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Phytochemical, pharmacological, and pharmacognostic overview of *Merremia tridentata* (L.) Hallier

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ABSTRACT

Merremia tridentate Linn., also known Prasarini in ayurveda and siddha text, is a species of plant in the family Convolvulaceae. The plant is a native to India, and is found in the Upper Gangetic Plain, Bihar, Orissa, West Bengal, South India, and Gujarat. This plant is used extensively in ayurveda as a laxative, astringent, and anti-inflammatory agent. The plant is also used for piles, swellings, rheumatic affections, stiffness of the joints, hemiplegia, and urinary affections. It is the main ingredient of the classical ayurvedic formulation *Prasaranadi Kashayam* which is used to treat joint pains and Vata diseases. It is mainly used in ayurvedic treatment of joint pain and musculoskeletal problems. The aerial parts contain flavonoids, diometin, luteolin, and 7-O-beta-D-glucosides. The objective of the present review is to provide a comprehensive collection of the published information concerning the traditional uses, phytochemistry, and therapeutic potential of *M. tridentata*.

1. INTRODUCTION

India is well known for its rich botanical heritage and there are more than 18,000 plant species and subspecies in the flora of India [1]. The Indian alternative and traditional systems of medicine, such as ayurveda, siddha, and unani, were in use from the prophylaxis and treatment of various types of health diseases over a vast period of time [2]. Therefore, exploration of the medicinal plants of the Indian flora will be a great contribution to the pharmaceutical industry for selecting plants with potential pharmaceutical properties.

The family Convolvulaceae comprises 60 genera with approximately 1,650 species, which include herbaceous vines, trees, shrubs, and herbs, and also food tubers [3]. *Merremia tridentata* (synonym: *Xenostegia tridentate*, *Merremia angustifolia*; Prasarni in ayurveda and siddha) [4] is a member of this family and has great importance in the ayurvedic and siddha systems and is used to treat various ailments. The plant is a widely distributed in tropical Africa, Asia, and Australia. In Africa, it occurs from the east of Senegal to Ethiopia and to South Africa [5]. It also occurs in the Indian Ocean islands, and is found in the Upper Gangetic Plain, Bihar, Orissa, West Bengal, South India, and Gujarat [6]. The different parts of this plant are shown in Figures 1 and 2.

In spite of its great traditional value, the plant *M. tridentata* remains unexplored and very limited phytochemical and pharmacological studies have been carried out on this plant. This review covers all the relevant published literature on the plant *M. tridentata* in relation to its phytochemical and pharmacological potential.

2. REVIEW METHODOLOGY

A literature search was carried out mainly by searching two main scientific literature databases (PubMed and China National Knowledge Infrastructure databases) using Google Scholar as the search engine. The authors mainly relied on the articles that were freely available (open access), and the articles without full-text and those not written in English were excluded. The search terms used include "*Merremia tridentata*," "*Xenostegia tridentate*," "Prasarini," "*Merremia tridentata* activity," "Pharmacology," "Phytochemistry," and "Botany."

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Figure 1: Aerial parts (A) and roots (B) of *M. tridentata* [7].

Figure 2: *Merremia tridentata*: (a) habit; (b) white flower; and (c) lemon yellow flower with a dark reddish throat [8].

The collected literature was subjected to snowballing of the references. The authors had included all types of peer-reviewed articles published in English.

3. PHARMACOGNOSTIC DISCRIPTION

3.1. Habit

A slender, perennial, prostrate herb with angular stems.

3.2. Leaves

Varied in shape and size, but deeply emarginated; three-toothed at the apex; cordate at the base with the basal lobes clasping the stem; the petioles were very short or 0.

3.3. Inflorescence

Axillary solitary.

3.4. Flowers

Calyx infundibuliform; outer sepals were shorter than the inner. The corolla was pale yellow.

3.5. Fruit

Pale brown, glabrous, and seeds were trigonous.

3.6. Flowering and Fruiting Time

During the monsoon season [9].

The anatomy of the different parts of the plant *M. tridentate* was conducted by Aron *et al.* [10]. The anatomy of the leaf showed the presence of collateral vascular bundles, paracytic stomata, peltate type of glandular trichomes, and the presence of calcium oxalates on the epidermis of the lamina. The stem showed the presence of a bicollateral vascular cylinder, with angular vessels and xylem fibers. The roots showed the presence of non-distinct secondary phloem in close proximity to the cortex. Another study reported that the TS of the stem of *M. tridentata* sp. *tridentate* appeared angular in outline with eight protruberances, whereas the TS of the stem is pentagonal in outline for *M. tridentata* sp. *hastata*. The cortex is chlorenchymatous with slightly tangentially elongated parenchymatous cells. Large cavities are present in the cortex [11].

Powder microscopy of the whole plant of *M. tridentata* ssp. *tridentata* showed a surface view with epidermal cells; vessel fragments and tracheids with pitted spiral thickenings; fiber fragments; lower epidermis with stomata; calcium oxalate rosette crystals; and trichome fragments [11]. The powdered plant sample was evaluated for physicochemical analysis parameters. The authors reported total ash (15.3%), water-soluble ash (5.8%), acid insoluble ash (3.1%), and moisture content (11.2%) [10].

4. TRADITIONAL AND ETHNOMEDICINAL USES

Merremia tridentate, also known as "Prasarini" in ayurveda, is the main ingredient of the traditional ayurvedic formulation *Prasarinyadi Kashayam* which is used for treating Rheumatoid Arthritis [12]. The plant is traditionally used for the treatment of piles, swellings, rheumatic affections, stiffness of the joints, hemiplegia, and urinary affections [6]. The plant is used as an ethnomedicine by the rural people of the Eastern Ghats of Tamil Nadu, India. The natives use the leaf paste to improve the growth of hair and the decoction of the root is used to cure diabetes [13].

5. PHYTOCHEMISTRY

The aerial parts contain tannins, flavonoids such as luteolin, diosmetin and 7-O-beta-D-glucosides [6]. Jenett-Siems *et al.* [14] isolated Ergosine alkaloids from the seeds of *M. tridentate*, whereas pyrrolidine alkaloids like hygrine and nicotine were isolated from the root and the aerial parts of *M. tridentate*, respectively. The acetone extract of the root possess high phenolic contents. The chemical structures of these constituents are shown in Figure 3. Mucilage obtained from the roots of the plant is used as a binding agent in tablet dosage forms [15].

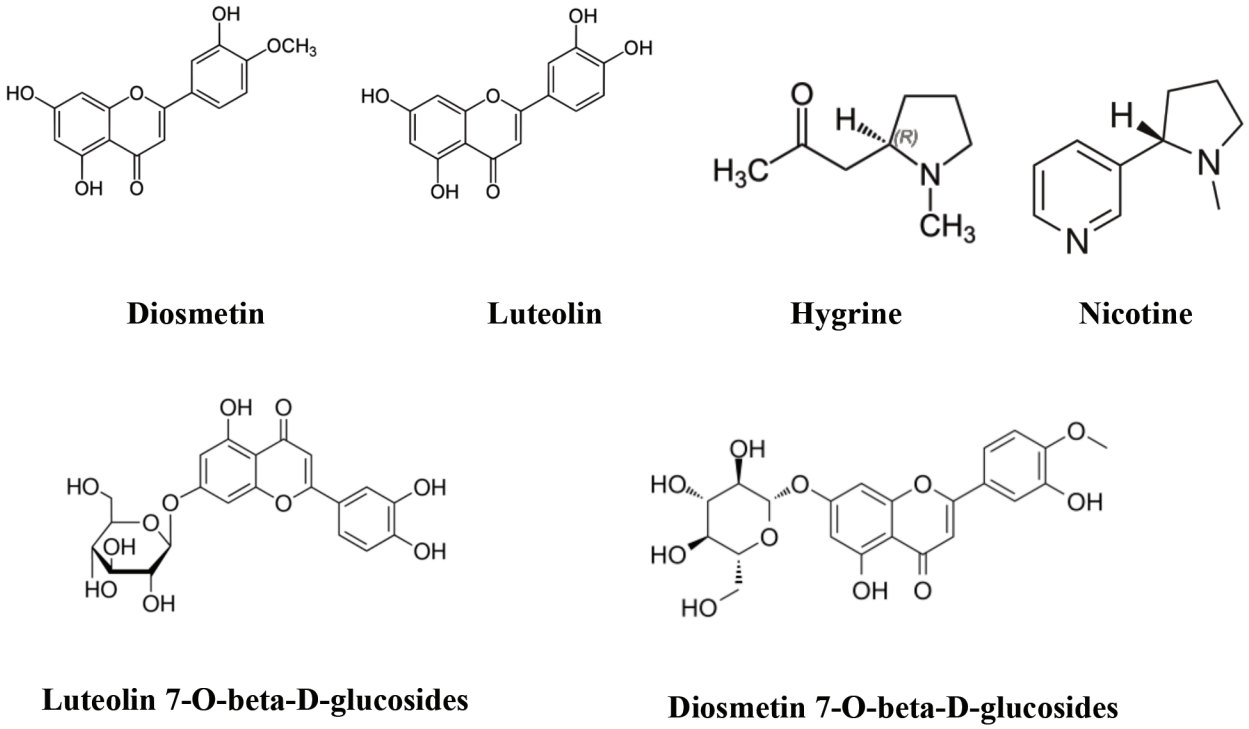

Figure 3: Phytochemical constituents of *M. tridentata*.

6. PHARMACOLOGICAL ACTIVITIES

6.1. Antioxidant Effect

DPPH•, ABTS•+, and OH• scavenging activities were evaluated along with the reducing power, phosphomolybdenum reduction, Fe2+ chelation, antihemolytic activity, and inhibition of peroxidation. The total phenolic content was analyzed and it was found that the acetone extract obtained from the roots of the plant demonstrated the highest amount of total phenolics (35.1/100 g extract), which is clearly reflected in the better radical scavenging and antioxidant properties in comparison to the other parts. Maximum Fe+ ion chelation was demonstrated by the hot water extract of aerial parts [16]. The report by Sowndhararajan and Chin [7] also confirm the antioxidant effect of this plant on same *in-vitro* models. The plant is rich in phenolics like tannins and flavonoids which are well-known scavengers of free radicals. However, there is no significant data available regarding the *in vivo* antioxidant effect of this plant.

6.2. Anti-Inflammatory, Antiarthritic, and Analgesic Activities

There are multiple reports regarding the anti-inflammatory effect of the plant. Methanolic extract of the root doses of 50 and 100 mg/kg body weight showed significant anti-inflammatory activity when compared to the control group in the carrageenan-induced paw edema mode [17]. Another study reported that the ethyl acetate, butanone, butanol, and solvent ether fractions showed significant inhibition of rat paw edema when compared to control [18].

Kamalutheen *et al.* [19] reported the anti-inflammatory activity evaluated on the carrageenan-induced rat paw edema model and the anti-arthritic activity on complete Freund's adjuvant-induced arthritis model. The ethanol extract of *M. tridentata* exhibited significant inhibition of acute inflammation in a dose-dependent manner. The doses of 100 and 200 mg/kg bw produced 38.3% and 42.8% inhibition, respectively, after 3 hours in comparison to Indomethacin (10 mg/kg bw). In the arthritis model, doses of 100 and 200 mg/kg bw of the ethanol extract produced 49.0% and 51.7% inhibition, respectively, after 19 days. Both doses of the ethanol extract of *M. tridentata* exhibited significant anti-inflammatory and antiarthritic activities. The almost comparable effect of *M. tridentata* acetone extract was reported by Arunachalam *et al.* [20] on carrageenin and histamine-induced paw edema in rats.

The anti-inflammatory effect of this plant is obvious in view of the chemical constitutes present in the plant. The plant is rich in pyrrolidine–pyridine type of alkaloids such as nicotine and flavonoids like luteolin, both these chemical constituents are well known for their strong anti-inflammatory activity [21,22]. Nicotine is reported to a show protective effect against neurological inflammation [23] and the inflammation induced by obesity and ulcerative colitis [24]. Luteolin has demonstrated its anti-inflammatory effect in various *in vitro*, *in vivo*, and *in silico* models [22,25,26].

The analgesic effect of the plant was evaluated on the hot plate test and writhing test in mice. Significant attenuation of the hot plate thermal stimulation-induced analgesia was carried out at a dose of 200 mg/kg. The analgesic effect produced by the plant extract was almost comparable with the standard drug pentazocine (30 mg/kg). The same dose significantly improved the writhing in mice [20].

6.3. Nephroprotective

Adikay *et al.* [27] tested the protective effect of methanolic extract of aerial parts of *M. tridentata* at doses of 300 and 600 mg/kg on gentamicin-induced renal damage in curative and prophylactic models. The methanol extract exhibited dose-dependent activity in the curative model. Animals administered a prophylactic dose showed mild-to-moderate protection against gentamicin-induced kidney damage. The level of protection was determined by assessing the levels of various serum markers level such as blood urea, nitrogen, serum creatinine, and urinary protein excretion [27].

6.4. Wound Healing Activity

The wound healing activity of *M. tridentata* was evaluated on excision, incision, and dead space wound models. A 6 cm long wound of 1.5 cm thickness was made for the sutured incision model and a wound area of 500 mm^2 was made for the excision wound model. Sterilized cylindrical glass piths were used between the axilla and groin to create a dead space wound. The generation of granulation tissues was used as a marker to test the tensile strength. Animals were treated with different solvent fractions of the total extract of *M. tridentata* and were compared with the control animals. The ethyl acetate fraction demonstrated highest tensile strength which is considered a marker for effective wound healing [18]. This effect may be attributed to the presence of various flavonoids, especially luteolin, which is reported to possess wound healing activity in various previous studies [28–31].

6.5. Anti-Ulcer Effects

The roots of the plant showed remarkable protection against ethanol-induced gastric ulcers. Pre-treatment with ethyl acetate fraction (MEF) (50, 100, and 200 mg/kg bw) showed significant protection against ethanol-induced depletion of gastric mucosa. This effect may be attributed to the ability of the plant to increase the activities of enzymatic antioxidants (SOD, CAT, and GSH) [7]. This effect may be attributed to the plant phenolics which is known to possess ulcer protective action [32–36].

6.6. Antidiabetic Activity

The antidiabetic effect of the aqueous extract of *M. tridentata* roots (MTRAE) was evaluated in normal, hyperglycemic, and streptozotocin (STZ)-induced diabetic rats. Oral administration of all three doses (50, 100, and 150 mg/kg) showed significant reduction in blood glucose levels in a dose-dependent manner. The test drug showed a significant increase in body weight, serum insulin, and liver glycogen content in STZ-induced diabetic rats. In addition to that, there was a significant reduction in total cholesterol and serum triglyceride level. The plant also showed

a significant anti-lipidperoxidative effect at the pancreas of STZ-induced diabetic rats [37,38].

6.7. Antibacterial Activity

Jain *et al.* [39] reported the antibacterial effect of *M. tridentata* against *Bacillus subtilis* and *Staphylococcus aureus*. The plant is known to contains diosmetin which is known to possess antimicrobial effect and also interact synergistically with the antibiotics such as norfloxacin, streptomycin, and ciprofloxacin against drug-resistant strains [40,41].

7. CONCLUSION

The available literature on the plant *M. tridentata* shows the pharmacological importance of this plant. The plant is widely used in ethnomedicinal and traditional systems of medicine for the treatment of a wide range of ailments, especially as an anti-inflammatory agent. The plant is also used for piles, swellings, rheumatic affections, stiffness of the joints, hemiplegia, and urinary affections. However, the most prominent and well-studied activities are antidiabetic activity, anti-inflammatory, antiarthritic, analgesic activities, antioxidant activity, etc. The phytochemical screening showed the presence of flavanoids, phenolics, alkaloids, and steroids in different parts of this plant. Considering the pharmacological and phytochemical relevance of this plant, there is a need for detailed phytochemical study of this plant, including the quantification of marker compounds.

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9. AUTHORS' CONTRIBUTIONS

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work. All the authors are eligible to be an author as per the International Committee of Medical Journal Editors requirements/guidelines.

10. CONFLICTS OF INTEREST

The authors report no financial or any other conflicts of interest in this work.

11. FUNDING

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12. ETHICAL APPROVAL

This study does not involve experiments on animals or human subjects.

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