CHAPTER 2

LITERATURE REVIEW
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(i) *TRIBULUS TERRESTRIS* LINN.

Phytochemical Investigations

Fruit contains an alkaloid in traces (0.001%); fixed oil 3.5% consisting mainly of unsaturated acids, essential oil in very small quantities resins and fair amounts of nitrates\(^2\).

Harman occurs in the herb and harmine in seeds. The plant contains saponins which on hydrolysis yield steroidal sapogenins. Kaempferol, keempferol-3-glucoside, kaempferol-3-rutinoside and a flavonoid tribuloside have been isolated from leaves and fruits\(^11\).

Nath *et al.* reported crude protein 12.06%; ether extract 2.61%; crude fibre 27.7%; nitrogen free extract 40.83% ; total carbohydrates 68.61% ; total ash 16.72% ; calcium 4.21% and phosphorus 0.24\(^%\)\(^12\).

Earlier investigations of this plant yielded a number of steroidal sapogenin viz., chlorgenin, gitogenin, diosgenin and ruscogenin. Tomowa *et al.* identified a new sapogenin viz., tigogenin\(^13\).

Purushothaman, *et al.* isolated two new steroid sapogenins, hecogenin and neotigogenin\(^14\).

Mahato, *et al.* found \(\beta\)-sitosterol, stigmasterol and neotigogenin in whole plant of *T. terrestris* L\(^15\).

Altogether 22 amino acids viz., Glutamic acid, Glutamine, Aspartic acid, Asparagine, Cystine, Cysteine, Tryptophan, Serine, Proline, Glycine, Alanine, Valine, Methionine, Leucine, Isoleucine, Tyrosine, Phenyl alanine, \(\gamma\)-Aminobutyric acid,
Ornithine, Lysine, Histidine and Arginine were identified in the root nodules of *T. terrestris* L. by Ather, *et al.*

Duhan *et al.* reported a rich source of calcium in the leaves of *T. terrestris* L.

Afria showed that young leaves possessed the maximum concentration of protein (92.5 mg/g, dry wt.) and most of the individual free amino acids as compared with mature leaves and immature fruits.

Saleh *et al.* detected 25 flavonoid glycosides which belong to the common flavonols, kaempferol, quercetin and isorhamnetin with the 3-gentiobiosides as the major glycosides in *T. terrestris* L.

Singh *et al.* isolated Diosgenin and Tigogenin from over ground part of *T. terrestris* L.

Prakash, *et al.* confirmed 4 beta-carboline alkaloids, harmine, harmaline, harmane and tetrahydroharmine in the plant *T. terrestris*.

Bourke, *et al.* identified beta-carboline alkaloid harmane and norharmane in the aerial parts of *T. terrestris*.

Zafar, R. *et al.* isolated diosgenin, hecogenin, ruscogenin and spirosta-3,5-diene from flowers of *T. terrestris* L.

Two compounds of cinnamic amide derivative named terrestriamide and 7-methyl hydroindanone-1, were isolated from *T. terrestris* L.

**Pharmacological Activity**

The plant *T. terrestris* L. is one of the most important ingredients of an Ayurvedic preparation. The drug is diuretic, tonic, aphrodisiac, blood purifier and often used to painful micturition, to remove ‘tridosh’, to cure skin and heart disease. The freshly expressed juice of the aqueous extract of the whole plant contains
inorganic nitrites, mostly potassium nitrite in toxic amounts. It is also used for the
treatment of piles, cough, calculi and leprosy.

Chakraborty, *et al.* studied the various pharmacological action and reported
that an alcoholic extract of the plant produced a sharp vasodepression in an
anaesthetised dogs mediated through cholinergic mechanism. It also possessed some
characteristics changes in C.N.S. and in Carbohydrate metabolism\(^{25}\).

Prakash, *et al.* reported marked C.N.S. stimulant activity in adult albino mice
in *T. terrestris* L\(^{26}\).

Bourke, *et al.* observed locomotor disorders in sheep with the *T. terrestris* L.
due to beta-carboline alkaloid\(^{27}\).

Bourke *et al.* administered harmane and norharmane from alkaloidal extract of
*T. terrestris* L. to normal sheep and showed that both compounds were able to cause
locomotor effects in sheep\(^{28}\).

Anand *et al.* found antiurolithiatic activity in albino rats in alcoholic extract of
*T. terrestris* L\(^{29}\).

Singh, *et al.* evaluated the diuretic action with minimal side effects on albino
rat in *T. terrestris* L\(^{30}\).

Administration of the fractions of ethanolic extract of the fruits of *T. terrestris*
resulted in a varying degree of reduction in deposition of stone in albino rats\(^{31}\).

Sangeeta *et al.* observed the effect of an aqueous extract of *T. terrestris* on the
metabolism of oxalate in male rats fed sodium glycolate that lowering hyperoxaluria
seemed to be mainly mediated through its inhibitory action on GAO and GAD, and its
enhanced production of glyoxylate\(^{32}\).

Vijaya, *et al.* examined in-vitro that aqueous extract of *T. terrestris* L.
inhibited amylase and activated lipase digestive enzyme\(^{33}\).
Antimicrobial Activity

Singh, et al. reported antibacterial activity against *E.Coli* in alcoholic extract of fruit of *Tribulus terrestris*\(^{34}\).

Ikram, et al. reported, negligible activity in stem and leaf extracts of *T. terrestris* against *Escherichia Coli*, *Bacillus subtilis*, *Shigella dysenteriae* and *Salmonella typhi* as compared to streptomycin\(^ {35}\).

Antimicrobial activity was reported in an ethyl ether and 50% ethanolic extracts of *Tribulus terrestris* shoot against *Staphylococcus aureus*\(^ {36}\).
Phytochemical Investigations

Seeds contain a bland oil, 4.5% : fresh roots contain moisture, 77% gummy matter, 7.5%; glucose, 1.1%; bitter extractive, 4.0%; fat, 0.6%; cellulose, inulin and fibre, 9.0% and ash, 0.8%. The ash of the roots and also of the leaves is rich in potash. Betaine and choline are also present in small concentrations. Flowers contain a colorless crystalline glucoside; cichoriiin, bitter substances lactucin and intybin\(^{37-39}\).

Barakat, \textit{et al.} reported mean of ferric iron content 3.4 mg % and cupric copper content 0.17 mg % by iodometric method in \textit{Cichorium intybus} L\(^{40}\).

Balbaa, \textit{et al.} reported the presence of flavonoids, catechol tannins, glycosides, carbohydrates, unsaturated sterols, triterpenoids and the absence of alkaloids, oxidase enzyme and saponins in the roots of each of the eight varieties of \textit{C. intybus} L\(^{41}\).

Wight, \textit{et al.} determined reducing sugars, sucrose and inulin content in roots of \textit{C. intybus} L.\(^{42}\).

The major anthocyanin of red leaves of \textit{Cichorium intybus} has been identified as cyanidin 3 - 0 - β - (6-0-malonyl)-D-glucopyranoside by fast atom bombardment mass spectrometry and NMR spectroscopy \(^{43}\).

Takeda, \textit{et al.} identified a pigment, Delphinidin 3-(6-malonyl glucoside)-5-malonylglucoside in blue flowers of \textit{C. intybus} L.\(^{44}\).

\textit{Cichorium intybus} L. seed oil (5.8%) was examined for its physico-chemical values and fatty acid composition by gas chromatography. The oil was fractionated by TLC into lipid classes; neutral lipids (56.74%) and polar lipids (43.26%). Fractionation of neutral lipids gave hydrocarbon wax-esters (6.46%), triglycerides (23.39%), free fatty acids (10.70%), 1, 3 - diglycerides (4.95%), 1, 2 - diglycerides (5.90%), 1 - monoglycerides (3.21%) and 2 - monoglycerides (2.13%). Polar lipids...
were separated into glycolipids (30.22%) and phospholipids (13.04%). All the lipid classes except phospholipids were studied for their fatty acid composition. Except for 2 – monoglycerides, all other lipid classes showed a similar fatty acids pattern, as the saturated fatty acids constituted 72-88% of the total. All the lipid classes have shown a fair amount of an odd numbered fatty acid\textsuperscript{45}.

Grayer, et al. reported an antifungal phytoalexin, cichoralexin in leaves of C. intybus L.\textsuperscript{46}

Park, et al. isolated two known endesmanolides, magnolialide and artesin from the roots of C. intybus and their structures were identified as magnolialide (1\(\beta\) - hydroxyeudesma – 4, 13 – dien – 6, 12 - olide) and its 11\(\beta\), 13 - dihydro derivative (artesin).\textsuperscript{47}

The known eudesmanolide magnolialide and the known guainolide ixerisoside - D reported from C. intybus, along with the previously known sesquiterpene lactones, have also been isolated and identified by Kisiel, et al.\textsuperscript{48}

Four anthocyanin pigments were isolated from flowers of C. intybus and identified as delphinidin 3 , 5 - di - 0 - (6 - 0 - malonyl - \(\beta\) - D - glucoside) and delphinidin 3 - 0 - (6 - 0 - malonyl - \(\beta\) - D - glucoside) - 5 - O - \(\beta\) - D - glucoside and the known compounds were delphinidin 3 - O - \(\beta\) - D - glucoside - 5 - 0 - (6 - O - malonyl - \(\beta\) - D - glucoside and delphinidin 3 , 5 - di - O - \(\beta\) - D - glucoside, in addition 3 - O - p - coumaroyl quinic acid has been identified by Norback, et al.\textsuperscript{49}

**Pharmacological Activity**

Balbaa, et al. observed marked depression on the amplitude and on the rate of the isolated toad's heart in roots of each of eight varieties of C. intybus L. This type of effect was similar to quinidine.\textsuperscript{41}
Pandey observed bradycardia in normal and hypodynamic heart of frog and a fall in B.P. with a corresponding increase in respiratory rates in dog treated with alcoholic extract of seeds of *C. intybus* L.\textsuperscript{50}.

Handa, *et al.* reported cholagoque activity in alcoholic extract of the *C. intybus* L.\textsuperscript{51}.

A significant decrease in the triglyceride level of liver, plasma and heart coupled with decreased cholesterol level in plasma was observed in rats, fed with high level of saturated fat(45%) supplemented with 5% roots of *C. intybus* L. as compared to high fat fed group, by Kaur *et al.*\textsuperscript{52}.

Misra, *et al.* found antimalarial activity against erythrocytic stages of *plasmodium berghei* only *in vitro* in alcoholic extract of seeds of *C. intybus* L.\textsuperscript{53}.

Gadgoli, *et al.* found hepatoprotective activity against carbon tetrachloride and paracetamol induced toxicity in rats , treated each with chloroform , methanol and water extract of seeds of *Cichorium intybus* L.\textsuperscript{54}.

Zafar *et al.* reported better antihepatotoxic effect against carbon tetrachloride induced hepatocellular damage in albino rats, treated with root callus extract as compared to the natural root extract of *Cichorium intybus* L.\textsuperscript{55}.

**Antimicrobial Activity**

Abou-Jawdah, *et al.* found antimycotic activity against phytopathogenic fungi in petroleum ether extract of *C. intybus* L.\textsuperscript{56}.
Phytochemical Investigations

The seed has moisture, 11.8%; crude protein 22.0%; fat, 0.5%; minerals, 3.1%; fibre, 5.3%; carbohydrates, 57.3%; calcium, 0.28%; phosphorus, 0.39%; iron, 0.0076%; nicotinic acid, 0.0015%; carotene, 11 IU/100g., arginine 6.0-7.1%, tyrosine 6.68% and lysine 7.64%. Other important constituents of *D. biflorus* are strelpogenin, β-sitosterol, bulbiformin, linoleic acid (in the seeds oil, 30-60%), polyphenols, oxalates (40% soluble) and crude fibre (5.3%)\(^{57-59}\).

Pant, *et al.* found moisture 10.58%; ash 3.86%; fat 2.26% and crude protein 21.35% in seeds\(^{60}\).

Mahadevappa *et al.* reported palmitic acid, linoleic acid, oleic acid and linolenic acid in seed oil of *D. biflorus* L.\(^{61}\).

An unusual enzyme allantoinase was isolated from germinated seeds of *D. biflorus* L. by Mary *et al.*\(^{62}\).

Seeds of *D. biflorus* L. contain total lipids 1.7 - 2.2%, neutral lipids 46 - 52% of total lipids, glycolipids 10 - 12% and phospholipids 35 - 40% of total lipids. Its amino acid composition is aspartic acid, lysine, phenyl-alanine, glycine, threonine, alanine, tyrosine, valine, glutamic acid, leucine, proline, serine and tryptophan. Seeds are rich source of ribonuclease. The glycosidases β- H-acetylgluco- samanidase, α- and β-galactosidases, α-mannosidase and β-glucosidase have been isolated and purified. Haemagglutinin was isolated from the seeds by fractionation and characterized as a glycoprotein of molecular weight about 130000 with amino acids and carbohydrates (0.5% galactose, 0.2% mannose, rhamnose and fructose)\(^{63}\).

A number of isoflavones have been isolated from the leaves and stems of *D. biflorus* L. namely Genistein, 2'-hydroxy genistein, dalbergioidin, kievitone,
phaseollidin and isofererin after inoculation by some nonpathogenic bacteria, along with coumestrol and psoralidin.  

Ingham, et al. isolated two minor isoflavonoids dolichin A and B from the bacteria inoculated leaves of *D. biflorus* L.  

Mitra, et al. isolated 5-Hydroxy-7,3',4'-trimethoxy-8-methyliso-flavone 5-neohesperidoside isoflavone from the ethanolic extract of seeds of *D. biflorus* L.  

Akihisa, et al. isolated and identified fourteen triterpene alcohols and one 3-oxosteroid, stigmasterone [(24R)-stigmast-4-en-3-one] and others were unidentified from seeds of *D. biflorus* L.  

Dubey et al. identified D-glucose, D-galactose, L-rhamnose, D-arabinose and L-ascorbic acid along with amino acids viz., glycine, alanine, serine, cystine and aspartic acid from seeds of *D. biflorus* L.  

**Pharmacological Activity**  

The seeds are diuretic; emmenagogue; increase appetite; remove stone from kidney; cure hiccup, eye troubles, piles, enlargement of the spleen, pain in the liver; improve the complexion; cause biliousness. The decoction is used in leucorrhoea and menstrual derangement.  

Kamboj, et al. reported that no anti-implantation activity at a dose of 200 mg/kg on days 1-7 post-coitum in rats in petroleum ether, alcohol and aqueous extracts of seeds of *D. biflorus* L.  

Laskar, et al. found antihepatotoxic activity in seeds of *D. biflorus* L. against paracetamol intoxicated rats at a dose of 10 mg/kg.
Antimicrobial Activity

Basak, et al. found antibacterial activity against *Pseudomonas aeruginosa*, *Escherichia coli*, *Proteus vulgaris* and *Bacillus subtilis* in methanolic extract of seeds of *D. biflorus* L.\textsuperscript{72}.

Looking to the medicinal utility of these plants in the literature mentioned above and comparatively pharmacognostic studies on the parts of these plants are very few and fragmentary. As pharmacognostic screening of the plant parts is essential for identification of the commercial sample; the same has been undertaken to standardize for prevention of admixtures and adulterants in the preparation of Ayurvedic formulation.