

TRIBULUS TERRESTRIS L. : A Multitarget Phytotherapeutic Agent Bridging Ethnopharmacology and Modern Medicine

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ABSTRACT

Herbal medicines have gained global recognition because they have a low risk of therapeutic benefits and side effects. *Tribulus terrestris* is often used in traditional medicine because of its diverse pharmacological properties. This overview highlights its biological activity and therapeutic potential in the treatment of diseases such as urolithiasis, diabetes, cardiovascular disease, and sexual dysfunction. It is rich in steroids, saponins, flavonoids, and alkaloids. The effects of *Tribulus terrestris* include antibacterial, antibiotic, antipathogenic, and hepatic properties, as well as hemoprotective and anti-inflammatory characteristics. Scientific research has confirmed its role in kidney health, blood glucose regulation, lipid metabolism, reproductive health, and psychosomatic and neuroprotective benefits. Despite this possibility, further testing is required to standardize the formulations, determine safe doses, and verify clinical efficacy. By integrating traditional knowledge into modern science, *Tribulus terrestris* can be constructed as a valuable natural remedy for various health conditions.

KEYWORDS : *Tribulus Terrestris*, Phytoconstituents, Diuretic herbs, Pharmacology.

INTRODUCTION

In recent years, there has been growing global interest in the use of herbal medicines. Researchers have conducted laboratory studies to investigate the pharmacological properties of bioactive compounds and their potential applications in the treatment of various diseases in both humans and animals. The integration of traditional medicine with ethnopharmacology has contributed to the development of numerous innovative drugs in the global market.^[1-4] For decades, herbal remedies have been used to manage and treat various health conditions. Because of their minimal side effects, they are often considered safer and more effective alternatives to synthetic treatments. While modern pharmaceutical drugs can produce significant therapeutic effects, concerns regarding their adverse reactions persist.

Many compounds currently used in medicine originate from plants, making herbal medicine an attractive option owing to its safety, accessibility, and affordability. Both now and in the future, phytochemicals are expected to play a crucial role in healthcare.

To fully harness their potential, medicinal plants used in traditional practices should be thoroughly studied to identify their active ingredients for possible use in phytomedicine. Among the vast range of herbal products, some have been reported to improve human sexual health.^[5-12]

Tribulus terrestris is a medicinal plant that has been traditionally used as a cardiogenic, appetite stimulant, aphrodisiac, anti-urolithiasis agent, diuretic, emollient, anthelmintic, digestive aid, and antibacterial remedy. It has demonstrated antihypertensive, antihyperlipidemic, and antioxidant properties.^[13] *Tribulus terrestris* has been incorporated into traditional medicine across different cultures to address various health disorders.^[14] Extensive research has examined its phytochemical and pharmacological activities, including diuretic, anti-urolithiasis, antihypertensive, analgesic, antihyperlipidemic, immunomodulatory, antidiabetic, anticancer, anthelmintic, aphrodisiac, antibacterial, hepatoprotective, and anti-inflammatory effects. Studies suggest that due to its potassium-sparing, cardioprotective, and lipid-lowering properties, *Tribulus terrestris* could serve as an effective herbal treatment for blood pressure management.^[15-17] This plant has been widely used in traditional Chinese and Indian medicine, with additional pharmacological benefits reported. Various studies indicate that dietary supplements containing *Tribulus terrestris* extracts may enhance muscle tone, have bio-stimulating effects, and improve spermatogenesis.^[18]

Animal and human studies have suggested that *Tribulus terrestris* enhances sperm quality. In animal research, it has been found to improve folliculogenesis and alleviate polycystic ovarian syndrome. Additionally, clinical trials in humans have demonstrated its effectiveness in the treatment of female sexual dysfunction. A comprehensive review of the existing literature highlights its therapeutic potential. The purpose of this review is to increase public awareness of the health benefits of *Tribulus Terrestris*, enabling individuals to use it for their own well-being and that of their animals, while also encouraging further research among scientists and veterinarians.^[19]

PLANT PROFILE**Taxonomic tree** ^[20]

Domain	Eukaryota
Kingdom	Plantae
Phylum	Spermatophyta
Subphylum	Angiospermae
Class	Dicotyledonae
Order	Geraniales
Family	Zygophyllaceae
Genus	Tribulus
Species	<i>Tribulus terrestris</i>

Vernacular name ^[21,22]

English	Calotropis fruits, puncture wine
Hindi	Gokhru
Sanskrit	Gokshuru, traikantaka, bahukantaka, shvadanstra
Gujarati	Mithagokhru
Marathi	Sarala
Bengali	Gokhri
Tamil	Yanai vanangi
Punjabi	Bhakra

BOTANICAL DESCRIPTION ^[17]

Tribulus terrestris is a small, prostrate, hirsute, or silky-hairy shrub that grows 10–60 cm in height. In contrast, paripinnate leaves have 5–8 pairs of elliptical to oblong lanceolate pinnae. The plant has a yellow flower. The fruit is a distinctive, stellate, five-cornered schizocarp covered with light-yellow prickles, resembling a cow's cloven hoof, hence the name *go-kshura*. Fruits are faint greenish-yellow, globose, and consist of five woody, nearly glabrous, muriculate cocci, each bearing two pairs of sharp spines forming a pentagonal framework. The outer surface is rough, with a faint aromatic odor and a slightly acrid taste. Each coccus contained several oily seeds that were separated by transverse partitions.

Roots are slender, fibrous, branched, 7–18 cm long, 0.3–0.7 cm in diameter, light brown to yellow, tough, woody, and aromatic, with a sweetish astringent taste. Both the roots and fruits are widely used in folk medicine to treat various ailments.



Figure 1 : *Tribulus Terrestris* Plant

PHYTOCHEMISTRY OF *TRIBULUS TERRESTRIS*

Many different compounds with many biological properties and chemical structures have been identified in *Tribulus terrestris*, including saponins, flavonoids, glycosides, phytosterols, tannins, terpenoids, amino acids, and proteins. Among different types of constituents, saponin steroids and flavonoids are considered the most important metabolites with different biological activities.^[23]

Sl no	Parts	Phytochemicals present	Reference
1	Aerial part	Furostanol and Spirostanol saponins (Tigogenin, Chlorogenin, Neotigogenin, Neogitogenin, Hecogenin, Neohecogenin, Diosgenin, Gitogenin, Ruscogenin, and Sarsasapogenin)	16,24
2	Leaf	Flavonoids (Kaempferol, Kaempferol-3-glucoside, and Tribuloside) Alkaloids (β -carboline Alkaloid, Tribulusterine, Terrestrisamide, Tribulusin A, Harmine, Tribulusamide, Harman, Terrestriamide, and N-trans- coumaroyltyramine.	25
3	Fruits	Furostanol and Spirostanol saponins (Chlorogenin, Ruscogenin, Gitogenin, Neotigogenin, Hecogenin, Diosgenin, Neohecogenin, and Sarsasapogenin) Flavonoid profiling of <i>Tribulus terrestris</i> roots confirms the presence of tribuloside and other active compounds. Flavonoids (Kaempferol-3-glucoside Tribuloside, Kaempferol, and Kaempferol-3-rutinoside Alkaloids (Tribulusterine, Tribulusamide, Tribulusin, Harmine, Harmmol, Terrestriamide and Terrestrisamide,	26-29

4	Stem	Saponins, Phytosterols, Rutin, Tannins, Protodioscin, Tannins, Arginine, Carbohydrates, β -carboline Alkaloid and Tribulusin,	9
5	Root	Flavonoids, Saponins, alkaloids, Triterpenoids, Xanthoprotein, and Unique phenolic compounds are phenol 2-(5,6-dimethyl pyrazinyl), and Histidine.	30,31

TRADITIONAL USES

Tribulus Terrestris has a long history of use in China, India, and Greece to treat various health conditions. It is a key component of medications and supplements supporting liver, heart, kidney, and immune functions. Traditionally, it has been used to boost muscle strength, enhance sexual health, and address urinary infections, heart ailments, and cough. Additionally, it acts as an aphrodisiac, stimulant, and nutrient-rich herb.^[32]

Tribulus Terrestris is a traditional medicinal plant used to address various health issues, including gonorrhea, liver disorders, urinary tract infections, heart conditions, eye ailments, edema, hypertension, skin irritation, and cardiovascular diseases.^[33]

The roots and fruits of *Tribulus terrestris* may help in rheumatism, bladder stones, hemorrhoids, premature ejaculation, menorrhagia, and impotence. Additionally, the plant is used to treat premature ejaculation, headaches, dizziness, and spermatorrhea.^[34]

The fruit of *Tribulus Terrestris* is valued for its diuretic effects and is used to treat sexual dysfunction and veiling.^[35]

Additionally, *Tribulus Terrestris* is used to support liver recovery, enhance eye pigmentation, boost blood circulation, and relieve abdominal bloating, edema, and cardiovascular issues.^[36]

MEDICINAL PROPERTIES OF *TRIBULUS TERRESTRIS* ^[19]

SL NO	MEDICINAL PROPERTIES
1	Anti-Inflammatory and Antiaging
2	Treatment of Urinary Stones, Lithiasis, Cystitis, Nephritis, Urinary Tenesmus, Hemorrhoids, Intestinal Parasites, Breathing Difficulties, Asthma, Painful Urination, Blood In The Urine, And Related Urinary Disorders.
3	Antispasmodic, Anticancer, Antibacterial
4	Diuretic, Aphrodisiac, Antiurolithic, Anticancer, Anthelmintic, Antibacterial, And Analgesic
5	Bone Marrow Activity, Immune System
6	Renal Difficulties
7	Liver Problems
8	Cardiovascular System Problems
9	Increased Physical Vigor, Aesthetic Stimulants
10	Aphrodisiac

11	Cooling, Demulcent, Aphrodisiac, Tonic, Boosts Strength, Cough, Difficulties Breathing, Impotence, and Heart Disorders
12	Antiuro lithic, Cardiotonic, Diuretic
13	Anthelmintic , Antibacterial
14	Anticarcinogenic
15	Impotence, Hormonal Imbalance

PHYTOPHARMACOLOGICAL ACTIVITIES

Tribulus terrestris offers a wide range of health benefits, including diuretic, immune-modulating, anticancer, antidiabetic, anti-urolithic, absorption-enhancing, larvicidal, anti-inflammatory, antispasmodic, cardiotonic, aphrodisiac, liver-protective, central nervous system-regulating, pain-relieving, antibacterial, anthelmintic, and anticarcinogenic properties.^[16,17]

Recent studies have identified steroidal saponins and flavonoids as the key chemical constituents responsible for the traditional medicinal effects of *Tribulus Terrestris*, attributing its potent anti-inflammatory and anti-aging properties to these compounds.^[20]

It also acts as a tonic to enhance digestion, increase strength, and aid in conditions such as breathing difficulties, cough, impotence, and heart ailments.^[37]

Tribulus terrestris has been utilized for various purposes, including as a diuretic, tonic, aphrodisiac, pain reliever, astringent, digestive aid, and urinary antiseptic. It supports testosterone production by stimulating the release of gonadotropin-releasing hormone (GnRH), which triggers follicle-stimulating hormone (FSH) and luteinizing hormone (LH) production. Beyond enhancing libido and fertility, testosterone is also known for its role in strengthening the immune system and stimulating bone marrow activity, which is essential for red blood cell production.^[38]

1. ANTICANCER ACTIVITY

The effectiveness of *Tribulus terrestris* saponins against UV-induced carcinogenesis in human keratinocytes was also investigated. These findings indicate that these saponins mitigate UVB-induced programmed cell death by inhibiting conventional apoptosis pathways, and that the photoprotective effect of *Tribulus terrestris* saponins was associated with the upregulation of NER genes and UVB blocking, which led to NF-κB activation. Expanding molecular insights into the mechanisms by which *Tribulus terrestris* saponins regulate cell death could pave the way for the development of new cancer treatments.^[39]

A Bulgarian study examined the effects of the saponin fraction and the complete extract of *Tribulus terrestris* L. on the survival of human breast cancer cells (MCF7) and apoptosis. The *Tribulus terrestris* extract from Bulgaria demonstrated significant dose-dependent inhibition of breast cancer cell viability. Compared with the whole extract, the saponin fraction exhibited a stronger inhibitory effect. The anticancer activity of *Tribulus terrestris* is associated with apoptotic mechanisms, as evidenced by the morphological changes and DNA fragmentation observed after treatment, marking both early and late apoptosis in tumor cells. These findings are the first to demonstrate the anticancer potential of *Tribulus terrestris* in human cancer cells.^[40]

The effect of *Tribulus terrestris* fruit on prostate and colon cancer cell lines was investigated. *Tribulus terrestris* was found to be less toxic to colon cancer cell lines and fibroblast-like cells compared to prostate cancer cell lines.^[41]

2. CARDIAC SYSTEM

Tribulus terrestris exhibited beneficial effects on coronary heart disease, myocardial infarction, cerebral atherosclerosis, and brain thrombosis.^[42]

Effects of *Tribulus terrestris* on New Zealand rabbits fed a cholesterol-rich diet. Their findings indicated that incorporating *Tribulus terrestris* into the diet resulted in lower serum lipid levels and improved the serum lipid

profile. They also suggested that the extract reduced endothelial cell damage in hypoglycemic conditions and may contribute to the partial recovery of endothelial dysfunction.^[43]

Studies on rats with myocardial infarction demonstrated that *Tribulus terrestris* extracts led to a reduction in serum lipidemia, alleviation of left ventricular remodeling, and enhancement of cardiac function in the early stages following a myocardial infarction.^[44]

Research on hypertensive rats induced by a high-fat diet showed that *Tribulus terrestris* extracts lowered systolic and mean arterial pressures, reduced heart rate, and helped prevent weight gain. Additionally, the extract demonstrated antihypertensive and endothelial protective effects..^[45]

Tribulus terrestris saponin was used to treat coronary heart disease (CHD), showing an 82.3% effective reduction in angina pectoris in 406 clinical cases. Compared with the control group (67 patients on "Yufen Ningxin Pian"), it had a significantly higher total effective rate (67.2%, $P < 0.05$) and ECG improvement rate (52.7% vs. 35.8%). It enhances coronary circulation, dilates arteries, and improves myocardial ischemia without adverse effects on the circulatory system, liver, or kidney. It is considered one of the most effective treatments for angina pectoris.^[46]

Tribulus terrestris was found to effectively prevent weight gain in rats without affecting dietary energy balance, testosterone levels, or heart histo-morphometry.^[47]

3. ANTHELMINTIC ACTIVITY

The use of medicinal plants, such as *Tribulus terrestris*, in chickens has shown promising anthelmintic properties. These plants have the potential to serve as natural alternatives to the conventional synthetic drugs. Integrating them into treatment strategies could lessen dependence on synthetic medications, thereby helping to mitigate drug resistance in populations affected by endemic pathogens and reducing drug residues in poultry meat.^[48]

The methanol extract of *Tribulus terrestris* (METT) exhibited wormicidal activity by inhibiting spontaneous motility (paralysis) and inducing death at lower doses, showing effects similar to Albendazole.^[49]

4. URINARY SYSTEM

The antibacterial activity of a methanol extract of *Tribulus terrestris* was evaluated against *Escherichia coli* strains isolated from tract infections. The saponin-rich methanol extract of *Tribulus terrestris* was tested in a microbroth dilution assay. The results suggested that *Tribulus terrestris* could be a potential alternative treatment for urinary tract infections.^[50]

The fruits of *Tribulus terrestris* have traditionally been used to treat urinary diseases, including urolithiasis. Kidney stones primarily consist of calcium oxalate, which exists as calcium oxalate monohydrate (COM) and calcium oxalate dihydrate (COD). Despite the historical use of medicinal plants for the treatment of urinary stones, their effectiveness is often not well understood. Research on *Tribulus terrestris* fruit extracts and their fractions has assessed their anti-urolithiatic potential. The n-butanol fraction, rich in quercetin, diosgenin, and tannic acid, was found to have a protective rather than curative effect against urolithiasis by inhibiting the nucleation and growth of COM stones.^[51]

5. ANTIBACTERIAL ACTIVITY

The antibacterial properties of *Tribulus terrestris* against *Escherichia coli*, *Pseudomonas aeruginosa*, and *Bacillus subtilis* were evaluated. The findings revealed that the total saponin content of *Tribulus Terrestris* exhibited antibacterial activity against both Gram-negative and Gram-positive bacteria.^[52]

The antibacterial activity of water and methanol extracts from *Tribulus terrestris* fruit was tested against gram-positive bacteria (*Bacillus subtilis*, *Staphylococcus aureus*, and *Staphylococcus epidermidis*) and gram-negative bacteria (*Escherichia coli*, *Shigella flexneri*, and *Pseudomonas aeruginosa*). The results showed that both extracts exhibited antibacterial properties, with the methanolic extract demonstrating greater efficacy than the aqueous extract.^[53]

The antibacterial efficacy of a water-based extract of *Tribulus terrestris* was evaluated using the plate agar diffusion method. The extract was tested against both gram-positive bacteria, including *Bacillus subtilis* and *Staphylococcus aureus*, and gram-negative bacteria, such as *Escherichia coli* and *Pseudomonas aeruginosa*. The susceptibility of these bacterial species to the plant extract was compared to that of other bacterial strains and the positive control antibiotic streptomycin. The results confirmed that the aqueous extract of *Tribulus Terrestris* possesses antibacterial properties.^[34]

The antibacterial properties of *Tribulus terrestris* have been studied extensively. Using the in vitro cup plate method, 50% of *H. pylori* strains were found to be sensitive to a 1000 mg/mL concentration of the total *Tribulus Terrestris* extract.^[54]

Tribulus terrestris was extracted using various solvents including methanol, petroleum ether, chloroform, and ethanol. The methanol extract exhibited the strongest inhibitory effect against *Bacillus cereus*, *Escherichia coli*, and *Staphylococcus aureus*. Additionally, the water extract (WETT) showed some inhibition against *Staphylococcus aureus* and *Pseudomonas aeruginosa*.^[55]

6. NEUROPROTECTIVE EFFECTS

In a previous study, Alzheimer's was induced in male Wistar rats using aluminum chloride, and the neuroprotective effects of *Tribulus terrestris* were evaluated. The findings revealed that Oral supplementation with *Tribulus terrestris* L. methanol extract at doses of 100, 300, or 1000 mg/kg significantly enhanced memory function. This improvement was attributed to a reduction in oxidative stress markers and an increase in antioxidant enzyme levels.^[56]

Researchers also discovered that crude saponins extracted from *Tribulus terrestris* fruit significantly alleviated the severity of ischemic stroke in rats.^[57]

The apoptosis of retinal ganglion cells (RGCs) plays a key role in glaucoma. *Tribulus terrestris* helps protect the optic nerve by inhibiting injury pathways and promoting nerve survival.^[58]

7. DIURETIC ACTIVITY

Diuretics enhance the removal of excess water and electrolytes from the body by stimulating urine production. The diuretic activity of *Tribulus terrestris* is believed to result from its ability to increase urine output and excretion via the kidneys. The diuretic potential of this plant is linked to its positive impact on renal function and its role in preventing kidney stone formation. Numerous toxicological studies have demonstrated the safety of *Tribulus terrestris* in various treatments, as it has shown no adverse effects in acute, subacute, or chronic toxicity evaluations. Previous research has extensively investigated the plant's nutraceutical benefits and renal protective properties.^[59]

8. ANTIDIABETIC ACTIVITY

Studies on hyperglycemic animals revealed that *Tribulus terrestris* fruit extracts effectively lowered blood sugar levels to normal.^[60]

Research on the protective effects of *Tribulus terrestris* herb extract in animals from the Arab Emirates showed a reduction in creatinine levels in both the liver and blood.^[61]

A study revealed that a single dose of *Tribulus terrestris* methanol extract significantly lowered fasting blood glucose levels, producing effects comparable to those of glibenclamide treatment.^[62]

Recent research suggests that saponins from *Tribulus terrestris* may help prevent nonalcoholic fatty liver disease in male rats while also acting as antidiabetic agents. In rats with induced type 2 diabetes, dietary supplementation with *Tribulus Terrestris* saponins, either alone or in combination with inulin, significantly reduced steatosis and restored the plasma lipid profile.^[63]

The gross saponins of *Tribulus terrestris* (GSTT) demonstrated inhibitory effects on α -glucosidase. Additionally, they helped regulate postprandial blood glucose levels and improved symptoms associated with insulin-dependent diabetes.^[64]

Clinical trials confirmed the antidiabetic effects of *Tribulus terrestris* water extract (WETT). Diabetic women who received 1000 mg/day of the extract for three months showed reduced fasting blood glucose, 2-hour postprandial glucose, glycosylated hemoglobin, and improved lipid profiles compared to the placebo group.^[65]

9. RENAL DISEASES

Tribulus terrestris is effective in treating renal infections. In India, it is traditionally used as an herbal tonic for urethral infections and diuretic for renal disorders. In Ayurveda, *Tribulus Terrestris* is well known for its role in managing kidney ailments and as an aphrodisiac.^[66]

The plant is valued for its diuretic properties, use in urethral disinfection, and as a carminative. In Bulgaria, its extracts are commonly recommended for addressing urethral and prostate gland issues, as well as for the treatment of kidney stones and urolithiasis.^[67]

10. APHRODISIAC ACTIVITY

Studies on the hormonal effects of *Tribulus terrestris* extracts in primates, rabbits, and rats revealed an increase in androgenic hormone levels and improvements in erectile dysfunction. Researchers concluded that *Tribulus Terrestris* exhibits aphrodisiac properties, likely due to its ability to enhance androgen levels.^[68]

Numerous studies have examined the effects of *Tribulus terrestris* extracts on mice and rats, focusing on their sexual behavior and physiological responses, such as erection, spermatogenesis, and ejaculation. These studies also assessed luteinizing hormone and steroid levels in the blood.^[69]

CONCLUSION

Tribulus terrestris is widely recognized in traditional medicine, and modern research has confirmed its therapeutic benefits. It has been demonstrated to be effective in the treatment of urinary disorders, diabetes, cardiovascular diseases, and sexual dysfunction. Among steroidal saponins, flavonoids, and alkaloids, *Tribulus terrestris* exhibits diuretic, anti-urolithiatic, antibacterial, antihyperlipidemic, aphrodisiac, antidiabetic, hepatoprotective, and neuroprotective effects.

Key applications include kidney health, where it prevents kidney stone formation and supports detoxification, as well as diabetes management by lowering blood glucose levels and improving lipid metabolism. Its cardioprotective properties aid in cholesterol regulation and blood pressure reduction. In addition, it enhances sexual function, boosts libido, and promotes reproductive health.

Further research is essential to establish the optimal dosage, mechanism, and long-term safety of *Tribulus terrestris* in human and veterinary medicine. Standardized extracts and large-scale studies are crucial to validate their therapeutic potential. With a growing interest in herbal medicine, *Tribulus terrestris* stands as a promising natural alternative to synthetic drugs, offering significant health benefits with minimal side effects.

ACKNOWLEDGEMENT

The authors*² would like to express their sincere gratitude to the Department of Pharmacology for providing the necessary facilities, resources, and academic support that greatly contributed to the successful completion of this review. We also extend our appreciation to our colleagues and mentors for their insightful feedback and encouragement throughout the writing process. Special thanks to the authors and researchers whose studies have laid the groundwork for this compilation. Lastly, we are thankful to our families for their patience and constant support.

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