated moderate cytotoxic effect against breast cancer cell line, hepatocellular carcinoma cell line, cervix cancer cell line, and normal melanocytes [120].

4.8. Effects on Liver and Serum Biochemical Parameters. *P. lentiscus* leaf demonstrated significant hepatoprotective activity against carbon tetrachloride induced hepatotoxicity in rats by reducing the level of bilirubin and activity of liver enzymes [121]. However, another study reported hepatic fibrosis, mild cholestasis, and depletion of reduced glutathione by long-term administration of aqueous leaf extract in healthy rats [122]. Administration of *P. lentiscus* var. *chia* gum for 18 months in healthy volunteers caused reduction in liver enzymes and exerted hypolipidemic effect [111]. Extracts from *P. vera* fruits have shown beneficial effects on HDL and LDL level in rabbit model of atherosclerosis [123]. Positive changes in lipid profile were recorded after three-week use of *P. vera* nuts in patients with moderate hypercholesterolemia. The decrease in triglyceride and LDL levels was not significant [124]. *P. terebinthus* fruit demonstrated hypolipidemic effect in hypercholesterolemic rabbits [125].

4.9. Effects on Atherosclerosis. More over than the antihyperlipidemic activity that described above, *Pistacia* species exerts their antiatherosclerotic effects by direct activity on atherosclerotic lesions moreover than their antihyperlipidemic activity. Both methanolic and cyclohexane extracts from *P. vera* fruits have shown beneficial effects on HDL, LDL, and aortic intimal thickness in rabbit model of atherosclerosis. The methanolic extract additionally showed an antioxidant activity and remarkable decrease in aortic surface lesions [123]. *P. terebinthus* fruits inhibited the development of the atherosclerotic lesions in the thoracic artery [125]. *P. lentiscus* resin that downregulated CD36 mRNA expression (as the oxLDL receptor in macrophages that play a pivotal role in atherosclerotic foam cell formation) resulted in antiatherogenic effects [126].

4.10. Anticholinesterase Activity. Aqueous extracts from *P. atlantica* and *P. lentiscus* leaves showed strong acetylcholinesterase (AChE) inhibition [13]; additionally, both the methanol and ethyl acetate extracts of *P. atlantica* leaf showed relatively weak AchE inhibitory activity [127]. However, one study showed that ethyl acetate and methanol extracts of various commercially terebinth coffee brands (an oily brown-coloured powder produced from the dried and roasted fruits of *P. terebinthus*) and the unprocessed fruits of *P. terebinthus* did not have inhibitory activity against AChE and tyrosinase, while they selectively inhibited butyrylcholinesterase (BChE) at moderate levels [85].

5. Conclusion

In traditional Iranian medicine textbooks and papers, five species of *Pistacia* genus including *P. vera*, *P. lentiscus*, *P. terebinthus*, *P. atlantica*, and *P. khinjuk* had been introduced for treating the wide range of ailments. These species until now have been utilized in Iran by people for different nutritional and medicinal proposes. This review considered findings about phytochemical and pharmacological properties of these five species and presents comprehensive analysis of papers published since the year 2000. Ethnopharmacological data about these species may help us to know that many pharmacological aspects proposed nowadays for these species have been derived from traditional uses like antiseptic and antimicrobial, anti-inflammatory and antinociceptive, antihepatotoxic, and anticancer activities and their beneficial effects in gastrointestinal disorders. Furthermore, there are several pharmacological activities discussed in traditional medicine such as diuretic, lithontripic, antitussive, antirheumatic, antiasthmatic, antihypertensive, and aphrodisiac activities which are not supported by any current scientific documents, and so, they could be considered for investigation by researchers.

Phytochemical studies provided evidence for traditional applications of these species. With respect to phytochemical assays, triterpenes found in the resin and monoterpenes are the most abundant composition of the essential oil from different parts of these species. Essential oil constituents might be valuable chemotaxonomic marker to ascertain different *Pistacia* chemotypes. Considering the therapeutic effect of isolated components, it can be concluded that terpenoids including mono, di-, and triterpenoids are associated with anti-inflammatory and antimicrobial effects. High amount of natural phenols and flavonoids is related to potent antioxidant and anticancer activities.

Review on current researches about the genus *Pistacia* L. highlighting pharmacological studies on crude plant parts, extracts, and some pure metabolites has provided scientific evidence for traditional uses and has revealed this genus to be a valuable source for medicinally important molecules.

So many studies were carried out on antioxidant activity of this genus considering their flavonoids, anthocyanins, and other phenolic compounds as preventive factors against cancer and cardiovascular diseases. *P. lentiscus* is the most studied species for antioxidant effects followed by *P. atlantica*, *P. vera*, *P. terebinthus* and *P. khinjuk*.

Most of the studies showed antimicrobial activity of these species especially *P. lentiscus* on a wide range of microorganisms including Gram-positive and -negative, aerobic and anaerobic bacteria, viruses and fungi. The findings indicated that α -pinene, verbenone, R-terpineol, linalool, carvacrol and flavones are major compounds related to antibacterial activity.

Abbreviations

- ABTS: 2,2'-Azino-bis(3-ethylbenzothiazoline-6-sulphonic acid)
- ALP: Alkaline phosphatase
- ALT: Alanine aminotransferase

AST:	Aspartate aminotransferase
B(a)p:	Benzo(a)pyrene
BHA:	Butylated hydroxyanisole
BHT:	Butylated hydroxytoluene
DMPD:	N,N-dimethyl-p-phenylenediamine
DPPH:	2,2-Diphenyl-1-picrylhydrazyl
EC50:	Half maximal effective concentration
EDTA:	Ethylenediaminetetraacetic acid
EPP:	Ethyl phenylpropionate
FRAP:	Ferric reducing antioxidant power
Gamma-GT:	Gamma-glytamyl transpeptidase
IC50:	The half maximal inhibitory concentration
LOX:	Lipoxygenase
MBC:	Minimum Bactericidal Concentration
MDA:	Malonaldehyde
MIC:	Minimum inhibitory Concentration
NF-kB:	Nuclear factor kappa-light-chain-enhancer of activated B cells
OxLDL:	Oxidized low density lipoprotein
PLA2:	Phospholipase A2
SGOT:	Serum glutamic oxaloacetic transaminase
SGPT:	Serum glutamic-pyruvic transaminase
SOD:	Superoxide dismutase
TBARS:	Thiobarbituric acid active substances
TBHQ:	Tertiary Butyl hydroquinone
TPA:	12-O-Tetradecanoylphorbol-13-acetate.

Conflict of Interests

The authors declare that they have no conflict of interests.

References

- [1] V. Mozaffarian, *Trees and Shrubs of Iran*, Farhang Moaser, Tehran, Iran, 1st edition, 2005.
- [2] C. Kole, *Wild Crop Relatives: Genomic and Breeding Resources Legume Crops and Forages*, Springer, Heidelberg, Germany, 2011.
- [3] V. Mozaffarian, *A Dictionary of Iranian Plant Names*, Farhang Moaser, Tehran, Iran, 1998.
- [4] A. derMarderosian and J. A. Beutler, *The Review of Natural Products*, Wolters Kluwer Health, Missouri, Mo, USA, 6th edition, 2010.
- [5] G. Durmaz and V. Gökmen, "Changes in oxidative stability, antioxidant capacity and phytochemical composition of *Pistacia terebinthus* oil with roasting," *Food Chemistry*, vol. 128, no. 2, pp. 410–414, 2011.
- [6] F. Gogus, M. Z. Ozel, D. Kocak, J. F. Hamilton, and A. C. Lewis, "Analysis of roasted and unroasted *Pistacia terebinthus* volatiles using direct thermal desorption-GCxGC-TOF/MS," *Food Chemistry*, vol. 129, no. 3, pp. 1258–1264, 2011.
- [7] L. Longo, A. Scardino, and G. Vasapollo, "Identification and quantification of anthocyanins in the berries of *Pistacia lentiscus* L., *Phillyrea latifolia* L. and *Rubia peregrina* L." *Innovative Food Science and Emerging Technologies*, vol. 8, no. 3, pp. 360–364, 2007.
- [8] K. Dimas, S. Hatziantoniou, J. H. Wyche, and P. Pantazis, "A mastic gum extract induces suppression of growth of human colorectal tumor xenografts in immunodeficient mice," *In Vivo*, vol. 23, no. 1, pp. 63–68, 2009.

- [9] Avicenna, *The Canon*, Soroush Press, Tehran, Iran, 2008, Translated by: A. Shrafkandi.
- [10] M. Kashaninejad, A. Mortazavi, A. Safekordi, and L. G. Tabil, "Some physical properties of Pistachio (*Pistacia vera L.*) nut and its kernel," *Journal of Food Engineering*, vol. 72, no. 1, pp. 30–38, 2006.
- [11] M. H. Aghili, *Makhzan-al-Advia*, Tehran University of Medical Sciences, Tehran, Iran, 2009, Edited by R. Rahimi, M.R. Shams Ardekani and F. Farjadmand.
- [12] M. H. Alma, S. Nitz, H. Kollmannsberger, M. Digrak, F. T. Efe, and N. Yilmaz, "Chemical composition and antimicrobial activity of the essential oils from the gum of Turkish Pistachio (*Pistacia vera L.*)," *Journal of Agricultural and Food Chemistry*, vol. 52, no. 12, pp. 3911–3914, 2004.
- [13] H. Benamar, W. Rached, A. Derdour, and A. Marouf, "Screening of Algerian medicinal plants for acetylcholinesterase inhibitory activity," *Journal of Biological Sciences*, vol. 10, no. 1, pp. 1–9, 2010.
- [14] A. Tsokou, K. Georgopoulou, E. Melissiou, P. Magiatis, and E. Tsitsa, "Composition and enantiomeric analysis of the essential oil of the fruits and the leaves of *Pistacia vera* from Greece," *Molecules*, vol. 12, no. 6, pp. 1233–1239, 2007.
- [15] M. Ramezani, M. Khaje-Karamoddin, and V. Karimi-Fard, "Chemical composition and anti-Helicobacter pylori activity of the essential oil of *Pistacia vera*," *Pharmaceutical Biology*, vol. 42, no. 7, pp. 488–490, 2004.
- [16] M. Özcan, O. Tzakou, and M. Couladis, "Essential oil composition of the turpentine tree (*Pistacia terebinthus L.*) fruits growing wild in Turkey," *Food Chemistry*, vol. 114, no. 1, pp. 282–285, 2009.
- [17] M. Usai, G. Pintore, M. Chessa, and B. Tirrellini, "Essential oil composition of different aerial parts of *Pistacia terebinthus L.* growing wild in Sardinia," *Journal of Essential Oil Research*, vol. 18, no. 4, pp. 383–385, 2006.
- [18] G. Flamini, A. Bader, P. L. Cioni, A. Katbeh-Bader, and I. Morelli, "Composition of the essential oil of leaves, galls, and ripe and unripe fruits of Jordanian *Pistacia palaestina* Boiss," *Journal of Agricultural and Food Chemistry*, vol. 52, no. 3, pp. 572–576, 2004.
- [19] C. Koutsoudaki, M. Krsek, and A. Rodger, "Chemical composition and antibacterial activity of the essential oil and the gum of *Pistacia lentiscus var. chia*," *Journal of Agricultural and Food Chemistry*, vol. 53, no. 20, pp. 7681–7685, 2005.
- [20] S. Mecherara-Idjeri, A. Hassani, V. Castola, and J. Casanova, "Composition and chemical variability of the essential oil from *Pistacia lentiscus L.* growing wild in Algeria part I: leaf oil," *Journal of Essential Oil Research*, vol. 20, no. 2, pp. 32–38, 2008.
- [21] S. Mecherara-Idjeri, A. Hassani, V. Castola, and J. Casanova, "Composition and chemical variability of the essential oil from *Pistacia lentiscus L.* growing wild in Algeria: part II: fruit oil," *Journal of Essential Oil Research*, vol. 20, no. 2, pp. 104–107, 2008.
- [22] S. Zirra, A. Elamrani, and B. Benjilali, "Chemical composition of the essential oil of *Pistacia lentiscus L.* from Morocco—a seasonal variation," *Flavour and Fragrance Journal*, vol. 18, no. 6, pp. 475–480, 2003.
- [23] C. Gardeli, P. Vassiliki, M. Athanasios, T. Kibouris, and M. Komaitis, "Essential oil composition of *Pistacia lentiscus L.* and *Myrtus communis L.*: evaluation of antioxidant capacity of methanolic extracts," *Food Chemistry*, vol. 107, no. 3, pp. 1120–1130, 2008.
- [24] A. Fernández, A. Camacho, C. Fernández, and J. Altarejos, "Composition of the essential oils from galls and aerial parts of *Pistacia lentiscus L.*," *Journal of Essential Oil Research*, vol. 12, no. 1, pp. 19–23, 2000.
- [25] S. Mecherara-Idjeri, A. Hassani, V. Castola, and J. Casanova, "Composition of leaf, fruit and gall essential oils of algerian *Pistacia atlantica* desf," *Journal of Essential Oil Research*, vol. 20, no. 3, pp. 215–219, 2008.
- [26] A. Delazar, R. G. Reid, and S. D. Sarker, "GC-MS analysis of the essential oil from the oleoresin of *Pistacia atlantica var. mutica*," *Chemistry of Natural Compounds*, vol. 40, no. 1, pp. 24–27, 2004.
- [27] A. F. Barrero, M. M. Herrador, J. R. Arteaga et al., "Chemical composition of the essential oils of *Pistacia atlantica Desf*," *Journal of Essential Oil Research*, vol. 17, no. 1, pp. 52–54, 2005.
- [28] J. N. Roitman, G. B. Merrill, and J. J. Beck, "Survey of ex situ fruit and leaf volatiles from several *Pistacia* cultivars grown in California," *Journal of the Science of Food and Agriculture*, vol. 91, no. 5, pp. 934–942, 2011.
- [29] M. Couladis, M. Özcan, O. Tzakou, and A. Akgül, "Comparative essential oil composition of various parts of the turpentine tree (*Pistacia terebinthus L.*) growing wild in Turkey," *Journal of the Science of Food and Agriculture*, vol. 83, no. 2, pp. 136–138, 2003.
- [30] M. E. Duru, A. Cakir, S. Kordali et al., "Chemical composition and antifungal properties of essential oils of three *Pistacia* species," *Fitoterapia*, vol. 74, no. 1-2, pp. 170–176, 2003.
- [31] O. Tzakou, I. Bazos, and A. Yannitsaros, "Volatile metabolites of *Pistacia atlantica* Desf. from Greece," *Flavour and Fragrance Journal*, vol. 22, no. 5, pp. 358–362, 2007.
- [32] N. Gourine, M. Yousfi, I. Bombarda, B. Nadjem, P. Stocker, and E. M. Gaydou, "Antioxidant activities and chemical composition of essential oil of *Pistacia atlantica* from Algeria," *Industrial Crops and Products*, vol. 31, no. 2, pp. 203–208, 2010.
- [33] S. Paraschos, P. Magiatis, P. Gousia et al., "Chemical investigation and antimicrobial properties of mastic water and its major constituents," *Food Chemistry*, vol. 129, no. 3, pp. 907–911, 2011.
- [34] R. Congiu, D. Falconieri, B. Marongiu, A. Piras, and S. Porcedda, "Extraction and isolation of *Pistacia lentiscus L.* essential oil by supercritical CO₂," *Flavour and Fragrance Journal*, vol. 17, no. 4, pp. 239–244, 2002.
- [35] E.-H. Benyoussef, S. Charchari, N. Nacer-Bey, N. Nabila-Yahiaoui, A. Chakou, and M. Bellatreche, "The essential oil of *Pistacia lentiscus L.* from Algeria," *Journal of Essential Oil Research*, vol. 17, no. 6, pp. 642–644, 2005.
- [36] V. Castola, A. Bighelli, and J. Casanova, "Intraspecific chemical variability of the essential oil of *Pistacia lentiscus L.* from Corsica," *Biochemical Systematics and Ecology*, vol. 28, no. 1, pp. 79–88, 2000.
- [37] S. Ait Said, C. Fernandez, S. Greff, A. Derridj, T. Gauquelin, and J.-P. Mevy, "Inter-population variability of leaf morpho-anatomical and terpenoid patterns of *Pistacia atlantica* Desf. ssp. *atlantica* growing along an aridity gradient in Algeria," *Flora*, vol. 206, no. 4, pp. 397–405, 2011.
- [38] M. Taran, M. Sharifi, E. Azizi, and M. Khanahmadi, "Antimicrobial activity of the leaves of *Pistacia khinjuk*," *Journal of Medicinal Plants*, vol. 9, no. 6, pp. 81–85, 2010.
- [39] T. Dob, D. Dahmane, and C. Chelghoum, "Chemical composition of the essential oils of *Pistacia lentiscus L.* from Algeria," *Journal of Essential Oil Research*, vol. 18, no. 3, pp. 335–338, 2006.
- [40] A. N. Assimopoulou and V. P. Papageorgiou, "GC-MS analysis of penta- and tetra-cyclic triterpenes from resins of *Pistacia* species. Part I. *Pistacia lentiscus var. Chia*," *Biomedical Chromatography*, vol. 19, no. 4, pp. 285–311, 2005.

- [41] A. N. Assimopoulou and V. P. Papageorgiou, "GC-MS analysis of penta- and tetra-cyclic triterpenes from resins of *Pistacia* species. Part II. *Pistacia terebinthus var. Chia*," *Biomedical Chromatography*, vol. 19, no. 8, pp. 586–605, 2005.
- [42] M. S. Sharifi and S. L. Hazell, "Isolation, analysis and antimicrobial activity of the acidic fractions of mastic, Kurdica, Mutica and Cabolica gums from Genus *Pistacia*," *Global Journal of Health Science*, vol. 4, no. 1, pp. 217–228, 2012.
- [43] E. M. Giner-Larza, S. Máñez, R. M. Giner et al., "Anti-inflammatory triterpenes from *Pistacia terebinthus* galls," *Planta Medica*, vol. 68, no. 4, pp. 311–315, 2002.
- [44] A. Tomaino, M. Martorana, T. Arcoraci, D. Monteleone, C. Giovinazzo, and A. Saija, "Antioxidant activity and phenolic profile of pistachio (*Pistacia vera L.*, variety Bronte) seeds and skins," *Biochimie*, vol. 92, no. 9, pp. 1115–1122, 2010.
- [45] A. Romani, P. Pinelli, C. Galardi, N. Mulinacci, and M. Tattini, "Identification and quantification of galloyl derivatives, flavonoid glycosides and anthocyanins in leaves of *Pistacia lentiscus L.*," *Phytochemical Analysis*, vol. 13, no. 2, pp. 79–86, 2002.
- [46] M. Yousfi, A. Djerdane, I. Bombarda, C.-H. Chahrazed-Hamia, B. Duhem, and E. M. Gaydou, "Isolation and characterization of a new hispolone derivative from antioxidant extracts of *Pistacia atlantica*," *Phytotherapy Research*, vol. 23, no. 9, pp. 1237–1242, 2009.
- [47] W. Bhouri, S. Derbel, I. Skandiani et al., "Study of genotoxic, antigenotoxic and antioxidant activities of the digallic acid isolated from *Pistacia lentiscus* fruits," *Toxicology in Vitro*, vol. 24, no. 2, pp. 509–515, 2010.
- [48] M. Saitta, D. Giuffrida, G. L. La Torre, A. G. Potorti, and G. Dugo, "Characterisation of alkylphenols in pistachio (*Pistacia vera L.*) kernels," *Food Chemistry*, vol. 117, no. 3, pp. 451–455, 2009.
- [49] Ö. Tokuşoğlu, M. K. Ünal, and F. Yemiş, "Determination of the phytoalexin resveratrol (3,5,4'-Trihydroxystilbene) in peanuts and pistachios by High-Performance Liquid Chromatographic Diode Array (HPLC-DAD) and Gas Chromatography-Mass Spectrometry (GC-MS)," *Journal of Agricultural and Food Chemistry*, vol. 53, no. 12, pp. 5003–5009, 2005.
- [50] F. Grippi, L. Crosta, G. Aiello et al., "Determination of stilbenes in Sicilian pistachio by high-performance liquid chromatographic diode array (HPLC-DAD/FLD) and evaluation of eventually mycotoxin contamination," *Food Chemistry*, vol. 107, no. 1, pp. 483–488, 2008.
- [51] G. Ballistreri, E. Arena, and B. Fallico, "Influence of ripeness and drying process on the polyphenols and tocopherols of *Pistacia vera L.*," *Molecules*, vol. 14, no. 11, pp. 4358–4369, 2009.
- [52] A. Abdelwahed, I. Bouhlel, I. Skandiani et al., "Study of antimutagenic and antioxidant activities of Gallic acid and 1,2,3,4,6-pentagalloylgucose from *Pistacia lentiscus*. Confirmation by microarray expression profiling," *Chemico-Biological Interactions*, vol. 165, no. 1, pp. 1–13, 2007.
- [53] G. Topcu, M. Ay, A. Bilici, C. Sarıkürkcü, M. Öztürk, and A. Ulubelen, "A new flavone from antioxidant extracts of *Pistacia terebinthus*," *Food Chemistry*, vol. 103, no. 3, pp. 816–822, 2007.
- [54] S. A. Kawashty, S. A. M. Mosharrafa, M. El-Gibali, and N. A. M. Saleh, "The flavonoids of four *Pistacia* species in Egypt," *Biochemical Systematics and Ecology*, vol. 28, no. 9, pp. 915–917, 2000.
- [55] M. Adams, I. Plitzko, M. Kaiser, R. Brun, and M. Hamburger, "HPLC-profiling for antiplasmoidal compounds-3-Methoxycarpachromene from *Pistacia atlantica*," *Phytochemistry Letters*, vol. 2, no. 4, pp. 159–162, 2009.
- [56] M. G. Bellomo and B. Fallico, "Anthocyanins, chlorophylls and xanthophylls in pistachio nuts (*Pistacia vera*) of different geographic origin," *Journal of Food Composition and Analysis*, vol. 20, no. 3, pp. 352–359, 2007.
- [57] X. Wu and R. L. Prior, "Identification and characterization of anthocyanins by high-performance liquid chromatography-electrospray ionization-tandem mass spectrometry in common foods in the United States: vegetables, nuts, and grains," *Journal of Agricultural and Food Chemistry*, vol. 53, no. 8, pp. 3101–3113, 2005.
- [58] F. Satil, N. Azcan, and K. H. C. Baser, "Fatty acid composition of pistachio nuts in Turkey," *Chemistry of Natural Compounds*, vol. 39, no. 4, pp. 322–324, 2003.
- [59] E. Arena, S. Campisi, B. Fallico, and E. Maccarone, "Distribution of fatty acids and phytosterols as a criterion to discriminate geographic origin of pistachio seeds," *Food Chemistry*, vol. 104, no. 1, pp. 403–408, 2007.
- [60] H. Trabelsi, O. A. Cherif, F. Sakouhi et al., "Total lipid content, fatty acids and 4-desmethylsterols accumulation in developing fruit of *Pistacia lentiscus L.* growing wild in Tunisia," *Food Chemistry*, vol. 131, no. 2, pp. 434–440, 2012.
- [61] M. Charef, M. Yousfi, M. Saidi, and P. Stocker, "Determination of the fatty acid composition of Acorn (*Quercus*), *Pistacia lentiscus* seeds growing in algeria," *Journal of the American Oil Chemists' Society*, vol. 85, no. 10, pp. 921–924, 2008.
- [62] M. Özcan, "Characteristics of fruit and oil of terebinth (*Pistacia terebinthus L.*) growing wild in Turkey," *Journal of the Science of Food and Agriculture*, vol. 84, no. 6, pp. 517–520, 2004.
- [63] M. Yousfi, B. Nedjmi, R. Bellal, D. Ben Bertal, and G. Palla, "Fatty acids and sterols of *Pistacia atlantica* fruit oil," *Journal of the American Oil Chemists' Society*, vol. 79, no. 10, pp. 1049–1050, 2002.
- [64] K. M. Phillips, D. M. Ruggio, and M. Ashraf-Khorassani, "Phytosterol composition of nuts and seeds commonly consumed in the United States," *Journal of Agricultural and Food Chemistry*, vol. 53, no. 24, pp. 9436–9445, 2005.
- [65] M. Aslan, I. Orhan, and B. Şener, "Comparison of the seed oils of *Pistacia vera L.* of different origins with respect to fatty acids," *International Journal of Food Science and Technology*, vol. 37, no. 3, pp. 333–335, 2002.
- [66] R. Farhoosh, J. Tavakoli, and M. H. H. Khodaparast, "Chemical composition and oxidative stability of kernel oils from two current subspecies of *Pistacia atlantica* in Iran," *Journal of the American Oil Chemists' Society*, vol. 85, no. 8, pp. 723–729, 2008.
- [67] H. Benhassaini, M. Bendahmane, and N. Benchalgo, "The chemical composition of fruits of *Pistacia atlantica* desf. subsp. *atlantica* from Algeria," *Chemistry of Natural Compounds*, vol. 43, no. 2, pp. 121–124, 2007.
- [68] S. Kizil and M. Turk, "Microelement contents and fatty acid compositions of *Rhus coriaria L.* and *Pistacia terebinthus L.* fruits spread commonly in the South Eastern Anatolia region of Turkey," *Natural Product Research*, vol. 24, no. 1, pp. 92–98, 2010.
- [69] P. Sharayei, R. Farhoosh, H. Poorazrang, and M. H. H. Khodaparast, "Improvement of canola oil frying stability by bene kernel oil's unsaponifiable matter," *Journal of the American Oil Chemists' Society*, vol. 88, no. 7, pp. 993–1000, 2011.
- [70] B. Matthäus and M. M. Özcan, "Quantitation of fatty acids, sterols, and tocopherols in turpentine (*Pistacia terebinthus Chia*) growing wild in Turkey," *Journal of Agricultural and Food Chemistry*, vol. 54, no. 20, pp. 7667–7671, 2006.

- [71] D. Giuffrida, M. Saitta, L. La Torre, L. Bombaci, and G. Dugo, "Carotenoid, chlorophyll and chlorophyll-derived compounds in pistachio kernels (*Pistacia vera L.*) from Sicily," *Italian Journal of Food Science*, vol. 18, no. 3, pp. 309–316, 2006.
- [72] B. Kivçak and S. Akay, "Quantitative determination of α -tocopherol in *Pistacia lentiscus*, *Pistacia lentiscus var. chia*, and *Pistacia terebinthus* by TLC-densitometry and colorimetry," *Fitoterapia*, vol. 76, no. 1, pp. 62–66, 2005.
- [73] R. Farhoosh and M. H. T. Kafrani, "Frying performance of the hull oil unsaponifiable matter of *Pistacia atlantica* subsp. *mutica*," *European Journal of Lipid Science and Technology*, vol. 112, no. 3, pp. 343–348, 2010.
- [74] A. Barra, V. Coroneo, S. Dessi, P. Cabras, and A. Angioni, "Characterization of the volatile constituents in the essential oil of *Pistacia lentiscus L.* from different origins and its antifungal and antioxidant activity," *Journal of Agricultural and Food Chemistry*, vol. 55, no. 17, pp. 7093–7098, 2007.
- [75] D. Atmani, N. Chaher, M. Berboucha et al., "Antioxidant capacity and phenol content of selected Algerian medicinal plants," *Food Chemistry*, vol. 112, no. 2, pp. 303–309, 2009.
- [76] H. Sakagami, K. Kishino, M. Kobayashi et al., "Selective antibacterial and apoptosis-modulating activities of mastic," *In Vivo*, vol. 23, no. 2, pp. 215–224, 2009.
- [77] N. K. Andrikopoulos, A. C. Kaliora, A. N. Assimopoulou, and V. P. Papageorgiou, "Biological activity of some naturally occurring resins, gums and pigments against in vitro LDL oxidation," *Phytotherapy Research*, vol. 17, no. 5, pp. 501–507, 2003.
- [78] A. Peksel, "Antioxidative properties of decoction of *Pistacia atlantica* Desf. leaves," *Asian Journal of Chemistry*, vol. 20, no. 1, pp. 681–693, 2008.
- [79] R. Farhoosh, M. H. H. Khodaparast, and A. Sharif, "Bene hull oil as a highly stable and antioxidative vegetable oil," *European Journal of Lipid Science and Technology*, vol. 111, no. 12, pp. 1259–1265, 2009.
- [80] R. Farhoosh, M. H. Tavassoli-Kafrani, and A. Sharif, "Antioxidant activity of the fractions separated from the unsaponifiable matter of bene hull oil," *Food Chemistry*, vol. 126, no. 2, pp. 583–589, 2011.
- [81] A. H. Goli, M. Barzegar, and M. A. Sahari, "Antioxidant activity and total phenolic compounds of pistachio (*Pistacia vera*) hull extracts," *Food Chemistry*, vol. 92, no. 3, pp. 521–525, 2005.
- [82] C. Gentile, L. Tesoriere, D. Butera et al., "Antioxidant activity of Sicilian pistachio (*Pistacia vera L. var. Bronte*) nut extract and its bioactive components," *Journal of Agricultural and Food Chemistry*, vol. 55, no. 3, pp. 643–648, 2007.
- [83] H. Hosseinzadeha, S. Abolghasem, S. Tabassib, N. M. Moghadamc, M. Rashediniac, and S. Mehri, "Antioxidant activity of *Pistacia vera* fruits, leaves and gum extracts," *Iranian Journal of Pharmaceutical Research*, vol. 11, no. 3, pp. 879–887, 2012.
- [84] D. D. Kavak, E. Altıok, O. Bayraktar, and S. Ülkü, "*Pistacia terebinthus* extract: as a potential antioxidant, antimicrobial and possible β -glucuronidase inhibitor," *Journal of Molecular Catalysis B*, vol. 64, no. 3–4, pp. 167–171, 2010.
- [85] I. E. Orhan, F. S. Senol, A. R. Gulpinar, N. Sekeroglu, M. Kartal, and B. Sener, "Neuroprotective potential of some terebinth coffee brands and the unprocessed fruits of *Pistacia terebinthus L.* and their fatty and essential oil analyses," *Food Chemistry*, vol. 130, no. 4, pp. 882–888, 2012.
- [86] F. B. Douissa, N. Hayder, L. Chekir-Ghedia et al., "New study of the essential oil from leaves of *Pistacia lentiscus L.* (Anacardiaceae) from Tunisia," *Flavour and Fragrance Journal*, vol. 20, no. 4, pp. 410–414, 2005.
- [87] N. Hayder, R. B. Ammar, A. Abdelwahed et al., "Antibacterial and antimutagenic activity of extracts and essential oil from (Tunisian) *Pistacia lentiscus*," *Toxicological & Environmental Chemistry*, vol. 87, no. 4, pp. 567–573, 2005.
- [88] N. Benhammou, B. FA, and T. K. Panovska, "Antioxidant and antimicrobial activities of the *Pistacia lentiscus* and *Pistacia atlantica* extracts," *African Journal of Pharmacy and Pharmacology*, vol. 2, no. 2, pp. 22–28, 2008.
- [89] B. Özçelik, M. Aslan, I. Orhan, and T. Karaoglu, "Antibacterial, antifungal, and antiviral activities of the lipophilic extracts of *Pistacia vera*," *Microbiological Research*, vol. 160, no. 2, pp. 159–164, 2005.
- [90] B. R. Ghalem and B. Mohamed, "Essential oil from gum of *Pistacia atlantica* Desf.: screening of antimicrobial activity," *African Journal of Pharmacy and Pharmacology*, vol. 3, no. 1, pp. 13–15, 2009.
- [91] M. Tohidí, M. Khayami, V. Nejati, and H. Meftahizade, "Evaluation of antibacterial activity and wound healing of *Pistacia atlantica* and *Pistacia khinjuk*," *Journal of Medicinal Plants Research*, vol. 5, no. 17, pp. 4310–4314, 2011.
- [92] Y. Gerchman and M. Inbar, "Distinct antimicrobial activities in aphid galls on *Pistacia atlantica*," *Plant Signaling & Behavior*, vol. 6, no. 12, pp. 2008–2012, 2011.
- [93] M. Taran, M. Mohebali, and J. Esmaeli, "In vivo efficacy of gum obtained *Pistacia atlantica* in experimental treatment of cutaneous leishmaniasis," *Iranian Journal of Public Health*, vol. 39, no. 1, pp. 36–41, 2010.
- [94] I. Orhan, M. Aslan, B. Sener, M. Kaiser, and D. Tasdemir, "In vitro antiprotozoal activity of the lipophilic extracts of different parts of Turkish *Pistacia vera L.*," *Phytomedicine*, vol. 13, no. 9–10, pp. 735–739, 2006.
- [95] E. M. Giner-Larza, S. Máñez, R. M. Giner-Pons, M. Carmen Recio, and J. L. Ríos, "On the anti-inflammatory and anti-phospholipase A₂ activity of extracts from lanostane-rich species," *Journal of Ethnopharmacology*, vol. 73, no. 1–2, pp. 61–69, 2000.
- [96] E. M. Giner-Larza, S. Máñez, M. C. Recio et al., "Oleanonic acid, a 3-oxotriterpene from *Pistacia*, inhibits leukotriene synthesis and has anti-inflammatory activity," *European Journal of Pharmacology*, vol. 428, no. 1, pp. 137–143, 2001.
- [97] H. Hosseinzadeh, E. Behravan, and M. M. Soleimani, "Antinociceptive and anti-inflammatory effects of *Pistacia vera* leaf extract in mice," *Iranian Journal of Pharmaceutical Research*, vol. 10, no. 4, pp. 821–828, 2011.
- [98] S. Loizou, S. Paraschos, S. Mitakou, G. P. Chroulos, I. Lekakis, and P. Moutsatsou, "Chios mastic gum extract and isolated phytosterol tirucallol exhibit anti-inflammatory activity in human aortic endothelial cells," *Experimental Biology and Medicine*, vol. 234, no. 5, pp. 553–561, 2009.
- [99] A. Triantafyllou, A. Bikineyeva, A. Dikalova, R. Nazarewicz, S. Lerakis, and S. Dikalov, "Anti-inflammatory activity of Chios mastic gum is associated with inhibition of TNF-alpha induced oxidative stress," *Nutrition Journal*, vol. 10, no. 1, article 64, 2011.
- [100] R. Rahimi, M. R. Shams-Ardekani, and M. Abdollahi, "A review of the efficacy of traditional Iranian medicine for inflammatory bowel disease," *World Journal of Gastroenterology*, vol. 16, no. 36, pp. 4504–4514, 2010.
- [101] R. Rahimi, S. Mozaffari, and M. Abdollahi, "On the use of herbal medicines in management of inflammatory bowel diseases: a systematic review of animal and human studies," *Digestive Diseases and Sciences*, vol. 54, no. 3, pp. 471–480, 2009.

- [102] M. H. Farzaei, R. Rahimi, Z. Abbasabadi, and M. Abdollahi, "An evidence-based review on medicinal plants used for the treatment of peptic ulcer in traditional Iranian medicine," *International Journal of Pharmacology*, vol. 9, no. 2, pp. 108–124, 2013.
- [103] M. S. Al-Said, A. M. Ageel, N. S. Parmar, and M. Tariq, "Evaluation of mastic, a crude drug obtained from *Pistacia lentiscus* for gastric and duodenal anti-ulcer activity," *Journal of Ethnopharmacology*, vol. 15, no. 3, pp. 271–278, 1986.
- [104] K. J. Dabos, E. Sfika, L. J. Vlatta, D. Frantzi, G. I. Amygdalos, and G. Giannikopoulos, "Is Chios mastic gum effective in the treatment of functional dyspepsia? A prospective randomised double-blind placebo controlled trial," *Journal of Ethnopharmacology*, vol. 127, no. 2, pp. 205–209, 2010.
- [105] H.-J. Kim and C. Neophytou, "Natural anti-inflammatory compounds for the management and adjuvant therapy of inflammatory bowel disease and its drug delivery system," *Archives of Pharmacal Research*, vol. 32, no. 7, pp. 997–1004, 2009.
- [106] R. Rahimi, A. Baghaei, M. Baeeri et al., "Promising effect of Magliasa, a traditional Iranian formula, on experimental colitis on the basis of biochemical and cellular findings," *World Journal of Gastroenterology*, vol. 19, no. 12, pp. 1901–1911, 2013.
- [107] A. C. Kaliora, M. G. Stathopoulou, J. K. Triantafyllidis, G. V. Z. Dedousis, and N. K. Andrikopoulos, "Chios mastic treatment of patients with active Crohn's disease," *World Journal of Gastroenterology*, vol. 13, no. 5, pp. 748–753, 2007.
- [108] A. C. Kaliora, M. G. Stathopoulou, J. K. Triantafyllidis, G. V. Z. Dedousis, and N. K. Andrikopoulos, "Alterations in the function of circulating mononuclear cells derived from patients with Crohn's disease treated withmastic," *World Journal of Gastroenterology*, vol. 13, no. 45, pp. 6031–6036, 2007.
- [109] I. I. Hamdan and F. U. Afifi, "Studies on the in vitro and in vivo hypoglycemic activities of some medicinal plants used in treatment of diabetes in Jordanian traditional medicine," *Journal of Ethnopharmacology*, vol. 93, no. 1, pp. 117–121, 2004.
- [110] V. Kasabri, F. U. Afifi, and I. Hamdan, "In vitro and in vivo acute antihyperglycemic effects of five selected indigenous plants from Jordan used in traditional medicine," *Journal of Ethnopharmacology*, vol. 133, no. 2, pp. 888–896, 2011.
- [111] A. Triantafyllou, N. Chaviaras, T. N. Sergentanis, E. Protopapa, and J. Tsaknis, "Chios mastic gum modulates serum biochemical parameters in a human population," *Journal of Ethnopharmacology*, vol. 111, no. 1, pp. 43–49, 2007.
- [112] K. V. Balan, J. Prince, Z. Han et al., "Antiproliferative activity and induction of apoptosis in human colon cancer cells treated in vitro with constituents of a product derived from *Pistacia lentiscus L. var. chia*," *Phytomedicine*, vol. 14, no. 4, pp. 263–272, 2007.
- [113] M.-L. He, W.-W. Chen, P.-J. Zhang et al., "Gum mastic increases maspin expression in prostate cancer cells," *Acta Pharmacologica Sinica*, vol. 28, no. 4, pp. 567–572, 2007.
- [114] M.-L. He, A. Li, C.-S. Xu et al., "Mechanisms of antiprostate cancer by gum mastic: NF- κ B signal as target," *Acta Pharmacologica Sinica*, vol. 28, no. 3, pp. 446–452, 2007.
- [115] S. Magkouta, G. T. Stathopoulos, I. Psallidas et al., "Protective effects of mastic oil from *Pistacia lentiscus* variation chia against experimental growth of lewis lung carcinoma," *Nutrition and Cancer*, vol. 61, no. 5, pp. 640–648, 2009.
- [116] H. Loutrari, S. Magkouta, A. Pyriochou et al., "Mastic oil from *Pistacia lentiscus var. chia* inhibits growth and survival of human K562 leukemia cells and attenuates angiogenesis," *Nutrition and Cancer*, vol. 55, no. 1, pp. 86–93, 2006.
- [117] K. Doi, M. Wei, M. Kitano, N. Uematsu, M. Inoue, and H. Wanibuchi, "Enhancement of preneoplastic lesion yield by Chios Mastic Gum in a rat liver medium-term carcinogenesis bioassay," *Toxicology and Applied Pharmacology*, vol. 234, no. 1, pp. 135–142, 2009.
- [118] C. Giaginis and S. Theocharis, "Current evidence on the anti-cancer potential of chios mastic gum," *Nutrition and Cancer*, vol. 63, no. 8, pp. 1174–1184, 2011.
- [119] P. F. Rezaei, S. Fouladdel, S. Hassani et al., "Induction of apoptosis and cell cycle arrest by pericarp polyphenol-rich extract of Baneh in human colon carcinoma HT29 cells," *Food and Chemical Toxicology*, vol. 50, no. 3-4, pp. 1054–1059, 2012.
- [120] H. Almehdar, H. M. Abdallah, A.-M. M. Osman, and E. A. Abdel-Sattar, "In vitro cytotoxic screening of selected Saudi medicinal plants," *Journal of Natural Medicines*, vol. 66, no. 2, pp. 406–412, 2012.
- [121] S. Janakat and H. Al-Merie, "Evaluation of hepatoprotective effect of *Pistacia lentiscus*, *Phillyrea latifolia* and *Nicotiana glauca*," *Journal of Ethnopharmacology*, vol. 83, no. 1-2, pp. 135–138, 2002.
- [122] P. Ljubuncic, H. Song, U. Cogan, H. Azaizeh, and A. Bomzon, "The effects of aqueous extracts prepared from the leaves of *Pistacia lentiscus* in experimental liver disease," *Journal of Ethnopharmacology*, vol. 100, no. 1-2, pp. 198–204, 2005.
- [123] K. A. Marinou, K. Georgopoulou, G. Agrogiannis et al., "Differential effect of *Pistacia vera* extracts on experimental atherosclerosis in the rabbit animal model: an experimental study," *Lipids in Health and Disease*, vol. 9, no. 73, pp. 1–9, 2010.
- [124] K. Edwards, I. Kwaw, J. Matud, and I. Kurtz, "Effect of pistachio nuts on serum lipid levels in patients with moderate hypercholesterolemia," *Journal of the American College of Nutrition*, vol. 18, no. 3, pp. 229–232, 1999.
- [125] T. Bakirel, "The investigation of the effects of *Pistacia terebinthus L.* upon experimentally induced hypercholesterolemia and atherosclerosis in rabbits," *Turkish Journal of Veterinary and Animal Sciences*, vol. 27, pp. 1283–1292, 2003.
- [126] G. V. Z. Dedousis, A. C. Kaliora, S. Psarras et al., "Antiatherogenic effect of *Pistacia lentiscus* via GSH restoration and down-regulation of CD36 mRNA expression," *Atherosclerosis*, vol. 174, no. 2, pp. 293–303, 2004.
- [127] A. Peksel, I. Arisan-Atac, and R. Yanardag, "Evaluation of antioxidant and antiacetylcholinesterase activities of the extracts of *Pistacia lentiscus* Desf. leaves," *Journal of Food Biochemistry*, vol. 34, no. 3, pp. 451–476, 2010.
- [128] M. Wellmann, *Pedanii Dioscuridis Anazarbei, de Materia Medica Libri Quinque*, Weidmann, Berlin, Germany, 1907.
- [129] E. Hanlidou, R. Karousou, V. Kleftoyanni, and S. Kokkini, "The herbal market of Thessaloniki (N Greece) and its relation to the ethnobotanical tradition," *Journal of Ethnopharmacology*, vol. 91, no. 2-3, pp. 281–299, 2004.
- [130] E. Mati and H. de Boer, "Ethnobotany and trade of medicinal plants in the Qaysari Market, Kurdish Autonomous Region, Iraq," *Journal of Ethnopharmacology*, vol. 133, no. 2, pp. 490–510, 2011.
- [131] A. M. Scherrer, R. Motti, and C. S. Weckerle, "Traditional plant use in the areas of Monte Vesole and Ascea, Cilento National Park (Campania, Southern Italy)," *Journal of Ethnopharmacology*, vol. 97, no. 1, pp. 129–143, 2005.
- [132] M. T. Palmese, R. E. Uncini Manganelli, and P. E. Tomei, "An ethno-pharmacobotanical survey in the Sarrabus district (South-East Sardinia)," *Fitoterapia*, vol. 72, no. 6, pp. 619–643, 2001.

- [133] E. Lev and Z. Amar, "Ethnopharmacological survey of traditional drugs sold in the Kingdom of Jordan," *Journal of Ethnopharmacology*, vol. 82, no. 2-3, pp. 131–145, 2002.
- [134] J. El-Hilaly, M. Hmammouchi, and B. Lyoussi, "Ethnobotanical studies and economic evaluation of medicinal plants in Taounate province (Northern Morocco)," *Journal of Ethnopharmacology*, vol. 86, no. 2-3, pp. 149–158, 2003.
- [135] M. H. Novais, I. Santos, S. Mendes, and C. Pinto-Gomes, "Studies on pharmaceutical ethnobotany in Arrabida Natural Park (Portugal)," *Journal of Ethnopharmacology*, vol. 93, no. 2-3, pp. 183–195, 2004.
- [136] M. J. Sanz, M. C. Terencio, and M. Paya, "Isolation and hypotensive activity of a polymeric procyanidin fraction from *Pistacia lentiscus L.*," *Pharmazie*, vol. 47, no. 6, pp. 466–467, 1992.
- [137] M. Mosaddegh, F. Naghibi, H. Moazzeni, A. Pirani, and S. Esmaeili, "Ethnobotanical survey of herbal remedies traditionally used in Kohgiluyeh va Boyer Ahmad province of Iran," *Journal of Ethnopharmacology*, vol. 141, no. 1, pp. 80–95, 2012.
- [138] E. Altundag and M. Ozturk, "Ethnomedicinal studies on the plant resources of East Anatolia, Turkey," *Procedia-Social and Behavioral Sciences*, vol. 19, pp. 756–777, 2011.
- [139] J. Duke, *Medicinal Plants of the Bible*, Conch Publications, New York, NY, USA, 1983.
- [140] A. Mohaghghzadeh, P. Faridi, and Y. Ghasemi, "Analysis of Mount Atlas mastic smoke: a potential food preservative," *Fitoterapia*, vol. 81, no. 6, pp. 577–580, 2010.
- [141] A. Agelet and J. Vallès, "Studies on pharmaceutical ethnobotany in the region of Pallars (Pyrenees, Catalonia, Iberian Peninsula). Part II. New or very rare uses of previously known medicinal plants," *Journal of Ethnopharmacology*, vol. 84, no. 2-3, pp. 211–227, 2003.
- [142] G. Benítez, M. R. González-Tejero, and J. Molero-Mesa, "Pharmaceutical ethnobotany in the western part of Granada province (Southern Spain): ethnopharmacological synthesis," *Journal of Ethnopharmacology*, vol. 129, no. 1, pp. 87–105, 2010.
- [143] U. Cakilcioglu, S. Khatun, I. Turkoglu, and S. Hayta, "Ethnopharmacological survey of medicinal plants in Maden (Elazig-Turkey)," *Journal of Ethnopharmacology*, vol. 137, no. 1, pp. 469–486, 2011.
- [144] E. Sezik, E. Yeşilada, G. Honda, Y. Takaishi, Y. Takeda, and T. Tanaka, "Traditional medicine in Turkey X. Folk medicine in Central Anatolia," *Journal of Ethnopharmacology*, vol. 75, no. 2-3, pp. 95–115, 2001.
- [145] E. Ugurlu and O. Secmen, "Medicinal plants popularly used in the villages of Yunt Mountain (Manisa-Turkey)," *Fitoterapia*, vol. 79, no. 2, pp. 126–131, 2008.
- [146] I. Orhan, E. Küpeli, M. Aslan, M. Kartal, and E. Yesilada, "Bioassay-guided evaluation of anti-inflammatory and antinociceptive activities of pistachio, *Pistacia vera L.*," *Journal of Ethnopharmacology*, vol. 105, no. 1-2, pp. 235–240, 2006.
- [147] M. Bahmani and Z. Eftekhari, "An ethnoveterinary study of medicinal plants in treatment of diseases and syndromes of herd dog in southern regions of Ilam province, Iran," *Comparative Clinical Pathology*, vol. 22, no. 3, pp. 1–5, 2012.
- [148] M. Salehi-Surmaghi, *Medicinal Plants and Phytotherapy*, Tehran University of Medical Sciences, Tehran, Iran, 2010.
- [149] A. N. Assimopoulou, S. N. Zlatanos, and V. P. Papageorgiou, "Antioxidant activity of natural resins and bioactive triterpenes in oil substrates," *Food Chemistry*, vol. 92, no. 4, pp. 721–727, 2005.
- [150] A. Rajaei, M. Barzegar, A. M. Mobarez, M. A. Sahari, and Z. H. Esfahani, "Antioxidant, anti-microbial and antimutagenicity activities of pistachio (*Pistacia vera*) green hull extract," *Food and Chemical Toxicology*, vol. 48, no. 1, pp. 107–112, 2010.
- [151] M. S. Sharifi, D. Ebrahimi, D. B. Hibbert, J. Hook, and S. L. Hazell, "Bio-activity of natural polymers from the genus pistacia: a validated model for their antimicrobial action," *Global Journal of Health Science*, vol. 4, no. 1, pp. 149–161, 2012.
- [152] M. S. Sharifi and S. L. Hazell, "Isolation, analysis and antimicrobial activity of the acidic fractions of Mastic, Kurdica, Mutica and Cabolica gums from genus *Pistacia*," *Global Journal of Health Science*, vol. 4, no. 1, pp. 217–228, 2011.
- [153] A. Shojaei, K. Javidnia, and R. Miri, "Antioxidant and antimicrobial activity of ethanolic extract of *Pistacia khinjuk* (anacardiaceae)," *European Journal of Pharmacology*, vol. 668, pp. e43–e44, 2011.
- [154] M.-L. He, H.-Q. Yuan, A.-L. Jiang et al., "Gum mastic inhibits the expression and function of the androgen receptor in prostate cancer cells," *Cancer*, vol. 106, no. 12, pp. 2547–2555, 2006.
- [155] P. Moulos, O. Papadodima, A. Chatziioannou, H. Loutrari, C. Roussos, and F. N. Kolisis, "A transcriptomic computational analysis of mastic oil-treated Lewis lung carcinomas reveals molecular mechanisms targeting tumor cell growth and survival," *BMC Medical Genomics*, vol. 2, pp. 1–15, 2009.
- [156] M. Toune, C. Abdennour, and N. Houaine, "Influence of *Pistacia lentiscus* oil on serum biochemical parameters of domestic rabbit *Oryctolagus cuniculus* in mercury induced toxicity," *European Journal of Scientific Research*, vol. 24, no. 4, pp. 591–600, 2008.

