REVIEW ARTICLE

Baliospermum montanum (Danti): Ethnobotany, phytochemistry and pharmacology- A review

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Baliospermum montanum (Willd.) Muell-Arg (Euphorbiaceae) is a leafy monoecious undershrub distributed throughout the greater parts of India, Burma and Malaya. The various parts of the plant (leaves, roots, seeds and seed oil) are widely used by various tribal communities and forest dwellers for the treatment of variety of ailments. The roots of the plant are ascribed to possess medicinal virtues in Ayurvedic system of medicine and used in preparation of important Ayurvedic formulations. The plant is documented to possess beneficial effects as digestive, anthelmintic, diuretic, diaphoretic, rubefacient, febrifuge and tonic. It believed to be useful in asthma, bronchitis, leprosy, jaundice, wounds, constipation, anemia, leucoderma and fever. Following various folk claims for cure of numerous diseases, efforts have been made by researchers to verify the efficacy of the plant through scientific biological screenings. A scrutiny of literature revealed some notable pharmacological activities of the plant such as anticancer, antimicrobial, free radical scavenging, immunomodulatory, hepatoprotective, and anthelmintic. The present review is an attempt to highlight the various ethnobotanical and traditional uses as well as phytochemical and pharmacological reports on *B. montanum*.

Key words: *Baliospermum montanum*, ethnobotanical uses, pharmacognosy, pharmacological activities, phytochemistry, tissue culture studies

INTRODUCTION

Baliospermum montanum (Willd.) Muell-Arg Euphorbiaceae, commonly known as 'Danti' is a leafy stout monoecious undershrub, 0.9-1.8 m in height, with many shoots arising from the base. The plant is found in Nepal, Burma, Malaya and India.[1] In India, it is distributed from Kashmir eastwards to Arunachal Pradesh, up to an elevation of 1,000 m and southwards into peninsular India, ascending to an altitude of 1,800 m in the hills of Kerala.[2] The leaves are simple, sinuate, toothed and very variable in shape and size. The upper ones are small, 8-12 cm long and long petioled while lower ones are large 10-30 cm long ovate, palmately lobed. The flowers are small, numerous, unisexual in axillary racemes with male flowers above and few female flowers below. The perianth in male globose, opening in 4-5 membranous concave, imbricate lobes while in female of 5-6 lanceolate toothed lobes sometimes persistent in fruits, disc in male of 4-5 glands, in female annular. Capsules are of about 8-13 mm long, obovoid, usually hairy, cells 2- valved. The seeds are ellipsoid, smooth, mottled, resemble castor seeds but are smaller in size.[3] The plant is common in shady places and often cultivated by using root-suckers. The various parts of *B. montanum* such as roots, leaves and seeds are documented to possess medicinal properties in ethnobotanical surveys conducted by ethnobotanists and in traditional systems of medicine such as Ayurveda. Our thorough literature search revealed an interesting fact that though the plant is a popular remedy for a variety of ailments and is one ingredient in a number of important Ayurvedic formulations, very little effort have been made to verify its efficacy through scientific screenings in animal models and clinical trials. The present review highlights the various folk, Ayurvedic uses and pharmacognostical, phytochemical and pharmacological studies conducted on *B. montanum* and also pinpoints unexplored potential of it.

MEDICINAL USES

Traditional Uses

Almost all the parts of Danti are of medicinal importance and used traditionally for the treatment of various ailments. The roots of the plant are considered as purgative, anthelmintic, diuretic, diaphoretic, rubefacient, febrifuge and tonic.[4] They are also reported to be useful in dropsy, constipation, jaundice, leprosy and skin diseases. The leaves are found to be good for asthma and bronchitis.[5] The seeds of the plant are drastic purgative, rubefacient, hydragogue and stimulant. The oil obtained from seeds is a powerful hydragogue cathartic and is found useful for external

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application in rheumatism.[6]

Ethnobotanical Uses

There are over 400 different tribal and other ethnic groups in India. Each tribal group is having their own tradition, folk language, beliefs and knowledge about use of natural resources as medicines. Almost all the parts of the plant are documented to be useful in ethnobotanical surveys conducted by ethnobotanists. It has been documented that the natives of Santal Pargana, Bihar, India using seeds for the treatment of rheumatism, gout and in gastric complaints.[7] The seeds are also reported as purgative, stimulant, rubefacient,[8-11] laxative,[12] as antidote in snake bite,[13] and in constipation.[14] The tribals of Madhya Pradesh and Karimnagar district, Andhra Pradesh, India using leaves of danti for the treatment of asthma,[10,15] and in headache.[16] Decoction of stem is used to get relief from toothache.[17,18] The roots of the plant are practiced as laxative,[18-20] in dropsy, jaundice, anasarca,[9,10] in rheumatism, anemia,[21] and also in the treatment of jaundice, skin diseases, helminthic infections, leucoderma and piles.[11] They are documented to be useful as an antiemetic.[22]

Uses Ascribed in Ayurveda

In Ayurvedic system of medicine roots of *B. montanum* are most popular and considered as good remedy in tvakdosa (skin diseases), krimi (worm infestation), daha (burning sensation), udararoga (gastrointestinal tract diseases), asmari (lithiasis), Kandu (itching), kushta (leprosy), vrana (wounds) and gulma (abdominal lump).[23] The plant is attributed medicinal in number of classical texts of Ayurveda like Ashtang Hridays, Bhav Prakash Nighantu, Dhanvantari Nighantu, Raj Nighantu, Shaligram Nighantu and Sushruta Samhita. The roots are used in some important Ayurvedic formulations such as Dantyarista, Punarnava Mandura, Abhayarista, Kankayana Gutika, Dantiharitaki, Kalyanaka Kshra and Kaisora Guggulu.[24]

Pharmacognostical Studies

There are about 600 single drugs of vegetable origin presently used in the preparation of about 1000 popularly used Ayurvedic formulations. The systematic identification of many of these indigenous herbal drugs is still a subject of confusion and controversies, because several different species of herbs are available for one and the same medicinal name crude drugs, on one hand, whereas the same plant is being used for different crude drugs on the other hand.[25] *B. montanum* is an important drug in Ayurvedic system of medicine. The plant is sold under various names as 'danti', 'dravanti', 'hastidanti'. On the basis of botanical studies it was established that 'danti' is *Baliospermum montanum*, 'dravanti' is *Jatropa curcus* Linn. (Euphorbiaceae) while 'hastidanti' is *Croton oblongifolius* Roxb. (Euphorbiaceae). A market survey revealed that genuine danti is not being sold in market and the samples were found to be pieces of the stem of *Jatropa curcus* and *Ricinus communis* Linn. (Euphorbiaceae).[26]

A detailed Pharmacognostic study of all the parts of *B. montanum* has been carried out by Nambiar *et al*.[27]

Leaf

The transverse section of the leaf shows single layered epidermis with thick cuticle. Mesophyll tissue consists of compactly arranged single-layered palisade and loosely arranged multilayered spongy tissue. Midrib region shows bicollateral vascular bundle bound both upper and lower sides by sclerenchymatous girdles. Lower epidermis possesses unicellular trichomes and rubiaceous type of stomata. The leaf constants like stomatal index (19.46), palisade ratio (7.9) and vein-islet number (4.01) are important parameters for identification of the plant.

A cross section through petiole is oval in outline and shows cuticularized single-layered epidermis. Below epidermis 3-5 layered collenchyma are conspicuous. Vascular bundles are numerous and arranged in ring. There is a large cavity in the centre.[27]

Stem

The transverse section of mature stem shows uniseriate epidermis and consists of tubular cells with thick deposition of cuticle. A predominant cortex composed of 13-15 layers of parenchymatous cells is seen. In the middle portion 3-4 layers are collenchymatous which extend towards the periphery at certain point and few latex vessels and mucilage ducts are present. The secondary xylem consists of vessels, which are predominantly in linear groups. The xylem fibers are conspicuous. The uniseriate medullary rays are devoid of starch grains. This is distinct feature as compared to root.[27]

Root

The transverse section of a mature root is circular in outline and shows 5-18 layered cork consisting of brown colored suberised or lignified brick-shaped cells and few cells containing tannin and red coloring matter. This is followed by phellogen consisting of few layers. Secondary cortex consists of 2-7 layers of oval to elliptical, tangentially elongated cells. Secondary phloem consists of usual elements, traversed by uni to biseriate phloem rays. Secondary xylem consists of vessels and tracheids, bordered pits, a few having reticulate thickening. The fibers slightly thick-walled with narrow lumen and blunt tips. The medullary rays are often uniseriate or biseriate containing starch grains in their cells.[27]

Root Powder

Root powder is brown in color and shows fragments of cork more or less rectangular, thick-walled in surface view. It also shows presence of rosette crystals of calcium oxalate, numerous phloem fibers with narrow lumen and blunt tips, border pitted and reticulate vessels, tracheids and tannin cells, round to oval simple starch grains measuring 6-17 μ in diameter.[23]

Because of similarity in synonyms, the seeds of 'jaipal' or 'jamalgota' botanically equated with *Croton tiglium* Linn. (Euphorbiaceae) are also being used as 'dantibeej'. Agarwal *et al* has established distinguishing morphological characters of seeds of *B. montanum* from *C. tiglium*.[28]

Phytochemistry

Danti has been explored phytochemically by various researchers and found to possess number of chemical constituents [Fig. 1]. The phytochemical studies on the roots of *B. montanum* revealed presence of five phorbol esters, viz. montanin ($C_{32}H_{48}O_8$; yield, 0.018%), baliospermin (0.003%), 12-deoxyphorbol-13-palmitate (0.021%), 12-deoxy-16-hydroxyphorbol-13-palmitate (0.001 %) and 12-deoxy-5β-hydroxyphorbol-13-myristate (0.007%).[29] A preliminary phytochemical study on the roots showed presence of flavonoids, glycosides, sterols and absence of alkaloids, saponins and terpenoids.[30]

Agrawal *et al* in a preliminary study on the seeds reported the presence of glycosides and terpenoids.[31] A non vicinal dihydroxy monosaturated acid was isolated from the seed oil and characterized as 11, 13-dihydroxytetracos-*trans*-9-enoic acid, designated as axillarenic acid.[32]

The leaves showed presence of steroids, terpenoids, flavonoids, and absence of alkaloids and saponins in the leaves of the plant.[33]

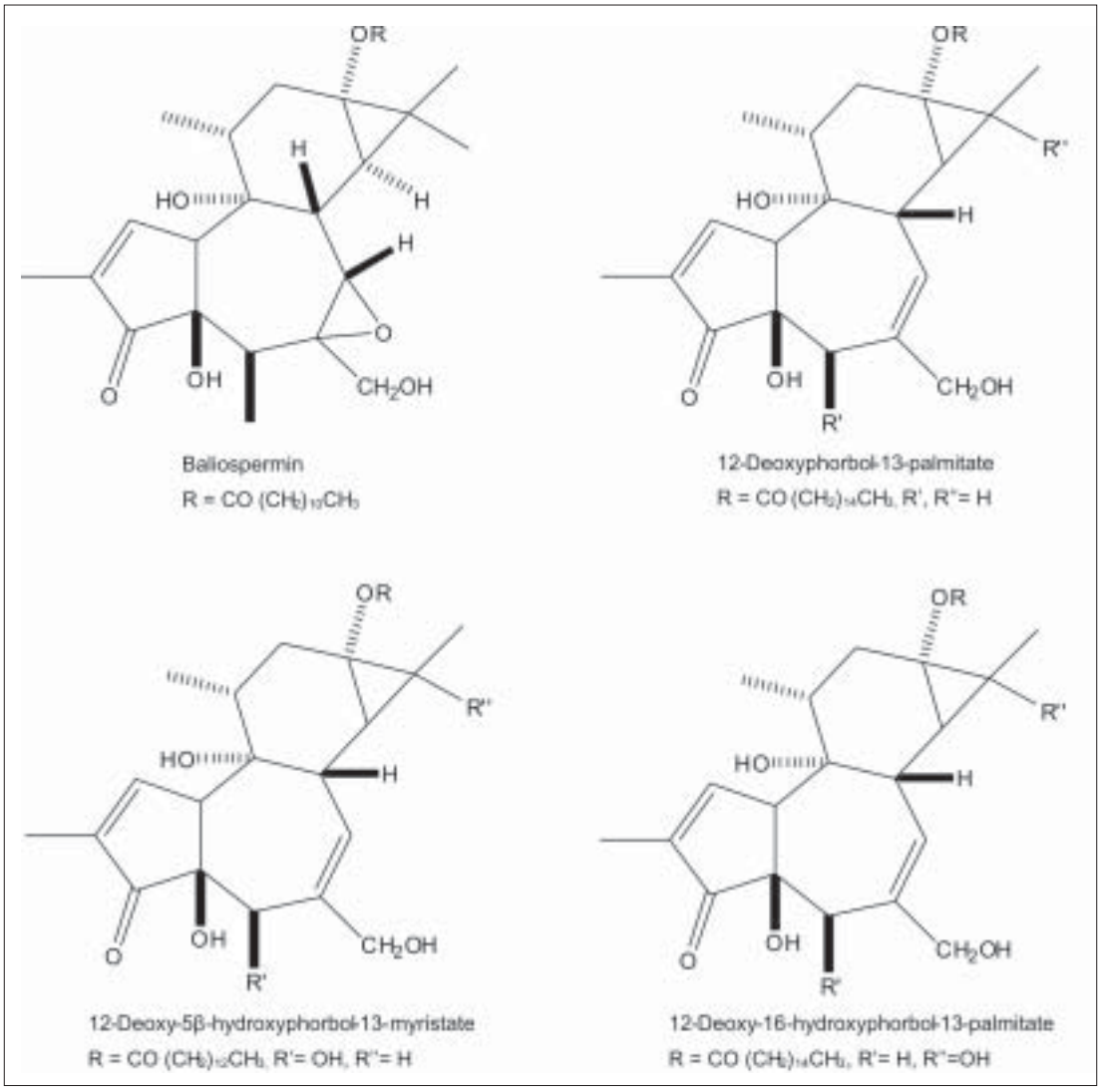

Figure 1: Structures of some phytoconstituents isolated from *Baliospermum montanum*

Pharmacological Uses

Following the folk and traditional uses of the plant, it has been investigated scientifically in animal models to validate the potential of the plant in cure of variety of ailments.

GENERAL PHARMACOLOGICAL ACTIVITIES

Bhakuni *et al* showed that 50% ethanolic extract of the plant has effect on respiration and CVS in dogs and cats. The extract did not show any antibacterial, antifungal, antiprotozoal, antiviral, hypoglycaemic and diuretic activities in experimental animals. The LD_{50} of the extract was found to be 250 mg/kg *i.p*. in mice.[34]

Anticancer Activity

All the five phorbol esters viz. montanin, baliospermin, 12-deoxyphorbol-13-palmitate, 12-deoxy-16-hydroxyphorbol-13-palmitate and 12-deoxy-5β-hydroxyphorbol-13-myristate isolated from roots of *B. montanum* were evaluated for their *in vivo* anti-leukemic activity and the results of the study showed significant activity. The results obtained also revealed ED 50 of 0.06-3.4 μg/ml against *Lymphocytic leukaemia* P-388 *in vitro* for all five esters.[29]

Hydroxynitrile Lyase (HNL) Activity

A simple HPLC method has been established to determine the activity and stereochemistry of the chiral mandelonitrile synthesized from benzaldehyde and cyanide, and applied it to screen for hydroxynitrile lyase (HNL) activity of plant origin. A total of 163 species of plants among 74 families were examined for (R)- and (S)-HNL activities using the method. The homogenate of leaves of *B. montanum* showed significant (S)-HNL activity.[35]

Antimicrobial Activity

The crude ethanolic extract of leaves of *B. montanum* was evaluated for its antimicrobial potential by disc diffusion method. The various concentration (10, 20 and 40 mg/ml) of extract prepared in DMSO were screened using *Staphylococcus aureus*, *Pseudomona aeruginosa*, *Escherichia coli* and *Candida albicans*. Ampicilline trihydrate (1 mg/ml) and Fluconazole (0.5 mg/ml) served as reference control for the study. The extract showed significant antibacterial activity but found ineffective against fungal strain used in the study.[36]

In another study, methanol and acetone extract of aerial parts of *B.montanum* were tested for antimicrobial activity against five strains of gram positive bacteria, seven gram negative bacteria and three fungal strains. The assay was performed by agar disc diffusion method using amikacin (30 μg/disc), amphotericin-B (100 units/disc) and Fluconazole (10 μg/disc) as standard antibiotics. The activity of both the extracts was found less against gram positive and negative bacteria when compared to the standards used in the bioassay and found ineffective against all the three fungal strains.[37]

Free Radical Scavenging Activity

Free radical scavenging potential of the aqueous extract (4, 8, 12, 16, 20 and 24 mg/ml) of roots of *B.montanum* was evaluated by using diphenyl-picryl-hydrazyl (DPPH) assay and nitric oxide (NO) scavenging assay. Ascorbic acid was used as standard for the study. The results of study revealed significant free radical scavenging activity of the extract in dose dependant manner and comparable to the standard drug ascorbic acid.[38]

Immunomodulatory Activity

In one study, different concentrations (25, 50 and 100 mg/ml) of alcoholic extract of roots of *B. montanum* were studied for their effect on different *in vitro* methods of phagocytosis such as neutrophil locomotion and chemotaxis, immunostimulant activity of phagocytosis of killed *Candida albicans* and qualitative nitroblue tetrazolium test using human neutrophils. The results of this study revealed that the extract has stimulated chemotactic, phagocytic and intracellular killing potency of human neutrophils in dose dependant manner. The study exhibited stimulatory effect of the plant on cell-mediated immune system by increasing neutrophil function.[39]

Anthelmintic Activity

Following the traditional claim, the roots of *B. montanum* were evaluated for their anthelmintic activity against *Pheretima posthuma* and *Ascardia galli* as test worms. Various concentrations (10 – 100 mg/ml) of alcoholic and aqueous extract were tested in the bioassay, which involved determination of time of paralysis and time of death of the worms. Both the extracts exhibited significant anthelmintic activity at highest concentration of 100 mg/ml. Piperazine citrate (10 mg/ml) was included as standard reference and distilled water as control.[40]

Hepatoprotective Activity

In one study, hepatoprotective activity of chloroform, alcohol and aqueous extract of roots of *B. montanum* was evaluated using paracetamol induced liver damage model in albino rats. Hepatotoxicity in rats was induced by paracetamol (2 g/kg, p.o.). All the extracts were administered orally to animals daily for seven days. Silymarin (200 mg/kg) was given as reference standard. The alcohol and aqueous extract treated group of rats showed significant reduction in serum enzyme aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), γ-glutamyl transpeptidase and lipid peroxidase and increase in reduced glutathione (GSH) when compared to paracetamol treated group of rats while chloroform extract

showed moderate hepatoprotective activity as compared to standard group. Histopathological observations also showed significant protection in alcohol and aqueous extract and silymarin treated rats.[41]

Tissue Culture Studies

In vitro micropropagation of *B. montanum* was achieved on Murashige and Skoog's (MS) medium augmented with BAP using nodal segments. Maximum number of shoots (3.4 ± 0.25) were found in MS medium fortified with BAP (3.10 μM). *In vitro* raised shoots were rooted on half strength MS medium augmented with various concentrations and combination of auxins viz. IAA, IBA and NAA. Maximum number of roots were observed on half strength MS medium fortified with IBA (9.84 μM**)** combined with NAA (5.37 μM).[42]

Patents Filed

Subbiah has patented aliquots of extracts from ethnopharmacological plants including *B. montanum*, which have activity against the effects of sarafotoxins present in snake venom (US Patent No.20050008710) and also have ability to induce apoptosis in selected cells (US Patent No. 20050084547).[43,44]

CONCLUSION

In recent years, ethnobotanical and traditional uses of natural compounds, especially of plant origin received much attention as they are well tested for their efficacy and generally believed to be safe for human use. They obviously deserve scrutiny on modern scientific lines such as phytochemical investigation, biological evaluation on experimental animal models, toxicity studies, investigation of molecular mechanism of action (s) of isolated phytoprinciples and their clinical trials. It is a best classical approach in search of new lead molecules for management of various diseases. Thorough screening of literature available on *B. montanum* depicted the fact that it is a popular remedy among the various ethnic groups, Vaidyas, Hakims and Ayurvedic practitioners for cure of variety of ailments. Following the traditional and folk claims, very little efforts have been made by the researchers to explore the therapeutic potential of this plant. It is interesting to note that crude organic and aqueous extracts of only roots of *B. montanum* have been screened for some pharmacological activities and found to possess anticancer, antimicrobial, free radical scavenging, immunomodulatory, hepatoprotective and anthelmintic potential. Till other parts of plant such as seeds, leaves and seed oil which are documented to possess important medicinal virtues, are not explored scientifically for their biological potential. In future study, the isolated principles from Danti needs to be evaluated in scientific manner using specific experimental animal models and clinical trials to understand the molecular mechanism of action, in search of lead molecule from natural resources.

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