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A REVIEW OF NON-STEROIDAL PHYTOCONSTITUENTS OF *TRIBULUS TERRESTRIS*

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ABSTRACT: The genus *Tribulus* belongs to family Zygophyllaceae comprises approximately 25 species which grow as prostrate hairy herbs in tropical and warm regions. In this review, the literature data on phytochemical investigations of the *Tribulus terrestris* are compiled. The well-recognized groups of secondary metabolites were sterols, alkaloids, flavonoids, and steroidal saponins.

INTRODUCTION: The genus *Tribulus* belongs to family Zygophyllaceae comprises approximately 25 species which grow as prostrate hairy herbs in tropical and warm regions. The fruit is resembling a club-shaped crest with sharp spines (each fruit breaking into five triangular-shaped segments, each with two large spines at the tip and several smaller spines). *Tribulus terrestris* L. (Zygophyllaceae), is commonly known as devil's thorn, cat head, puncture vine, goat head, and caltrop. It is a herbaceous, annual, prostrate or semierect, diffusely branched herb; native in dry and sandy districts in South Europe to Central Asia and in tropical and South Africa, growing in India, other warm countries such as Ceylon, desert plains, waste ground, a weed of cultivation and the Mediterranean region¹⁻⁵.

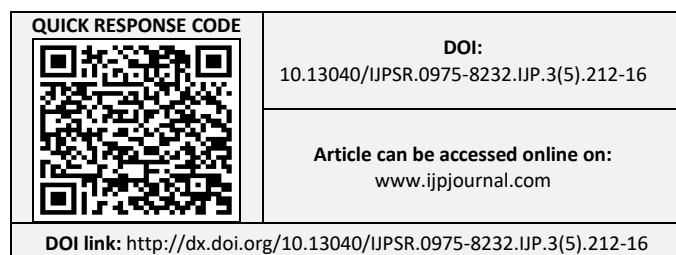
It is used in folk medicine to increase spermatogenesis, for treatment of eye troubles, edema, abdominal distension, leucorrhea, and impotence, as an aphrodisiac, galactagogue, anti-inflammatory, antidiarrheal and diuretic⁶.

Chemical Constituents: The chemical constituents of *Tribulus terrestris* include steroidal saponins, flavonoids, alkaloids, coumarins, amino and organic acids, and sterols. Their structures, 1 – 48 are shown below, and their names and the corresponding plant sources are collected in **Table 1** and **Fig. 1**. As can be seen, steroidal saponins are the predominant constituents of *T. terrestris*.

This review focus on non-steroidal phyto-constituents of *T. terrestris*.

1. Sterols: Four phytosterols, campesterol (1), stigmasterol (2), β -sitosterol (3) and β -sitosterol glucoside (4) have been isolated from *T. terrestris*^{6-9, 11, 13}.

2. Alkaloids: Sixteen alkaloids, (5-20), were obtained from the plant^{6, 9, 10, 13-17}.



3. Flavonoids: Nineteen flavonoids (21-39), were found in *T. terrestris*^{18, 19}. Kaempferol, quercetin and isorhamnetin and their glycosides are the most common flavonols isolated from this plant.

4. Amino Acids: Four amino acids (40-43), were isolated from this plant²⁰.

5. Organic Acids: Two organic acids (44, 45), were obtained from the plant¹⁰.

6. Indanone: Only one indanone (48) was obtained from the plant⁹.

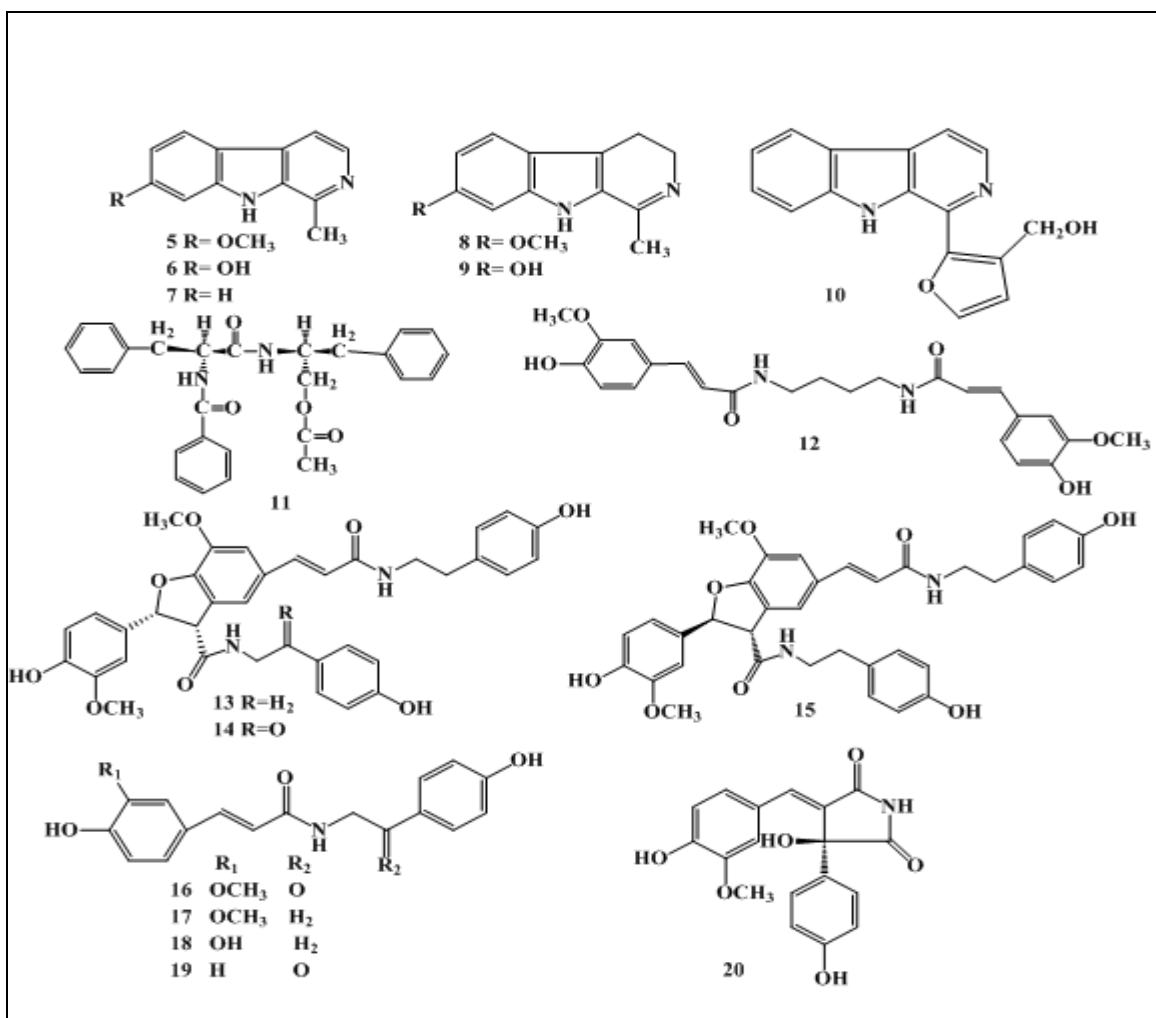
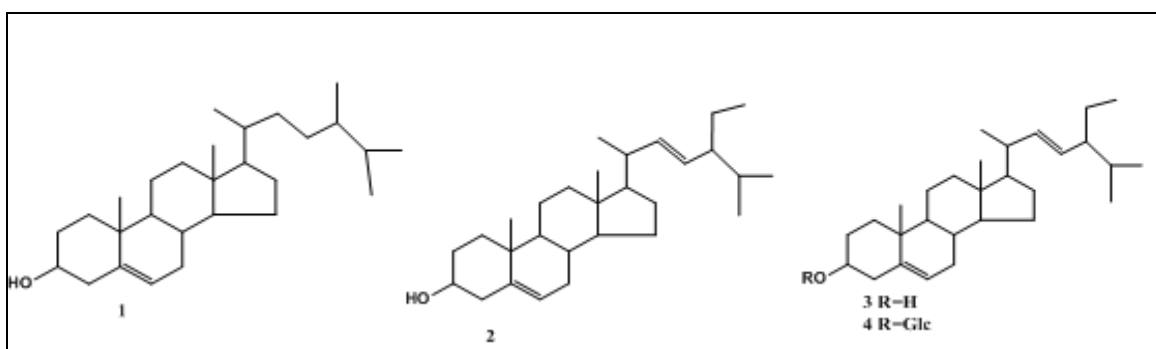
7. Coumarins: Only one coumarin; scoparon (49), was isolated from *T. terrestris*⁷.

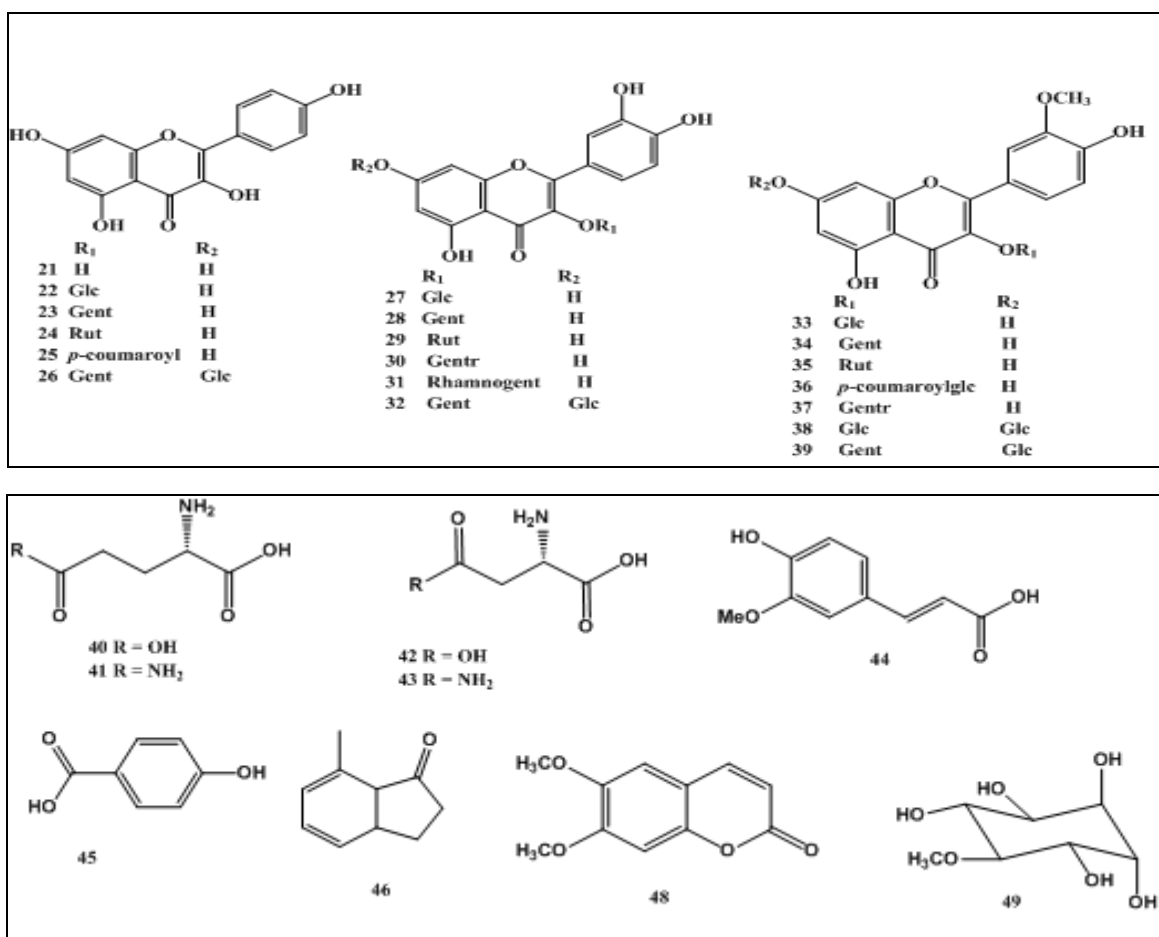
8. Other Constituents: D-(+)-pinitol (50) was obtained from *T. terrestris*⁷.

TABLE 1: A LIST OF ISOLATED COMPOUNDS FROM *TRIBULUS TERRESTRIS* LINN.

Item	No	Reference
Sterols:	I-	
Campesterol	1	[6], [7]
Stigmasterol	2	[6], [7], [8]
β-Sitosterol	3	[6], [7], [9], [11]
β-Sitosterol glucoside	4	[13]
Alkaloids:	II-	
Harmine	5	[6], [12]
Harmol	6	[6],[13]
Harman	7	[12], [13]
Harmaline	8	[6]
Harmalol	9	[6]
Tribulusterine	10	[9], [10]
Aurantiamide acetate	11	[10]
Terrestribisamide	12	[10]
Tribulusamide A	13	[14]
Tribulusamide B	14	[14], [15]
Grossamide	15	[14]
Terrestriamide	16	[10], [14], [16]
N-Trans-feruloyl tyramine	17	[14], [16]
N-Trans-coumaroyl tyramine	18	[10], [14], [16]
Tribulusimide C	19	[16]
Tribulusamide C	20	[17]
Flavonoids:	III-	
Kaempferol	21	[18], [19]
Kaempferol 3- <i>O</i> -glucoside	22	[19]
Kaempferol 3- <i>O</i> -gentiobioside	23	[18]
Kaempferol 3- <i>O</i> -rutinoside	24	[18]
Kaempferol 3- <i>O</i> - <i>P</i> -coumaroyl glucoside	25	[18]
Kaempferol 3- <i>O</i> -gentiobioside- 7- <i>O</i> -glucoside	26	[18]
Quercetin 3- <i>O</i> -glucoside	28	[18]
Quercetin 3- <i>O</i> -gentiobioside	29	[18]
Quercetin 3- <i>O</i> -rutinoside	30	[18]
Quercetin 3- <i>O</i> -gentiotrioside	31	[18]
Quercetin 3- <i>O</i> -rhamnogentiobioside	32	[18]
Quercetin 3- <i>O</i> -gentiobioside- 7- <i>O</i> -glucoside	33	[18]
Isorhamnetin-3- <i>O</i> -glucoside	35	[18]
Isorhamnetin 3- <i>O</i> -gentiobioside	36	[18]
Isorhamnetin 3- <i>O</i> -rutinoside	37	[18]
Isorhamnetin 3- <i>O</i> - <i>P</i> -coumaroyl glucoside	38	[18]
Isorhamnetin 3- <i>O</i> -gentiotrioside	39	[18]
Isorhamnetin 3,7-di- <i>O</i> -glucoside 7- <i>O</i> -glucoside		
Isorhamnetin 3- <i>O</i> -gentiobioside- 7- <i>O</i> -glucoside		

Amino acids:	IV-	
Glutamic acid	40	[20]
Glutamine	41	[20]
Aspartic acid	42	[20]
Asparagine	43	[20]
Organic acids:	V-	
Ferulic acid	44	[10]
<i>p</i> -Hydroxybenzoic acid	45	[10]
Indanone:	VI-	
7-Methyl hydroindanone	46	[9]
Coumarin	VII-	
Scoparon	47	[7]
Others	VIII-	[7]
D-(+)-Pinitol	48	



FIG. 1: STRUCTURES OF CONSTITUENTS OF *T. TERRESTRIS*

CONCLUSION: *Tribulus terrestris* is widespread all over the world, and have been used in traditional folk medicine. Phytochemical investigations of this species have revealed that many components exhibit significant biological and pharmacological activities. The typical constituents of this plant are steroidal saponins, flavonoids, alkaloids, coumarins, amino and organic acids, and sterols. Further phytochemical and biological studies should be carried out on this species to elucidate their active principles and mechanisms of action of the active constituents.

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CONFLICT OF INTEREST: NIL

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