

MEDICINAL PLANTS EXHIBITING DIURETIC ACTIVITY: PHYTOCHEMICAL CONSTITUENTS AND EXPERIMENTAL EVIDENCE

Gagan Yadav S. R.^{1*}, Dr. C. D. Saraswathi², Nethravathi L.³, G. Rakesh⁴

^{1,2,3,4}Department of Pharmacology, Gautham College of Pharmacy, Bangalore- 560032,
Rajiv Gandhi University of Health and Sciences, Bangalore, Karnataka.

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*Corresponding Author

Gagan Yadav S. R.

Department of Pharmacology,
Gautham College of Pharmacy,
Bangalore- 560032, Rajiv Gandhi
University of Health and Sciences,
Bangalore, Karnataka.



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1. ABSTRACT

Millions of patients suffer from hypertension, edema, congestive heart failure, and renal disorders. Diuretics are widely prescribed drugs that increase urine flow and sodium excretion to regulate body fluids and treat hypertension. However, long-term use of synthetic diuretics may cause electrolyte imbalance and nephrotoxicity, creating a need for safer plant-based alternatives. Plants such as *Mimosa pudica*, *Aerva lanata*, *Hibiscus sabdariffa*, *Mangifera indica*, and *Nyctanthes arbor-tristis* have shown significant diuretic activity in animal models. Phytochemicals including flavonoids, saponins, alkaloids, terpenoids, phenolics, and glycosides contribute to diuretic effects through inhibition of renal tubular reabsorption, aquaporin modulation, glomerular filtration, and antioxidant activity. This review highlights the phytochemicals, mechanisms, experimental evidence, and therapeutic potential of plant-based diuretics.

KEYWORDS: Medicinal plants, Herbal diuretics, Phytochemicals, Natriuresis.

2. INTRODUCTION

Diuretics are medications, commonly used to manage hypertension, edema, heart failure, and renal disorders due to their ability to enhance urine excretion and promote sodium and water output.^[1] Despite the effectiveness of synthetic diuretics including loop diuretics, thiazides,

and potassium-sparing agents, long-term use may cause dehydration, hyperuricemia, electrolyte imbalance, and metabolic disturbances.^[2] Therefore, scientific curiosity in plant-based diuretics has increased because they may offer fewer side effects and multi-target mechanisms.^[3]

Across cultural medicinal systems like Siddha, Ayurveda, and Traditional Chinese medicine, herbal remedies are used for treating chronic kidney disorders, urinary retention, and edema.^[4-6] Modern pharmacological studies show that many plant extracts exert diuretic effects through inhibition of tubular electrolyte reabsorption, modification of glomerular filtration rate (GFR), antioxidant activity, and modulation of renal prostaglandins.^[7-9] Phytochemicals like saponins, flavonoids, alkaloids, terpenoids, phenolic acids, and glycosides, including rutin, quercetin, phytol, and triterpenes, are responsible for diuretic activity due to their capability to affect renal transporters, oxidative pathways, and aquaporins.^[10-13] Medicinal plants including *Tribulus terrestris*, *Achyranthes aspera*, *Clerodendrum myricoides*, and *Cyclea peltata* have demonstrated experimentally validated diuretic activity in animal models, often comparable to standard agents like furosemide or hydrochlorothiazide.^[14-17]

Despite their therapeutic potential, data on herbal diuretics remain dispersed. A scientific review of experimentally proven diuretic plants, their phytochemicals, and mechanisms is essential for rational drug development and evidence-based practice.

3. GENERAL MECHANISM OF DIURETICS

Diuretics are important drugs to treat edema, hypertension by change renal water electrolytes handling. Therapeutic effect from sodium reabsorption inhibition at nephron segments increase urinary sodium water excretion reduce extracellular fluid volume. Proximal convoluted tubule reabsorbs 50–66% filtered fluid active passive transport. Loop of Henle thin descending limb water permeable solutes impermeable osmotic water withdrawal medullary interstitium. Reduced water reabsorption here enhances diuresis. Thin ascending limb water impermeable sodium chloride passive move is not main diuretic target. These segment actions control fluid overload blood pressure.^[18]

4. DIFFERENT TYPES OF DIURETICS

Table 1: Types of diuretics with mechanism.

Class		Site of action	Mechanism of action	References
Loop diuretics		Loop of Henle	Inhibit $\text{Na}^+ / \text{K}^+ / 2\text{Cl}^-$ reabsorption	19
Thiazides		Distal tubule	Inhibit $\text{Na}^+ / \text{Cl}^-$ reabsorption	20
K^+ -sparing		Collecting duct	Reduce Na^+ reabsorption, conserve K	20
CA inhibitors		Proximal tubule	$\downarrow \text{HCO}_3^-$ and Na^+ reabsorption	21
Osmotic		Proximal + loop of Henle	Prevent water reabsorption or osmotic action	20
Potassium sparing diuretics	Na^+ channel inhibitor	Collecting tubule	Inhibition of Na^+ channel	20
	Aldosterone antagonist	Collecting tubule	Inhibition of aldosterone receptor	20

5. HERBAL TREATMENT

Medicinal herbs represent an important natural source of diuretic agents. Both single-herb and multi-herb formulations have been traditionally and clinically employed to promote diuresis. It has been reported that over 650 herbal formulations, prepared either as individual or combined remedies, are currently used in clinical practice. These preparations are available in various dosage forms, including decoctions, tinctures, tablets, and capsules.^[22]

5.1 Medicinal herbs traditionally utilized as a natural diuretic

Herbal diuretics are plant-derived agents that increase urine output through mechanisms such as natriuresis, aquaresis, carbonic anhydrase inhibition, and modulation of renal hemodynamic. Traditional systems (Ayurveda, Unani) and modern pharmacology report clinically relevant diuretic effects for several botanicals, supported by preclinical and limited clinical data. Systematic reviews collate experimental evidence linking specific phytochemicals—flavonoids, saponins, terpenoids, alkaloids—with diuretic activity via effects on tubular transport and renal vasculature.^[13]

6. CHEMICAL CONSTITUENTS RESPONSIBLE FOR DIURETIC ACTIVITY

1. Flavonoids

Flavonoids are major phytochemicals associated with diuretic activity. They enhance renal blood flow, inhibit tubular sodium reabsorption, and promote natriuresis, thereby increasing urine output.^[23] Main compounds such as isoquercitroside, quercetol 3-triglucoside, and kaempferol glucoside are reported to contribute to diuretic activity.^[24]

Saponins contribute to diuretic activity by increasing membrane permeability in renal tubules and promoting sodium, potassium, and chloride excretion. Triterpenoid and steroidal saponins are mainly responsible for this activity.^[25, 26] Saponins may also act as loop diuretics by inhibiting the Na⁺, Cl⁻, K⁺ co-transporter system in the thick ascending loop of the nephron, thereby increasing natriuresis and kaliuresis.^[27]

3. Alkaloids

Alkaloids are abundant secondary metabolites found in different plants and exert diuretic effects through influence on renal hemodynamics and ion transport mechanisms. Alkaloids such as berberine, pelosine, cycleanine, bebeerine, hayatinin, hayatidin, and hayatin are reported to possess diuretic activity.^[28]

4. Triterpenes

Triterpenes are plant secondary metabolites with diverse pharmacological activities. Compounds such as alisol B 23-acetate, alisol B, alisol A-24 acetate, alisol A, and alisol C-23 acetate show significant diuretic activity by increasing Na⁺, Cl⁻, and K⁺ excretion.^[29]

5. Glycosides

Glycosides play an important role in diuretic activity by influencing electrolyte transport and water balance through inhibition of renal tubular absorption.^[23] Iridoid glycosides such as aucubin and catalpol are mainly responsible for diuretic activity.^[30]

The synergistic interaction of these phytochemicals produces effective diuresis with protective effects, highlighting the therapeutic relevance of herbal diuretics in managing fluid-related disorders.

7. HERBAL PLANTS WITH DIURETIC ACTIVITY

1. *Cyclea peltata*

Cyclea peltata, is the member of Menispermaceae and it is extensively distributed in western coastal regions of India. This plant roots are used in the system of Ayurveda medicine under the name of Rajapatha with various therapeutic application. The leaves of the *cyclea peltata* takes place for their antidandruff, cooling, antipyretic, herpes infection, and diuretic properties. It also present in the coastal areas of the Karnataka. This plant was used as a diuretic activity is contains with the presences of phytochemical constituents like alkaloids, tannins, flavonoids, diterpenes, and saponins. The Evaluation shows the excretion of urine that revealed a significant increase in the excretion of urine volume along potassium and sodium. This evaluation is compared with the standard drug furosemide.^[28]

The diuretic activity of ethanolic and petroleum leaf extract of *cyclea peltata* was done by using the Lipschitz method. This method performed in the healthy wistar rats of either sex or gender, comparing with the standard drug of furosemide (20mg/kg) as a reference. The ethanolic extract of *cyclea peltata* showed significant diuretic effect based on dose-dependent at 200 and 300 mg/kg of body weight, it produced diuretic indices of 1.7 and 2.6, respectively. In alternatively the extract of petroleum ether demonstrated mild diuretic activity at higher dose of 300 mg/kg body weight, with the diuretic indices of 1.1. This experimental performance supported for the traditional benefit of *cyclea peltata* as a diuretic activity in system of Ayurveda medicine.^[17]

2. *Mimosa pudica*

Mimosa pudica Linn., popularly referred to as the sensitive plant or sleepy plant, is a creeping herbaceous species known for its characteristic nyctinastic movements, where the leaves rapidly fold and droop in response to touch or mechanical stimulation before returning to their normal position after a short period. The plant is native to South and Central America and commonly grows in shaded environments under trees and shrubs.^[31]

The diuretic potential of the aqueous leaf extract of *Mimosa pudica* was evaluated in normally fed albino rats using the Lipschitz experimental model. In this study, the control animals received 0.9% sodium chloride solution, while the experimental groups were treated orally with aqueous extract doses of 100, 200, and 400 mg/kg. A standard group was administered furosemide for comparison. Urinary parameters and electrolyte concentrations

were determined using colorimetric analytical methods. The findings demonstrated that the aqueous extract at a dose of 100 mg/kg exhibited significant diuretic activity, characterized by increased urine volume along with enhanced excretion of sodium, potassium, and chloride ions. However, higher doses did not produce any marked improvement in the diuretic response.^[31]

3. *Mangifera indica*

Mangifera indica, it known as mango, tropical fruit tree of Anacardiaceae family. Native to India and grown wide in tropical subtropical areas for nutrition and traditional medicine. Tree grows large up to 30 m height with thick trunk. Appreciated for fruit and active parts bark, leaves, seeds, roots. Traditional medicine gives health benefits anti-inflammatory, antioxidant, antimicrobial, liver-protective, anti-diabetes, anti-cancer, anti-parasitic, anti-HIV, anti-allergic from extracts. These extracts rich in flavonoids, tannins, saponins, other secondary compounds.^[32, 33]

Experiments support traditional uses. Diuretic potential of *Mangifera indica* studied in animal models with various extracts. In study on root extract, albino rats given alcoholic root extract at 100, 200, 400 mg/kg body weight showed dose dependent increase urine volume and electrolytes sodium, potassium, chloride vs control. Highest dose gave significant diuresis in 5 hours Extract improved sodium potassium chloride elimination like known diuretics^[34] Leaf extracts of *Mangifera indica* by lipschitz method, aqueous and 60% ethanolic at 200, 400 mg/kg increased urine output electrolytes vs control. Supports use in fluid balance disorders.^[35] Another study in reviews, aqueous extracts of *Mangifera indica* at 250 mg/kg to wistar rats increased urine volume Na⁺/k⁺ ratios. Shows natriuretic diuretic activity of polar compounds, backs traditional use of mango as natural diuretic.^[13]

These findings prove diuretic effect of *Mangifera indica* with increased urine electrolytes in animals at doses. But more research needed like isolate compounds clinical trials for human use.

4. *Coriandrum sativum*

Coriandrum sativum L, aromatic annual herb of Apiaceae family, cultivated wide in warm temperate regions like India, Egypt, Europe countries. Besides culinary use, coriander in traditional medicine. Seeds used for digestive regulation, inflammatory conditions, antiseptic,

health restoration. Therapeutic from phytoconstituents flavonoids, caffeic acid derivatives, coumarins, sesquiterpene lactones, volatile oils for pharmacological profile.^[36, 37]

Renal function effect of coriander checked with aqueous seed extracts in wistar rats. Intravenous doses 40, 100 mg/kg body weight gave dose dependent urine output increase vs control. Also enhanced sodium, potassium, chloride excretion shows saluretic activity. Response lower than furosemide 10 mg/kg reference but extract promoted electrolytes elimination, shows diuretic efficacy. Mechanism suggests modulation of ion transport in nephron. Pattern of natriuresis kaliuresis like loop diuretics, maybe interfere $\text{Na}^+/\text{K}^+/\text{2Cl}^-$ cotransporter in thick ascending limb loop of henle. Sodium to potassium ratio balanced, indicates milder diuretic safer electrolyte profile than loop diuretics.^[38]

5. *Aerva lanata*

Aerva lanata (L.) Juss. Ex Schult, member of Amaranthaceae family, distributed wide in tropical subtropical regions India, Sri Lanka, Africa, Southeast Asia. In Ayurvedic literature known for urinary ailments specially urolithiasis urinary tract disorders. Aerial parts used as decoctions for urinary flow. Besides diuretic also analgesic, anti-inflammatory, antidiabetic, antivenom properties. Ethnomedicinal for respiratory like bronchitis, epistaxis, scorpion stings, postpartum uterine care.^[39-40] Pharmacological studies support diuretic activity. Oral extracts from stems leaves at doses 200, 400, 800, 1600 mg/kg body weight gave progressive urine output increase in animals. Enhanced sodium, potassium, chloride excretion shows natriuretic, saluretic response. At 1600 mg/kg diuresis near furosemide 25 mg/kg standard.

Phytochemical analysis shows steroids, alkaloids, flavonoids, glycosides, carbohydrates influence renal electrolyte fluid balance. Toxicological no mortality adverse effects up to 3000 mg/kg, broad safety margin. Repeated dose 30 days 18 ml/kg/day kept high urinary output, no acute toxicity.^[41-43]

These findings validate traditional claims of *A. lanata* diuretic dose dependent electrolyte modulating experimentally proven. But more mechanistic clinical studies needed for human use.

6. *Bixa orellana*

Bixa orellana, known as annatto or lipstick tree, member of Bixaceae family. Used in traditional medicine by indigenous in Brazil tropical regions, local name Sappiravirai. Seeds rich source of bixin apocarotenoid used as coloring in cosmetic textile food industries.

Carotenoids more than 80% in annatto seed coat give orange-red color. Besides dye, annatto for medicinal like heartburn, inflammation, high blood glucose. Plant parts show pharmacological activities antibacterial, anti-hyperglycaemic, antihistaminic, antidiarrheal, anticancer, anti-inflammatory, antioxidant. Phytochemicals carotenoids, apocarotenoids, terpenes, terpenoids, sterols, aliphatic compounds in plant. Different parts used in traditional healthcare for disease prevention therapy.^[44]

Diuretic potential of *Bixa orellana* checked with methanolic leaf extracts at 500 mg/kg in wistar rats. Extract gave marked urine output increase with high sodium Na⁺, potassium k⁺, chloride cl⁻ excretion, comparable to furosemide standard. Acute oral toxicity in wistar rats n=6 per group with petroleum ether, methanolic, aqueous extracts in groundnut oil. No mortality toxicity signs up to 1000 mg/kg in 72 hours observation, monitored first 6 hours than 24 hours. Shows *Bixa orellana* leaf extracts well tolerated significant diuretic activity.^[45]

7. *Xanthium strumarium L*

Xanthium strumarium L., a member of the Asteraceae family, is an annual herb commonly distributed in wastelands across India. The plant is traditionally known as Gokh or Kutta Zad and is referred to as Shankeshwara or Arishta in Ayurveda. Different parts of the plant, particularly the roots and fruits, have been widely utilized in Ayurvedic and Unani medicine for the treatment of various disorders. Traditionally, it is regarded as a blood purifier and is used in the management of skin diseases, epilepsy, leucoderma, and insect bites. In addition, the plant has been reported to possess anthelmintic, antipyretic, diuretic, laxative, digestive, cooling, and tonic properties.^[46, 47]

Diuretic activity of *Xanthium strumarium* checked in albino rats with petroleum ether extracts at 250, 500 mg/kg body weight. Compared to furosemide 5 mg/kg standard. Findings show dose dependent urine output increase with sodium Na⁺ potassium k⁺ chloride cl⁻ excretion and glomerular filtration rate improvement. Diuretic effect from phytoconstituents flavonoids, saponins organic acids. Increased diuresis from direct renal action or secondary physiological changes.^[48]

8. *Nyctanthes arbor-tristis Linn*

Nyctanthes arbor-tristis linn, member of Oleaceae family, important medicinal plant cultivated in tropical subtropical regions India neighbouring countries. Known as harsingar parijat night-flowering jasmine, also mythological plant. Prominent in ayurvedic medicine for

diverse therapeutic uses. Grows as small tree shrub with aromatic white flowers open night shed morning, tree of sadness *arbor-tristis*. Parts leaves bark flowers seeds used traditionally for fever arthritis, skin disorders, helminthic infections. Pharmacological activities antioxidant, antibacterial, anti-inflammatory, hepatoprotective, antileishmanial, immunomodulatory.^[49]

Diuretic potential of *Nyctanthes arbor-tristis* checked with ethanolic extracts from flowers seeds bark leaves. Oral doses 200, 400, 600 mg/kg to wistar albino rats for dose response. Findings marked urine volume increase with sodium Na⁺ potassium k⁺ chloride cl⁻ excretion, seed leaf extracts most pronounced. Acute toxicity well tolerated up to 2 g/kg, good safety margin. Diuretic activity from bioactive flavonoids, glycosides.^[50]

9. *Hibiscus sabdariffa* L.

Hibiscus sabdariffa L, belongs to Malvaceae family known as Roselle, important medicinal plant cultivated in tropical subtropical regions India, Africa, Southeast Asia, Central America. Grows well in warm climates well-drained soils, traditional use for hypertension, Edema, liver disorders, urinary ailments. Phytochemical studies show rich in anthocyanins, flavonoids, phenolic acids, organic acids, polysaccharides for pharmacological properties.^[51, 52]

Experiments show diuretic natriuretic activity of aqueous extracts hibiscus sabdariffa calyces leaves in animal models. Oral aqueous extract doses 50-200 mg/kg body weight gave dose dependent urine output increase electrolyte excretion sodium Na⁺ chloride cl⁻ vs control. Higher doses more diuretic response no significant renal toxicity. Mechanism suggests diuretic action from increased renal blood flow nitric oxide vasodilation inhibition tubular sodium reabsorption aldosterone pathways for natriuresis diuresis.^[53, 54]

10. *Raphanus sativus* Linn

Raphanus sativus linn, known as Radish Muli in India, belongs to Brassicaceae cruciferae family. Cultivated wide across India tropical temperate regions world, grows up to 5000 m altitude. Parts roots seeds leaves used in ayurvedic traditional medicine for therapeutic potential. In Ayurveda, Ushna, Virya hot potency for digestive stimulation balance vata, pitta kapha, doshas. Traditional use enhances voice fever, respiratory, dyspnea, throat, eyes disorders. Seeds recognized emmenagogue diuretic, laxative, Lithonriptic, for menstrual,

urinary kidney stones. Fresh root juice strong antiscorbutic for scurvy prevention treatment.^[46, 55]

The diuretic activity of *Raphanus sativus* Linn. (radish) has been demonstrated in experimental studies using aqueous root extract in Wistar albino rats. Oral administration of the extract at doses of 100, 300, and 400 mg/kg body weight produced a significant increase in urine volume and sodium ion excretion, suggesting a marked natriuretic effect similar to that of conventional diuretic agents. The observed activity may be associated with improved glomerular filtration and alterations in renal tubular handling of electrolytes. Phytochemical constituents including flavonoids, alkaloids, glycosides, and volatile oils are believed to contribute to this effect through enhancement of renal blood flow, stimulation of urine formation, and promotion of electrolyte elimination. These findings provide pharmacological support for the traditional use of *Raphanus sativus* in the management of edema, urinary ailments, and hypertension.^[56, 57]

11. *Pistia stratiotes* L.

Pistia stratiotes L, known as water lettuce, free-floating aquatic plant of Araceae family in still slow-moving freshwater tropical subtropical regions. Traditional medicine uses leaves for urinary function, edema, urinary tract disorders from richness alkaloids glycosides, flavonoids, phytosterols.^[58, 59]

Scientific studies validate diuretic potential p stratiotes extracts in animal models. Male wistar albino rats intraperitoneal ethanolic leaf extract doses 200, 400 mg/kg gave significant urine output increase 5-hour 24-hour vs control, dose dependent diuretic effect. Higher dose 400 mg/kg urine volume like furosemide standard, enhanced electrolyte excretion shows natriuretic activity. Another study oral 200 mg/kg leaf extract appreciable diuretic response rats, supports water lettuce diuretic potential.^[60, 61]

These findings support traditional use p stratiotes natural diuretic for further research active components mechanisms.

12. *Solanum lycopersicum* L.

Solanum lycopersicum L, known as tomato, widely cultivated vegetable of Solanaceae family in tropical subtropical temperate regions. Grown low moderate altitudes India, China, USA, Italy, Spain, Africa, south America southeast Asia. Traditional medicine Ethiopia leaves parts

for urinary health fluid balance natural diuretic.^[62] Pharmacological properties anti-oxidant, anti-inflammatory, cardio-protective, atherosclerosis, lipid metabolism, anti-cancer. Phytochemicals alkaloids, phenols, saponins, flavonoids, glycosides, triterpenoids, lycopene beta-carotene, quercetin naringenin, alpha-tomatine.^[63, 64]

Scientific studies show diuretic potential tomato leaf extracts. Controlled study swiss albino mice 80% hydro-methanol leaf extract solvent fractions oral doses 100, 200, 400 mg/kg. 400 mg/kg hydro-methanol aqueous fraction significant urine volume sodium excretion $p < 0.001$ vs control, enhanced diuresis natriuresis like furosemide 10 mg/kg reference. Acute oral toxicity safe up to 2000 mg/kg good safety margin.^[62, 65]

These findings support traditional use of *solanum lycopersicum*, leaves as natural diuretic and suggest potential for further pharmacological development urinary disorders management.

13. *Geranium seemannii* Peyr.

Geranium seemannii peyr, perennial herb of Geraniaceae family, used in mexican ethnomedicine. Local Hindi name sher ki panja. Used for renal urinary tract disorders, inflammatory conditions, dysentery. Phytochemicals rich tannins, flavonoids, phenolic compounds for therapeutic potential. Ethnobotanical herbal infusions for diuresis detoxification urinary health.^[66]

Diuretic activity of geranium seemannii checked in wistar albino rats oral ethanolic extracts doses 25, 50 mg/kg lipschitz method. Gave significant dose dependent urine volume sodium excretion vs control, shows diuretic natriuretic effects. Activity lower than furosemide 20 mg/kg Ip standard but consistent urinary output. Effect from flavonoid inhibition renal tubular sodium reabsorption. Urinary electrolytes Na^+ k^+ cl^- by ion-sensitive electrode analyzer, no serum electrolyte disturbances good renal safety. Supports traditional use *Geranium seemannii* diuretic for plant-based development.^[66]

14. *Amaranthus spinosus* L.

Amaranthus spinosus L, known as spiny amaranth of amaranthaceae family, wide in tropical india africa southeast asia. Whole plant used in siddha ayurvedic medicine for fluid imbalance renal complaints urinary dysfunction. Phytochemicals flavonoids, phenolics, saponins, tannins, glycosides for therapeutic properties.^[67, 68]

Diuretic potential of a spinous checked in rodent models aqueous whole plant extracts. Controlled study journal ethnopharmacology oral *Amaranthus spinosus* aqueous extract asae doses 200, 500, 1000, 1500 mg/kg gave significant urine volume key electrolytes Na^+ K^+ Cl^- excretion vs control 24 hours. At 500 mg/kg most pronounced saluretic effect urine alkalization carbonic anhydrase inhibition like thiazide diuretic profile. Effects like reference diuretics supports traditional a *spinosus* diuretic herb.^[69]

15. *Elettaria cardamomum*

Elettaria cardamomum (L.) maton, known as cardamom chhoti elaichi, perennial aromatic herb of Zingiberaceae family. Cultivated wide tropical regions India, Sri Lanka as spice medicinal. Dried capsules seeds main therapeutic parts. Traditional Ayurveda, Unani Carminative, Stomachic, Diuretic, Antibacterial, Antiviral, Antifungal. Used for constipation, diarrhea, epilepsy, cardiovascular disorders. Phytochemicals alkaloids, flavonoids, tannins saponins, volatile essential oils for pharmacological effects.^[70]

Diuretic activity of *Elettaria cardamomum* checked in wistar rats with fruit extracts aqueous petroleum ether chloroform ethyl acetate fractions. Crude extract 400 mg/kg body weight gave pronounced diuretic response significant urine volume sodium Na^+ potassium K^+ excretion increase. Response comparable furosemide 10 mg/kg standard loop diuretic. Diuretic saluretic effects from flavonoids, saponins, renal electrolyte handling. Findings support traditional *cardamom* plant-derived diuretic ethnomedicine.^[71]

16. *Opuntia ficus-indica* (L.) Mill.

Opuntia ficus-indica (L.) mill, known as prickly pear, member of Cactaceae family native Americas. Now wide Africa, Australia arid semi-arid climates. Among *Opuntia* species *ficus-indica* most cultivated domesticated Mexico cladodes nopal fruits tuna. Nutritional medicinal value rich bioactive, carotenoids, betalains, flavonoids, quercetin, kaempferol isorhamnetin, phenolic acids, ferulic coumaric, gallic essential fatty acids. Traditional medicine for skin disorders, gastric ulcers, inflammation, metabolic, diabetes mellitus.^[72, 73]

Opuntia ficus-indica shows significant diuretic activity rats rabbits cladode gel aqueous extracts. Oral extracts gave marked urine volume increase sodium, potassium excretion improved creatinine clearance no serum creatinine blood urea changes. Diuretic effects comparable furosemide similar mechanism. From flavonoids, isorhamnetin, glycosides renal tubular ion transport. Rats 100 mg/kg extract gel significant diuretic 24-hour 8-day subacute

study daily urine electrolytes. Eighth day plasma electrolytes creatinine clearance osmolar free water clearance. Supports of *ficus-indica* natural diuretic like loop diuretics.^[74, 75]

17. *Boerhaavia diffusa* Linn.

Boerhaavia diffusa linn belongs to family Nyctaginaceae, known as Punarnava, perennial creeping herb wide in India, Sri lanka, Africa tropical regions. Traditional Ayurveda folk medicine for edema, urinary disorders, nephritis, hypertension by using roots, whole plant used.^[76] Phytochemicals alkaloids, punarnavine, flavonoids, lignans, rotenoids, glycosides, phenolics for diuretic nephroprotective, anti-inflammatory, antioxidant effects.^[77]

Diuretic potential of *Boerhaavia diffusa* checked with aqueous ethanolic root extracts wistar albino rats. Oral doses 200-400 mg/kg body weight gave significant dose dependent urine output sodium excretion increase, potassium loss low. Diuretic effect comparable furosemide 20 mg/kg standard shows pronounced diuretic natriuretic activity. Effect from flavonoid, alkaloid modulation renal tubular reabsorption glomerular filtration increase.^[76, 78]

Findings support traditional *Boerhaavia diffusa* fluid retention urinary disorders management.

18. *Ocimum gratissimum*

Ocimum gratissimum, known as ram Tulsi in Hindi African basil clove basil, perennial aromatic plant of Lamiaceae family. Grows as herb small shrub 1-2 meters height. Leaves opposite ovate lance-shaped slightly hairy clove-like fragrance from volatile essential oils. Square stems, mint family type small flowers, white light purple terminal spikes. Wide in tropical Africa, Asia, South America, valued traditional medicinal for culinary aromatic uses.^[79] It shows Anti-inflammatory, antioxidant, antimicrobial, antidiabetic, Antihypertensive and anticancer.^[80] *Ocimum gratissimum* is responsible for diuretics activity flavonoids, phenolics, and oleanolic acid that inhibit renal sodium reabsorption and enhances urine output.^[81]

Diuretic potential of *Ocimum gratissimum* checked in male wistar rats five groups six animals. Control distilled water treatment groups aqueous leaf extracts oral doses 0.4, 0.8, 1.6, 3.2 g/kg body weight 15 days. Separate experiment methanolic leaf extract 100-400 mg/kg 28 days. No adverse effects body weight hematological biochemical organ histology shows well tolerated. Treatments dose dependent urine output increase sodium, potassium excretion significant confirms diuretic activity supports traditional natural remedy urinary excretion.^[79]

Table 2: Summary of Diuretic activity of selected medicinal plants in Animal models.

Plant name	Part used	Extract	Phytoconstituents	Diuretic response	References
<i>Cyclea peltata</i> (Menispermaceae)	Leaves	Ethanolic	alkaloids, tannins, flavonoids, diterpenes, saponins.	Dose-dependent diuresis with ↑ urine output and ↑ Na ⁺ /K ⁺ excretion (DI 1.7–2.6).	28, 17
<i>Mimosa pudica</i> L. (Fabaceae)	Root, Leaves, Whole plant	Ethanolic (root), Hydro-alcoholic (whole plant), Aqueous (leaf)	tannins, steroids, flavonoids, triterpenes, glycosyl, flavones	Significant natriuretic and chloruretic activity with minimal potassium loss; ethanolic root extract showed highest diuretic response.	31
<i>Mangifera indica</i> L. (Anacardiaceae)	Root, Leaves	Alcoholic (root), Aqueous & 60% Ethanolic (leaf)	flavonoids, tannins, saponins, alkaloids	Dose-dependent diuresis with ↑ urine output and ↑ Na ⁺ /K ⁺ /Cl ⁻ excretion	32-35
<i>Coriandrum sativum</i> L. (Apiaceae)	Seeds (fruits)	Aqueous	Flavonoids, Tannin, saponins	Dose-dependent diuresis with ↑ urine output and ↑ Na ⁺ /K ⁺ /Cl ⁻ excretion (mild saluretic activity).	36-38
<i>Aerva lanata</i> (Amaranthaceae)	Aerial parts (stems & leaves)	Extract (oral)	Steroids, Alkaloids, Flavonoids, Glycosides, Carbohydrates	Dose-dependent diuresis with progressive ↑ urine output and ↑ Na ⁺ /K ⁺ /Cl ⁻ excretion, comparable to furosemide at higher dose.	39-43
<i>Bixa orellana</i> L. (Bixaceae)	Leaves	Methanolic	Carotenoids (especially bixin), Apocarotenoids Terpenes, Terpenoids, Sterols	Marked diuresis with ↑ urine output and ↑ Na ⁺ /K ⁺ /Cl ⁻ excretion at 500 mg/kg, comparable to furosemide.	44, 45
<i>Xanthium strumarium</i> L. (Asteraceae)	Whole plant / Aerial parts	Petroleum ether	Flavonoids, Saponins, Organic acids	Dose-dependent diuresis with ↑ urine output and ↑ Na ⁺ /K ⁺ /Cl ⁻ excretion at 250–500 mg/kg, comparable to furosemide.	46, 47, 48

<i>Nyctanthes arbor-tristis</i> Linn (Oleaceae)	Flowers, Seeds, Bark	Ethanolic	Flavonoids, Glycosides	Dose-dependent diuresis with ↑ urine output and ↑ Na ⁺ /K ⁺ /Cl ⁻ excretion at 200–600 mg/kg (seed and leaf extracts most potent).	49, 50
<i>Hibiscus sabdariffa</i> L. (Malvaceae)	Calyces, Leaves	Aqueous	Anthocyanins, Flavonoids, Phenolic acids, Organic acids, Polysaccharides	Dose-dependent diuresis with ↑ urine output and ↑ Na ⁺ /Cl ⁻ excretion at 50–200 mg/kg, indicating significant natriuretic activity.	51-54
<i>Raphanus sativus</i> Linn. (Brassicaceae)	Seeds / Whole plant	Hydro-alcoholic	Alkaloids, Flavonoids, Saponins, Tannins, Phenolics	Dose-dependent diuresis with ↑ urine output and enhanced Na ⁺ /Cl ⁻ excretion (maximum at 400 mg/kg).	46, 55-57
<i>Pistia stratiotes</i> L. (Araceae)	Leaves	Ethanolic	Alkaloids, glycosides, flavonoids, phytosterols.	Dose-dependent diuresis with significant ↑ urine output and natriuretic activity at 200–400 mg/kg, comparable to furosemide at higher dose.	58-61
<i>Solanum lycopersicum</i> L. (Solanaceae)	e v s	80% Hydro-methanol; aqueous fraction	Alkaloids, Phenols, Saponins, Flavonoids, Glycosides, Triterpenoid	Dose-dependent diuresis with significant ↑ urine output and ↑ Na ⁺ excretion at 100–400 mg/kg, comparable to furosemide at 400 mg/kg.	62-65
<i>Geranium seemannii</i> Peyr. (Geraniaceae)	Whole plant / aerial parts	Ethanolic	tannins, flavonoids, phenolic	Dose-dependent diuresis with significant ↑ urine volume and ↑ Na ⁺ excretion at 25–50 mg/kg (mild natriuretic activity).	66
<i>Amaranthus spinosus</i> L. (Amaranthaceae)	Aqueous whole plant	Aqueous	flavonoids, phenolics, saponins, tannins, glycosides	Dose-dependent diuresis with significant ↑ urine output and ↑ Na ⁺ /K ⁺ /Cl ⁻ excretion at 200–1500 mg/kg	67-69

				(maximum saluretic effect at 500 mg/kg).	
<i>Elettaria cardamomum</i> (Zingiberaceae)	Fruit / Seeds	Aqueous & solvent fractions	flavonoids, tannins, saponins,	Significant diuresis with $\uparrow$ urine output and $\uparrow$ Na^+/K^+ excretion at 400 mg/kg, comparable to furosemide.	70, 71
<i>Opuntia ficus-indica</i> (Cactaceae)	Cladodes / Gel	Aqueous	flavonoids, isorhamnetin, glycosides	Marked diuresis with $\uparrow$ urine output and $\uparrow$ Na^+/K^+ excretion, showing loop diuretic-like activity.	72-75
<i>Ocimum gratissimum</i> (Lamiaceae)	Leaves	Aqueous & Methanolic	flavonoids, phenolics, and oleanolic acid	Dose-dependent diuresis with significant $\uparrow$ urine output and $\uparrow$ Na^+/K^+ excretion at 0.4–3.2 g/kg (aqueous) and 100–400 mg/kg (methanolic) extracts.	79-81
<i>Boerhaavia diffusa</i> (Nyctaginaceae)	Roots	Aqueous & Ethanolic	Glycosides, punarnavine, flavonoids	Dose-dependent diuresis with significant $\uparrow$ urine output and $\uparrow$ Na^+ excretion at 200–400 mg/kg, with minimal K^+ loss (comparable to furosemide).	76-78

8. DISCUSSION

Growing interest in plant diuretics shows limits of synthetic drugs and traditional herbal use. Review shows plants like *Mimosa pudica*, *Hibiscus sabdariffa*, *Aerva lanata*, *Mangifera indica* with significant diuretic effects comparable furosemide but less side effects. Effects from phytochemicals flavonoids, saponins, alkaloids, terpenoids, glycosides, phenolics act on renal mechanisms electrolyte transport glomerular filtration antioxidant nephroprotection.

Different plant parts roots leaves seeds extracts vary in potency. Like *Mimosa pudica* ethanolic root extracts stronger diuretic natriuretic than aqueous leaf extracts, shows extraction method plant part important for efficacy. *Aerva lanata* dose dependent urine volume electrolyte excretion, dosing key for benefits safety.

Mechanisms herbal diuretics mimic conventional by renal co-transporters aquaporins hormonal pathways. Plants *Coriandrum sativum*, *Nyctanthes arbor-tristis* balanced Na, k

excretion safer long term than loop diuretics potassium loss. Antioxidant anti-inflammatory properties protect renal tissues prevent injury improve kidney function.

Preclinical data promising but challenges many animal models human clinical sparse. Variations extraction phytochemical content study designs hard compare. Future need standardize extracts isolate compounds clinical trials for efficacy safety.

Medicinal plants valuable natural diuretics multi-target mechanisms good safety. Integrate herbal modern therapy for long-term diuresis sensitive patients. More investigation pharmacological potential mechanisms for safer plant diuretics.

9. CONCLUSION

Medicinal plants good natural alternative synthetic diuretics for fluid retention hypertension renal disorders. Studies past two decades show *Mimosa pudica*, *Aerva lanata*, *Hibiscus sabdariffa*, *Mangifera indica*, *Nyctanthes*, *Arbor-tristis* with significant diuretic natriuretic kaliuretic effects. From phytochemicals flavonoids, saponins, alkaloids, terpenoids, phenolics, glycosides act renal transporters aquaporins, glomerular filtration, antioxidant pathways. Many extracts like furosemide potency fewer adverse effects broader safety margin. Shows therapeutic potential herbal diuretics need more clinical application standardization development safe multi-target renal cardiovascular health.

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