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A comprehensive review on *Parnabeeja* [*Bryophyllum pinnatum* (lam.) Oken]

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Abstract

Bryophyllum pinnatum (lam.) Oken is an indigenous and exotic plant used widely by the traditional practitioners for treating various ailments like renal calculi, hypertension, asthma, cold, abscesses, bleeding disorders. The local people of southern India and Bengal use the plant in renal diseases as a source of *Pashanabheda*, which is commonly known as *Parnabeeja*, a member of Crassulaceae. Plant is found naturally throughout the country. It is a succulent herb, leaves are variable and leaflets are elliptic. Flowers are reddish purple. Over the years, studies have been carried out to explore various pharmacological activities like Urolithic, Diuretic, Anti-Diabetic, Wound healing property. Besides, phyto-chemical investigations reveal the presence of Alkaloids, cardiac glycoside, Flavonoids. Keeping in view, the medicinal properties of the plant, an attempt has been made in this review paper to explore various dimensions of the drug including; Ayurvedic aspects, botany, phytochemical and pharmacological studies carried out on this drug.

Keywords: *Bryophyllum pinnatum* (lam.) Oken, *Parnabeeja*, Diuretic, Cardiac glycoside.

1. Introduction

Bryophyllum pinnatum (lam.) Oken plant is an environmental weed from the family Crassulaceae, but commonly used traditionally as a medicine in different regions of India mainly to treat urinary stones, as well as in other parts of world. The traditional practitioners in various parts of world use this plant in numerous conditions like hypertension, skin disorders, asthma, cold, insect stings, abscesses etc. *Bryophyllum pinnatum* (lam.) Oken is commonly known as *Parnabeeja* in Ayurvedic science, it is used as a source plant for *Pashanabheda* [*Berginia ligulata* wall.] in Bengal regions, where the plant is locally known as *Pathar kuchi* which is widely used in urinary stones in place of original source of *Pashanabheda* ^[1, 2] Most of the traditional practitioners in Bengal, Unani and Ayurveda physicians use this plant in conditions like: *Raktasrava* (bleeding disorders), *Ashmari* (renal calculi), *Vrana* (ulcers), *Atisara* (diarrhea) ^[2, 3]. As the plant is known for its ethno-botanical importance, there are also many research works carried out to validate the traditional medicine in different parts of world which have proved many pharmacological activities of the plant known and unknown like Anti-Diabetic activity, Wound healing property, Antilithogenic activity, Hepato-protective activity, Anticancer property etc. The species of these is thought to be poisonous to livestock, as it contains cardiac glycosides ^[4].

2. Synonyms: *Bryophyllum calycinum* Salisb, *Kalanchoe pinnata* (Lam.) Pers, *Cotyledon pinnata* Lam., *Sedum madagascariicum* Clus ^[4].

3. Vernacular names ^[5, 6]

Sanskrit : *Parnabeeja*, *Asthibhaksha*
English : Air plant
Hindi : Zakhmhaiyat, Pathharchoor
Kannada : Gandukalinga, Kadu basale
Malayalam : Elamarunga
Tamil : Malaikalli, Ranakalli
Telugu : Ranapala
Marati : Gayamari
Bengali : Koppatha, Pathar kuchi.

4. Taxonomical classification ^[7]

Kingdom : Plantae – Plants

Sub kingdom : Tracheobionta – Vascular plants

Division : Spermatophyta – seed plants

Subdivision : Magnoliophyta – Flowering plants

Class : Magnoliopsida – Dicotyledons

Subclass : Rosidae

Order : Rosales

Family : Crassulaceae – stonecrop

Genus : *Bryophyllum*

Species : *Bryophyllum pinnatum* (lam.) Oken

The word meaning of *Bryophyllum pinnatum*: Derived from Greek- Bryo means to sprout & phyllon is a leaf i.e. ability to propagate via leaf cutting, *pinnatum* is from Latin feathered, winged.

5. Common names ^[8]

Cathedral bells, curtain plant, floppers, good luck leaf, green mother of millions, leaf of life, Mexican love plant, miracle leaf, resurrection plant, sprouting leaf.

6. Family features

The family Crassulaceae which means the plant of crassula tribe; the leaves are fleshy & succulent ^[9,10].

The family has 25 genera & 450 species.

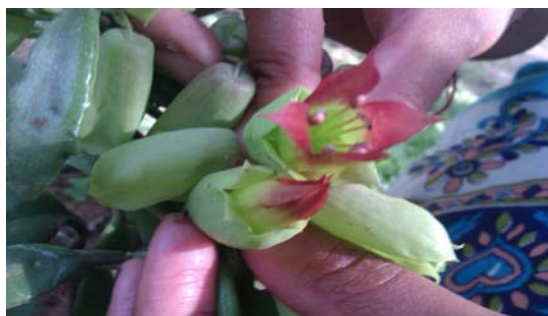
The plants of this family are herbs/ under shrubs. Stem & branches are usually with fleshy & succulent. Leaves are alternate/ opposite, simple less commonly pinnately divided, ex stipulate. Flowers are usually cymose, hermaphrodite/ rarely unisexual & regular. Calyx is free, 4-5 fid/ 4-5 partite. Petals are as many as sepals & alternate to the monopetalous corolla. Carpels are as many as petals & are opposite to them with a hypogynous gland/ scale at the base. Fruits are follicles & membranous with few seeds.

7. Habitat ^[11]

It's a native of Madagascar and southern Africa, Naturalised throughout the tropics of the world.

8. Morphology

Bryophyllum pinnatum is a succulent glabrous herb 0.3-1.2 m high. Stems obtusely four angled, older one are light coloured & younger ones are reddish speckled with white. Leaves are variable & decussate lower are usually simple/ compound, upper ones are 3-5/7 foliolate with long petioled. Petioles are united by a ridge around the stem. Leaflets are ovate/ elliptic with crenate/ serrate margin. Flowers are pendent, in large spreading panicles with opposite stout branches, pedicels slender. Sepals are red striated, green at the base & pale green above. Petals are reddish purple, swollen & octagonal at the base, lobes triangular. Filaments green at the base, pinkish below the anthers. Anthers are hastate, black. Styles green. Fruit are enclosed in a persistent papery calyx & corolla. Seeds are small, oblong-ellipsoid, smooth.



9. Ethno-botanical importance

- In Odisha the plant is identified as Basampatri, its leaves are used in flatulence.
- Thukotali is the local name in poojapura (Kerala), people use crushed leaves externally to apply over the burn wound.
- Similarly in West Bengal & Andhra Pradesh the matured leaves are made warm and are placed over the wounds and tied ^[12].
- In konkan the leaf juice is used in dysentery with ghee.
- Two tea spoon of leaf juice is given in renal calculi ^[13].
- In chota Nagpur the steamed leaf juice is used in cough along with ghee/ garlic. The leaves are treated with palm oil & used externally in sore eyes ^[11].

10. Ayurvedic properties ^[14].

Rasa : Kashaya, Amla

Guna : Laghu

Virya : Sheeta

Vipaka : Madhura

Doshaghata : Vatakaphahara

Karma : Ashmarighna, Vranaropaka, Mootrala, Shonita sthapana, Rakta stambaka, Grahi.

Rogaghata : Ashmari, Atisara, Raktasrava, Visuchika.²

11. Part used : Patra (Leaves) ^[14]

12. Dosage : Leaves powder 2.5-5g ^[14]

13. Pharmacognosy

13.1 Microscopic features of leaf ^[15]

Fragments of upper & lower epidermis in surface view embedded with cyclocytic stomata, where stomata is guarded by three cells forming a griddle around it, the cells of the upper epidermis are bigger in size with slightly wavy anticlinal walls unlike the cells, which is bit more wavy

Transversely cut fragments of lamina showing thick cuticle, over two layered upper epidermis, a hypodermal layer embedded with anthocyanin pigments & a layer of palisade underneath it.

Longitudinal cut fragments of the petiole with prismatic crystals of calcium oxalate embedded in the parenchymatous cells.

Longitudinally cut fragments of spiral vessels from the meristele.

14. Reproduction ^[16]

By seed & plantlets

15. Growth & propagation ^[17]

The leaf sections of were used as explants, the various plant hormones (TDZ, BAP, BAP & NAA) with different concentrations (2.5, 5.0, 10.0, 15.0, 20.0 μ M) were used. TDZ 10 μ M gave better results for shoot proliferation and elongation in both varieties. The regeneration frequency and number of shoots per explants were also enhanced on these concentrations. Only shoots were produced from leaf sections in lower concentrations of BAP (1 μ M). The best survival rate was 91% in 75% sand with 25% coco peat for *B. pinnatum*.

16. Phyto-chemical constituents

Bryophyllum pinnatum contains Alkaloids, Saponins, Flavonoids and Tannins ^[18]

The active principle through NMR and HPTLC our study revealed that one of the cardiac glycoside that converge in fraction F4 could be bryophyllin-A. However, the study showed presence of high levels of alkaloid that also converge to fraction F4 ^[19].

B. pinnatum contains two flavonoids i.e. 5¹ Methyl 4¹, 5, 7 trihydroxyl flavone) and (4¹, 3, 5, 7 tetrahydroxy 5-methyl 5¹-propanamine anthocyanidines) ^[20]

Nutritive values

The dried & fresh leaves of *B. pinnatum* when subjected to proximity composition revealed that carbohydrate values were the highest and ash had the least values in both samples & the mineral contents showed that calcium & potassium levels were the highest while lead and Zinc levels were shown to be the least in both fresh & dried samples ^[21, 22]

17. Pharmacological activities**17.1 Antimicrobial activity**

The study revealed that *B. pinnatum* leaves extracts (Aqueous, methanol, Palm-wine, Omidun, local gin & fresh leaf juice) with the dilutions 256, 128, 64, 32, 16, 8, 4 mg/ml have varied antibacterial activities against the tested Gram positive & Gram negative organisms. Among them methanol extract showed marked antibacterial activities against Control strain of *Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus subtilis* and *Pseudomonas aeruginosa* with the control antibiotic (Ciprofloxacin). Even the extract from the squeezed leaves of *Bryophyllum pinnatum* showed significant effect on some of the Gram positive and Gram-negative organisms. Other extracts showed moderate to weak activity against tested organisms ^[23].

The other *in-vitro* study revealed the presence of antibacterial activity of two isolated flavonoidal compounds. Compound 1(5¹ Methyl 4¹, 5, 7 trihydroxyl flavone) and compound 2(4¹, 3, 5, 7 tetrahydroxy 5-methyl 5¹-propanamine anthocyanidines) from leaf of *B. pinnatum* with thew dilution of 100mg/ml in both bacteria (three gram-negative organism comprising *Escherichia coli*, *Pseudomonas aeruginosa* and *Klebsiella pneumonia* and a gram positive *Staphylococcus aureus*) & in fungi (*Candida albicans* and *Aspergillus Niger*). The compounds successfully inhibited *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Klebsiella pneumonia*, *Aspergillus niger* and *Candida albicans*. However compound 1 could not inhibit *Escherichia coli* ^[24].

17.2 Anticancer property

The *in vitro* study of *B. pinnatum* leaves crude extracts & its specific chromatographic fractions revealed the presence of

growth inhibitory activity in the human cervical cancer cells. The leaf extract & its fraction F4 (Petroleum Ether: Ethyl Acetate: 50:50) have a dose dependent cytotoxic activity, similarly the inhibition of viral transcription of HPV18 was lesser in cells treated with fraction F4 which indicate higher concentration of active principles ^[19]

17.3 Anti hypertensive activity

The study has shown the presence of Anti hypertensive activity of *B. pinnatum* aqueous & methanolic leaf extracts (50-800mg/kg i.v. or i.p.) on arterial blood pressure & heart rates of normotensive & spontaneously hypertensive rats. The hypotensive effect was more pronounced in the hypertensive than in normotensive rats. Even the leaf extracts (0.25-5.0 mg/ml) also produced dose-dependent decrease in the rate & force of contractions of guinea-pig isolated atria ^[25].

17.4 Anti- Diabetic activity

The study revealed the presence of anti-diabetic activity of *B. pinnatum* aqueous leaf extract in four different doses (200, 400, 800mg/kg and 800mg/kg + glibenclamide 2mg/kg) in diabetic induced rats (Glucose D- 3g/kg). The 200mg/kg aqueous extract resulted significant decrease in the blood sugar level when compared with the other dose. But the mixture of 800mg/kg aqueous extract + glibenclamide 2mg/kg showed more effective & efficient than the use of 200mg/kg and the other single doses ^[26]

17.5 Wound healing property

The study revealed the presence of wound healing action of *B. pinnatum* leaf extracts (petroleum ether, water & alcohol) in the dose of each 400mg/ kg orally on healing of excision wound, re-sutured incision and dead space wound models in Albino rats for 10 consecutive days. And water extract was topically applied for excision wound model for 21 days till the formation of eschar. All the three extracts i.e. petroleum ether, alcohol and water showed significant increase in the breaking strength of incision wound when compared to control group. Granuloma breaking strength and hydroxyproline content of granulation tissue in dead space wound model was significantly increased when compared to control group. Water extract showed significant increase in wound contraction and formation of scars on 17th post wounding day in excision wound model. Even topical application of water extract hastened the healing process in excision wound model ^[27]

17.6 Antilithogenic activity

The clinical study revealed the presence of antilithogenic activity of fresh leaf juice of *B. pinnatum* in the 23 clinically diagnosed patients of lithiasis with the stone size ranging between (>5mm to <10mm diameter) were treated with the dose of 10ml/day for 30 days orally, early morning in void stomach. During the study twenty patients passed stones & three had a size reduction. Effective improvement was observed in 87% patients & remaining 13% patients also showed moderate improvement. And also there was decreased urinary oxalate & phosphate and increased citrate excretion which was favourable ^[28]

17.7 Hepato-protective activity

The study revealed the presence of hepatoprotective activity of leaves of *B. pinnatum* aqueous and ethanolic extract in the doses of 250 and 500 mg/ kg orally in N-diethylnitrosamine (DEN) induced hepatic injury in rats. At 500 mg/ kg dose of ethanolic extract of *B. pinnatum* slightly protect the liver. Aqueous extract of both the dose (250 and 500 mg/ kg) have

shown significant liver protection against DENA induced liver toxicity [29].

17.8 Anti-inflammatory activity

The study revealed the presence of Anti-inflammatory activity of leaf extracts of *B. pinnatum* (pet-ether, chloroform, acetone, methanol, aqueous, alkaloidal fraction, flavonoids fraction, phenol and phenolic acid, alkaloidal anhydride) in the doses of 500mg/kg each orally once a day for a period of two days in Formaldehyde-induced hind paw edema in rats. Methanolic fraction showed also more or less significant inhibition of formaldehyde induced edema in early phases while significant inhibition at later phases when compared to the standard drug Indomethacin [30].

17.9 Cytotoxicity of testis

The study revealed the cytotoxic effect of ethanolic extract of leaf of *B. pinnatum* on cells of rat's testis in two different doses (100 mg/kg & 200 mg/kg) orally for a period of 8 weeks. At the dose of 100 mg/kg the seminiferous tubules were shrunken and intracellular spaces were seen within the epithelium & higher dose (200 mg/kg) showed marked increase in intracellular spaces within the germinal epithelium and reduction of spermatozoa when compared with the control group which showed intact normal histological features of the testes [31].

17.10 Uterine Contractility

The *In-vitro* study of tocolytic effect of *B. pinnatum* versus fenoterol in human myometrium, were the contractility was measured in strips of term myometrium biopsied at caesarean section in 14 women and exposed to increasing concentrations of *B. pinnatum* versus +/- oxytocin 1 U/l. Result state inhibition of spontaneous contraction was concentration dependent. *B. pinnatum* increased contraction frequency by 91% at constant amplitude and inhibited oxytocin stimulated contractions by 20% at constant amplitude with slightly decreased frequency. Fenoterol decreased contraction by 50% with a significant decrease in frequency [32].

An *In-vitro* study of tolerability and tocolytic effect was carried out in 67 pairs of pregnant women in preterm labour treated with intravenous *B. pinnatum* plant extract or beta-agonists were closely matched for maternal age, gestational age at tocolysis, Cardiotocography recorded contractions, cervical effacement, preterm premature rupture of the membranes, and history of preterm labour. Endpoints were prolongation of pregnancy, gestational age at delivery, pre- and postpartum duration of hospitalization, maternal tolerability, neonatal outcome and morbidity. Results obtained was Pregnant women with *B. pinnatum* and beta agonists were equal in the prolongation of pregnancy, the gestational age at delivery and the duration of hospitalisations, but had less adverse effects ($P = 0.02$). The neonatal outcome and morbidity in the *B. pinnatum* group were equal or better (oxygen use 10.4 versus 44.8%, $P < 0.001$; respiratory distress syndrome 4.5 versus 19.4%, $P = 0.01$). *B. pinnatum* is no less effective than beta-agonists, but is significantly better tolerated in the management of preterm labour [33].

17.11 Immunosuppressive effect

The fatty acids present in *B. pinnatum* may be responsible for its immunosuppressive effect *In-vivo*. [Rossi Bergmann *et al.*] showed the aqueous extract of leaves cause significant inhibition of cell-mediated and humoral immune responses in mice. The spleen cells of animals pre-treated with plant extract showed a decreased ability to proliferate in response to both

mutagen and antigen *In-vitro*. Treatment with extract also impaired the ability of mice to mount a delayed type hypersensitivity reaction (DTH) to ovalbumin. The *In-vitro* and topical routes of administration were the most effective by almost completely abolishing the DTH reaction. The intraperitoneal and oral routes reduced the reaction by 73% and 47% of controls, respectively. The specific antibody responses to ovalbumin were also significantly reduced by treatment. Thus the aqueous extract of leaves possesses immunosuppressive activities. [Almeida *et al.*] in an investigation also found that leaf extracts inhibited *In-vitro* lymphocyte proliferation and showed *In-vivo* immunosuppressive activity. An attempt to identify the immunosuppressive substances present in *B. pinnatum* guided by the lymphoproliferative assays. From the ethanolic extract a purified fraction (KPI2SA) found twenty-fold more potent to block murine lymphocyte proliferation than the crude extract. Thus provides evidence that saturated fatty acids present in herb plays an important role on lymphocyte proliferation, which explains its immunosuppressive effect *In-vivo* [34].

17.12 Protein profiling

Phosphate extraction buffer (pH) was used to extract proteins from the leaves of *Bryophyllum pinnatum*. On sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) separation, the results showed that, Bands on the gel was then excised and digested with trypsin and subjected to liquid chromatography tandem mass spectrometry (LC/MS/MS) for protein identification. Proteinase K has been identified from the MS/MS data. The protein identified was Proteinase K, which is used commercially in digesting of unwanted proteins liked keratin [35].

17.13 Neuropharmacological activity

Effects of aqueous leaf extracts of *B. pinnatum* on some neuropharmacological activities were studied in mice. The extract in dosages (50,100 and 200 mg/kg) was found to produce a profound decrease in exploratory activity in a dose-dependent manner. It also showed a marked sedative effect as evidenced by a significant reduction in gross behaviour and potentiation of pentobarbitone-induced sleeping time. It delayed onset in strychnine-and picrotoxin-induced convulsion (seizures) respectively with the protective effect being significantly higher in picrotoxin- than strychnine-induced convulsion. It also decreases the rate of picrotoxin-induced mortality in mice with LD50 of 641mg/kg. Totality all these effects showed that the extract possesses depressant action on the central nervous system [36]



18. Conclusion

B. pinnatum is a well-known herb, used worldwide. Studies have confirmed the ethanobotanical use of *B. Pinnatum* and supported the therapeutic utility of the plant in various disorders mainly in diseases of the urinary system without adverse side effects. So far the studies were performed *In-vivo*

and *In-vitro*. However, these results should be further evaluated for their isolated principles on the toxicity of plant especially on bufadienolides and its use during pregnancy and also to understand the mechanism of action. Further, there is an area for clinical trials of revalidating the studies elicited through various animal models. Hence, this paper provides critical review on the recent advancements of the drug to authenticate its use as a multipurpose medicinal plant.



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