



**INTERNATIONAL JOURNAL OF
PHARMACEUTICAL SCIENCES**
[ISSN: 0975-4725; CODEN(USA): IJPS00]
Journal Homepage: <https://www.ijpsjournal.com>



Review Paper

The Antimicrobial Potential of Bryophyllum Pinnatum Gel

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ARTICLE INFO

Published: 27 Feb. 2025

Keywords:

Bryophyllum pinnatum;
Bufadenolides; Herbal gel;
Antimicrobial activity

DOI:

10.5281/zenodo.14934905

ABSTRACT

Bryophyllum pinnatum, a succulent plant with traditional medicinal uses, has been investigated for its antimicrobial properties. Bryophyllum pinnatum gel exhibits antimicrobial properties against a range of microorganisms, including bacteria, fungi, and viruses. This review highlights its potential health benefits, such as accelerating wound healing by reducing infection risk, inhibiting acne-causing bacteria, and potentially alleviating inflammatory skin conditions. Furthermore, it may stimulate the immune response, contributing to overall health. Traditional medicine has explored its potential use in addressing various ailments, including kidney stones, inflammatory bowel diseases and some other action like antimicrobial agent in wound healing process. These properties, coupled with its natural benefits, offer a promising avenue for developing novel natural antimicrobial agents. The gel's antimicrobial activity is attributed to the presence of various bioactive compounds, including bufadienolides, flavonoids, and organic acids, which have been shown to inhibit microbial growth and disrupt their cellular processes. However, further research is imperative to fully understand its mechanisms of action and establish safe and effective dosage guidelines for human use, particularly regarding its potential role in treating various diseases.

INTRODUCTION

The plant Bryophyllum pinnatum, also called kalanchoe pinnata or the magical plant, is a member of the Crassulaceae family. The herb has been utilized in traditional medicine for ages and is also well-known for its therapeutic qualities. According to earlier research, B. pinnatum contains a variety of bioactive substances, such as organic acids, terpenoids, and flavonoids [1].

Numerous pharmacological effects, such as antibacterial, anti-inflammatory, and antioxidant qualities, wound healing, and anti-hypertensive activity, have been linked to these substances [14]. B. pinnatum has been studied for its possible antibacterial properties due to its historical medical applications and the presence of bioactive chemicals [4]. Nevertheless, there hasn't been much progress in creating a topical gel formulation

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Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.



for real-world use. Non-steroidal anti-inflammatory medications, or opioids, are commonly used to treat inflammation of many kinds, but they have serious side effects include itching and burning. Therefore, it appears that a search for more advantageous options is required. The purpose of this work was to create a gel with leaf extract from *B. pinnatum* and assess its antibacterial efficacy against a variety of harmful microbes. The goal was to investigate this natural product's potential as a viable supplement or substitute for traditional antimicrobial therapies. The World Health Organization (WHO) is increasingly favoring natural antibacterial gels over their synthetic equivalents because of a number of important benefits, including as fewer side effects, increased antimicrobial action, sustainability, and better patient compliance. [3] The WHO actively supports the study and development of natural products because it acknowledges their potential to solve global health issues, especially the emergence of resistance to drugs like antibiotics.

1.1 Introduction of Gel: -

Gels are colloidal systems characterized by a three-dimensional network of cross-linked macromolecules or particles dispersed within a

continuous liquid phase. This network imparts unique properties to gels, such as a semi-solid consistency, the ability to swell in response to solvents, and the capacity to retain significant amounts of liquid. [29] Due to these properties, gels have emerged as promising platforms in various fields, particularly in drug delivery. [6,30]

1.2. Ideal properties of Gel:

A transparent, uniform, inert, non-stick, and stable gel formulation is preferable. Additionally, it must to keep its viscosity [29]

1.3. Perfect Features of Gel:

- **pH:** The gel should have an isotonic pH; otherwise, it would irritate the skin.
- **Swelling:** The gel's ability to swell is dependent on the gelling agent, which exhibits strength in binding the gel's particles.
- **Structure:** The gelling agent causes stiffness and is also in charge of particle bonding and viscosity.
- **Spread ability:** A high spread ability power is required of the gel composition.
- **Syneresis:** The gel formulation should be free of syneresis or refrain from releasing water. [29, 30].

1.4. Classification of Gel: -

Table1. Classification of Gel

On the Basis	Types	Example
1. Based on Composition	i. Hydrogels. ii. Organogels. iii. Xerogels.	Contact lenses, wound dressing Pharmaceutical formulations. Silica gel desiccant
2. Based on Structure	i. Physical gel. ii. Chemical gel.	Gelatin dessert. Polyvinyl chloride, polyvinyl alcohol.
3. Based on Properties:	i. Elastomers. ii. Viscoelastic Gels. iii. Thermoresponsive Gels.	Rubber bands Toothpaste. NDDS, TDDS.
4. Other Classifications:	i. Natural Gels. ii. Synthetic gels.	Agar, Gelatine Polyacrylamide gels.

2. Anatomy and Physiology of Skin: -

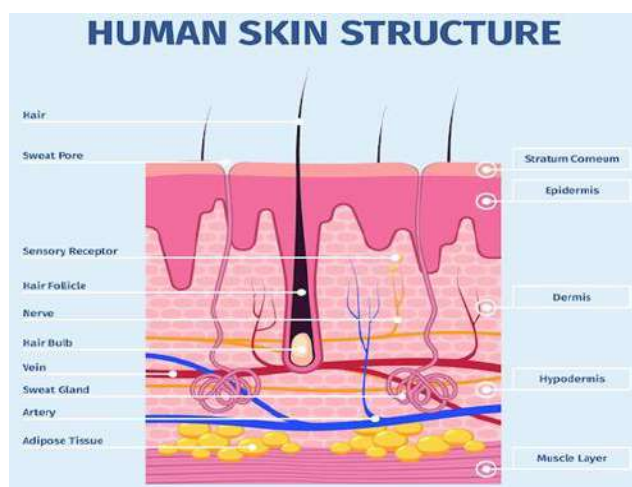


Figure 1 Anatomy of Skin.

2.1.A Multiple Skin Layers:

- **Epidermis:** The skin's outermost layer. It serves as a barrier, keeping out viruses, germs, and other dangerous substances. It also stops water loss and helps control body temperature.
- **Dermis:** The skin's middle layer. It has sweat glands, hair follicles, nerves, and blood vessels. The dermis helps control body temperature and gives the skin structural stability.
- **Hypodermis:** The skin's deepest layer. It is mostly made up of fat cells, which store energy and act as insulation for the body. Additionally, the hypodermis secures the skin to the bone and muscles beneath it. [2,15]

2.2. The skin has several other structures in addition to these three primary layers, such as:

- **Hair Follicles:** These are the hair-producing structures. They support maintaining temperatures, UV protection, and ability to sense.
- **Sweat Glands:** Sweat from these glands' aids in the body's cooling process by evaporating. They also contribute to the excretion of trash.
- **Sebaceous Glands:** These glands secrete sebum, an aqueous material that keeps the skin hydrated and smooth. Sebum has antibacterial qualities as well.
- **Nerves:** Touch, pressure, pain, and temperature are all sensed by the skin's rich innervation of nerves. These nerves are essential to how we interact with the world around us.

- **Blood Vessels:** The skin receives nourishment from a huge network of blood vessels provides oxygen and nutrients to the skin while eliminating waste. Because blood arteries dilate or contract to regulate blood flow, they also contribute to temperature regulation. [15]

2.3. Skin Physiology:

- **Protection:** Serves as a barrier against chemicals, infections, UV rays, and mechanical harm. stops excessive loss of water.
- **Thermoregulation:** vasodilation to release heat, vasoconstriction to retain heat, and sweating to cool.
- **Sensation:** has sensors for temperature, vibration, pressure, touch, and pain.
- **Synthesis of Vitamin D:** UV radiation promotes the production of vitamin D, which is essential for calcium absorption.
- **Immune Function:** Contains cells that aid in the defense against infections.

3. Bryophyllum Pinnatum Is The plant.

The medicinal herb *Bryophyllum pinnatum* is widely used in traditional medicine to treat rheumatoid arthritis, kidney stones, gastric ulcers, and pulmonary infections [7]. *Bryophyllum pinnatum* is a succulent plant native to Madagascar that is also known as the air plant, cathedral bells, life plant, or miracle leaf. [1] Its peculiar ability to multiply from plantlets that develop on the margins of its leaves makes it a well-liked

ornamental plant. It has also been used to treat a variety of illnesses in traditional medicine. [13] **Taxonomy:**

Taxonomy of Bryophyllum pinnatum	
Kingdom	Plantae
Subkingdom	Tracheobionta
Superdivision	Spermatophyta
Phylum	Magnoliophyta
Subclass	Rosidae
Order	Saxifragales
Family	Crassulaceae
Genus	Kalanchoe
Section	Bryophyllum
Species	Kalachoe pinnatum

• **Synonyms:** - Bryophyllum pinnatum, Bryophyllum calycinum, Bryophyllum germinans cotyledon. [Research gate citation 102,7]

3.1. Past background:

Bryophyllum pinnatum, also referred to as the mother-of-thousands, miraculous leaf, or leaf of life, has a long history that is based in traditional medicine. It has been used for ages, and proof of its therapeutic benefits may be found in many ancient societies.

3.2. Traditional Medicine:

***Ayurveda:** For generations, the herb Bryophyllum pinnatum has been used in Ayurvedic medicine to treat a wide range of conditions, such as fever, urinary disorders such

kidney stones, skin illnesses with wound healing, and anti-inflammatory action. To optimize its therapeutic benefits, it is commonly combined with other herbs.

***Chinese Medicine:** Because of the plant's ability to lessen inflammation and encourage wound healing, it has also been used in traditional Chinese medicine. [16]

***Indigenous Practices:** Bryophyllum pinnatum has been used as a folk treatment for a number of ailments, including headaches, digestive disorders, and irregular menstruation, in many indigenous communities worldwide. [7, 9]

3.3: Plant Chemical Components:

Table 2. Plant Chemical Components. [12,9]

Constituents	Example	Roles
Bufadenolides	Bryophyllin A and Bryophyllin B	Antimicrobial activity, Potential cardiogenic and diuretic properties.
Flavonoids	Quercetin, Rutin, Kaempferol.	Antioxidant properties, Anti-inflammatory and Anti-cancer effects.
Sterols	β -sitosterol	Cholesterol-lowering properties, Anti-inflammatory effects.
Organic Acids	Malic acid, citric acid	Antioxidant and anti-inflammatory properties, antimicrobial effects.
Tannins	Condensed tannins, hydrolyzable tannins.	Astringent properties, inflammation reduction, wound healing models
Other Compounds.	Alkaloids, glycosides, volatile oils.	Potential medicinal properties.

4. Pharmacological Activity:

1. Anti-inflammatory:

B. pinnatum is used in traditional medicine to treat many forms of fever and pain. [10] Traditional

medicine, especially Ayurveda, has long used *Bryophyllum pinnatum*. Its usage to treat a variety of illnesses is described in ancient writings and folklore from many cultures. Plant-based flavonoid chemicals have been shown to have anti-inflammatory properties by preventing edema. [20] Because of its chemical richness, *Bryophyllum pinnatum*'s anti-inflammatory properties have been linked to the synergy of triterpenoids, steroids (α - and β -amyrin and stigmast4), and flavonoids (quercetin, kaempferol, rutin, and luteolin). [18]

2. Anti-ulcer:

It is commonly known that *B. pinnatum* is used in the traditional treatment of ulcers. Significant protection against stomach lesions caused by aspirin, indomethacin, serotonin, reserpine, stress, and ethanol was discovered to be provided by the leaf's methanolic extract. [10] The development of histamine-induced ulcerations in guinea pigs was not stopped by the pretreatment with leaf press juice. Nonetheless, *B. pinnatum*'s methanolic fraction showed anti-ulcer properties in rats. [21]

3. Wound healing:

Due to the presence of steroid glycosides, the histological analysis revealed that an ethanolic extract from plant leaves had a considerable capacity for wound healing. [11] A key flavonoid in *B. pinnatum* is essential for wound healing. [17] The comparable outcomes for the two creams suggest that using the crude extract of *B. pinnatum* should be more profitable than using the isolated component. [27]

4. Insecticidal:

In ethnomedicine, *B. pinnatum* has been used to treat bug bites. [9] There have been reports of the methanolic extract of Indonesian leaves having an insecticidal action on silkworms. [10] Supratman et al. discovered two bufadienolides from *B. Pinnatum*, bryophyllin A and bryophyllin C, which demonstrated potent insecticidal activity against silkworm larvae in their third instar. [25]

5. Antihistaminic effect:

It has also been shown that the methanol extract of the leaves exhibits histamine receptor (H1) antagonism in the bronchial muscle, peripheral vasculature, and ileum. [11] We conclude that the antihistamine effect of the juice and fraction B was caused by blocking of H1 and not H2 receptors because the juice did not protect the stomach mucosa from histamine-induced ulcers. [23]

6. Antimicrobial activity:

Using the agar-well diffusion method, in vitro tests showed that a number of bacteria and fungi were sensitive to *B. pinnatum* flavonoids, methanolic extracts, and hot water. [21] Several Gram-positive and Gram-negative bacteria, including *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Candida albicans*, Herpes simplex virus, and influenza virus, were significantly impacted even by the extract from crushed leaves of *Bryophyllum pinnatum*. [5]. This demonstrates that methanolic extracts of *Aspilia africana* and *Bryophyllum pinnatum* can be utilized to combat pathogenic organisms that can impede wound healing, such as *Pseudomonas aeruginosa*, *Escherichia coli*, and *Staphylococcus aureus*. [26]

7. Antioxidant:

From ethyl acetate extract, they separated seven kaempferol rhamnose derivatives and evaluated their antioxidant capacity. [5] Study outcomes have indicated that the ethanolic extract has marked anti-oxidant activity. [19] The DPPH radical scavenging ability of the extract showed the following trend Ascorbic acid > extract. According to these findings, the antioxidant capacity of *B. pinnatum* leaves is modest. [24]

8. Anti-urolithiatic activity:

Bryophyllum pinnatum leaves are frequently used to treat stone problems and urinary insufficiency in traditional and ethnomedical practices. [22]. The current study demonstrated that alcoholic and hydro-alcoholic extracts of *Bryophyllum*

pinnatum had a positive effect by halting changes in body weight, urine and serum biochemical parameters, oxidative stress, and kidney histology that were brought on by ethylene glycol. [28]

9. Antihypertensive:

In India and Africa, among other places, *B. pinnatum* is utilized as an antihypertensive medication. Additionally, the blood pressure decreased as a result of the aqueous leaf extract. [9]

5. Formulation of Herbal Gel: -

Table 3. Formulation of Herbal Gel. [31]

Ingredients	Quantity	Roles
Carbopol	1 gm	Gelling agent.
Sorbitan monooleate	0.2ml	Emulsifier.
PEG 400	0.25ml	solubilizer.
Methyl paraben	0.2 gm	Preservative.
Plant Extracts	5 %	Active ingredient.
Distilled water	30 ml	Solvent.

CONCLUSION:

Bryophyllum pinnatum, a medicinal plant with a rich ethnomedicinal history, has garnered significant attention for its diverse pharmacological properties, particularly its antimicrobial activity. The plant's phytochemical constituents, including flavonoids, phenolic compounds, and alkaloids, contribute to its potent antimicrobial effects. Gel formulations of *Bryophyllum pinnatum* offer a convenient and effective delivery system for topical applications. The gel base enhances the penetration of active compounds into the skin, promoting localized antimicrobial action.

However, further research is necessary to fully elucidate the underlying mechanisms of action and to optimize the formulation for maximum efficacy. Additionally, rigorous clinical trials are required to validate the safety and efficacy of *Bryophyllum pinnatum* gel in various clinical settings. Despite these limitations, the promising antimicrobial potential of *Bryophyllum pinnatum* gel positions it as a valuable natural alternative for the treatment of microbial infections, particularly in the context of increasing antibiotic resistance

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HOW TO CITE: Priti Gadge*, Sanika Karale, Kashish Patel, Somanath Narsale, Shubham Gadge, The Antimicrobial Potential of *Bryophyllum Pinnatum* Gel, *Int. J. of Pharm. Sci.*, 2025, Vol 3, Issue 2, 2033-2040. <https://doi.org/10.5281/zenodo.14934905>

