REVIEW ARTICLE

TRIBULUS TERRESTRIS LINN.: A PHYTO-PHARMACOLOGICAL REVIEW

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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), moolala (diuretic), shothahara (anti-inflammatory), vajikarana (aphrodisiac) etc. and useful in the management of mutrakrichpra (dysurea), ashrir (renal calculi) etc. It is a perennial plant, grown predominantly in India and Africa. Its extract contains alkaloids, saponins, resins, flavonoids 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 gokhkurakata (Assamese), gokhri (Bengali), bethagokharu (Gujarati), neggilmullu (Kannada), michikand (Kashmiri), nerjinl (Malayalam), sarate (Marathi), gokhyura (Oriya), bhakhra (Punjabi), nerjinl (Tamil), pallere 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 churuna7 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 cattle.9 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 as:
- 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
- Shwadanshtra: 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

<table>
<thead>
<tr>
<th>samhita</th>
<th>varga</th>
<th>according to karma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charaka Samhita</td>
<td>krimighna12</td>
<td>shothahara16</td>
</tr>
<tr>
<td></td>
<td>anuvasanopaga13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>mootrandevichaniya14</td>
<td></td>
</tr>
<tr>
<td></td>
<td>madhuraskanda15</td>
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</tr>
<tr>
<td></td>
<td>aashhapan17</td>
<td></td>
</tr>
<tr>
<td>Sushruta Samhita</td>
<td>vidarigandhadi18</td>
<td></td>
</tr>
<tr>
<td></td>
<td>veeratarvadi19</td>
<td></td>
</tr>
<tr>
<td></td>
<td>laghupanchamooola20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>madhuravarga21</td>
<td></td>
</tr>
<tr>
<td>Astanga Hridaya</td>
<td>veerataradi gana22</td>
<td></td>
</tr>
<tr>
<td></td>
<td>madhura gana23</td>
<td></td>
</tr>
<tr>
<td>Dhanvantari Nighantu24, Sodhala Nighantu24, Bhavaprakash Nighantu25, Shaligrama Nighantu27</td>
<td>guduchyadi varga</td>
<td></td>
</tr>
<tr>
<td>Madanapala Nighantu28</td>
<td>abhayadi varga</td>
<td></td>
</tr>
<tr>
<td>Kaiyadeva Nighantu29</td>
<td>oshadhi varga</td>
<td></td>
</tr>
<tr>
<td>Raja Nighantu30</td>
<td>shatahvadi varga</td>
<td></td>
</tr>
<tr>
<td>Priya Nighantu31</td>
<td>haritakyadi varga</td>
<td></td>
</tr>
</tbody>
</table>

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 oppresed hairs below, and to a lesser extent above. The solitary yellow flowers have five petals, and are borne in the leaf axils, on hairy pedicles 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 microscopically and found to have characteristics as depicted in Table 2.

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

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

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. sclereides

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III. **Phytochemistry:**

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

<table>
<thead>
<tr>
<th>Table 3: chemical constituents</th>
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</thead>
<tbody>
<tr>
<td><strong>part</strong></td>
</tr>
<tr>
<td>Plant</td>
</tr>
<tr>
<td>Leaf</td>
</tr>
<tr>
<td>Flower</td>
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<tr>
<td>Fruit</td>
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<tr>
<td>Shoot</td>
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<tr>
<td>Seed</td>
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</tbody>
</table>

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%.

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>
<thead>
<tr>
<th>Table 4: Ayurvedic properties</th>
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<tbody>
<tr>
<td><strong>rasa</strong></td>
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<tr>
<td>madhura</td>
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</table>

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>
<thead>
<tr>
<th>Table 5: Action of Tribulus terrestris emphasized in Ayurvedic classics</th>
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</thead>
<tbody>
<tr>
<td><strong>action</strong></td>
</tr>
<tr>
<td>agnideepaka16</td>
</tr>
<tr>
<td>balya17</td>
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<tr>
<td>brinhana16</td>
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<tr>
<td>garbhashthapana27</td>
</tr>
<tr>
<td>hridya21</td>
</tr>
<tr>
<td>moortra14</td>
</tr>
<tr>
<td>rasayana19</td>
</tr>
<tr>
<td>shothahara15</td>
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<tr>
<td>vrishya17</td>
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<tr>
<td>vajikara16</td>
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<tr>
<td>vastishodhaka19</td>
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<td>vedanasthapana18</td>
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<td>vatashamaka18</td>
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**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. Furostanol saponin extract from T. terrestris shows positive effect on spermatogenesis of rams during breeding season with increase in count of spermatozoids, time of viability and sperm motility.

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.

Urolithiatic activity:
Ethanolic extract of the fruits of Tribulus terrestris showed significant dose dependent protection against uroliths induced by glass bead implantation in albino rats.

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

Anti-hyperlipidemic effect:
Methanolic extract of Tribulus terrestris show hypolipidemic effect. 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.

Effect on diabetes mellitus:
Levels of malondialdehyde (MDA) and significant recovery of liver was found in treated rats. T. terrestris methanolic extract caused a significant decrease in blood glucose level and glycosylated haemoglobin. In another study, methanolic extract of T. terrestris showed significant decrease in blood sugar level.

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.

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.

Antispasmodic activity:
Significant decrease was found in peristaltic movement of sheep ureter and rabbit jejunum when treated with lyophilized saponin extract of dried and powered Tribulus terrestris.

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

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. 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-B signalling and can be used as an anticancer drug for hepato cellular carcinoma patients. 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 \textit{T. terrestris} apoptotic processes are involved. Apoptotic processes showed selective antitumor activity of Bulgarian \textit{Tribulus terrestris} Linn. on human cancer cells in vitro.\(^{58}\)

Wound healing action:
The leaves of \textit{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:
\textit{Tribulus terrestris} is found to be rich source of calcium.\(^{60}\)

Contraindications:
Use of drug is contraindicated in dehydration\(^{61}\) and pregnancy.\(^{62}\)

Conclusion:
Gokshura has been used since centuries in traditional system of medicine and have therapeutic potential in disorders like shotha (edema), agnimandya (impaired digestion), arsha (piles), hridroga (cardiac disorders), HTN, kushtha (skin diseases), vatakra (gout), amavata (RA), vrikkaroga (renal diseases), Madhumeha (DM), Kshaya (emaciation), and kasa (cough) 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 \textit{Tribulus terrestris} Linn. is an incredible source.

References:
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