

Comprehensive Review On Ethnobotany, Phytochemistry And Pharmacological Potential Of *Bryophyllum* *Pinnata*

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Abstract : *Bryophyllum pinnatum* (Lam.), commonly known as the “Life Plant” or “Miracle Leaf,” is a perennial succulent herb belonging to the family Crassulaceae. It has been widely used in traditional systems of medicine such as Ayurveda, Unani, and folk remedies for the treatment of various ailments including wounds, inflammation, diabetes, hypertension, and kidney stones. Phytochemical investigations reveal that the plant is rich in flavonoids, alkaloids, bufadienolides, glycosides, tannins, and phenolic compounds, which contribute to its broad pharmacological activities. Experimental and clinical studies have reported anti-inflammatory, antimicrobial, antidiabetic, antioxidant, anticancer, nephroprotective, and CNS-modulating effects, validating many of its ethnomedicinal uses. However, the presence of bufadienolides necessitates careful toxicity and dose standardization. Future prospects lie in the development of standardized herbal formulations, exploration of novel bioactive compounds, and execution of large-scale clinical trials to establish its safety and therapeutic efficacy. In conclusion, *bryophyllum pinnate* represents a valuable medicinal resource with significant potential for phytopharmaceutical and nutraceutical development.

INTRODUCTION

Medicinal plants have been used since ancient times as a major source of therapeutic agents and continue to play an essential role in modern healthcare systems. Among these, *Bryophyllum pinnatum* (Lam.) Oken, belonging to the family Crassulaceae, is one of the most valuable medicinal plants used in various traditional systems of medicine such as Ayurveda, Unani, and folk practices [1]. It is commonly known as Patharchatta, Life Plant, or Air Plant, due to its remarkable regenerative property where new plantlets grow from the margins of its leaves [2].

Traditionally, *B. pinnatum* has been employed in the treatment of wounds, burns, insect bites, kidney stones, asthma, hypertension, and inflammatory disorders [3]. The plant is also used as a remedy for ulcers, diarrhea, and urinary infections, demonstrating its broad ethnobotanical applications [4].

Phytochemical investigations have shown that *Bryophyllum pinnatum* is rich in flavonoids, glycosides, alkaloids, steroids, triterpenoids, and bufadienolides, which contribute to its pharmacological effects [1,5]. Various experimental and pharmacological studies have confirmed its anti-inflammatory, antimicrobial, antidiabetic, anticancer, antihypertensive, hepatoprotective, nephroprotective, and wound-healing activities (2,3,5). Due to its wide traditional use, diverse phytochemical composition, and proven pharmacological activities, *Bryophyllum pinnatum* has emerged as a promising medicinal plant with great potential in the field of drug discovery and herbal medicine research [1,2].

BOTANICAL DESCRIPTION :

The Crassulaceae family includes about 33 genera and 1500 species found worldwide, except in Australia and the Pacific Islands. These plants have xeromorphic adaptations that help them survive in bright light and dry environments. They are important in studies of biochemistry, ecophysiology, and Crassulacean Acid Metabolism (CAM), a unique photosynthetic adaptation. [6]

Bryophyllum pinnatum (Lam.) Kurz., a member of this family, is a medicinal herb widely used in traditional medicine. The name originates from Greek, where *bryo* means “to sprout” and *phyllon* means “leaf,” reflecting its regenerative property.

Scientific name: *bryophyllum pinnatum*, *kalanchoes*.

Family: *crassulaceae*

Common names: life plant, miracle leaf, patharchatta, panphuti plant

Biological source: *Bryophyllum pinnatum* (syn. *Kalanchoe pinnata*) is a succulent perennial plant native to Madagascar that was introduced in anthroposopic medicine in the early 20th century.

Commonly found in india, africa, and madagascar geographical source: grows in tropical and subtropical regions america and china.
Plant type: it is a succulent herb (a plant with thick, fleshy leaves that store water).
Leaves: fleshy, green, and shiny with red-tinted edges. The margins of the leaves have small buds (plantlets) that can grow into new plants.
Flowers: small, tubular, and greenish-red.
Plant description : The herb is a about 0.3-1.2m.in height. It comprises of the various parts.
Reproduction: mostly vegetative regenerative properties- meaning new plants grow from margin of leaves.

ETHNOBOTANICAL SIGNIFICANCE :

“Ethnobotanical significance” means how people from different cultures and traditions use this plant for healing. In ayurvedic medicine, it is known as panfuti and used to treat: wounds and cuts(for quick healing) urinary disorders, kidney stones, cough & cold, asthma and ulcers.

Ayurveda: In Indian traditional medicine, the leaves are used for the treatment of renal calculi (patharchatta), wounds, dysentery, cough, fever, and skin diseases. The fresh leaf juice is administered orally for its antidiabetic, antihypertensive, and diuretic effects [7].

Folk medicine: Leaf paste is applied externally for wounds, boils, insect bites, and burns due to its cooling and healing properties. In rural communities, the leaf juice is consumed for jaundice, asthma, and digestive disorders [8].

Unani system: The plant is recommended as a blood purifier, tonic, and anti-inflammatory agent. Decoction of leaves is used in urinary disorders and gastric ulcerations [9].

African traditional medicine: Widely used for the management of epilepsy, convulsions, infections, and inflammation. In Nigeria, the leaves are applied for earaches, abscesses, and chest complaints [10].

Other ethnomedicinal uses: Reported as effective in toothache, rheumatism, hypertension, menstrual disorders, and hepatic conditions. The plant is also regarded as sacred in some cultures and used in rituals for protection [11].

PHYTOCHEMICAL CONSTITUTE :

1. Flavonoids

Quercetin, Kaempferol, Luteolin, Apigenin

Responsible for antioxidant, anti-inflammatory, and antimicrobial effect .the ability of flavonoids to lower oxidative stress – which may contribute to the development of kidney stone has been investigation . flavonoids have been identified , showcasing a rich chemical composition that includes derivatives of kaempferol and quercetin ,as well as flavone glycosides such as acacetin , diosmetin glycoside, ans liteolin.

2. Glycosides & Bufadienolides :

Bryophyllin A, Bryophyllin C, Bersaldegenin derivatives

Exhibit cytotoxic, anticancer, and cardiotonic properties [12].

3. Alkaloids :

Contribute to analgesic and antimicrobial activities.certain alkaloids have the ability to diuretic, which can help in the excretion of certain kidney stones . however , bryophyllum pinnatum particular alkaloids and their kidney stones.

4. Triterpenoids&Steroids :

α -Amyrin, β -Amyrin, Oleanolic acid, Sitosterol . triterpenoids have been investigated for their diuretic and anti- inflammatory properties , which may have an impact on kidney stone treatment.

5. Betalains :

Some varieties of bryophyllum pinnatum contain betalains, which are pigment with potential antioxidant properties.

6. Phenolic Compounds&Tannins :

Contribute to antioxidant, antimicrobial, and wound-healing properties.

7. Bufadienolides :

thirteen bufadienolides have been reported in bryophyllum pinnatum ,and among them ,three are glycosides. Glycosides are compounds that contain a sugar molecule. These bufadienolides exhibit various bioactivities , notably cytotoxic and insecticidal properties. Cytotoxicity refers to the ability to kill or inhibit the growth of certain cells ,while insecticidal properties suggest toxicity to insect.Several bufadienolides, including bersaldegenin-1-acetate, bersaldegenin-1,3 , 5-orthoacetate, bryotoxin C , glycosides bryophyllins A , Have been reported only in kalanchoe pinnata, suggesting that these bufadienolides are specific to this particular species.

8. Other Constituents

Organic acids, lipids, polysaccharides, and amino acids have also been reported. adienolides (cardiac glycosides) in the plant, which in high doses may lead to toxicity. Communities often use dosages based on traditional knowledge to avoid harmful effects. [12]

PHARMACOLOGICAL ACTIVITIES :

1. Anti-inflammatory and Analgesic Effects :

B. pinnatum has demonstrated significant anti-inflammatory and analgesic properties. In studies, the plant's extracts inhibited cyclooxygenase enzymes and reduced tissue necrosis factor levels, decreasing inflammation and pain. This suggests its potential in managing arthritis and other inflammatory disorders [13,14].

2. Antidiabetic Activity :

The plant exhibits antidiabetic effects by lowering blood glucose levels. This action is attributed to bioactive compounds such as flavonoids and alkaloids, which enhance insulin sensitivity and glucose metabolism. These findings support its traditional use in diabetes management [13,15].

3. Antimicrobial Properties :

B. pinnatum shows antimicrobial activity against bacteria and fungi. Its extracts disrupt microbial cell membranes, inhibiting growth and proliferation, supporting its use in treating infections [14,15].

4. Anticonvulsant Effects :

Ethanol extracts of *B. pinnatum* have demonstrated anticonvulsant properties in animal models, increasing the duration of tonic extension and recovery time in seizure models, suggesting potential benefits in managing epilepsy [14].

5. Neuropharmacological Activity :

The plant exhibits neuropharmacological effects, including CNS depressant activity. Methanol fractions of *B. pinnatum* leaf extract potentiated pentobarbitone sleeping time, indicating potential use in managing anxiety and sleep disorders. [14,16]

6. Anticancer Potential :

Extracts of *B. pinnatum* inhibit cancer cell proliferation and induce apoptosis, suggesting potential as a chemopreventive agent [14,16].

7. Anti-urolithiasis and Diuretic Activity :

Traditionally used for kidney stones ("Patharchatta"), extracts reduce calcium oxalate crystal formation and promote diuresis in animal models. This validates its use as a kidney-protective herb

8. Antiallergy Effects :

B. pinnatum has been found to reduce allergic responses by inhibiting mast cell degranulation and histamine release. These antiallergic properties make it a candidate for managing allergic conditions such as rhinitis and asthma. [14]

9. Wound Healing and Hemostatic Properties :

The plant is known for its wound-healing and hemostatic properties. Topical application of *B. pinnatum* leaf extracts has been shown to promote skin wound healing by increasing vascular endothelial growth factor (VEGF) expression, facilitating tissue regeneration. [15]

10. Kidney stone :

The mineral and others components that contribute to kidney stone development may be cleared out with increased urine output . since inflammation can be a significant role in kidney stones, the plant anti inflammatory qualities may help reduce kidney stone ,may have the ability to relax smooth muscle which may helps stones flow through ureter.

TOXICOLOGICAL PROFILE :

While *Bryophyllum pinnatum* (Patharchatta) has many pharmacological benefits, it also contains bufadienolides (cardiac glycoside-like compounds), flavonoids, and alkaloids. These compounds, if consumed in large doses, can cause toxic effects. Therefore, evaluating its toxicological profile is important for safe medicinal use.

1. Acute Toxicity Studies :

Rodent studies: Ethanolic and aqueous extracts of *B. pinnatum* leaves were found to be non-toxic up to 2000 mg/kg (oral) in rats, as per OECD guidelines. No signs of acute toxicity (mortality, behavioral changes, convulsions) were observed at therapeutic doses.[17]

2. Sub-acute and Chronic Toxicity :

Repeated administration of methanolic extract (up to 400 mg/kg for 28 days) did not produce significant alterations in hematological or biochemical parameters.

At higher doses, mild hepatotoxic changes (elevated liver enzymes) were reported in some studies.[20]

3. Cardiotoxicity Risk (Bufadienolides):

The plant contains bufadienolides, which are structurally similar to cardiac glycosides (like digoxin).

These can interfere with the Na^+/K^+ -ATPase pump, potentially leading to arrhythmias, bradycardia, or cardiac toxicity in case of overdose or prolonged use.

Cases of livestock poisoning (cattle, sheep) after grazing on *Bryophyllum* species have been documented.[19]

4. Reproductive and Developmental Toxicity :

Animal studies suggest no significant teratogenic effects at therapeutic doses.

However, due to presence of bufadienolides, traditional medicine advises avoiding use during pregnancy, as high doses may induce uterine contractions.[21]

5. Cytotoxicity and Safety Window :

Some isolated compounds show cytotoxic activity against cancer cells, but this may also reflect potential toxicity at higher doses.

The therapeutic window is narrow for bufadienolide-containing extracts.

Summary of Toxicological Profile

Safe at therapeutic doses: Acute and subacute studies show extracts are safe up to 2000 mg/kg (oral).

Risk at high doses/prolonged use: Cardiotoxicity possible due to bufadienolides.

Liver concerns: Very high doses may affect liver enzymes.

Pregnancy caution: Avoided during pregnancy due to possible uterine stimulant effect.

Overall: Considered relatively safe for traditional use in controlled doses, but long-term clinical safety studies are still lacking.[18]

CURRENT RESEARCH STATUS :

Comprehensive reviews (2023–2025) — Several recent reviews consolidate ethnobotany, phytochemistry (flavonoids, bufadienolides, glycosides, phenolics) the broad pharmacology (anti-inflammatory, antimicrobial, antidiabetic, hepatoprotective, wound-healing, anticancer). Good entry points: a 2024 open review and an updated 2024–2025 review on PubMed Central.

2. Antimicrobial activity & MDR bacteria — Multiple 2023–2024 experimental papers report antibacterial and antifungal activity of leaf extracts (ethanol/methanol) against Gram-positive and Gram-negative strains including some multidrug-resistant isolates. These studies support traditional use for infections and urinary isolates.

3. Green synthesis — metal nanoparticles with enhanced bioactivity (2023–2024) — Researchers used *B. pinnatum* extracts to produce silver (Ag) and zinc-oxide (ZnO) nanoparticles. These biogenic nanoparticles showed stronger antimicrobial and bioactive properties than crude extracts in in-vitro assays. (Notable: Sci. Rep. / Nature family article summarizing enhanced activity.)

4. Wound-healing formulations (2024) — Formulations (e.g., ethanolic extract loaded into ointments) produced faster wound contraction and improved healing in animal models; phytochemicals (flavonoids, tannins) are suggested active components.

5. Anticancer / cytotoxic mechanisms (preclinical, 2023–2025) — Several in-vitro studies report growth inhibition and apoptosis induction in lines (cervical, colorectal, fibrosarcoma). More recent mechanistic work (2024–2025) suggests p53-dependent apoptosis pathways colorectal cells and HPV-targeting activity in cervical cancer cell models — promising but preclinical.

6. Clinical & translational applications — urology / overactive bladder / nocturia (2012–2023) — Randomized clinical trials and controlled studies have investigated standardized *B. pinnatum* preparations (tablets/extracts) for overactive bladder and nocturia;

some trials reported symptom improvements and good tolerability. There are also clinical trial registrations investigating anxiety and other indications (see clinicaltrials.gov entries).

7. Obstetrics application — preterm labour trials (2018) — Two randomized trials assessed *B.pinnatum* in preterm labour ; these trials were discontinued early and result Are limited evidence is therefore inconclusive and not practice – changing .use in Pregnancy requires caution.

FUTURE PROSPECTS :

2. Women's Health (Dysmenorrhea, Uterine Relaxation) :

Recent clinical observations suggest *B. pinnatum* extracts are effective in dysmenorrhea due to smooth muscle relaxant and anti-inflammatory properties. This could be developed into a herbal alternative for menstrual pain relief.

3. Sleep Disorders and Stress Management :

Observational studies in cancer patients found improvement in sleep quality after *B. pinnatum* therapy.
Future use: herbal sleep aid or adjunct in oncology care for insomnia and stress.

4. Antidiabetic Potential :

Zinc-loaded extracts and flavonoid-rich fractions showed hypoglycemic effects in experimental models.
Possible future role as adjunct therapy for type-2 diabetes.

5. Anticancer and Antiviral (Anti-HPV) Potential :

Extracts demonstrated cytotoxic activity against cervical cancer cells and inhibition of HPV.
Bufadienolides may serve as lead compounds for anticancer drug discovery

6. Renal Disorders and Urolithiasis :

Preclinical studies suggest effectiveness in preventing kidney stone formation and protecting renal tissues.
Future application: herbal nephroprotective formulations.

7. Antimicrobial and Immunomodulatory Use :

Extracts show activity against bacteria, fungi, and protozoa.
May be developed into herbal antimicrobials or immune-supportive formulations.

CONCLUSION

Bryophyllum pinnatum is a medicinally important plant with a long history of use in traditional systems of medicine, and modern research has validated many of its ethnomedicinal claims. Its rich phytochemical profile, especially bufadienolides, flavonoids, and triterpenes, contributes to a wide spectrum of pharmacological activities including anti-inflammatory, antidiabetic, anticancer, nephroprotective, antimicrobial, and CNS-related effects. Recent preclinical and limited clinical studies have provided encouraging evidence of its potential use in women's health (dysmenorrhea, uterine relaxation), sleep disorders, kidney stone prevention, and oncology support care.

Despite these promising results, its future therapeutic applications depend largely on overcoming certain challenges:

REFERENCE

- 1.Sharma A, Shukla S. *Bryophyllum pinnatum* (Lam.) Oken: Ethnobotany, phytochemistry and pharmacological profile – A comprehensive review. *Journal of Ethnopharmacology*. 2022; 292:115242
2. Akinmoladun FO, Komolafe TR. Medicinal significance and therapeutic potential of *Bryophyllum pinnatum*: A review. *Heliyon*. 2021;7(4):e06810.
3. Nayak BS, Marshall JR, Isitor G. Wound healing potential of ethanolic extract of *Kalanchoe pinnata* Lam. leaf—A preliminary study. *Indian J Exp Biol*. 2010;48(6):572-576.
4. Singh A, Singh PK. *Bryophyllum pinnatum* (Lam.) Oken: A review. *International Journal of Research in Pharmaceutical and Biomedical Sciences*. 2012;3(1):334-341.

5. Patel DK, Patel K, Dhanabal SP. Phytochemical standardization and biological activities of *Bryophyllum pinnatum*. *Journal of Pharmacognosy and Phytochemistry*. 2014;3(6):18-23
6. Ramesh D. Ingole, Avinash B. Thalkari, Pawan N. Karwa, Krushna K. Zambare, Pallavi S. Shinde. *Bryophyllum pinnatum*: A Magical Herb. *Res. J. Pharmacognosy and Phytochem*. 2020; 12(3):162-167. doi: 10.5958/0975-4385.2020.00027.8
7. Yadav NP, Dixit VK. Recent approaches in herbal drug standardization. *Int J Integr Biol*. 2008;2(3):195–203.
8. Morton JF. *Kalanchoe pinnata* (Lam.) Pers. In: *Atlas of Medicinal Plants of Middle America*. Springfield: Charles C. Thomas Publisher; 1981. p. 482–485.
9. Nadkarni KM. *Indian Materia Medica*. Vol. 1. Bombay: Popular Prakashan; 2002. p. 759–761.
10. Akinmoladun FO, Komolafe TR, Farombi EO. Medicinal potential of *Bryophyllum pinnatum* (Lam.) Oken: phytochemistry, pharmacological activities and prospects. *Afr J Tradit Complement Altern Med*. 2020;17(4):45–58.
11. Ojewole JA. Antinociceptive, anti-inflammatory and antidiabetic properties of *Bryophyllum pinnatum* leaf extract. *J Ethnopharmacol*. 2005;99(1):13–19.
12. Dhumane S, Naik T, Shelke M, Dukare K, Dhongade K, Exploring the Therapeutic Potential: Phytochemistry and Pharmacology of *Bryophyllum pinnatum*, *Journal of Drug Delivery and Therapeutics*. 2024; 14(2):171-17
13. Chaithra, S., et al. (2020). A Review On Pharmacological Activities of *Bryophyllum Pinnatum*. *American Journal of PharmHealth Research*, 8(2). Link
14. Selvakumar, P., et al. (2022). Phytochemical and Pharmacological Profile Review of *Bryophyllum Pinnatum*. *Biomedical and Biotechnology Research Journal*, 6(3), 295-301. Link
15. Araújo, E. R. D., et al. (2023). Gel Formulated with *Bryophyllum Pinnatum* Leaf Extract Promotes Skin Wound Healing In Vivo by Increasing VEGF Expression. Link
16. Mule, P., et al. (2020). A Review on *Bryophyllum Pinnatum* (Lam.) Oken. *Research Journal of Pharmacognosy and Phytochemistry*, 12(2), 111-113. Link
17. Singh V, et al. *Bryophyllum pinnatum* (Lam.) Oken: Unravelling therapeutic activities. *Pharmacogn Rev*. 2024.
18. Verma R, et al. Pharmacological activity of *Bryophyllum pinnatum*. *Int J Pharm Res Appl*. 2024.
19. Patel H, et al. Exploring pharmacological activities of *Kalanchoe pinnata*. *Int J Pharm Sci*. 2024
20. Khan A, et al. Comprehensive medicinal review of *Bryophyllum pinnatum*. *Int J Novel Res Dev*. 2024..
21. Gupta A, et al. Immunomodulatory effects of *Bryophyllum pinnatum*: A review. *J Ethnopharmacol*. 2024.