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Review Article

PHARMACOLOGICAL SCIENTIFIC EVIDENCE FOR THE PROMISE OF *TRIBULUS TERRESTRIS*

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ABSTRACT
The usage of plants, plant extracts or plant-derived pure chemicals for disease management, become a therapeutic modality, which has stood the test of time. In the present review, we focus on pharmacological profile (in tabular form) of *Tribulus terrestris* L., apart from Phytochemistry, Taxonomy and Traditional uses. Data were located, selected and extracted from SCI database, Medline, Pubmed, Highwire and Google Scholar. Fruits and seeds of *Tribulus terrestris* L., (Zygophyllaceae) are of immense importance in oriental medicine because they are used as an aphrodisiac, diuretic and anthelmintic, as well as to treat coughs and kidney failure. *Tribulus terrestris* L. has reported to have antimicrobial, antihypertension, diuretic, antiacetylcholine, haemolytic activity, spermatogenesis and libido enhancer, antitumor activity and effects on cardiovascular system. Furostanol and spirostanol saponins, flavonoid glycosides, alkaloids, steroidal saponins named terrestrosins A, B, C, D and E, F-gitonis, gitnin and amides have been reported to occur in *Tribulus terrestris* L. Traditionally *T. terrestris* is used in folk medicine as a tonic, aphrodisiac, palliative, astringent, stomachic, antihypertensive, diuretic, lithon-triptic, cordial drug and urinary anti-infective. The ash of the whole plant is good for external application in rheumatic-arthritis.
KEY WORDS: *Tribulus terrestris* Phytochemistry, Taxonomy, Traditional uses, Pharmacological actions.

INTRODUCTION

The genus *Tribulus terrestris* (Zygophyllaceae) comprises with 20 species which grow as shrubs in subtropical areas around the world and only two species distributed in China, *T. terrestris* and *T. cistoides*. In traditional Chinese medicine, the fruit of *T. terrestris*, which is known as "Ci Ji Li", has been used against diverse diseases for a long time. Recently, the crude saponin fraction of the whole plant has been used as a convivial drug[1].

Tribulus terrestris (L.,) is also known as puncture vine or small caltrops 10 to 60 cm height, annual herb, with pinnate leaves and yellow flowers[2]. Its carpel fruits are very distinguishing in nature like a stellate and are known as "Chih-hsing" in China or "Goat head" in the USA. The plant can be found in arid climate regions around the world as in southern USA, Mexico, Spain, Bulgaria, India, and China[3]. The fruits and seeds are of immense importance in oriental medicine because they are used as an aphrodisiac, diuretic and anthelmintic, as well as to treat coughs and kidney failure[4-5].

Tribulus terrestris L. has reported to have antimicrobial, antihypertension, diuretic, antiacetylcholine, hemolytic activity, stimulate spermatogenesis, libido[6], antitumor activity and effects on cardiovascular system[7].

Taxonomy of the Plant

Class	Dicotyledons
Sub class	Polypetatae
Series	Thalamiflorae
Order	Geraniales
Family	Zygophyllaceae
Genus	*Tribulus*
Species	*terrestris*[8].

Phytochemistry: Furostanol and spirostanol saponins, flavonoid glycosides, alkaloids and some amides have been reported to this Traditional medicine[7,9-11]. The major constituents of this plants are steroidal saponins[12] named terrestrosins A, B, C, D and E, desgalactotigonis, F-gitonis, desglucolanatigoneis, gitnin, which on hydrolysis yield diosgenins, hecogenins and neotigogenin[13-16]. Four pairs of sapogenins, tigogenin and neotigogenin, gitogenin and neogitogenin, hecogenin and neohecogenin, and manogenin and neomanogenin, have been isolated through hydrolysis of the crude saponins of *T. terrestris*[17].

Safety parameter: The ethanolic (95%) extract was tested in rats intraperitoneally and the LD_{50} was found to be 56.4 mg/kg[18]. The maximum tolerated dose in mouse was 100 g/kg, the extract used was ethanol and water (1:1) intraperitoneally[19].

Traditional uses: *T. terrestris* is used in folk medicine as a tonic, aphrodisiac, palliative, astringent, stomachic, antihypertensive, diuretic, lithon-triptic and urinary antiinfectives[20-21]. Crude saponin fraction of the whole plant has been used as a cordial drug[1]. The ash of the whole plant is good for external application in rheumatic-arthritis[22]. The diuretic properties of the plant are due to the large quantities of the nitrates present as well as the essential oil which occurs in the seeds[23].

It has been reported that *T. terrestris* stimulates spermatogenesis, increases the activity of Sertoli cells, diminish urinary oxalate excretion, and decrease the activity of liver enzymes such as GAO (glycolate oxidase) and GAD (glycolate dehydrogenase) [9,24].

THE PRINCIPAL PHARMACOLOGICAL ACTIONS OF *TRIBULUS TERRESTRIS*

1. Antiurolithiatic activity

Evaluation of diuretic potential of *T. terrestris* in albino rats has been observed. The diuretic effect was attributed to the presence of potassium salts in high concentration[25] and this action with minimal side effect of *Tribulus terrestris* in albino rats was confirmed[26].

The ethanolic extract of the plant was tested for activity against artificially induced urolithiasis in albino rats by

administeration of oral dose at 25, 50 and 100mg/kg daily for 4 months. It exhibited dose dependent antiurolithiatic activity and almost completely inhibited stone creation[27] along with anti hyperoxaluria potential[28].

Tribulus terrestris fed rats produced a significant decrease in urinary oxalate action and a significant increase in urinary glycoxylate excretion, as compared to sodium glycolate fed animals. The supplementation of *Tribulus terrestris* extract also caused a reduction in liver GAO and GAD activities, where as liver LDH activity remained unaltered[24].

2. Aphrodisiac activity

A study was conducted to investigate the effect of oral treatment of *Tribulus terrestris* extract on the isolated corpus carvenosal tissue of rabbits to determine the mechanism by which protodioscin (PTN) a constituent of *Tribulus terrestris* exerted its pharmacological activity. The penile tissues from the sacrificed animals were subjected for responses to both contractions and relaxing pharmacological agents and electrical field stimulation (EFS) and results indicating the relaxant responses to Acetyl chloline, nitroglycerin and EFS by more than 10%, 24% and 10% respectively compared to their control values and the lack of such effect on the contractile response to noradrenaline and histamine indicated that PTN had a proerectile activity. The enhanced relaxant effect was attributed to the increase of nitric oxide from the endothelium and nitrergic nerve endings, which may account for its claims as an aphrodisiac potential[29].

3. CNS Activity

The pharmacological screening of the *Tribulus terrestris* extract showed marked CNS stimulant activity[30].

4. Cardiotonic activity: Saponins of *Tribulus terrestris* have the action of dilating coronary artery and improving coronary circulation. In a clinical trial 406 patients with coronary heart disease were treated, results showed that the total efficacious rate of remission angina pectoris was 82.3 % and efficacious rate of ECG improvement (52.7 %) was even higher than that of control group (35.8 %) were observed[31].

CONCLUSION

T. terrestris L., have great significance in the Traditional System of Medicine (Ayurveda, Unani and Chinese) for the treatment of various ailments such as aphrodisiac, diuretic, anthelmintic, antimicrobial, antihypertension, spermatogenesis and effects on cardiovascular diseases.

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TABLE 1. CURRENT RESEARCH STATUS OF *TRIBULUS TERRESTRIS*

SN.	Year	Author	Reported Scientific Evidence for *Tribulus terrestris* L.
1.	2011	32	Evaluation of traditional Indian antidiabetic medicinal plants for human pancreatic amylase inhibitory effect *in vitro*.
2.	2010	33	Tribulosin protects rat hearts from ischemia/reperfusion injury.
3.	2010	34	Tribuli fructus constituents protect against tacrine-induced cytotoxicity in HepG2 cells
4.	2010	35	Antioxidant activity of aerial parts of *Tribulus alatus* in rats.
5.	2010	36	Effects of *Tribulus terrestris* on endocrine sensitive organs in male and female Wistar rats.
6.	2009	37	Five furostanol saponins from fruits of *Tribulus terrestris* and their cytotoxic activities.
7.	2009	38	Molluscicidal activity of *Piper cubeba* Linn., *Piper longum* Linn. and *Tribulus terrestris* Linn. and their combinations against snail Indoplanorbis exustus Desh.
8.	2009	39	Evaluation of *Tribulus terrestris* Linn (Zygophyllaceae) acetone extract for larvicidal and repellence activity against mosquito vectors.
9.	2009	40	Screening of some saponins and phenolic components of *Tribulus terrestris* and Smilax excelsa as MDR modulators.
10.	2009	41	Two new furostanol saponins from *Tribulus terrestris* L.
11.	2009	42	Mechanisms of gross saponins of *Tribulus terrestris* via activating PKCepsilon against myocardial apoptosis induced by oxidative stress
12.	2009	43	Changes in the brain cortex of rabbits on a cholesterol-rich diet following supplementation with a herbal extract of *Tribulus terrestris*.
13.	2009	44	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.
14.	2008	45	Antibacterial and antifungal activities of different parts of *Tribulus terrestris* L. growing in Iraq.
15.	2008	46.	Effects of *Tribulus terrestris* L. saponion on apoptosis of cortical neurons induced by hypoxia-reoxygenation in rats.
16.	2008	47	The hormonal effects of *Tribulus terrestris* L. and its role in the management of male erectile dysfunction-an evaluation using primates, rabbit and rat.
17.	2008	48	A triterpene saponin from *Tribulus terrestris* L. attenuates apoptosis in cardiocyte via activating PKC signalling transduction pathway.
18.	2007	49	Hypoglycemic and hypolipidemic effects of alcoholic extract of *Tribulus terrestris* L. in streptozotocin-induced diabetic rats: a comparative study with *T.* terrestris (Caltrop).
19.	2007	50	The effect of five weeks of *Tribulus terrestris* L. supplementation on muscle strength and body composition during preseason training in elite rugby league players.
20.	2007	51	Effects of *Tribuli* saponins on ventricular remodeling after myocardial infarction in hyperlipidemic rats.
21.	2007	52	The analgesic effect of *Tribulus terrestris* L. extract and comparison of gastric ulcerogenicity of the extract with indomethacine in animal experiments.
22.	2006	53	Role of *Tribulus terrestris* L. (Zygophyllacea) against mercuric chloride induced nephrotoxicity in mice, Mus musculus (Linn.).
23.	2006	54	The protective effect of *Tribulus terrestris* L. in diabetes.
24.	2006	55	Inhibitory effects of saponins from *Tribulus terrestris* L. on alpha-glucosidase in small intestines of rats
25.	2006	56	Chemopreventive potential of *Tribulus terrestris* L. against 7,12- dimethylbenz (a) anthracene induced skin papillomagenesis in mice.
26.	2006	57	Abnormal turning behaviour, GABAergic inhibition and the degeneration of astrocytes in ovine *Tribulus terrestris* L. motor neuron disease.
27.	2006	58	Antifungal activities and action mechanisms of compounds from *Tribulus terrestris* L.
28.	2005	59	In vitro and in vivo antifungal activities of the eight steroid saponins from *Tribulus terrestris* L. with potent activity against fluconazole-resistant fungal pathogens.
29.	2005	60	Antihypertensive and vasodilator effects of methanolic and aqueous extracts of *Tribulus terrestris* L. in rats.
30.	2005	61	The aphrodisiac herb *Tribulus terrestris* L. does not influence the androgen production in young men.
31.	2005	62	Inhibition of the growth of urinary calcium hydrogen phosphate dihydrate crystals with aqueous extracts of *Tribulus terrestris* L.
32.	2005	63	Effect of *Tribulus terrestris* L. on nicotinamide adenine dinucleotide phosphate-diaphorase activity and androgen receptors in rat brain.
33.	2004	64	Investigation on inhibitory and apoptosis-inducing effects of saponins from *Tribulus terrestris* L. on hepatoma cell line BEL-7402
34.	2004	65	Gynaecomastia and the plant product *Tribulus terrestris* L.
35.	2003	66	Study of antihypertensive mechanism of *Tribulus terrestris* L. in 2K1C hypertensive rats: role of tissue ACE activity.
36.	2003	67	Sexual effects of puncturevine (*Tribulus terrestris* L.) extract (protodioscin): an evaluation using a rat model.
37.	2003	68	The inhibitory effect of saponins from *Tribulus terrestris* L. on Bcap-37 breast cancer cell line in vitro.
38.	2003	69	*Tribulus terrestris* L.: preliminary study of its diuretic and contractile effects and comparison with Zea mays.
39.	2002	70	Tribulosin and beta-sitosterol-D-glucoside, the anthelmintic principles of *Tribulus terrestris* L.
40.	2002	71	Hypoglycemic effect of saponin from *Tribulus terrestris* L.
41.	2002	72	Effect of *Tribulus terrestris* L. decoction of different concentrations on tyrosinase activity and the proliferation of melanocytes.
42.	2002	73	Aphrodisiac properties of *Tribulus terrestris* L. extract (Protodioscin) in normal and castrated rats.
43.	2001	74	Effect of the decoction of *Tribulus terrestris* L. on mice gluconeogenesis
44.	2001	75	Experimentally induced cholangiohepatopathy by dosing sheep with fractionated extracts from *Tribulus terrestris* L.
45.	2001	76	Studies on the chemical constituents from *Tribulus terrestris* L.
46.	2000	77	The effects of *Tribulus terrestris* L. on body composition and exercise performance in resistance-trained males.
47.	2000	29	Proerectile pharmacological effects of *Tribulus terrestris* L. extract on the rabbit corpus cavernosum.
48.	1998	78	Tribulusamide A and B, new hepatoprotective lignanamides from the fruits of *Tribulus terrestris* L.: indications of cytoprotective activity in murine hepatocyte culture.
49.	1994	27	Activity of certain fractions of *Tribulus terrestris* L. fruits against experimentally induced urolithiasis in rats.
50.	1992	79	Locomotor effects in sheep of alkaloids identified in Australian *Tribulus terrestris* L.
51.	1990	80.	406 cases of angina pectoris in coronary heart disease treated with saponin of *Tribulus terrestris* L.
52.	1976	81	Cardiac action of *Tribulus terrestris* L.
53.	1971	82	Effect of *Tribulus terrestris* L. fruit extracts on chloride and creatinine renal clearances in dogs.
54.	1967	25	Preliminary studies on the diuretic effects of *Hygrophila spinosa* and *Tribulus terrestris* L.
55.	1963	83	Some aspects of chemical and pharmacological Studies of *Tribulus terrestris. Linn.*