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Pharmacological evaluation of Sonchus oleraceus Leave extract for Antiurolithiatic activity

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Abstract

Urolithiasis, a common urinary tract disorder, is characterized by the formation of calculi composed mainly of calcium oxalate, leading to pain, infection, and renal damage. Current therapeutic approaches, such as extracorporeal shock wave lithotripsy and pharmacotherapy, are costly and associated with adverse effects and recurrence. Medicinal plants are gaining attention as safer alternatives for managing kidney stones. This study aimed to investigate the phytochemical composition and antiurolithiatic activity of Sonchus oleraceus leaves in ethylene glycol–induced urolithiasis in Wistar rats. Ethanolic leaf extract was prepared by Soxhlet extraction, yielding 9.41% w/w, and subjected to phytochemical screening, which confirmed the presence of flavonoids, phenols, saponins, diterpenes, and proteins. Quantitative analysis revealed total phenolic content of 0.875 mg gallic acid equivalents/100 mg and total flavonoid content of 0.623 mg quercetin equivalents/100 mg. Acute toxicity studies confirmed safety up to 2000 mg/kg. In vivo, urolithiasis was induced by administering 0.75% ethylene glycol in drinking water for 28 days. Rats treated with S. oleraceus extract (100 and 200 mg/kg p.o.) showed significant reductions in urinary calcium, oxalate, and phosphate, along with normalization of serum urea, creatinine, and BUN levels compared to toxic controls. Histopathological examination demonstrated reduced calcium oxalate deposition and near-normal kidney architecture in extract-treated groups. These findings suggest that S. oleraceus possesses potent antiurolithiatic activity, likely mediated by its antioxidant phytoconstituents, supporting its traditional use and potential as a phytopharmaceutical candidate for kidney stone management.

Keywords

Sonchus oleraceus; urolithiasis; calcium oxalate; phytochemicals; Wistar rats; antiurolithiatic activity.

1. Introduction

Urolithiasis, commonly known as kidney stone disease, is a major global health problem affecting 10–15% of the population, with recurrence rates as high as 50% within 10 years. It is associated with severe renal colic, hematuria, urinary tract infections, and increased risk of chronic kidney disease and hypertension. The majority of calculi are composed of calcium oxalate (CaOx). Conventional treatment modalities, including extracorporeal shock wave lithotripsy (ESWL), ureteroscopy, and nephrolithotomy, though effective, are invasive, expensive, and often lead to recurrence. Medicinal plants are emphasized in Ayurveda and folk medicine for their diuretic, antioxidant, and

crystallization inhibitory properties. Sonchus oleraceus, a common edible leafy plant, has traditional diuretic and hepatoprotective uses. This study evaluates the phytochemical profile and in vivo antiurolithiatic efficacy of ethanolic extract of S. oleraceus leaves in ethylene glycol–induced rat model.

Sonchus oleraceus was used in this study due to its long-standing use in traditional medicine for treating urinary tract disorders, including kidney stones. It was widely recognized for its diuretic properties, which promoted urine flow and helped in flushing out stone-forming substances from the urinary tract. Additionally, the plant was known for its anti-inflammatory, analgesic, and antioxidant activities, which were believed to reduce renal inflammation, alleviate pain, and protect kidney tissues from oxidative damage a key factor in the pathogenesis of urolithiasis. Its hepatoprotective effects further supported systemic detoxification. Despite these traditional claims, there was limited scientific validation of its efficacy in urolithiasis, which created a strong justification for conducting this study. The need for this research was also driven by the increasing interest in identifying natural, affordable, and safe alternatives to conventional drugs, particularly in low-resource settings where access to standard treatments may be limited.

To evaluate its therapeutic potential, the ethylene glycol-induced urolithiasis model in rats was employed, as it closely mimicked human kidney stone formation. Phytochemical screening of the *Sonchus oleraceus* leaf extract revealed the presence of flavonoids, phenolics, alkaloids, tannins, and saponins bioactive compounds known to inhibit stone formation by preventing crystal nucleation, aggregation, and growth. For comparison, Cystone, a standard polyherbal formulation with established antilithiatic activity, was used as a reference drug. Cystone was administered orally and delivered systemically after gastrointestinal absorption, allowing its active constituents to act on the kidneys. It exhibited multiple beneficial effects including stone dissolution, increased urine output, anti-inflammatory action, antimicrobial activity, and pain relief. Comparing the outcomes of *Sonchus oleraceus* extract with Cystone allowed for a meaningful assessment of the plant's efficacy and provided scientific support for its traditional use in managing urolithiasis.

In the current study, the extract of *Sonchus oleraceus* leaves was subjected to phytochemical screening to identify active constituents such as flavonoids, phenolic compounds, alkaloids, saponins, and tannins, which are known to interfere with stone formation by inhibiting crystal nucleation, aggregation, and growth.

The experimental evaluation involved the assessment of various biochemical parameters, including urinary volume, pH, and concentrations of calcium, oxalate, and phosphate key components involved in lithogenesis. By integrating traditional knowledge with scientific experimentation, this study aimed to lay a robust foundation for the therapeutic application of *Sonchus oleraceus* in urolithiasis. The findings are expected to contribute to the development of a natural, safe, and cost-effective herbal formulation that could serve as an alternative or complementary treatment for the prevention and management of kidney stones, especially in resource-limited settings where access to conventional therapies is constrained.

Plant name: *Sonchus oleraceus*

Figure 1: ***Sonchus oleraceus***

Scientific Classification:

- **Domain-** Eukaryota
- **Kingdom-** Plantae
- **Phylum-** Spermatophyta
- **Subphylum-** Angiospermae
- **Class-** Dicotyledonae
- **Order-** Asterales
- **Family-** Asteraceae
- **Genus-**Sonchus
- **Species-***Sonchus oleraceus*

Common Names: common sowthistle, annual sowthistle, common sow-thistle, pualele, sow thistle, sow-thistle

Distribution: *S. oleraceus* originates from Europe, Northern Africa and Western Asia. It has spread to North America, India, China, Australia Pacific Islesand the Antarctic Isles.In countries with extensive farming practices, although *S. oleraceus* is widespread, For example, it occurs in all the states of the USA, but a greater density is recorded along the Pacific Coast, In addition to south-western and south-eastern states **(Reed, 1970).**

Description: *S. oleraceus* is an annual and sometimes biennial herb, 40-150 cm tall, containing white latex in all plant parts. The taproot is upright with many branches, especially near the soil surface. Stem below synflorescence simple or branched, glabrous. Basal and lower stem leaves with basal portion petiole-like and attenuate, mostly smaller than middle stem leaves, otherwise similar. Middle and upper stem leaves extremely variable, elliptic, oblanceolate, or lanceolate, 6-20 × 2-9 cm, almost entire to ± irregularly, soft, glabrous, adaxially dull green, base articulately clasping with auricles usually acutely prostrate, margin ± coarsely spinulosely dentate, apex acute; lateral lobes triangular to elliptic, usually recurved, apex acute to acuminate; terminal lobe larger than others, broadly triangular, broadly hastate, or obovate-cordate. Synflorescence shortly corymbiform or racemiform, with few to several capitula. The flower-head has a green involucre consisting of 27-35 lance-shaped bracts, 10-13 mm long and

hairy while young. Each flower-head contains 80-250 ligulate flowers which are longer than the involucre. The flowers are yellow and the ligule is about as long as the corolla tubs. Achenes are brown, 2.5-3.75 x 0.7-1 mm, oblanceolate, and transversely tuberculate-rugose. Thistledown is white and persistent. One plant may produce 4000-6000 seeds or more **(AVH, 2016).**

Habitat: *S. oleraceus* is a common weed and found growing in open disturbed areas in cultivated land, gardens, sand dunes, waste places, and roadsides, near waterways, burned areas, construction sites, and rail yards. It rarely grows in closed communities like forest or pasture because it needs light to germinate and grow and grazed by both wild and farmed livestock. In desert areas it is usually only found near waterways **(Chader Soumia, 2018).**

Uses of *S. oleraceus*

S. oleraceus has been consumed for peoples in many parts of as a salad vegetable and pot herb. Annual sow thistles (*S. oleraceus* and S. asper) have many uses as human food and as herbs in Africa, and Asia where they are also used for feeding cattle and other livestock.

In Africa and elsewhere. *S. oleraceus* is collected from the wild, but apparently it is grown commercially on a small scale in Indonesia. In New Zealand *S. oleraceus* is highly valued as a green vegetable usually cooked with meat. The juice is used a tonic and laxative, and the white sap treated to use as chewing gum **(Mlango, 2018).**

2. Materials and Methods

Plant material: Fresh leaves of S. oleraceus were collected from Bhopal, MP, authenticated, shade-dried, powdered. Extraction: Soxhlet extraction with ethanol (yield 9.41% w/w) and petroleum ether (2.52% w/w). Phytochemical screening: Flavonoids, phenols, proteins, saponins, diterpenes positive; alkaloids, glycosides, carbohydrates negative.

Figure 2: Soxhlation extraction

Estimation of bioactive compounds: TPC (0.875 mg GAE/100 mg); TFC (0.623 mg QE/100 mg). Experimental animals: Male Wistar rats (150–200 g). Ethical approval obtained.

Acute toxicity: Safe up to 2000 mg/kg (OECD 425). Induction of urolithiasis: 0.75% ethylene glycol in drinking water for 28 days.

Experimental design: 5 groups (Control, Disease control, Standard (Cystone 750 mg/kg), Extract 100 mg/kg, Extract 200 mg/kg).

Parameters: Urinary calcium, oxalate, phosphate; serum urea, creatinine, BUN; kidney histopathology.

Statistical analysis: One-way ANOVA, Dunnett's test, $p<0.05$.

3. Results

Extraction yield: Ethanol extract 9.41% > petroleum ether 2.52%.

Phytochemistry: Flavonoids, phenols, proteins, saponins, diterpenes present.

TPC: 0.875 mg GAE/100 mg; TFC: 0.623 mg QE/100 mg.

Urinary parameters: Extract-treated groups significantly reduced calcium, oxalate, phosphate compared to EG control.

Serum biochemistry: Extract normalized elevated urea, creatinine, and BUN.

Histopathology: Reduced CaOx deposits and preserved renal architecture in extract-treated rats.

Phytochemical screening

Qualitative Phytochemical Analysis of extracts

Table 1: Phytochemical analysis of *Sonchus oleraceus* extracts

		Result	
S. No.	**Experiment**	**Pet. Ether extract**	**Aqueous**
Test for Carbohydrates			
1.	Molisch's Test	-	+
2.	Fehling's Test	-	+
3.	Benedict's Test	-	+
4.	Bareford's Test	-	+
Test for Alkaloids			
1.	Mayer's Test	-	+
2.	Hager's Test	-	+
3.	Wagner's Test	-	+

4.	Dragendroff's Test	-	+
Test for Terpenoids			
1.	Salkowski Test	-	-
2.	Libermann-Burchard's Test	-	-
Test for Flavonoids			
1.	Lead Acetate Test	-	+
2.	Alkaline Reagent Test	-	+
3.	Shinoda Test	-	+
Test for Tannins and Phenolic Compounds			
1.	$FeCl_3$ Test	-	+
2.	Lead Acetate Test	-	+
3.	Gelatine Test	-	+
4.	Dilute Iodine Solution Test	-	+
Test for Saponins			
1.	Froth Test	+	-
Test for Protein and Amino acids			
1.	Ninhydrin Test	-	-
2.	Biuret's Test	-	+
3.	Million's Test	-	+
Test for Glycosides			
1.	Legal's Test	-	+
2.	Keller Killani Test	-	+
3.	Borntrager's Test	-	+

Figure 3: Phytochemical analysis of *Sonchus oleraceus* extracts

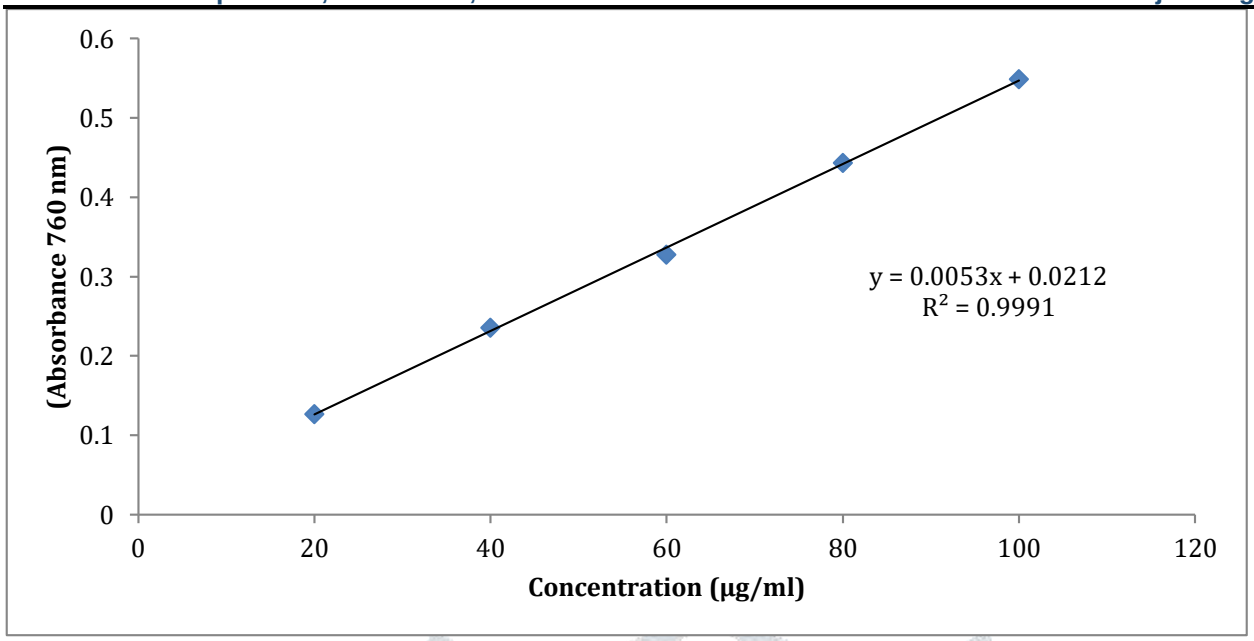
The phytochemical analysis of *Sonchus oleraceus* extracts revealed significant variations based the solvent used. Aqueous extract showed the presence of carbohydrates, alkaloids, flavonoids, tannins, phenolic compounds, proteins, amino acid, and glycosides. This wide range of detected phytochemicals indicates that Aqueous, due to its polarity, effectively extracts diverse bioactive compounds from the plant. In contrast, petroleum ether extract tested positive only for saponins, highlighting its limited extraction capacity for other phytochemicals due to its non-polar nature.

Quantitative phytochemical estimation

- **Total Phenolic Content (TPC) Estimation:**

Table 2: Standard table for Gallic acid

Concentration (µg/ml)	**Absorbance**
20	0.127
40	0.236
60	0.328
80	0.444
100	0.549



Graph 4: Graph represent standard curve of Gallic acid

Table 3: Total Phenolic content in *Sonchus oleraceus* extract

	Total phenolic content in Aqueous extract of *Sonchus oleraceus* (mg/gm equivalent to Gallic acid)
Absorbance Mean±Sd	0.342±0.008
TPC	64.2

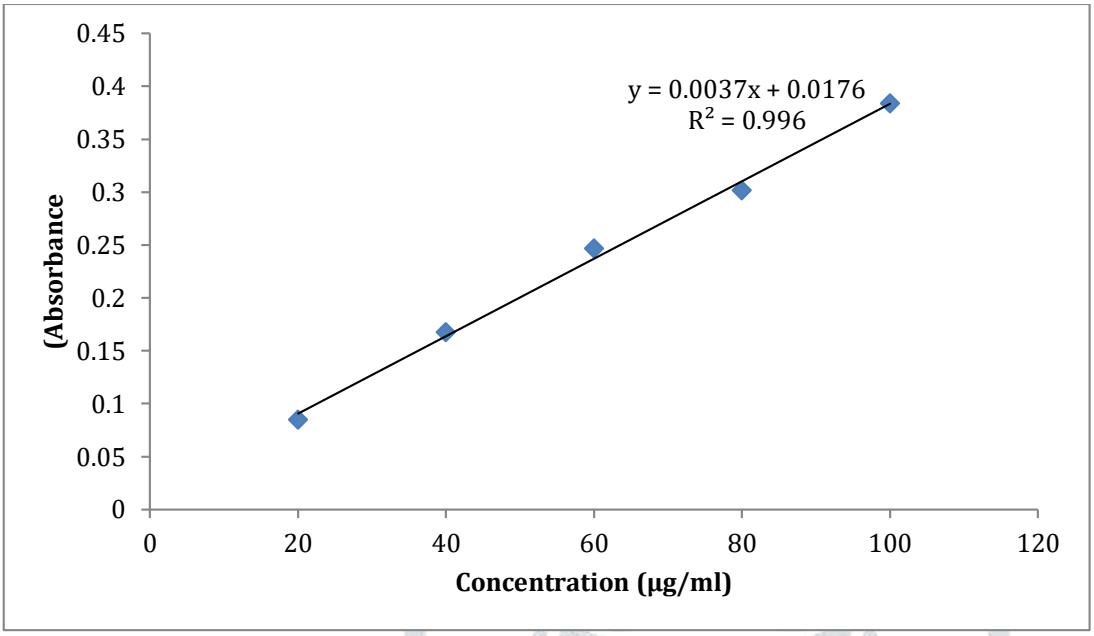
Figure 5: Total Phenolic content in *Sonchus oleraceus* extract

- **Total Flavonoid Content (TFC) Estimation:**

Table 4: Standard table for Rutin

Concentration (µg/ml)	**Absorbance**
20	0.085
40	0.168

60	0.247
80	0.302
100	0.384



Graph 6: Graph represent standard curve of Rutin

***In vivo* acute toxicity study (OECD 423)**

Table 5: General appearance and behavioral observations of acute oral toxicity study for control and treated groups:

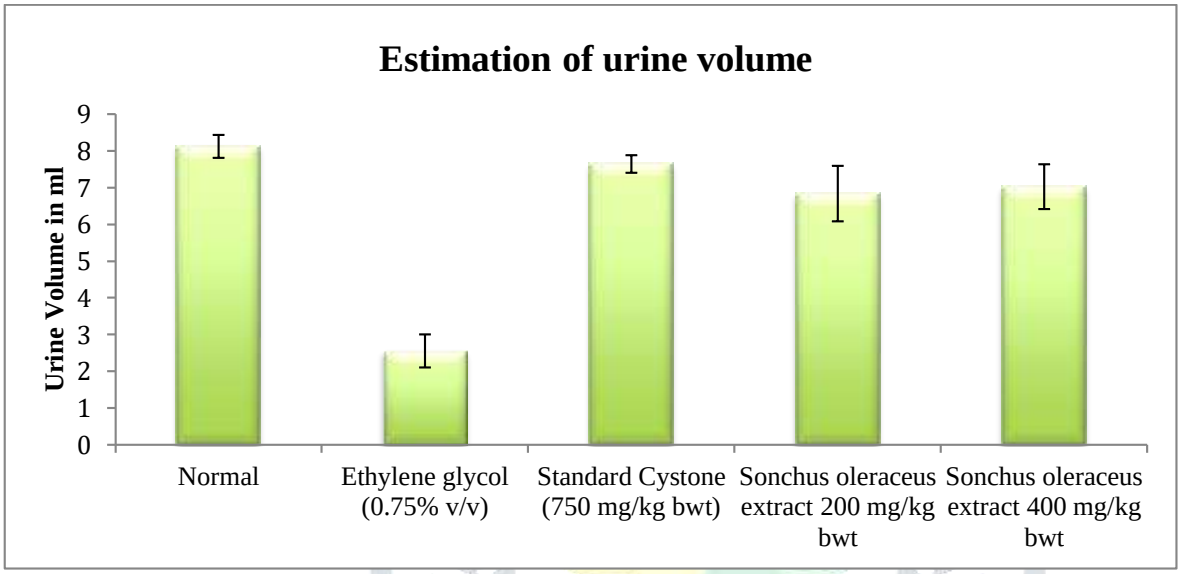
Observations	Control	5 mg/kg	50 mg/kg	300 mg/kg	2000 mg/kg
Food intake	Normal	Normal	Normal	Normal	Normal
Body weight	Normal	No change	No change	No change	No change
Temperature	Normal	Normal	Normal	Normal	Normal
Changes in skin and fur	No effect	No effect	No effect	No effect	No effect
Urination	Normal	No effect	No effect	No effect	No effect
Diarrhoea	Not present	Not present	Not present	Not present	Not present
Death	Alive	Alive	Alive	Alive	Alive

Mortality, behavioral signs, body weight and food consumption are very sensitive indicators to evaluate the acute toxicity (LD50 of any test substance). The body weight is also an important factor to monitoring the wellness of animal. The results of the acute oral toxicity studies showed that oral administration of the methanolic leaves extract of *Sonchus oleraceus* to rats up to 2000 mg/kg body weight resulted in no death of any test animal during the observation period of 14 days. All animals survived and gained bodyweight over the period. There was no significant loss of fur and skin lesions. Animals did not show any sign of aggression or abnormal Behaviour during handling. Therefore, 1/10th and 1/5th of the maximum tolerated dose 200 mg/kg b.w. and 400 mg/kg b.w. were chosen for further studies.

***In vivo* anti-urolithic activity**

Table 7 Estimation of urine volume

S. No	Groups	Urine Volume (ml)
1	Normal	8.13±0.31
2	Ethylene glycol (0.75% v/v)	2.56±0.45
3	Standard Cystone (750 mg/kg bwt)	7.65±0.24
4	*Sonchus oleraceus* extract 200 mg/kg bwt	6.84±0.76
5	*Sonchus oleraceus* extract 400 mg/kg bwt	7.03±0.61

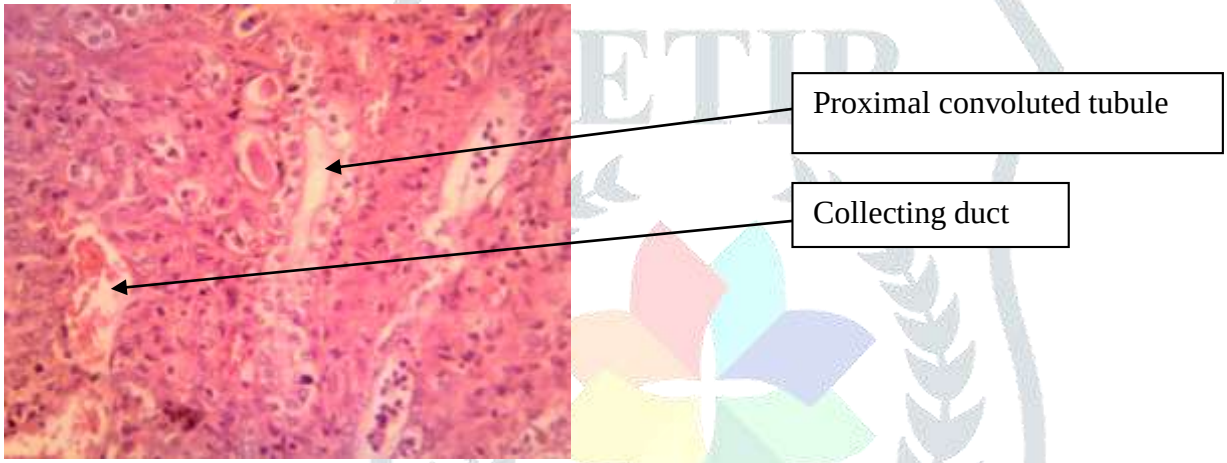


Graph 6: Estimation of urine volume

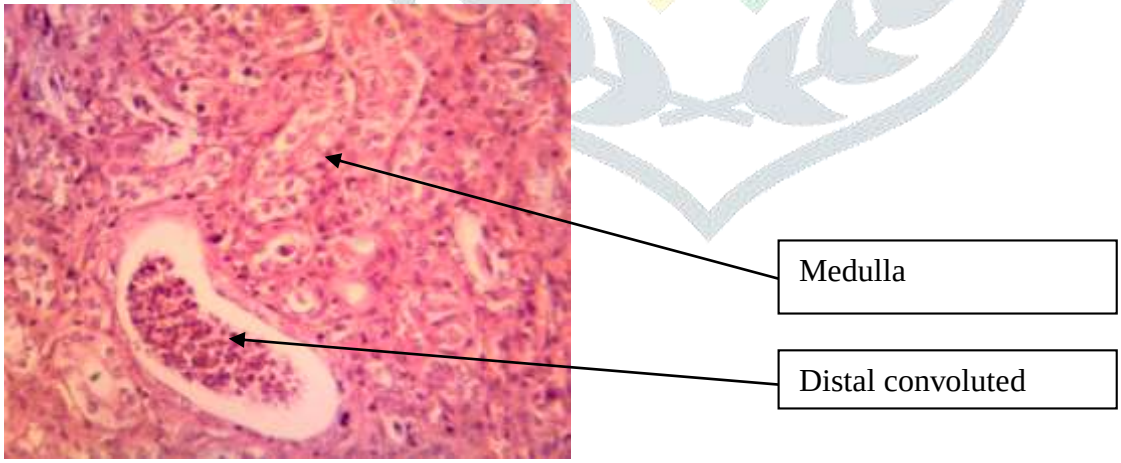
Histopathological examination of Kidney

Figure 8: Normal Kidney

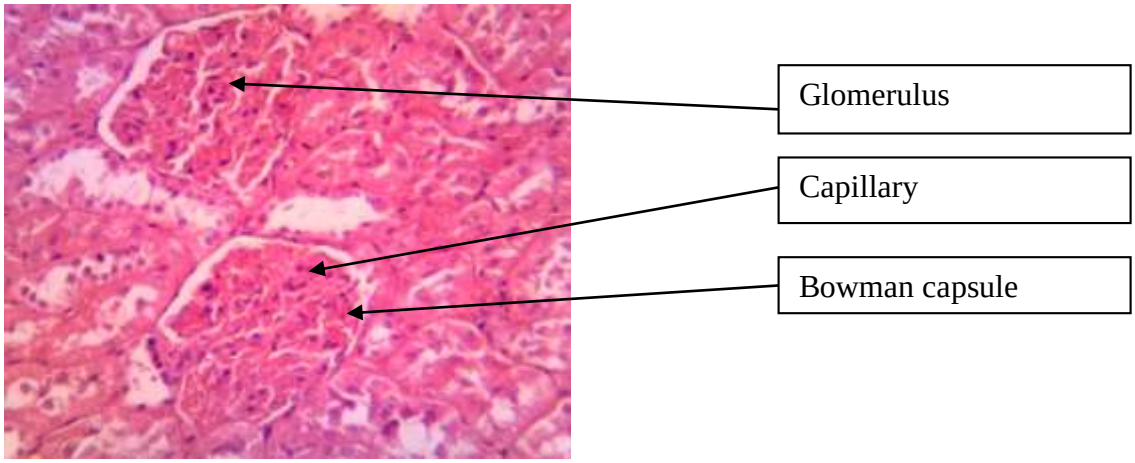
Group-1



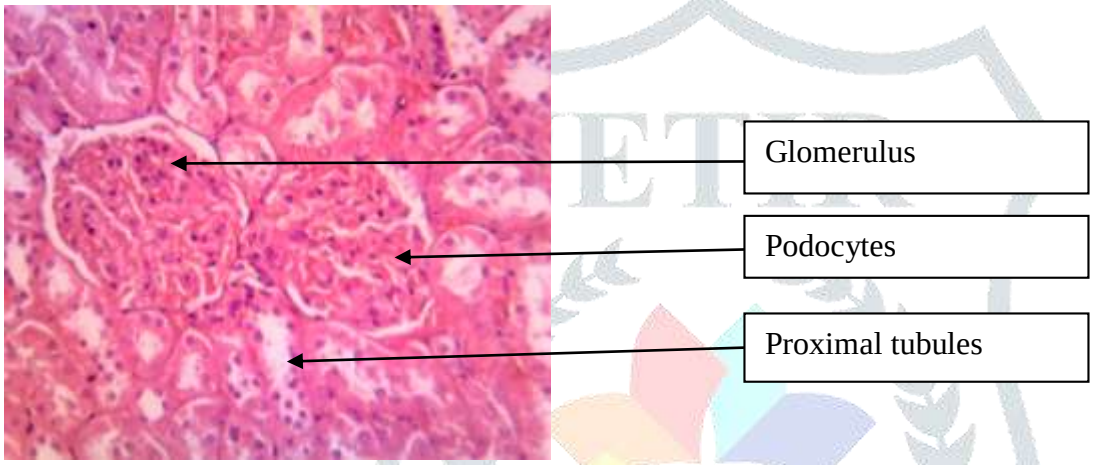
Group-2



Group-3



Group-4



Group-5

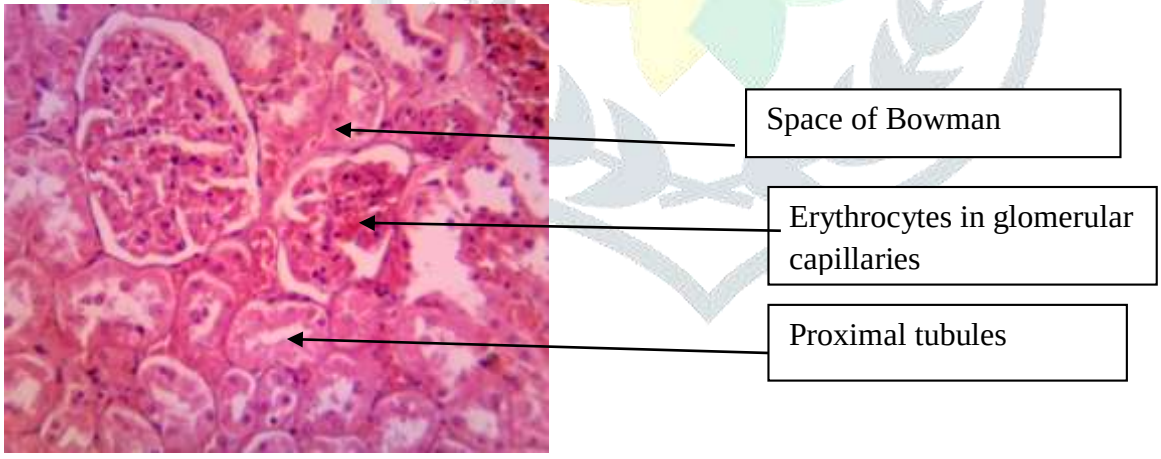


Figure 9: Histopathological examination of Kidney

4. Discussion

The ethanolic extract of S. oleraceus showed significant dose-dependent antiurolithiatic activity, comparable to Cystone. Mechanisms may include antioxidant action, inhibition of CaOx nucleation/aggregation, and diuretic effect. Flavonoids and phenolics are likely responsible for these effects. These findings validate traditional claims and align with previous studies on herbal antiurolithiatic agents.

5. Conclusion

Ethanolic extract of Sonchus oleraceus leaves exhibited significant protective effects against ethylene glycol–induced urolithiasis in rats. The activity can be attributed to flavonoids and phenols, which modulate urinary and serum biochemical parameters and preserve renal tissue integrity. S. oleraceus is a promising candidate for phytopharmaceutical development in kidney stone management. Further studies should focus on isolation of active compounds and clinical validation.

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