# Phytopharmacological overview of *Tribulus terrestris*

**Saurabh Chhatre, Tanuja Nesari, Gauresh Somani[1], Divya Kanchan[1], Sadhana Sathaye[1]**

*Department of Dravyaguana, Centre for Post Graduate Studies and Research in Ayurveda, Tilak Ayurveda Mahavidyalaya, Pune, [1]Pharmaceutical Sciences and Technology, Pharmacology Research Lab-II, Institute of Chemical Technology, (University under Section 3 of UGC Act-1956, Elite Status and Centre of Excellence - Government of Maharashtra, TEQIP Phase II Funded), Mumbai, Maharashtra, India*

Submitted: 16-06-2013 Revised: 16-06-2013 Published: 20-01-2014

## ABSTRACT

*Tribulus terrestris* (family Zygophyllaceae), commonly known as *Gokshur or Gokharu* or puncture vine, has been used for a long time in both the Indian and Chinese systems of medicine for treatment of various kinds of diseases. Its various parts contain a variety of chemical constituents which are medicinally important, such as flavonoids, flavonol glycosides, steroidal saponins, and alkaloids. It has diuretic, aphrodisiac, antiurolithic, immunomodulatory, antidiabetic, absorption enhancing, hypolipidemic, cardiotonic, central nervous system, hepatoprotective, anti-inflammatory, analgesic, antispasmodic, anticancer, antibacterial, anthelmintic, larvicidal, and anticariogenic activities. For the last few decades or so, extensive research work has been done to prove its biological activities and the pharmacology of its extracts. The aim of this review is to create a database for further investigations of the discovered phytochemical and pharmacological properties of this plant to promote research. This will help in confirmation of its traditional use along with its value-added utility, eventually leading to higher revenues from the plant.

**Key words:** Pharmacology, saponin, *tribulus terrestris*

## INTRODUCTION

The genus *Tribulus*, belonging to family Zygophyllaceae, comprises about 20 species in the world, of which three species, viz. *Tribulus cistoides, Tribulus terrestris*, and *Tribulus alatus*, are of common occurrence in India.[1] Among them, *T. terrestris* (TT) is a well-patronized medicinal herb by Ayurvedic seers as well as by modern herbalists.[2] The plant is used individually as a single therapeutic agent or as a prime or subordinate component of many compound formulations and food supplements. It is an annual shrub found in Mediterranean, subtropical, and desert climate regions around the world, viz. India, China, southern USA, Mexico, Spain, and Bulgaria.[3,4]

### Taxonomical classification

- Kingdom: Plantae
- Division: Phanerogams
- Subdivision: Angiospermae
- Class: Dicotyledonae
- Subclass: Polypetalae
- Series: Disciflorae
- Order: Giraniales
- Family: Zygophyllaceae
- Genus: *Tribulus*
- Species: *terrestris* Linn.

**Address for correspondence:**
Dr. Saurabh P. Chhatre, D: 32, 2/1, Sagar Sangam CHS, Sector - 4, Nerul, Navi Mumbai - 400 706, Maharashtra, India.
E-mail: saurabh_chhatre@yahoo.com

**Access this article online**

Quick Response Code:

Website: www.phcogrev.com

DOI: 10.4103/0973-7847.125530

## PLANT PROFILE

TT is commonly known as *Gokshur* (Sanskrit); puncture vine, land (or small) caltrops (English); *Gokharu* (Hindi); *Bethagokharu* or *Nanagokharu* (Gujarathi); *Nerinjil* (Tamil); and *Khar-e-khusak khurd* (Urdu). It is distributed along a wide geographic perimeter. It is found all over India up to 11,000 ft in Kashmir, Ceylon, and all warm regions of both hemispheres. It is a common weed of the pasture lands, road sides, and other waste places, chiefly in hot, dry, and sandy regions including West Rajasthan and Gujarat in India.[5]

### Botanical description *T. terrestris*

It is small prostrate, 10-60 cm height, hirsute or silky hairy shrub. Leaves are opposite, often unequal, paripinnate; pinnae from five to eight pairs, elliptical or oblong lanceolate [Figure 1]. Flowers are yellow in color. Its carpel fruits are of characteristic, stellate shape, somewhat round-shaped, compressed, five cornered, and covered with princkles of very light yellow color. There are several seeds in each crocus with transverse partitions between

them. The seeds are oily in nature. When fresh, the root is slender, fibrous, cylindrical, frequently branched, bearing a number of small rootlets and is of light brown color. Fruits and roots are mainly used as a folk medicine for the treatment of various ailments. Root occurs in pieces, 7-18 cm long and 0.3-0.7 cm in diameter, cylindrical, fibrous, frequently branched, bearing a number of small rootlets, tough, woody, yellow to light brown in color, surface rough due to the presence of small nodules; fracture fibrous; odor aromatic; taste sweetish astringent. The fruits of the herb are known as "Chih-hsing" in China or goat head in USA. The spiky fruit looks like the cloven hoof of a cow and, hence, is known as go-ksura (cow-hoof). Fruits are faint greenish yellow with spines [Figure 2]. They are globose, consisting of five, nearly glabrous, muriculate, wedge-shaped, woody cocci, each with two pairs of hard sharp spines, one pair longer than the other. Tips of spines almost meet in pairs together forming pentagonal framework around the fruit. Outer surface of the schizocarp is rough. There are several seeds in each coccus, with transverse partitions between them. Odor of fruits is faintly aromatic and taste is slightly acrid.

## PROPERTIES AND ACTIONS MENTIONED IN AYURVEDA

- *Rasa* (taste based on activity): *Madhura* (sweet)
- *Guna* (properties): *Guru* (heavy to digest), *Snigdha* (unctuous)
- *Veerya* (potency): *Sheeta* (cooling)
- *Vipaka* (taste after digestion based on activity): *Madhura* (sweet)
- *Karma* (pharmacological actions): *Brumhana* (nourishing), *Vatanut* (pacifies *Vata-dsha*), *Vrusya* (aphrodisiac), *Ashmarihara* (removes urinary stone), *Vastishodhana* (cures bladder ailments).

## CHEMICAL CONSTITUENTS

The preliminary phytochemical study of TT revealed the presence of saponins, flavonoids, glycosides, alkaloids, and tannins.[6] According to literature data, the saponin composition and the saponin content of TT from different geographic regions is different.[7] Kostova *et al.* studied the chemistry and bioactivity of saponins in TT. They reported that furostanol and spirostanol saponins of tigogenin, neotigogenin, gitogenin, neogitogenin, hecogenin, neohecogenin, diosgenin, chlorogenin, ruscogenin, and sarsasapogenin types are frequently found in this plant. In addition, four sulfated saponins of tigogenin and diosgenin type were also isolated. Majorly present are furostanol glycosides including protodioscin and protogracillin, of which protodioscin is the most dominant saponin and spirostanol glycosides are present in small quantities.[7,8] Wu *et al.* found that the quantity of main flavonoids is about 1.5 times that of main saponins. This indicated that the flavonoid contents in TT should be studied, developed, and further used.[9] Bhutani *et al.* isolated kaempferol, kaempferol-3-glucoside, kaempferol-3-rutinoside, and tribuloside [kaempferol-3-β-d-(6"-*p*-coumaroyl) glucoside] from leaves as well as fruits and identified them by spectroscopic analysis.[10] Louveaux *et al.* detected 18 flavonoids (caffeoyl derivatives, quercetin glycosides, including rutin and kaempferol glycosides) using high-performance liquid chromatography (HPLC) in four *Tribulus* species leaf extracts.[11] Yang *et al.* optimized the extraction condition using orthogonal experiment.[12] Matin Yekta *et al.* isolated three flavonoid glycosides, viz. quercetin 3-*O*-glycoside, quercetin 3-*O*-rutinoside, and kaempferol 3-*O*-glycoside from the aerial parts of *T. terrestris* L. var. *orientalis* (Kerner) G. Beck in the northeast of Iran.[13]

Raja and Venkataraman identified flavonoids from the petroleum ether and chloroform extracts of fresh fruits of TT from India using ethyl acetate: benzene (1:9) solvent system. These flavonoids were not detected in the fruit extracts of other variety, namely *T. alatus*. Hence, presence of such pharmacognostic constituents can be used as a diagnostic tool in the identification of the species and study of contamination/adulteration.[14,15] Tian Shung *et al.* isolated and characterized three new compounds, terrestribisamide, 25*R*-spirost-4-en-3, 12-dione, and tribulusterine, together with 10 known compounds, *N*-*p*-coumaroyltyramine, terrestriamide, hecogenin, aurantiamide acetate, xanthosine, fatty acid ester, ferulic acid, vanillin, *p*-hydroxybenzoic acid, and β-sitosterol, from the dried fruits of TT.[16] The alkaloids present are harmane and norharmane. The β-carboline alkaloid, tribulusterine, is present in minor quantities in fruits.[17] Gas chromatography-mass spectrometry analysis of methanolic extract of the whole plant of TT revealed the presence of α-Amyrin as the major constituent and seven minor constituents, which are 3,7,11,15-tetramethyl-2-hexadecen-1-ol, *n*-hexadecadienoic acid, hexadecadienoic acid ethyl ester, phytol, 9,12-octadecadienoic acid, 9,12,15-octadecatrienoic acid, and 1,2-benzenedicarboxylic acid disoctyl ester. Sterols such as β-sitosterols and stigmasterols were also found to be present.[18]

## TRADITIONAL USES

TT is used in folk medicines as a tonic, aphrodisiac, palliative, astringent, stomachic, antihypertensive, diuretic, lithotriptic, and urinary disinfectant. The dried fruit of the herb is very effective in most of the genitourinary tract disorders. It is a vital constituent of *Gokshuradi Guggul*, a potent Ayurvedic medicine used to support proper functioning of the genitourinary tract and to remove the urinary stones. TT has been used for centuries in Ayurveda to treat impotence, venereal diseases, and sexual debility. In Bulgaria, the plant is used as a folk medicine for treating impotence. In addition to all these applications, the Ayurvedic Pharmacopoeia of India attributes cardiotonic properties to the root and fruit. In traditional Chinese medicine, the fruits were used for treatment of eye trouble, edema, abdominal distension, emission, morbid leukorrhea, and sexual dysfunction. TT is described as a highly valuable drug in the

Shern-Nong Pharmacopoeia (the oldest known pharmacological work in China) in restoring the depressed liver, for treatment of fullness in the chest, mastitis, flatulence, acute conjunctivitis, headache, and vitiligo. In Unani medicine, TT is used as diuretic, mild laxative, and general tonic.[19]

## PHARMACOLOGICAL ACTIVITIES

### Diuretic activity

The diuretic properties of TT are due to large quantities of nitrates and essential oil present in its fruits and seeds. The diuretic activity can also be attributed to the presence of potassium salts in high concentration. Ali *et al.* tested the aqueous extract of TT prepared from its fruit and leaves in rat diuretic model and strips of isolated Guinea pig ileum were used for the contractility test. The aqueous extract of TT, in oral dose of 5 g/kg, elicited a positive diuresis, which was slightly more than that of furosemide. Sodium and chloride concentrations in the urine were increased. The increased tonicity of the smooth muscles, which was produced by TT extract, together with its diuretic activity helped in the propulsion of stones along the urinary tract.[20] Saurabh *et al.* evaluated the different extracts of TT fruits, viz. aqueous, methanolic, *Kwatha*-high strength, *Kwatha*-low strength, and *Ghana* powder, for diuretic activity in rats. *Kwatha*-high strength showed diuretic effect comparable to that of the reference standard frusemide and also exhibited additional advantage of potassium-sparing effect.[21] The diuretic action of TT makes it useful as an anti-hypertensive agent.

### Aphrodisiac activity

Adaikan *et al.* reported that the TT extract exhibited a pro-erectile effect on rabbit corpus cavernosum smooth muscle *ex vivo* after oral treatment at doses of 2.5, 5, and 10 mg/kg body weight for 8 weeks. A significant relaxation of 24% was observed with nitroglycerine in the corpus cavernosum smooth muscle tissue. Similarly, 10% relaxation was observed with both acetylcholine and electrical field stimulation, respectively, following the above treatment with TT in rabbits. The enhanced relaxant effect observed is due to increase in the release of nitric oxide from the endothelium and nitrergic nerve endings, which may account for its claims as an aphrodisiac.[22] Singh *et al.* evaluated the acute and repeated dose administration of lyophilized aqueous extract of the dried fruits of TT (LAET) at doses of 50 and 100 mg/kg of body weight as a sexual enhancer in the management of sexual dysfunction in male rat. A dose-dependent improvement in sexual behavior was observed with the LAET treatment, which was more prominent on chronic administration of LAET. A significant increase in serum testosterone levels too was observed. These findings confirm the traditional use of TT as a sexual enhancer in the management of sexual dysfunction in males.[23] Ethanolic extract of TT exhibited protective effect against cadmium-induced testicular damage. The protective effect appears to be mediated directly either through inhibition of testicular tissue peroxidation by antioxidant and metal chelating activity or by stimulating the testosterone production from Leydig cells.[24] TT extract (100-300 mg/l) treatment to a fish colony was found to be effective in increasing the proportion of males in the population. It was found that testes of fish treated with TT extract showed all stages of spermatogenesis with improved growth performance in *Poeciliata reticulata* fish species.[25] The two main components of the saponin fraction from TT, namely protodioscin and protogracillin, are responsible for the observed biological aphrodisiac activity.[26] It is suggested that protodioscin works by increasing the conversion of testosterone into the potent dehydrotestosterone, which stimulates not only increase in the sex drive but also the production of red cells from bone marrow along with muscular developments contributing to improvement of blood circulation and the oxygen transport systems, leading to optimal health.

### Antiurolithic activity

An ethanolic extract of TT fruits was tested in urolithiasis induced by glass bead implantation in albino rats by Anand *et al.* It exhibited significant dose-dependent protection against deposition of calculogenic material around the glass bead, leukocytosis, and elevation in serum urea levels. Subsequent fractionation of the ethanol extract led to decrease in activity.[27] Various other biochemical parameters in urine, serum, and the histopathology of urinary bladder were restored in a dose-dependent manner. A novel antilithic protein having cytoprotective potency and of molecular weight ~ 60 kDa was purified from TT.[28] Aggarwal tested the activity of TT on the nucleation and growth of calcium oxalate (CaOx) crystals as well as on oxalate-induced cell injury of NRK 52E renal epithelial cells. The experiments revealed that TT extract not only has a potential to inhibit nucleation and growth of the CaOx crystals but also has a cytoprotective role.[28] TT was found to inhibit stone formation in various models of urolithiasis using sodium glycolate and ethylene glycol.[29]

Glycolate oxidase (GOX) is one of the principal enzymes involved in the pathway of oxalate synthesis converting glycolate to glyoxylate by oxidation and finally to oxalate. The antiurolithic activity of TT is attributed to its GOX inhibition. Quercetin and kaempherol, the active components of TT, were found to be non-competitive and competitive inhibitors of GOX, respectively.[30]

### Immunomodulatory activity

Saponins isolated from the fruits of TT demonstrated dose-dependent increase in phagocytosis, indicating stimulation of nonspecific immune response. An alcoholic extract of the whole plant of TT exhibited a significant dose-dependent increase in humoral antibody titre and delayed type hypersensitivity response, indicating increased specific immune response.[31]

### Antidiabetic activity

Saponin from TT possesses hypoglycemic properties.[32] TT significantly reduced the level of serum glucose, serum triglyceride, and serum cholesterol, while serum superoxide dismutase (SOD) activity was found to be increased in alloxan-induced diabetic mice. The decoction of TT showed

inhibition of gluconeogenesis in mice.[33,34] TT ethanolic extract at 2 g/kg body weight produced protective effect in streptozotocin-induced diabetic rats by inhibiting oxidative stress. Ethanolic extract of TT exhibited 70% inhibition of α-glucosidase at 500 μg/ml using maltose as the substrate and 100% inhibition of aldose reductase at a dose of 30 μg/ml using dl-glyceraldehyde as the substrate.[35] A significant decrease in the postprandial blood glucose level of rats was found after administration of saponin from TT. TT produced dilation of coronary artery and improved the coronary circulation. It is therefore recommended in Ayurveda for the treatment of angina pectoris and other cardiac complications of diabetes. Thus, TT could be beneficial in the treatment of diabetes by lowering blood glucose, lipid levels, and by its antioxidant mechanism.

### Absorption enhancer

Ethanolic extract of TT enhanced the absorption of metformin hydrochloride, a Biopharmaceutics Classification System (BCS) class III drug, in everted sac technique using goat intestine, due to the presence of saponins in the extract.[36]

### Hypolipidemic activity

The aqueous extract of the fruits of TT was evaluated for their hypolipidemic activity in Wistar albino rats. A dose of 580 mg/kg of the extract was found to decrease cholesterol-induced hyperlipidemia, with a decrease in cholesterol, triglycerides, low density lipoprotein (LDL), very low density lipoprotein (VLDL), and atherogenic index (AI), and an increase in high density lipoprotein (HDL) levels in the blood. Hypolipidemic activity may be due to the presence of phenolic compounds leading to increased lipoprotein lipases in the muscles and decreased activity in the adipose tissues, thus indicating that plasma triglycerides are utilized for energy production by the muscle and not for energy storage by the adipose tissue.[37] The pleotropic effect of TT at 5 mg/kg/day dose for 8 weeks on the lipid profile and vascular endothelium of the abdominal aorta in New Zealand rabbits fed on a cholesterol-rich diet was studied. It was found that dietary intake of the herb significantly lowered the serum lipid profile, decreased endothelial cellular surface damage as well as ruptures, and partially repaired the endothelial dysfunction resulting from hyperlipidemia.[38]

Saponins from TT were studied on diet-induced hyperlipidemia in mice for its preventive and therapeutic effect. The preventive effect was demonstrated by decrease in the levels of serum total cholesterol (TC) and LDL-cholesterol. It also reduced the liver TC and triglycerides and increased the activity of SOD in the liver. It showed therapeutic effect by significantly reducing the serum TC and liver TC.[39]

### Activity in cardiac disorders

TT showed significant effect in the treatment of various cardiac diseases including coronary disease, myocardial infarction, cerebral arteriosclerosis, and the sequelae of cerebral thrombosis. Zhang *et al.* evaluated the protective effect of tribulosin from TT against cardiac ischemia/reperfusion injury to study the underlying mechanism in rats. Tribulosin protected myocardium against ischemia/reperfusion injury through protein kinase C epsilon activation.[40] Tribulosin treatment resulted in a significant reduction of malondialdehyde, aspartate transaminases, creatine kinase, lactate dehydrogenase activity, and myocardial apoptosis rate. It increased the activity of SOD. Crude saponin fraction of this plant has shown significant effects in the treatment of various cardiac diseases including hypertension, coronary heart disease, myocardial infarction, cerebral arteriosclerosis, and thrombosis. It also has been shown that the aqueous extract of TT fruits has significant acetylcholinesterase (ACE) inhibitory effects *in vitro*. Methanolic and aqueous extracts of TT are shown to possess significant antihypertensive activity by direct arterial smooth muscle relaxation and membrane hyperpolarization in spontaneously hypertensive rats.[41] TT also appears to protect the heart cells and may even improve the heart function following a heart attack.[42]

### Central nervous system (CNS) activity

Swiss Albino mice demonstrated antidepressant and anxiolytic activity on administration of 260 mg/kg dose of *Rasayana Ghana* tablet comprising three potent well-established rejuvenator herbs, viz. *Tinospora cordifolia* (stem), *Emblica officinalis* (fruit), and TT (fruit and root), present in equal quantities in the tablet. It was suggested that harmine, a β-carboline alkaloid present in TT, is one of the main active constituents that contributes to the above-mentioned activities. Harmine is an inhibitor of monoamine oxidase which helps to increase level of dopamine in the brain.[43]

### Hepatoprotective activity

The TT extract (250 mg/kg) showed a remarkable hepatoprotective activity against acetaminophen-induced hepatotoxicity in *Oreochromis mossambicus* fish. The elevated biochemical parameters and decreased level of reduced glutathione enzymes were normalized by treatment with TT extract (250 mg/kg) for acetaminophen-induced toxicity in freshwater fish.[44]

### Antiinflammatory activity

The ethanolic extract of TT inhibited the expression of cyclooxygenase-2 (COX-2) and inducible nitric oxide synthase (iNOS) in lipopolysaccharide-stimulated RAW264.7 cells. It also suppressed the expression of proinflammatory cytokines such as tumor necrosis factor-alpha (TNF-α) and interleukin (IL)-4 in macrophage cell line. Thus, the ethanolic extract of TT inhibits the expression of mediators related to inflammation and expression of inflammatory cytokines, which has a beneficial effect on various inflammatory conditions.[45] The methanolic extract of TT showed a dose-dependent inhibition of rat paw volume in carrageenan-induced inflammation in rats.[46]

### Analgesic activity

Analgesic activities of TT were studied in male mice using formalin and tail flick test. The study indicated that the methanolic extract of TT at a dose of 100 mg/kg produced analgesic effect. This analgesic effect of the TT extract may be mediated centrally and/or peripherally. Effect of the extract was

lower than morphine and higher than acetylsalicylic acid (aspirin) in both tests. Pretreatment of animals with opioid receptor antagonist, naloxone, did not change the analgesic effect of the extract in both tests; therefore, the involvement of opioid receptors in the analgesic effect of TT is excluded. However, the other mechanisms responsible for the analgesic effect of TT remain to be investigated. The results of ulcerogenic studies indicate that the gastric ulcerogenecity of TT is lower than indomethacin in the rat's stomach.[47]

## Antispasmodic activity

The lyophilized saponin mixture of the plant exhibited a significant decrease in peristaltic movements of rabbit jejunum preparation in a dose-dependent manner. These results showed that the saponin mixture may be useful for smooth muscle spasms or colic pains.[48]

## Anticancer activity

Chemopreventive potential of the aqueous extract of the root and fruit of TT at 800 mg/kg on 7,12-dimethylbenz (a) anthracene (DMBA) and croton oil induced papillomagenesis in Swiss albino male mice depicted significant reduction in tumor incidence, tumor burden, and cumulative number of papillomas, along with a significant increase in the average latent period in mice treated orally with TT suspension continuously at pre-, peri-, and post-initiation stages of papillomagenesis, as compared to the control group treated with DMBA and croton oil alone. The root extract of TT exhibited better chemopreventive potential than the fruit extract at the same concentration (800 mg/kg body weight) in skin papillomagenesis in mice.[49] The aqueous extract of TT blocked proliferation in HepG2 cells and could also induce apoptosis through the inhibition of nuclear factor kappa-light-chain-enhancer of activated B cells (NF-κB) signaling. Thus, TT has clinical therapeutic effects against liver cancer cells.[50] The aqueous root extract of TT produced significant radioprotection when given orally (800 mg/kg) for seven consecutive days prior to gamma irradiation. TT extract pretreatment protected against radiation damage by inhibiting radiation-induced glutathione depletion and decreasing lipoperoxidation level in the liver of mice.[51]

Saponins isolated from the aerial parts of TT were studied for their cytostatic/cytototoxic activity on human fibroblasts. The effects were determined by 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) analysis and $^{3H}$thymidine incorporation to assess cell viability and proliferation, respectively. Saponins showed a dose-dependent decrease in $^{3H}$thymidine incorporation into the DNA, indicating decreased proliferation. Similarly, they were found to be less toxic for normal human skin fibroblasts. The mechanism of action involves up- and down regulation of polyamines' homeostasis, suppression of proliferation, and induction of apoptosis.[52]

## Antibacterial activity

All parts (fruits, stems, leaves, and roots) of Turkish and Iranian TT showed antibacterial activity against *Enterococcus faecalis*, *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa*, in contrast to the aerial parts of Yemeni TT which had no detectable antibacterial activity against these bacteria, while only the fruits and leaves of Indian TT were active exclusively against *E. coli* and *S. aureus*. These different results relating to the antibacterial activity of TT may be due to using different geographic sources of the plant, types of strains, and assay methods. The methanolic extract of fruits of TT was found to be most active against gram-positive and gram-negative bacteria, while moderate activity was observed in its petroleum ether extract and chloroform extract.[53,54]

## Anthelmintic activity

The methanolic extract of TT was found to be more effective than the petroleum ether, chloroform, and water extracts for *in vitro* anthelmintic activity on the nematode *Caenorhabditis elegans*. Further bioactivity-guided fractionation confirmed tribulosin and β-sitosterol-d-glucoside to be the active components with $ED_{50}$ of 76.25 and 82.50 μg/ml, respectively.[55,56]

## Larvicidal activity

The petroleum ether extract of the leaves of TT exhibited better larvicidal activity against the third instar larvae and adults of the mosquito, *Aedes aegypti*, which is the vector of dengue fever, with $LC_{50}$ of 64.6 ppm as compared to the crude ethanol and



**Figure 1:** Whole plant of *tribulus terrestris*



**Figure 2:** Fruit of *tribulus terrestris* plant

acetone extracts.[57,58]

### Anticariogenic activity

The ethanolic extract of fruits of TT (0.1-0.5 mg/ml) possesses significant anticariogenic activity against *Streptococcus mutans*, the pathogen responsible for dental caries. The growth, acid production, adhesion, and water-insoluble glucan synthesis of *S. mutans* were significantly inhibited in the presence of the ethanol extract of TT. Further studies are necessary to elucidate the active constituents of TT responsible for such activities.[59]

### Recommended dose of TT in Ayurveda

- Fruit: 3-6 g of the drug in powder form; 20-30 g of the drug for decoction
- Root: 20-30 g of the drug for decoction[60].

### Important formulations

*Gokshuradi Guggulu, Trikantak Ghruta, Drakshadi Choorna, Rasayana Choorna, Gokshuradi Kwatha, Dashamoola Kwatha*[60]

## CONCLUSION

TT, a commonly available weed, is of significant value in the traditional systems of medicine, viz. Ayurveda, Chinese, Siddha, and Unani. TT is also a reputed herb in the folk medicine of many countries for a number of diseases. The whole plant of TT has been explored exhaustively for its phytochemical and pharmacological activities such as diuretic, aphrodisiac, antiurolithic, immunomodulatory, antihypertensive, antihyperlipidemic, antidiabetic, hepatoprotective, anticancer, anthelmintic, antibacterial, analgesic, and anti-inflammatory. Considering the available literature on TT, the plant could have a potential as a herbal medicine for effective blood pressure control due to its diuretic activity (potassium sparing), antihyperlipidemic activity, and cardioprotective activity. Though TT has been used extensively over the centuries and currently scientific evidence with respect to its pharmacological activities is also being generated, more studies at the molecular level are needed to further understand the mechanism by which it modifies the disease condition. The pharmacological experiments performed on the plant must be extended to the next level of clinical trials to generate novel drugs. This will help TT in achieving a status of medicine or to be prescribed as a dietary supplement in various disease conditions.

## REFERENCES


1. Trease GE, Evans WC. A taxonomic approach to the study of medicinal plants and animal derived drugs. Trease and Evans Pharmacognosy. 15th ed. Singapore: Harcourt Brace and Company Asia Pvt. Ltd.; 2002. p. 27.
2. Duke J, Duke PK, Cellier JL. 2nd edn. Duke Handbook of medicinal herbs. United States: CRC Press; 2002. p. 595.
3. Nadkarni KM. Indian Materia Medica. Mumbai: Popular Prakashan; 1927. p. 1230-1.
4. The wealth of India. Raw materials. Vol. 9. Publications and Information Directorate. New Delhi: CSIR; 1972. p. 472.
5. Kokate CK, Purohit AP, Gokhale SB. Pharmacognosy. 13th edn. Pune: Nirali Prakashan Publisher; 2007. p. 370.
6. Usman H, Abdulrahman F, Ladan A. Phytochemical and antimicrobial evaluation of *Tribulus terrestris* L. growing in Nigeria. Res J Biol Sci 2007;2:244-7.
7. Kostova I, Dinchev D. Saponins in *Tribulus terrestris* - chemistry and bioactivity. Phytochem Rev 2005;4:111-37.
8. Xu YJ, Xu TH, Zhou HO, Li B, Xie SX, Si YS, *et al*. Two new furostanol saponins from *Tribulus terrestris*. J Asian Nat Prod Res 2010;12:349-54.
9. Wu TS, Shi LS, Kuo SC, Alkaloids and other constituents from *Tribulus terrestris*. Phytochemistry 1999;50:1411-5.
10. Bhutani SP, Chibber S, Seshadri TR. Flavonoids of the fruits and leaves of *T. terrestris*. Phytochemistry 1969;8:299.
11. Louveaux A, Jay M, Taleb O, Hadi ME, Roux G. Variability in flavonoid compounds of four *Tribulus* species: Does it play a role in their identification by desert locust Schistocerca gregaria?. J Chem Ecol 1998;24:1465-81.
12. http://eng.hi138.com [homepage on the Internet]. Research paper centre, Yang M, Yang C, Bai S, Zhao M, Zhu M. *Tribulus terrestris* Extraction of total flavonoids, Posted: 2011-4-27 16:01:00 Available from: http://eng.hi138.com/medicine-papers/pharmacypapers/201104/304632_tribulus-terrestris-extraction-of-total-flavonoids.asp#.UekwFtIwet8.
13. Matin Y, Alavi S, Hajiaghaee R, Ajani Y. Flavonoid Glycosides from *Tribulus terriestris L. orientalis* Iran J Pharm Sci 2008;4:231-6.
14. Raja M, Venkataram AR. Pharmacognostical studies on *Tribulus terrestris* and *Tribulus alatus*. Der Pharmacia Sinica 2011;2:136-9.
15. Mitra N, Mehdi DM, Reza ZM *Tribulus terrestris L*. Flavonoid Compounds. Int J Mod Bot 2012;2:35-9.
16. Wu TS, Shi LS, Kuo SC. Alkaloids and other constituents from *Tribulus terrestris*. Phytochemistry 1999;50:1411-5.
17. Bremner J, Sengpracha W, Southwell I, Bourke C, Skelton B, White A. The Alkaloids of *Tribulus terrestris*: A revised structure for the Alkaloid Tribulusterine. Perspect Nat Prod Chem 2005;3:11-7.
18. Abirami P, Rajendran A. GC-MS Analysis of *Tribulus terrestris*. L Asian J Plant Sci Res 2011;1:13-1.
19. Khare CP. Indian medicinal plants: An illustrated dictionary. Berlin, Heidelberg: Springer Verlag; 2007. p. 669-71.
20. Al-Ali M, Wahbi S, Twaij H, Al-Badr A. *Tribulus terrestris*: Preliminary study of its diuretic and contractile effects and comparison with *Zea mays*. J Ethnopharmacol 2003;85:257-60.
21. Chhatre S, Nesari T, Somani G, Kenjale R, Sathaye S. Comparative Evaluation of Diuretic Activity of Different Extracts of *Tribulus terrestris* Fruits in Experimental Animals. Int J Res Phytochem Pharmacol 2012;3:129-33.
22. Adaikan PG, Gauthaman K, Prasad RN, Proerectile pharmacological effects of *Tribulus terrestris* extract on the rabbit corpus cavernosum. Ann Acad Med 2000;29:22-6.
23. Singh S, Nair V, Gupta YK. Evaluation of the aphrodisiac activity of *Tribulus terrestris* Linn. in sexually sluggish male albino rats, J Pharmacol Pharmacother 2012;3:43-7.
24. Rajendar B, Bharavi K, Rao GS, Kishore PV, Kumar PR, Kumar CS, *et al*. Protective effect of an aphrodisiac herb *Tribulus terrestris* Linn on cadmium-induced testicular damage. Indian J Pharmacol 2011;43:568-73.
25. Kavitha P, Ramesh R, Subramanian P. Histopathological changes in *Poecilia latipinna* male gonad due to *Tribulus terrestris* administration. *In Vitro* Cell Dev Biol Anim 2012;48:306-12.
26. Adaikan PG, Gauthaman K, Prasad RN. History of herbal medicines with an insight on the pharmacological properties of *Tribulus terrestris*. Aging Male 2001;4:163-9.

27. Anand R, Patnaik GK, Kulshreshtha DK, Dhawan BN Activity of certain fractions of *Tribulus terrestris* fruits against experimentally induced urolithiasis in rats. Indian J Exp Biol 1994;32:548-52.
28. Aggarwal A, Tandon S, Singla SK, Tandon C. A novel antilithiatic protein from *Tribulus terrestris* having cytoprotective potency. Protein Pept Lett 2012;19:812-9.
29. Sangeeta D, Sidhu H, Thind SK, Nath R. Effect of *Tribulus terrestris* on oxalate metabolism in rats. J Ethnopharmacol 1994;44:61-6.
30. Shirfule AL, Sangamwar AT, Khobragade CN. Exploring glycolate oxidase (GOX) as an antiurolithic drug target: Molecular modeling and *in vitro* inhibitor study. Int J Biol Macromol 2011;49:62-70.
31. Tilwari A, Shukla NP, Devi U. Effect of five medicinal plants used in Indian system of medicines on immune function in Wistar rats. Afr J Biotechnol 2011;10:16637-45.
32. Li M, Qu W, Wang Y, Wan H, Tian C. Hypoglycemic effect of saponin from *Tribulus terrestris*. Zhong Yao Cai 2002;25:420-2.
33. Li M, Qu W, Chu S, Wang H, Tian C, Tu M. Effect of the decoction of *Tribulus terrestris* on mice gluconeogenesis. Zhong Yao Cai 2001;24:586-8.
34. Amin A, Lotfy M, Shafiullah M, Adeghate E. The protective effect of *Tribulus terrestris* in diabetes, Ann N Y Acad Sci 2006;1084:391-401.
35. Lamba HS, Bhargava CH, Thakur M, Bhargava S. $\alpha$- glucosidase and aldose reductase inhibitory activity *in vitro* and antidiabetic activity *in vivo* of *Tribulus terrestris*. Int J Pharm Pharma Sci 2011;3:270-2.
36. Ayyanna C Ayyanna.C, Chandra Mohan Rao. G, Sasikala.M, Somasekhar. P. Absorption Enhancement Studies of Metformin Hydrochloride by Using *Tribulus terrestris* Plant Extract. Int J Pharm Technol 2012;4:4118-25.
37. Khan S, Kabir H, Jalees F, Asif M, Naquvi KJ. Antihyperlipidemic potential of fruits of *Tribulus terrestris* linn. Int J BiomedRes 2011;2:98-101.
38. Tuncer MA, Yaymaci B, Sati L, Cayli S, Acar G, Altug T, Demir R. Influence of *Tribulus terrestris* extract on lipid profile and endothelial structure in developing atherosclerotic lesions in the aorta of rabbits on a high-cholesterol diet. Acta Histochem 2009;111:488-500.
39. Chu S, Qu W, Pang X, Sun B, Huang X. Effect of saponin from *Tribulus terrestris* on hyperlipidemia. Zhong Yao Cai 2003;26:341-4.
40. Zhang S, Li H, Yang SJ. Tribulosin protects rat hearts from ischemia/reperfusion injury. Acta Pharmacol Sin 2010;31:671-8.
41. Phillips OA, Mathew KT, Oriowo MA. Antihypertensive and vasodilator effects of methanolic and aqueous extracts of *Tribulus terrestris* in rats. J Ethnopharmacol 2006;104:351-5.
42. Zhang S, Li H, Xu H, Yang SJ. Effect of gross saponins of *Tribulus terrestris* on cardiocytes impaired by adriamycin. Yao Xue Xue Bao 2010;45:31-6.
43. Deole YS, Chavan SS, Ashok BK, Ravishankar B, Thakar AB, Chandola HM. Evaluation of antidepressant and anxiolytic activity of *Rasayana Ghana* tablet (a Compound Ayurvedic formulation) in albino mice. Ayu 2011;32:375-9.
44. Kavitha P, Ramesh R, Bupesh G, Stalin A, Subramanian P. Hepatoprotective activity of *Tribulus terrestris* extract against acetaminophen-induced toxicity in a freshwater fish. *In Vitro* Cell Dev Biol Anim 2011;47:698-706.
45. Oh JS, Baik SH, Ahn EK, Jeong W, Hong SS. Anti-inflammatory activity of *Tribulus terrestris* in RAW264.7 Cells. J Immunol 2012;88:54.2
46. Baburao B, Rajyalakshmi G, Venkatesham A, Kiran G, Shyamsunder A, Gangarao B. Anti-inflammatory and antimicrobial Activities of methanolic extract of *Tribulus terrestris* linn plant. Int J Chem Sci 2009;7:1867-72.
47. Heidari MR, Mehrabani M, Pardakhty A, Khazaeli P, Zahedi MJ, Yakhchali M, *et al*. The analgesic effect of *Tribulus terrestris* extract and comparison of gastric ulcerogenicity of the extract with indomethacine in animal experiments. Ann N Y Acad Sci 2007;1095:418-27.
48. Arcasoy HB, Erenmemisoglu A, Tekol Y, Kurucu S, Kartal M. Effect of *Tribulus terrestris L*. saponin mixture on some smooth muscle preparations: A preliminary study. Boll Chim Farm 1998;137:473-5.
49. Kumar M, Soni AK, Shukla S, Kumar A. Chemopreventive potential of *Tribulus terrestris* against 7, 12- dimethylbenz (a) anthracene induced skin papillomagenesis in mice. Asian Pac J Cancer Prev 2006;7:289-94.
50. Kim HJ, Kim JC, Min JS, Kim MJ, Kim JA, Kor MH, *et al*. Aqueous extract of *Tribulus terrestris* Linn induces cell growth arrest and apoptosis by down-regulating NF-$\kappa$B signaling in liver cancer cells. J Ethnopharmacol 2011;136:197-203.
51. Kumar M, Panwar M, Samarth R, Kumar A. Evaluation of radiomodulatory influence of *Tribulus terrestris* Root extract against gamma radiation: Hematological, Biochemical and cytogenetic alterations in swiss albino mice. Pharmacologyonline 2009;1:1214-28.
52. Neychev VK, Nikolova E, Zhelev N, Mitev VI. Saponins from *Tribulus terrestris* L. are less toxic for normal human fibroblasts than for many cancer lines: Influence on apoptosis and proliferation. Exp Biol Med (Maywood) 2007; 232:126-33.
53. Al-Bayati FA, Al-Mola HF. Antibacterial and antifungal activities of different parts of *Tribulus terrestris* L. growing in Iraq. J Zhejiang Univ Sci B 2008; 9:154-9.
54. Mohammed MJ. Biological Activity of Saponins Isolated from *Tribulus terrestris* (Fruit) on Growth of Some Bacteria. Tikrit J Pure Sci 2008;13.
55. Kiran B, Lalitha V, Raveesha KA. *In Vitro* Evaluation of Aqueous and Solvent extract of *Tribulus terrestris* L. leaf against Human bacteria. Int J Pharm Tech Res 2011;3:1897-903.
56. Deepak M, Dipankar G, Prashanth D, Asha MK, Amit A, Venkataraman BV. Tribulosin and $\beta$-sitosterol-D-glucoside, the anth*elmintic principles* of *Tribulus terrestris*. Phytomedicine 2002;9:753-6.
57. El-Sheikh TM, Bosly HA, Shalaby NM. Insecticidal and repellent activities of methanolic extract of *Tribulus terrestris* L. (Zygophyllaceae) against the malarial vector Anopheles arabiensis (Diptera: Culicidae). Egypt Acad J Biolog Sci 2012;5:13-22.
58. Singh SP, Raghavendra K, Singh RK, Mohanty SS, Dash AP. Evaluation of *Tribulus terrestris* Linn (Zygophyllac*eae) acetone extract* for larvicidal and repellence activity against mosquito vectors. J Commun Dis 2008; 40:255-61.
59. Oh HK, Park SJ, Moon HD, Jun SH, Choi NYand You YO. *Tribulus terrestris* inhibits caries-inducing properties of *Streptococcus mutans.* J Med Plants Res 2011;5:6061-6.
60. Ayurvedic Pharmacopoeia of India, 1st ed, Vol. 1. Govt of India, Ministry of Health and Family Welfare Gokshura (Rt.) 1989; 126:49-52. The book has no author, it's a publication of Govt. of India


**How to cite this Article:** Chhatre S, Nesari T, Somani G, Kanchan D, Sathaye S. Phytopharmacological overview of *Tribulus terrestris*. Phcog Rev 2014;8:45-51.

**Source of Support:** Nil, **Conflict of Interest:** None declared

Copyright of Pharmacognosy Reviews is the property of Medknow Publications & Media Pvt. Ltd. and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.