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Review Article

Pistacia vera: Bridging Unani Wisdom and Modern Nutraceutical Science: A Comprehensive Review

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Abstract

Background: *Pistacia vera* L. (pistachio), a member of the Anacardiaceae family, has been traditionally valued in Unani medicine as a tonic for the brain, heart, and reproductive system. Modern research increasingly supports its diverse nutraceutical and pharmacological properties.

Objective: This review aims to integrate traditional Unani insights with contemporary scientific evidence on the morphology, nutritional composition, therapeutic applications, and pharmacological activities of *Pistacia vera*.

Materials and Methods: A comprehensive literature review was conducted using databases such as PubMed, Google Scholar, ScienceDirect, and Scopus, alongside classical Unani texts including *Khazā'in al-Advia*, *Muḥīt-i-Aʿẓam*, and *Makhzan al-Mufradāt*. Data on phytochemistry, temperament, dosage, traditional uses, and pharmacological effects were critically analysed and synthesised.

Results: Pistachio kernels contain 55–60% oil, 15–21% protein, 14–18% carbohydrates, ~10% fibre, essential amino acids, unsaturated fatty acids, vitamins (B6, E, K, folate), minerals (Cu, Mn, Zn, Mg), and polyphenols, flavonoids, and carotenoids. Traditional Unani literature highlights its role as *Muqawwī-i-Dimāgh* (brain tonic), *Muqawwī-i-Qalb* (cardiac tonic), and *Muqawwī-i-Bāh* (aphrodisiac). Modern studies demonstrate neuroprotective, cardioprotective, hepatoprotective, nephroprotective, antidiabetic, anti-obesity, anti-inflammatory, anticancer, bronchodilator, anti-melanogenic, acetylcholinesterase inhibitory, and anxiolytic activities. Mechanisms include antioxidant effects, modulation of glucose transporters, anti-inflammatory pathways, and multitargeted organ protection.

Conclusion: *Pistacia vera* bridges Unani wisdom and modern pharmacology, validating its therapeutic potential as a nutrient-rich functional food. Future clinical trials, standardisation of extracts, and mechanistic studies are needed to translate preclinical findings into human applications, establishing pistachio as an integrative nutraceutical for brain, cardiac, metabolic, and reproductive health.

Keywords: *Pistacia vera*, pistachio, Unani medicine, nutraceutical, pharmacological activities, neuroprotection, cardiometabolic health.

Introduction

The genus *Pistacia* belongs to the family Anacardiaceae, which also includes economically important plants such as cashew, mango, and sumac. Among the various species, *Pistacia vera* L. is the only one that produces commercially edible nuts.[1] The word *pistachio* is derived from the ancient Persian term *"pistak,"* reflecting its strong geographical and cultural origins. *Dioscorides* explained the origin of the term as being derived from the Greek words *pissa* (resin) and *aklomai* (to heal), indicating a plant endowed with health-promoting resinous properties.[2]

Materials and Methods

A comprehensive literature review on *Pistacia vera* (Pista) was conducted using major scientific databases, including PubMed, Google Scholar, ScienceDirect, and Scopus, with relevant keywords such as *Pistacia vera*, pistachio, pista, Unani medicine, nutritional composition, and pharmacological activities. Classical Unani texts—*Khazā'in al-Advia*, *Muḥīt-i-Aʿẓam*, *Makhzan al-Mufradāt*, *Qārābādīn Najm al-Ghani*, *Bustān al-Mufradāt*, *Qārābādīn-i-Aʿẓam*, and *Kitāb al-Fatḥ fī al-Tadāwī*—were thoroughly reviewed, along with standard botanical and pharmacognostical references such as *Flora Medica*, *Glossary of Indian Medicinal Plants*, *Indian Materia Medica*, *Indian Medicinal Plants*, *Handbook of Medicinal Herbs*, and

the *Compendium of Indian Medicinal Plants*. Data from classical literature and contemporary scientific research were critically analysed and systematically compiled to develop an integrated overview of the nutraceutical and pharmacological profile of Pista.

History

The primary centre of origin of pistachio extends across Turkey, Iran, Syria, Lebanon, the Caucasus region of southern Russia, and Afghanistan. The species is believed to have evolved in arid inland desert regions, as it requires prolonged hot summers for proper fruit ripening, exhibits strong tolerance to drought and salinity, and possesses a high winter chilling requirement.[3,6,7]

Archaeological evidence suggests that pistachio consumption dates back as early as 300,000 years ago, based on the discovery of burnt pistachio shells in the Mousterian layers of Kebara Cave in Israel.[4] Further excavations at Jarmo, near northeastern Iraq, indicate that pistachio nuts were a common dietary component as early as 6750 BC. Historically, pistachios have been regarded as symbols of royalty, endurance, and prestige. Exceptionally fine pistachios were reportedly a favoured delicacy of the Queen of Sheba, who is said to have reserved all Assyrian supplies exclusively for her royal court (24). During the 8th century BC, the Babylonian king Nebuchadnezzar is believed to have introduced pistachio trees into his legendary Hanging Gardens.[3]

By the 2nd century BC, Nicander documented the presence of pistachios in Susa, a region in southwestern Iran near the Iraqi border. In the 1st century BC, Poseidonius recorded the cultivation of pistachios in Syria, from where it was introduced to Italy in the 1st century AD and subsequently spread throughout the Mediterranean region. The crop later expanded eastward and was reported in China around the 10th century AD. Pistachios were introduced into the United States in 1854; however, organised commercial cultivation began only after 1970. In recent decades, pistachio cultivation has further extended to Australia.

At present, pistachios are widely cultivated in Iran, the Middle East, Mediterranean regions, and the United States. In 2009, Iran accounted for nearly 40% of global pistachio production, while the United States contributed approximately 27% of the total world output.[3]

Description of the Plant According to Unani Literature

According to Unani literature, the Pista (Pistacia vera) tree closely resembles the *Batam* tree, known as *Saqar* in Persian. The tree is small in size, dusty, thornless, and long-lived. Fruiting begins at the onset of the rainy season, and ripening occurs by early winter.

Pista is classified into two varieties: ***Bustānī*** (garden variety) and ***Pahāṛī*** (hilly variety). The *Bustānī* variety produces larger fruits and is commonly referred to as commercial Pista. The best quality Pista is characterised by large size, soft texture, and a white shell. The outer thin layer is bluish-green, while the kernel is green, glossy, and tasty.

Grafting *(Qalamdārī)* of Pista onto Batam is traditionally practised to enhance yield. The seed coat (*Pista kā Juft*) refers to the thin covering of the kernel inside the hard shell. The tree shows alternate bearing, producing kernel-bearing fruits in one year and non-kernel fruits *(Bazghaj)* in the following year.

Pista kernels stored within the shell remain stable for longer durations compared to de-shelled kernels. Traditional practice also suggests that lemon water helps prevent kernel deterioration. [5,11,12]

Figure 1: Pistachio

Scientific Classification

Kingdom: Plantae

Subkingdom: Tracheobionta

Division: Magnoliophyta

Class: Magnoliopsida

Order: Sapindales

Family: Anacardiaceae

Genus: *Pistacia*

Species: *Pistacia vera* L.

Botanical Name: *Pistacia vera* [6]

Vernacular Names

Arabic	فستق (*fustuq / fustāq ḥalbī*)
Bengali	পিস্তা (*pistā / pēstā*)
Chinese	开心果 (*kāixīn guǒ*)
Dutch	Pistache
English	Pistachio
French	Pistache
German	Pistazie
Greek	φυστίκι (*fistíki*)
Gujarati	પિસ્તા (*pistā*)
Hindi	पिस्ता (*pistā*)
Japanese	ピスタチオ (*pisutachio*)
Kannada	ಪಿಸ್ತಾ (*pistā*)
Kashmiri	پستہ (*pista*)
Latin	*Pistacia vera*
Malayalam	പിസ്ത (*pista*)
Marathi	पिस्ता (*pistā*)
Nepali	पिस्ता (*pistā*)
Persian	پسته (*pesteh*)
Punjabi	ਪਿਸ਼ਤਾ (*pistā*)
Russian	фисташка (*fistashka*)
Sanskrit	पिष्टा (*piṣṭā*)
Spanish	Pistacho
Tamil	பிஸ்தா (*pistā*)
Telugu	పిస్తాపప్పు (*pistā pappu*)
Unani	Pistā / پِسْتَا
Urdu	پستہ / پستا (*pistā / pesteh*)

Parts Used - Fruit, Flower, and Shell

***Mizāj* (Temperament)**

According to *Ibn Sīnā* (Avicenna), the kernel of Pista possesses a *Garm wa Tār* (hot and moist) temperament in the second degree.

Tamīmī has reported the temperament of Pista as hot and dry in the first degree.[5,8,12]

***Miqdār-e-Khūrāk* (Dose)**

Pistachio Kernel *(Maghz-e-Pistah)*: 6 *masha* to 1 *tola* (approximately 6–12 g) daily. [8]

***Muẓir* (Adverse Effects)**

Maghz-e-Pistah, particularly the peeled kernel, may harm the stomach, impair digestion, and disturb food assimilation. Pistachio oil can produce similar gastric discomfort. Some classical sources indicate that pistachios may be harmful to the lower organs if consumed in excess. [8,11]

***Musleh* (Corrective Measures)**

To mitigate adverse effects, pistachio is traditionally combined with *Zard Aalu* (Apricot), *Aalu Bukhara* (Dried Plum/Prune) or *Sikanjabeen* (Oxymel) [11]

***Badal* (Substitutes)**

Maghz-e-Bādām (Almond kernel), *Maghz-e-Akhrot* (Walnut kernel) [11]

Compound Unani Formulations

Kernal *(Maghz-e-Pistah)*

- *Ma'jūn Supari Pak*
- *Labūb Kabeer*

Outer Shell *(Post-e-Bairun-e-Pistah)*

- *Jawārish Amla*
- *Jawārish Anarain*

Flower *(Gul-e-Pistah)*

- *Ḥabb-e-Gul-e-Pistah* [8]

Nutrient and Bioactive Composition

The kernel of pistachio contains approximately 55.2–60.5% oil, 15.0–21.2% protein, and 14.9–17.7% carbohydrates. Pistachios are among the richest dietary sources of fiber (10.3 g/100 g) and provide about 600 kcal per 100 g, indicating a high energy value.

Like most nuts, pistachios are rich in fats, predominantly monounsaturated and polyunsaturated fatty acids, with smaller proportions of saturated fatty acids. Oleic acid and linoleic acid together constitute more than 50% of the total lipid content. Pistachios also supply a substantial amount of high-quality protein (~21% of total weight). The Protein Digestibility Corrected Amino Acid Score (PDCAAS) of roasted pistachios is 81, which decreases to 73 in raw pistachios. The Digestible Indispensable Amino Acid Score (DIAAS) is 86 for raw and 83 for roasted pistachios. Compared to many other edible nuts, pistachios possess a higher proportion of essential amino acids, including a notable concentration of branched-chain amino acids (BCAAs).

Pistachios are also fibre-dense, containing approximately 10% insoluble fibre and 0.3% soluble fibre by weight. According to the U.S. Food and Drug Administration (FDA), pistachios provide at least 15 essential micronutrients in significant amounts, each contributing more than 10% of the Daily Reference Value (DRV) per ounce (28.5 g) serving.

Pistachios are particularly rich in copper, manganese, vitamin B6, thiamine, potassium, phosphorus, chromium, magnesium, iron, zinc, selenium, vitamins E and K

(phylloquinone), riboflavin, and folate, along with smaller quantities of other micronutrients. In addition, pistachios contain high levels of lutein and zeaxanthin (xanthophyll carotenoids) and a wide spectrum of bioactive phenolic compounds, contributing to their antioxidant and health-promoting properties. [9,10]

THERAPEUTIC ACTIONS *(Afʿāl)*

Fruit *(Thamar-e-Pista)*

The fruit of Pista is highly valued in Unani medicine for its tonic, nutritive, and organ-strengthening actions, particularly on the brain, heart, and reproductive system.

- ***Muqawwī-i-Dimāgh* (Brain Tonic):** Strengthens cerebral functions and is beneficial in weakness of the nervous system.[1]
- ***Muqawwī-i-Qalb* (Cardiac Tonic):** Supports cardiac strength and improves vitality.[2]
- ***Muqawwī-i-Ḥāfiẓa* (Memory Enhancer):** Enhances memory and cognitive performance.[1]
- ***Musammin-e-Badan* (Weight Gainer):** Promotes healthy weight gain due to its high nutritive value.[3]
- ***Munaffis-e-Balgham* (Expectorant):** Helps in expelling phlegmatic humours from the respiratory tract.[2]
- ***Muqawwī-i-Bāh* (Aphrodisiac):** Strengthens sexual power and improves semen quality.[1]
- ***Muḥallil* (Resolvent):** Aids in the resolution of swellings and inflammatory conditions.[4]
- ***Jālī* (Detergent):** Cleanses tissues and improves clarity of skin and internal organs.[3]
- ***Munqī* (Expulsive):** Eliminates morbid matter from the body and vital organs.[4]
- ***Mufattiḥ* (Deobstruent):** Opens obstructions in channels, especially vascular and visceral blockages.[2]

Shell *(Post-e-Pista)*

The shell of Pista is primarily valued for its astringent and strengthening properties

- ***Qābiẓ* (Astringent):** Causes tissue contraction and reduces excessive secretions.[2]
- ***Muqawwī-i-Āam* (General Tonic):** Provides an overall strengthening effect to the body.[3]
- ***Muqawwī-i-Qalb* (Cardiac Tonic):** Supports cardiac tone and functional efficiency.[5,8,13,14]

THERAPEUTIC USES *(Istʿemālāt)*

Fruit (*Thamar-e-Pista*)

Respiratory System: Pistachio is particularly beneficial for chest and lung disorders. It helps in cough and facilitates the expulsion of *Balgham* (phlegm). The flowers of pistachio are traditionally used to relieve cough, and *Habb-e-Gul-e-Pistah* is a well-known compound formulation for respiratory ailments.[12]

Nervous System Disorders: Due to its aromatic and tonic properties, pistachio is considered *Muqawwī-i-Aam* (general tonic). Classical Unani physicians recommend it for brain *(Dimāgh)* weakness, improving cognition, memory *(Nisyān)*, and mental vigour.

Headaches and Migraines: Traditional Unani texts describe nasal administration *(Saʿut)* of *Ravghan-e-Pistah* (pistachio oil) after exposure to steam (*Ḥammām*) as effective in relieving *Shaqeeqah* (migraine) by displacing morbid humors toward the shoulders.[12,13]

Cardiovascular Health: Pistachio acts as a *Muqawwī-i-Qalb* (cardiac tonic) and is beneficial in *Khafaqān* (palpitations) and general cardiac weakness.[2]

Digestive System: The fruit is *Muqawwī-i-Miʿda* (gastric tonic) and *Musammin-i-Badan* (body-nourishing/ fattening). It strengthens the cardiac end of the stomach *(Fam al-Miʿda)* and prevents *Ghathayān* (nausea) and *Inqilāb al-Miʿda* (vomiting/gastric upsets).[23]

Hepatobiliary Disorders: Pistachio is beneficial in conditions of cold-temperament liver *(Burudat-e-Jigar)* and mild *Yarqān* (jaundice).[2]

Reproductive System: The fruit is considered a *Muqawwī-i-Bāh* (aphrodisiac) and enhancer of semen production.[5,8,12]

Shell *(Post-e-Pistah)*

Astringent Uses: The hard white shell is *Qābiẓ* (astringent) and helps prevent nausea, vomiting, and diarrhea.[2]

Anal and Genital Health: Boiling the shell in water and using it as an *Ābzān* (sitz bath) is effective for *Khurooj-e-Maqʿad* (anal fissures). The decoction *(Joshanda)* of bark and leaves, applied topically *(Natool)*, is traditionally used in *Nazla* (catarrh), *Dard-e-Maqʿad* (rectal pain), *Dard -i-Raḥim* (uterine pain), skin greasiness *(Jarab wa Ḥikka)*, and lice infestation.[2]

Hair and Mental Health: Regular washing of hair with the decoction is believed to reduce *Waswasah* (obsessive thoughts/delusions) and balance *Saudawi Mawad* (melancholic humors)[5,12]

Pharmacological Activities

Pistacia vera (pistachio) exhibits a wide array of pharmacological activities, which are attributed to its rich composition of unsaturated fatty acids, polyphenols, flavonoids, carotenoids, tocopherols, minerals, and other bioactive compounds.

- Antiemetic Effect
- Anti-epileptic Effect
- Sedative and Hypnotic Activity
- Muscle Relaxation
- Effect on Memory
- Neuroprotective Effect
- Nephroprotective Effect
- Hepatoprotective Effect

- Anti-Melanogenic Effect
- Anti-inflammatory Activity
- Antidiabetic Effect
- Antiulcer Effect
- Acetylcholinesterase Inhibition
- Effective for Metabolic Syndrome and CHD
- Anti-obesity Effect [13]

Evidence-Based Pharmacological Studies

Anti-epileptic Effect

Hydroalcoholic extracts of *Pistacia vera* and petroleum ether extracts of *Pistacia integerrima* significantly reduced PTZ- and MES-induced seizures in animal models, confirming their antiepileptic potential.[15]

Sedative and Hypnotic Activity

Hydroalcoholic extract of *Pistacia vera* gum exhibited significant sedative and hypnotic effects by increasing sleep duration and reducing sleep latency in phenobarbital-induced sleep models.[16]

Muscle Relaxation

The hydroalcoholic extract of *Pistacia vera* gum demonstrated muscle relaxant effects in traction and rotarod tests, with significant activity observed at the high dose of 1 g/kg.[17]

Effect on Memory

Pistacia lentiscus essential oil improved memory in LPS-induced memory-deficient rats by reducing oxidative stress and acetylcholinesterase activity.[360] Additionally, *Pistacia vera* fruit extract was effective in regulating chemically induced memory impairment. [17,18]

Neuroprotective Effect

The *Pistacia* genus is recognized for strong neuro-protective properties. *Pistacia vera* gum has shown notable protection in ischemia-induced animal models, while *P. terebinthus* exhibits neuroprotection mainly through significant acetylcholinesterase inhibition. Leaf extracts and key phenolic compounds of *P. lentiscus* reversed aluminium-induced neurotoxicity in mice. Similarly, *P. atlantica* mitigated mercury-induced brain damage, further supporting its neuroprotective potential. [19]

Anxiolytic effect

The global prevalence of anxiety and depression is high, and long-term use of conventional anxiolytics can lead to dependence and withdrawal symptoms. Plant-based alternatives may help reduce these adverse effects. Studies show that the fruit extract of *Pistacia atlantica* produces significant anxiolytic activity in both intact and gonadectomized rats. Similarly, *Pistacia vera* gum extract demonstrated anxiolytic effects in the elevated plus maze model, particularly at higher doses (1 g/kg). [16]

Nephroprotective Effect

Hydroalcoholic extracts of *Pistacia vera* reduced gentamicin-induced nephrotoxicity in rats by improving kidney function and reducing inflammation and oxidative stress. [21]

Hypoglycemic effect

Pistacia species show strong antidiabetic potential. *P. atlantica* extracts improved STZ-induced hyperglycemia, enhanced β-cell function, and inhibited α-amylase and α-glucosidase. *P. lentiscus* leaf, fruit, and crude extracts normalized alloxan- and STZ-induced diabetes, while *P. terebinthus* also reversed STZ-induced hyperglycemia. Mild activity was noted in *P. vera* stem metabolites. Additional mechanisms include 11β-HSD1 inhibition by *P. lentiscus* oleoresin and α-glucosidase inhibition by pistagremic acid from *P. integerrima*. Because many *Pistacia* species also aid diabetic neuropathy and wound healing, they may simultaneously address multiple diabetes-related complications, reducing polypharmacy. Further clinical studies are needed. [21,22]

Effect on GLUT

The glucose transporter (GLUT) system plays a key role in regulating blood glucose levels. Among these, GLUT-II is bidirectional, while others function unidirectionally. *P. atlantica* extract has been shown to enhance GLUT-IV expression, suggesting improved insulin responsiveness. Further evaluation of other *Pistacia* species on GLUT modulation is warranted. [23]

Anticancer effect

Pistacia species exhibit notable anticancer potential. *P. lenticus* leaf and fruit extracts inhibited melanoma (B16F10) and BHK21 cell growth, while its essential oils showed stronger effects on RD and L20B cell lines. Protective effects against bleomycin-induced lung fibrosis and oxidative stress were also reported. *P. atlantica* demonstrated antiproliferative activity against COLO205, gastric, and cervical carcinoma, attributed to its antioxidant phenolics. *P. palaestina* essential oil inhibited colorectal cancer, and *P. vera* ethyl acetate extract suppressed MCF-7 breast cancer cells. Additionally, the natural antiemetic properties of these plants complement their anticancer activity, offering a dual therapeutic advantage in managing chemotherapy-induced nausea. [24,25,26]

Bronchodilator effect

P. integerrima exhibits bronchodilator activity, with its methanolic extract fully relaxing tracheal contractions, and its essential oil showing anti-asthmatic effects.[27]

Hepatoprotective Effect

Hydroalcoholic extracts of *Pistacia vera* protect the liver from CCl_4-induced damage, mainly through antioxidant and anti-inflammatory mechanisms.[396] Extracts from *Pistacia lentiscus* leaves and fruits reduced paracetamol-induced liver damage in mice, lowering liver enzymes, oxidative stress markers, and tissue necrosis.[28]

Anti-gout effect

P. integerrima leaves reduce uric acid levels in fructose-induced hyperuricemia, with compounds like quercetin, kaempferol, rutin, and their derivatives inhibiting xanthine oxidase, highlighting its potential as an effective anti-gout agent. [29]

Anti-Melanogenic Effect

Methanol extract of *Pistacia vera* seeds (MPH) exhibited strong anti-melanogenic activity in SKMEL-3 human melanoma cells, reducing melanin content (~57%) and showing cytotoxicity (~63%) after 72 hours.[30]

Multiple Sclerosis and Nutritional Support

Pistachios are a good source of essential fatty acids (EFAs) and antioxidants, which may support myelin health and immune modulation in multiple sclerosis. Evidence from animal studies suggests dietary lipids, especially n-6 PUFAs, influence myelin formation, though human data remain limited. Sauder KA, McCrea CE, Ulbrecht JS, Kris-Etherton PM, West SG. Pistachio nut consumption modifies serum oxidized LDL in adults with controlled type 2 diabetes: a randomized crossover trial. J Nutr. 2014;144(4):475-480. [31]

Metabolic Syndrome, Diabetes, and Cardiovascular Health

Regular pistachio consumption has been shown to:

- Lower blood glucose and improve insulin sensitivity
- Support endothelial function and cardiovascular health
- Reduce oxidative stress and inflammatory markers
- Improve lipid profiles and vascular function in type 2 diabetes
- Reduce aminotransferase levels associated with insulin resistance
- Provide a low glycemic index, reducing postprandial glucose when consumed with carbohydrates

Frequent intake (e.g., 4 times/week) may reduce dyslipidemia and support heart health, while also enhancing antioxidant status and reducing oxidized LDL. [32]

Anti-inflammatory Activity

Crude leaf extract of *Pistacia vera* has shown significant anti-inflammatory effects in both acute and chronic inflammation models. Similarly, *Pistacia atlantica* exhibited notable anti-inflammatory activity in animal studies. Additional in vivo and in vitro experiments further confirmed the strong anti-inflammatory properties of P. vera.[24,29,33]

Anti-obesity Effect

Bioactive compounds in *Pistacia atlantica* root, particularly protocatechuic acid (452 µg/g dry weight) and quinic acid (960 µg/g dry weight), demonstrated significant inhibitory activity against porcine pancreatic lipase, suggesting potential anti-obesity effects. No further studies on this effect have been reported.[34]

Acetylcholinesterase Inhibition

Pistacia atlantica exhibits notable acetylcholinesterase inhibitory activity. Similarly, both the crude extract and various fractions, including metabolites from the fruit stems of *Pistacia vera*, demonstrated significant inhibition of acetylcholinesterase.[35]

Antihypertensive effect

Research on the antihypertensive potential of the *Pistacia* genus is limited, yet *P. atlantica* leaf extract has shown strong ACE-I inhibition, suggesting promising antihypertensive activity. Since hypertension commonly coexists with diabetes, clinical trials in patients with both conditions may yield particularly valuable insights.[23]

Anthelmintic effect

Extracts and essential oils of *Pistacia khinjuk* show strong anthelmintic activity, particularly against *Echinococcus granulosus*, the cause of hydatid cysts. *P. lentiscus* also demonstrates potent deworming properties, with its polyphenols disrupting the exsheathment of gastrointestinal nematode larvae. Additionally, formulations containing *P. lentiscus* effectively eliminated nematodes in naturally infected sheep.[36]

Diabetic wound healing effect

Diabetic wound management remains a major global challenge with no definitive treatment, making medicinal plants valuable candidates for therapy. *Pistacia atlantica* resin oil has shown notable wound-healing potential in STZ-induced diabetic rats, although further studies on this activity are still lacking.[37]

Discussion

Pistacia vera exemplifies a convergence of traditional Unani medicine and modern pharmacology. Classical texts describe its use as a tonic for the brain, heart, and reproductive system, highlighting its organ-strengthening and nutritive properties. Modern evidence supports these traditional claims, demonstrating neuroprotective, cardioprotective, hepatoprotective, nephroprotective, antidiabetic, anti-obesity, and anti-inflammatory activities. The presence of bioactive compounds such as unsaturated fatty acids, polyphenols, flavonoids, carotenoids, and tocopherols underpins these effects, corroborating the holistic benefits described in Unani literature.

Pharmacological studies reveal multitargeted mechanisms of action. Pistacia vera not only modulates glucose transporters (GLUT), lipid metabolism, and oxidative stress but also inhibits acetylcholinesterase and inflammatory pathways, supporting cognitive, metabolic, and cardiovascular health. Its anti-cancer, antiemetic, and wound-healing potentials further illustrate its broad-spectrum therapeutic applicability.

While preclinical studies provide strong evidence, clinical validation remains limited, emphasizing the need for standardized extracts, dosage optimization, and long-

term safety assessment. Integrating traditional insights with modern trials could unlock Pistacia vera's full therapeutic potential, positioning it as a functional food for preventive and adjunctive therapy.

Conclusion

Pistacia vera bridges Unani wisdom and contemporary science, confirming its status as a nutrient-dense functional food with extensive therapeutic benefits. Traditional knowledge identifies it as a brain, cardiac, and reproductive tonic, while modern research validates its neuroprotective, cardiometabolic, hepatoprotective, nephroprotective, and anti-inflammatory effects. Its bioactive compounds enable multitarget pharmacological actions, including antidiabetic, anti-obesity, anti-cancer, and acetylcholinesterase-inhibitory effects.

Future research should focus on clinical trials, standardisation of extracts, and mechanistic studies to translate preclinical evidence into human applications. Such investigations will establish Pistacia vera as a scientifically validated integrative therapy, harmonizing traditional Unani practices with modern nutraceutical and pharmacological advancements.

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References

1. Kader AA, Heintz CM, Labavitch JM, Rae HL. Studies Related to the Description and Evaluation of Pistachio Nut Quality1. J Amer Soc Hort Sci. 1982 Sept;107(5):812-6. https://doi.org/10.21273/JASHS.107.5.812

2. Dioscorides Pedanius, Osbaldeston TA, Wood RP. De materia medica: being an herbal with many other medicinal materials : written in Greek in the first century of the common era : a new indexed version in modern English. Johannesburg: IBIDIS; 2000.

3. Kashaninejad M, Tabil L. Kashaninejad, M. and L.G. Tabil. 2011. Pistachio (Pistacia vera L.). In Postharvest Biology and Technology of Tropical and Subtropical Fruits: Volume 4: Mangosteen to white sapote. E. M. Yahia, ed., 218-246. Cambridge, U.K.: Woodhead Publishing Ltd. In 2011. p. 218-46. https://doi.org/10.1533/9780857092618.218

4. Hillman G. Late Pleistocene changes in wild plant-foods available to hunter-gatherers of the northern Fertile Crescent: possible preludes to cereal cultivation. In: The Origins And Spread Of Agriculture And Pastoralism In Eurasia. Routledge; 1996.

5. Khan MA. Muhit-e-Azam [Urdu translation]. Vol. 1. New Delhi: Central Council for Research in Unani Medicine (CCRUM), Ministry of Health and Family Welfare, Government of India; Year of publication. p. 669-671.

6. Chopra RN, Nayar SL, Chopra IC. Glossary of Indian medicinal plants. New Delhi: National Institute of Science Communication and Information Resources (CSIR); 1986. p. 195.

7.Nadkarni KM. Indian Materia Medica: With Ayurvedic, Unani-Tibbi, Siddha, Allopathic, Homoeopathic, Naturopathic & Home Remedies. Vol. 1. Revised and enlarged by Nadkarni AK. Bombay: Popular Prakashan; n.d. p. 975-976.

8. Khan NG. Maghzan-ul-Mufridat. New Delhi: Idara Kitab-ul-Shifa; [year unknown]. p. 134.

9.Ghafoor K, Al-Juhaimi FY, Choi YH, Lee JH, Kim YH, et al. Pistachio Nuts (Pistacia vera L.): Production, Nutrients, Bioactives and Novel Health Effects. Plants (Basel). 2022;11(1):18. https://doi.org/10.3390/plants11010018 PMid:35009022 PMCid:PMC8747606

10.Bulló M, Garcia-Gavilán JF, Megias-Rodriguez F, Salas-Salvadó J. Plant-based snacking: research and practical applications of pistachios for health benefits. J Nutr Sci. 2021;10:e41. https://doi.org/10.1017/jns.2021.77 PMid:34733499 PMCid:PMC8532077

11. Abdul Hakeem M. Bustanul Mufradat. Lucknow: Idarah Taraqqi Urdu; 2002. p.166.

12. Najmul Ghani M. Khazain al-Adwiya. Vol 1-4. Delhi: Idara Kitab-us-Shifa; n.d. p. 466-467.

13. Ibn Sina. Al-Qanun fi'l-Tibb. Vol. 3. Urdu translation. Translated by Maulana Hakim Syed Ghulam Husain Kantori. Lahore: Idara Kitab-ul-Shifa; 2075 H. p. 531.

14. Rauf A, Al-Awthan YS, Muhammad N, Shah MM, Mitra S, Emran TB, et al. Pharmacological investigation of genus Pistacia. In: Pharmacognosy - Medicinal Plants. London: IntechOpen; 2021. p. 1-15. https://doi.org/10.5772/intechopen.97322

15. Fatehi, F., et al., The effect of hydroalcoholic extract of Pistacia vera on pentylenetetrazole-induced kindling in rat. Research Journal of Pharmacognosy, 2017. 4(2): p. 45-51.

16. Ziaee, T. and H. Hosseinzadeh, Muscle relaxant, hypnotic and antianxiety effects of Pistacia vera gum hydroalcoholic extract in mice. Journal of Medicinal Plants, 2010. 9(36): p. 96-207.

17. Ammari, M., et al., Pistacia lentiscus oil attenuates memory dysfunction and decreases levels of biomarkers of oxidative stress induced by lipopolysaccharide in rats. Brain research bulletin, 2018. 140: p. 140-147 https://doi.org/10.1016/j.brainresbull.2018.04.014 PMid:29715489

18. Singh, S. and M. Kulshreshtha,Pharmacological approach of Pistacia Vera fruit to assess learning and memory potential in chemicallyinduced memory impairment in mice. Central Nervous System Agents in Medicinal Chemistry (Formerly Current Medicinal Chemistry-Central Nervous System Agents), 2019. 19(2): p. 125-132. https://doi.org/10.2174/1871524919666190304122927 PMid:30836928

19. Fatiha, B., et al., Toxicity of mercury on the brain: ability of extract of Pistacia atlantica regulated effect. Journal of Drug Delivery and Therapeutics, 2020. 10(4-s): p. 17-24. https://doi.org/10.22270/jddt.v10i4-s.4269

20. Ehsani, V., et al., Protective effect of hydroalcoholic extract of Pistacia vera against gentamicin-induced nephrotoxicity in rats. Renal failure, 2017. 39(1): p. 519-525 https://doi.org/10.1080/0886022X.2017.1326384 PMid:28558475 PMCid:PMC6014520

21. Hashemnia, M., Z. Nikousefat, and M. Yazdani-Rostam, Antidiabetic effect of Pistacia atlantica and Amygdalus scoparia in streptozotocin-induced diabetic mice. Comparative Clinical Pathology, 2015. 24(6): p. 1301-1306. https://doi.org/10.1007/s00580-015-2068-1

22.Ahmed, Z.B., et al., Potentially antidiabetic and antihypertensive compounds identified from Pistacia atlantica leaf extracts by LC fingerprinting. Journal of pharmaceutical and biomedical analysis, 2018. 149: p. 547-556. https://doi.org/10.1016/j.jpba.2017.11.049 PMid:29190580

23. Zarekar, M., et al., Combined effect of aerobic training and pistacia athlantica extract on GLUT-4 protein expression and muscle glycogen in diabetic rats. Iranian Journal of Endocrinology and Metabolism, 2014. 16(4): p. 245-253.

24. Remila, S., et al., Antioxidant, cytoprotective, anti-inflammatory and anticancer activities of Pistacia lentiscus

25. Hashemi, L., et al., Anticancer activity and phenolic compounds of Pistacia atlantica extract. International Journal of Pharmaceutical and Phytopharmacological Research, 2017. 7(2): p. 26-31.

26.Seifaddinipour, M., et al., Cytotoxic effects and anti-angiogenesis potential of pistachio (Pistacia vera L.) hulls against

27. Janbaz, K.H., et al., Antidiarrheal, antispasmodic and bronchodilator activities of Pistacia integerrima are mediated through dual inhibition of muscarinic receptors and Ca++ influx. Science, Technology and Development, 2015. 34(1): p. 52. https://doi.org/10.3923/std.2015.52.59

28. Mehenni, C., et al., Hepatoprotective and antidiabetic effects of Pistacia lentiscus leaf and fruit extracts. journal of food and drug analysis, 2016. 24(3): p. 653-669. https://doi.org/10.1016/j.jfda.2016.03.002 PMid:28911573 PMCid:PMC9336671

29. Ahmad, N.S., et al., Pharmacological basis for use of Pistacia integerrima leaves in hyperuricemia and gout. Journal of Ethnopharmacology, 2008. 117(3): p. 478-482 https://doi.org/10.1016/j.jep.2008.02.031 PMid:18420362

30. Sarkhail, P., et al., Anti-melanogenic activity and cytotoxicity of Pistacia vera hull on human melanoma SKMEL-3 cells. Acta Medica Iranica, 2017: p. 422-428

31. van Meeteren M, Teunissen C, Dijkstra C, et al. Antioxidants and polyunsaturated fatty acids in multiple sclerosis. Eur J Clin Nutr. 2005;59(11):1347-61. https://doi.org/10.1038/sj.ejcn.1602255 PMid:16118655

32. Sauder KA, McCrea CE, Ulbrecht JS, Kris-Etherton PM, West SG. Pistachio nut consumption modifies serum oxidized LDL in adults with controlled type 2 diabetes: a randomized crossover trial. J Nutr. 2014;144(4):475-480.

33. Rauf, A., et al., Antinociceptive and anti-inflammatory activities of flavonoids isolated from Pistacia integerrima galls. Complementary Therapies in Medicine, 2016. 25: p. 132-138 https://doi.org/10.1016/j.ctim.2016.02.002 PMid:27062961

34. Ben Hmed, M., et al., Antiobesity and Inhibitory Pancreatic Lipase Effects of Bioactive Compounds of Pistacia atlantica Roots Extract. Austin Pancreat Disord, 2019. 3(1): p. 1013

35. Lawali, Y.D., et al., Antidiabetic and Anticholinesterase Properties of Extracts and Pure Metabolites of Fruit Stems of Pistachio (Pistacia vera L.). Current Organic Chemistry, 2020. 24(7): p. 785-797 https://doi.org/10.2174/1385272824666200401111036

36. Saric, T., et al., Anthelmintic effect of three tannin-rich Mediterranean shrubs in naturally infected sheep. Small Ruminant Research, 2015. 123(1): p. 179-182. https://doi.org/10.1016/j.smallrumres.2014.11.012

37. Shahouzehi, B., et al., Effects of Pistacia atlantica resin oil on the level of VEGF, hydroxyproline, antioxidant and wound healing activity in STZ-induced diabetic rats. The Ukrainian Biochemical Journal, 2018. 90(1): p. 34-41. https://doi.org/10.15407/ubj90.01.034