



FORMULATION AND EVALUATION OF BRYOPHYLLUM PINNATUM TEA SACHETS AS A SUPPORTIVE THERAPY FOR NEPHROLITHIASIS AND UROLITHIASIS

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ABSTRACT

Bryophyllum pinnatum is widely used in the Ayurvedic system of medicine due to its astringent and therapeutic properties. It has been traditionally utilized for the treatment of various ailments and is well known for its nephroprotective and anti-inflammatory effects. The plant is commonly found in tropical and subtropical regions and contains several bioactive phytoconstituents such as flavonoids, alkaloids, glycosides, tannins, and phenolic compounds. The present study focuses on the formulation and evaluation of *Bryophyllum pinnatum* tea sachets as a convenient herbal dosage form for the supportive management of nephrolithiasis and urolithiasis. The prepared formulation was evaluated based on organoleptic and physicochemical parameters. The results indicate that the formulated tea sachets possess acceptable quality characteristics and contain active phytoconstituents that may contribute to diuretic and antioxidant activities. Therefore, *Bryophyllum pinnatum* tea sachets can be considered as a potential natural supportive therapy for urinary stone disorders.

KEYWORDS: *Bryophyllum pinnatum*, Herbal tea, Urolithiasis, Nephrolithiasis, Phytochemicals, Diuretic activity.

INTRODUCTION TO “*Bryophyllum pinnatum*”

Botanical Name

Kalanchoe pinnatum (also known as ***Bryophyllum pinnatum***)

Bryophyllum pinnatum, also known as *Kalanchoe pinnata*, is a succulent medicinal plant belonging to the family Crassulaceae. It is widely^[1] distributed in tropical and subtropical regions and is commonly used in traditional systems of medicine such as Ayurveda and folk medicine. The plant is well known for its therapeutic properties, including nephroprotective, anti-inflammatory, antimicrobial, antioxidant, and diuretic activities.

The leaves of *Bryophyllum pinnatum* contain a variety of bioactive compounds such as flavonoids, alkaloids, glycosides, saponins, phenolic compounds, triterpenes, and steroids. These phytoconstituents contribute to its medicinal value, particularly in the management of

kidney-related disorders.

Nephrolithiasis and urolithiasis are common urinary tract disorders characterized by the formation of stones due to supersaturation of urinary salts. Herbal remedies play an important role in managing such conditions due to their safety, affordability, and minimal side effects.

The present study focuses on the formulation and evaluation of *Bryophyllum pinnatum* tea sachets as a convenient herbal dosage form for the supportive treatment of urinary stones.

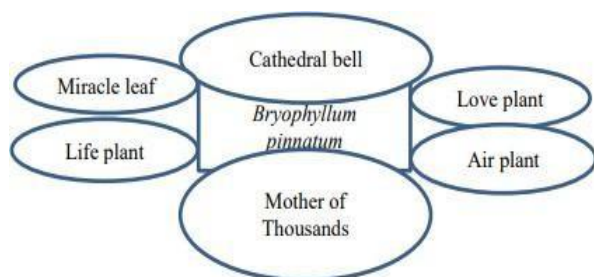


FIG-1: Common names of *Bryophyllum pinnatum*.

❖ Chemical Constituents

Bryophyllum pinnatum contains a wide range of bioactive^[2] compounds that contribute to its therapeutic properties:

1. Glycosides

These compounds are known for their nephroprotective activity, helping to protect and maintain kidney function. Examples include Bryophyllin A & B, Bryophollone, and phenolic glycosides.

2. Alkaloids

Alkaloids present in the plant exhibit anti-urolithiatic (stone-dissolving) effects. They include bufadienolide-type alkaloids and minor compounds such as berberine-like alkaloids.

3. Flavonoids

Flavonoids possess potent antioxidant and anti-inflammatory properties, which help reduce oxidative stress and^[3] inflammation.

Examples include Quercetin, Kaempferol, Luteolin, Apigenin, and Rutin.

4. Triterpenes and Steroids

These constituents show diuretic and antimicrobial activities, aiding in increased urine flow and protection against infections.

Examples include Taraxerol, Taraxerone, Friedelin, and Stigmasterol.

5. Phenolic Compounds

Phenolic compounds contribute to nephroprotective and antioxidant effects, supporting kidney health and preventing cellular damage.

Examples include Gallic acid, Caffeic acid, Ferulic acid, and Coumarins.

6. Saponins

Saponins are known for their anti-urolithiatic properties, helping in the dissolution and prevention of kidney stones.



FIG-2: *Bryophyllum pinnatum* Leaves.



Bryophyllum pinnatum leaf reproduction.

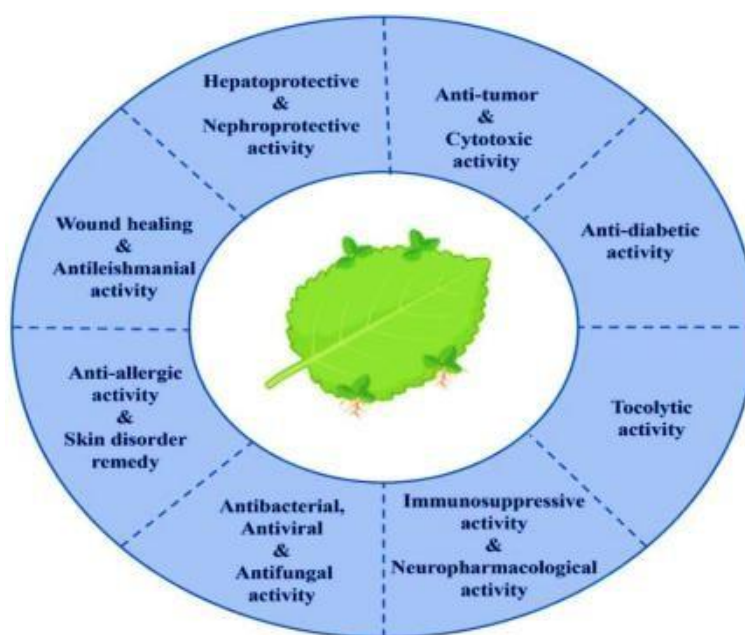
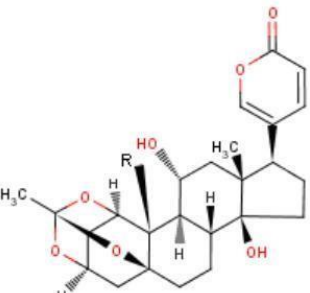
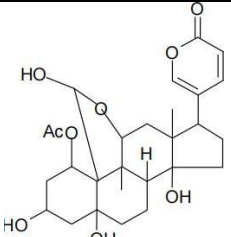
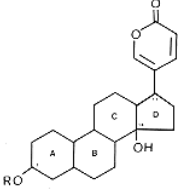
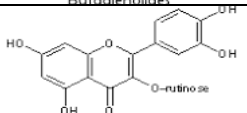
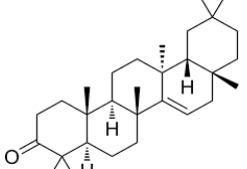


FIG-3: Pharmacological activity.

❖ CHEMICAL STRUCTURES

S.n	Chemical constituents	Chemical structure	Derived from	Activity
1 a	Glycosides Bryophyllin A		Leaves	Nephro protective
b	Bryophyllin B			
2	Alkaloids: Bufadienolide		Stem	Anti Urolithiatic
3	Flavonoids: Rutin		Leaves	Anti-Oxidant Anti- Inflammatory
4	Triterpenes & Steroids: Taraxerone		Leaves	Anti- Microbial Anti Urolithiatic

❖ MACROSCOPIC CHARACTERS OF plants.

BRYOPHYLLUM PINNATUM**1. Plant Type**

- A succulent, perennial herb growing up to 0.5–1.5 m in height.
- Stem is erect, thick, fleshy, and may be branched.

2. Leaves

- Leaves are opposite, fleshy, and may be simple or pinnately compound.
- Shape ranges from ovate to oblong with crenate margins.
- Leaves are bright green and succulent in nature.

3. Stem

- Cylindrical, thick, and fleshy structure.
- Green in color, sometimes^[4] becoming slightly reddish on maturity.
- Functions in water storage, typical of succulent

4. Inflorescence

- Terminal, pendulous panicles.
- Flowering generally occurs during winter and spring.

5. Flowers

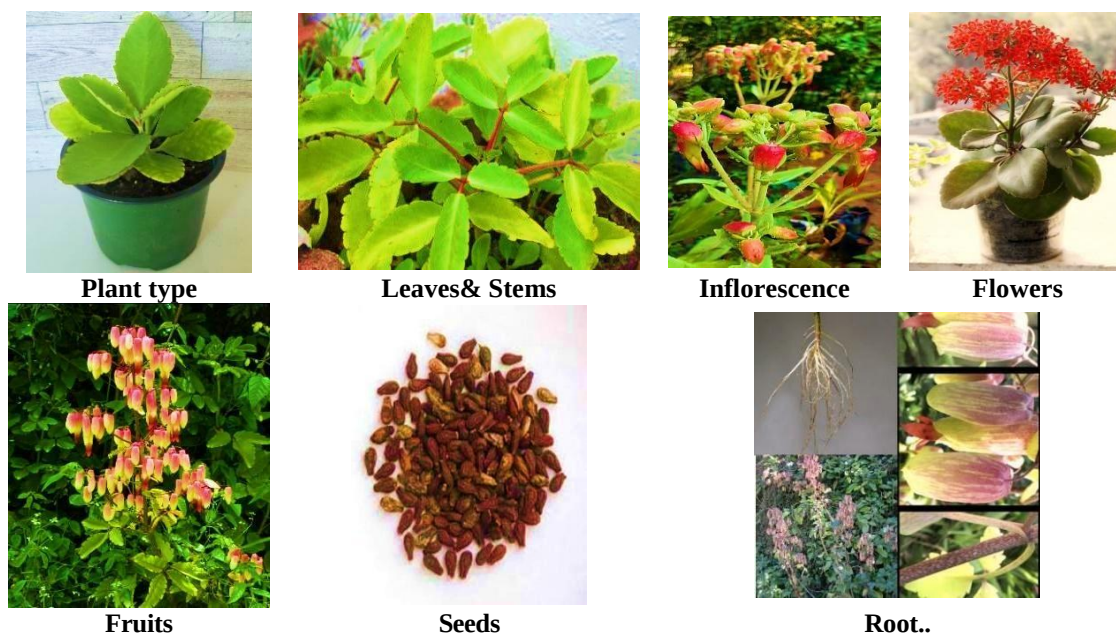
- Pendulous, tubular, bell-shaped flowers.
- Color varies from greenish-yellow to reddish-purple.
- Calyx: 4-lobed and persistent
- Corolla: Tubular with 4 lobes

6. Fruits

- Fruits are follicles, containing many seeds.
- Enclosed within the persistent calyx.

7. Seeds

- Small, numerous, and brown in color.

FIG-4: Macroscopic characters of *B.pinnatum*.

□ MICROSCOPICAL CHARACTERS OF *BRYOPHYLLUM PINNATUM*

1. Leaf Surface

- Epidermis: Single-layered and^[5] covered with a thick cuticle.
- Stomata: Present on both upper and lower surfaces (amphistomatic).
- Stomatal Type: Mainly anomocytic, surrounded by irregular epidermal cells.
- Trichomes: May be present; typically non-glandular and unicellular.

2. Mesophyll

- The leaf is dorsiventral in structure.
- Palisade Cells: Arranged in 2–3 layers below the upper epidermis;^[6] elongated and rich in chloroplasts.
- Spongy Parenchyma: Loosely arranged with large intercellular spaces and contains chlorophyll.

3. Vascular Bundle

- Type: Collateral vascular bundles surrounded by a bundle sheath.

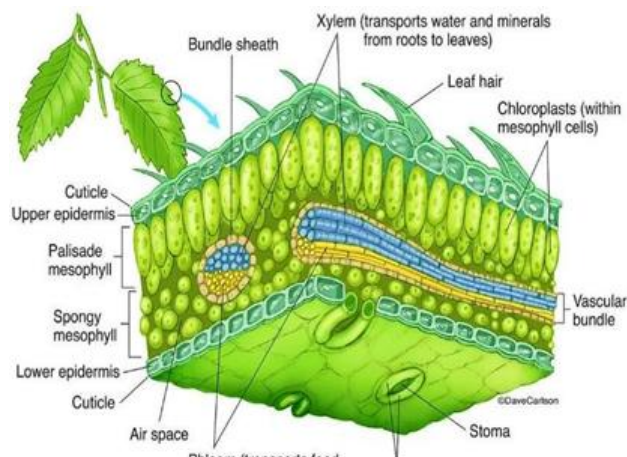
Arrangement: Xylem is oriented towards the upper epidermis Phloem is oriented towards the lower epidermis

4. Special Features

- Water Storage Tissue: Large parenchymatous cells present, characteristic of succulent plants.
- Crystals: Calcium oxalate crystals found within mesophyll cells.
- Mucilage Cells: Present and help in water retention.

5. Stem Anatomy

- Epidermis: Covered with a protective cuticle.
- Cortex: Composed of chlorenchyma and water-storage parenchyma.
- Vascular Bundles: Collateral and open, arranged in a ring patter

FIG-5: Transverse section of *B.pinnatum*.

➤ PHARMACOLOGICAL ACTIVITY

1. Nephroprotective Activity (Kidney Protection)

Fresh leaves of *Bryophyllum pinnatum* are traditionally used in India for managing jaundice.

Research studies^[7] indicate that the fresh leaf juice shows better protective effects compared to ethanolic extracts on liver and kidney tissues. It has been proven to reduce kidney damage caused by drugs like gentamicin in experimental animals. This protective action is mainly due to its antioxidant properties, which help in scavenging free radicals and decreasing oxidative stress in renal tissues.

2. Anti-inflammatory Activity

The plant contains a high amount of saponins, which play an important role in controlling bleeding and promoting wound healing. Saponins exhibit properties such as foam formation, red blood cell interaction, and cholesterol binding, contributing to their medicinal value. Additionally, tannins present in the plant have an astringent effect that accelerates the healing of wounds and inflamed tissues. Due to these properties, the plant is widely used in traditional medicine for treating burns, wounds, and inflammation.

3. Antibacterial Activity

Bryophyllum pinnatum possesses significant antimicrobial activity due to the presence of **phenolic compounds**. It is effective against a wide range of bacteria, including *Staphylococcus aureus*, *Escherichia coli*, *Salmonella typhi*, *Klebsiella* species, and *Pseudomonas* species. Studies show that leaf extracts exhibit bactericidal activity against both Gram-positive and Gram-negative organisms. This property helps in treating infections, preventing pus formation, and enhancing^[8] wound healing.

4. Antioxidant Activity

The plant is rich in phytochemicals that provide strong antioxidant effects. It works by neutralizing harmful free radicals (reactive oxygen species), inhibiting lipid peroxidation, and enhancing the activity of antioxidant enzymes such as catalase, superoxide dismutase (SOD), and glutathione peroxidase.

5. Diuretic Activity (Urine Increasing Effect)

Extracts of *Bryophyllum pinnatum* leaves have been shown to increase urine output, similar to standard diuretics like furosemide. They promote the excretion of important electrolytes such as sodium, potassium, and chloride. The presence of flavonoids and saponins helps improve kidney function by enhancing renal blood flow^[9] and filtration.

- Reduction of fluid retention (edema)
- Control of hypertension

➤ Mechanisms and Stages of Renal Stone Formation

Kidney stone formation, also referred to as biomineralization,^[10] is a complex biochemical process

that is not yet fully understood. It primarily involves changes in urine composition, especially supersaturation and other physicochemical factors.

1. Nucleation

Crystal-forming substances such as calcium oxalate, calcium phosphate, uric acid, and cystine accumulate and combine to form microscopic crystals.

2. Aggregation

These small crystals join together or adhere to surfaces within the kidney, increasing in size. In some cases, new crystals may form on existing ones, a process known as secondary nucleation.

3. Retention and Growth

For a stone to develop, crystals must^[11] remain within the kidney. They may attach to damaged tissues, cell surfaces, or interstitial plaques, or remain within the collecting system. Over time, continued growth leads to the formation of a clinically significant kidney stone.

Urinary Stones

Urinary stones form when urine becomes highly concentrated with substances that can form crystals, such as calcium oxalate, calcium phosphate, and uric acid. When these substances exceed the dissolving capacity of urine, they begin to crystallize.

At the same time, if urine lacks sufficient inhibitory substances that normally prevent crystals from sticking together, these crystals can combine, grow in size, and eventually develop into stones.



FIG-6: Urinary stones.

Classification of Urinary Stones by Location

Urinary stones are classified^[12] based on their location within the urinary tract:

- **Nephrolithiasis** – Stones present in the kidneys
- **Ureterolithiasis** – Stones located in the ureters
- **Cystolithiasis** – Stones found in the urinary bladder

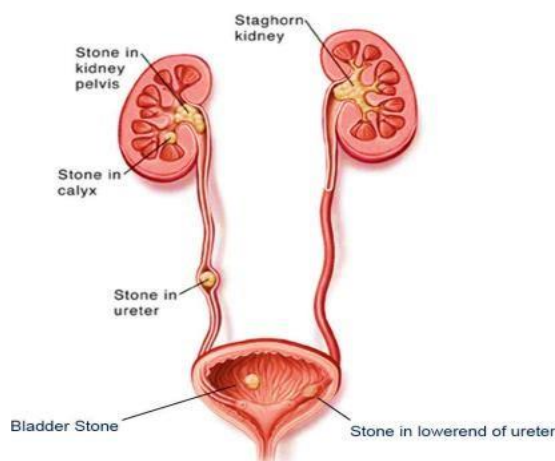


FIG-7: Location of urinary stones.

1. Nephrolithiasis (Kidney Stones)

Nephrolithiasis refers to the formation of stones within the kidneys. It is commonly associated with severe flank pain, known as renal colic, which may radiate to the abdomen or groin. Other symptoms include nausea, vomiting, and blood in the urine.

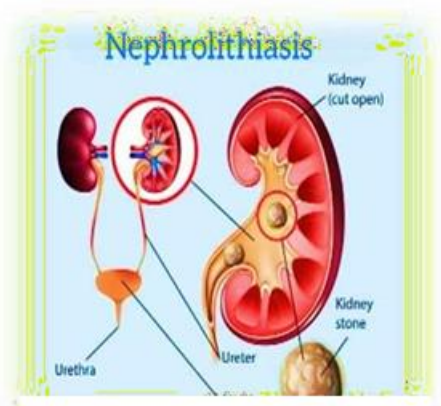


FIG-8: Nephrolithiasis.

2. Ureterolithiasis (Ureter Stones)

Ureterolithiasis is characterized by the presence of stones in the ureter, the tube connecting the kidney to the bladder. These stones can^[13] obstruct the flow of urine, resulting in sudden and intense colicky pain in the flank region, often radiating toward the groin.

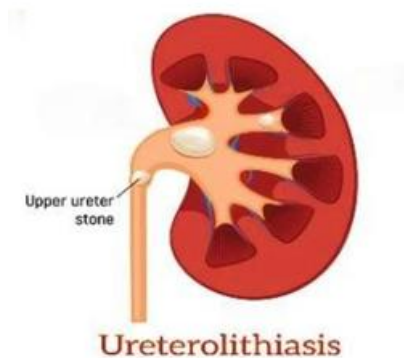


FIG. 9: Ureterolithiasis.

3. Cystolithiasis (Bladder Stones): Cystolithiasis refers to the formation or presence of stones in the urinary bladder. These stones develop when urine becomes concentrated, leading to the crystallization of minerals such as calcium or magnesium salts.

Common symptoms include lower abdominal pain, painful urination, frequent urination, and sometimes blood in the urine. In some cases, small stones may not produce noticeable symptoms.

This condition is often associated with^[14] urinary stasis, bladder outlet obstruction, prostate enlargement, or neurogenic bladder disorders. Treatment may involve procedures such as cystolitholapaxy, where stones are broken into smaller fragments and removed using a cystoscope and laser.



FIG-10: Cystolithiasis.

Urinary stones are typically classified based on their chemical composition (calcium-containing, struvite, uric acid or other compounds).

• Calcium Stones

Calcium stones are the most common type, accounting for about 70–80% of all urinary stones. They may occur as calcium oxalate, calcium phosphate, or, less^[15] commonly, calcium carbonate. Calcium oxalate exists in two forms: monohydrate (COM) and dihydrate (COD), with the monohydrate form being more stable and frequently observed. Factors such as increased urinary calcium (hypercalciuria), excess oxalate (hyperoxaluria), and elevated uric acid levels (hyperuricosuria) contribute to their formation.

• Uric Acid (Urate) Stones

Uric acid stones make up approximately 5–10% of all cases. A diet rich in purines, particularly from animal proteins, is a major risk factor. Other contributing factors include low urine volume, increased uric acid excretion (hyperuricosuria), and acidic urine (low pH), all of which favor uric acid crystallization.

• Magnesium Ammonium Phosphate (Struvite) Stones

Struvite stones, also known as infection or triple phosphate stones, account for about 12–15% of urinary

stones. They are typically associated with urinary tract infections caused by urease- producing bacteria. These microorganisms break down urea into ammonia and carbon dioxide, making the urine alkaline. In this alkaline environment, phosphate becomes less soluble and combines with ammonia and magnesium to form stones. These are more commonly seen in females.

• Cystine Stones

Cystine stones are rare, representing less than 3% of all cases. They occur due to a hereditary condition called cystinuria, an autosomal^[16] recessive disorder that affects the transport of cystine in the kidneys. As a result, cystine is not properly reabsorbed and is excreted in large amounts in urine. Since cystine has low solubility, it tends to precipitate and form stones.



FIG-11: Types of Urinary stones.

❖ MATERIALS AND METHODS

PREPARATION OF BRYOPHYLLUM PINNATUM POWDERY SUBSTANCE

Preparation of Bryophyllum pinnatum Powder

1. Collection and Authentication

Mature, healthy, and pesticide-free^[17] leaves of *Bryophyllum pinnatum* (also known as *Kalanchoe pinnata*) were collected from a local nursery. Proper identification of the plant is essential to ensure the correct medicinal species is used and to avoid toxic substitutes.

The collected plant material was authenticated by A. Venkateswara Rao, Head of the Department of Herbal Drug Technology at Pydah College of Pharmacy. The collection process was carried out under the guidance of Satya Anusha.

Process of Stone Formation

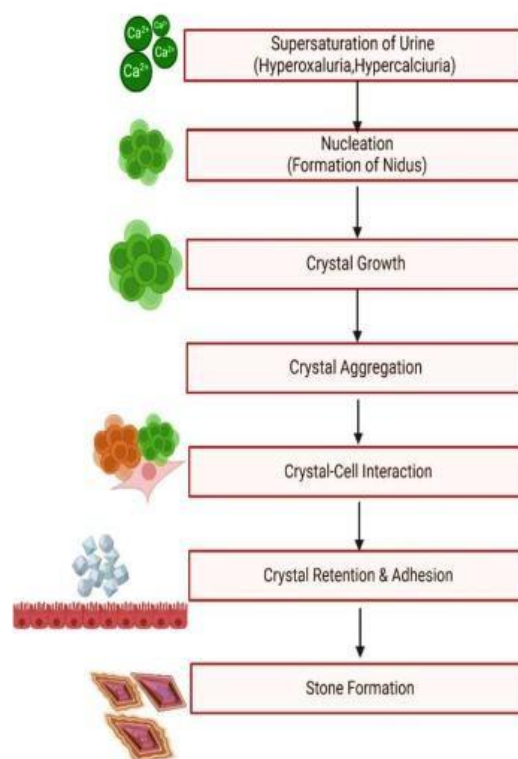


FIG-12: Process of stone formation.

2. Cleaning

The collected leaves were thoroughly washed with distilled water to remove soil, dust, and other contaminants. This step ensures the purity and quality of the raw material before further processing.

3. Drying Process

Drying is a crucial step that involves removing moisture from plant material to prevent microbial growth and enzymatic degradation. In this study, three drying methods were used:

• Sun Drying

Leaves were spread evenly on trays and exposed to direct sunlight. A protective net was used to prevent contamination from insects. Complete drying took approximately 2–3 weeks, depending on weather conditions.



FIG - 13: Sun drying.

- **Shade Drying**

Leaves were placed in a well-ventilated area away from direct sunlight. This method helps preserve heat-sensitive (thermolabile) compounds. Drying was completed within 1–2 weeks.



FIG -14: Shade drying.

- **Oven Drying**

A laboratory hot air oven was used at a^[18] controlled temperature of 40–50°C. This method reduced drying time significantly and ensured uniform drying.



FIG-15: Oven drying.

4. Pulverization (Size Reduction)

Pulverization is the mechanical process of reducing dried botanical matter into fine particles or a homogeneous powder. Once the *Bryophyllum pinnatum* leaves have reached a brittle, bone-dry state, they are subjected to size reduction using one of the following methods, depending on the required scale and desired fineness:

- **Manual Grinding (Mortar and Pestle):** Utilized for small-scale laboratory batches. This traditional method is advantageous as it minimizes heat generation, thereby preserving the integrity of **thermolabile (heat-sensitive) bioactive** compounds.



FIG - 16 Motor and pestle.

- **Mechanical/Electric Grinding:** For medium-to-large quantities, high-speed electric pulverizers or laboratory blenders are employed. To prevent thermal degradation of active constituents, grinding should be performed in **short pulses** to mitigate excessive heat buildup.



FIG - 17: Electric grinder.

- **Impact Pulverizer:** In industrial or^[19] commercial applications, specialized impact pulverizers are used to process large volumes of dried herbs into a consistent, fine powder through high-velocity attrition.

- **Sieving and Particle Size Uniformity**

Sieving is a critical separation technique used to ensure the uniformity of the powdered drug. This process utilizes a mesh screen to categorize particles based on their dimensions.



FIG - 18 Sieve shaker.

- **Sieve Selection:** A standardized sieve (e.g., **Mesh No. 44** or as specified by pharmacopoeial standards) is selected to achieve a fine, uniform powder suitable for extraction.
- **The Process:** The ground leaf material is passed through the sieve. Particles smaller than the mesh aperture pass through, while larger fractions are retained.
- **Recycling Coarse Fractions:** Any fibrous or coarse material retained on the sieve is returned to the pulverizer for further grinding. This iterative process continues until the entire batch meets the required particle size specifications.

5. Final Collection and Storage

The resulting fine, uniform powder is immediately transferred to airtight, light-resistant containers. This protects the phytochemicals from moisture absorption (hygroscopy) and photo-oxidation, ensuring the long-term stability of the prepared substance.

6. Packaging of Bryophyllum pinnatum Powder

Packaging of powdered materials is a vital step in pharmaceutical, food, herbal, and cosmetic industries. It involves enclosing the powder in suitable containers or sachets to protect it from moisture, contamination, and environmental factors that may affect its quality and stability. Proper packaging ensures product safety, accurate dosage, ease of handling, and an extended shelf life.



FIG -19: B.Pinnatum packed powder.

The packaging process generally^[20] includes stages such as preparation of the powder, accurate weighing, filling into containers, sealing, and labeling. The selection of packaging materials such as paper, polyethylene, aluminum foil, or composite laminates depends on the nature of the powder and its sensitivity to external conditions.

1. Primary Packaging

Primary packaging is the first layer that comes into direct contact with the powder. It plays a crucial role in protecting the product from moisture, air, light, and contamination, thereby maintaining its freshness and potency.

2. Secondary Packaging

Secondary packaging is the outer layer that encloses one or more primary packages. It is mainly used for protection during handling, transportation, storage, and marketing.

❖ FORMULATION OF BRYOPHYLLUM PINNATUM TEA SACHETS

1. Aim of the Study

To formulate and evaluate herbal tea sachets of Bryophyllum pinnatum for their potential use in the management of nephrolithiasis^[21] and urolithiasis.

The scope of the study includes

1. Collection and authentication of *Kalanchoe pinnata* leaves from a reliable source.
2. Preparation of herbal tea powder using standardized procedures to ensure consistency and quality.
3. Preliminary phytochemical screening to identify active constituents such as flavonoids, alkaloids,

saponins, and phenolic compounds that may contribute to anti-urolithiatic (anti-kidney stone) activity.

4. Evaluation of physicochemical properties of the tea, including pH, colour, flavour, and aroma.

The study aims to explore the potential of *Kalanchoe pinnata* as a safe and effective herbal tea formulation and to scientifically support its traditional use in the treatment of kidney stones.

2. Objectives of the Study

1. To collect and authenticate *Kalanchoe pinnata* leaves for the preparation of herbal tea.
2. To develop a standardized method for the formulation of *Kalanchoe pinnata* herbal tea.
3. To evaluate the diuretic and antioxidant properties of the tea, which may help in the management of kidney stones.
4. To assess the palatability and safety of the herbal tea formulation for potential therapeutic use.

➤ Herbal Ingredients

1. (Synonym: Bryophyllum pinnatum)

- **Family:** Crassulaceae
- **Common Names:** Life plant, Miracle leaf, Air plant, Cathedral bells, Pattharchatta (Hindi), Panfuti (Marathi), Ranapala (Bengali).

• Description

Kalanchoe pinnata is a succulent medicinal herb^[22] widely used in traditional systems like Ayurveda, Unani, and folk medicine. The plant is known for its therapeutic properties and is commonly used in natural remedies.



FIG – 20: Bryophyllum pinnatum leaves.

Uses

- Helps in the management of kidney stones (anti-urolithiatic)
- Shows antimicrobial activity
- Promotes^[23] wound healing
- Acts as an antioxidant

2. Cardamom (Elettaria cardamomum)

Family: Zingiberaceae

Common Name: Cardamom / Elaichi

Description

Cardamom is a well-known aromatic spice used in cooking as well as in traditional medicine. It is valued for its pleasant flavor and multiple health benefits.



FIG. 21: Cardamom.

Uses

- Aids digestion

❖ **METHODOLOGY**• **INGREDIENTS**

SR NO.	INGREDIENTS	FAMILY	QUANTITY
1.	Kalanchoe pinnata leaves	crassulaceae	90%
2.	cardamom	zingiberaceae	10%

• **INGREDIENTS AND ITS FUNCTIONS**

SR. NO	INGREDIENTS	FUNCTION
1.	Kalanchoe pinnata	Anti-urolithiatic
2.	cardamom	Anti-oxidant

➤ **METHODOLOGY**➤ **PROCEDURE****1. Collection of Plant Material**

Fresh leaves of *Kalanchoe pinnata* are collected from a clean, pesticide-free environment to ensure safety and quality.



FIG-22: B.pinnatum powder.

2. Cleaning and Drying

- The collected leaves are thoroughly^[25] washed with distilled water to remove dirt and contaminants.

If fresh leaves are used, they are steamed immediately after harvesting to prevent oxidation.

- The leaves are then dried either by hot air drying or shade drying to preserve their phytoconstituents.
- Once dried, the leaves are pulverized into a fine powder and sieved using a sieve shaker to obtain uniform particle size.
- For flavor enhancement, 2–3 crushed green cardamom pods are added to the powdered material.

3. Packaging

Packaging is done to protect the product from moisture, light, oxygen, and contamination, while ensuring ease of use, transport, and storage.

- Helps in reducing bad breath
- Provides relief in cough and cold
- Supports detoxification processes

Benefits

- Improves digestive function
- Helps maintain fresh breath and oral hygiene
- Helps in managing^[24] respiratory conditions

A. Primary Packaging (Direct Contact with Tea)

- The powdered material is packed into sachets containing measured quantities (1–2 g) of *Kalanchoe pinnata* tea.
- Sachets are made from food-grade filter paper or biodegradable PLA mesh.



FIG – 23: Tea sachets.

B. Secondary Packaging (Outer Packaging)

- Paperboard boxes are used to^[26] hold multiple sachets or jars.

This provides additional protection as well as space for labeling and branding.

Manual Manufacturing Steps for Filling Tea Sachets with Powder

The manual process of filling tea sachets with tea powder involves the following steps

4. Preparation of Materials

Collect all necessary materials, including tea powder, empty tea sachets (filter bags), a weighing scale or scoop, and a heat sealer or pressing iron.

1. Measurement of Tea Powder

Accurately measure the required quantity of tea powder (typically 1–2 g) for each sachet using a weighing scale or scoop to ensure uniformity.

2. Filling of Sachets

Open each tea sachet carefully and fill it with the

measured tea powder. Distribute the powder evenly the sachet to ensure consistent infusion.

3. Sealing of Sachets

Seal the filled sachets using a heat sealer or pressing iron. Apply heat for a few seconds to ensure a secure and tight seal, preventing leakage of the powder.

4. Quality Control Check

Examine each sachet to confirm proper sealing, absence of holes or leaks, and correct weight of tea powder.

5. Final Packaging

Pack the sealed sachets into larger pouches or boxes for storage, transportation, or sale.

This manual method requires careful handling to maintain consistency in weight and quality. It is particularly suitable for small-scale or artisanal tea production, where machinery is not used. Accurate measurement, careful filling, and proper sealing are essential to preserve the freshness and quality of the tea while preventing contamination.

This process is practical for producers manually packaging tea powders or leaves on a small scale.

➤ Best Equipment for Manual Tea Sachet Powder Filling

The following equipment is commonly used for manually filling tea sachets with powder in small- scale or artisanal production:

1. Manual Tea Bag Filling and Sealing Machines

These machines are designed to assist in^[27] filling pre-measured quantities of tea powder into ready-made filter paper sachets. They are typically made of stainless steel to maintain hygiene and can handle quantities ranging from 1–20 g per sachet. Some models support manual filling and require a separate heat sealer for sealing.



FIG – 24: Tea Bag.

2. Vibration-Based Manual Filling Machines

These machines use a vibrating or rotating disc mechanism to dispense tea powder into sachets. This method improves accuracy and ensures more uniform filling, making it suitable for small-batch production.

3. Heat Sealers (Impulse Sealers)

Heat sealers are used to close the filled sachets securely

after filling. They provide a tight and reliable seal, preventing leakage and preserving the freshness of the tea powder.

➤ Labeling Requirements

Each package should be clearly labeled with the following information:

- Brand name
- List of ingredients
- Batch number
- Manufacturing and expiry dates
- Nutritional information
- Directions for use

➤ Storage Conditions

Ranapala leaves or tea sachets should be stored in^[28] airtight containers and kept in a cool, dark, and dry place to maintain quality. Under optimal storage conditions, herbal teas like *Bryophyllum pinnatum* generally retain their aroma, flavor, and nutritional value for about 6–12 months. Some sources suggest they may remain safe for use up to 24 months; however, the flavor and potency may gradually decline over time. For best results, especially for kidney health or medicinal purposes, it is recommended to^[29] use the product within one year.

➤ Directions for use

- Preparation of *Bryophyllum pinnatum* Herbal Tea:
 - Take one tea bag of *Bryophyllum pinnatum* herbal tea and dip it into 100 ml of boiling purified water.
 - Allow the tea bag to steep for 1–2 minutes, stirring occasionally.
 - Add honey or lemon (optional) for a milder or sweeter taste.
 - Consume the tea once or twice daily while warm for best result



FIG – 25: *B. pinnatum* Herbal tea.

❖ EVALUATION PARAMETERS

1. Organoleptic evaluation

Organoleptic (sensory) evaluation involves using the senses - sight, smell, taste, and touch - to assess the physical characteristics of the plant powder. It^[30] provides a quick and simple method to identify and verify the authenticity and quality of the drug material.

S.No	Parameter	Observation/Description
1.	Color	The powder of bryophyllum pinnatum leaves is typically green in color. The shade may vary depending on drying conditions and age of the leaves. A dull or brownish tint may indicate poor drying or degradation of chlorophyll.
2.	Odor	The powder has a characteristic, mild, Leafy and slightly earthy odor. It is not pungent or unpleasant. A musty smell may indicate microbial contamination or improper storage.
3.	Taste	The taste is slightly bitter and astringent due to the presence of flavonoids, tannins and other phytoconstituents. When tasted on the tongue, a mild bitterness is followed by astringent sensation.
4.	Texture/Touch	The powder is fine to moderately coarse and smooth to touch when properly sieved. It may feel slightly fibrous if not finely powdered.
5.	Appearance	A uniform, dry free-flowing powder without visible foreign matter. The color should be consistent throughout, with no clumpin or dampness

- **Significance**

- ✓ Organoleptic evaluation:
- ✓ Provides preliminary^[31] identification of the plant material.
- ✓ Helps detect adulteration, contamination, or degradation.
- ✓ Serves as a quick quality control parameter before chemical analysis.

sample.

- Method: Weigh 2 g of powder and dry at 105°C to constant weight.
- Normal value: 5%.
- Helps prevent microbial growth and spoilage.

2. PHYSICOCHEMICAL EVALUATION

Determine the physical and chemical properties for standardization:

01. Moisture Content (Loss on Drying)

- Determines the amount of water present in the

02: Ash Values

Used to estimate the inorganic^[32] residue left after ignition.

S.NO	PARAMETER	SIGNIFICANCE	TYPICAL VALUE
01.	Total Ash	Indicates total inorganic content (minerals + extraneous matter)	12%
02.	Acid Insoluble Ash	Indicates presence of siliceous matter (e.g., sand)	2%
03.	Water Soluble Ash	Measures water-soluble salts	6%

03. Extractive Values

Indicate the amount of active^[33] constituents soluble in various solvents.

S.NO	SOLVENT	EXTRACTIVE VALUE(%)	INFERENCE
01.	Alcohol Soluble	20%	Presence of glycosides, flavonoids, phenolics
02.	Water Soluble	28%	Presence of sugars, mucilage, glycosides
03.	Petroleum Ether Soluble	3%	Fatty substances, waxes, chlorophyll

04. PH Determination

- Method: 1% and 10% aqueous solutions tested using a pH meter.
- Result: pH ≈ 6.0
- Indicates slightly acidic nature of the plant extract.

05. Foreign Matter

- Determines the percentage of^[34] extraneous material (dust, soil, etc.).
- Should not exceed 2%.

06. Swelling Index / Foaming Index (if applicable)

- Swelling index indicates mucilage content (present

in *B. pinnatum* leaves).

- Foaming index can indicate the presence of saponins.

07. Fluorescence Analysis

- Powder treated with various reagents and observed under UV and visible light for characteristic color changes — helps in authentication.

S.NO	REAGENT	VISIBLE LIGHT	U.V LIGHT(365NM)
01.	Powder + Water	Green	Dark green
02.	Powder + NaOH (aq.)	Yellowish green	Brownish
03.	Powder + HCl	Light brown	Dark brown

- Significance:** These evaluations:

- ✓ Help standardize the plant material for medicinal use
- ✓ Detect adulteration or substitution
- ✓ Provide data for pharmacopoeial standards
- ✓ Ensure reproducible therapeutic efficacy.

03. PHYTOCHEMICAL SCREENING**01. Alkaloids**

Alkaloids are a diverse group of naturally occurring organic compounds that primarily contain basic nitrogen atoms, often arranged within heterocyclic ring structures. These compounds are mainly synthesized by plants and certain microorganisms. Alkaloids are well known for their significant pharmacological and toxicological properties.

Uses of Alkaloids

- Pain management
- Effects on the nervous system
- Stimulant properties
- Anticancer activity
- Tests for Detection of Alkaloids:

✓ Dragendorff's Test

Approximately 2 mg of the ethanolic extract is^[35] mixed with 5 ml of distilled water. Hydrochloric acid (2M) is added until the solution becomes acidic. Then, 1 ml of Dragendorff's reagent is introduced. The formation of orange-red precipitate indicates the presence of alkaloids.

✓ Mayer's Test

A small quantity of the plant extract is taken in a test tube, and a few drops of Mayer's reagent are carefully added along the sides. The appearance of a white or cream-colored precipitate suggests the presence of alkaloids.

✓ Wagner's Test

To a few milliliters of the plant extract, several drops of Wagner's reagent are added along the walls of the test tube. The development of a reddish-brown precipitate confirms a positive result for alkaloids.

02. Glycosides

Glycosides are naturally occurring compounds made up of two components: a sugar part (glycone) and a non-sugar part (aglycone), connected through a glycosidic bond. Their therapeutic effects largely depend on the aglycone component. Glycosides are classified based on

the type of aglycone and the nature of their glycosidic linkage. Medicinally, they are used in treatments for heart conditions (cardiac glycosides) and as laxatives (anthraquinone glycosides).

Uses of Glycosides

- Protecting kidney function (nephroprotective)
- Managing heart failure
- Treating arrhythmias
- Anti-inflammatory effects
- Anti-cancer potential
- Respiratory condition management
- Tests for Detection of Glycosides

✓ Keller-Killiani Test

The alcoholic extract of the plant is mixed with an equal volume of water and 0.5 ml of strong lead acetate solution, then shaken and filtered. The filtrate is extracted with an equal volume of chloroform (CHCl_3), and the chloroform layer is evaporated to dryness. The^[36] residue is dissolved in 3 ml of glacial acetic acid, a few drops of ferric chloride (FeCl_3) solution are added, and 2 ml of concentrated sulfuric acid (H_2SO_4) is poured carefully. A reddish-brown layer that changes to bluish-green indicates the presence of an aglycone.

✓ Legal Test

The alcoholic extract is treated with an equal volume of water and 0.5 ml of strong lead acetate solution, shaken well, and filtered. The filtrate is extracted with an equal volume of chloroform, which is then evaporated to dryness. The residue is dissolved in 2 ml of pyridine, followed by the addition of sodium nitroprusside and sodium hydroxide (NaOH) to make the solution alkaline. The appearance of a pink color confirms the presence of a glycosidic aglycone.

3. Flavonoids

Numerous fruits, vegetables, herbs, and medicinal plants contain flavonoids, a class of naturally occurring polyphenolic chemicals. These substances have anti-inflammatory, diuretic, and antioxidant qualities.

Flavonoids' Uses

Activity of antioxidants Healing of wounds

- Preventing kidney stones
- Reduction of^[37] inflammation
- Antimicrobial properties

- Properties that prevent ulcers

✓ **Shinoda test (Mg+conc.HCL)**

1. Add a few tiny bits of magnesium ribbon to one milliliter of extract in a test tube.
2. Add two to three drops of strong HCl.
3. Gently shake, then watch.

Positive: within minutes, pink, crimson-red, or orange hues emerge. Negative: no change in color.

✓ **Test for alkaline reagent (NaOH)**

1. Add 2 mL of 10% NaOH to 1 mL of extract
2. A bright yellow color appears; add a few drops of diluted HCl.

Positive: yellow turns colorless on acidification (reversible), indicating flavonoid phenolic OH groups.

04. Tannins / Phenolic Compounds

Tannins are a class of naturally occurring phenolic substances present in plants. They have the ability to interact with proteins and form stable complexes. As a^[38] subgroup of polyphenols, tannins contribute to the characteristic astringent taste and slight bitterness observed in products such as tea and wine.

Phenolic compounds represent a wider category of plant-based molecules, among which tannins are a specific group. Tannins are mainly classified into two types: **hydrolysable tannins** and **condensed tannins**.

Uses of Tannins / Phenolic Compounds

- Protect kidney function (nephroprotective activity)
- Act as antioxidants
- Reduce inflammation
- Exhibit antimicrobial properties
- Promote wound healing
- ✓ **Ferric Chloride Test (FeCl₃ Test) : Procedure:**
- Take 1 mL of *Bryophyllum pinnatum* extract in a clean test tube.
- Add 2–3 drops of freshly prepared 1% ferric chloride solution.
- Shake gently and observe any color change.

Result Interpretation

- **Positive Result**
 - Blue-black color → Indicates presence of^[39] hydrolysable tannins or phenolic compounds
 - Greenish-black color → Indicates presence of condensed tannins or catechins
- **Negative Result**
 - No color change → Suggests absence or very low concentration of phenolics/tannins
- ✓ **Lead Acetate Test: Procedure**
- Take 1 mL of *Bryophyllum pinnatum* extract in a test tube.

- Add 2–3 drops of 10% lead acetate solution.
- Shake gently and observe for precipitate formation.

Result Interpretation

- **Positive Result**
 - Formation of white or yellowish precipitate → Indicates presence of tannins or phenolic compounds
 - **Negative Result**
 - No precipitate → Indicates absence or very low levels of phenolic compounds
- Here is a rewritten, plagiarism-free version with improved clarity and flow:

05. Steroids and Triterpenoids

Triterpenoids are a large group of naturally occurring organic compounds composed of 30 carbon atoms, originating from the precursor squalene. They are commonly found in plants and frequently possess oxygen-containing functional groups.

Steroids are a specific category within terpenoids,^[40] distinguished by their unique structure consisting of four interconnected carbon rings. Similar to triterpenoids, they are also derived from squalene. Steroids play vital roles in both plant and animal systems, particularly in maintaining cell membrane stability and functioning as signaling molecules such as hormones.

Both steroids and triterpenoids are biologically^[41] important due to their wide range of pharmacological activities.

Uses of Steroids and Triterpenoids

- Provide liver protection (hepatoprotective action)
- Promote diuretic activity
- Exhibit antimicrobial properties
- Help reduce inflammation
- Show potential anticancer effects
- Aid in wound healing

✓ **Liebermann–Burchard Test**

(Primary test for detection of steroids and triterpenoids)

Procedure

- Take 1 mL of the plant extract dissolved in chloroform in a dry test tube.
- Add 2 mL of acetic anhydride and stir gently.
- Carefully introduce 2 drops of concentrated sulfuric acid along the wall of the test tube without vigorous shaking.
- Monitor the solution for any change in color over the next few minutes.

Result Interpretation

- **Positive Result**
 - Appearance of pink or red color initially, followed by a gradual change to blue or green

- The development of a green or blue color confirms the presence of steroids or triterpenoids

- **Negative Result**

- No noticeable color change.

- ✓ **Foam Test**

(Test for detection of triterpenoid saponins)

Procedure

- Take 1 mL of aqueous plant extract in a test tube.
- Add 5 mL of water and shake vigorously for about one minute.
- Leave the mixture undisturbed for^[42] approximately 10 minutes.

Result Interpretation

- **Positive Result**

- Formation of stable foam that persists for 10–15 minutes indicates the presence of saponins, which are commonly associated with triterpenoids

- **Negative Result**

- No stable foam formation.

06. Saponins

Saponins are plant-derived chemical substances that produce a stable, soap-like foam when mixed with water and shaken. They have a unique structure consisting of a water-attracting (hydrophilic) sugar component and a fat-attracting (lipophilic) non-sugar part called aglycone. This dual nature enables them to interact with both aqueous and lipid environments.

These compounds may taste either sweet or bitter. They are generally safe when taken orally but can be harmful if directly introduced into the bloodstream. Because of their ability to reduce surface tension, saponins are commonly used as natural foaming and emulsifying agents in products such as cosmetics, beverages, and medicinal formulations. They are also valued for their therapeutic properties.

Uses of Saponins

- Assist in breaking down kidney or gall stones
- Offer protective effects on the liver
- Help reduce inflammation
- Provide biological protective actions
- Aid in lowering lipid levels in the body
- Support management of diabetes
- Contribute to the treatment of^[43] liver disorders

- ✓ **Froth Test**

(Identification test for saponins):

Procedure

- Take 1 mL of the plant extract in a clean test tube.
- Add 5 mL of distilled water.
- Shake the mixture vigorously for^[44] about 30

seconds to 1 minute.

- Leave the mixture undisturbed for around 10 minutes.
- Observe the presence and height of foam formed.

Results

- **Positive Result**

- Formation of a stable foam layer of about 1 cm or more that remains for at least 10 minutes indicates the presence of saponins

- **Negative Result**

- No foam formation or foam that^[45] disappears quickly indicates absence of saponins

Overall Result

The presence of alkaloids, flavonoids, tannins, glycosides, saponins, steroids, and triterpenoids in *Bryophyllum pinnatum* tea sachets was confirmed by standard preliminary phytochemical test.

- **Significance**

- Helps detect the presence of active plant constituents
- Provides insight into the medicinal potential of plant extracts
- Supports further pharmacological and research studies
- Ensures the quality and safety of herbal preparations
- Allows comparison between different plant samples
- Assists in selecting appropriate extraction technique

➤ **RESULT AND DISCUSSION**

The formulated tea sachets showed acceptable organoleptic properties and physicochemical parameters within standard limits. The presence of bioactive compounds supports its potential role in managing urinary stones through diuretic and antioxidant mechanisms.

❖ **CONCLUSION**

The present study demonstrates that *Bryophyllum pinnatum* tea sachets can be successfully formulated and standardized with acceptable physicochemical and organoleptic properties. The presence of key phytoconstituents such as flavonoids, alkaloids, and saponins supports its potential anti-urolithiatic and diuretic activities. These findings suggest that the formulation may serve as a safe and convenient supportive therapy for the management of nephrolithiasis and urolithiasis. Further experimental and clinical studies are required to validate its therapeutic efficacy.

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