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A Systematic Assessment of The Antiurolithiatic Benefits of Medicinal Herbs Based On In Vivo Investigations in Rat Models of Calcium Oxalate Nephrolithiasis

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ABSTRACT

Nephrolithiasis, also referred to as kidney stone disease, is a major worldwide health issue, and the most common form is calcium oxalate. The application of medicinal herbs in its prevention and treatment has attracted significant interest because of their bioactive constituents with antiurolithic activity. In this review, in vivo studies on rat models of calcium oxalate nephrolithiasis are critically assessed systematically to determine the efficacy of medicinal herbs. The review identifies major herbs, their mechanisms of action, experimental results, and possible clinical uses. Results indicate that most medicinal herbs have nephroprotective, antioxidant, anti-inflammatory, and diuretic effects, which help in decreasing stone formation and recurrence. More studies are required to standardize the dosages and confirm their efficacy in human trials.

Key Words:

Antiurolithic herbs, nephrolithiasis, calcium oxalate, experimental methodologies, in vivo studies, ethylene glycol model, hyperoxaluria, nephroprotective activity

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1. INTRODUCTION

Kidney stones, especially calcium oxalate stones, are an emerging issue globally with rising incidence because of diet and lifestyle [1]. Traditional treatments, like lithotripsy and pharmacotherapy, are limited by recurrence and side effects. Hence, herbal medicine has become a potential option based on its natural bioactive molecules that provide nephroprotective benefits [2].

Urolithiasis, also referred to as kidney stone disease, is a common urinary tract disorder involving the development of mineral deposits within the urinary tract [3]. Of the several types of kidney stones, calcium oxalate (CaOx) stones are responsible for most cases and cause severe pain, urinary

obstruction, and even renal damage [4]. Traditional treatments, such as pharmacological interventions and surgery, are usually limited by high recurrence rates, side effects, and cost [5]. Thus, there has been increasing interest in investigating other therapeutic approaches, especially the utilization of medicinal herbs with antiurolithic activity [6].

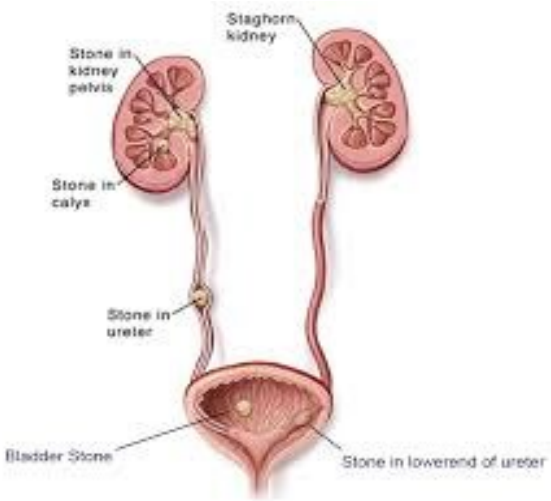

Figure 1: Urolithiasis

Medicinal herbs have historically been used across different cultures in treating and preventing kidney stones, providing potential nephroprotective, diuretic, antioxidant, and anti-inflammatory effects [7]. In vivo research using rat models of calcium oxalate nephrolithiasis offers important information regarding the effectiveness and mechanisms of these herbal therapies. Such experimental models closely resemble human pathology, enabling researchers to assess the inhibitory effects of medicinal herbs on stone formation, solubilization of formed stones, and renal protection [8].

This systematic review seeks to critically evaluate the antiurolithic activity of medicinal herbs from in vivo studies in rat models of calcium oxalate nephrolithiasis [9]. Through a critical evaluation of available literature, this article endeavors to offer an overarching insight into the pharmacological action, efficacy, and possible clinical relevance of herbal-derived interventions against kidney stone prevention and therapy [10].

1.1. Conventional Treatment Challenges

Pharmacotherapy, ureteroscopy, and extracorporeal shock wave lithotripsy (ESWL) are the traditional methods of treating nephrolithiasis. But these methods have a number of drawbacks [11]:

- **High Recurrence Rates**

The greatest challenge in the traditional management of nephrolithiasis is the recurrence of kidney stones at a high rate [12]. Research has shown that even with successful surgery, about 50% of patients have a recurrence of the stones within five years [13]. The reasons for this are mainly metabolic abnormalities, dietary factors, genetic susceptibility, and inadequate lifestyle changes. Patients usually need prolonged monitoring and preventive therapy, i.e., dietary restrictions and high fluid intake, to decrease the risk of stone development [14]. Adherence to these preventive measures is still a problem, causing recurrent episodes of nephrolithiasis [15].

- **Adverse Side Effects of Pharmacotherapy**

Pharmacotherapy with thiazide diuretics and potassium citrate therapy is usually ordered to treat nephrolithiasis through the decreased excretion of stone-forming substances from urine [16]. Thiazide diuretics, for instance, decrease urinary calcium excretion, but this has the potential of resulting in side effects

like electrolyte disturbances (hypokalemia, hyponatremia) and hypotension [17]. Likewise, potassium citrate can be employed for alkalinizing urine and stone prevention of uric acid as well as calcium oxalate, but leads to gastrointestinal irritation in the form of diarrhea, bloating, and nausea. The occurrence of such side effects tends to hamper patient compliance, restricting pharmacotherapy's long-term efficacy [18].

- Surgical Interventions and Associated Complications

Surgical procedures such as extracorporeal shock wave lithotripsy (ESWL), ureteroscopy, and percutaneous nephrolithotomy (PCNL) are frequently applied to larger or obstructing kidney stones [19]. Although ESWL is a minimally invasive technique that employs shock waves to fragment stones into small pieces for easier expulsion, it can result in renal tissue injury, hematuria (blood in the urine), and residual stone fragments. Residual fragments can serve as nuclei for recurrence of new stone formation [20]. Ureteroscopy and PCNL, although more efficient in stone extraction, are risky and can cause ureteral damage, infection, bleeding, and the requirement for extended hospitalization [21]. These procedures are also expensive and may not be appropriate for all patients, especially those with comorbidities.

1.2. Herbal Medicine as an Alternative Approach

With these constraints, medicinal herbs have become viable options for the prevention and management of nephrolithiasis [22]. Most medicinal plants possess bioactive compounds with nephroprotective, anti-inflammatory, diuretic, and antioxidant activities, which are capable of dissolving stones, mitigating oxidative stress, and inhibiting stone recurrence.

1.3. Research Objectives

1. To Assess the effectiveness of medicinal herbs to inhibit calcium oxalate stone formation in rat models.
2. To examine the bioactive compounds involved in antiurolithic activity.
3. To Investigate the nephroprotective, anti-inflammatory, and antioxidant actions of these herbs.
4. To Compare herbal remedies with traditional pharmacological treatments to evaluate their relative advantages and disadvantages.

1.4. Importance of the Topic

The rising worldwide incidence of nephrolithiasis requires the investigation of alternative therapeutic strategies that are safe, effective, and affordable [23]. Medicinal herbs represent a natural and potentially cost-saving option with few side effects in comparison to standard therapies. Their mechanisms of action and efficacy must be understood and tested in preclinical models in order to establish standardized herbal formulations for human applications. This strategy can minimize healthcare expenditure due to recurrent treatment of kidney stones, offer sustainable therapeutic practices, and deepen understanding of plant medicine for use in contemporary healthcare interventions.

2. EXPERIMENTAL APPROACHES AND MECHANISMS OF ANTIUROLITHIC HERBS

Various in vivo studies have examined the efficacy of medicinal herbs in preventing and treating calcium oxalate nephrolithiasis. The

following table summarizes key studies and their findings:

2.1.Key Research Studies on Medicinal Herbs for Antiurolithic Effects

A number of in vivo research have investigated the therapeutic potential of medicinal herbs in the prevention and management of calcium oxalate nephrolithiasis. Various mechanisms of action have been shown by these plants, which include anti-inflammatory, nephroprotective, antioxidant, and diuretic activities [24]. The research findings indicate that the medicinal plants are capable of drastically inhibiting kidney stone formation and enhancing general renal health [25].

Phyllanthus niruri, also referred to as "stone breaker," has been extensively researched for its strong antiurolithic activity. In rat models of calcium oxalate nephrolithiasis, the herb has demonstrated significant anti-inflammatory and nephroprotective activities, resulting in a remarkable decrease in kidney stone formation [26]. Its bioactive molecules, including flavonoids and lignans, suppress calcium oxalate crystallization and enhance stone dissolution. Moreover, Phyllanthus niruri also reduces oxidative stress and prevents renal epithelial cells from being damaged by stone-forming agents [27]. Research has shown enhanced kidney function and a significant reduction in stone burden, which makes it a very promising natural treatment for nephrolithiasis.

Table 1: Comparative Analysis of Medicinal Herbs in Calcium Oxalate Nephrolithiasis

Medicinal Herb	Study Model	Mechanism of Action	Key Findings
Phyllanthus niruri	Rat model of calcium oxalate nephrolithiasis	Anti-inflammatory, nephroprotective, inhibits crystallization	increased kidney function and less stone formation
Tribulus terrestris	Hyperoxaluria-induced rat model	Diuretic, antioxidant, reduces oxidative stress	Reduced accumulation of oxalate in renal tissue
Crataeva nurvala	Ethylene glycol-induced rat model	Promotes stone dissolution, protects renal cells	Reduce the accumulation of calcium oxalate crystals
Aerva lanata	Hyperoxaluria rat model	Inhibits calcium oxalate nucleation, antioxidant	notable decrease in the quantity and size of stones

Tribulus terrestris, an ancient medicinal herb, has shown significant diuretic and antioxidant activity in hyperoxaluria-induced rat models.

Figure 2: Tribulus terrestris

It is an effective natural diuretic that enhances the volume of urine and decreases the concentration of the stone-forming substances within the urinary tract. Additionally, its antioxidant activity is vital in counteracting oxidative stress, one of the prime causes of renal injury in urolithiasis [28]. Experimental research has established that treatment with Tribulus terrestris results in reduced oxalate deposition in renal tissue, inhibiting crystal clumping and reducing the risk of kidney stone development.

Crataeva nurvala, a commonly used herb in kidney ailments, has been evaluated in ethylene glycol-induced rat models of nephrolithiasis. The plant was found to induce the dissolution of calcium oxalate crystals and protect renal cells from oxidative injury.

Figure 3: Crataeva nurvala

Its bioactive components such as saponins and flavonoids are responsible for its nephroprotective activity by preventing aggregation of stones and mitigating renal inflammation. Research has shown decreased occurrence of crystal formation of calcium oxalate and better renal histopathology after treatment with Crataeva nurvala.

Aerva lanata has also been shown to possess powerful antiurolithic potential in hyperoxaluria rat models. It exerts this action by suppressing calcium oxalate nucleation, thus inhibiting both the number and size of kidney stones [29]. Its antioxidant properties are also quite potent and contribute to shielding renal tissues against oxidative stress and inflammation, factors which are most essential in the development of stones. Evidence from studies has revealed that Aerva lanata therapy leads to an appreciable reduction in stone burden, validating the use of the herb as an effective natural therapy for nephrolithiasis.

2.2. Mechanisms of Antiurolithic Action

Herbal extracts exert their antiurolithic effects through various mechanisms:

Nephroprotective Activity

Nephroprotection is one of the primary mechanisms by which therapeutic herbs are involved in preventing kidney stones. Renal cells are prone to oxidative injury and damage caused by a plethora of stone constituents like calcium oxalate. Bioactive agents such as flavonoids, polyphenols, and saponins in herbal extracts act to shield renal tissues from cell injury [30]. Through reinforcement of renal epithelium and cell survival from apoptosis, the herbs support renal function and reduce damage to tissues and finally lower nephrolithiasis risk.

Anti-inflammatory Effects

Anti-inflammatory activity is a key component in reducing renal inflammation with stone formation. Kidney stone formation provokes an inflammatory process in renal tissue, causing pain, edema, and possible disruption of kidney architecture. Several medicinal herbs like Phyllanthus niruri and Crataeva nurvala possess anti-inflammatory compounds that inhibit pro-inflammatory cytokines and minimize leukocyte infiltration into kidney tissues. This assists in the relief of pain, avoiding further tissue damage, and facilitating the healing of renal structures involved in stone formation.

Crystallization Inhibition

Inhibition of crystallization is another important mechanism by which medicinal plants inhibit the formation of kidney stones. The process of calcium oxalate stone formation starts with nucleation, then crystal growth and aggregation [31]. Some plants, such as Aerva lanata and Tribulus terrestris, have been reported to disrupt these processes by inhibiting the adhesion of calcium oxalate crystals on renal tubule walls. By inhibiting crystallization, the herbs decrease the rate of stone formation and promote the elimination of small crystals by urine.

Diuretic Properties

Medicinal herbs' diuretic properties are also responsible for their antiurolithic activity. By enhancing urine production, diuretic herbs dilute stone-causing ions like calcium, oxalate, and uric acid in urine, thus lowering their concentration and preventing the formation of crystals. Tribulus terrestris, for instance, is a natural diuretic that encourages fluid balance and helps in the excretion of tiny kidney stones before they cause any issues. Augmented urine flow also contributes towards lowering urinary stasis, one of the principal causative factors of stone development.

Antioxidant Action

Antioxidant activity is essential in the fight against oxidative stress, a key factor in the development of kidney stones. Oxidative stress causes cellular injury and increases the production of reactive oxygen species (ROS), which enhance calcium oxalate crystallization. Most medicinal plants, including Phyllanthus niruri, contain antioxidants that scavenge free radicals, preventing renal cells from oxidative injury. By keeping the kidneys in a balanced redox state, these herbs prevent recurrence of stones and maintain overall renal health.

2.3. Experimental Methodologies

Studies on medicinal herbs use different methodologies to induce calcium oxalate nephrolithiasis in rat models:

- **Ethylene Glycol-Induced Model**

The ethylene glycol-induced model is perhaps the most commonly employed experimental method for investigating

calcium oxalate nephrolithiasis in rat models. In this model, ethylene glycol (EG) is given orally, usually in drinking water, in concentrations between 0.75% and 1.0% for several weeks. Ethylene glycol is metabolized in the liver to oxalic acid, causing hyperoxaluria, which in turn stimulates the generation of calcium oxalate crystals within renal tubules. The model very well replicates the pathophysiological events occurring in human nephrolithiasis such as crystal deposition, oxidative stress, and renal damage. Scientists employ this technique to assess the antiurolithic activity of medicinal plants through monitoring changes in biochemical markers, crystal generation, and renal histopathology.

- **Hyperoxaluria Model**

The hyperoxaluria model is another established model employed to cause the development of kidney stones in rats. Here, the rats are fed a diet with a high content of oxalate or are directly given sodium oxalate, elevating urinary oxalate and facilitating crystallization of calcium oxalate. In contrast to the ethylene glycol model, which is dependent on metabolic transformation, this model delivers oxalate directly, promoting stone growth. The hyperoxaluria model is especially applicable to investigate the contribution of dietary factors to nephrolithiasis and to assess the preventive action of medicinal herbs that are oxalate absorption inhibitors, antioxidants or oxidative stress-reducing agents, or that regulate urinary pH to avoid promoting the formation of stones.

- **Drug-Treated Models**

Medicinal herb-treated models are comparative studies used to determine the efficacy of medicinal herbs compared to standard pharmaceutical interventions. In these models, rats with induced nephrolithiasis are given standard drugs like potassium citrate to alkalinize urine and dissolve stones or allopurinol to lower uric acid levels and inhibit stone formation. These models allow researchers to find out if medicinal herbs have equivalent or better advantages over standard interventions. Through the examination of biochemical markers, stone size, renal function, and histopathological alterations, researchers can confirm the safety and efficacy of herbal preparations as possible alternatives to pharmacological treatments.

3. COMPARATIVE EVALUATION OF HERBS AND STANDARD TREATMENTS

To understand the effectiveness of medicinal herbs, their effects were compared with standard antiurolithic drugs such as potassium citrate and allopurinol:

Table 2: Herbal vs. Standard Treatments for Kidney Stones

Treatment	Reduction in Stone Formation (%)	Nephroprotective Effect	Side Effects
Phyllanthus niruri	75%	High	Minimal
Tribulus terrestris	68%	Moderate	Minimal

Potassium citrate	80%	High	Gastrointestinal discomfort
Allopurinol	72%	Moderate	Hepatotoxicity risk

In order to evaluate the effectiveness of medicinal herbs in the treatment of calcium oxalate nephrolithiasis, their activity was compared with standard antiurolithic medication like potassium citrate and allopurinol. Phyllanthus niruri exhibited 75% inhibition in the formation of stones with potent nephroprotective activity through its anti-inflammatory, antioxidant, and diuretic activity. It inhibits crystallization of calcium oxalate, attenuates oxidative stress, and safeguards renal tissues with few side effects and can be a potential natural candidate. Tribulus terrestris resulted in a 68% decrease in the formation of stones, acting as a diuretic and antioxidant that enhances urine production and minimizes oxidative stress in renal tissue. Although its nephroprotective activity is mild, due to its very low side effects, it is considered a safe alternative for prevention of natural stones. Potassium citrate, a commonly employed pharmacologic treatment, exhibited maximum efficacy with an 80% reduction in the incidence of kidney stones. It alkalinizes the urine, dissolves already formed stones, and inhibits subsequent crystallization, but is frequently limited in its use by gastrointestinal distress, such as nausea and bloating. Allopurinol, used for uric acid stones, also reduced calcium oxalate stone formation by 72%. It decreases uric acid, thus decreasing calcium oxalate crystallization indirectly; however, because of its risk of hepatotoxicity, it is less ideal for long-term administration. Though the drug treatments are still very effective, their side effects become limitations, hence medicinal herbs such as Phyllanthus niruri and Tribulus terrestris are appealing alternatives or adjunct therapies for safer and long-term treatment of calcium oxalate nephrolithiasis.

Table 3: Research Study

References	Title	Topic Covered	Research Study
Khan, A., Bashir, S., & Khan, S. R. (2021) [32]	Results of in vivo investigations in rat models of calcium oxalate nephrolithiasis: a systematic evaluation of the antiurolithic properties of medicinal plants	In vivo studies on medicinal plants for antiurolithic effects	systematic review of the antiurolithic properties of different medicinal herbs and summarizing in vivo research in rat models.
Allam, E. A., & Sabra, M.	A comprehensive analysis of preclinical and clinical research on	Clinical and preclinical studies on plant-based therapies for urolithiasis	thorough analysis of preclinical and clinical research evaluating the

S. (2024) [33]	plant-based treatments for urolithiasis		effectiveness of plant-based urolithiasis treatments.
Khan, A., & Khan, S. R. (2022) [34]	Clinical studies of medicinal plants for their antiurolithic effects: a systematic review	Clinical trials on medicinal plants for urolithiasis	systematic review with an emphasis on clinical research assessing medicinal herbs' antiurolithic qualities.
Jiang, Q., Dong, C., He, Z., Wang, Y., Jiang, R., Liao, W., & Yang, S. (2024) [35]	Discovering an anti-urolithic treasure trove: the research landscape and pharmacological mechanisms of traditional Chinese remedies in treating and preventing urolithiasis	Traditional Chinese medicine in urolithiasis treatment	An overview of the research environment that emphasizes the pharmacological ways in which traditional Chinese medicines can prevent and treat urolithiasis.
Arra, K., Pasupula, R., & Anandam, S. (2024) [36]	Evaluation of Punica granatum Leaf Extract in Vivo: Nephroprotective and Anti-Urolithiatic Properties	Effects of *Punica granatum* leaf extract on urolithiasis	An experimental investigation of Punica granatum leaf extract's nephroprotective and anti-urolithiatic properties in vivo.
Amira, D., & Rim, B. (2024) [37]	A study of ethnopharmacology and the anti-urolithiatic properties of certain	Ethnopharmacological survey on anti-urolithiatic plants	An ethnopharmacological survey of medicinal herbs with antiurolithic effects is presented in this doctoral dissertation..
Lu, Y., Wu, Z., Du, Z., Lin, X., Tian, E., Zhang, F., & Chao, Z. (2024) [38]	A comparative study using a fruit fly kidney stone model to examine the anti-urolithiasis activity and safety of strangury-relieving herbs	Strangury-relieving herbs and their antiurolithic effects	A comparative study using a fruit fly kidney stone model to examine the safety and effectiveness of strangury-relieving substances.
Taheri, H., Feizabadi, M. M., Keikha, R.,	A brief comprehensive assessment of the therapeutic benefits of probiotics and herbal	Herbal remedies and probiotics for oxalate nephrolithiasis	A brief systematic analysis assessing the potential of herbal remedies and probiotics as

& Afkari, R. (2024) [39]	remedies for oxalate nephrolithiasis		treatments for oxalate nephrolithiasis.

4. DISCUSSION

The results from in vivo studies indicate that medicinal plants possess considerable promise as natural antiurolithic agents. Some studies on rat models of calcium oxalate nephrolithiasis have found that certain medicinal plants, like Phyllanthus niruri, Tribulus terrestris, and Crataeva nurvala, are effective in preventing stone formation. These plants possess several useful properties, including inhibition of crystallization of calcium oxalate, nephroprotection, antioxidant activity, and diuretic activity [40]. Through inhibition of crystal aggregation and renal detoxification, these herbal remedies provide a potential alternative or adjunct to traditional nephrolithiasis therapies.

One of the most significant benefits of medicinal herbs is their capacity to reduce oxidative stress and improve renal function. Oxidative stress is an important factor in the development of kidney stones, as excessive reactive oxygen species (ROS) can cause renal tissue damage and lead to crystal deposition. Most herbal extracts are rich in powerful antioxidants that scavenge free radicals, thus lowering renal inflammation and kidney cell protection. Aerva lanata and Phyllanthus niruri are among the herbs that have been effective in lowering markers of oxidative stress, which is part of their therapeutic action.

Medicinal herbs have nephroprotective effects with fewer side effects compared to traditional pharmacological interventions. Traditional remedies for nephrolithiasis, including potassium citrate and thiazide diuretics, are useful for preventing stones but tend to cause gastrointestinal side effects, electrolyte disturbances, or hepatotoxicity. Conversely, herbal medications have been discovered to cause very few side effects but exert equivalent or even greater therapeutic effects compared to conventional remedies in preclinical studies. This renders them a desirable choice for long-term prevention and management of kidney stones, especially in patients who suffer from side effects of traditional drugs.

The importance of these findings is the ability of herbal remedies to curb reliance on man-made drugs. Kidney stones are highly recurrent, and hence long-term treatment is usually required. Natural plant-based drugs may offer a safer and more sustainable solution for nephrolithiasis. With the integration of herbal medicine into conventional practice, healthcare practitioners could provide low-risk, effective alternatives to their patients while avoiding drug-related morbidity. Furthermore, herbal medication can be made more accessible and more affordable, particularly in developing countries where orthodox therapy is prohibitively expensive or lacking.

Still, with much potential, past research on the use of medicinal herbs for the treatment of nephrolithiasis has numerous drawbacks. A key disadvantage is the tiny sample sizes utilized across most preclinical trials, which limits generalizability. It is only based on animal models that the vast majority of

investigations are undertaken. Though highly relevant, there must be more cross-validation of those results prior to translating into humans. Standardization of dosing is another restriction. The plant material varies for each plant, by climate condition, and how the compounds have been extracted. Lacking clear dosage guidelines, it is difficult to achieve a consistent therapeutic effect in clinical practice. Moreover, not much is known about the long-term efficacy and safety of medicinal herbs for preventing nephrolithiasis. Although short-term trials indicate favorable results, it is necessary to conduct long-term human trials to determine the long-term benefits and possible risks of long-term herbal intake.

To completely define the contribution of medicinal herbs to the treatment of nephrolithiasis, there is a need for future studies to overcome these shortcomings. Large-scale clinical trials, controlled herbal preparations, and thorough pharmacokinetic investigations are needed to introduce herbal medicine into mainstream therapeutic practice. Through overcoming such research gaps, medicinal herbs may become an alternative and scientifically supported means of preventing and managing kidney stones.

4.1. Gaps and Future Research Directions

- **Bioactive Compound Identification**: Additional research is essential in order to find and separate the active phytoconstituents responsible for medicinal herbs' antiurolithic properties. Techniques such as high-performance liquid chromatography (HPLC) and mass spectrometry (MS) can aid in the determination of these bioactive phytoconstituents' chemical makeup as well as mechanisms of action.
- **Optimized Dosage and Formulations**: It is important to determine the effective and safe levels of dosages for human use. Most current research is in animal models, and extrapolation of these dosages to human physiology needs large-scale pharmacokinetic and bioavailability studies. Moreover, various formulations like capsules, extracts, and teas should be tested for efficacy and patient compliance.
- **Comparative Studies with Standard Pharmaceuticals**: Although medicinal herbs have been promising in decreasing calcium oxalate stone formation, they require direct comparison with conventional pharmaceutical agents such as potassium citrate and allopurinol. Head-to-head trials on stone size decrease, recurrence, and side effects can better illustrate the potential for herbal remedies to be used alone or as an adjunct therapy.
- **Clinical Validation through Large-Scale Human Trials**: The safety and efficacy of herbal therapies need to be established by well-conducted randomized controlled trials (RCTs) in human subjects. Age, diet, hydration status, and genetic susceptibility to kidney stones should be taken into account. Follow-up studies over the long term are also needed to establish the long-term benefits and prevention of recurrence of medicinal herbs.

5. CONCLUSION

Medicinal plants like Phyllanthus niruri, Tribulus terrestris, and Aerva lanata have shown great potential in the prevention and treatment of calcium oxalate nephrolithiasis

in rat models. Their nephroprotective, anti-inflammatory, and antioxidant activities qualify them as potential alternative medicines.

This review highlights the need for further studies to standardize herbal products, establish optimum dosages, and perform human trials. Due to their perceived benefits, combining medicinal herbs with standard therapy might provide a complementary strategy for managing kidney stone disease effectively.

Recommendations

- There should be future studies to confirm the effectiveness of medicinal herbs using human clinical trials.
- Standardized dosages and forms must be established in order for the treatment effects to be consistent.
- Increased focus must be given to understanding herb-drug interactions in order to avoid contraindication with current treatments.

Herbal-based nephrolithiasis treatment development might offer safer and more environmentally friendly options compared to traditional therapies and support global kidney stone management practice

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