

Review on Phytochemistry and Phytopharmacological Activities of Tribulus Terrestris Linn (Puncture Vine)

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Abstract: *Tribulus terrestris* Linn. (Family: Zygophyllaceae), commonly referred to as Puncture vine or Gokshura, is a widely acknowledged medicinal herb with a rich history of therapeutic application in traditional medical systems such as Ayurveda, Unani, and Traditional Chinese Medicine. This review offers a thorough examination of the phytochemistry, ethnobotany, pharmacological effects, and potential health advantages of *T. terrestris*. The plant is abundant in bioactive compounds including steroidal saponins (protodioscin, diosgenin), flavonoids (kaempferol, quercetin, rutin), alkaloids, tannins, and phenolic compounds, all of which contribute to its extensive range of biological effects. Documented pharmacological activities encompass diuretic, anti-urolithic, cardioprotective, antioxidant, antidiabetic, anti-inflammatory, analgesic, antibacterial, anticancer, immunomodulatory, and neuroprotective properties. Ethnobotanical data underscore its application in the treatment of urinary disorders, sexual dysfunction, hypertension, and metabolic conditions. The presence of vital nutrients and secondary metabolites indicates its potential as a nutraceutical and dietary supplement. Despite the substantial preclinical evidence supporting its therapeutic effectiveness, additional molecular investigations and rigorously designed clinical trials are necessary to validate its safety, mechanisms of action, and clinical significance. In summary, *Tribulus terrestris* stands out as a promising medicinal and nutraceutical plant with diverse benefits for human health.

Keywords: *Tribulus terrestris*, Phytopharmacology, Nutraceutical potential, Phytochemical constituent, Therapeutic applications

I. INTRODUCTION

Tribulus terrestris, commonly known as Puncture vine, is a globally recognized medicinal herb. Its therapeutic benefits as part of Eastern medicine have been acknowledged since ancient times. For millennia, the fruits and roots of TT have been employed as traditional medicine in regions such as India, Pakistan, and China. Numerous bioactive phytochemicals, including flavonoids and saponins, have been identified in *Tribulus terrestris*, contributing to a range of pharmacological effects, whether individually or in synergy. This plant is recognized for its various properties, including antioxidant, antibacterial, antidiabetic, antihelmintic, larvicidal, anti-inflammatory, cardioprotective, antispasmodic, diuretic, analgesic, immunomodulatory, hepatoprotective, and anticancer activities. (1) *Tribulus terrestris* Linn. (Family: Zygophyllaceae) (2)





(figure 1) *Tribulus terrestris* (3)

Literature review

Zhu et al., 2017 A review of traditional pharmacological uses, phytochemistry, and pharmacological activities of *Tribulus terrestris* L.

The review conducted by Zhu and colleagues in 2017 offers a comprehensive examination of *Tribulus terrestris*, emphasizing its traditional medicinal applications, phytochemical makeup, and pharmacological properties. The authors indicate that this plant has been utilized for an extended period in Ayurveda, Chinese medicine, and various other traditional practices to address urinary issues, kidney stones, sexual dysfunction, and to enhance vitality. The review underscores that *T. terrestris* is rich in numerous bioactive compounds, particularly steroidal saponins, flavonoids, alkaloids, and glycosides, with saponins thought to be the primary contributors to many of its biological effects. The preclinical investigations detailed in the paper reveal a range of pharmacological activities, such as aphrodisiac, antioxidant, anti-inflammatory, diuretic, antidiabetic, antimicrobial, and hypolipidemic effects. Nevertheless, the authors stress that clinical evidence involving human subjects is still limited and inconsistent, primarily due to the absence of standardized extracts, variations in dosages, and methodological shortcomings. The review concludes by stating that while *Tribulus terrestris* exhibits considerable medicinal promise, further rigorous and wellstructured human studies, along with improved standardization of extracts, are essential to validate its therapeutic efficacy.(12)

Ștefănescu et al.,2020 A Comprehensive Review of the phytochemical Pharmacological, and Toxicological Properties of *Tribulus terrestris* L. The review offers a comprehensive examination of *Tribulus terrestris* (TT), a medicinal plant that is extensively utilized in traditional medicine across Asia, Europe, and Africa. It underscores the botanical features of the plant and its historical applications for enhancing vitality, sexual health, and addressing urinary issues. TT is abundant in bioactive phytochemicals, particularly steroidal saponins, which are regarded as the



primary agents responsible for its pharmacological properties. Additional compounds present include flavonoids, alkaloids, lignanamides, tannins, amino acids, and plant sterols. The levels of active compounds differ based on geographical location, the season of harvest, and the specific part of the plant utilized. Protodioscin and prototribestin are recognized as the key saponins that mediate biological effects. The review highlights the antioxidant properties of the plant, which are achieved through the scavenging of free radicals and the enhancement of endogenous antioxidant enzymes. TT demonstrates anti-inflammatory properties by inhibiting inflammatory mediators such as TNF- α , IL-6, and COX-2. It exhibits potential antidiabetic effects, enhancing glucose tolerance and insulin sensitivity in experimental research. The lipid-lowering effects include a decrease in total cholesterol, LDL, and triglycerides. Cardioprotective benefits are evidenced by improved myocardial antioxidant levels and diminished cardiac tissue damage. TT has also displayed hepatoprotective properties, safeguarding the liver from damage induced by toxins. It contributes to antimicrobial activity, demonstrating effectiveness against various bacterial and fungal strains. (10)

Chhatre et al., 2014 Phytopharmacological overview of Tribulus terrestris. Pharmacognosy Reviews

This review provides a comprehensive overview of the botanical characteristics, phytochemistry, and pharmacological activities of Tribulus terrestris (TT). The authors describe TT as a traditional medicinal plant widely used in Ayurveda and other systems for treating urinary, reproductive, and cardiovascular disorders. The plant contains bioactive compounds such as steroidal saponins (especially protodioscin), flavonoids, alkaloids, and tannins, which contribute to its therapeutic potential. The review highlights multiple pharmacological activities supported by experimental studies, including aphrodisiac, diuretic, antiurolithic, cardioprotective, antioxidant, antiinflammatory, analgesic, hepatoprotective, and antimicrobial effects. (15)

Sivapalan, S.R. 2016 Biological and pharmacological studies of Tribulus terrestris Linn – A review.

This review highlights the traditional uses, phytochemical composition, and wide range of biological activities of Tribulus terrestris (TT). Sivapalan explains that TT has been used in Ayurveda, Unani, and Chinese medicine for centuries, especially for urinary disorders, sexual dysfunction, infertility, and general vitality enhancement. The article describes the plant's major phytoconstituents—including steroidal saponins (protodioscin), flavonoids, alkaloids, glycosides, and tannins—which contribute to its medicinal actions. The review summarizes experimental findings showing that TT exhibits aphrodisiac, antiurolithic, diuretic, anti-inflammatory, antioxidant, hepatoprotective, antimicrobial, antidiabetic, and cardioprotective effects. The author emphasizes that although many animal and in-vitro studies support these pharmacological activities, clinical evidence is still limited, and further well-designed human trials are needed to establish therapeutic efficacy and safety.

Saeed M. et al. 2024 Promising phytopharmacology, nutritional potential, health benefits, and traditional usage of Tribulus terrestris L.

The review discusses Tribulus terrestris (also known as Gokharu) as a widely used medicinal herb in traditional systems. The phytochemistry of T. terrestris includes steroidal saponins, flavonoids, alkaloids, unsaturated fatty acids, and other bioactive compounds. In terms of pharmacology, the herb exhibits a broad range of therapeutic effects: immunomodulatory, aphrodisiac, anti-urolithic (prevents kidney stones), cardioprotective, antidiabetic, anti-inflammatory, hypolipidemic, neuroprotective, anticancer, analgesic, and more. The review emphasizes antioxidant and antiinflammatory actions as central to many of these beneficial effects. According to studies, T. terrestris can boost testosterone levels, regulate blood pressure, and protect organs (like liver) from damage. (11)

Botanical Description

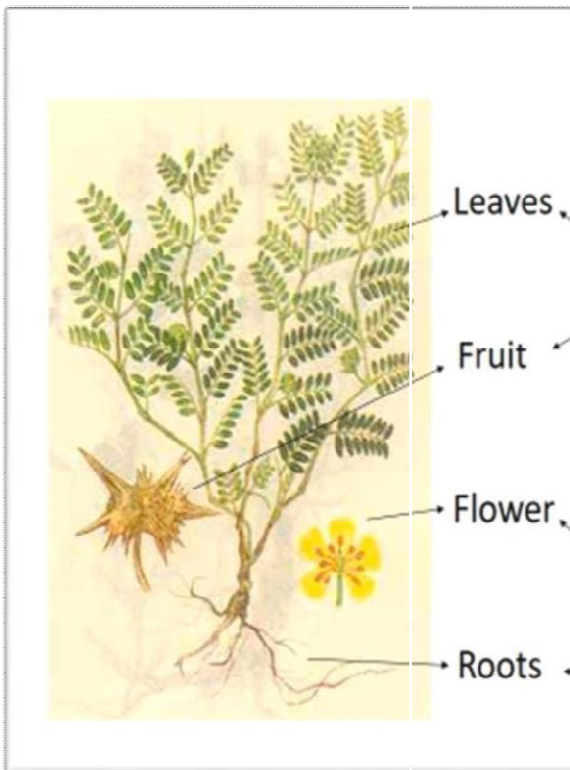
Tribulus terrestris Linn. is a member of the Zygophyllaceae family. This herb is characterized as diffused, prostrate, and annual, and is typically found in tropical and subtropical areas across the globe. It thrives in dry, sandy, and wasteland environments, and is extensively distributed in regions such as India, China, Africa, southern Europe, and



Australia. The stems of the plant are slender, branched, and hairy, radiating from the crown and spreading flat along the ground.

The leaves are arranged oppositely and are paripinnate, consisting of 4–8 pairs of small oblong or elliptic leaflets that are covered with fine hairs, which impart a silvery-green hue to them. The flowers are small, bright yellow, solitary, and axillary, measuring approximately 8–12 mm in diameter. Each flower is composed of five sepals, five petals, and ten stamens, organized in two whorls. The ovary is superior, containing five cells, with a short style and five stigmas. The fruit is a woody pentamerous schizocarp that divides into five nutlets (cocci) upon reaching maturity. Each coccus features two to three sharp spines, which are a distinctive trait of the species, giving the fruit a caltrop-like appearance. The seeds are small, brown, and hard, encased within the woody nutlets. This plant possesses a robust taproot system, enabling it to flourish in arid and semi-arid environments. Flowering typically takes place from June to September, followed by fruiting from

August to November, contingent upon the climatic conditions.(4)



(figure 2) Different parts of tribulus terrestris (5)

Language	Other names of T. Terrestris
Assamese	Gokshura, Gokshurkata
Bengali	Gokhri, Gokshura
English	Caltrops root



Gujarati	Betha Gokharu
Hindi	Gokhru
Marathi	Sarate,Gokharu
Punjabi	Bhakhra

Table:1 Vernacular name of T. terrestris in various Indian languages.(6)

classification of Tribulus terrestris.

Kingdom	Plantae
Division	Phanerogams
Subdivision	Angiospermae
Class	Dicotyledonae
Subclass	Polypetalae
Order	Giraniales
Family	Zygophyllaceae
Genus	Tribulus
Species	terrestris Linn

Table:2 Taxonomic classification of Tribulus Terrestris (7)

Traditional Uses

T. terrestris is employed in folk medicine as both a tonic and a diuretic. The fruit, root, and entire plant of T. terrestris, whether used individually or in conjunction with other medicinal plants, are extensively utilized in Ayurvedic medicine for addressing genital-urinary disorders, which range from difficulties in urination to urinary stones and sexual debility. Both simple and multi-ingredient formulations containing Gokshura are documented in the Ayurvedic Formulary and Pharmacopoeia of India. It serves as a crucial component of Gokshuradi Guggul, a potent Ayurvedic remedy aimed at promoting the proper functioning of the genital tract and eliminating urinary stones. The leaves are abundant in calcium, offering an economical supplement to rice based diets. Furthermore, it holds potential applications in treating eczema, psoriasis, hypertension, liver and eye diseases, Parkinson's disease, and benign prostatic hyperplasia. The plant is known to enhance male sexual function and improve athletic performance.

Additionally, the roots and fruits are regarded as having cardiotoxic properties. In Kashmir, a tea is prepared from the plant to treat various types of fever.(8)



Ethnobotanical and Ethnomedicine Of Tribulus Terrestris

Country	Plant component; utilize goals.
Egypt	The aerial components serve as nourishment for animals. They are unspecified in nature; they possess hepatoprotective and diuretic properties, are effective against kidney stones, and have aphrodisiac qualities, yet they can be detrimental to other crops. This section pertains to the intended uses.
India	The entire plant; acts as a diuretic and alleviates swelling in the hands and legs. The whole plant and its fruits; provide a cooling effect on the body, help combat kidney stones, address urinary issues, and assist with liver disorders.
Sudan	Roots; kidney disorders, antidiabetic.
Turkey	Male reproductive health
Yemen	Fruits; beneficial for preventing kidney stones and alleviating urinary issues
Saudi Arabia	Leaves; management of male infertility
China	Fruits; used in treatment for UTI

Table:3 Ethnobotanical and Ethnomedicine of TT.(9)

Phytochemical Constituents of Tribulus Terrestris

TT fruits are rich in significant secondary metabolites, including saponins, polyphenolic compounds, and alkaloids. The predominant types of steroidal saponins are furostanol and spirostanol. It is thought that furostanol saponins serve as biogenetic precursors to the spiro analogs. As of now, more than 70 distinct compounds have been recognized in TT(10)T. terrestris comprises a variety of compounds, such as steroids, vitamins, alkaloids, unsaturated fatty acids, aspartic acid, saponins, tannins, flavonoids, resins, potassium nitrate, and glutamic acid. Diosgenin and steroidal saponins are found within this plant. It boasts a significant amount of proteins and calcium content. The dried fruits contain semidrying oil, peroxides, diastase, small quantities of glucosides, protein, and a diverse array of inorganic substances. Fruits containing nitrates have a minimal presence of essential oil, resin, and traces of alkaloids (0.001%). An alcoholic extract of the fruits yields a crystalline residue in water, which contains an alkaloid-like substance that precipitates from its solution when treated with ammonia and is associated with alkaline chlorides or hydrochloric acid. The fruits also possess fat and resin, the latter likely contributing to the drug's aroma, as it emits a sweet scent when combusted. Mineral content is abundant in the fruits. The chemical constituents of T. terrestris fruits encompass flavonoids, flavonol glycosides, steroidal glycosides, steroidal saponins, saponins, furostanol, furosteroidal saponins, sapogenins, furostanol glycosides, and alkaloids. Secondary metabolites identified in T. terrestris fruits include saponins, polyphenolic compounds, and alkaloids. Furostanol and spirostanol are the predominant steroidal saponins. The biogenetic precursors of the spiro analogs are believed to be the furostanol saponins. Research indicates that T. terrestris contains approximately 70 distinct chemical entities. This plant is recognized for its elevated levels of steroidal saponins. Various parts of this herb yield gitogenin, tigogenin, hecogenin, diosgenin, neohecogenin, chlorogenin, ruscogenin, neotigogenin, and sarsasapogenin derivatives.(11) Spirostanol and furostanol saponins are



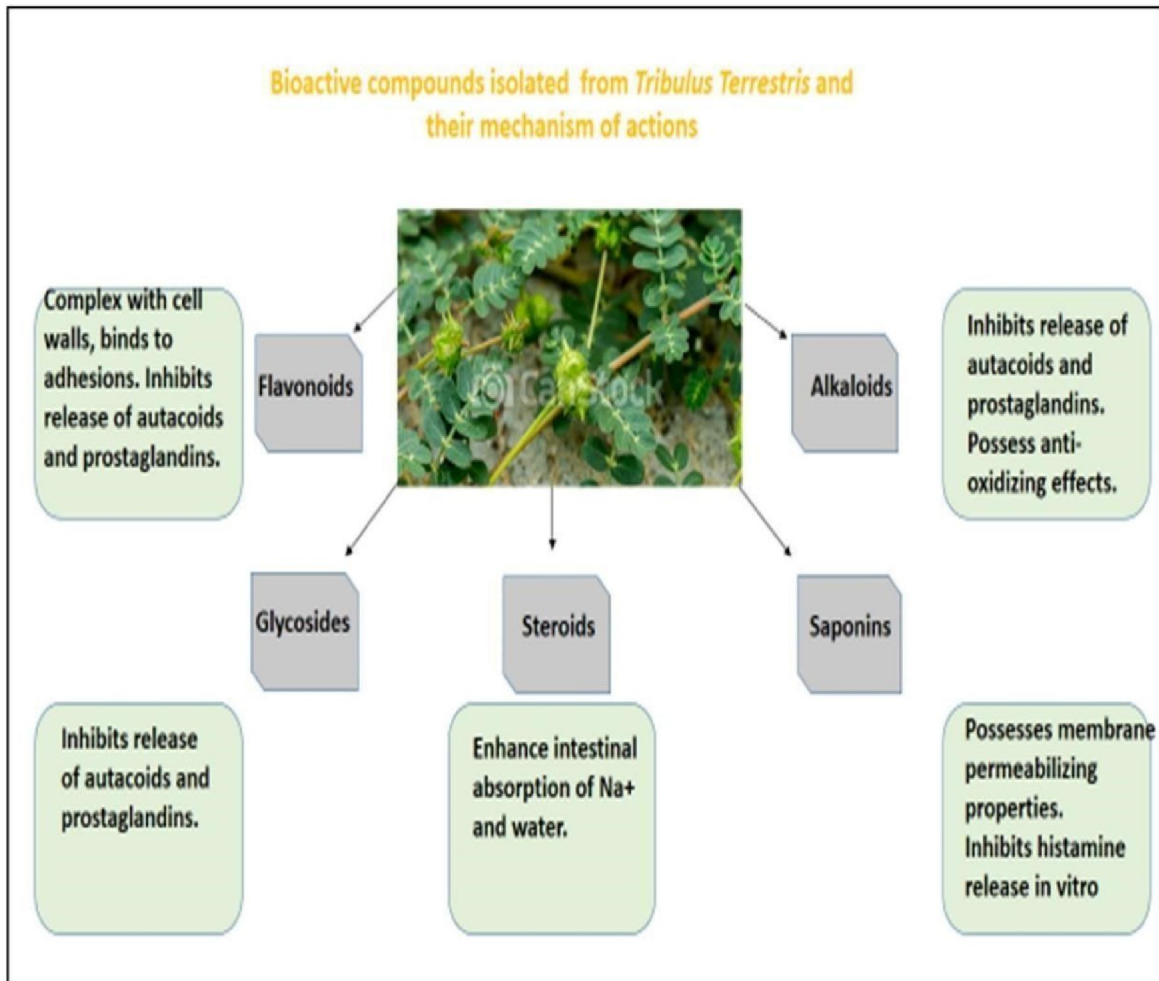
regarded as the most distinctive compounds found in TT. As of now, 108 different types of steroidal saponins have been extracted from TT. Among these, there are 58 varieties of spirostane saponins and 50 varieties of furostane saponins. The steroidal saponins, including protodioscin and protogracillin, are believed to impart unique biological activities to TT.(12) Protodioscin is the main bioactive compound present in T. terrestris. The plant primarily consists of furostanol and spirostanol steroid saponins.(13)

Phytochemistry of Tribulus terrestris (Phytochemical, Their prevalence, and their effect)

Sr. no	Phytochemical constituents of Tribulus Terrestris	Present in	Major Effect
1.	Furostanol and Spirostanol saponins furastanol and spirostanol saponins (including Tigogenin, Chlorogenin, Neotigogenin, Neogitogenin, Hecogenin, Neohecogenin, Diosgenin, Gitogenin, Ruscogenin, and Sarsasapogenin)	The above group of the Leaf	Diuretic, antihypertensive, aphrodisiac, and anti-diabetic.
2.	Flavonoids (Kaempferol, Kaempferol-3-glucoside, and Tribuloside)	Leaf	Painrelieving, Aphrodisiac, and Antidiabetic
3.	Alkaloids (including β -carboline Alkaloid, Tribulusterine, Terrestribisamide, Tribulusin A, Harmine, Tribulusamide, Harman, Terrestriamide, and Ntranscoumaroyltyramine)	Leaf	Anticancer, aphrodisiac, and prevention of cardiac diseases.
4.	Furostanol and Spirostanol saponins (Chlorogenin, Ruscogenin, Gitogenin, Neotigogenin, Hecogenin, Diosgenin, Neohecogenin, and Sarsasapogenin)	Fruit	Anti-helminthic diuretic, aphrodisiac, Antispasmodic and antioxidant.
5.	Flavonoids (Kaempferol-3-glucoside, Tribuloside, Kaempferol, and Kaempferol-3-rutinoside)	Fruit	Aphrodisiac, diuretic, antispasmodic, and antioxidant.

Table:4 Phytochemistry of Tribulus terrestris (Phytochemical and their effect)(11)





(figure 3): chemical constituents and their uses of tribulus terrestris.(14)

Pharmacological/ Phytopharmacological Activities

Diuretic and Antiurolithic effects

Cardiotonic effects

Antioxidant effect

Neuroprotective activity

Antidiabetic effects

Anti-inflammatory effects

Analgesic effect

Anticancer effects

Antibacterial effects (6)

Diuretic and Antiurolithic effect

The diuretic characteristics of TT can be attributed to the substantial amounts of nitrates and essential oils found in its fruits and seeds. Additionally, the diuretic effect is linked to the high concentration of potassium salts present.(15)

Kidney stones rank as the third most prevalent issue affecting the urinary tract.Tribulus terrestris (51.58%) is a most



effective solution for kidney stones and UTI infection; they increase a flow of urine and help in removing kidney stones from the body.(16)

Cardiotonic effect

The roots and fruits of *T. terrestris* are considered to have cardiotonic properties in traditional usage. (12) Tribulosin reduced the myocardial apoptosis rate. The major phytochemical saponin is positive in response to dilate the coronary artery and improves circulation in blood vessels.

T. terrestris also appears to protect the heart cells and may even improve the heart function.(17)

Antioxidant effect

Tribulus terrestris demonstrates antioxidant properties that safeguard kidney tissues from harm due to oxidative stress induced by crystalline deposits. The flavonoids and phenolic compounds counteract free radicals that lead to renal inflammation and damage. Consequently, *Tribulus terrestris* is regarded as a natural remedy for urolithiasis, as it inhibits the formation of stones, enhances diuresis, and shields renal tissue from oxidative damage.(18)

Neuroprotective activity

Neurodegenerative disorders represent a significant issue within the healthcare sector. The use of herbal sources that offer neuroprotective compounds has garnered considerable interest, particularly in light of the inadequacies in certain treatments, the high costs of medications, and the elevated morbidity rates linked to neurodegenerative disorders. Numerous in-vitro investigations have recognized the neuroprotective properties of *T. terrestris*, attributed to its effectiveness in inhibiting acetylcholinesterase (AChE). The extract derived from the roots of this plant demonstrated a dose-dependent antiacetylcholinesterase (AChE) activity. The application of *T. terrestris* in alleviating neurodegenerative disorders, including Parkinson's disease and Alzheimer's disease. The saponin fraction derived from *T. terrestris* exhibits a notable protective effect against damage to the optic nerve. The fruit of *T. terrestris* has been documented to enhance cognitive abilities and memory retention.(19)

Antidiabetic effect

Ethanol extract of *T. terrestris* preventing oxidative stress. The ethanol extract of *T.*

terrestris demonstrated a 70% inhibition of α -glucosidase at a concentration of 500 $\mu\text{g/ml}$, utilizing maltose as the substrate, and achieved a complete inhibition of aldose reductase at a dosage of 30 $\mu\text{g/ml}$, employing dl-glyceraldehyde as the substrate. *T. terrestris* markedly suppresses gluconeogenesis, affects glycometabolism, and lowers triglyceride and total cholesterol levels. The saponin fraction derived from *T. terrestris* has been shown to possess a hypoglycemic effect with a corresponding decrease in serum triglycerides and cholesterol, along with a rise in serum superoxide dismutase. *T. terrestris* reduces serum glucose levels, potentially by inhibiting gluconeogenesis, which may offer protective effects against diabetes mellitus. It is well-established that diabetes elevates the levels of reactive oxygen species, which in turn plays a role in the pathogenesis of the disease. The extract of *T. terrestris*, which contains saponins, seems to lower blood sugar levels.(20) The TT extract led to a notable reduction in the serum levels of ALT and creatinine in diabetic groups.(21)

Anti-inflammatory effect

It is well-established that physical activity leads to an elevation in plasma concentrations of IL-6, which may serve as a marker for a heightened inflammatory response. Elevated levels of IL-6 are observed prior to the release of inflammatory cytokines including TNF- α , macrophage inflammatory protein-1 (MIP), IL-4, IL-1, and acute phase proteins such as CRP. This increase could adversely affect the athlete's muscular system due to heightened inflammation or leukocyte infiltration. TT extracts are recognized for their anti-inflammatory properties in both in vivo and in vitro studies. Furthermore, the characteristics of TT include the down-regulation of enzymes that facilitate the production of cytokines and inflammatory mediators. These observations align with the sole study that investigated the anti-inflammatory effects of TT, which indicated that a dosage of 500 mg per day for two weeks of TT supplementation was adequate to produce a moderate, albeit not statistically significant, reduction in IL-6 and Hs-CRP. TT was also



found to inhibit leukocyte infiltration, activation, and maturation, as well as the synthesis of proinflammatory mediators TNF- α and IL-4 at the site of inflammation. Regulating IL-6 levels could mitigate a broad spectrum of inflammatory processes that disrupt the organism's homeostasis. These attributes are comparable to those of other nutritional supplements such as glycoposphopeptical AM3.(22)

Analgesic effect

Tribulus terrestris has been used in traditional medicine for relieving rheumatic pain and as an analgesic plant for a long time. In this investigation the analgesic effect of methanolic extract of this plant on body . The findings from ulcerogenic studies suggest that the gastric ulcerogenic potential of the plant T. terrestris extract possesses a favorable analgesic effect, and additional research is necessary to develop a more effective product derived from this plant as an alternative to traditional analgesic medications. The fruit of T. terrestris L. is utilized for the treatment of cutaneous pruritus, edema, tracheitis, and inflammation.(23)

Anticancer effect

Alkaloids (which encompass β -carboline Alkaloid, Tribulusterine, Terrestribisamide, Tribulusin A, Harmine, Tribulusamide, Harman, Terrestriamide, and N-transcoumaroyltyramine) used in treatment of cancer. Fruit of tribulus terrestris used in treatment of neoplastic The methanol extract of T. terrestris exhibits anticancer properties against human breast cancer cells. Additionally, it identifies bioactive compounds such as saponins and flavonoids as probable contributors.(24)

Antibacterial effect

The methanol extract demonstrates the most significant inhibition zone against Bacillus cereus, Escherichia coli, and Staphylococcus aureus .The ethanol extract of TT showed considerable antibacterial efficacy against Streptococcus mutans, Streptococcus sanguis, Actinomyces viscosus, Enterococcus faecalis, Staphylococcus aureus, and Escherichia coli. When combined with other plants such as Capsella bursa-pastoris and Glycyrrhiza glabra, the complexes of TT exhibited synergistic effects in comparison to TT used in isolation.(25)

Nutritional Potential of tribulus terrestris

TT's many phytochemical constituents (flavonoids, steroidal saponins, alkaloids) and outlines its traditional uses (e.g., strengthening, rejuvenating). "nourishing" (Ayurvedic concept brimhana) and having "rasayana" (rejuvenator) qualities. These are mentioned in the ancient traditional medicine of Indian. (15)

II. CONCLUSION

This comprehensive review offers an in-depth insight into T. terrestris, covering its phytochemistry, phytopharmacology, positive effects, and therapeutic uses. The phytochemical and pharmacological properties of the entire T. terrestris plant have been thoroughly investigated, including diuretic, anti-urolithiasis, anti-hypertensive, analgesic, anti-hyperlipidemic, immunomodulatory, anticancer, anti-helminthic, aphrodisiac, antibacterial, hepatoprotective, and anti-inflammatory characteristics. Due to its potassium-sparing, cardioprotective, and anti-hyperlipidemic effects, T. terrestris may represent a promising herbal treatment for effective blood pressure management. Although TT has been widely utilized throughout history and contemporary scientific research is also producing evidence regarding its pharmacological effects, additional studies at the molecular level are essential to gain a deeper understanding of the mechanisms through which it alters disease conditions. The pharmacological investigations conducted on the plant should progress to the next phase of clinical trials to develop new medications. This advancement will assist TT in attaining recognition as a medicinal product or being recommended as a dietary supplement for various health issues.



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