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Original Article

Pharmacognostic Evaluation and *in vitro* Antiurolithiatic Study of *Musa paradisiaca* Linn. Pseudostem Extracts

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ABSTRACT

Background: Urolithiasis is a complex process that happens from series of numerous physicochemical events involving super-saturation, nucleation, growth, aggregation and retention within the kidneys. Data from *in vitro* investigation suggest that Phyto therapeutic drugs could be effective as either alternative or an additional therapy in the management of Urolithiasis. *Musa paradisiaca* Linn. have been stated to contain antiurolithiatic property by many folklore practitioners. **Objectives:** The present study was designed to investigate the pharmacognostic evaluation and antiurolithiatic effect of *Musa paradisiaca* Linn. pseudostem extracts. **Materials and Methods:** The *in vitro* antiurolithiatic study of the ethanolic and lyophilized extract of *Musa paradisiaca* Linn. pseudostem extract through turbidity method to check their potential in dissolving calcium oxalate crystals using Cystone as the standard compound. **Results:** The turbidity showed by the ethanolic extract and the lyophilized aqueous extract of test drug (*Musa paradisiaca* Linn.) was significant compared to the standard (Cystone). **Conclusion:** In conclusion, the current study provides scientific evidence that the pseudostem of *Musa paradisiaca* Linn. is a possible natural source for the prevention and treatment of urolithiasis.

Keywords: Antiurolithiatic Activity, *Musa paradisiaca* Linn., Nephrolithiasis , Thin layer Chromatography, Urolithiasis.

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INTRODUCTION

Nephrolithiasis, also called urolithiasis, is a kidney disease and is one of the first medical conditions. At some point in their life, 1% to 15% of people will develop kidney stones and research suggests kidney stones are becoming more common throughout the world (Wang *et al*., 2021).

Kidney Stone Disease (KSD) is a common and potentially life-threatening condition, and half of patients experience a repeat kidney stone episode within 5-10 years (Geraghty *et al*., 2024). Kidney stones cause kidney injury through multiple mechanisms including obstruction of urine and inflammation (Stamatelou *et al*., 2023). Kidney Stone Disease (KSD) is a common disease with a global economic burden (Wang *et al*., 2022). Stones are formed of crystals that form in urine. Urine is a mixture of ions, salts, macromolecules and metabolites. Crystals go through different stages (nucleation, growth and aggregation) until they become a stone (Negri *et al*., 2023).

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Calcium, Struvite, Uric acid and Cystine this are the types of stones (Nimavat *et al*., 2022). The pathogenesis of calcium oxalate stone formation is a multistep process involving nucleation, crystal growth, crystal aggregation and crystal retention (Phatak *et al*., 2015). Medical practitioners may use methods such as the following when stones are larger than 5 mm or do not disappear on their own: Extracorporeal Shock Wave Lithotripsy (ESWL), b. Percutaneous Nephrolithotomy (PNL) and Ureteroscopy (URS) (Gilhotra *et al*., 2013). However, these procedures are rather expensive, uncomfortable, and require skilled personnel with the right tools (Patel *et al*., 2011).

According to Ayurveda, "stone-breaking" or "Pashanbheda" plants aid in the breakdown and removal of kidney stones. By inhibiting the development, proliferation, and grouping of stone-forming crystals, the natural chemicals found in these medicinal plants may help avoid kidney stones (Ram *et al*., 2015; Gilhotra 2013). It has been demonstrated that long-term usage of synthetic drugs can have negative consequences. In this study, a safe substitute made from natural derivatives was presented to address the side effects of medications used to treat kidney stones. Because bananas are considered to have therapeutic qualities, particularly in traditional medicine, the pseudostem and juice of bananas were selected for this study in order to assess the extract's potential anti-urolithiasis effects in treating kidney stone illness.

MATERIALS AND METHODS

Collection and Authentication of Plant Material

The stem of *Musa paradisiaca* Linn. *w*as collected from a local agricultural farm in Karad, Maharashtra, India. The plant material was authenticated at Agharkar Research Institute, Shivajinagar, Pune, and assigned authentication number AUTH-26-18.

Morphological characterization

Macroscopic analyses of *Musa paradisiaca* Linn. and its powder included organoleptic characteristics such the plant material's colour, shape, and texture. These metrics were assessed in accordance with normal World Health Organization (WHO) guidelines and are thought to be highly helpful in the crude drug's quality control. The observations are presented in Table 1, and the representative photograph is shown in Figure 1.

Microscopic characterization

The banana plant's fresh pseudostem and powder were chosen for microscopic analysis. Free hand sectioning was used to make microscopic sections. The microscopical sections of the banana pseudostem were converted into several temporary and permanent mounts, which were then studied under a microscope. Staining agents such as Hydrochloric acid (HCl) and phloroglucinol were added to microscopical sections. Using a MOTIC Digital Microscope equipped with MOTIC IMAGE PLUS 2.0 software, photomicrographs of the microscopical sections were captured. The representative photomicrograph is shown in Figures 5 and 6.

Preparation of *Musa paradisiaca* Linn. Powder and Collection of Fresh Juice

Preparation of Musa paradisiaca Linn. Powder

The outer layers of fresh banana pseudostem were carefully peeled off to remove the inner core. The collected material was washed with distilled water to remove foreign matter, dust and adhered impurities. The pseudostem was chopped into very small pieces after washing. The pieces were dried in a hot air oven at 50-60°C until the complete moisture removal. The dried material was powdered in a mechanical mill. The powder was sieved by a 60-mesh sieve in order to get uniform particle size. The powder of pseudostem of banana was stored in an air tight container for further analysis (Garcia *et al*., 2019; Hefnawy, 2022).

Collection of *Musa paradisiaca* Linn. Juice

Fresh *Musa paradisiaca* Linn. pseudostem selected, cleaned and cut to desired length. A hole was made into the trunk with the help of sterile sharp knife. The stem was wrapped with banana leaves and left alone for next 24 hr. The collected juice was separated after 24 hr in the pseudostem. The juice was filtered by using filter paper to remove the impurities. The clear filtrate was kept in refrigeration for further analysis (Ghadage *et al*., 2024).

Extraction

Preparation of Ethanolic Extract of Musa paradisiaca Linn. Pseudostem Powder

Procedure

5 g of coarsely powdered *Musa paradisiaca* Linn. pseudostem was extracted using 50 mL of ethanol by cold maceration method. Then mixture was incubated at room temperature (25-30°C) for 18 hr with shaking. The extract was filtered by Whatman filter paper after maceration. The filtrate was evaporated in a water bath at 40-50°C in order to obtain the ethanolic extract (Gayathry *et al*., 2024).

Preparation of Lyophilized Aqueous Extract of *Musa paradisiaca* Linn. Pseudostem Juice: Procedure

The fresh *Musa paradisiaca* Linn. pseudostem juice collected as mentioned above and filtered. The clear filtrate was used for lyophilization using a freeze dryer. The frozen juice dried under vacuum by sublimation to get a powder. The lyophilized extract was stored in airtight containers for further analysis.

Chromatographic Characterization

Thin Layer Chromatography (TLC)

Precoated silica plates were used for TLC. Sample was spotted 2 cm above base. Solvent system developed using n-hexane: ethyl acetate (6:4). Then, Plates were visualized under Ultra-violet light and iodine vapour. Finally, Retention factor (R_f) values were calculated (Khan *et al*., 2025).

In vitro Antiurolithiatic Activity (Turbidity Method)

Calcium chloride and sodium oxalate were used with Tris buffer (pH 7.4). Extracts were tested for different concentrations. Absorbance was measured at 620 nm. Percentage inhibition was calculated by using standard formula (Sasidharan *et al*., 2018).

RESULTS AND DISCUSSION

Morphological characterization

Musa paradisiaca Linn. Pseudostem (Banana pseudostem)

The macroscopic features of the fresh pseudostem of *Musa paradisiaca* Linn. were analyzed. The observations are presented in Table 1, and the representative photograph is shown in Figure 2.

Banana pseudostem powder

The powdered *Musa paradisiaca* Linn. pseudostem organoleptic properties were assessed. The organoleptic characteristics are summarized in Table 2, and the powdered drug is shown in Figure 3.

Microscopic characterization

Transverse Section of Musa paradisiaca Linn. Pseudostem

The transverse segment of the *Musa paradisiaca* Linn. pseudostem showed well-developed vascular bundles made up of xylem and phloem tissues encircled by lignified fibers when examined under a microscope. The representative photomicrograph is shown in Figure 5.

Powder Microscopy

Powder microscopic examination of the *Musa paradisiaca* Linn. pseudostem indicated the presence of lignified fibrous fragments and xylem vascular fragments, which are distinctive features of the powdered substance. The lignified tissues produced a red-pink hue following staining with phloroglucinol and strong hydrochloric acid, showing the presence of lignin. The representative powder microscopic image is presented in Figure 4.

Extraction

The pseudostem of *Musa paradisiaca* Linn. was effectively extracted. The percentage yield of both extracts is presented in Table 3, and the representative photographs are shown in Figures 5 and 6.

Thin Layer Chromatography (TLC)

The ethanolic extract of *Musa paradisiaca* Linn. was analyzed using thin layer chromatography. Pseudostem was performed on silica gel F254 precoated aluminum plates as the stationary phase and n-hexane:ethyl acetate (6:4) as the mobile phase. The Thin Layer Chromatography (TLC) chromatogram is shown in Figure 7 and the corresponding Retention factor (R_f) values are presented in Table 4.

In vitro Antiurolithiatic Activity

Musa paradisiaca Linn. aqueous and ethanolic extracts have antiurolithiatic action *in vitro*. The inhibitory impact of pseudostem on calcium oxalate crystal formation was measured at 1, 2, and 3 mg/mL doses. At 1 mg/mL, the aqueous extract showed 41.11±0.49% inhibition, while the ethanolic extract showed 44.32±0.94% inhibition. Cystone, the standard medication, had a 65.73±0.95% inhibition rate. At 2 mg/mL, the percentage inhibition increased to 52.89±0.05% for the aqueous extract and 57.17±0.16% for the ethanolic extract, while Cystone showed 73.23±0.14% inhibition. At 3 mg/mL, the aqueous extract inhibited by 61.24±0.22%, while the ethanolic extract inhibited by 65.31±0.19%. Cystone inhibited 82.33±0.22% of the cells under comparable conditions.

These data suggest that both extracts have antiurolithiatic activity, with the ethanolic extract showing a higher inhibitory capability against calcium oxalate crystal formation. The results are presented in Table 5 and the graphical representation is shown in graph number 1.

DISCUSSION

The present study scientifically estimated the pharmacognostical, chromatographic, and *in vitro* study of *Musa paradisiaca* Linn. pseudostem for its possible effect against urolithiasis. The banana pseudostem had a fibrous texture, a cylindrical shape, and a whitish-yellow color. These distinctive morphological characteristics verified the plant material's identity and

Table 1: **Morphological characteristics of fresh *Musa paradisiaca* Linn. pseudostem.**

Sl. No.	Parameters	Observations
1.	Colour	Whitish Yellow
2.	Shape	Cylindrical
3.	Texture	Fibrous

Table 2: **Organoleptic characteristics of *Musa paradisiaca* Linn. pseudostem powder.**

Sl. No.	Parameters	Observations
1.	Colour	Light brown
2.	Odour	Characteristic
3.	Taste	Slightly sweet

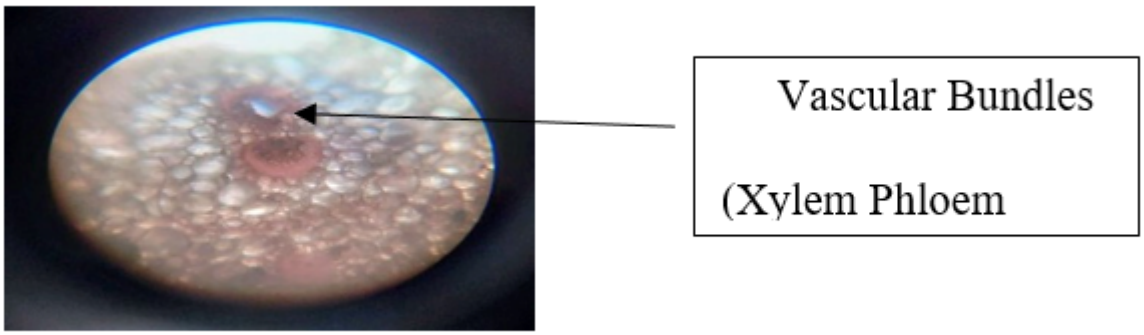


Figure 1: T.S. of *Musa paradisiaca* Linn. pseudostem.

validity. The organoleptic characteristics of powdered banana pseudostem was evaluated. The powder was light brown in color, had a distinct smell, and tasted somewhat sweet. Microscopic examination of the transverse section of the banana pseudostem shows the presence of well-developed vascular bundles. After being treated with phloroglucinol and strong hydrochloric acid, the lignified tissues turned reddish-pink, indicating the presence of lignin. These anatomical traits are crucial diagnostic elements for the crude drug's identification. The powder microscopic examination of the banana pseudostem revealed the presence of lignified fibrous fragments and xylem vessel fragments. The lignified tissues produced a red-pink hue following staining with phloroglucinol and strong hydrochloric acid, showing the presence of lignin. The lignified tissues produced a red-pink hue following staining with phloroglucinol and strong hydrochloric acid, showing the presence of lignin. The lyophilized aqueous extract was obtained as a light brown, dry powder, while the ethanolic extract was obtained as a dark brown, semisolid mass. The chromatogram showed seven well-resolved spots with Retention factor (R_f) values of 0.08, 0.20, 0.22, 0.24, 0.64, 0.75, and 0.83, showing the presence of several phytoconstituents in the extract. The antiurolithiatic activity of ethanolic and lyophilized aqueous extracts was evaluated using an *in vitro* turbidity assay. Both extracts exhibited significant inhibition of calcium oxalate crystal formation in a concentration-dependent manner. The standard drug cystone, exhibited the highest percentage inhibition among all tested samples. These findings suggest that



Figure 2: *Musa paradisiaca* Linn. pseudostem.

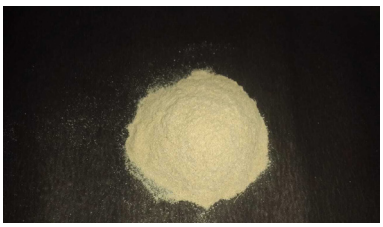


Figure 3: *Musa paradisiaca* Linn. pseudostem powder.

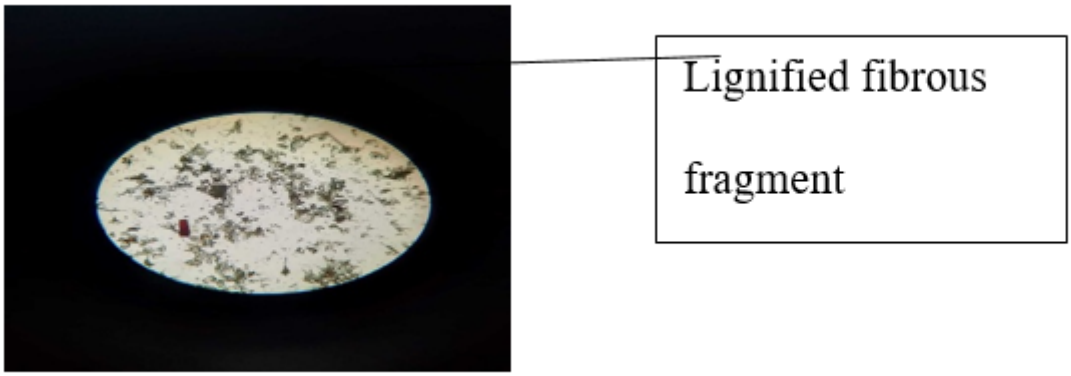


Figure 4: Powder microscopy of *Musa paradisiaca* Linn. pseudostem.

Table 3: **Percentage yield of banana pseudostem extracts.**

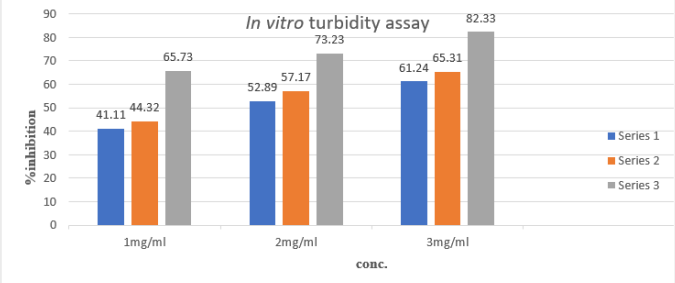
Sl. No.	Extract	Appearance	Percentage Yield
1.	Ethanolic extract	Dark brown, semisolid	18.4%
2.	Lyophilized aqueous extract	Light brown, dry powder	1.5%

Table 4: **Thin-layer chromatographic profile of the ethanolic extract.**

Sl. No.	Extract	Stationary phase	Mobile phase	Retention factor (R_f) value
1.	Ethanolic extract	Silica gel F254 precoated aluminium plate	n-Hexane: Ethyl acetate (6:4)	0.08, 0.20, 0.22, 0.24, 0.64, 0.75, 0.83

Table 5: *In vitro* **antiurolithiatic activity.**

Sl. No.	Concentrations	Aqueous Extract (% Inhibition)	Ethanolic Extract (% Inhibition)	Standard (Cystone) (% Inhibition)
1.	1 mg/mL	41.11±0.49	44.32±0.94	65.73±0.95
2.	2 mg/mL	52.89±0.05	57.17±0.16	73.23±0.14
3.	3 mg/mL	61.24±0.22	65.31±0.19	82.33±0.22



Graph 1: Comparative inhibitory activity of aqueous extract, ethanolic extract, and Cystone against calcium oxalate crystal formation. Blue colour-Aqueous extract, Orange colour-ethanolic extract, Grey colour-Standard.



Figure 5: Ethanolic extract of *Musa paradisiaca* Linn. pseudostem.

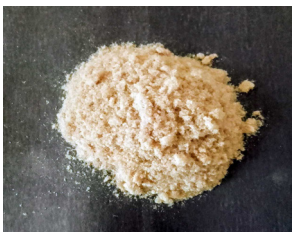


Figure 6: Lyophilized aqueous extract of *Musa paradisiaca* Linn. pseudostem.

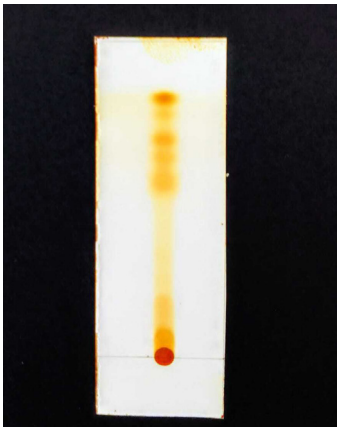


Figure 7: TLC of the ethanolic extract of *Musa paradisiaca* Linn. pseudostem.

both extracts possess antiurolithiatic potential, with the ethanolic extract showing comparatively superior efficacy (Graph 1).

CONCLUSION

The current study included pharmacognostical, chromatographic, and *in vitro* tests on *Musa paradisiaca* Linn. pseudostem. The results demonstrate the quality and authenticity of the plant material. Scientific research was carried out on the *Musa paradisiaca* Linn. pseudostem to assess its antiurolithiatic potential. The *in vitro* antiurolithiatic study revealed that the ethanolic extract suppresses the development of calcium oxalate crystals in a concentration-dependent way. It was discovered that the aqueous extract is less effective than the ethanolic extract. In conclusion, the current study provides scientific evidence that the pseudostem of *Musa paradisiaca* Linn. is a possible natural source for the prevention and treatment of urolithiasis, but further *in vivo* and clinical research is required.

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ABBREVIATIONS

KSD: Kidney Stone Disease; **ESWL:** Extracorporeal Shock Wave Lithotripsy; **PNL:** Percutaneous Nephrolithotomy; **URS:** Ureteroscopy; **WHO:** World Health Organization; **HCl:** Hydrochloric acid; **TLC:** Thin-Layer Chromatography; **UV:** Ultraviolet.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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