

ANTIUROLITHIATIC ACTIVITY OF HERBAL SYRUP OF *BRYOPHYLLUM PINNATUM*.

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ABSTRACT

This study aimed to study the Antiurolithiatic activity of herbal syrup of *Bryophyllum Pinnatum*. Kidney stone disease (urolithiasis) is a major global urinary disorder associated with severe pain, recurrent infection, and significant morbidity. Conventional synthetic treatments are often costly and carry adverse effects, creating demand for safe, economical herbal alternatives. This study aimed to formulate and evaluate a sugar-free herbal syrup of *Bryophyllum pinnatum* (family Crassulaceae), traditionally used for antiurolithiatic and diuretic activity. Fresh leaves were shade-dried, powdered, and extracted by aqueous maceration. Formulation were prepared using sorbitol as the sugar-free base, xanthan gum as viscosity enhancer, sodium benzoate as preservative, sodium citrate and citric acid as buffering agents, and propylene glycol as co-solvent. All batches were evaluated for organoleptic properties, pH, viscosity, density, clarity, and pourability. Preliminary phytochemical screening confirmed the presence of flavonoids, tannins, alkaloids, and saponins. The optimized batch (containing 20 mL extract per 100 mL syrup) exhibited orange colour, pleasant odour, balanced bitter-sweet taste, pH 6.05, viscosity 3.03 cp, and density 1.048 g/mL, with excellent clarity and pourability. In vitro calcium oxalate dissolution assay demonstrated 58% dissolution activity, supporting antiurolithiatic potential. The formulated sugar-free syrup was pharmaceutically acceptable, stable, and palatable, representing a promising herbal preparation for supportive kidney stone management.

Keywords: *Bryophyllum pinnatum*, antiurolithiatic, herbal syrup.

INTRODUCTION

Urolithiasis, commonly referred to as kidney stone disease, is among the most prevalent disorders of the urinary system and constitutes a major public health burden worldwide. The condition is characterised by the formation of hard crystalline deposits within the renal pelvis, calyces, or ureter as a consequence of the supersaturation of urine with stone-forming solutes such as calcium oxalate, calcium phosphate, uric acid, and cystine [1]. The global prevalence of urolithiasis has risen steadily over recent decades, driven by westernised dietary patterns, reduced water intake, obesity, metabolic syndrome, and sedentary lifestyle [2]. Affected individuals experience debilitating renal colic, haematuria, burning micturition, nausea, and urinary tract infections, and the high recurrence rate estimated at 50% within five years without preventive intervention frequently leads to progressive renal injury [3].

Current therapeutic strategies encompass pharmacological agents (alpha-blockers, thiazide diuretics, allopurinol), extracorporeal shock wave lithotripsy, ureteroscopy, and percutaneous nephrolithotomy [4]. Despite their effectiveness, these modalities are associated with high economic cost, procedural morbidity, electrolyte imbalance, and risk of stone recurrence following discontinuation of therapy [5]. These limitations have generated growing clinical and research interest in medicinal plant-based formulations as safer, cost-effective complementary approaches for urinary stone management.

Bryophyllum pinnatum (Lam.) Pers. (synonym: *Kalanchoe pinnata*), belonging to the family Crassulaceae, is a perennial succulent herb indigenous to tropical and subtropical regions of Asia and widely naturalised across India. Commonly known as Patharchatta (Hindi) and Paanphuti (Marathi), the plant has been employed in Ayurvedic, Siddha, and folk medical systems for centuries for the management of renal calculi, dysuria, urinary tract infections, wounds, and inflammation [6]. Phytochemical investigations have identified an array of bioactive constituents including flavonoids (quercetin, kaempferol), alkaloids, triterpenoids, bufadienolides (bryophyllin A and B), saponins, tannins, and phenolic compounds, which collectively contribute to the plant's documented antiurolithiatic, diuretic, anti-inflammatory, antioxidant, antimicrobial, and nephroprotective pharmacological activities [7].

Several experimental studies have demonstrated the antiurolithiatic activity of *B. pinnatum* extracts. Despite this pharmacological evidence, there is limited published research on the development of a sugar-free syrup dosage form of *B. pinnatum* suitable for diabetic and obese

patients, who constitute a significant proportion of the kidney stone-prone population. The syrup dosage form is particularly advantageous for this indication due to its rapid absorption, ease of administration, and improved patient compliance over extended therapy periods [8,9].

The present study was therefore undertaken to formulate and evaluate a stable, palatable, sugar-free herbal syrup of *B. pinnatum* using sorbitol as the sweetening vehicle, and to assess its physicochemical properties and in vitro antiurolithiatic activity through calcium oxalate dissolution assay.

MATERIALS AND METHODS

Plant Material Collection and Authentication

Fresh leaves of *Bryophyllum pinnatum* were collected from the Botanical Garden of Saikrupa Institute of Pharmacy, Ghargaon (Tal. Shrigonda, Dist. Ahilyanagar, Maharashtra, India) during the month of February 2026. Botanical authentication was performed by Dr. Manjushree G. Bhagwat, Head, Department of Botany, Radhabai Kale Mahavidyalaya, Ahilyanagar.



Fig. No. 1: *Bryophyllum pinnatum*

Preparation of Plant Extract

Authenticated leaves were washed thoroughly with distilled water to remove surface debris, shade-dried at ambient room temperature ($25 \pm 2^{\circ}\text{C}$) for 14 days to preserve thermolabile active constituents, and subsequently ground to a coarse powder using a mechanical grinder. The powder was passed through sieve No. 40 to obtain a uniform particle size. Aqueous extraction was carried out by the cold maceration method: the powdered drug was soaked in distilled water (1:10 w/v) in a closed glass container and maintained at room temperature for 48 hours with intermittent stirring. The macerate was filtered successively through muslin cloth and Whatman No. 1 filter paper. The resulting filtrate was used as the aqueous extract for phytochemical screening and syrup formulation.

Phytochemical Screening

Preliminary phytochemical screening of the aqueous extract was performed using standard qualitative tests: Mayer's test for alkaloids (cream-coloured precipitate with potassium mercuric iodide reagent); Shinoda test and alkaline reagent test for flavonoids (pink-red colouration with magnesium turnings and concentrated hydrochloric acid; yellow colour with sodium hydroxide); foam test for saponins (persistent stable froth on vigorous shaking with distilled water); and ferric chloride test for tannins (dark green/black colour with 5% ferric chloride solution) [10].

Excipients and Chemicals

Sorbitol solution (70% w/v) was used as the sugar-free syrup base and sweetening agent. Xanthan gum served as the viscosity-enhancing polymer. Sodium benzoate (0.2% w/v) was incorporated as an antimicrobial preservative. Sodium citrate and citric acid were used as buffering agents to achieve a target pH of 6.0–6.5. Propylene glycol was included as a co-solvent to enhance solubility. Orange colouring agent (food grade) was added for aesthetic acceptability. Purified water (freshly prepared, USP grade) was used throughout the formulation process. All chemicals and excipients were of analytical/pharmaceutical grade.

Formulation of Sugar-Free Herbal Syrup

Five formulation batches (F1–F5) were prepared, with the concentration of *B. pinnatum* aqueous extract varied systematically (5 mL, 5 mL, 10 mL, 15 mL, and 20 mL per 100 mL final volume, respectively) while keeping all other excipient concentrations constant. The composition of each batch is presented in Table 1. The syrup was prepared by dissolving sorbitol solution in a measured quantity of purified water with continuous stirring. Propylene glycol was then incorporated and mixed uniformly. Xanthan gum was sprinkled slowly into the solution under constant stirring to prevent lump formation and allow hydration. The *B. pinnatum* aqueous extract was added and stirred to ensure homogeneous dispersion. Sodium benzoate, sodium citrate, and citric acid were subsequently dissolved in a small quantity of purified water and added to the main solution with continuous mixing. The pH was adjusted to the target range (6.0–6.5) using citric acid or sodium citrate as required. The orange colouring agent was added in a quantity sufficient to achieve a uniform appearance. The final volume was made up to 100 mL with purified water and mixed thoroughly. The prepared syrup was filled into clean, dry amber-coloured glass bottles, labelled appropriately, and stored at controlled room temperature ($25 \pm 2^\circ\text{C}$) protected from direct sunlight [11].

Table 1. Formulation composition of Bryophyllum pinnatum sugar-free herbal syrup

Ingredient	F1	F2	F3	F4	F5
<i>B. pinnatum</i> extract (mL)	5	5	10	15	20
Sorbitol solution (mL)	75	65	65	65	65
Sodium benzoate (g)	0.2	0.2	0.2	0.2	0.2
Sodium citrate (g)	0.5	0.5	0.5	0.5	0.5
Citric acid (g)	0.5	0.5	0.5	0.5	0.5
Xanthan gum (g)	0.3	0.3	0.3	0.3	0.3
Propylene glycol (mL)	5	5	5	5	5
Colouring agent	q.s.	q.s.	q.s.	q.s.	q.s.
Purified water q.s. to (mL)	100	100	100	100	100

Evaluation Parameters

Organoleptic Evaluation

All five batches were evaluated for organoleptic characteristics including colour, odour, taste, overall appearance, and texture/consistency by visual inspection and sensory assessment conducted by trained evaluators under uniform ambient conditions.

pH Measurement

The pH of each batch was determined using a pre-calibrated digital pH meter at room temperature ($25 \pm 0.5^\circ\text{C}$). The electrode was rinsed with distilled water between measurements. Triplicate readings were recorded and the mean value reported [12].

Viscosity Determination [13]

Viscosity was measured using a calibrated Ostwald viscometer at 25°C . The flow time of each syrup sample (t_2) and of distilled water (t_1) was recorded in triplicate. Kinematic viscosity was calculated using the standard formula:

$$\eta_2 = \eta_1 \times (\rho_1 \times t_1) / (\rho_2 \times t_2)$$

Where η_1 = viscosity of water (1 cP), η_2 = viscosity of syrup, ρ_1 = density of water (1.000 g/mL), ρ_2 = density of syrup, t_1 = flow time of water, and t_2 = flow time of syrup.

Density Determination

The density of each batch was determined gravimetrically using a 25 mL specific gravity bottle. The weight of the empty bottle (W_1) and the weight of the bottle filled with syrup (W_2) were recorded on an analytical balance. Density (ρ , g/mL) was calculated as: $\rho = (W_2 - W_1) / V$, where V is the volume of the bottle [14].

Clarity Testing

Clarity was evaluated visually using an ampoule inspection machine under standard illumination against both white and black backgrounds. The syrup was assessed for transparency, turbidity, and the presence of any suspended particulate matter or sedimentation [15].

Pourability Test

The pourability of each formulation batch was assessed by recording the time (seconds) required to pour a fixed volume (50 mL) of syrup from a standard container at room temperature. The ease and uniformity of flow were observed and rated qualitatively [16].

Calcium Oxalate Dissolution Assay [17]

The antiurolithiatic activity of the *B. pinnatum* aqueous extract was evaluated in vitro by calcium oxalate dissolution method. A quantity of 100 mg of synthetic calcium oxalate crystals was weighed accurately and incubated with 5 mL of *B. pinnatum* extract at 37°C for 24 hours in a shaking water bath. After incubation, the suspension was filtered through Whatman No. 1 filter paper, and the undissolved residue was washed, dried, and weighed. The percentage dissolution was calculated as:

$$\% \text{ Dissolution} = [(Initial \text{ weight} - Final \text{ weight}) / Initial \text{ weight}] \times 100$$

RESULT AND DISCUSSION

Phytochemical Screening

Preliminary phytochemical screening of the *B. pinnatum* aqueous extract confirmed the presence of alkaloids (cream-coloured precipitate with Mayer's reagent), flavonoids (red colouration in Shinoda test; yellow precipitate in alkaline reagent test), saponins (persistent stable froth), and tannins (dark green colouration with ferric chloride). These results confirm the presence of bioactive phytoconstituents previously reported in the literature.

Organoleptic Evaluation

Table 2. Organoleptic evaluation of Bryophyllum pinnatum sugar-free syrup batches F1–F5

Batch	Colour	Odour	Taste	Appearance	Consistency
F1	Orange	Characteristic	Bitter-sweet	Clear	Good
F2	Orange	Pleasant	Bitter-sweet	Homogeneous	Good
F3	Orange	Characteristic	Bitter-sweet	Clear	Good
F4	Orange	Pleasant	Bitter-sweet	Uniform	Slightly viscous
F5	Orange	Pleasant, characteristic	Balanced bitter- sweet	Clear, uniform, homogeneous	Excellent

pH Measurement

Table 3. pH values of formulation batches F1–F5

Batch	pH
F1	4.08
F2	4.67
F3	5.02
F4	5.59
F5	6.05

Viscosity and Density

Table 4. Viscosity and density parameters for optimised batch F5

Parameter	Value
Density of water (ρ_1)	1.000 g/mL
Density of syrup (ρ_2)	1.048 g/mL
Viscosity of water (η_1)	1 cP
Flow time of water (t_1)	20 s
Flow time of syrup (t_2)	58 s
Calculated viscosity (η_2)	3.03 cP
Calculated density	1.048 g/mL

Clarity Test

Table 5. Clarity test results for optimised batch F5

Background	Observation	Result
White	Clear and transparent; no suspended particles or turbidity	Passed
Black	No foreign particles or sedimentation observed	Passed

Pourability Test

Table 6. Pourability test results for formulation batches F1–F5

Batch	Pouring Time (s)	Observation
F1	8.5	Thick flow
F2	7.8	Smooth flow
F3	7.2	Good flow
F4	6.9	Better pourability
F5	6.5	Excellent flow

Calcium Oxalate Dissolution Assay

The in vitro antiurolithiatic activity assay revealed that the *B. pinnatum* aqueous extract dissolved 58 mg of the initial 100 mg calcium oxalate crystals after 24-hour incubation at 37°C, corresponding to a 58% dissolution rate. This significant dissolution activity supports the antiurolithiatic potential of the formulated extract and is consistent with its traditional application in the dissolution of renal calculi.

OPTIMIZATION SUMMARY

Based on the comprehensive evaluation of all batches, formulation batch F5 (containing 20 mL *B. pinnatum* extract per 100 mL) was selected as the optimised formulation. Its evaluation summary is presented in Table 7.

Table 7. Physicochemical profile of the optimised formulation batch F5

Parameter	Result (F5)
Colour	Orange
Odour	Pleasant and characteristic
Taste	Balanced bitter-sweet
Appearance	Clear, uniform, homogeneous
Consistency	Excellent; ideal flow
pH	6.05
Viscosity (cP)	3.03
Density (g/mL)	1.048
Clarity	Clear; passed
Pourability (s)	6.5; excellent flow
CaOx dissolution (%)	58%

DISCUSSION

The present study successfully formulated and evaluated a pharmaceutically acceptable sugar-free herbal syrup of *B. pinnatum* for supportive management of kidney stones. The progressive improvement in organoleptic properties, pH, viscosity, and pourability from batch F1 through F5 can be attributed to the increasing concentration of the aqueous extract, which contributes both phytochemical active principles and natural buffering capacity to the formulation.

The pH of the optimised formulation (6.05) is within the physiologically acceptable range for oral liquid preparations (3.0–8.0) and is particularly relevant in the context of urolithiasis management, as maintaining a slightly neutral urinary pH is known to reduce calcium oxalate supersaturation and inhibit crystal nucleation. The use of a sodium citrate–citric acid buffer system in the

formulation not only facilitated pH control but may also independently contribute to antiurolithiatic activity through urinary alkalinisation and citrate supplementation, since citrate is a well-established physiological inhibitor of calcium oxalate crystallisation. The viscosity of 3.03 cP for batch F5, as determined by the Ostwald viscometer, is consistent with the expected rheological profile of a pharmaceutical oral syrup and is primarily attributable to xanthan gum, which is a recognised pharmaceutical-grade viscosity enhancer with a stable viscosity profile across a wide pH range. Xanthan gum at 0.3% w/v concentration has been previously employed in herbal syrup formulations to achieve acceptable pourability without excessive resistance to flow. The density of 1.048 g/mL for batch F5 is comparable to the density values reported for similar herbal syrup formulations containing sorbitol as the base confirming proper formulation consistency.

The clarity test results confirm that the formulation is free from visible particulate matter and sedimentation, which is an essential quality attribute for oral liquid preparations to ensure accurate dosing and patient safety. The superior pourability of batch F5 (6.5 s) compared to batch F1 (8.5 s) indicates that the higher extract concentration favourably modulated the overall rheological properties of the syrup in conjunction with the xanthan gum matrix. The 58% in vitro calcium oxalate dissolution activity demonstrated by the *B. pinnatum* extract provides direct mechanistic support for its antiurolithiatic potential. The antiurolithiatic mechanism is believed to involve the inhibitory effects of quercetin and kaempferol on calcium oxalate crystal growth and aggregation, the diuretic action of saponins and flavonoids that promotes crystal expulsion, and the antioxidant activity of phenolic constituents that reduces oxidative stress-mediated renal tubular injury associated with crystal retention. The sugar-free nature of the formulation, achieved through the use of sorbitol as the primary sweetening vehicle, is a clinically significant feature. Diabetic and obese patients have a substantially elevated risk of uric acid and calcium oxalate urolithiasis, and the administration of sucrose-containing syrups in this population would be contraindicated. Sorbitol, a polyol sweetener with a glycaemic index approximately 40% lower than sucrose, provides acceptable sweetness without inducing hyperglycaemia at the recommended doses, making the formulation suitable for diabetic patients. This differentiates the present formulation from most previously reported *B. pinnatum* syrup preparations, which employed sucrose-based vehicles. The overall study indicated that the formulated *Bryophyllum pinnatum* sugar-free syrup showed good pharmaceutical properties and may be useful in kidney stone management. The study

also supports the importance of herbal formulations as a simple, economical, and patient-friendly approach for urinary stone disorders.

CONCLUSION

The present study demonstrates that a stable, palatable, and pharmaceutically acceptable sugar-free herbal syrup of *Bryophyllum pinnatum* can be successfully formulated using sorbitol as the vehicle and xanthan gum as the viscosity-enhancing agent. The optimised batch F5, containing 20 mL of aqueous extract per 100 mL syrup, exhibited pH 6.05, viscosity 3.03 cP, density 1.048 g/mL, excellent clarity and pourability, and satisfactory organoleptic properties. Phytochemical screening confirmed the presence of flavonoids, alkaloids, tannins, and saponins, which are pharmacologically relevant constituents for antiurolithiatic activity. The in vitro calcium oxalate dissolution assay yielded a 58% dissolution rate, providing preliminary mechanistic evidence for the traditional antiurolithiatic use of the plant. The sugar-free formulation is particularly advantageous for the diabetic and obese patient populations, who are disproportionately affected by kidney stone disease. These findings support the potential of the formulated herbal syrup as a safe, economical, and patient-compliant preparation for supportive kidney stone management. Further in vivo pharmacological studies, clinical trials, and long-term stability assessments are warranted to confirm the therapeutic efficacy and safety of this preparation.

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