



REVIEW ARTICLE

TRIBULUS TERRESTRIS LINN.: A PHYTO-PHARMACOLOGICAL REVIEW

VERMA PRIYANKA,^{1*} GALIB,² PATGIRI BJ,³ PRAJAPATI PK⁴

¹Postgraduate Scholar, ²Assistant Professor, ³Associate Professor, ⁴Professor and Head, Department of Rasa Shastra & Bhaishajya Kalpana, Institute for Post Graduate Teaching & Research in Ayurveda, Gujarat Ayurved University, Jamnagar-361 008, Gujarat, India

*Corresponding author email address: drpriyanka.verma23@gmail.com

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Abstract:

Plants have a significant role in maintaining human health and improving quality of life. gokshura (*Tribulus terrestris* Linn.) one of such plants, is mentioned in Ayurvedic texts for various therapeutic properties like balya (strengthening), brimhana (nutritive), rasayana (rejuvenator), mootrala (diuretic), shothahara (anti-inflammatory), vajikarana (aphrodisiac) etc. and useful in the management of mutrakrichhra (dysurea), ashmari (renal calculi) etc. It is a perennial plant, grown predominantly in India and Africa. Its extract contains alkaloids, saponins, resins, flavanoids and nitrates. Considering its therapeutic values, a review has been done to gather information on different aspects of gokshura. Besides Ayurvedic references, the present paper also emphasizes on recent researches carried out on this plant for its clinical and pharmacological evaluation.

Keywords: gokshura, diuretic, pharmacology, *Tribulus terrestris*

INTRODUCTION:

Tribulus terrestris Linn. (gokshura) is a procumbent annual or perennial herb and belongs to Zygophyllaceae family.¹ It is native to southern Europe, Africa, temperate and tropical Asia.² *Tribulus terrestris* is adapted to warm, temperate regions and is prevalent in areas having hot summers and dry soils. In India, *Tribulus terrestris* is found primarily on loose and compact sandy loam soils, and reportedly grows on sand dunes in the desert regions.³

In India it is commonly known as gokharu and other vernacular names are gokhurkata (Assamese), gokhri (Bengali), bethagokharu (Gujarati), neggilamullu (Kannada), michikand (Kashmiri), nerinjil (Malayalam), sarate (Marathi), gokhyura (Oriya), bhakhra (Punjabi), nerinjil (Tamil), palleru kaya (Telugu), khar-e-khasak khurd (Urdu), caltrops fruit (English).⁴ It is having both curative and nutritive values.

Gokshura has been used as a single drug and used as a component in many ayurvedic formulations like gokshuradi guggulu,⁵ dashmoolaristha,⁶ rasayana churna⁷ and jatyadi taila⁸ etc. In this review, information related with the drug from the classics ranging from classification, properties, uses etc. has been collected. In addition, researches that have been carried-out in recent past were also referred and gathered information has been categorized into pharmacological properties, therapeutic action or nutritional utility etc.

Review of gokshura (*Tribulus terrestris*):

I. Literary review:

Etymology:

Gokshura: Literally the word gokshura means, the spines of the fruit that injures a grazing cow or cattle⁹.

Tribulus is a Latin word indicating trouble, pointing to the three- projecting spikes of fruit;¹⁰ in Latin 'terrestris' means "on land".

Thus, meaning of *Tribulus terrestris* together can be understood as three spike fruit growing on land.

Synonyms:

There are about 25 synonyms for gokshura found in different nighantus and some of which are given as¹¹

- Ikshugandhi : Smell of sugarcane
 Gokantak : Prickle causes pain to cattle
 Trikantaka : Fruits bear three spines
 Vanasringara : Thorn in the garden
 Palankasha : Easily digest the meat
 Shwadanshra :Thorns prick causes pain equivalent to that of dog bite
 Swadukantaka : Sweet thorn
 Chanadruma : Leaves like horse gram

Table 1: Classification of gokshura in different Ayurvedic Texts

| <i>samhita</i> | <i>varga</i> | <i>according to karma</i> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| Charaka Samhita | krimighna ¹² anuvasanopaga ¹³ mootravirechaniya ¹⁴ madhuraskanda ¹⁵ aasthapan ¹⁷ | shothahara ¹⁶ mootrakri- chrahara ¹⁷ anilhara karmas |
| Sushruta Samhita | vidarigandhadi ¹⁸ veeratarvadi ¹⁹ laghupanchamoola ²⁰ madhuravarga ²¹ | |
| Astanga Hridaya | veertaradi gana ²² madhura gana ²³ | |
| Dhanvantari Nighantu ²⁴ , Sodhala Nighantu ²⁵ , Bhavaprakash Nighantu ²⁶ , Shaligrama Nighantu ²⁷ | guduchyadi varga | |
| Madanapala Nighantu ²⁸ | abhayadi varga | |
| Kaiyadeva Nighantu ²⁹ | oshadhi varga | |
| Raja Nighantu ³⁰ | shatahvadi varga | |
| Priya Nighantu ³¹ | haritakyadi varga | |

II. Pharmacognostical review:

1) Macroscopic:

Tribulus terrestris Linn. (gokshura) has many spreading slender branches, the immature portions covered in a fine silky hair. Leaves are oppositely arranged, pinnate, with 3-8 simple leaflets that are almost sessile to the leaf stem, with oppressed hairs below, and to a lesser extent above. The solitary yellow flowers have five petals, and are borne in the leaf axils, on hairy pedicels up to 2 cm long. The fruits are globose, comprised of five woody cocci that bear two pairs of sharp spines, each cocci containing several seeds.

2) Microscopic characters:

Different parts of the plant has been studied microscopically³² and found to have characteristics as depicted in Table 2.

Table 2: Microscopic characters of different part of *Tribulus terrestris*:

| <i>part</i> | <i>Characters</i> |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| Root | cork, cortex, pericyclic fibres, prismatic and Ca oxalate crystals, mucilage cells, endodermis with xylem |
| Fruit | epidermis with coccus, glandular trichomes, epicarp, mesocarp, stone cells with mucilage |
| Stem | multicellular trichomes, epidermis, palisade, pericyclic fibres, vascular bundle with large pith. |
| Leaf | upper epidermis with multicellular glandular trichomes, palisade, chlorophyll, lower epidermis single layered with multiscellular trichome. |

Powder microscopy of whole Plant – powder microscopy of whole plant revealed the presence of-

- i. starch with unicellular trichomes
- ii. prismatic and rosette crystals
- iii. fragments of stomata
- iv. spiral vessels
- v. pitted vessels with group of fibres
- vi. epidermal cells in surface view
- vii. sclereides³³

III. Phytochemistry:

Different parts of the whole plant were found to contain a number of chemical constituents that are placed in below table-

Table 3: chemical constituents³⁴

| <i>part</i> | <i>chemical constituents</i> |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Plant | astragalín, chlorogenín, cistocardin, cracillin, D-(+)-pinitol harman, polysaccharide H, ruscogenín, saponoside-C, 5'-(hydroxysulphonyloxy) jasmonic acid, hecogenín3-O-beta-D glucopyranosyl(1-->4)-beta-d galactopyranoside etc. |
| Leaf | ascorbic acid, ASH, Calcium, carbohydrate, fat, fiber, Iron, oxalates, Phosphorus, Potassium, protein, tribuloside |
| Flower | beta-sitosterol, campesterol, gitogenín, kaempferol, kaempferol-3-beta-D-(6"P-coumaroyl)-glucoside, kaempferol-3-glucoside, kaempferol-3-rutinoside, neogitogenín, quercetin, stigmaterol |
| Fruit | aspartic acid, fat, glutamic-acid, linoleic-acid, neohecogenín-3-O-beta-D-glucopyranoside, oleic acid, palmitic-acid, stearic-acid |
| Shoot | duacosterol, desoxydiosgenín, diosgenín, diosgin, hecogenín, protodioscin, rutin, terrestrosides, tribulosin |
| Seed | fat, harmine, protein |

IV. Analytical review:

Fruit of gokshura should not have foreign matter, total ash and acid-insoluble ash more than 1%, 15%, 2% respectively and alcohol-soluble extractive and water-soluble extractive should be more than 6% and 10% respectively. Foreign matter, total ash, acid-insoluble values of root of gokshura should not be more than 2%, 13%, 3% respectively whereas alcohol-soluble extractive and water-soluble extractive should not be less than 4% and 10%.⁴

V. Pharmacological review:

In modern pharmacology, action of a drug depends on active principle whereas in Ayurveda system, the mode of action of the drug

depends on its five principles known as rasapanchaka.³⁵

Table 4: Ayurvedic properties³⁶

| <i>rasa</i> | <i>guna</i> | <i>Virya</i> | <i>vipaka</i> |
|-------------|---------------|--------------|---------------|
| madhura | guru, snigdha | Sheeta | madhura |

Action of gokshura depends upon the above qualities. In classics, gokshura is said to be useful in treatment of mutrakrichhra (dysurea), prameha (diabetes), jeerna jwara (chronic fever), asmari (renal calculi), hridroga (cardiac disease), amavata (rheumatoid arthritis), rasayana (rejuvenator), vajikarana (aphrodisiac), shwasa (dyspnoea), kasa (cough) etc.¹

Table 5: Action of Tribulus terrestris emphasized in Ayurvedic classics

| <i>action</i> | <i>Efficacy</i> | <i>effect on dosha</i> |
|-------------------------------|------------------------------|---------------------------------|
| agnideepaka ¹⁶ | ashmari ¹⁸ | vatapitta-shamaka ³⁰ |
| ashmaribhedana ²⁵ | agni-daurbalya ¹⁶ | kapha-pittaghna ¹⁷ |
| balya ¹⁷ | arsha ¹⁹ | tridosha-ghna ¹⁶ |
| brinhana ¹⁶ | amavata ³⁸ | |
| garbhasthapanam ³⁷ | dhwaja-bhanga ¹⁸ | |
| hridya ²¹ | garbhapatam ²⁴ | |
| mootrala ¹⁴ | hridroga ¹⁶ | |
| rasayana ¹⁹ | indralupta ³⁹ | |
| shothahara ¹⁵ | kasa ¹⁸ | |
| vrishya ¹⁷ | klaibya ¹⁸ | |
| vajikara ¹⁶ | kustha ¹⁹ | |
| vastishodhaka ¹⁹ | mootrakrichhra ¹⁶ | |
| vedanasthapanam ¹⁸ | mootraghata ⁴⁰ | |
| vatashamaka ¹⁸ | prameha ¹⁶ | |
| | raktapitta ²⁰ | |
| | shotha ¹⁵ | |
| | shoola ¹⁶ | |
| | swapnadosha ¹⁸ | |
| | shwasa kasa | |
| | rujahara ⁴¹ | |
| | vastivata ¹⁹ | |
| | vastiroga ¹⁸ | |
| | vatarakta ¹⁸ | |

Pharmacological Activities

Aphrodisiac activity:

Gokshura is emphasized to be a vajikara dravya (aphrodisiac).²⁴ Studies reported that,

furastanolic type of saponin present in *T. terrestris* increases the amount of luteinizing hormone (LH), motivate spermatogenesis and results in stimulation of Testosterone. These activities may help in improving the quality and quantity of sperm significantly.⁴² Furostanol saponin extract from *T. terrestris* shows positive effect on spermatogenesis of rams during breeding season with increase in count of spermatozooids, time of viability and sperm motility.⁴³

Diuretic activity:

The plant is found to be beneficial in diuresis. Potassium and rich amount of nitrates present in the plant may be responsible for this activity.⁴⁴

Urolithiatic activity:

Ethanollic extract of the fruits of *Tribulus terrestris* showed significant dose dependent protection against uroliths induced by glass bead implantation in albino rats.⁴⁵

Effect on hypertension:

Decreased systolic blood pressure was reported with the treatment of lyophilized aqueous extract of tribulus fruits.⁴⁶ gokshura ghana (solid aqueous extract) is reported to be used in mild to moderate essential hypertension.⁴⁷

Anti-hyperlipidemic effect:

Methanolic extract of *Tribulus terrestris* show hypolipidemic effect.⁴⁸ Saponins of *Tribulus terrestris* were found to significantly lower serum total cholesterol, low density lipoprotein cholesterol and liver total cholesterol, triglycerides in diet-induced hyperlipidemia in mice.⁴⁹

Effect on diabetes mellitus:

Levels of malondialdehyde (MDA) and significant recovery of liver was found in treated rats.⁵⁰ *T. terrestris* methanolic extract caused a significant decrease in blood glucose level and glycosylated haemoglobin.⁴⁹ In another study, methanolic extract of *T. terrestris* showed significant decrease in blood sugar level.⁴⁴

Cardio-protective effect:

Hydro-alcoholic lyophilized extract of whole plant of *Tribulus terrestris* has been reported to have cardio-protective function. The fraction is

reported to attenuate myocardial infarction in rats.⁵¹

Analgesic effect:

Methanolic extract of fruits reported to have analgesic activity. The extract also found to have lesser gastric ulcerogenic activity as compared to Indomethacin.⁵²

Antispasmodic activity:

Significant decrease was found in peristaltic movement of sheep ureter and rabbit jejunum when treated with liophilized saponin extract of dried and powered *Tribulus terrestris*.⁵³

Anti-microbial activity:

Spirosonin, ethnolic extract of the fruit and leaves of *Tribulus terrestris* has activity against *E. coli* and *S. aureus*.⁵⁴ Hexanoic and methanolic extracts of the plant showed considerable activity against bacteria like *E. coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Proteus vulgaris* and *Staphylococcus aureus*.⁴³ Tribulosin and sitosterol glycosides present in 50% methanolic extract of *T. terrestris* reported to possess anti-helminthic properties.⁵⁴ Steroidal saponins from *T. terrestris* Linn. have antifungal action against fluconazole-resistant fungi (*Candida albicans*, *Candida glabrata*, *Candida parapsilosis*, *Candida tropicalis*, *Candida krusei*, and *Cryptococcus neoformans*).⁵⁵

Cytotoxic effect:

T. terrestris of different regions (Bulgaria, China and India) and different parts of plants (stem and fruit) shows that only the spiro compounds exhibit remarkable activity. The inhibitory effect of saponin mixture from Chinese origin on Bcap37 breast cancer cell has potent inhibitory effect.⁵⁶ In another study, data showed that *Tribulus terrestris* aqueous extract blocks proliferation and induces apoptosis in human liver cancer cells through the inhibition of NF- κ B signalling and can be used as an anticancer drug for hepato cellular carcinoma patients.⁵⁷ Total extract of the Bulgarian *T. terrestris* has a marked dose-dependent inhibitory effect on viability of breast cancer cells whereas saponin fraction has increased inhibitory effect compared to the total extract. Morphological

changes and DNA fragmentation were observed as markers for early and late apoptosis in tumor cells after treatment. In the mechanisms of antitumor activity of *T. terrestris* apoptotic processes are involved. Apoptotic processes showed selective antitumor activity of Bulgarian *Tribulus terrestris* Linn. on human cancer cells in vitro.⁵⁸

Wound healing action:

The leaves of *Tribulus terrestris* are used traditionally in folklore for the treatment of various kinds of wounds. Aqueous extract in carbopol at 2.5% and 5% concentrations showed significant reduction in period of epithelisation and wound contraction by 50% in excision and burn wound models. In the incision wound model a significant increase in the breaking strength was observed.⁵⁹

Nutritional values:

Tribulus terrestris is found to be rich source of calcium.⁶⁰

Contraindications:

Use of drug is contraindicated in dehydration⁶¹ and pregnancy.⁶²

Conclusion:

Gokshura has been used since centuries in traditional system of medicine and have therapeutic potential in disorders like shotha, agnimandya, arsha, hridroga, raktabharadhikya, kushtha, vatarakta, amavata, vrikkaroga, prameha, kshaya, and kasa, etc. Most of these activities have been revalidated through relevant experimental models in recent past. Yet, there are certain other properties which are still to be screened out.

Various fractions of the plant were found to have properties like aphrodisiac, diuretic, analgesic, anti-urolithiatic, anti-hypertensive and anti-diabetic etc. demonstrates diverse versatility of the plant. There is a need to conduct studies to elucidate exact pharmacokinetics and also to know the effects on structure- function relationship. With so much to offer to the world of medicine, the plant *Tribulus terrestris* Linn. is an incredible source.

References:

1. Sharma PC, Yelne MB, Dennis TJ. Database on Medicinal plants used in Ayurveda and Sidha. New Delhi: CCRAS, Dept. of AYUSH, Ministry of Health and Family Welfare, Govt. of India; vol 3. 2000. p.229.
2. Parker KF. An Illustrated Guide to Arizona Weeds. Tucson (AZ):The University of Arizona Press. 1972, p.338.
3. Pathak, PS. Contributions to the ecology of *Tribulus terrestris* Linn. II. Habitat studies, Agra University Journal of Research Science 19(2), 1970, p149-166.
4. Anonymous, API, part 1, volume 1, Dept of AYUSH, Ministry of Health & Family Well fare, Govt of India, New Delhi, p49 & 51
5. Brahmanand Tripathi, editor, 'Dipika' Hindi commentary of Sharngadhara Samhita by Sharngadhara, madhayama khanda, chapter 7, verse 84, Varanasi, Chaukhamba Surbharati Prakashan, 2007
6. Ibid 5, madhyama khanda, chapter 10, verse 77-92.
7. Indradev Tripathi and Srikant Tripathi, editor, Hindi commentary by Kashinath Shastri on Astanga Hridaya of Vagabhatt, Sutrasthana, chapter 15, verse 25, 1st ed, Varanasi, Krishnadas Academy, 1994.
8. Brahmashankara Mishra, editor, 'Vidyotini' Hindi commentary of Bhavaprakasha by Bhavamishra, , Madhayama, chapter 66, verse 60, Part 2, Varanasi, Chaukhambha Sanskrit Bhawan, 2009.
9. Nighantu Aadarsh by Bapalal Vaidhya,, Vol.1, Varanasi, Chaukhambha Bharti Academy, 2007, p211.
10. <http://en.wiktionary.org/wiki/terrestre#Latin>, cited on 24 nov 2012.
11. Namarupajnanam by Sharma P.V., Ed. 1st, Varanasi, Satyapriya Prakashan, 2000.
12. Kashinath Shastri and Gorakhanatha Chaturvedi, editor, Caraka Samhita of Caraka, Sutrasthana, chapter 4, verse 15, Varanasi, Chaukhambha Bharti Academy, 2005.
13. Ibid 12, Sutrasthana, chapter 4, verse 26.
14. Ibid 12, Sutrasthana, chapter 4, verse 35.
15. Ibid 12, Sutrasthana, chapter 4, verse 38.
16. Ibid 12, Sutrasthana, chapter 25, verse 40.
17. Ibid 12, vimanasthana, chapter 8, verse 139.

18. Ambika Datta Shashtri, editor, Sushruta Samhita of Sushruta, Sutrasthana, chapter 38, verse 4, Varanasi, Chaukhambha Sanskrita Sansthan, 2001.
19. Ibid 18, Sutrasthana, chapter 38, verse 13.
20. Ibid 18, Sutrasthana, chapter 38, verse 67.
21. Ibid 18, Sutrasthana, chapter 42, verse 11.
22. Indradev Tripathi and Srikant Tripathi, editor, Hindi commentary by Kashinath Shastri on Astanga Hridaya of Vagabhatt, Sutrasthana, chapter 15, verse 25, 1st ed, Varanasi, Krishnadas Academy, 1994.
23. Ibid 22, Sutrasthana, chapter 10, verse 22-24.
24. P.V. Sharma and Guru Prasad Sharma, editor, Dhanvantari Nighantu of Dhanvantari, reprint ed, Varanasi, Chaukhambha Orientalia, 2008, p34.
25. P. V. Sharma, editor, Sodhala Nighantu of Sodhala, Baroda, Oriental Institute, 1978, p16.
26. K.C. Chuneekar and Gangasahaya Pandey, editor, Bhavaprakasha Nighantu of Bhava Misra, revised ed, Varanasi, Chaukhambha Bharti Academy, 2010, p279.
27. Shaligram Vaisya, editor, Shaligrama Nighantu of Lala Shaligram, june ed, Mumbai, Khemraj Shrikrishna Das Prakashan, 2011, p210.
28. Harihar Prasad Tripathi, editor, "Hari" hindi commentary on Madanapala Nighantu of Madanapala, 1st ed, Varanasi, Chaukhambha Krishnadas Acedemy, 2010, p12
29. P.V. Sharma and Guruprasad Sharma, editor, Kaiyadeva Nighantu of Kaiyadeva, 2nd ed, Varanasi, Chaukhambha Orientalia, 2006, p16.
30. Indradev Tripathi, editor, 'Dravyaguna Prakashika' Hindi commentary on Raj Nighantu of Narahari Pandit, 5th ed, Varanasi, Chaukhambha Krishnadas Acedemy, 2010, p69.
31. 'Padma' hindi commentary on Priya Nighantu of P. V. Sharma, Varanasi, Chaukhambha surbharti Prakashana, 2004, p13.
32. Chandrika N. Methekar et al, A comparative Pharmacognostical and phyto-pharmacological Assessment of Moola, Panchanga of Laghu Gokshura(Tribulus terrestris Linn.) and Brihat Gokshura (Pedalium murex Linn.) w.s.r. to its Kasa-hara Karma, M.D. dissertation, Jamnagar, IPGT & RA, 2012, p64-65
33. Ibid 32, p65
34. <http://www.mdidea.com/products/herbextract/tribulus/data05> cited on 2 nov 2012
35. E-book, Dr. K. Nishteshwar, Basic concepts of Ayurvedic Pharmacology, Varanasi. Chowkhamba Sanskrit Series Office, 2007, p3-4
36. Dravya Guna Vijnana of P.V. Sharma, Part- 2, 5th edition, Varanasi, Chaukhamba Bharati Academy, 1981, p633
37. Ambika Datta Shashtri , editor, Sushruta Samhita of Sushruta, Chikitsasthana, chapter 7, verse 19, Varanasi, Chaukhambha Sanskrita Sansthan, 2001.
38. Chakrapanidatta, Chakradatta, 'Vaidayaprabha' hindi commentary, edited by Indradeva Tripathi, Varanasi, Chaukhambha Sanskrit Sansthana, 1997, Amavata chikitsa, 167p
39. Brahmashankara Mishra, editor, 'Vidyotini' Hindi commentary of Bhavaprakash of Bhavamishra, , Part 2, Madhayama, chapter 6, verse 19, Varanasi, Chaukhambha Sanskrit Bhawan, 2009.
40. Indradev Tripathi and Srikant Tripathi, editor, Hindi commentary by Kashinath Shastri Astanga Hridaya of Vagbhata, Chikitsasthana, chapter 11, verse 10, 1st ed, Varanasi, Krishnadas Academy, 1994,
41. Ambika Datta Shashtri , editor, Sushruta Samhita of Sushruta, Sutrasthana, chapter 20, verse 5, Varanasi, Chaukhambha Sanskrita Sansthan, 2001.
42. Hussain et al, Study the Biological Activities of Tribulus Terrestris Extracts, World Academy of Science, Engineering and Technology, vol. 57, 2009
43. Kistanova et al, Effect of plant Tribulus terrestris extract on reproductive performance on Rams, Biotecnology in animal Husbandry, vol. 21 (1-2), 2005, p55-63
44. M.D. Ukani, D.D. Nanavati, N.K. Mehta, A Review on the Ayurvedic herb Tribulus terrestris L., Ancient Science of Life, vol. 17(2), 1997, p144-150
45. Anand R, Patnaik GK, Kulshreshtha DK, Dhawan BN, Activity of certain fractions of Tribulus terrestris fruits against experimentally induced urolithiasis in rats, Indian journal of experimental biology, vol. 32(8), 1994, p548-552

46. Ali M Sharifi, Radbod Darabi, Nasrin Akbarloo, Study of antihypertensive mechanism of Tribulus terrestris in 2K1C hypertensive rats: Role of tissue ACE activity, Life sciences, vol. 73, 2003, p2963-2971
 47. Murthy A.R., Dubey S.D., Tripathi K., Anti-hypertensive effect of Gokshura (Tribulus terrestris Linn.) A clinical study, Ancient Science of Life, vol. XIX(3 & 4), 2000. p139-145
 48. W H EI-Tantawy & L A Hassanin, Hypoglycemic and hypolipidemic effects of alcoholic extracts of Tribulus alatus in streptozotocin-induced diabetic rats: A comparative study with T. terrestris, Indian journal of experimental biology, vol. 45, 2007, p785-790
 49. Chu Shudi, Qu Weijing, Pang Xiufeng, Sun Bin, Huang Xiaoqing, Effect of Saponin from Tribulus terrestris on Hyperlipidemia, journal of Chinese Medicinal Material, 2003-05
 50. AMR Amin, Mohamed Lotfy, Mohamed Shafiullah, Ernest Adeghate, The Protective Effect of Tribulus terrestris in Diabetes, Annals of the New York Academy of Sciences, vol. 1084, 2006, p391-401
 51. Shreesh k. ojha, Mukesh Nandave, Sachin arora, Rajeev Narang, Amit K. Dinda, Dharamvir Singh Arya, Chronic Administration of Tribulus terrestris Linn. extracts improves cardiac function and Attenuates Myocardial Infarction in Rats, International Journal of Pharmacology, vol. 4(1), 2008, p1-10
 52. Heidari M.R., Mehrabani M., Pardakhty A., Khazaeli P., Zahedi M.J., Yakhchali M. and Vahedian M., The Analgesic Effect of Tribulus terrestris Extract and Comparison of Gastric Ulcerogenicity of the Extract with Indomethacine in Animal Experiments. Annals of the New York Academy of Sciences, vol. 1095, 2007, p418-427
 53. Arcasoy, H.B. et al., Effect of Tribulus terrestris L. saponin mixture on some smooth muscle preparations: a preliminary study. Boll Chim Farm Dec, vol. 137(11), 1998, p473-5
 54. Devi Datt Joshi, Ramesh Chandra Uniyal, Different chemo types of Gokhru (Tribulus terrestris): A herb used for improving physique and physical performance, International journal of green pharmacy, 2008, p158-161
 55. Jun dong Zhang, Yong bing Cao, Zheng Xu, Hui Hua Sun, In Vitro and in Vivo Antifungal Activities of the Eight Steroid Saponins from Tribulus terrestris L. with Potent Activity against Fluconazole-Resistant Fungal, Biol. Pharm. Bull., vol. 28(12), 2005, p2211-5
 56. Sun et al, The inhibitory effect of saponins from Tribulus terrestris on Bcap-37 breast cancer line in vitro. Zhong Yao Cai, 26, 2003, p104-6.
 57. Hye Jin Kim et al, Aqueous extract of Tribulus terrestris Linn. induces cell growth arrest and apoptosis by down-regulating NF- κ B signaling in liver cancer cells, Journal of Ethnopharmacology, vol. xxx, 2011, xxx-xxx
 58. Angelova et al, Antitumor activity of Bulgarian herb Tribulus terrestris L. on human breast cancer cells, J. BioSci. Biotech., vol. 2(1), 2013, p25-32
 59. Wesley et al, Wound healing activity of the leaves of Tribulus terrestris (Linn.) aqueous extract in rats, Journal of Pharmacy Research vol. 2(5), 2009, p841-3
 60. Duhan et al, Nutritional value of some non-conventional plant foods of India. Plant Foods Hum Nutr. Jul; vol. 42(3), 1992, p193-200
 61. Frawley, David and Vasant Lad. The Yoga Of Herbs: An Ayurvedic Guide to Herbal Medicine. Santa Fe: Lotus Press, 1986, p169
 62. Bensky, D. and A. Gamble, Chinese Herbal Medicine Materia Medica. Seattle: Eastland Press, Revised edition: 1993, p42
- Cite this article as: Priyanka Verma, Galib, Patgiri BJ, Prajapati PK. Tribulus terrestris Linn.: A Phyto-pharmacological Review. Journal of Ayurveda and Holistic Medicine. 2013; 1(3): 6-12

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