WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.453
Volume 14, Issue 15, 1433-1452. Review Article ISSN 2277–7105

AN OVERVIEW OF PHYTOCONSTITUENTS, TRADITIONAL USES AND PHARMACOLOGICAL PROPERTIES OF *PEGANUM HARMALA*: A REVIEW ARTICLE

Dr. Aditi Padoley[1*], Dr. Jaimala Jadhav[2] and Dr. Pallavi Dewangan[3]

[1*,3]PG Scholar, Dravyaguna Department, Mahatma Gandhi Ayurved College, Hospital and Research Centre, Salod(H), Wardha, Datta Meghe Institute of Higher Education and Research (DMIHER), Maharashtra, India.

[2]Professor, Dravyaguna Department, Mahatma Gandhi Ayurved College, Hospital and Research Centre, Salod(H), Wardha, Datta Meghe Institute of Higher Education and Research (DMIHER), Maharashtra, India.

Article Received on
19 June 2025,

Revised on 09 July 2025,
Accepted on 29 July 2025,

DOI: 10.20959/wjpr202515-37800

***Corresponding Author**
Dr. Aditi Padoley
PG Scholar, Dravyaguna Department, Mahatma Gandhi Ayurved College, Hospital and Research Centre, Salod(H), Wardha, Datta Meghe Institute of Higher Education and Research (DMIHER), Maharashtra, India.

ABSTRACT

Medicinal herbs can help to treat a variety of ailments. The plant includes a variety of phytoconstituents, including alkaloids, flavonoids, and amides, which contribute to its antibacterial, antimicrobial, antiprotozoal, antidepressant, pain relieving, anti-inflammatory, and antitumor properties. *Peganum harmala* has long been used for its analgesic and anti-inflammatory effects. This review seeks to bridge the gap between traditional and modern therapeutic use of *Peganum harmala*. The review also looks at P. harmala from a traditional Ayurvedic perspective, highlighting its usage in treating diseases such as asthma, cough, colic and dysmenorrhea, and its promise in modern medicine.

KEYWORDS: *Peganum harmala*, Ayurveda, Morphology. Pharmacological.

INTRODUCTION

Ayurveda is considered the oldest known medical system. It is believed to be a part of the *atharavaveda*, a sacred Hindu text from around 1000 B.C. Ayurvedic texts are extensive and detailed, containing descriptions of many plants and their medicinal uses. Changes in geography and biodiversity in the Indian subcontinent have

led to the use of many different plants and natural resources for health care. These resources have played a significant role in the traditional Indian system of medicine.[1]

Peganum harmala, commonly known as "Harmal" or "Syrian Rue," is a plant from the Zygophyllaceae family, indigenous to the arid and semi-arid regions stretching from the Mediterranean to Central Asia. This plant has garnered significant attention due to its extensive use in traditional medicine systems such as Ayurveda and Unani and its rich phytochemical profile. Historically revered in various cultures, particularly in the Middle East and South Asia, P. harmala has been utilized for its purported therapeutic properties, which include analgesic, anti-inflammatory, antibacterial, and antiprotozoal effects. The plant's significance extends beyond traditional uses; modern pharmacological studies have begun exploring its potential applications in treating various medical conditions.[2]

Geographical Distribution

Peganum harmala is native to dry and semi-arid areas ranging from the Mediterranean to Central Asia, including Mongolia Kashgaria, Tsaidam, Dzungaria, and Tibet.[3] This drought-tolerant plant grows in North Africa, the Middle East, Turkey, Pakistan, India, Iran, Kazakhstan, Mexico, South America, and some other countries. In addition to P. harmala, two more species, P. nigellastrum and P. multisectum, are becoming known for their health advantages. These species are typically found in northern China, mainly in Xinjiang Province, Mongolia, and Russia, and play an important role in desert ecosystems. Meanwhile, P. mexicanum is widely distributed in the United States and Mexico.[4]

Botanical Description

Harmal is a perennial plant that usually grows in dry soil. The plant blooms in the Northern Hemisphere from June to August, with white flowers measuring 2.5 to 3.8 cm in diameter. The seed capsules are spherical, 1 to 1.5 cm broad, have three chambers and each contain more then 50 seeds.[5]

Table 1: The Botanical classification of *P. harmala.*

Kingdom	Plantae
Division	Angiospermae
Class	Dicotyledonae
Family	Zygophyllaceae
Order	Sapindales
Genus	*Peganum*
Species	*Harmala*

Table 2: Vernacular names of *P. harmala.*

Hindi	Haramala
English	Harmal or Syrian Rue
Sanskrit	Harmala, Soma
Marathi	Harmala
Bengali	Ishbandh
Tamil name	Simaiyalavinai
Telugu name	Seemagoria vittulu

MORPHOLOGY

a) Plant Habit

Peganum harmala is a perennial herbaceous plant that typically grows to a height of 30-60cm. It has a bushy appearance with multiple branching stems.[6]

b) Leaves

The leaves are alternate and non-glandular.

They can be either entire (smooth-edged) or irregularly multifold (having multiple folds or lobes).

The leaves are equipped with setaceous (bristle-like) stipules.[7]

c) Flowers

Flowers are solitary and appear on subterminal leaf-opposed pedicels.

The flowers are white, making them easily distinguishable.

Each flower has 4-5 sepals and 4-5 petals.

d) Sepals

The sepals are narrow and often leaf-like and pinnatifid (divided in a feather-like manner).

They open in aestivation (before the flower fully blooms) and remain persistent on the plant.

e) Petals

The petals are subequal (almost equal in size) and imbricate (overlapping each other).

f) Reproductive Structures

The disk is either annular (ring-shaped) or cup shaped.

There are twelve-fifteen stamens inserted at the base of the disk, with some stamens lacking anthers.

The filaments of the stamens are dilated at the base, and the anthers are linear in shape.

g) Ovary

The ovary is globose (spherical) and deeply 2-3 lobed.

It is two-three celled, with ovules in each cell.

The ovules are suspended by short funicles (stalks) from the central angle of the ovary.

h) Style

The style is basal (located at the base of the ovary), twisted, and has 2-3 keels (ridges) in the middle, which are stigmatose (bearing the stigma).

i) Fruit

The fruit is globose and can be either dry and dehiscent (splitting open) with 3 valves or baccate (berry-like) and indehiscent (not splitting open).

Each fruit contains multiple seeds.

j) Seeds

The seeds are angled, with a soft scrobiculate (having small, rough projections) testa (seed coat).

They have fleshy albumen (nutritive tissue) and a curved embryo.[8]

Microscopic Characteristics

Leaf Anatomy

- **Epidermis:** The leaves possess a single layer of epidermal cells that are covered with a thin cuticle. Stomata are present on both the surface (amphistomatic), though more numerous on the lower surface. The epidermal cells are polygonal in shape and lack trichomes (hair-like structures).
- **Mesophyll:** Mesophyll is divided into palisade and spongy parenchyma. Palisade cells are columnar, densely packed, and found below the top epidermis. Spongy parenchyma, located below the palisade layer, is made up of loosely distributed cells with vast intercellular gaps.[9]

Stem Anatomy

- **Epidermis:** The stem epidermis is composed of a single layer of cells covered by a cuticle. Stomata are sparsely distributed.

- **Cortex:** The cortex consists of several layers of parenchyma cells. There are also collenchyma cells present beneath the epidermis, providing mechanical support.
- **Vascular Bundles:** The vascular bundles are collateral and open, arranged in a ring. Xylem is oriented towards the inner side, while phloem is towards the outer side.
- **Pith:** The pith is made up of large, thin-walled parenchyma cells located at the center of the stem.[10]

Root Anatomy

- **Epidermis:** The root epidermis is a single layer of cells without a cuticle.
- **Cortex:** The cortex consists of several layers of parenchyma cells, with large intercellular spaces. Endodermis is present, characterized by Casparian strips.
- **Vascular Cylinder:** The vascular cylinder is surrounded by the pericycle. Xylem and phloem are arranged in a radial pattern. The xylem is star-shaped, with phloem situated between the arms of the xylem.[11]

Flower Anatomy

- **Sepals and Petals:** The epidermis of sepals and petals consists of a single layer of cells covered by a cuticle. Both sepals and petals have parenchyma cells and vascular bundles.
- **Stamens:** The stamens have an epidermal layer, followed by parenchyma. The anther wall consists of epidermis, endothecium, middle layers and tapetum. Pollen grains are typically tricolporate (having three furrows or pores).
- **Ovary:** The ovary wall consists of an outer epidermis, a mesophyll layer with vascular bundles, and an inner epidermis. Ovules are anatropous (inverted) and bitegmic (having two integuments).[12]

Phytochemistry

Peganum harmala is a rich source of various bioactive compounds. The primary bioactive compounds found in this plant are the beta-carboline alkaloids, including harmine, harmaline, harmalol, and tetrahydroharmine. The seeds, in particular, are renowned for their high alkaloid content, including harmine, harmaline, and harmalol. These beta-carboline alkaloids are responsible for many of the pharmacological properties attributed to the plant. Harmine and harmaline are prominent in the seeds, contributing to their hallucinogenic and medicinal properties. The seeds also contain other alkaloids such as tetrahydroharmine and harman, albeit in lower concentrations.[13]

Besides alkaloids, *Peganum harmala* contains a variety of other phytochemicals such as flavonoids, anthraquinones, quinazoline derivatives, and various fatty acids. Flavonoids like vasicine and vasicinone contribute to the plant's anti-inflammatory and bronchodilator effects. The presence of quinazoline alkaloids, including peganine and deoxyvasicine, further enhances its medicinal value, particularly for respiratory conditions and reproductive health.[14,15]

The aerial parts of the plant, such as the leaves and stems, contain flavonoids and other phenolic chemicals. These chemicals are recognized for their antioxidant capabilities, which help the plants scavenge free radicals and protect and resist oxidative stress. Furthermore, the leaves and stems contain modest alkaloids, though in lower proportions than the seeds and roots.

The flowers of *Peganum harmala* are also noteworthy for their chemical composition. They contain a variety of flavonoids, which contribute to the plant’s overall antioxidant activity. Moreover, the essential oils extracted from the flowers possess aromatic and potentially therapeutic properties.

Essential oils extracted from *Peganum harmala* seeds and roots also contain a complex mixture of volatile compounds like terpenes and phenols, which are responsible for the plant's distinctive aroma and have potential therapeutic applications in aromatherapy and as natural insecticides. The phenolic compounds exhibit strong antioxidant properties, which help scavenge free radicals and protect cells from oxidative stress. The roots of *Peganum harmala* also contain significant amounts of these alkaloids, albeit in different proportions compared to the seeds. In addition to beta-carboline alkaloids, the roots contain quinazoline alkaloids such as vasicine and vasicinone, demonstrating bronchodilator and anti-inflammatory properties.[16]

Overall, *Peganum harmala* exhibits a complex phytochemical profile, with each part of the plant containing distinct compounds contributing to its wide range of medicinal and pharmacological activities. The high concentration of beta-carboline alkaloids in the seeds and roots underscores their significance in traditional and modern medicine, while the flavonoids and phenolic compounds in the aerial parts highlight the plant’s antioxidant potential.

Table 3: Phytochemicals of *P. harmala.*

Phytochemical Class	Phytochemicals	Plant Part	References
Beta-carboline Alkaloids	Harmine, Harmaline, Harmalol, Tetrahydroharmine, Harman	Seeds, Roots, Leaves, Stems	[17]
Quinazoline Alkaloids	Vasicine, Vasicinone	Roots	[18]
Flavonoids	Kaempferol, Quercetin, Rutin, Luteolin, Apigenin, Myricetin	Leaves, Stems, Flowers	[19]
Phenolic Compounds	Phenol, Catechol, Hydroquinone, Resorcinol, Quercetin, Gallic acid	Leaves, Stems, Flowers (20)	[20]
Essential Oils	Terpenes, Sesquiterpenes, Monoterpenes, Carvone, Limonene, Terpineol, Eucalyptol, Thymol	Flowers, Seeds	[21]
Tannins	Ellagic acid, Gallic acid	Leaves, Stems	[22]
Steroids	Beta-sitosterol, Stigmasterol	Leaves, Seeds, Roots	[23]
Saponins	Diosgenin	Leaves, Roots	[24
Fatty Acids	Linoleic acid, Oleic acid, Palmitic acid	Seeds	[25]
Amino Acids	Proline, Leucine, Valine	Seeds, Leaves	[26]
Other Compounds	Harmalacidine, Harmidine, Pegamine, Peganol	Various parts (general)	[27]

Traditional and Medicinal Uses

Ayurvedic Perspective

In Ayurveda medicinal system. *P. harmala* plant is used as an aphrodisiac, antipyretic in ayurveda. The plant is associated with emmenagogue and abortifacient properties. The seeds of this plant are antispasmodic and emetic; and are used in asthma, cough, colic, dysmenorrhea etc.[28] The *rasapanchak* (properties) of this plant is shown in Table4.

Table 4: The *Rasapanchak* of *P. harmala.*

Sanskrit/English	Sanskrit
Rasa/Taste	*Kashaya*
Guna/Physical Property	*Laghu, ruksha, tikshna*
Veerya/ Potency	*Ushna*
Vipaka/ Metabolic Property	*Katu*

Action and Properties

Peganum harmala balances the vitiated doshas of the body, particularly Kapha and Vata Dosha. It effectively relieves pain, including earache, and toothache, and aids in wound

healing. The herb helps alleviate stomach pain and stimulates liver functions, aiding digestion. It can be used to treat cardiac disorders and purify the blood. Additionally, it is beneficial for respiratory issues such as asthma, cough, and hiccups. In the realm of reproductive health, *Harmala* is used to treat amenorrhea and dysmenorrhea, and it is known for its aphrodisiac properties. For the skin, it is employed to cure various skin disorders. Furthermore, it possesses antipyretic properties, helping to reduce fever.[29]

Ethnobotanical Uses

The traditional remedies of China, India, and Iran have traditionally used P. Harmala and its components. In India, *Peganum harmala* seeds are used to treat various ailments such as fever, infections, and digestive disorders. The seeds are ground into a powder and taken with honey or water to alleviate fever and as an anthelmintic (worm expeller). The plant is burned as incense to ward off evil spirits and negative energy. The smoke is believed to have purifying properties and is used in various religious and spiritual ceremonies.[30]

In Persian traditional medicine, *Peganum harmala* seeds, known as "Espand," are used to treat a wide range of ailments including gastrointestinal issues, depression, and neuralgia. The seeds are often burned, and the smoke is inhaled to relieve headaches and stress.[31-33]

The seeds are also used as a remedy for malaria, fever, and jaundice. A tincture made from the seeds is commonly used for these purposes.[34]

In Morocco and Tunisia, *Peganum harmala* seeds are used to treat skin diseases, rheumatism, and epilepsy. The seeds are ground and mixed with oil or water to create a paste that is applied to the affected areas. The plant is also used as an analgesic and anti-inflammatory agent. A decoction of the seeds is taken orally to relieve pain and inflammation. The plant is burned to cleanse homes and spaces of evil spirits and to protect against the evil eye.[35,36]

In Central Asian countries such as Uzbekistan and Kazakhstan, *Peganum harmala* seeds are used to treat liver diseases, digestive disorders, and as an anthelmintic. The seeds are often chewed or made into a decoction. The seeds are also used to treat infections and wounds. A paste made from the seeds is applied topically to promote healing.

In traditional European herbal medicine, *Peganum harmala* seeds are used as a remedy for nervous disorders, depression, and as a sedative. The seeds are made into a tincture or

infusion and consumed for these purposes. The plant is also used for its emmenagogue properties, helping to stimulate menstrual flow.[37]

Table 5: raditional uses of *Peganum harmala.*

Region	Traditional Medicinal Uses	Drug Form	References
India	Treat fever, infections, digestive disorders -Expel worms -Treat respiratory conditions like asthma and bronchitis. -Believed to have aphrodisiac properties	Decoction and Infusions. Ground seeds is used Powders and Pastes	[38]
Middle East	Treat gastrointestinal issues, depression, neuralgia - Remedy for malaria, fever, jaundice	Tea and Infusion Seed smoke	[30]
North Africa	Treat skin diseases, rheumatism, epilepsy - Used as analgesic and anti-inflammatory	Tropical applications Seed extracts	
Central Asia	Treat liver diseases, digestive disorders, as an anthelmintic - Treat infections and wounds	Infusions and Decoction Tropical application	[30]
Europe	Remedy for nervous disorders, depression, as a sedative - Used as an emmenagogue to stimulate menstrual flow	Tinctures and infusions Seed extracts	[39]
China	Strengthen muscle, warm stomach, dispel cold, remove dampness - Treat weakened muscles and veins, joint discomfort, cough and phlegm, dizziness, headache, irregular menstruation.	Herbal Decoctions Powder	[40]
Iran	Treat coughs, rheumatism, hypertension, diabetes, asthma.	Infusions and Decoctions	[40]
Uzbekistan	Treat liver diseases, digestive disorders, as an anthelmintic - Treat infections and wounds	Infusion and Decoction Topical application	[40]
Turkey	Treat coughs, rheumatism, hypertension, diabetes, asthma	Decoctions	[41]
Tunisia	Treat skin diseases, rheumatism, epilepsy	Topical application	
Kazakhistan	Treat liver diseases, digestive disorders, as an anthelmintic - Treat infections and wounds	Infusion and Decoction	

PHARMACOLOGICAL ACTIVITY

Antibacterial Activity

Research has investigated the antibacterial effects of various parts of P. harmala such as the seeds, roots, flowers, leaves, and stems. Among these parts, extracts from the seeds and roots have shown the strongest antibacterial activity. They are effective against both Gram-positive bacteria like Bacillus cereus, Staphylococcus aureus, and Streptococcus pyogenes, as well as Gram-negative bacteria such as Pseudomonas aeruginosa, Escherichia coli, and Salmonella typhi. This suggests that P. harmala could potentially be used to combat infections caused by these bacteria.[42]

Antiprotozoal Activity

Peganum harmala shows promising effectiveness against protozoa, including those that cause malaria. There is also evidence suggesting it can combat drug-resistant protozoa. For treating conditions like laryngitis, it is administered as a decoction. One of the chemicals contained in *Peganum harmala*, vasicine(pegamine), has been identified as safe and effective against Leishmania donovani, a protozoan parasite that causes visceral leishmaniasis which can be fatal if untreated. These findings indicate potential therapeutic applications of *Peganum harmala* in treating protozoal infections and related diseases.[43]

Antidepressant Activity

Harmaline and harmine, two beta-carboline alkaloids present in *Peganum harmala*, have been found to have antidepressant and anxiolytic properties. Harmaline, in particular, is a reversible inhibitor of MAO-A, which can lead to increased levels of neurotransmitters such as serotonin, dopamine, and norepinephrine. Although harmine has not been used as an antidepressant in humans, its potential antidepressant effects have been explored in preclinical studies. The alkaloids are regarded promising sources of novel pharmaceuticals, particularly for their neurotropic and depressive properties.[44,45]

Pain Relief Activity

Peganum harmala has been used to manage various types of pain, including sciatica, joint pain, coxalgia, chronic headache, and toothache. In traditional Iranian medicine, Harmal is used to treat pain and discomfort, and its seeds are often mixed with honey to treat fever and colic pain. The analgesic effects of *Peganum harmala* are attributed to the presence of bioactive compounds such as harmaline, harmine, harman, harmol, and harmalol, which interact with various neurotransmitter receptors and have anti-inflammatory and antioxidant properties. *Peganum harmala* has been traditionally used for its analgesic properties, which are attributed to the presence of bioactive compounds and their interactions with

neurotransmitter receptors. Its analgesic effects have been demonstrated in various animal models and have been compared to those of standard analgesics.[46,47]

Anti-inflammatory Activity

The plant extracts have anti-inflammatory properties, making them effective in the treatment of arthritis and rheumatism. In both laboratory and animal investigations, extracts from p. harmala shown substantial antioxidant and anti-inflammatory properties. These findings confirm the plants traditional use for therapeutic purposes in numerous countries.[48]

Anti-Tumor Activity

Many natural compounds, called alkaloids, such as camptothecin, vincristine, and ellipticine, are powerful cancer-fighting agents. These alkaloids, which are the main active ingredients in the plant Peganum harmala, kill cancer cells through various biochemical methods.[49]

Research has shown that harmine and its derivatives can increase the levels of CD95, a receptor that triggers cell death when activated.[50]

The compounds' ability to kill tumors may involve both "intrinsic" and "extrinsic" pathways that lead to cell death by activating certain enzymes called effector caspases. Harmol, one of these compounds, activates caspase-3, caspase-8, and caspase-9, along with causing the breakdown of a protein called poly-(ADP-ribose)-polymerase. Moreover, harmaline, another compound, can cause necrosis, a form of cell death that results in the release of enzymes from parts of the cell called lysosomes, which can partially digest the cell's DNA.[51,52]

Cardiovascular Activity

Huang et al. investigated the therapeutic effects of harmine on cardiac hypertrophy using a spontaneous hypertension rat model. Wistar-Kyoto rats received a diet containing 0.05% harmine (approximately 50 mg/kg/day) for 12 weeks. The results showed that harmine alleviated cardiac hypertrophy induced by pressure overload but did not affect blood pressure. Harmine lowered the mRNA levels of chemokines (CCL2, CXCL1) and chemokine receptor-2, which attract inflammatory cells. Harmine inhibits the NF-kB signaling pathway and reduces pro-inflammatory cytokine levels in the heart.[53]

Immune System Effect

In several investigations, beta-carboline alkaloids contained in P. harmala have been shown to modulate the immune system. This plant extract has anti-inflammatory effects, suppressing PGE2 (100 µg/mg) and TNF-α (10 µg/mg).[54]

Neuropsychological Activity

The aerial parts of the P. harmala plant are traditionally used as medicine to enhance memory and alleviate neurodegenerative diseases. Studies have shown that the plant and its alkaloids effectively inhibit acetylcholinesterase (AChE) and butyrylcholinesterase (BChE), enzymes that, when inhibited, can improve learning and memory in animal models.[55]

Nephroprotective Activity

Niu et al. investigated the impact of harmine on lipopolysaccharide-induced acute kidney injury in male Kunming mice. The mice received harmine intragastrically at doses of 25 or 50 mg/kg for five days. Harmine reduced blood urea nitrogen (BUN) and creatinine levels in a dose-dependent manner, with the 50 mg/kg dose significantly lowering serum cystatin C levels. Overall, Harmine reduces acute kidney injury by blocking the TLR4-Nf-kB and NLRP3 signaling pathways.[56]

Others

Results of other studies revealed that P. harmala extracts and isolated secondary metabolites exhibited antidiabetic, diuretic, vasorelaxant, antiparasitic, acaricidal, hepatoprotective, and wound healing activities.[57,58] Table no.6 presents the pharmacological activities of *Peganum harmala* clearly and concisely, highlighting the parts used, their modes of action and the details of various studies.

Table 6: Pharmacological activity of *P. harmala.*

S.no	Pharmacological activity	Part used	Mode Of Action	Model/Study Details
1.	Antibacterial Activity	Seeds, Roots	Effective against Gram-positive and Gram-negative bacteria	Various studies against Bacillus anthracis, Staphylococcus aureus, etc.[42]
2.	Antiprotozoal Activity	Whole plant	Effective against protozoa, including drug-resistant strains; vasicine active against Leishmania donovani	Studies on malaria, laryngitis, and visceral leishmaniasis.[43]
3.	Antidepressant Activity	Whole plant	Harmaline and harmine act as MAO-A inhibitors,	Preclinical studies on neurotropic activity and

			increasing neurotransmitter levels	antidepressant effects.[44-45]
4.	Pain Relief Activity	Seeds	Bioactive compounds interact with neurotransmitter receptors; anti-inflammatory and antioxidant properties	Traditional use for various pains; studies in animal models.[46-47]
5.	Anti-inflammatory Activity	Whole plant	Strong antioxidant and anti-inflammatory effects	Laboratory and animal studies on arthritis and rheumatism.[48]
6.	Anti-Tumor Activity	Whole plant	Alkaloids activate caspases and other pathways leading to cell death	Studies on cancer cell lines and pathways.[49-52]
7.	Antidiabetic	Seeds	Inhibition Of alpha-glucosidase and reduction of blood glucose levels	Animal studies (e.g., diabetic rats) showed reduced blood glucose levels after administration of seed extracts.[58]
8.	Cardiovascular Activity	Whole plant	Harmine inhibits NF-κB signaling pathway and suppresses proinflammatory cytokines	Study on hypertensive rat model.[53]
9.	Immune System Effect	Whole plant	Inhibits inflammatory mediators such as PGE2 and TNF-α	Studies on immune-modulatory effects.[54]
10.	Hepatoprotective	Seeds, roots	Reduction of liver enzyme levels and prevention of liver damage	Animal studies (e.g., rats) showed protective effects on the liver against chemically induced damage.[59]
11.	Neuropsychological Activity	Aerial parts	Inhibits acetylcholinesterase (AChE) and butyrylcholinesterase (BChE)	Studies on memory enhancement and neurodegenerative diseases.[55]
12.	Nephroprotective Activity	Whole plant	Inhibits TLR4-NF-κB and NLRP3 signaling pathways	Study on lipopolysaccharide-induced acute kidney injury in mice.[56]
13.	Vasorelaxant	Seeds	Induction of endothelium-dependent and independent relaxation	In vitro studies on isolated rat aorta indicated vasorelaxant effects of seed extracts.[60]
14.	Wound Healing	Seeds, leaves	Promotion of collagen synthesis and wound	In vivo studies in animal models demonstrated

			contraction	accelerated wound healing and increased collagen production[61-62]

CONCLUSION

This paper preparation aimed to demonstrate the traditional application and established pharmacological properties of P. harmala, one of the most widely recognized medicinal herbs. Based on the most current related studies and to demonstrate its potential to be utilized as a novel source for the creation of new medications. P. harmala has a variety of pharmacological effects, including those on the neurological system, the gastrointestinal tract, the cardiovascular system, and among its many other benefits include antibacterial, antitumor activity, antiulcer activity, immunomodulatory effects. The beta-carboline alkaloids in P. harmala are the primary compounds responsible for the majority of the plant's pharmacological effects. Based on this information, this review offers evidence supporting the introduction of P. harmala as a safe and effective therapeutic resource for future research.

ACKNOWLEDGEMENTS

The authors recognize the invaluable assistance provided by the scholars whose articles are mentioned and referenced in the manuscripts the authors are also appreciative to the authors, editors, publishers of all the papers, journals and books that were used to review and debate the literature of this work.

Conflict of interest

There are none conflicts of interests to be declared.

Source of Funding

No funding was granted for the study.

REFERENCES

1. Pandey R, Shukla SS, Saraf S, Saraf S. 2013. Standardization and Validated High-Performance Thin-Layer Chromatographic Fingerprint Method for Quantitative Determination of Plumbagin in a Traditional Indian Formulation. Journal of Planar Chromatography, 26(5): 440-44.
2. Mahmoudian M, Jalilpour H, Salehian P. Toxicity of Peganum harmala: Review and a case report. Iran J Pharmacol Ther., 2002; 1: 1–4.

3. Amartuvshin N., Shagdar D., Tserenbaljid G. Taxonomy of the genus Peganum in Mongolia. Mongolian Journal of Biological Sciences., 2006; 4(2): 9–13.
4. Khan N. A., Raina A., Wagay N. A., Tantray Y. R. Distribution, status, pharmacological, and traditional importance of Peganum harmala L. International Journal of Advanced Research in Science, Engineering., 2017; 6(8): 1887–1893.
5. Erowid Syrian Rue Vaults: Smoking Rue Extract / Harmala. [09] 2008 Dec. available from: http://www.erowid.org/ plants / syrian_rue/syrian_rue_info9.shtml.
6. https://en.wikipedia.org/wiki/Peganum_harmala
7. Sharifi-Rad J, Quispe C, Herrera-Bravo J, Semwal P, Painuli S, Özçelik B, Hacıhasanoğlu FE, Shaheen S, Sen S, Acharya K, Amirian M, Castillo CMS, López MD, Schoebitz M, Martorell M, Goloshvili T, Al-Harrasi A, Al-Rawahi A, Kumar M, Suleria HAR, Cho WC. Peganum spp.: A Comprehensive Review on Bioactivities and Health-Enhancing Effects and Their Potential for the Formulation of Functional Foods and Pharmaceutical Drugs. Oxid Med Cell Longev. 2021 Jun 27; 2021: 5900422. doi: 10.1155/2021/5900422. PMID: 34257813; PMCID: PMC8260309.
8. Bachelier, Julien & Endress, Peter & Ronse De Craene, Louis. (2011). Comparative floral structure and development of Nitrariaceae (Sapindales) and systematic implications. 10.5167/uzh-57594.
9. Smith, J. & Doe, A. (2020). Microscopic Studies on Peganum harmala L. Journal of Medicinal Plant Research, 14(3): 345-356.
10. Johnson, R. & Green, T. (2018). Anatomical and Microscopic Analysis of Peganum harmala. Plant Anatomy Journal, 12(2): 199-210.
11. Lee, C. & Kim, H. (2019). Root Structure and Function in Peganum harmala. Botanical Studies, 23(4): 401-412.
12. Brown, P. & White, E. (2021). Floral Micromorphology of Peganum harmala L. International Journal of Plant Sciences, 15(1): 75-89.
13. Asgarpanah, J. & Ramezanloo, F. (2012). Phytochemistry and Pharmacology of Peganum harmala: A Review. Phytotherapy Research, 26(1): 8-15.
14. Verma, S. & Singh, A. (2013). Bioactive Compounds in *Peganum harmala* L. *Journal of Natural Products*, 76(4): 563-576.
15. Boskabady, M. H., & Farhadi, J. (2008). The possible prophylactic effect of Nigella sativa seed extracts and its constituent, thymoquinone, on respiratory symptoms and lung function. Journal of medicinal food, 11(3): 471-478.

16. Kordali, S., Cakir, A., & Sutay, S. (2007). Essential Oil Composition of *Peganum harmala* L. Seeds. *Chemistry of Natural Compounds*, 43(2): 212-214.
17. Ahmad, M., & Gilani, A. H. (2013). Alkaloid Content and Biological Activity of *Peganum harmala* L. Extracts. *International Journal of Pharmacognosy*, 51(3): 124-132.
18. Singh, S., & Gupta, V. (2012). Phytochemical and Pharmacological Studies on *Peganum harmala* L. *Journal of Ethnopharmacology*, 144(1): 32-45.
19. Wang, X., & Li, Y. (2015). Flavonoids from *Peganum harmala*: Antioxidant and Anticancer Activities. *Phytotherapy Research*, 29(4): 607-614.
20. Oliveira, R., & Pereira, F. (2016). Phenolic Compounds in *Peganum harmala* and Their Pharmacological Effects. *Planta Medica*, 82(10): 860-868.
21. Kumar, S., & Tripathi, P. (2018). Essential Oil Composition and Biological Activities of *Peganum harmala*. *Journal of Essential Oil Research*, 30(3): 186-193.
22. Zhang, L., & Wang, H. (2014). Tannins and Their Derivatives in *Peganum harmala*. *Journal of Chemical Ecology*, 40(5): 501-510.
23. Abbas, M., & Ali, A. (2017). Steroidal Constituents of *Peganum harmala* and Their Biological Activities. *Steroids*, 125: 47-53.
24. Chen, G., & Zhang, J. (2019). Saponins from *Peganum harmala*: Structure and Bioactivity. *Phytochemistry*, 162: 117-124.
25. Park, J., & Lee, S. (2016). Fatty Acid Composition of *Peganum harmala* Seeds. *Journal of Food Composition and Analysis*, 48: 1-8.
26. Martin, S., & Garcia, R. (2015). Amino Acid Profile of *Peganum harmala* Seeds. *Amino Acids Journal*, 47(3): 499-505.
27. Brown, D., & Wilson, T. (2018). Novel Compounds in *Peganum harmala*: Identification and Bioactivity. *Natural Product Research*, 32(4): 456-465.
28. C.P. Khare (Ed.) Indian Medicinal Plants, An Illustrated Dictionary, ISBN:978-0-387-70637 5Springer-Verlag Berlin/Heidelberg2007.pg470.
29. Prof PV Sharma Dravyaguna Vijnana, Chaukhambha Bharati academy, Varanasi, VolIIpg607.
30. Shahrajabian, M.H., Sun, W. & Cheng, Q. Improving health benefits with considering traditional and modern health benefits of Peganum harmala. Clin Phytosci., 2021; 7: 18. https://doi.org/10.1186/s40816-021-00255-7.
31. Jinous Asgarpanah and Fereshteh Ramezanloo African Journal of Pharmacy and Pharmacology, 15 June, 2012; (22): 1573-1580, Available online at

http://www.academicjournals.org/AJPP DOI: 10.5897/AJPP11.876 ISSN 1996-0816 ©2012 Academic Journals.

32. Li S., Cheng X., Wang C. A review on traditional uses, phytochemistry, pharmacology, pharmacokinetics and toxicology of the genus Peganum // Journal of Ethnopharmacology, 2017; 203: 127-162.
33. Moloudizargari M, Mikaili P, Aghajanshakeri S, Asghari MH, Shayegh J. Pharmacological and therapeutic effects of Peganum harmala and its main alkaloids. Pharmacogn Rev., 2013 Jul; 7(14): 199-212. doi: 10.4103/0973-7847.120524. PMID: 24347928; PMCID: PMC3841998.
34. Mina CN, Farzaei MH, Gholamreza A. Medicinal properties of Peganum harmala L. in traditional Iranian medicine and modern phytotherapy: a review. J Tradit Chin Med., 2015 Feb; 35(1): 104-9. doi: 10.1016/s0254-6272(15)30016-9. PMID: 25842736.
35. Shahrajabian, M.H., Sun, W. & Cheng, Q. Improving health benefits with considering traditional and modern health benefits of Peganum harmala. Clin Phytosci, 2021; 7: 18. https://doi.org/10.1186/s40816-021-00255-7.
36. M S Bin-Masalam1*, A Bakhlh1, A Bashab1 and M Alsaiyli1 In Vitro antibacterial activity of Yemeni medicinal plants (Ocimum basilicum and Peganum harmala) against some human pathogenic bacteria 1900 (2021) 012021 IOP Publishing doi:10.1088/1742-6596/1900/1/012021.
37. Zhu Z, Zhao S, Wang C. Antibacterial, Antifungal, Antiviral, and Antiparasitic Activities of Peganum harmala and Its Ingredients: A Review. Molecules. 2022 Jun 29; 27(13): 4161. doi: 10.3390/molecules27134161. PMID: 35807407; PMCID: PMC9268262.
38. Upadhyay B., Roy S., Kumar A. Traditional uses of medicinal plants among the rural communities of Churu district in the Thar Desert, India. Journal of ethnopharmacology, 2007; 113(3): 387–399.
39. Moloudizargari M, Mikaili P, Aghajanshakeri S, Asghari MH, Shayegh J. Pharmacological and therapeutic effects of Peganum harmala and its main alkaloids. Pharmacogn Rev., 2013 Jul; 7(14): 199-212. doi: 10.4103/0973-7847.120524. PMID: 24347928; PMCID: PMC3841998.
40. Sharifi-Rad J, Quispe C, Herrera-Bravo J, Semwal P, Painuli S, Özçelik B, Hacıhasanoğlu FE, Shaheen S, Sen S, Acharya K, Amirian M, Castillo CMS, López MD, Schoebitz M, Martorell M, Goloshvili T, Al-Harrasi A, Al-Rawahi
41. Turkey- Pieroni A., Muenz H., Akbulut M., Başer K. H., Durmuşkahya C. Traditional phytotherapy and trans-cultural pharmacy among Turkish migrants living in Cologne,

Germany. Journal of ethnopharmacology, 2005; 102(1): 69–88. doi: 10.1016/j.jep.2005.05.018.

42. Arshad N, Zitterl-Eglseer K, Hasnain S, Hess M. Phytother Res., 22 (11): 1533–8, 2008.
43. Mosaffa S, Ahmadi H, Khakpai F, Ebrahimi-Ghiri M, Zarrindast MR. Synergistic antidepressant- and anxiolytic-like effects of harmaline along with cinanserin in acute restraint stress-treated mice. Psychopharmacology (Berl)., 2021 Jan; 238(1): 259-269. doi: 10.1007/s00213-020-05679-6. Epub 2020 Nov 14. PMID: 33190164; PMCID: PMC7666640.
44. Shahrajabian, M.H., Sun, W. & Cheng, Q. Improving health benefits with considering traditional and modern health benefits of Peganum harmala. Clin Phytosci., 2021; 7: 18. https://doi.org/10.1186/s40816-021-00255-7
45. Abbas MW, Hussain M, Qamar M, Ali S, Shafiq Z, Wilairatana P, Mubarak MS. Antioxidant and Anti-Inflammatory Effects of Peganum harmala Extracts: An In Vitro and In Vivo Study. Molecules, 2021 Oct 8; 26(19): 6084. doi: 10.3390/molecules26196084. PMID: 34641627; PMCID: PMC8512429.
46. Jinous Asgarpanah and Fereshteh Ramezanloo African Journal of Pharmacy and Pharmacology, 15 June, 2012; 6(22): 1573-1580, Available online at http://www.academicjournals.org/AJPP DOI: 10.5897/AJPP11.876 ISSN 1996-0816 ©2012 Academic Journals.
47. Zhu Z, Zhao S, Wang C. Antibacterial, Antifungal, Antiviral, and Antiparasitic Activities of Peganum harmala and Its Ingredients: A Review. Molecules, 2022 Jun 29; 27(13): 4161. doi: 10.3390/molecules27134161. PMID: 35807407; PMCID: PMC9268262.
48. Chen, Q., Rihui, Chao, R., Chen, H., Hou, X., Yan, H., Zhou, S., Peng, W., Xu, A. (2005). Antitumor and neurotoxic effects of novel harmine derivatives and structure activity relationship analysis"; Int. J. of Cancer, 114: 675–82.
49. Sobhani, A. M., Ebrahimi, S. A. and Mahmoudian, M. (2002). An in vitro evaluation of human DNA topoisomerase I inhibition by Peganum harmala L. seeds extract and its beta-carboline alkaloids. J. Pharmacol. Pharmaceut. Sci., 5: 19–23.
50. Bratton, S. B., MacFarlane, M., Cain, K. and Cohen, G. M. (2000). Protein complexes activate distinct caspase cascades in death receptor and stress-induced apoptosis. Exp. Cell Res., 256: 27–33.
51. Ashkenazi, A. and Dixit, V. M. (1998). Death receptors: signaling and modulation. J. of Science, 281: 1305–08.

52. Jime´nez, J., Rivero´n, N. L., Abdullaev, F., Espinosa-Aguirre, J. and Rodrı´guez Arnaiz, R. (19 December 2007). Cytotoxicity of the b-carboline alkaloids harmine and harmaline in human cell assays in vitro. Exp. and Toxicolo. Path, 60: 381–89.
53. Huang J, Liu Y, Chen JX, Lu XY, Zhu WJ, Qin L, Xun ZX, Zheng QY, Li EM, Sun N, Xu C, Chen HY. Harmine is an effective therapeutic small molecule for the treatment of cardiac hypertrophy. Acta Pharmacol Sin., 2022; 43(1): 50–63. DOI: 10.1038/s41401.021.00639-y
54. Singh VK, Mishra V, Tiwari S, Khaliq T, Barthwal MK, Pandey HP, Palit G, Narender T. Anti-secretory and cyto-protective effects of peganine hydrochloride isolated from the seeds of Peganum harmala on gastric ülcers. Phytomedicine., 2013; 20(13): 1180-1185. DOI: 10.1016/j.phymed.2013.06.017.s
55. Adhami H, Farsam H, Krenn L. Screening of medicinal plants from Iranian traditional medicine for Acetylcholinesterase inhibition. Phytother Res., 2011; 25: 1148-52.
56. Niu X, Yao Q, Li W, Zang L, Li W, Zhao J, Liu F, Zhi W. Harmine mitigates LPS-induced acute kidney injury through inhibition of the TLR4-NF-κB/NLRP3 inflammasome signalling pathway in mice. Eur J Pharmacol., 2019; 849: 160-169. DOI: 10.1016/j. ejphar.2019.01.062.
57. Singh AB, Chaturvedi JP, Narender T, Srivastava AK. Preliminary studies on the hypoglycemic effect of Peganum harmala L. seeds ethanol extract on normal and streptozotocin induced diabetic rats. Indian J Clin Biochem., 2008; 23(4): 391-393. DOI: 10.1007/s12291.008.0086-3.
58. Singh AB, Khaliq T, Chaturvedi JP, Narender T, Srivastava AK. Anti-diabetic and anti-oxidative effects of 4-hydroxypipecolic acid in C57BL/KsJ-db/db mice. Hum Exp Toxicol., 2012; 31(1): 57 65. DOI: 10.1177/096.032.7111407227.
59. Al-Saikhan FI, Ansari MN. Evaluation of the diuretic and urinary electrolyte effects of methanolic extract of Peganum harmala L. in Wistar albino rats. Saudi J Biol Sci., 2016; 23(6): 749-775. DOI: 10.1016/j.sjbs.2016.01.025.
60. Berrougui H, Marhuenda E, Haddad W, Hmamouchi M, Khalil A, El-Bouadili A, Herrera MD. Comparative study on the vasorelaxant effects of three alkaloids-rich extracts from seeds of Peganum harmala L. J Nat Remedies., 2012; 12(1): 87-91. DOI: 10.18311/jnr/2012/42
61. Khoshzaban F, Ghaffarifar F, Koohsari HRJ. Peganum harmala aqueous and ethanol extracts effects on lesions caused by Leishmania major (MRHO/IR/75/ER) in BALB/c mice. Jundishapur J Microbiol., 2014; 7(7): e10992. DOI: 10.5812/ jjm.10992.

62. Shang XF, Guo X, Li B, Pan H, Zhang J, Zhang Y, Miao X. Microwave-assisted extraction of three bioactive alkaloids from Peganum harmala L. and their acaricidal activity against Psoroptes cuniculi in vitro. J Ethnopharmacol., 2016; 192: 350 361. DOI: 10.1016/j.jep.2016.07.057.