ISSN: 0976-3376

Available Online at http://www.journalajst.com

ASIAN JOURNAL OF SCIENCE AND TECHNOLOGY

Asian Journal of Science and Technology
Vol. 08, Issue, 11, pp.6462-6467, November, 2017

RESEARCH ARTICLE

ENUMERATIONS ON PHYTOCHEMICAL AND PHARMACOLOGICAL PROPERTIES OF TRIBULUS TERRESTRIS LINN: INDIAN VIAGRA

*** Dilip Kumar Sharma**

Vardhaman Mahaveer Open University, Kota, Rajasthan, India

ARTICLE INFO

Article History:
Received 19th August, 2017
Received in revised form
24th September, 2017
Accepted 23rd October, 2017
Published online 30th November, 2017

Key words:

Tribulus terrestris Linn, therapeutic, pharmacological, saponin, antimicrobial, pathogenic, minimum inhibitory concentration, gokshur, dysuria, gokhru, Zygophyllaceae, phytochemicals, ethanomedicinal, medicinal uses.

ABSTRACT

Tribulus terrestris of Zygophyllaceae grown world wide as herb containing several bioactive compounds that are used as medicinal values for therapeutic use as diuretic, aphrodisiac, antibacterial, hepatoprotective, anthelmintic, antiurolithic, immunomodulatory, antihypertensive, antihyperlipidemic, antidiabetic, anticancer, analgesic and anti-inflammatory. The plant contains phytochemical such as saponins, flavonoids, glycosides, alkaloids and tannins. It is known as puncture vine, goat's-head, bindii, bullhead, burra gokharu, bhakhdi, caltrop, small caltrops, cat's-head, devil's eyelashes, devil's-thorn, devil's-weed and tackweed. It is a commonly available weed valued in the traditional systems of medicine, viz. Ayurveda, Chinese, Siddha and Unani. The aim of this review is to search overview its therapeutic, nutritive values and industrial effects. For the preprationof this review article, searching studies in pubmed, medline, web of science available books, journals and other databases were used.

INTRODUCTION

Tribulus terrestris of Zygophyllaceae is a tropical vine common in sandy soil throughout India, Pakistan and Sri Lanka. It is native to warm temperature and tropical regions of the old world in Southern Europe, Southern Asia, Africa, India and Northern Australia. It can thrive even in desert climates, poor soil, pasture lands, road sides and other waste places, chiefly in hot, dry, and sandy regions in India (Kokate, Purohit and Gokhale, 2007, Usman, Abdulrahman and Ladan, 2007). The plant is an annual creepinng herb found in Mediterranean, subtropical, and desert climate regions around the world, viz. India, China, Southern USA, Mexico, Spain, and Bulgaria (Anonymous, 1972, Trease and Evans, 2002, Chhatre, 2012, 2014). The plant is distributed along a wide geographic perimeter and found all over India up to 11,000 ft in Kashmir, Ceylon, and all warm regions of both hemispheres. It is a common weed distributed in pasture lands, road sides, waste places especially in hot, dry and sandy regions as West Rajasthan and Gujarat in India (Kokate, Purohit and Gokhale, 2007, Chhatre, 2014).The genus *Tribulus* comprises about 20 species distributed world wide, out of them 3 species viz. tribulus terrestris, T. cistoides and T. alatus, commonly occurred in India (Trease and Evans, 2002). T. terrestris is common medicinal herb used for a long time in both the Indian and Chinese systems (Gupta, Zafar and Pathak, 1997, Duke, Duke and Cellier, 2002). TT has three groups of active phytochemicals as Dioscin, protodioscin and diosgenin; these substances useds to cure several diseases, stimulate sexual performance and useful for a variety of sexual disorders. The plant contains saponins as ruscogenin, hecogenin, diosgenin; polysaccharide; Sterols-sitosterol, campesterol;flavanoid, kaempferol, kaempferolglycosides, quercetin; fatty acids-palmitic, stearic, oleic, linoleic acid; tannins; potassium salts are important metabolites or chemicals found in Tribulus terristris. The plant contains astragalin; chlorogenin; cistocardin; cracillin; d-(+)-pinitol; harman; polysaccharide h; ruscogenin; saponoside-c; jasmonic acid; hecogenin; leaf as ascorbic acid; ash; calcium, carbohydrates; fat (5,000 ppm); fiber (64,000 - 278,000 ppm); iron (92 ppm); oxalates (4,000 ppm); phosphorus (800 - 2,500 ppm); potassium (28,400 ppm); protein (54,000 ppm); tribuloside; fruit as aspartic acid; fat, glutamic-acid; linoleic acid, neohecogenin-3-o-beta-d-glucopyranoside; oleic-acid, palmitic-acid, stearic-acid; flower as beta-sitosterol; campesterol; gitogenin; kaempferol, neogitogenin; quercetin; stigmasterol; shoot contains duacosterol, desoxydiosgenin, diosgenin, diosgin, hecogenin, protodioscin, rutin, terrestrosides, tribulosin, seed contains fat,

Corresponding author: **Dilip Kumar Sharma,**
Vardhaman Mahaveer Open University, Kota, Rajasthan, India.

harmine and protein (Chhatre, Nesari, Somani, Kanchan and Sathaye, 2014, Shelke, Ramteke and Patankar, 2014).

COMMON OR VERNACULAR NAMES

Tribulus terrestris is commonly known as gokshur or gokharu or puncture vine used for a long time in Indian and Chinese systems. In traditional Chinese Medicine it is known as Ci Ji Li, Bai Ji Li or just Ji Li and is given to calm the liver and smooth the flow of liver qi (Xiao, 2001). The genus *Tribulus* means three pointed, a caltrop, with three-pronged fruit and referring to the caltrop, a military weapon, an iron ball with projecting spikes in Latin; terrestris means "on land". It is known as puncture vine, goat's head, bindii, bullhead, burra gokharu, bhakhdi, caltrop, small caltrops, cat's head, devil's eyelashes, devil's-thorn, devil's-weed, puncturevine, tackweed, small caltrops (English), gokshura, kshuraka, kantaphala, gokantaka, trikantaka, bhakshakanta, bhukshura, shvadanshtra, svadukantaka, palankasha, ikshugandhika, sthalashringataka and vanashrigataka, shadanga (possesses the sixth part, spines, apart from usual five parts), chanadruma (plant has leaves like those of bengal gram plant) (Sanskrit), gokharu (hindi), gokuri (bengali), kante gokaru (marathi), nerinci, nerunji (tamil), palleru kayalu (telugu), bhakhara (punjabi), pallerukayalu (telegu), bethaa gokhru (gujarati); sanna neggilic (kannada), nerinnil (malayali); charatte (mar), *bethagokharu* or *nanagokharu* (gujarathi); *khar-e-khusak khurd* (urdu), zahra, isslamabad: bhakra (arabic) and Gokhur (nepali) (Arcasoy, Erenmemisoglu, Tekol, Kurucu and Kartal, 1998, Quattrocchi, 2000, Miraj, 2016, Anomymus, 2016).

In ayurvedic classics that Gokshura is described in Charaka Samhita, Sushruta Samhita, Ashtanga Hridaya, Sharangadhara Samhita, Harita Samhita, Nighantus and Chikitsagranthas. It is described by various names in different classics such as mutrakrichchhra (in Sushruta Samhita), Rasayana (in Ashtanga Hridaya), shvadanshtraphalachurna is used in shosharoga (Rajamartanda), krichchhrashmari (in Raj Nighantu, gokshuradvaya), ashmarihara (in Harita Samhita), Hridaroga, krichchhashmari, shvasakasarujahara (in Kaideva Nighantu). Its properties are described as vrishya, ashmarihara, ramehashvasakasarsha, hridroga (in Bhavaprakasha Nighantu), Bhavamishra, in his section Bhavaprakash, madhyamakhanda mentions indication of trikantakabeejachurna in ashmari. The properties of TT and actions mentioned in ayurveda are 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 (pharmacologicalactions), brumhana (nourishing), vatanut (pacifies vata-dsha), vrusya (aphrodisiac), ashmarihara (removes urinary stone) and vastishodhana (cures bladder ailments) (Chhatre, 2014).

ETHANOBOTANICAL USES

Tribulus terrestris used as traditional medicine in India, China, South Africa and to cure oedemas, cardiovascular diseases, and abdominal dysfunction, to increase spermatogenesis, for treatment of eye troubles, leucorrhea and impotency (Ross, 2001, Baris O. Gulluce, Sahin, Ozer, Kilic, Ozkan, Sokmen and Ozbek, 2006). It is used as folk medicine as diuretic, against colic pains, hypertension and hypercholesterolemia in Turkey.

In Isslamabad it regarded as a tonic and aphrodisiac (Nadkarni 1976, Frawley and Lad 1986, Kirtikar and Basu 1993). In China, it is widely used to cure diseases of liver, kidney, cardiovascular and immune systems. Its role in Easter European folk medicine for muscle strength and sexual potency led to two decades in Sofia, Bulgaria culminating for improving physical and sexual performance. In Ayurvedic system and Ancient Greeks, it is known as a mood-enhancing used as smoke, tea, or decoction and as tonic for physical rejuvenation. In Iraq, it is used in folk medicine as tonic, aphrodisiac, anti-hypertensive, lithontriptic, analgesic, astringent, stomachic, diuretic and urinary antiinfectives (Saad, 1986, Usman, Abdulrahman and Ladan, 2007, Sharma, Kumar, Sharma, Akshita and Dwivedi, 2013). The Ayurvedic pharmacopoeia of India attributes cardiotonic properties to the root and fruit and 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 system it is used in the treatment of sexual disorders, relieving rheumatic pain, analgesic for a long time, diuretic, mild laxative and general tonic (Adaikan, Gauthaman and Prasad, 2001, Khare, 2007, Chhatre, 2014, Suresh Reddy Yanala et al, 2016). In Easter European it is used for muscle strength and sexual potency, treat high blood pressure stamina and rib pain. Tribulus also inhibits stone formation in experimental animals and may have hepatoprotective properties, useful in the treatment of vitiligo and bacterial infections (Chhatre, Nesari, Somani, Kanchan and Sathaye, 2014).

PLANT PROFILE

The odour of *Tribulus terrestris* is faint, agreeable (fruit); strong, agreeable (root) and slightly bitter, acidic (fruit); sweetish, astringent (root) in taste. It is a prostrate, spiny, hairy weed, coming up during rains in wastelands (Scott, 2011, Shelke, Ramteke and Patankar, 2014). Flowering and fruiting time is rainy to autumn seasons and onwards from May-September. It can thrive even in dry climates with fine rootlets arises take advantage of soil moisture that help in very arid conditions (Miraj, 2016). The stems radiate from the crown often branching, forming flat patches, may grow more upwards in shade or among taller plants (Kianbakht and Jahaniani, 2003) (Yasuji, 1982). Leaves are opposite, usually unequal, paripinnate, leaflets are oblong, mucronate, sericeos-villous with appressed hairs beneath and more or less so on the upper surfaces, base rounded oblique; petioles very short pilose (Nikolova and Vassilev, 2011). These are long hairs on the leaf margins and lower surface.The flowers contain with five lemon yellow petals, claw short, hairy five sepals (Yan, Ohtani and Kasai, 1996, Miraj, 2016), axillary or leaf-opposed, solitary; pedicels long, slender, hairy. Sepals are lanceolate, acute, hairy, and oblong-obovate; its carpel is of characteristic, stellate shape, round-shaped, compressed, five cornered, covered with princkles of very light yellow color. Ovary is bristly; style short; stout; stigmatic lobes longer than the diameter of the style (Samy, Bishr, Ahmed, Hanaa Sayed and Kamel, 2013). Fruits are faint greenish yellow with spines, globose, spinous or tuberculate; consisting of fine hairy or nearly glabrous, often muriculate and woodi cocci, each with two pairs of hard sharp spines, one pair longer than the other. Fruit often cling to clothes and bodies of animals and humans (Jayanthy, Deepak and Remashree, 2013).

Tips of spines almost meet in pairs together forming pentagonal framework around the fruit. Outer surface of the schizocarp is rough oblong, hairy, greenish yellow in colour contains several seeds which yeld fragrant oil. The nutlets are hard and bear two to four sharp spines broad point. The spiky fruit looks like the cloven hoof of a cow and, hence, is known as go-ksura (cow-hoof). Seeds are many in woodi cocci. Each nutlet or seeds are stacked on top of each other separated by a hard membrane (Anand, Patnaik, Kulshreshtha and Dhawan, 1994, Jayanthy, Deepak and Remashree, 2013). The spines of the nutlets point upward help in dispersal (Kostova and Dinchev, 2005, Miraj, 2016). Each plant can produced upto 2000 seeds up to five seeds in each carpel. Cotyledons of seedlings are narrowing oval, round apex and hairless. Odor of fruits is faintly aromatic and taste is slightly acrid (Chhatre, 2014).

PHARMACOLOGICAL ACTIVITIES

In Charaka Samhitaa plant classified as a diuretic, antiinflammatory, anthelmintic and useful in enemas. Sushruta considers gokshura valuable in the treatment of all sorts of urinary disorders, splenetic diseases, aching of limbs, asthma, and cough (Addis, Abebe and Urga, 2001).

Diuretic activity: The plant has large quantities of nitrates and essential oil in its fruits and seeds. The aqueous extract of fruit and leaves in rat diuretic model and strips of isolated Guinea pig ileum were used for the contractility test (Al-Ali, Wahbi, Twaij, Al-Badr, 2003). It is evaluated that the different extracts of TT fruits, viz. aqueous, methanolic, *Kwatha*-high strength, *Kwatha* -low strength, and *Ghana* powder, for diuretic activity in rats (Hashmi and Singh, 2002). Saponin possesses hypoglycemic properties (Baranwal, Kumar and Trivedi, 1978). The diuretic action of TT makes it useful as an anti-hypertensive agent (Shelke et al. 2014). Ethanolic extract plant enhanced the absorption of metformin hydrochloride (class III drug in BCS) becaused of presence of saponins in the extract (Ayyanna C Ayyanna, Chandra Mohan Rao, Sasikala and Somasekhar, 2012).

Antiurolithic activity: An ethanolic extract of TT fruits in urolithiasis induced by glass bead implantation in albino rats (Singh, Chatterjee and Srivastava, 1994, Shelke, Ramteke and Patankar, 2014). It exhibited significant dose-dependent protection against deposition of alculogenic material around the glass bead, leukocytosis, and elevation in serum urea levels (Anand, Patnaik, Kulshreshtha, Dhawan, 1994, Shelke et al. 2014). TT was found to inhibit stone formation in various models of urolithiasis using sodium glycolate and ethylene glycol (Sangeeta, Sidhu, Thind and Nath, 1994). The gastric ulcerogenecity is lower than indomethacin in the rat's stomach by TT (Heidari, Mehrabani, Pardakhty, Khazaeli, Zahedi and Yakhchali, 2007, Chhatre, 2014). Glycolate oxidase (GOX) 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 (Shirfule, Sangamwar and Khobragade, 2011).

Immunomodulatory activity: The whole plant extract (alcoholic) of TT exhibited a significant dose-dependent increase in humoral antibody titre and delayed type hypersensitivity response sepecially saponins increase in phagocytosis process (Singh, Raina, Chatterjee, Srivastava, 1998, Tilwari, Shukla and Devi, 2011, Chhatre, 2014, Shelke, Ramteke, Patankar, 2014).

Hypolipidemic activity: 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 fromhyperlipidemia (Triratana and Thaweboon, 1987, Tuncer, Yaymaci, Sati, Cayli, Acar, Altug, Demir, 2009, Chhatre, 2014). The aqueous extract of the fruits of TT tested for their hypolipidemic activity in albino rats and found that extract 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 due to phenoloic compounds. Due to the presence of phenolic compounds, it lead to increased lipoprotein lipases in the muscles and decreased activity in the adipose tissues in plasma triglycerides areutilized for energy production by the muscle and not for energy storage by the adipose tissue (Khan, Kabir, Jalees, Asif and Naquvi, 2011). Saponins effect on diet-induced hyperlipidemia in mice and found that it also reduced the liver TC, triglycerides and increased the activity of SOD in the liver (Chu, Qu, Pang, Sun, Huang, 2003, Chhatre, 2014).

Central nervous system (CNS) activity: In Swiss Albino mice demonstrated antidepressant and anxiolytic activity due to harmine (β-carboline alkaloid, an inhibitor of monoamine oxidase) increase level of dopamine in the brain (Taweechaisupapong, Singhara and Choopan, 2005, Deole, Chavan, Ashok, Ravishankar, Thakar, 2011, Chhatre, 2014, Shelke et al 2014)

Antispasmodic and analgesic activity:A liopihilized saponin extract of dried and powdered plant significantly decrease in peristaltic movements of isolated sheep ureter and rabbit jejunum preparations in a dose-dependent manner. The same extract had no effect on isolated rabbit aorta and its contractile response to KCl or noradrenaline (Garrod, Lambert and Gray, 1981, Arcasoy, Erenmemisoglu, Tekol, Kurucu and Kartal, 1998, Asres, Taddese and Gebremariam, 2003, Krishnaraju, Rao, Sundararaju, Vanisree, Subbaraju, *et al*. 2005, Chhatre, 2014). Methanolic extract of TT produced analgesic effect in male mice was studied its effect found lower than morphine and higher than acetylsalicylic acid (aspirin) using formalin and tail flick test (Das and Beuria, 1991, Shelke *et al*. 2014).

Aphrodisiac activity: Tribulus is as an aphrodisiac means putative testosterone elevator in animal models and improves libido in humans. Saponin fraction namely protodioscin and protogracillin are responsible for the observed biological aphrodisiac activity (Adaikan, Gauthaman and Prasad, 2001). When protodioscin is administered to castrate rats, it increases levels of testosterone, LH, DHEA, and adjustment of DHT. It is a testosterone precursor; it leads to the production of the luteinizing hormone (LH) (Qureshi, Naughton and Petroczi, 2014). The effect of acute and repeated dose administration of lyophilized aqueous extract of the dried fruits of Tribulus terrestris (LAET) on sexual function in sexually sluggish male albino rats (Wang, Zhang, Hui, Zhang and Hu, *2013,* Miraj, 2016). TT extract exhibited a pro-erectile effect on rabbit

corpus cavernosum smooth muscle *ex vivo* after oral treatment. The enhanced relaxant effect observed is due to increase in the release of nitric oxide from the endothelium and nitrergic nerve endings and significant increase in serum testosterone levels was observed (Adaikan, Gauthaman and Prasad, 2000, Singh, Nair and Gupta, 2012). 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 (Rajendar, Bharavi, Rao, Kishore, Kumar and Kumar, 2011). In *Poeciliata reticulata* fish treated with TT extract showed all stages of spermatogenesis with improved growth performance (Kavitha, Ramesh and Subramanian, 2012). Aphrodisiac effect of TT as an androgen enhancing botanical supplement was evaluated and semen quality and physiological parameters studied and found that there is a significant enhancement in sperm concentration, motility and liquefaction time. Protodioscin acts on sertoli cells, germ cell proliferation and growth of seminiferous tubules, convert testosterone into dihydrotestosterone (Salgado, Marques-Silva, Gonçalves, Mathias, Aguiar and Wolff, 2016). Plant was found ineffective in the treatment of idiopathic infertility (Roaiah, Elkhayat, Saleh, Abd El Salam, 2016).

Antimicrobial assay

The aqueous and ethanol extracts of *Tribulus terrestris* fruit were tested against gram positive *Bacillus subtilius*, *Staphylococcus aureus*, *Streptococcus epidermidis* and Gram-negative *E. coli*, *Shigella flexneri*, *Pseudomonas aeruginosa* for their antimicrobial activity. The antimicrobial activity of crude extracts of plants was initially assessed against the six tested microorganisms using the agar diffusion method (Bauer, Kirby, Sherris and Turck, 1966). Each herbal extract reconstituted in DMSO at different concentration was dispensed into the discs. Standard antibiotics (5 µg) Gram-positive (tetracycline, ofloxacin, azithromycin, piperacillin) and Gram-negative as nitrofurantoin, gentamicin, cefotaxime, norfloxaci, (5 µg/disc) were prepared as positive control for control. Pure dimethyl sulfoxide (99.9%) was used as negative control. The plant was found effective against gram-positive bacteria *S. aureus, E. coli* and *P. aeruginosa* and *S. epidermidis* (Mason and Curran and Al-Salihi, 1980, Wassermn, 1987, Ya, Gaffiney, Lilley, Haslam 1988, Tsuchiya, Sato, Miyazaki, Fujiwara, Tanigaki *et al*. 1996, Ryan and Ray, 2004).

Ethanol extract of *Tribulus terrestris* alone and in combination with *Capsella bursapastoris* and *Glycyrrhiza glabra* were examined *in vitro* against 6 pathogens aginst treatment of oral infections (Soleimanpour, Sedighinia, Afshar, Zarif and Ghazvini, 2015, Miraj, 2016). 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. All parts as 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* (Al-Bayati and Al-Mola, 2008, Mohammed, 2008).

Antidiabetic activity: The efficacy of the hydroalcoholic extract (saponin) of *T. terrestris* on the serum glucose and lipid profile of women with noninsulin- dependent diabetes mellitus type 2 was evaluated (Li, Qu, Wang, Wan, Tian, 2002, Samani, Jokar, Soveid, Heydari and Mosavat, 2016, Miraj, 2016). 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 (Li, Qu, Chu, Wang, Tian, Tu, 2001, 2002, Amin, Lotfy, Shafiullah, Adeghate, 2006, Lamba, Bhargava, Thakur and Bhargava, 2011, Chhatre, 2014).

Anticariogenic activity: The antitumoral properties of TT were evaluated and inhibitory effect against the progression of castration-resistant prostate cancer was investigated. The cell cycle arrest and induction of apoptosis in cancer cells and endothelial cells might be plausible mechanisms of actions for the observed antitumor and antiangiogenic activities of TED (Sisto, Lisi, D'Amore M, De Lucro R, Carati, Castellana, 2012, Miraj, 2016). TT has a preventive efficacy against UVB-induced carcinogenesis and saponins regulate cell death suggests great potential to be developed into a new medicine for cancer patients (Neychev and Mitev, 2005). 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 and clinical therapeutic effects against liver cancer cells (Kim, Kim, Min, Kim, Kim and Kor, 2011). The ethanolic extract of fruits has significant anticariogenic activity against *Streptococcus mutans* (the pathogen responsible for dental caries) and found it check the growth of pathogen, acid roduction and adhesion and glucan synthesis (Oh, Park, Moon, Jun, Choi and You, 2011, Chhatre, 2014). TT extract pretreatment protected against radiation damage by inhibiting radiation-induced glutathione depletion and decreasing lipoperoxidation level in the liver of mice (Kumar, Panwar, Samarth and Kumar, 2009). Saponins showed a dose-dependent decrease in 3Hthymidine incorporation into the DNA, indicating decreased proliferation. It was 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 (Neychev, Nikolova, Zhelev and Mitev, 2007, Chhatre, 2014).

Liver and kidney protective activities: Tribulus may also reduce and aid in the prevention of kidney stones, cystitis, renal calculi (kidney stones), incontinence, gout, impotence and mild diuretic action. The extract of aerial parts of *T. terrestris* on acute kidney injury (AKI) was investigate and found that oral administration for 2 weeks can decrease kidney functional disturbance, oxidative stress, and cellular damages following reperfusion injury in rats (Shalaby, Hammouda, 2014, Miraj, 2016). Prominent pathological changes observed in liver were as severe vascular and sinusoidal congestion with diffuse degenerative changes and mononuclear infiltration into peripheral areas, while the kidney showed vascular and glomerular congestion, cloudy swelling of tubular epithelium. Coadministration of ethonolic extract of *T. terrestris* or vitamin E along with Cd significantly reversed the Cd induced

changes along with significant reduction in Cd load (Rajendar, Bharavi, Rao, Kishore, Kumar and Kumar, 2011). It showed a remarkable hepatoprotective activity against acetaminophen-induced hepatotoxicity in *Oreochromis mossambicus* fish (Amarnath Gupta, Kulshreshtha and Dhawan, 2002). The 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 (Milasius, Dadeliene, Skernevicius, 2009, Kavitha, Ramesh, Bupesh, Stalin and Subramanian, 2011, Chhatre, 2014). The influence of hydroalcoholic extract of TT plant on cisplatin (CIS) induced renal tissue damage in male mice suggested that the oral administration of TT fruit extract provided protection against the CIS induced toxicity in the mice (Raoofi, Khazaei and Ghanbari, 2015). Nishchal *et al* (2014) investigated that the anticataleptic effect on haloperidol-induced catalepsy in albino mice was evaluated and found protective effect against haloperidol-induced catalepsy (standard drug). *T. terrestris* can be used to prevent haloperidol-induced extrapyramidal side effects.

Antiinflammatory activity: The ethanolic extract 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. 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 (Oh, Baik, Ahn, Jeong and Hong, 2012). The methanolic extract showed a dose-dependent inhibition of rat paw volume in carrageenan-induced inflammation in rats (Hashim and Devi, 2003, Baburao, Rajyalakshmi, Venkatesham, Kiran, Shyamsunder and Gangarao, 2009, Chhatre, 2014). The effects of N-trans-ρ-caffeoyl tyramine (CT) isolated from *T. terrestris* on the production of nitric oxide (NO) was investigated and found that the ethanolic extract of T. terrestris (EETT) and CT inhibited the production of NO, tumor necrosis factor-α (TNF-α), interleukin (IL)-6 and IL-10 in the LPS-stimulated RAW 264.7 cells in a dose-dependent manner. These findings indicate that CT may be beneficial as a possible treatment for chronicinflammatory diseases (Ko, Ahn and Oh, 2015, Miraj, 2016). In support of antinflammatory action of the plant there is a clinical, report on the efficacy of decoction of the aerial parts in the treatment of patients suffering from Bright's disease with dropsy (nephritis) and patients derived much benefit from this treatment.

Anthelmintic activity: The methanolic extract of TT was found more effective than the petroleum ether, chloroform and water extracts for *in vitro* against anthelmintic activity on the nematode *Caenorhabditis elegans.* The bioactivity-guided fractionation confirmed tribulosin and β-sitosterol-d-glucoside to be the active components with ED50 of 76.25 and 82.50 µg/ml, respectively (Deepak, Dipankar, Prashanth, Asha, Amit, Venkataraman, 2002, Kiran, Lalitha, Raveesha, 2011). The petroleum ether extract of leaves exhibited better larvicidal activity against the third instar larvae and adults of the mosquito *Aedes aegypti* (vector of dengue fever) with LC50 of 64.6 ppm as compared to the crude ethanol and acetone extracts (Singh, Raghavendra, Singh, Mohanty, Dash, 2008, El-Sheikh, Bosly, Shalaby, 2012, Chhatre, 2014).

Cardiovascular activities and cardiac disorders: TT showed significant effect in the treatment of various cardiac diseases as coronary disease, myocardial infarction, cerebral arteriosclerosis, and the sequelae of cerebral thrombosis. It is evaluated the protective effect of tribulosin against cardiac ischemia/reperfusion injury to myocardium against through protein kinase C epsilon activation in rats (Zhang, Li, Yang, 2010). Tribulosin treatment resulted in a significant reduction of malondialdehyde, aspartate transaminases, creatine kinase, lactate dehydrogenase activity and myocardial apoptosis rate. Crude saponin fraction from plant showed significant effects in the treatment of various cardiac diseases. The aqueous extract of TT fruits has significant acetylcholinesterase (ACE) inhibitory effects *in vitro*. Methanolic and aqueous extracts of TT shown significant antihypertensive activity by direct arterial smooth muscle relaxation and membrane hyperpolarization in spontaneously hypertensive rats and even improve the heart function following a heart attack (Taweechaisupapong, Choopan and Singhara, 2005, Phillips, Mathew and Oriowo, 2006, Zhang, Li, Xu and Yang, 2010, Chhatre, 2014, Miraj, 2016). The protective effect of partially fruit methanol extract against mitochondrial dysfunction in cell based (H9c2) myocardial ischemia model was investigated and found effective in safeguarding mitochondria via its antioxidant potential, mediated through various bioactives as well as to ameliorate ischemic insult in H9c2 cells (Reshma, Sainu, Mathew and Raghu, 2016). The saponin fraction of *T. terrestris* dilates the coronary artery and improves coronary circulation. No adverse affects were noted and to improve conditions such as angina, high blood pressure and myocardial ischaemia.

Anti-oxidant properties: The protective and anti-oxidant activities or anti stress activities of the methanolic extract of *T. terrestris* fruits against sodium valproate (SVP)-induced testicular toxicity in rats was assssed affirm that the traditional use as an aphrodisiac for treating male sexual impotency and erectile dysfunction in patients and recommends beneficial for male patients suffering from infertility (Wei, Fukuhara, Chen, Kawada, Kurabayashi and Furihata, 2014). The effect of saponins from plant on behavior, neuroendocrine of chronic mild stress (CMS) depression rats was observed and found that CMS can affect rat behavior, neuroendocrine and cause depression. TTS has the antagonism on CMS and produce antidepressive effects (Kamboj, Aggarwal, Puri, Singla, 2011). The effect of TT on different parameters of oxidative stress and gene expression profiles of antioxidant enzymes was examined and found that plant also reduced hyperoxaluria-caused oxidative stress and restored antioxidant enzyme activity and their expression profile in kidney tissue. *T. terrestris* treatment decreased renal epithelial damage, inflammation and restored normal glomerular morphology (Lakshmi Devi, Poornima, Rahamathulla, Sailaja and Shivaranjani, 2013). The possible protective effects of fruit aqueous extract (TTFAEt) on lipid profile and oxidative stress in isoproterenol (ISO) and found that Pretreatment with extract significantly showed a protective effect against ISO altered lipid profile, lipid peroxidation and antioxidant enzyme levels. Therapeutic effect of TTFAEt on lipid profile and oxidative stress in isoproterenol (ISO) induced myocardial necrosis in experimental rats (Sengupta, Hazra, Kundu and Ghosh, 2011, Miraj, 2016).

Conclusion

Tribulus terrestris of Zygophyllaceae is world wide herb weed grown in warm regions with 20 species. The plant has various medicinal propertys; as it contains a lot of nitrate and potassium chloride make it better for diuretic powers. It is used against urinary infections, throat or mouth inflammations. The leaves are used to rub rheumatisms; the fruits are supposedly galactologue, aphrodisiac and effective to stimulate the appetite. It has properties to improve in treatment of several diseases as antiurolithic, immunomodulatory, hypolipidemic, diuretic, central nervous system, antispasmodic, analgesic, aphrodisiac, antimicrobial, antidiabetic, anticariogenic, liver and kidney protective, antiinflammatory, anthelmintic, cardiovascular or heart diseases or cardiac disorders, anti-oxidant and pro-sexual and androgen enhancing effects.

Acknowledgement

Authors is grateful to Prof. Ashok Sharma, hon'ble vice-chancellor, VMOU, Kota, Prof. Kailash Agrawal Head, Department of Botany, University of Rajasthan, Jaipur, faculty members of P.G. Department of Botany for valuable support and academic guidance. Thanks to Dr. Meena Sh. Kailash Chaudhrary and Sh. Mahesh Kumar for the valuable technical support in preparing this review article.

REFERENCES

Adaikan, P.G., Gauthaman, K. and Prasad, R.N. 2001. History of herbal medicines with an insight on the pharmacological properties of *Tribulus terrestris*. Aging Male, 4:163-9.

Adaikan, P.G., Gauthaman, K., Prasad, R.N. and Ng, S.C. 2000. Proerectile pharmacological effects of *Tribulus terrestris* extract on the rabbit corpus cavernosum. Ann. Acad. Med. Singapore, 29: 22-26.

Addis, G., Abebe, D. and Urga, K. 2001. A survey of traditional medicinal plants in shirka district, ARSI zone. Ethio Pharm Journal, 19: 30-35.

Al-Ali, M., Wahbi, S., Twaij, H. and Al-Badr, A. 2003. *Tribulus terrestris*: Preliminary study of its diuretic and contractile effects and comparison with *Zea mays*. *J Ethnopharmacol,* 85: 257-60.

Amarnathgupta, P.P., Kulshreshtha, D.K. and Dhawan, B.N. 2002. Antiallergic activity of *Streblus asper*. *Indian J Pharmacol; Proceedings* of the XXXIV Annual conference of the *Indian Pharmacological Society;* January 10–12, 2002; Nagpur, pp. 211-26.

Amin, A., Lotfy, M., Shafiullah, M. and Adeghate, E. 2006. The protective effect of *Tribulus terrestris* in diabetes. Ann NY Acad Sci, 1084:391-401.

Anand, R., Patnaik, G.K., Kulshreshtha, D.K. and Dhawan, B.N. 1994. Activity of certain fractions of *Tribulus terrestris* fruits against experimentally induced urolithiasis in rats. *Indian J Exp Biol,* 32: 548-552.

Anonymous, 1972. Publications and information directorate. Vol. 9. New Delhi: CSIR.

Anonymous, 1989. Ayurvedic pharmacopoeia of India, 1st ed, Vol. 1. Govt of India, Ministry of Health and Family Welfare Gokshura (Rt.). apoptosis by down-regulating NF-κB signaling in liver cancer cells. *J Ethnopharmacol,* 136:197-203.

Arcasoy, H.B., Erenmemisoglu, A., Tekol, Y., Kurucu, S. and Kartal, M.1998. Effect of *Tribulus terrestris* L. saponin mixture on some smooth muscle preparations: A preliminary study. *Boll Chim Farm,* 137:473-5.

Asres, K., Taddese, S. and Gebremariam, T. 2003. In vitro antimicrobial activities of some selected topically applied medicinal plants of Ethiopia. *Ethio Pharm J,* 21: 34-45.

Ayyanna, C.A.C., Chandra Mohan Rao, G., Sasikala, M. and Somasekhar, P. 2012. Absorption Enhancement Studies of Metformin Hydrochloride by Using *Tribulus terrestris* Plant Extract. *Int J Pharm Technol*, 4:4118-25.

Baburao, B., Rajyalakshmi, G., Venkatesham, A., Kiran, G., Shyamsunder, A. and Gangarao, B. 2009. Anti-inflammatory and antimicrobial Activities of methanolic extract of *Tribulus terrestris* linn plant. *Int J Chem Sci,* 7:1867-72.

Baranwal, A.K., Kumar, P., Trivedi, V.P. 1978. A preliminary study of *Streblus asper* Lour. (Shakhotak) as an anti-lymphoedematous agent. Nagarjun, 21:22–4.

Baris O.G.M., Sahin, F., Ozer, H., Kilic, H., Ozkan, H., Sokmen, M. and Ozbek, T. 2006. *Turk. J. Biol*., 30: 65-73.

Bauer, A.W., Kirby, W.M., Sherris, J.C. and Turck, M. 1966. Antibiotic susceptibility testing by a standardized single disk method. Am J Clin Pathol, 45: 493-496.

Chhatre, S., Nesari, T., Somani, G., Kanchan, D. and Sathaye, S. 2014. Phytopharmacological overview of *Tribulus terrestris.* Pharmacognosy Reviews, 8 (15): 45-51

Chhatre, S., Nesari, T., Somani, G., Kenjale, R. and Sathaye, S. 2012. Comparativeevaluation of diuretic activity of different extracts of *Tribulus terrestris* fruits in experimental animals. *Int J Res Phytochem Pharmacol,* 3:129-33.

Chu, S., Qu, W., Pang, X., Sun, B. and Huang, X. 2003. Effect of saponin from *Tribulus terrestris* on hyperlipidemia. Zhong Yao Cai, 26: 34.

Deepak, M., Dipankar, G., Prashanth, D., Asha, M.K., Amit, A. and Venkataraman, B.V. 2002. Tribulosin and β-sitosterol-D-glucoside, the anth*elmintic principles* of *Tribulus terrestris*. Phytomedicine, 9: 753-6.

Deole, Y.S., Chavan, S.S., Ashok, B.K., Ravishankar, B., Thakar, A.B. and Chandola, H.M. 2011. Evaluation of antidepressant and anxiolytic activity of *Rasayana Ghana* tablet (a Compound Ayurvedic formulation) in albino mice. Ayu, 32:375-9.

Duke, J., Duke, P.K., Cellier, J.L. 2002. Duke Handbook of medicinal herbs 2nd edn.. United States: CRC Press, pp. 595.

El-Sheikh, T.M., Bosly, H.A., Shalaby, N.M. 2012. 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,* 5:13-22.

Frawley, D. and Lad, V. 1986. The Yoga of Herbs (An Ayurvedic Guide to Herbal Medicine).Motilal Banarsidass Publishers Pvt. Ltd., New Delhi, India. Pp 284.

Garrod, L.P., Lambert, H.P., Gray, F. 1981. Antibiotics and Chemotherapy. (5thedn) Edinburgh: Churchill Livingstone, 4: 501-512.

Hashim, M.S. and Devi, K.S. 2003. Insecticidal action of the polyphenolic rich fractions from the stem barks of *Streblus asper* on *Dysdercus cingulatus*. Fitoterapia, 74:670–6.

****