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# Ethnopharmacological and Phytochemical profile of three potent *Desmodium* species: *Desmodium gangeticum* (L.) DC, *Desmodium triflorum* Linn and *Desmodium triquetrum* Linn

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**ABSTRACT**

*In this present investigation, three potent Desmodium plants species including Desmodium gangitecum DC, Desmodium triflorum Linn, Desmodium triquetrum, family Fabaceae, were reviewed for their considerable phytochemical, antioxidant, anti-inflammatory and antiasthmatic properties. Desmodium species are well explored in the treatment of neurological imbalances by traditional Indian medicinal system. The recent pharmacological studies recognized the multi-directional therapeutic significance like anti-leishmanial, anti-inflammatory and cardio-protective activity. It is also proved for detoxification and blood purification properties which might be attributed to its immunomodulatory activity. Phytochemical evaluation revealed that the plants have alkaloids, pterocarpans, phospholipids, sterols and flavonoids. The ethno-pharmacological assessment disclose that the plants of Desmodium (Fabaceae), such as Desmodium gangeticum DC, Desmodium triflorum Linn and Desmodium triquetrum Linn, have a long history of medicinal use in Traditional Chinese Medicine (TCM) to treat various ailments including rheumatism, pyrexia, dysentery, wounds, cough, malaria, hepatitis and hemoptysis, etc., The review emphasizes the primarily on their folkloric uses, pharmacological activities of the different extracts and its fractions, biological activities of isolated compounds, toxicity and safety profile of Desmodium species. It provides comprehensive data for researchers to hit upon new chemical entity responsible for its claimed traditional uses and for future clinical trials. In this present review, the ethno pharmacological data's of Desmodium species have been consolidated to highlight the modern scientific evidence to prove their potency.*

**Key words:** *Desmodium* species, Folkloric use, alkaloids, Phytoconstituents, anti-asthmatic activity

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## INTRODUCTION

The World Health Organization (WHO), defined as , the finished, labeled medicinal products that contain active ingredients, aerial or underground parts of the plant or other plant material or combinations. For the assessment of safety, efficacy and quality of herbal medicines, specific set of guidelines has been set by World Health Organization (WHO). As per the estimation of WHO, around 80% of the world's population presently use herbal medicine for primary health care (WHO technical report series 1996) [1]. Since ancient time herbal medicine is playing crucial role in treatment of human diseases with limited side effects.The scientific evidences on safety and efficacy were recorded for various raw material plants and many of exiting herbal modern formulations. Medicinal

plants constitute the main source of new pharmaceuticals and healthcare products. A great number of medicinal plants have been used for management of antitussive and other respiratory disorders [2-5].

*Desmodium* is a genus in the flowering plant family Fabaceae, sometimes called tick-trefoil, tick clover, hitch hikers or beggar lice. There are dozens of species and the delimitation of the genus has shifted much over time. These are mostly inconspicuous legumes; few have bright or large flowers. Though some can become sizeable plants, most are herbs or small shrubs. Their fruit are loments, meaning each seed is dispersed individually enclosed in its segment. This makes them tenacious plants and some species are considered species in places. It is an ingredient of Ayurvedic preparations like 'Dashmoolarishta' and 'Dashmoolakwaath 'recommended for post-natal care to avoid secondary complications [6]. Moreover, pharmacological studies reveal the potentiality of *Desmodium gangeticum* DC extract and its active principles viz. desmodin, hordenine and gangetin as anti-amnesic, immunomodulatory, anti-diabetic, antioxidant, cardio-protective, hepatoprotective, anti-inflammatory drug [7]. The extensive uses of *Desmodium gangeticum* DC by different pharmaceutical industries coupled with the recent revival of interest in herbal medicine have led to an ever-increasing demand of this species. It has therefore become essential to search for a possible substitute for this species and to ensure the quality of the raw drug by pharmacognostical investigations. The situation has become more adverse as there is no detailed pharmacognostical data available on this species, it has become extremely important to make effort towards standardization of the plant material to be used as medicine, to maintain safety and efficacy of the formulations. Therefore the present work has been undertaken to establish various pharmacognostical and phytochemical parameters which could serve as a measures of authentication and quality control for commercial samples of the crude drug. In addition the detailed microscopy of the aerial parts of the plant (stem and leaf) had also been studied and documented which will be useful to pharmaceutical industries for the authentication of their commercial samples [8]. *Desmodium Triflorum (L.) DC* (Fabaceae/Leguminosae) a medicinal plant is a very small terrestrial, annual, prostrate herb, up to 50cm long, slender branches rooting at nodes. Its leaves are small, alternate, stipulate and trifoliate. Flowers are irregular, bisexual, very small and bright purplish blue color. This plant is found on a wide range of soils and most commonly in dry, distributed in lawns, waste places and along road sides in tropical countries including India, Srilanka, Philippines and Taiwan. The plant is easily available throughout the states of India [9]. *Desmodium triquetrum* DC (Leguminosae, Subfamily-Papilionaceae) is an erect or sub erects undershrub, distributed throughout central and eastern Himalayas, South India and Sri Lanka. The leaves are used as a substitute for tea by hill tribes in upper Assam. The TrefleGros, (Tadehagi triquetrum), is a species of flowering plant in the legume family, Fabaceae. It belongs to the sub family Faboideae. The maximum height of this shrub tree is 3m. Leaves alternate, linear-oblong, ovate with a tapering tip. Flowers show raceme inflorescence type, which are small, pale purplish in color. Fruit is a hairy legume. It is widespread in all South Asian, East Asian, and Southeast Asian countries [10-14].

***Desmodium gangeticum* (DC)**

***Desmodium triflorum* (Linn)**

***Desmodium triquetrum* (Linn)**

**Fig.1 -Images of *Desmodium* species**

**1. Pharmacological profile of *Desmodium* species**
**Pharmacological profile of *Desmodium gangeticum* DC**

| Plant Part | Type of extract | Pharmacological activity | Treatment procedure on animals | Finding activity/Trend/ Effective Dose | Observed mechanism |
|---|---|---|---|---|---|
| Aerial parts [14] | Flavonoid and alkaloid fractions | Antioxidant and anti-inflammatory | 10 mg/kg, i.p. in rats | Flavonoid fraction exhibited anti-inflammatory activity better than alkaloid fraction and indomethacin. Flavonoid fraction exhibited better superoxide dismutase, glutathione peroxidase and catalase activity - superior antioxidant activity. | Presence of polyphenols such as caffeic acid and chlorogenic acid, which are reported antioxidants, in the flavonoid fraction. |
| Roots [15] | Ethyl acetate extract | Antioxidant against revascularization injury | 100 mg/kg,p.o. for 30 days in rats | ***In vitro* anti-oxidant activity (2-1000 µg/ml)** Concentration dependent free radical scavenging. Half maximum inhibitory concentration (IC50) scavenging DPPH (36.3 µg/ml), superoxide (55.3 µg/ml), hydroxide (43.7 µg/ml), nitric oxide (39.4 µg/ml) and lipid peroxidation (248 µg/ml). **In vivo anti-oxidant activity (100 mg/kg)** Levels of cardiac enzymes such as CK, LDH, SGOT and SGPT improved by 50%. | Improvement of cardiac function. By improving the level of these cardiac enzymes like CK, LDH, SGOT and serum glutamic pyruvic transaminase (SGPT). By decreasing the release of LDH in coronary effluent. By decreasing the level of Malandialdehyde in myocardial tissues. |
| Leaves[16] | Ethanolic | Analgesic and anti-inflammatory | 50, 100 and 200 mg/kg; p.o. in rats | **Models of Anti-inflammatory activity *Carrageenin-induced paw oedema***. Dose dependent activity; 200 mg/kg maximally inhibited paw edema by 68% and 98%, up to 3 h and 5 h respectively.<br>**Models of Analgesic activity**<br>***Hot plate test***<br>All doses raised the threshold of heat tolerance, as observed from the increased reaction time (rt); 200 mg/kg increased reaction by 3.8 seconds in a span of 1 hour. | |
| | | Free radical scavenging potential | 250-1000 µg/ml | **Formalin-induced paw licking tests.** Only 100 and 200 mg/kg were effective, of which 200 mg/kg was most effective. Reduced licking time (time spent on licking) by 52% and 47% in early and late phase, better than standard drug indomethacin (32% and 29%). Antioxidant activity Dose dependent inhibition of nitric oxide and superoxide radicals | |
| Dried root [24] | Chloroform, Ethanolic and Aqueous alcoholic extracts of the plant (DG) | Anti-asthmatic activity | 200 mg/kg | The plant had been investigated in a systemic way covering its phytochemical and anti-asthmatic aspects to rationalize its use as a drug. In this present study, the anti-asthmatic effects of the chloroform, ethanolic and hydro-alcoholic dried root extracts of *Desmodium gangitecum* DC were evaluated. | There was a significant decrease in WBC count for extract-treated rats as compared to sensitized control II (Ovalbumin) treated rats and the significance was observed for the estimation of total tissue protein content as compared to sensitized control II treated rats. The extracts showed significant results of tissue Malonyldialdehyde levels in the experimental rats as compared to sensitized control II treated rats and this study indicates that the veracity of anti-asthmatic activity claimed by the natural medical practitioners of The Nilgiris. |

**1.1. Anti-inflammatory and anti-nociceptive activity**

Aqueous decoction (5, 10 and 20 mg/kg) of roots and aerial parts of *Desmodium gangeticum* DC showed anti-inflammatory and anti-nociceptive activity *in-vivo* in dose-dependent manner. The inhibition of swelling caused by carrageenan was equivalent to 14.58–51.02 % protection and in cotton pellet granuloma the protection was observed up to 14.43–38.67 %. Moreover, a significant increase in analgesio-meter-induced force and acetic acid induced writhing were observed equivalent to 6.56-67.66 % & 22.18–73.83 % protection respectively [17]. Juice of whole plant of *Desmodium gangeticum* DC possess anti-rheumatic and anti-osteo arthritic activity via anti-inflammatory activity. The activity might be associated with several phytoconstituents like polyphenolics, pterocarpinoid (gangetin) [18]. Gangetin, a pterocarpens, isolated from n-hexane extract of root of *Desmodium gangeticum* DC showed significant anti-inflammatory activity in both exudative and proliferative phases of inflammation in rat model at dose of 50 and 100 mg/kg body weight [19]. The whole plant of *Desmodium gangeticum* DC enhance the NO production of and provided resistance against infection established in peritoneal macrophage by the protozoan parasite *Leishmaniadonovani* [43].

**1.2. Traditional uses and Ethno-pharmacology**

Root powder is boiled with milk and half cup of it is prescribed for seven or more days by tribal people of Jalgaon District, Maharastra, India, to promote flatulence [20]. Villagers of Sivagangai district, Tamilnadu, India, drink leaf decoction (locally known as Pulladi) twice a day for 2- 3 days to cure diarrhea and dysentery. Leaf paste is applied on anus once a day for two weeks to cure piles [21]. Paliyar and Muthuvar Tribes, Theni District of Tamil Nadu, India, prescribe shade dried roots decoction (locallycalled Muvilaikurunthu) against asthma and other bronchial complications [22]. Tribes like Gond, Kols, Mushar, Baiga&Nutts in Vindhya region of Uttar Pradesh, India, administered orally rootpaste and powder to treat typhoid fever, cerebrospinal meningitis and also as an antidote of snake venom [23]. The roots of *Desmodium gangeticum* DC were used traditionally used in the treatment of asthma [30]

**1.3. Phytochemical Profile of *Desmodium gangeticum* DC**

Preliminary phytochemical screening reveals *Desmodium gangeticum* is rich in flavonoids, alkaloids, steroids, terpenoids, phenylpropanoids, pterocarpans, coumarins and volatile oil [25]. Among the isolated compounds flavonoids, alkaloids and pterocarpans are considered as major bio-active constituents. Alkaloids like 5-methoxy N, N-dimethyl tryptamine, N-methyl- H4–Harman, β-carboliniumcation, indole-3-alkyl-amines have been isolated from aerial parts of the plant. Pterocarpans such as gangetin, gangetinin, desmodin, and desmocarpin were reported to be present in roots. Recently a new pterocarpan, gangetial, had been isolated from the chloroform extract of the roots of *Desmodium gangeticum* DC. Flavones like 4,5,7-Trihydroxy-8-prenylflavone, 4-O-α-L-rhamnopyranosyl-(1→6)-β-d-glucopyranoside, 8-C-prenyl-5,7,5-trimethoxy- 3,4-methylenedioxyflavone, rutin and quercetin-7-O-β-d-glucopyranoside were also reported from the aerial parts. Phytosterols viz. β-sitosterol, α-amyrone, lupeol and its acetate, stigmastrol had been isolated from aerial parts. Moreover, aminoglucosylglycerolipid was reported for the first time from seed. Further, minor phytoconstituents viz. trans-5- hexadecenoic acid, salicylic acid, 5-O-methylgenistein-7-O-β-d-glucopyranoside, 3,4- dihydroxy benzoic acid, kaempferol- 7-O-β-d-glucopyranoside, and uridine triacetate were also reported [26-29].

**1.4. Pharmacological profile of *Desmodium triflorum* DC**

In this study mature whole plants of *Desmodium triflorum* Linn were evaluated of the antioxidant and anti proliferative activities of the crude methanol extract and various fractions of methanol extract like n-hexane, chloroform, ethyl acetate and n-butanol. the total phenolic content,1,1-diphenyl-2- picrylhydrazyl hydrate (DPPH) free radical scavenging activity, trolox equivalent antioxidant capacity (TEAC), reducing power, total flavonoid content of *Desmodium triflorum* Linn were evaluated for the exploration of its antioxidant activities. Furthermore, its antiproliferative activities were investigated through the MTT method. It was compared with the antioxidant capacities of known antioxidants, including catechin, *α*-tocopherol, trolox and ascorbic acid. *Desmodium triflorum* Linn, a medicinal plant from the Fabaceae family and also knownassan-dam-jin-cao, is commonly used by traditional Chinese medicine (TCM) cliniciansin Taiwan for the treatment of dysmenorrheal, muscle spasm, cough, pain and poisoning.The Taiwanese also call this plant “wings of fly” because of the shape and arrangementof the leaves [32]. Dried powder of whole plant *Desmodium triflorum* Linn *when* taken on empty stomach is useful in curing bone fracture [33]. *Desmodium triflorum* Linn leaf paste (or) external leaf paste in water is applied on forehead to bring down high fever [34].The fresh leaves of the plant are applied to wounds and abscesses that are usually difficult to heal. The paste is sometimes applied to sores and itch. The fresh juice of the plant is also recommended for use in dysentery and as a laxative [35]. The roots are reputedly carminative, tonic and diuretic and

used in bilious complaints. The leaves are ground with cow's milk; they are given daily in the morning. The main actions include antispasmodic, sympathomimetic, central nervous system stimulation, curare-mimetic activity and diuretic. In Philippines, a decoction is also used as mouth wash and as an expectorant. In Thailand, the whole plant is used as an antipyretic and to quench thrust. In Indonesia, Malaysia, Philippines, Laos and India, the plant in crushed form (or) a poultice of the leaves is externally applied on wounds, ulcers and for skin problems in general, apparently for its antiseptic properties [36].In this study an attempt to know the anthelmintic activity of the leaves and roots of the *Desmodium triflorum* Linn. For this work, the leaves and roots were extracted separately with cold water, Methanol andpetroleum ether by following maceration method. Various doses of cold water, methanolic and combined (cold water, Methanol and petroleum ether) extracts were evaluated for their anthelmintic activity on adult Indian earthworms, *Pheretimaposthuma*. All extracts were able to show anthelmintic activity of 10mg/mL concentration. All the doses of cold water, methanolic and combined extracts of *Desmodium triflorum* Linn *DC* showed dose dependent anthelminticactivity in comparison to standard drugs [37].

**1.5. Phytochemical profile of *Desmodium triflorum* (Linn)**

*Desmodium Triflorum (L.) DC* contains chemical constituents Ursolic acid, Vitexin, Genistin, Fucosteroland rare diholosylflavane, 2-Glucosylvitexin. *Desmodium triflorum* Linn leaves contains total alkanoid, 0.01-0.015%, Phenethylamine(major alkaloid), Indole-3-acetic acid, Tyrumine, Trigonelline, Hypaphorine and Choline. *Desmodium triflorum* Linn root contains the total alkaloid 0.01-0.018% Hypaphorine (major alkaloid), N, N-Dimethyl tryptophan betaine and Choline. The leaves are used in diarrhea, convulsions and as a galactagogue [35, 38-40].

**1.6. Pharmacological profile of *Desmodium triquetrum* (Linn)**

**Anti-inflammatory and *in vitro* antioxidant activity of *Desmodium triquetrum* Linn** - DTE was found to be safe up to at a dose of 2000 mg/kg. Hence, the doses of 100, 200, and 300 mg/kg were selected for the activity. The results of this investigation suggest that DTE produced significant anti-inflammatory and and antioxidant activity. Carragenan administration to the control group resulted in increase in paw volume at 30 and 60 min and gradually decreased after 120 min. The treatment with DTE in all the doses showed significant decrease in the paw volume compared to control. The maximum inhibition of paw edema was observed at 60 min at the dose of 300 mg/kg body weight. The results were comparable with the standard drug. The maximum $H_2O_2$ scavenging activity was observed at 50 $\mu$g/ml of the test extract. NO is a potent pleiotropic mediator of physiological processes. DTE (25 to 75$\mu$g/ml) also moderately inhibited nitric oxide in a dose dependent manner. Standard ascorbic acid was found to have 76.82% activity at 75 $\mu$g/ml. Carrageenan induced inflammatory process is believed to be biphasic. DTE showed a significant anti-inflammatory activity in both phases of inflammation. Increase in cyclic adenosine monophosphate (cAMP)-phosphodiesterase (cAMP-PDE) activity in edematous tissue after carrageenan injection paralleled the increase in migrated cells as reported. It has been reported that alcohol extract of *D. triquetrum* was found to inhibit cAMP-PDE activity. Therefore, the possible mechanism for significant anti-inflammatory activity of DTE may be by inhibition of cAMP-PDE activity and also it can be attributed to its antioxidant activity as evidenced by the presence of flavonoids [41]. *Desmodium triquetrum* Linn contains a wide variety of free radical scavenging molecules, such as phenolic and nitrogen compounds, terpenoids, and carotenoids that are rich in antioxidant activity [42]. The leaf extracts or pills are used for the treatment of piles [43].

**Hepatoprotective and Antioxidant Activities of *Desmodium triquetrum* Linn**-The effect of DTE on hepatospecific enzymes, serum bilirubin, SOD, CAT and GSH in rats with $CCl_4$induced liver damage were review. There was a significant rise in the levels of SGOT, SGPT, SALP and serum bilirubin in $CCl_4$ treated group as compared to normal. Administration of DTE significantly reduced the increased levels of these enzymes and serum bilirubin and caused a subsequent recovery as compared to silymarin treated group. Thus, the ethanol extract of *Desmodium triquetrum* Linn leaf has potent hepatoprotective and antioxidant activities against $CCl_4$-induced liver toxicity. Further phytochemical and pharmacological investigations are underway to identify the active constituents responsible for hepato protection. Reaction of reactive species with cellular antioxidants causes depletion of antioxidant enzymes that may result in oxidative stress. The administration of DTE significantly preserved SOD and catalase activities thus exhibiting hepatoprotective activity due to inactivation of reactive oxygen species. GSH protects the cells by scavenging of free radicals. The DTE is reported to contain flavonoids, phenolic compounds and glycosides, which may be responsible for the hepatoprotective and antioxidant activities of the plant [44].

**1.7. Phytochemical profile *Desmodium triquetrum* Linn**

The preliminary phytochemical analysis of the extract confirmed the presence of flavonoids, glycosides, steroids, saponins, phenolic compounds and amino acids, The leaves of this plant contains tannins, alkaloids, hipaforin, trigonelin, tanning material, silicic and the fruits of this plants contains saponin and flavonoids while the roots contain saponins, flavonoids, tannins [41, 45].

**1.8. Safety profile**

Toxicity of *all* three potent *Desmodium species* extract/ Fractions were accessed in animal model (mice) at different doses (50–2000 mg) based on acute oral toxicity guidelines 423 and parameters like Itching, Body weight, skin reaction,hyperactivity, grooming, convulsions, sedation, hypothermia and mortality were observed. No mortality was observedfollowing oral administration of highest dose (2000 mg/kg) of extract. However, doses more than 1000 mg/kg producedprofuse watery stools, ptosis (dropping of upper eyelids) and lethargy in animals. Further, as traditional medicine no reports of toxicityof *Desmodium species* have been documented.

## CONCLUSION

The three potent *Desmodium* species like *Desmodium gangeticum* DC, *Desmodium triflorum* Linn, *Desmodium triquetrum Linn*, has been used for the treatment of various ailments in traditional and folklore medicine throughout India, China and other African countries. *Desmodium gangeticum* DC is one of the main ingredients of several Ayurvedic formulations like Dashamularishta, Chyavanaprasam and Agasthyarasayanam, routinely prescribed to treat colic pain, fever, respiratory diseases. The decoction of Dasamula and Laghupancamula, polyherbal formulations are used in pain, hysteria, rheumatism, asthma, cardiac and renal problems. *Desmodium triflorum* Linn and *Desmodium triquetrum* Linn subsequently very useful as antioxidant and anti-inflammatory, piles etc. Isolated phytoconstituents like Gangetin, Desmodin, 5-Methoxy-N-dimethyltryptamine are considered as predominant bioactive constituents due to their diverse therapeutic potentiality. Although the constituents responsible for the pharmacological properties of the plant seem to have been determined, the molecular mechanisms of most of these principles are still unknown. The bioassay guided isolation, identification of the bioactive components is essential and in depth research is also crucial to reveal the structure-activity relationship of these active compounds. Based on these facts, the authors made upto date information highlighting the current ethno pharmacological and phytochemical status of the plant.

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