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Tribulus Terrestris: A Comprehensive Review of Botanical, Pharmacological, and Therapeutic Aspects.

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ABSTRACT:

The medicinal plant *Tribulus terrestris* also referred to as "puncture vine" or "Gokshura," has drawn interest from scientists, medical experts, and herbal enthusiasts. The aim of this thorough analysis is to present investigation of the pharmacological, botanical and medicinal features of *Tribulus terrestris*. The historical significance of the plant and its use in several traditional medical systems are introduced at the beginning of the article. Its botanical description and phytochemical composition are then thoroughly examined, providing insight on the chemical components supporting its possible health advantages. *Tribulus terrestris'* pharmacological properties are carefully examined, emphasising the plant's potential as an aphrodisiac, cardiovascular agent, anti-inflammatory, and antioxidant. Furthermore, the plant's significance in the fields of sports nutrition and performance enhancement is examined, emphasising the necessity for additional research as well as its potential. The article explores both traditional and modern uses, showing how herbal therapy today can be connected to centuries-old wisdom. An analysis of clinical trials and scientific research offers insight into the data proving its application. The paper ends with a summary of the main conclusions and their implications for the fields of herbal medicine and healthcare, as well as directions for further research. This thorough analysis emphasises the significance of using *Tribulus terrestris* in a balanced and evidence-based manner while providing a useful resource for scholars, medical professionals, and anyone wishing to learn more about the plant and its potential advantages.

Keywords: *Tribulus terresteris*, pharmacological activities, chemical constituents,saponins,flavonoids.

1. Introduction:

The Tribulus genus belongs to the Zygophyllaceae family, which is also referred to by its Sanskrit names, Gokhshura, little caltrop, goat head, devil's throne, and Chota Gokhru. The term *Tribulus*, which refers to the three-pronged fruit of *TT* with projecting spikes which means "three pointed caltrops" in Latin. This plant has about 20 species, of which three major species are found in India: *Tribulus cistoides*, *Tribulus terrestris*, and *Tribulus alatus*. It is an important medicinal plant that has been used for many years to cure a wide range of illnesses. It is primarily found in the world's tropical and subtropical climates. By tradition, it has been applied to increase hormone production in both genders. The Unani medical system uses the matured dry fruit known as Khar-e Khasak Khurd to cure dysuria and gonorrhoea. The primary saponin components in this plant, which has been used for medicinal purposes, are furostanol and spirostanol. The primary indications for *T. terrestris* include kidney and urinary diseases. Moreover, it has additional therapeutic qualities, including being diuretic, anticancer, aphrodisiac, stomachic, lithontriptic, anti-inflammatory, antispasmodic, anti-hypertensive, anthelmintic, analgesic, larvicidal, immunomodulatory, antibacterial and anti-carcinogenic for the urine(1,2,3,4).

1.1 Taxonomical Classification:

Kingdom: Plantae

Division: Phanerogams

Subdivision: Angiosperm

Class: Dicotyledonae

Subclass: Polypetalae

Series: Disciflorae

Order: Giraniales

Family: Zygophyllaceae

Genus: Tribulus

Species: terrestris Linn(5,6).

Fig. 1: *Tribulus terresteris*.

2. Geographical Description:

Tribulus terresteris is a widely distributed plant species that grows throughout the world in a variety of climate zones. It is a hardy and adaptable plant that is well-known for growing in semi-arid and dry environments. The plant's native range includes parts of Asia, Africa, the Middle East, and Europe. Europe contains locations where *Tribulus terrestris* is present, including Greece, Italy, Spain, and the Balkan Peninsula. It is also native to parts of the Middle East, such as Iraq and Iran, and various Asian countries, such as China and Iran. It is also present in a number of African countries, most notably Egypt, Sudan, and those in North Africa. Because of its ability to spread, *Tribulus terrestris* has been able to colonise new areas of the world. *Tribulus terrestris'* adaptability to a variety of soil types and climatic situations has allowed it to spread to other regions of the world. Additionally, several parts of Australia, South America, and North America are home to it. It was brought to these areas due to its ability to flourish in harsh conditions, and it is sometimes considered an invasive species(7).

3. Ethno-Botanical Description:

Tribulus terresteris is a tiny annual herb with branching stems that is a member of the Zygophyllaceae family. This plant can grow up to 90 centimetres in length. The plant's roots are 4-5 inches long, fibrous, slender, light brown, broken, sweet and astringent tasting. The leaves are opposite, rather rounded, pinnately compound, and have a short stalk with five to six pairs of leaflets, each measuring six to twelve millimeters. Silky and hermaphrodite, the single axillary blooms have five broad yellow petals that range in width from 4 to 10 mm and emerge from the leaf axils. The plant produces spiny, glabrous, five-cornered, hairy fruits that are coated in tiny, muricate, woody cocci with two pairs of sharp spines that are typically greenish-yellow in colour(8,9,10).

Fig. 2: *Tribulus terresteris* fruit.

Fig. 3: *Tribulus terresteris* leaves.

4. 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 Vatadsha), Vrusya (aphrodisiac), Ashmarihara (removes urinary stones), and Vastishodhana (cures bladder ailments)(11).

5. Traditional Pharmacological Uses:

It is used as a traditional medicine as well as a tonic, palliative, stomachic, aphrodisiac, diuretic, antihypertensive, astringent, lithotriptic, and urinary disinfectant. The dried fruit of the herb is effective for most genitourinary tract ailments. It is a crucial part of Gokshuradi Guggul, an effective Ayurvedic treatment that eliminates urinary stones and supports the normal function of the genitourinary system. TT has been used for millennia in Ayurveda to treat impotence, sexual debility, and illnesses related to the venereal system. In Bulgaria, the herb is used as a traditional treatment for impotence. The fruit and root are described as having cardiotonic properties in the Indian Ayurvedic Pharmacopoeia in addition to all these other uses. In traditional Chinese medicine, the fruits were used to treat oedema. In traditional Chinese medicine, the fruits were used to cure oedema, sexual dysfunction, emission, stomach distension, and morbid leucorrhea. The Shern-Nong Pharmacopoeia, the first known pharmaceutical work in China, lists TT as a highly beneficial drug that treats vitiligo, mastitis, flatulence, migraines, acute conjunctivitis, and chest fullness. It aids in the liver's recovery as well. In Unani medicine, TT is used as a general tonic, a moderate laxative, and a diuretic(12,13,14,15,16).

6. Chemical Constituents:

Initial research into the photochemistry of TT showed that it contained tannins, alkaloids, glycosides, flavonoids, and saponins. Data from the literature indicates that the saponin concentration and composition of TT vary depending on the geographical location(17,18).

Kostova et al. looked into the chemistry and bioactivity of saponins in TT. They found that furostanol and spirostanol saponins of the tigogenin, neotigogenin, gitogenin, neogitogenin, hecogenin, neohecogenin, diosgenin, chlorogenin, ruscogenin, and sarsasapogenin kinds are often present in this plant. In addition, four sulfated saponins of the tigogenin and diosgenin types were discovered(19).

Protodioscin and protogracillin, the most prevalent saponin among the furostanol glycosides, predominate, while spirostanol glycosides are found in trace amounts(19,20).

Primary flavonoids are over 1.5 times more abundant than primary saponins, according to Wu et al. This implied that further investigation, creation, and utilisation of TT's flavonoid content were necessary. Bhutani et al. identified kaempferol, kaempferol 3 glucoside, kaempferol 3 rutinoside, and tribuloside [kaempferol 3 β d (6″ p coumaroyl) glucoside] from leaves and fruits using spectroscopic analysis(21).

Louveaux et al. identified 18 flavonoids (caffeoyl derivatives, quercetin glycosides, including rutin and kaempferol glycosides) in four leaf extracts from Tribulus species using high-performance liquid chromatography (HPLC)(22). Yang and colleagues optimised the extraction condition by an orthogonal experiment(23). Matin Yekta et al. extracted three flavonoid glycosides—quercetin 3 O glycoside, quercetin 3 O rutinoside, and kaempferol 3 O glycoside—from the aerial sections of T. terrestris L. var. orientalis (Kerner) G. Beck in northeastern Iran(24).

Raja and Venkataraman used an ethyl acetate:benzene (1:9) solvent method to identify flavonoids from petroleum ether and chloroform extracts of fresh TT fruits from India. The fruit extracts of another type, *T. alatus*, did not contain these flavonoids. Therefore, the presence of these pharmacognostic elements can be employed as a diagnostic tool to research adulteration and contamination and identify species(25,26).

From the dried fruits of TT, Tian Shung et al. isolated and characterised ten known compounds: N-p-coumaroyltyramine, terrestriamide, hecogenin, aurantiamide acetate, xanthosine, fatty acid ester, ferulic acid, vanillin, p-hydroxybenzoic acid, and β-sitosterol. They also identified three new compounds: terrestribisamide, 25R-spirost-4-en-3, 12-dione, and tribulusterine(27).

Alkaloids come in two varieties: norharmane and harmane. Trace levels of the β-carboline alkaloid tribulusterine are found in fruits(28). Gas chromatography-mass spectrometry analysis of the methanolic extract of the whole TT plant revealed seven minor constituents, including phytol, 9,12 octadecadienoic acid, 9,12,15 octadecatrienoic acid, 1,2 benzenedicarboxylic acid disoctyl ester, and 3,7,11,15 tetramethyl 2 hexadecen 1 ol, n hexadecadienoic acid, hexadecadienoic acid ethyl ester, and n hexadecadienoic acid. Furthermore, it was found that steroids like β-sitosterols and stigmasterols were present(29).

7. Pharmacological Activities:

7.1 Aphrodisiac Activity:

The TT extract was found to have a pro-erectile impact on rabbit corpus cavernosum smooth muscle ex vivo following oral therapy at doses of 2.5, 5, and 10 mg/kg body weight for eight weeks, according to Adaikan et al. Nitroglycerine caused a considerable 24% relaxation in the smooth muscular tissue of the corpus cavernosum(30).Similarly, after the TT therapy mentioned above, 10% relaxation was seen in the rabbits under cholinergic and electrical field stimulation, respectively. Its touted aphrodisiac properties may be explained by the increased production of nitric oxide from nitrergic nerve endings and the endothelium, which results in an intensified relaxing action(31).In order to treat male rat sexual dysfunction, Singh et al. assessed the use of lyophilized aqueous extract of the dried fruits of TT (LAET) at doses of 50 and 100 mg/kg of body weight both acutely and repeatedly. With LAET medication, there was a dose-dependent improvement in sexual behaviour that became more pronounced with long-term LAET administration. Serum testosterone levels also showed a notable increase. These results support the long-standing use of TT as a sexual enhancer to treat male sexual dysfunction(32).An ethanolic extract of TT showed a preventive effect against testicular damage caused by cadmium. The protective effect seems to be directly mediated by either boosting testosterone production from Leydig cells or inhibiting the peroxidation of testosterone-containing tissue through antioxidant and metal-chelating activities. It was discovered that treating a fish colony with TT extract (100–300 mg/l) increased the percentage of male fish in the population. It was discovered that Poeciliata reticulata fish species with testes treated with TT extract displayed all phases of spermatogenesis with enhanced growth performance(33).The biological aphrodisiac activity that has been identified is caused by protodioscin and protogracillin, the two primary constituents of the saponin fraction from TT.Protodioscin may function by enhancing the conversion of testosterone into the powerful dehydrotestosterone, which in turn stimulates the production of red blood cells from bone marrow, muscular growth, and an improvement in blood circulation and oxygen transport systems, ultimately leading to optimal health(34).

7.2 Diuretic Activity:

The fruits and seeds of TT contain significant amounts of essential oil and nitrates, which give it its diuretic qualities. High concentrations of potassium salts are another factor contributing to the diuretic action. In a rat diuretic model, Ali et al. evaluated the aqueous extract of TT made from its fruit and leaves. For the contractility test, they utilised strips of isolated Guinea pig ileum. At a dosage of 5 g/kg orally, the TT aqueous extract produced a positive diuresis that was somewhat greater than that of furosemide. Urine included higher amounts of sodium and chloride. The diuretic action of TT extract, combined with the enhanced tonicity of the smooth muscles it caused, assisted in the passage of stones in the urinary tract(35).The diuretic efficacy of various TT fruit extracts, including aqueous, methanolic, Kwatha-high strength, Kwatha-low strength, and Ghana powder, was assessed in rats by Saurabh et al. Kwatha-high strength demonstrated a potassium-sparing effect in addition to a diuretic effect that was on par with the reference standard furosemide.TT's diuretic activity renders it a valuable anti-hypertensive medication(36).

7.3 Antiurolithic Activity:

Anand et al. evaluated an ethanolic extract of TT fruits in albino rats with urolithiasis brought on by glass bead implantation. It demonstrated a notable, dose-dependent defence against leukocytosis, an increase in serum urea levels, and the deposition of calculogenic material surrounding the glass bead. Activity decreased as a result of the ethanol extract's subsequent separation. In a dose-dependent way, several other biochemical values in urine, serum, and the histology of the bladder were recovered. From TT, a new anti-lithic protein with a molecular weight of less than 60 kDa and cytoprotective efficacy was isolated(37).Aggarwal examined the effects of TT on NRK 52E renal epithelial cells' oxalate-induced cell damage as well as the nucleation and development of calcium oxalate (CaOx) crystals. The results of the trials showed that TT extract possesses cytoprotective properties in addition to the ability to prevent the nucleation and development of CaOx crystals. TT was reported to prevent the production of stones in a variety of urolithiasis models that employed ethylene glycol and sodium glycolate(38).One of the key enzymes in the process of oxalate formation is glycolate oxidase (GOX), which oxidises glycolate to glyoxylate and then back to oxalate. TT's suppression of GOX is responsible for its antiurolithic action. The active ingredients in TT, quercetin and kaempherol, were discovered to be competitive and non-competitive GOX inhibitors, respectively(39,40).

7.4 Absorption Enhancer:

Because TT contains saponins, the ethanolic extract improved the absorption of metformin hydrochloride, a Biopharmaceutics Classification System (BCS) class III medicine, in the everted sac technique utilising goat intestine(41).

7.5 Central Nervous System (CNS) activity:

After receiving a 260 mg/kg dose of Rasayana Ghana tablet, which contains three powerful and well-known rejuvenator herbs in equal amounts—*Tinospora cordifolia* (stem), *Emblica officinalis* (fruit), and TT (fruit and root)—Swiss Albino mice exhibited antidepressant and anxiolytic activity. Harmine, a β-carboline alkaloid found in TT, has been proposed as one of the primary active ingredients that support the aforementioned actions. Monoamine oxidase is inhibited by heroine, which contributes to the brain's increased dopamine levels(42).

7.6 Hepato-protective Activity:

In *Oreochromis mossambicus* fish, the TT extract (250 mg/kg) demonstrated a notable hepatoprotective effect against acetaminophen-induced hepatotoxicity. Treatment with TT extract (250 mg/kg) normalised the increased metabolic parameters and decreased the amount of reduced glutathione enzymes in freshwater fish exhibiting acetaminophen-induced toxicity(43).

7.7 Anti-carcinogenic Activity:

The bacterium that causes dental caries, *Streptococcus mutans*, is significantly inhibited by the ethanolic extract of TT fruits (0.1–0.5 mg/ml). The ethanol extract of TT strongly reduced the proliferation, acid generation, adhesion, and water-insoluble glucan synthesis of S. *mutans*. To determine the active ingredients in TT that are responsible for these actions, more research is required(44).

7.8 Larvicidal Activity:

With an LC50 of 64.6 ppm, the petroleum ether extract of the TT leaves demonstrated superior larvicidal activity against the adults and third instar larvae of the dengue-carrying mosquito, *Aedes aegypti*, than the crude ethanol(45,46).

7.9 Anthelmintic Activity:

When it came to in vitro anthelmintic action on the nematode *Caenorhabditis elegans*, the methanolic extract of TT outperformed the petroleum ether, chloroform, and water extracts. Additional bioactivity-guided fractionation verified that the active ingredients were tribulosin and β-sitosterol-d-glucoside, with ED50 values of 76.25 and 82.50 µg/ml respectively(47,48).

7.10 Anticancer Activity:

When 7, 12-dimethylbenz (a) anthracene (DMBA) and croton oil were used to induce papillomagenesis in Swiss albino male mice, the aqueous extract of the root and fruit of TT at a dose of 800 mg/kg demonstrated a significant reduction in tumour incidence, tumour burden, and cumulative number of papillomas. Additionally, the average latent period increased significantly in the mice that were continuously given TT suspension orally at the pre-, peri-, and post-initiation stages of papillomagenesis when compared to the control group that was given DMBA and croton oil alone. In mice with cutaneous papillomagenesis, the TT root extract showed superior chemopreventive activity than the fruit extract at the same dose (800 mg/kg body weight). HepG2 cell proliferation was inhibited by the TT aqueous extract, which also has the ability to cause apoptosis by suppressing the NF-κB (nucleus kappa-light-chain enhancer of activated B cells) signalling pathway. TT thus exhibits clinically meaningful therapeutic actions on liver cancer cells.When administered orally for seven consecutive days before gamma irradiation, the TT aqueous root extract (800 mg/kg) resulted in considerable radioprotection. The pretreatment of TT extract provided protection against radiation damage by preventing the depletion of glutathione caused by radiation and lowering the level of lipoperoxidation in the mice's liver.The cytostatic and cytotoxic effects of saponins extracted from the aerial portions of TT were investigated on human fibroblasts. In order to evaluate cell viability and proliferation, respectively, 3H thymidine incorporation and 3 (4, 5)-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assays were used to identify the effects. Reduced proliferation was indicated by a dose-dependent decrease in 3H thymidine incorporation into the DNA by saponins. They were also discovered to be less harmful to healthy human skin fibroblasts. The mode of action includes inducing apoptosis, suppressing proliferation, and regulating the homeostasis of polyamines both up and down(49,50,51,52).

7.11 Antibacterial Activity:

In contrast to the aerial parts of Yemeni TT, which showed no detectable antibacterial activity against these bacteria, only the fruits and leaves of Indian TT were exclusively active against *E. coli* and *S. aureus*. All parts (fruits, stems, leaves, and roots) of Turkish and Iranian TT demonstrated antibacterial activity against *Enterococcus faecalis*, *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa*. These disparate findings on the antibacterial activity of TT could be the result of employing various strain types, assay techniques, and plant sources located in different parts of the

world. The fruit of TT was shown to have the highest level of activity against both gram-positive and gram-negative bacteria when its methanolic extract was used; however, its petroleum ether and chloroform extracts showed only moderate activity(53,54).

7.12 Antispasmodic Activity:

In a dose-dependent way, the plant's lyophilized saponin mixture significantly reduced the peristaltic motions of rabbit jejunum preparation. These findings suggested that the saponin combination might be helpful for colic or smooth muscle spasms(55).

7.13 Analgesic Activity:

Formalin and the tail flick test were used to examine the analgesic effects of TT in male mice. According to the study, TT's methanolic extract had analgesic effects when administered at a dose of 100 mg/kg. The TT extract's analgesic action could have a central or peripheral-mediated mechanism. In all experiments, the extract's effect was greater than that of acetylsalicylic acid (aspirin) and lower than that of morphine. The analgesic effect of the extract in all experiments was not affected by pretreating rats with the opioid receptor antagonist naloxone; so, the possibility that opioid receptors are involved in the analgesic effect of TT is ruled out. According to the findings of ulcerogenic investigations, TT has a reduced propensity to cause gastric ulcers in rats compared to indomethacin(56).

7.14 Anti-inflammatory Activity:

In lipopolysaccharide-stimulated RAW264.7 cells, the ethanolic extract of TT reduced the production of cyclooxygenase-2 (COX-2) and inducible nitric oxide synthase (iNOS). Additionally, it inhibited the production of pro-inflammatory cytokines in macrophage cell lines, including interleukin (IL)-4 and tumour necrosis factor-alpha (TNF-α). Thus, the ethanolic extract of TT has a positive effect on a variety of inflammatory disorders by inhibiting the expression of inflammatory cytokines and mediators linked to inflammation. Rat paw volume was shown to be dose-dependently inhibited by the TT methanolic extract when rats were inflamed with carrageenan(57).

7.15 Activity in cardiac disorders:

When used to treat a variety of heart conditions, including coronary disease, myocardial infarction, cerebral arteriosclerosis, and cerebral thrombosis, TT has a noteworthy impact. In order to investigate the underlying mechanism in rats, Zhang et al. assessed the preventive effect of tribulosin from TT against cardiac ischemia/reperfusion injury. Tribulosin activates protein kinase C epsilon to protect the myocardium from ischemia and perfusion damage.Malondialdehyde, aspartate transaminases, creatine kinase, lactate dehydrogenase activity, and the rate of cardiac apoptosis were all significantly reduced after receiving ribulosesin treatment. It raised SOD activity. The plant's crude saponin fraction has demonstrated noteworthy efficacy in managing a range of cardiac conditions, including hypertension, coronary heart disease, myocardial infarction, cerebral arteriosclerosis, and thrombosis. Additionally, it has been demonstrated that the TT fruit aqueous extract significantly inhibits acetylcholinesterase (ACE) in vitro. In spontaneously hypertensive rats, direct arterial smooth muscle relaxation and membrane hyperpolarization are demonstrated as major antihypertensive effects of TT's methanolic and aqueous extracts. Additionally, TT seems to shield cardiac cells and may even enhance heart function after a heart attack(58,59,60).

7.16 Hypolipidemic Activity:

Wistar albino rats were used to test the hypolipidemic potential of the TT fruit aqueous extract. It was discovered that the extract, at a dose of 580 mg/kg, reduced the levels of cholesterol-induced hyperlipidemia, triglycerides, low density lipoprotein (LDL), very low density lipoprotein (VLDL), and atherogenic index (AI), while increasing the levels of high density lipoprotein (HDL) in the blood. The presence of phenolic compounds may be the cause of hypolipidemic activity, as this would increase the activity of lipoprotein lipases in the muscles and decrease it in the adipose tissues. This would suggest that the muscles use plasma triglycerides for energy production, while the adipose tissue uses them for energy storage.The study examined the pleotropic effects of TT at a dose of 5 mg/kg/day for 8 weeks on the vascular endothelium and lipid profile of the abdominal aorta in New Zealand rabbits fed a diet high in cholesterol. The herb's dietary consumption was shown to considerably reduce the blood lipid profile, lessen endothelial cellular surface damage and ruptures, and partially heal endothelial dysfunction brought on by hyperlipidemia.The preventative and therapeutic effects of saponins derived from TT were investigated in mice with diet-induced hyperlipidemia. A reduction in the levels of serum LDL-cholesterol and total cholesterol (TC) indicated the preventative impact. Additionally, it raised the liver's SOD activity while lowering TC and triglycerides. The liver and serum TC levels were considerably reduced, demonstrating a therapeutic impact(61,62,63).

7.17 Anti-diabetic Activity:

TT saponin possesses hypoglycemic properties. TT significantly reduced serum levels of cholesterol, triglycerides, and glucose while increasing serum superoxide dismutase (SOD) activity in mice with diabetes induced by alloxan. The TT decoction decreased gluconeogenesis in mice. Streptozotocin-induced diabetic rats were protected by TT ethanolic extract at a dose of 2 g/kg body weight, which prevented oxidative stress. An ethanolic extract of TT demonstrated 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. Giving saponin from TT to rats resulted in a considerable decrease in their postprandial blood glucose

levels. TT increased coronary circulation and dilated coronary arteries. Because of this, Ayurveda advises taking it to treat other diabetic cardiac issues, such as angina pectoris. TT may therefore be beneficial in the treatment of diabetes due to its antioxidant mechanism and capacity to lower cholesterol and blood sugar(64,65,66,67).

7.18 Innumomodulatory Activity:

A dose-dependent increase in phagocytosis was seen by saponins extracted from TT fruits, suggesting that they stimulated a nonspecific immune response. A notable dose-dependent rise in humoral antibody titre and delayed type hypersensitivity response was observed in an alcoholic extract of the entire TT plant, suggesting an enhanced specific immune response(68).

7.19 Antioxidant Activity:

In spleen cells, the aqueous extract of TT fruit exhibited antioxidant activity that prevented oxidative stress-induced apoptosis by scavenging reactive oxygen species (ROS) produced by y-radiation and AAPH. In spleen cells, it also demonstrated mitogenic action(69,70).

7.20 Anti-arthritic Activity:

The anti-arthritic benefits of flavonoids are probably due to their presence. These flavonoids' ability to neutralise surface charges is being noted. *Tribulus terrestris* has been found to suppress leukocyte migration, which may be beneficial for the preservation of joints. The activity could be due to steroid glycosides(71).

7.21Anti-fungal Activity:

The study looked at the ability of saponins isolated from TT to inhibit the growth of fluconazole-resistant yeast, *Candida albicans*. The results showed that saponins produced from *Tribulus terrestris* have substantial antifungal action both in vitro and in vivo. These saponins kill fungus by rupturing their cell membranes and reduce the pathogenicity of candida albicans(72).

7.22 Radio protective Activity:

Aqueous root extract from *Tribulus terrestris* considerably decreased radioprotection when taken orally prior to gamma irradiation. The extract pretreatment offered protection against radiation damage by reducing lipoperoxidation levels in the livers of mice and decreasing radiation-induced glutathione depletion(73).

7.23 Activity on the Female Reproductive System:

In a study, the impact of *Tribulus terrestris* aqueous extract on mature albino female mice's reproductive system was assessed. The number of developing follicles, mature follicle diameter, height of endometrial lining cells, and diameter of endometrial glands all significantly increased, according to the results(74).

7.24 Spasmolytic Activity:

Sri Ranjani studied an In-vitro Bioassay on aqueous extract of T.terrestris fruit on virgin rat uterine tissue and identified spasmolytic effect vs. acetylcholine induced contraction [45]. Ivan identified that the alkaloid fraction and water extract of the dried fruits of T.terrestris were active on the rat intestine vs. Ach- induced contraction(75).

8. Conclusion:

TT, a widely accessible weed, has great medicinal efficacy in the traditional Chinese, Siddha, Unani, and Ayurvedic systems. In several nations, traditional medicine uses TT as an herb for a variety of illnesses. The pharmacological and phyto chemical properties of the entire TT plant, including its antihyperlipidemic, diuretic, antiurolithic, antihypertensive, antidiabetic, hepatoprotective, immunomodulatory, anticancer, antibacterial, anthelmintic, analgesic, aphrodisiac, and anti-inflammatory properties have been thoroughly investigated. Based on the existing research on TT, the plant's diuretic (potassium sparing), antihyperlipidemic, and cardioprotective properties suggest that it may be useful as an alternative remedy for successful control of blood pressure. Even though TT has been used for millennia and there is currently a growing body of research indicating its pharmacological actions, further molecular studies are required to fully comprehend the mechanism by which it alters the state of the disease. To produce new medications, the pharmacological studies carried out on the plant need to be advanced to the next stage of clinical trials. This will assist TT in becoming recognised as a medicine or in being recommended as a dietary supplement for a range of medical ailments.

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