RESEARCH PAPER

Anti-Urolithic Activity of Polyherbal Formulation against Ethylene Glycol-induced Urolithiasis in Sprague Dawley Rats

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ABSTRACT
BackgroundUrolithiasis is a common kidney condition characterized by the formation of stones, mainly formation of calcium oxalate crystals. High recurrence rate and possible side effects are linked to current strategies. The safety profile and synergistic pharmacological effects of polyherbal preparations have attracted increasing attention. The aim of the current study was to assess the antiurolithic potential of a polyherbal formulation made from three medicinal plants in rats experimentally induced to develop urolithiasis.
Material & Method Male Sprague Dawley rats were given drinking water containing 0.75% ethylene glycol and 1% ammonium chloride for 28 days in order to establish experimental urolithiasis. The animals were divided into four groups (I, II, III, IV): standard drug-treated, disease-control, polyherbal-treated, and normal-control. During treatment, the formulation was administered orally. Urine parameters, including oxalate, phosphate, and calcium, were examined, as were biochemical parameters like serum creatinine, urea, uric acid, and calcium. To evaluate renal damage, including crystal deposition and renal damage, the kidney tissue was examined histopathologically. One-way ANOVA and post-hoc test were used for statistical analysis.
ResultSerum creatinine, urea, and uric acid, and urinary oxalate level were markedly increased in the disease control group after ethylene glycol and ammonium chloride were administered. These biochemical markers were significant ($P < 0.05$) return to normal after treatment with the polyherbal formulation. Additionally, the formulation enhanced the histologic architecture of the kidneys and decreased calcium oxalate crystal deposition.
Conclusion The polyherbal formulation demonstrated strong anti-urolithic activity by restoring metabolic homeostasis and inhibiting the formation of renal crystals. These results point to its potential to aid in the natural treatment of a urolithiasis..
Keywords: Antiurolithic activity, Polyherbal Formulation, Ethylene glycol-induced urolithiasis, Calcium oxalate crystallization
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INTRODUCTION

Urinary stones are most common in people between the ages of 20 and 40 [1]. The risk of stone formation can be increased by conditions that slow the normal flow of urine, leading to urinary retention [2]. Men are more prone than women due to variances in the biology. For example, men typically have higher calcium and lower citrate levels in urine [1]. In addition to gender, ethnicity plays a vital role because people of Native American, Israeli, and African ancestry are more likely to have this disease [3]. Urolithiasis arises when the kidney fails to maintain the balance between removing chemicals and adequate hydration [4]. Food intake, physical activities, and environmental factors are the variables that need to be coordinated and adapted. An excessive amount of chemicals that are difficult to break down leads to urine supersaturation due to excretion or reduced fluid levels. This results in crystal formation, growth, and their grouping to form stones. Most people with high blood pressure, liver diseases, or obesity are greatly affected as the body becomes severely and complicatedly affected by these stones. Daily lifestyle and dietary habits play a significant role in urolithiasis, as there are several contributing factors. Modern treatment procedures, such as Extracorporeal shock wave lithotripsy and other methods, are often used to treat urolithiasis, but they are much more expensive and painful, and do not guarantee that the stone will not recur in the near future [5]. According to the studies, recurrence occurs rapidly in the absence of preventive treatment procedures (10% of patients in the first year, one-third within 5 years, and up to half within 10 years) [6]. Bleeding, hypertension, tubule injury, and the potential for further kidney scarring may also limit medical interventions. Seeing this, alternative treatment procedures must be considered. Natural remedies are the most interesting within traditional systems of medicine. Plant-based remedies have long been used for urolithiasis with minimal adverse effects. A detailed scientific study is

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needed to support the rational use of treatment procedures, especially the use of herbal remedies, as conventional acceptability is lower [7]. Further studies will be helpful, and these herbs can help ensure that kidney stones do not recur. Several medicinal plants were traditionally used to treat urolithiasis. Plants with diuretic and antiurolithic potential are much considered over the modern treatment procedures. WHO always promotes the use of herbs and rational medicines, highlighting the significance in general health conditions. The herbal combinations (polyherbal formulations) yield a variety of pharmacological actions and benefits, frequently blending the herbal remedies to get the synergistic potential [8]. *Kalanchoe pinnata* is rich in glycosides, quercetin, flavonoids, terpenoids, alkaloids, and kaempferol contents and has shown promise in dissolving the calcium oxalate, the most important component of stones. The flavonoid content of this plant is responsible for the inhibition of calcium oxalate crystal formation. The plant extracts have been shown to reduce the size of these crystals, which is beneficial in the management of urolithiasis [9]. *Grewia optiva* is the plant used to treat cough, fever, diarrhoea, and several other ailments in the traditional system of medicine. According to the phytochemical screening, the plant contains flavonoids, terpenoids, and saponins, which are responsible for preventing calcium oxalate crystal formation and for reducing oxidative damage. The investigation for urolithic potential of this plant will be fruitful, as the phytochemical makeup is promising for inhibiting the stone formation [10]. *Macrotyloma uniflorum,* which is commonly known as Kulthi or Kuladh in the Uttarakhand region, is a significant source of amino acids, proteins, carbohydrates, and lipids with phenolic compounds such as quercetin, myricetin, and kaempferol, which have been widely used for the treatment of kidney stones in the traditional system of medicine [11]. People used to consume this as home pulses in their meals, and its phytochemical composition supports its antiurolithic potential [12]. The aim of this research was to evaluate the anti-urolithic potential of the polyherbal suspension made up of the above-stated plants. Individual plants have already been proven to have efficacy for treating urolithiasis. By combining these plants, antiurolithic effects can be enhanced, but less knowledge about how to combine these plants for better results than they promised individually. Male SD (Sprague Dawley) Rats with urolithiasis induced by ethylene glycol and ammonium chloride were used to evaluate the polyherbal suspension [13]. Cystone was used as a standard in this study, which is a potent herbal medicine made by the Himalaya Wellness company.

METHODS

Plant Collection and Authentication

This study used three plant components: *Kalanchoe pinnata* roots, *Macrotyloma uniflorum grains,* and *Grewia Optiva leaves*. *K. pinnata* & *G. Optiva* were collected from Bageshwar, Uttarakhand, and authenticated by the Botanical Survey of India in Dehradun. *M. uniflorum* grains were purchased from the local market of Bhauwala, Dehradun, and verified by the Dravya Guna Department at Dev Bhoomi Medical College of Ayurveda and Hospital, Dehradun, Uttarakhand, India.

Preparation of Plant Extract

The roots of *K. pinnata*, leaves of *G. Optiva*, and grains of *M. uniflorum* were washed in double-distilled water, then shade-dried for 7 days at room temperature. After drying, cut the roots and leaves into small pieces, then grind them into a fine powder with a mortar and pestle. Each powdered sample was handled separately and stored in airtight glass containers before extraction. A hydro-ethanolic solvent system (ethanol: water, 70:30) was used, with 100-200 mL of solvent added to each sample. Maceration was carried out at 60-80 °C for about 2 hours with continuous stirring using a magnetic stirrer. The mixtures were later cooled, filtered, and concentrated with a rotary evaporator to produce semi-solid extracts. These were stored in airtight glass containers for further experiments. The methodology used a safer solvent system and followed green chemistry principles, thereby reducing environmental impact while maintaining efficient extraction.

Preparation for Polyherbal Suspension

All three extracts were weighed and then mixed to form a mixture. This mixture was then suspended in Xanthan gum to create the suspension, which was used as a sample for further study.

Experimental Animals

Male Sprague-Dawley (SD) rats weighing 150-180g were acquired from the Translam Institute of Pharmaceutical Education and Research's animal facility in Meerut. The animals were housed in polypropylene cages under a 12-hour light/dark cycle at 23 ± 20 °C and 50% relative humidity in a controlled environment for 1 week prior to the study. All rats were given a standard diet [14]. The entire study was conducted in accordance with the Guide for the Care and Use of Laboratory Animals. IAEC approval was obtained under proposal number IAEC/PH25/TIPER/225.

Acute Toxicity Study

According to OECD guideline No. 423, this study was conducted using Sprague-Dawley rats to assess the safety of Polyherbal Suspension. The therapeutic dose was calculated based on an oral acute toxicity study [15]. Three doses were selected:

Low dose (LD): *150 mg/kg*
Moderate dose (MD): *300 mg/kg*
High dose (HD): *450 mg/kg*

Suspension was prepared freshly in 5% Xanthan gum for oral administration.

Experimental Design and Protocol

A total of forty-eight male Sprague–Dawley rats were allocated into two principal regimens: prophylactic and curative [16]. Within each regimen, animals were further subdivided into four groups (n = 6 per group) as follows:

Prophylactic regimen (1-7 days)

Group I- Control: Rats were given 1 ml of saline

Group II- Urolithiasis rats were injected with Calcium oxalate (CaOx) 0.75% EG intraperitoneally for 7 days.

Group III- Test Polyherbal Suspension treated: Rats were administered the test suspension at the dosage (mentioned in Table 1) with CaOx from 1 to 7 days.

Group IV- Cystone treated: Rats were administered Cystone (750 mg/kg) prophylactically with CaOx from day 1 to day 7 of Urolithiasis induction.

Table 1: Experimental design for Prophylactic Regimen

Group	Treatment
I	Normal control (vehicle only)
II	Disease control (0.75%EG)
III	Standard control (Cystone 750 mg/kg)
IV	Test group A (Polyherbal formulation – 150 mg/kg)
V	Test group B (Polyherbal formulation – 300 mg/kg)
VI	Test group C (Polyherbal formulation – 450 mg/kg)

Curative Regimen: (7-15 days)
Group 1- Control: Rats were given 1 ml of saline
Group 2- Urolithiasis rats were injected with Calcium oxalate (CaOx) 0.75% EG intraperitoneally for 7 days.
Group 3- Test Polyherbal Suspension treated: Rats were first administered CaOx from day 1 to day 7 and then administered Polyherbal Suspension from day 8 to the 15th day.
Group 4- Cystone treated: Rats were first injected with CaOx from day 1 to day 7, then cystone (750 mg/kg), Curative Urolithiasis induction.

Urine Analysis
24 Hours before the end of each experimental regimen, the rats' body weights were recorded, and the animals were individually housed in metabolic cages figure 1. Urine was collected continuously for 24 hours in 50 mL beakers kept on ice. The total urine volume was measured using a graduated cylinder, and urinary pH and specific gravity were assessed by strip-based methods. To facilitate microscopic analysis of the sediment, aliquots of the samples were centrifuged at 3,000 rpm for 10 minutes [17]. The biological components of the supernatant, such as creatinine, urea, calcium, uric acid, phosphorus, and magnesium, were then examined.

Figure 1: SD Rat in Metabolic Cage

Evaluation of Serum parameters
Rats were put to sleep with sodium pentobarbital at the end of each treatment. Using recognized procedures and diagnostic kits, blood was obtained by heart puncture for biochemical investigation of mineral levels (calcium, phosphate) and renal function markers (creatinine, uric acid, urea). The kidneys were separated into two parts, cleaned, and weighed relative to body weight. To measure oxidative and antioxidant stress indicators (MDA, GSH, GST, SOD, and CAT), one fraction was homogenized in Tris-HCl buffer, centrifuged, and the supernatant was collected [18]. To assess crystal deposition histologically, the remaining piece was fixed in saline.
Statistical analysis
There are six animals in each group (n=6), and the data are shown as mean ± SEM. One-way analysis of variance (ANOVA) was used for statistical comparisons, and Duncan's multiple range test was then used to analyze group differences. A p-value of less than 0.05 was used to indicate statistical significance. SPSS software was used for all statistical methods [19].

RESULTS
Acute toxicity study
Rats were given the suspension at a dose of 5g/kg body weight for a limit test (432). The animals were observed for 14 days after being given the suspension orally. At this dosage, no mortality or discernible behavioural changes were seen, suggesting its safety. Furthermore, biochemical examination revealed no appreciable variation in AST and ALT enzyme activity between the treatment and control groups.

Urine Analysis
Calcium oxalate crystalluria was markedly increased in the disease control group that received EG + AC. The number and size of crystals notably decreased in the animals in the treatment groups, showing results similar to those seen with the conventional medication, as shown in the figure 2 and table 2.

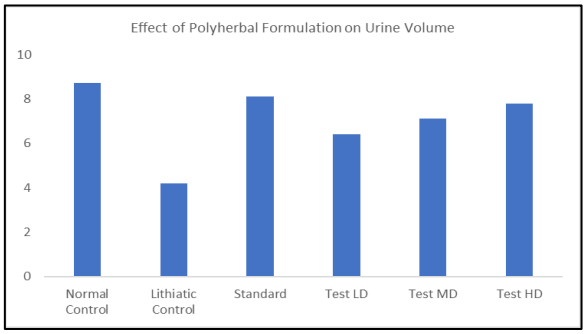


Figure 2: Effect of Polyherbal Formulation on Urine Volume

Table 2: Urine Volume

Group	Volume (mL)
Normal Control	8.7±0.4
Lithiatic Control	4.2±0.3
Standard	8.1±0.4
Test LD	6.4±0.3
Test MD	7.1±0.4
Test HD	7.8±0.3

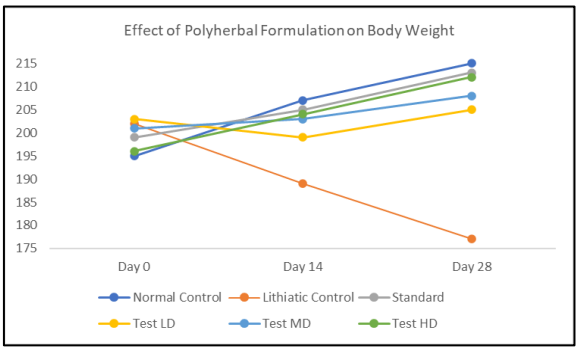
Effect on Body Weight

Rats in the lithiasis control group showed a significant decrease in body weight, indicating ethylene glycol-induced systemic toxicity. The preventive and restorative effects of the polyherbal formulation were demonstrated by its ability to effectively mitigate this weight loss, especially at medium and high doses, as shown in Table No. 3.

Table 3: Body Weight Changes

Group	Day 0	Day 14	Day 28
Normal Control	195±5	207±6	215±5
Lithiatic Control	202±6	189±5	177±6
Standard	199±5	205±6	213±5
Test LD	203±6	199±5	205±6
Test MD	201±5	203±6	208±5
Test HD	196±6	204±5	212±6

Figure 3: Effect of Polyherbal suspension on Body Weight



Evaluation of Urinary Biochemical Parameters

1. The levels of calcium, salt, and phosphate in the urine significantly decreased.

2. Urine magnesium levels are elevated.
3. Creatinine excretion returned to nearly normal levels.

Table 4: Effect of Polyherbal formulation on Urinary biochemical parameters in EG+ AC induced Urolithiasis

Parameter	Normal	Lithiatic	Standard	Test LD	Test MD	Test HD
Calcium (mg/dL)	2.8±0.2	7.8±0.4	3.4±0.3	5.8±0.3	4.3±0.3	3.6±0.2
Oxalate (mg/dL)	1.8±0.2	6.7±0.4	2.4±0.2	5.3±0.3	3.8±0.3	2.6±0.2
Phosphate (mg/dL)	3.2±0.2	6.8±0.3	3.6±0.3	5.3±0.3	4.2±0.3	3.9±0.2

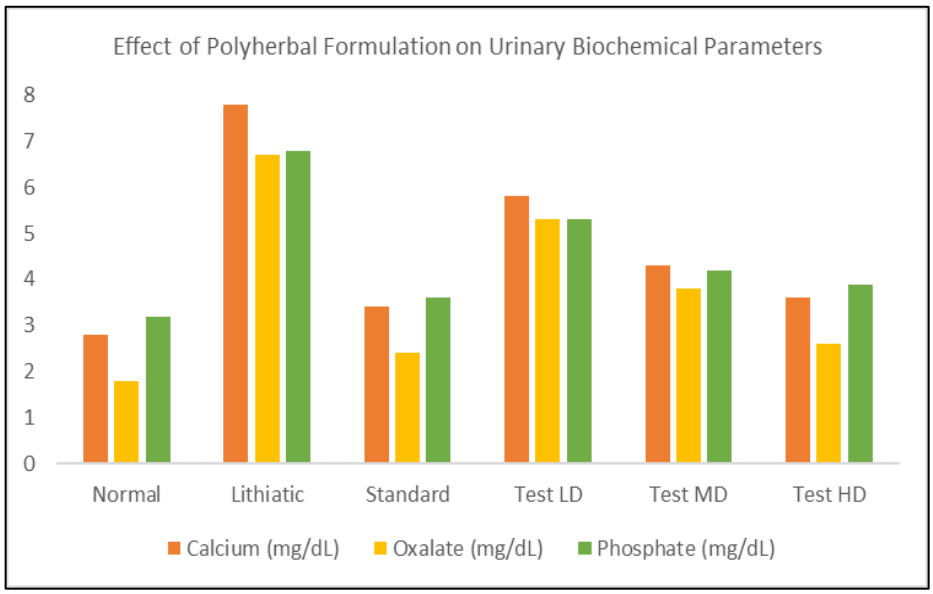


Figure 4: Effect of Polyherbal formulation on Urinary Biochemical Parameters

Serum parameter:

Serum creatinine and urea levels increased after EG+AC administration, suggesting impaired renal function. Following the treatment with polyherbal formulation, these kidney biomarkers significantly improved and returned to normal.

Table 5: Effect of polyherbal formulation on serum biochemical parameters

Parameter	Normal	Lithiatic	Standard	Test HD
Creatinine (mg/dL)	0.71±0.04	1.93±0.08	0.83±0.05	0.84±0.04
Urea (mg/dL)	32±3	70±4	36±3	39±3
Uric Acid (mg/dL)	3.1±0.2	7.5±0.3	3.4±0.2	3.8±0.2

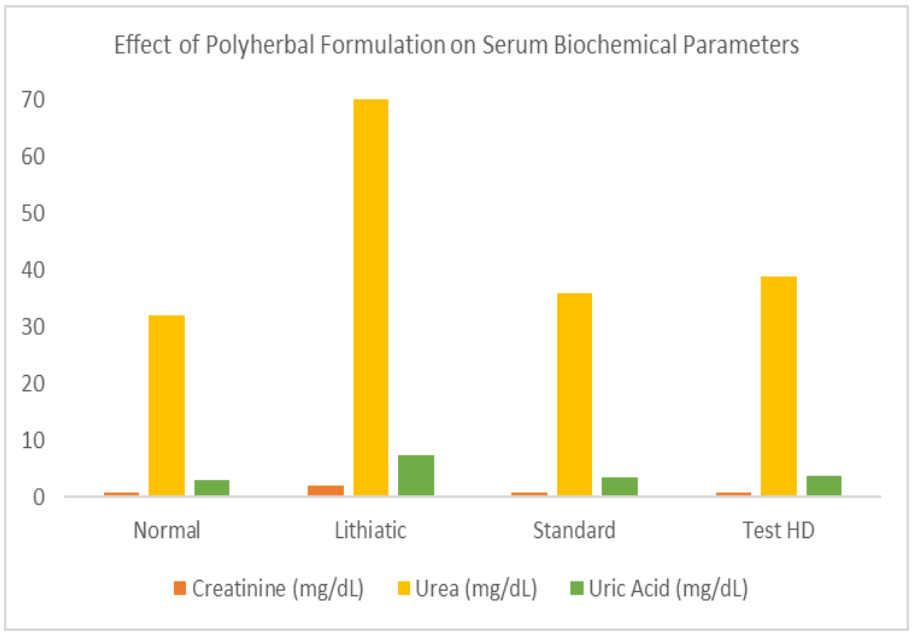


Figure 5: Effect of Polyherbal formulation on Serum Biochemical Parameters

Kidney Homogenate Analysis

Renal tissue showed increased calcium and phosphate accumulation in the disease control group. These deposits were significantly reduced in the treated animals, indicating the formulation's anti-lithiatic ability.

Table 6: Kidney Homogenate Parameters

Parameter	Normal	Lithiatic	Standard	Test HD
Calcium (mg/g tissue)	2.4±0.2	8.3±0.4	2.9±0.3	3.2±0.2
Oxalate (mg/g tissue)	1.9±0.2	7.3±0.4	2.3±0.2	2.5±0.2

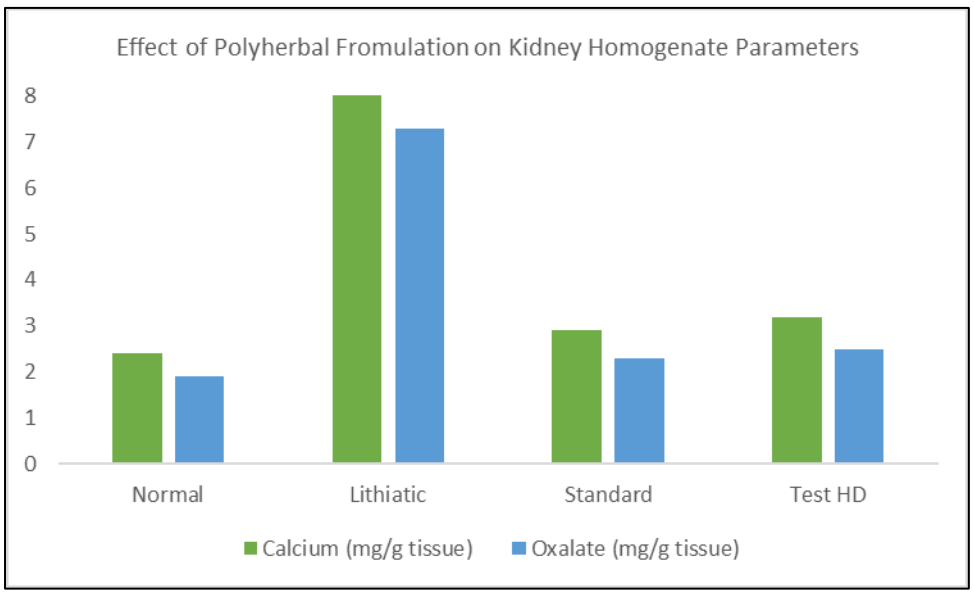


Figure 6: Effect of Polyherbal Formulation on Kidney Homogenate Parameters

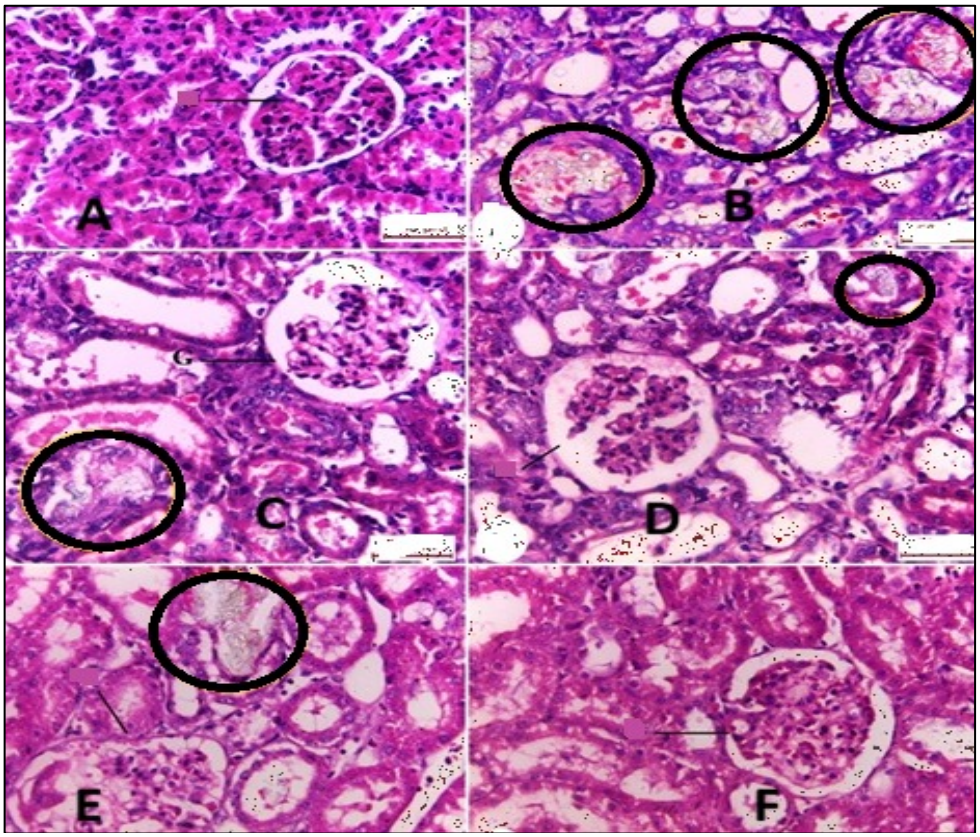


Figure 7: Effect of Kidney section (A) Control rats showing normal glomeruli and tubular renal structure (B) Urolithiasis rat showing multiple crystal deposition (circle in black) (C, D) Urolithiasis rats treated with polyherbal suspension (500 mg/kg body weight) showing low crystal deposit (E, F) Urolithiasis rats treated with cystone (750mg/kg body weight) showing more or less drop in crystal deposition accumulation

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DISCUSSION

People of all racial, cultural, and geographic backgrounds are impacted by the worldwide issue of urinary stones [20]. Calcium oxalate, either alone or in combination with calcium phosphate, is the most common urolith, accounting for more than 80% of stones [19,21]. Although the mechanisms underlying crystal nucleation, aggregation, and insoluble particle formation remain unknown, urinary lithiasis is well recognized as a complex process [14]. Diuretics are one of many treatments being tested to prevent calculi from recurring, although the scientific evidence for their efficacy is less convincing [22]. The majority of people worldwide still use plants as an inexpensive form of medication. The plants employed in traditional antiurolithic therapy have been the subject of numerous pharmacological investigations that have shown their therapeutic effects in vitro or in animal models [10]. The current study assessed the antiurolithic activity of a polyherbal suspension comprising extracts of *G. optiva*, *M. uniflorum*, and *K. pinnata* against ethylene glycol-induced urolithiasis. A preliminary phytochemical analysis was performed. The polyherbal formulation mainly contained terpenoids, glycosides, and flavonoids. The presence of these components and their interactions with the other phytochemicals may alter the therapeutic profile of specific formulations. Overall, the presence is in line with previously reported findings showing antiurolithic activity. The toxicity profile was evaluated using an acute oral toxicity assessment, and the results showed that the formulation was suitable. Different doses of 200, 300, and 450 mg/kg were chosen for additional research based on this. This synergistic effect was influenced in various ways by the plant components added to the combination. *K. pinnata* offered nephroprotective and antioxidant benefits by lowering oxidative damage and protecting renal tissue from crystal-induced damage. By supporting mineral homeostasis and providing anti-inflammatory qualities, *G. optiva* decreased calcium-phosphate imbalance and alleviated tissue irritation. In traditional medicine, the horse gram, *M. uniflorum*, is widely recognized for its litholytic activity and urinary alkalization, which aid in the dissolution of calculi and reduce the precipitation of lithogenic salts. Therefore, combining plant components into a single formulation provides a reasonable and complementary pharmacological basis for its apparent performance. According to biochemical and urine examination, the treated groups' serum creatinine, urea, and calcium and oxalate levels all reverted to normal, indicating that renal function had been restored and the risk of lithogenic disease had decreased [23]. The histological examination, which showed that treated rats had less crystal deposition and preserved tubular architecture than controls, provided additional evidence for nephroprotection. These findings support the earlier research on the anti-Urolithiasis potentials of plants extracts and demonstrate the enhanced efficiency attained by their combination [24]. Particular consideration should be given to formulations' antioxidant potential. Oxidative stress is the primary source of damage

to the renal epithelium, which serves as a nidus for crystal attachment. By reducing oxidative damage, the formulation inhibits the production of stones while simultaneously promoting tissue recovery. The diuretic impact seen in treated groups, which dilutes urine solutes and lowers the danger of supersaturation, further facilitates this process. Despite these encouraging outcomes, there are still important limitations that need to be addressed. Since the study was carried out in an animal model, a careful assessment is necessary before applying the formulation to humans. Clinical trials, dose modification, and long-term safety are necessary to establish therapeutic relevance. However, the IAEC-approved process and the comprehensive evaluation provide strong evidence for the formulations' efficacy. For the treatment of urolithiasis, the combination of *M. uniflorum, G. optiva,* and *K. pinnata* offers a solid pharmacological justification. To prove this formulation is a viable substitute, future research should focus on long-term safety profiles, molecular-level mechanistic studies, and clinical translation. These results will be further supported by ongoing statistical validation of datasets.

CONCLUSION

In this study, a prepared polyherbal formulation was found to have anti-urolithic effects through various complementary mechanisms, including antioxidant defense, diuresis, renal protection, and inhibition of crystal formation. Pharmacological activity indicates that the combined contribution of *M. uniflorum, G. optiva, and K. pinnata* provides a strong foundation, addressing a distinct aspect of stone genesis. In vivo testing, using IAEC-approved procedures, confirmed the formulation's therapeutic potential and demonstrated improvements in biochemical and urine parameters, reduced crystal deposition, and preserved renal tissue integrity. Although more research is needed to assess long-term safety, adjust dosage, and incorporate findings into clinical practice, the available data show that this polyherbal solution is a promising alternative for treating Urolithiasis.

REFERENCE

1. Liu Y, Chen Y, Liao B, Luo D, Wang K, Li H, et al. Epidemiology of urolithiasis in Asia. Asian J Urol. 2018 Oct 1;5(4):205–14. doi:10.1016/j.ajur.2018.08.007 PubMed PMID: 30364478.
2. Lulat S, Yadav Y, Balaraman R, Maheshwari R. Antiurolithiatic effect of lithocare against ethylene glycol-induced urolithiasis in Wistar rats. Indian J Pharmacol. 2016 Jan 1;48(1):78. doi:10.4103/0253-7613.174564 PubMed PMID: 26997728.
3. Rajeshwari T, Suresh R, Sudhakar M. Anti-urolithiatic activity of saponin rich fraction from the methanolic extract of Achyranthes aspera against ethylene glycol induced urolithiasis in Wistar rats. J Appl Pharm Sci. 2023 Sep 4;13,(9):197–203. doi:10.7324/JAPS.2023.144912
4. Kumar RR, Janadri S, Mudagal MP, Sharma UR, Vada S, Babu HT, et al. In vivo and in vitro experimental models for urolithiasis pathophysiology research. Asian J Urol. 2025 Oct 1;12(4):486–95. doi:10.1016/j.ajur.2024.08.006
5. Raj S, Gnana Soundara Rajan MS, Ramasamy S, Rajamony Suthies Goldy RI, Ariyamuthu R, Sudhagar M, et al. An in vitro Anti-urolithiasis Activity of a Herbal Formulation: Spinacia oleracea L. and Coriandrum sativum L. Clinical Complementary Medicine and Pharmacology. 2024 Mar 1;4(1):100124. doi:10.1016/j.ccmp.2023.100124
6. Lolla S, Peddinti H, Gojuvaka S, Saba S, Dasari UD, Pillalamarri M. Evaluation of Anti-urolithiasis Activity by Nucleation Assay. Int J Trop Dis Health. 2024 Apr 8;45(6):13–20. doi:10.9734/ijtdh/2024/v45i61535
7. Argal A, Saxena N. AMELIORATIVE ANTIUROLITHIATIC EFFECT OF A POLYHERBAL SUSPENSION. Journal of Drug Delivery and Therapeutics. 2014 Nov 15;4(6):83–7. doi:10.22270/jddt.v4i6.1007
8. Ballotin VR, Bigarella LG, Brandão AB de M, Balbinot RA, Balbinot SS, Soldera J. Herb-induced liver injury: Systematic review and meta-analysis. World J Clin Cases. 2021 Jul 16;9(20):5490–513. doi:10.12998/wjcc.v9.i20.5490 PubMed PMID: 34307603.
9. Bigoniya P, Sohgaura AK, Shrivastava B. Antilithiatic effect of C. dactylon, E. officinalis, K. pinnata, and B. nutans ethyl acetate fraction on glyoxylate-induced nephrolithiasis. Future Journal of Pharmaceutical Sciences 2021 7:1. 2021 Mar 25;7(1):79-. doi:10.1186/s43094-021-00227-1
10. Butterweck V, Khan SR. Herbal Medicines in the Management of Urolithiasis: Alternative or Complementary? Planta Med. 2009;75(10):1095. doi:10.1055/s-0029-1185719 PubMed PMID: 19444769.
11. Sudheer A, Reddy KS, Naidu RJ, Kumar KV, Mahaboobjan S, Likithasree P, et al. Horse gram (Macrotyloma uniflorum) a traditional food medicine protects the kidney from the cisplatin-induced nephrotoxicity in albino rats. Indian Journal of Traditional Knowledge (IJTK). 2023 Dec 13;22(4):746–54. doi:10.56042/ijtk.v22i4.7198
12. Parasuraman S, Qi YZ, Jie LW. Hepato- and Nephroprotective Effects of Ethanolic Extract of Seeds of Macrotyloma uniflorum on Paracetamol-induced Hepato- and Nephrotoxicity in Rats. Indian Journal of Pharmaceutical Education and Research. 2022 Jul 1;56(3):772–9. doi:10.5530/ijper.56.3.127
13. Bopda OSM, Longo F, Bella TN, Edzah PMO, Taïwe GS, Bilanda DC, et al. Antihypertensive activities of the aqueous extract of Kalanchoe pinnata (Crassulaceae) in high salt-loaded rats. J Ethnopharmacol. 2014 Apr 28;153(2):400–7. doi:10.1016/j.jep.2014.02.041 PubMed PMID: 24583107.
14. Anti-Urolithiatic Activity of Dolichos Biflorus Seeds [Internet]. [cited 2026 Mar 15]. Available from: https://www.phytojournal.com/vol2Issue2/19.1.html
15. Saravanan V, Murugan SS, Krishnan KRN, Mohana N, Sakthivel K, Sathya TN. Toxicological Assessment of Ethanolic Leaves Extract of Kalanchoe pinnata in Rats. Indian Journal of Forensic Medicine & Toxicology. 2021 Mar 24;15(2):1148–55. doi:10.37506/ijfmt.v15i2.14476

16. Worcester E, Evan A, Bledsoe S, Lyon M, Chuang M, Orvieto M, et al. Pathophysiological correlates of two unique renal tubule lesions in rats with intestinal resection. Am J Physiol Renal Physiol. 2006;291(5). doi:10.1152/ajprenal.00033.2006 PubMed PMID: 17028259.
17. Abbona F, Calleri M, Ivaldi G. Anti-urolithiatic and anti-inflammatory activities through a different mechanism of actions of Cissus gongylodes corroborated its ethnopharmacological historic. J Ethnopharmacol. 2020 May 10;253(3):112655. doi:10.1107/S0108768184002020
18. Patel PK, Patel MA, Saralai MG, Gandhi TR. Antiurolithiatic Effects of Solanum xanthocarpum Fruit Extract on Ethylene-Glycol-Induced Nephrolithiasis in Rats. J Young Pharm. 2012;4(3):164. doi:10.4103/0975-1483.100022 PubMed PMID: 23112535.
19. (PDF) Biostatistical analysis [Internet]. [cited 2026 Mar 15]. Available from: https://www.researchgate.net/publication/221959634_Biostatistical_analysis
20. Khan SR. Renal tubular damage/dysfunction: key to the formation of kidney stones. Urol Res. 2006 Apr;34(2):86–91. doi:10.1007/s00240-005-0016-2 PubMed PMID: 16404622.
21. Aihara K, Byer KJ, Khan SR. Calcium phosphate-induced renal epithelial injury and stone formation: Involvement of reactive oxygen species. Kidney Int. 2003 Oct 1;64(4):1283–91. doi:10.1046/j.1523-1755.2003.00226.x PubMed PMID: 12969146.
22. Coe FL, Evan A, Worcester E. Kidney stone disease. J Clin Invest. 2005 Oct;115(10):2598–608. doi:10.1172/JCI26662 PubMed PMID: 16200192.
23. Wesson JA, Worcester EM, Wiessner JH, Mandel NS, Kleinman JG. Control of calcium oxalate crystal structure and cell adherence by urinary macromolecules. Kidney Int. 1998 Apr 1;53(4):952–7. doi:10.1111/j.1523-1755.1998.00839.x PubMed PMID: 9551403.
24. |Review INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES 3033 | P a g e [Internet]. doi:10.5281/zenodo.15712225.