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"Phytotherapy for Renal protection: A review of Herbal Nephroprotectors"

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Abstract:
The prevalence of kidney disease is 10–12% worldwide, and as people age, conditions like diabetes and hypertension increase. These lead to renal disorders such as Glomerulonephritis, Hydronephrosis, Nephrolithiasis, Chronic Kidney Disease (CKD). The balance of metabolites, electrolytes, and other substances required for the regular functioning of most organs is maintained by the kidneys, which are vital organs. Apart from preserving blood's ability to transport oxygen and carbon dioxide via erythropoietin-regulated erythropoiesis, appropriate kidney function manages acid-base and mineral equilibrium, controls the equilibrium of salt, potassium, and water to manage blood pressure, and enhances metabolism in general by means of gluconeogenesis. In contemporary times, herbal medications have gained popularity for their ability to prevent and treat various diseases, owing to the toxicity of synthetic combinations. This review focuses on potent methods of utilizing herbs or herbal extracts to ease urogenital issues, hence improving the prevention and treatment of common kidney ailments. Researchers looking into complementary and alternative medicine may also use it as a filter to discover how kidney disorders, such as chronic kidney failure (CKD), are being treated with plant-based medicines.

Key Word: Glomerulonephritis , Hydronephrosis, Nephrolithiasis, CKD, Herbal Medicine.

Introduction: The kidney's anatomical and functional unit, known as the "nephron," is ma de up of the renal tubule and the renal corpuscle, which is a glomerulus encased in a Bowman capsule. An adult human kidney has about a million nephrons(1). After the creation of an inner glomerular layer by a fenestrated endothelium, a layer consisting of several extracellular proteins forms the complex structure known as the basement membrane of glomerular tissue (GBM). Within the external layer are mesangial cells, podocytes, and visceral epithelial cells. This complicated system enables a constant volume of blood purification at the glomerular level.

Renal Disorders and their causes :

Nephrolithiasis :

Introduction –

About 12% of people worldwide suffer with nephrolithiasis, also known as kidney stones, with a yearly incidence of 600,000 in the United States. It is the most frequent disorder affecting the urinary system. It is caused by a crystalline concretion that exits the kidney and passes via the genitourinary system[2][3].There is an increased incidence of kidney stones in patients with

persistent kidney disease, end-stage renal impairment, cardiovascular disease, diabetic complications, and hypertension.

Most calcium stones are composed of calcium oxalate or calcium phosphate, and they occur in 90% of patients with nephrolithiasis [4]. Ninety percent of individuals with nephrolithiasis develop calcium stones, which are mainly made of calcium phosphate or calcium oxalate. The other common forms are cystine stones, struvite (magnesium ammonium phosphate), and uric acid. Notably, a patient can have a stone with multiple crystal types in it[5].

Pathophysiology:

Renal stones can occur as a result of urine supersaturation and biophysical changes. Precipitation of solutes in the urine due to supersaturation results in conglomerations of crystal and nucleation. pH and specific excess chemical concentrations have an impact on liquid-to-solid conversion. Crystallisation in nephrolithiasis is a risk factor associated with supersaturation of components that form stones, including the minerals calcium and phosphorus, uric acid, oxalate, the amino acid cystine and low urine volume[6]. The best defence against nephrolithiasis is to avoid supersaturation.

Glomerulonephritis :

Introduction:

The phrase "glomerulonephritis" refers to a group of kidney disorders where immune system injury to the mesangium, the capillary endothelium, or the basement membrane causes haematuria, proteinuria, and azotaemia. It is generally accepted that glomerulonephritis is a progressive condition. Lower glomerular filtration rate due to increasing glomerular injury and tubulointerstitial fibrosis are the hallmarks of chronic glomerulonephritis, which can develop in the absence of prompt therapy. The accumulation of uremic toxins leads to the development of cardiovascular diseases, end-stage renal disease (ESRD), and chronic renal failure (CKD). Glomerulonephritis (GN) is prevalently responsible for renal dysfunction. 10–15% of cases of renal failure in its final stages occur in the US as a result. This means that, behind insulin resistance and hypertension, chronic glomerulonephritis accounts for 10% of dialysis patients and is the third most common cause of severe renal failure in the US[7].

Pathophysiology :

The division of glomerulonephritis into five categories according to underlying immunological mechanisms is a more contemporary and well recognised method of classification. The pathogenic type of glomerulonephritis and the related disease entity are included in the current classification as:

Infection-related GN, fibrillary GN with polyclonal Ig deposits, lupus nephritis, IgA nephropathy, and IgA vasculitis are instances of immune-complex GN.GN that is not immune-stimulating, such as ANCA-negative GN, PR3-ANCA GN, and MPO-ANCA GN.- GBM antigen: Glomerular basement membrane (GBM) antigen. Monoclonal Ig GN comprises of immuneotactoid glomerulopathy, fibrillary GN containing monoclonal Ig deposits,

proliferation GN with monoclonal Ig deposits, and monoclonal Ig deposit illness. Another name for C3 glomerulopathy is C3 glomerulonephritis or dense deposit disease [8].

Chronic Kidney Disease (CKD):

Introduction:

Chronic renal failure, or CKD for short, is characterized by a decline in glomerular filtration rate spanning several months or years, which causes the body to accumulate harmful waste products [9].

Globally, there are 697.5 million instances of chronic kidney disease (CKD), translating to a prevalence incidence of 9.1% Most persons in the US with CKD go undiagnosed, with an estimated 37 million having the disease. It is estimated that forty percent of people with significantly reduced kidney function who are not on dialysis do not know they have long-term kidney failure (CKD).For 360 people per 24 hours, dialysis is the initial treatment for renal failure. Thirty out of every four new occurrences of renal failure in the United States are caused by diabetes and high cholesterol levels, with the two most prevalent causes [10].

Pathophysiology :

Prolonged kidney disease (CKD) is divided into six progressive phases based on the rate of glomerular filtration (GFR): 1, 2, 3a and 3b, 4, and 5.Although not always progressive, many persons with CKD eventually reach End-stage renal failure (ESKD), or stage 5, is characterized by total and permanent kidney failure. Numerous factors and signalling pathways can lead to chronic kidney disease (CKD). One of the main cause is apoptosis, acute kidney injury (AKI) and ischemia-reperfusion injury (IRI). Kidney structure malfunctions as a result of tubular inflammation, which induces immune cells to create and deposit extracellular matrix (ECM). A transcription factor called nuclear factor-κB (NF-κB) stimulates pro-inflammatory cytokines. Kidney fibrosis and, eventually, chronic kidney disease (CKD) are caused by reactive oxygen species, proinflammatory cytokines, and problems with the structure of the kidneys[11].

Hydronephrosis:

Introduction:

The primary function of the complex and multidimensional urinary system is to maintain homeostasis in the body by regulating fluid levels, electrolyte balance, and the elimination of end products of metabolism in the form of urine. It comprises the kidneys, ureters, bladder, and urethra anatomically. Every kidney consists of an inner medulla and an outer cortex that combine to form renal pyramids that stretch into the renal pelvis and, ultimately, the ureter. Hydronephrosis and hydroureter can both appear singly or in combination. The enlargement and stretching of one or both kidneys' renal collecting systems due to an obstruction in the urine's outflow away from the renal pelvis—which consists of the ureter, bladder, and urethra—is known as Hydronephrosis. The term "hydroureter" refers to ureter dilatation caused by blockage of urine outflow[12].

Pathophysiology:

Urinary obstructions can be roughly categorised as either intrinsic or extrinsic in their cause. Renal cysts, benign prostatic hyperplasia, neurogenic bladder, among the reasons of intrinsic blockage include renal stones, cancer, ureteropelvic joint a narrowing of ureteral strictures from prior inflammation, and more. The following conditions can result in extrinsic compression: pregnancy, retrocaval ureter, peripelvic cysts, cancer, trauma, retroperitoneal fibrosis, prostate abscess, etc.In children, the majority of instances are caused by anatomic anomalies. The ureterovesical or ureteropelvic junction stenosis, as well as urethral valves or strictures, are examples of these [13].

Nephro Protective Herbs

1. Urtica Diocia (Common nettle, Burn nettle, Stinging nettle)

Fig.1: Urtica diocia [14]

Taxanomy

Kingdom	Plantae-Plants
Division	Magnoliophyta-Flowering Plants
Class	Mangoliopsida-Dicotyledons
Order	Utricales
Family	Utricacea-Nettle Family
Genus	Utrical
Species	Diocia L.-Stinging Nettle

Table no.1: Taxonomy of Urtica diocia [15]

Geographical Distribution

Nettle creates a widespread but modest presence across Southern Europe and North Africa, while Urtica Dioica is primarily common in North Europe and significant parts of Asia. Nettle is a common plant throughout North America, which includes the United States, Canada, and Mexico. In the Indian subcontinent, Urtica dioica finds its ecological niche in the temperate

and sub-tropical Himalayan regions, flourishing between the elevations of 1200 to 3500 meters above sea level from Kashmir to Sikkim. Within the specific topography of Uttarakhand, nettle asserts itself as a resilient undergrowth, thriving across diverse districts. [16]

Botanical Description

Urtica dioica, commonly known as stinging nettle, belongs to the broadleaf angiosperm category within the Urticaceae family. This perennial plant, characterized by its distinctive features, assumes a height ranging from 1 to 3 meters. Its dark green foliage are fashioned like an oval or heart, with sawtooth edges and occasional stinging hairs. They are placed in an opposing pattern. Stinging nettle rhizomes are cylindrical and sometimes branched, and the roots are around 5 mm thick, with irregular twists, a hollow cross-section, and a greyish-brown colour. The upright stem has a strong, fibrous texture and might be hollow or solid. Typically simple or branched, the stem is bluntly square with four deep vertical grooves. Stinging hairs, measuring 1 mm in length, taper to a fine sharp point. These hairs, ranging from sparse to numerous, point upward and possess a thick base.

Leaves of stinging nettle are characterized as simple, meaning they are either lobed or unlobed but not separated into leaflets. Positioned opposite each other, the leaves are coarsely toothed. The bloom is symmetrical in all directions, with a lamina that is 1.5–20 cm long and 0.6–12 cm wide. The 0.7–7 cm petiole has grooves above as well as along the outer edges of the prickly hairs. Pale green, paired, whole, pointed, straight, and silky stipules enhance the overall structure of the leaf. A panicle-shaped inflorescence of green flowers, ranging in length from 2 to 8 cm, blooms through the uppermost leaf axils.

Notably, the flower’s sepals and petals are distinct from one another. The flower has four stamens and four petals in addition to four sepals. When ripe, the stinging nettle fruit (achene) is described as being dry but cannot fall apart. The fruit is solitary and has dimensions of between 0.7 and 0.9 mm in width and 1 to 1.4 millimetres in length. Its texture is smooth,

featuring an extremely thin wall. These botanical attributes collectively define the morphology

COMPOUND NAME	PLANT ORGANS
Alkaloids	
Benzylisoquinoline	Leaves
Chlorophyll A	Leaves
Chlorophyll B	Leaves
Flavonoids	
Quercetin	Leaves
Kaempferol	Leaves
Nicotiflorin	Leaves
Gossypetin	Leaves
Phenols	
Vanillic Acid	Leaves
Ferulic Acid	Leaves
Chlorogenic Acid	Leaves
Salicylic Acid	Leaves
Alcohols	
Erythritol	Leaves
1,2,3—Butanetriol	Leaves
14-Octacosanol	Leaves
Benzopyranoids	
Scoplin	Leaves
Scoparone	Leaves
Scopoletin	Leaves
Terpenoids	
Geranyl Acetone	Leaves
(E)-Anethole	Leaves
B-Ionone	Leaves
Amino Acids	
Alanine	Leaves
Glutamic Acid	Leaves
Isoleucine	Leaves
Leucine	Leaves
Organic Acids	
Citric Acid	Leaves
Malic Acid	Leaves
Acetic Acid	Leaves
Formic Acid	Leaves
Fatty Acids	
Palmitic Acid	Leaves
Erucic Acid	Leaves
Linolenic Acid	Leaves
Pentadecanoic Acid	Leaves

and structure of Urtica dioica. [17-18]PHYTOCHEMICAL CONSTITUENTS

Table no.2: Phytochemical Chemical Constituents [19]

General Uses

- Rheumatoidarthritis
- Gout
- Eczema skin disorders

- Anemia
- Urinary tract infections kidney stones
- Cardio vascular disorder
- Anti-diabetic effect
- Allergic Rhinitis (Hay Fever)
- Anti-inflammatory action
- Early stages of an enlarged prostate (BPH). [20-24]

Nephro Protective Action

Nettle is a natural plant that has been shown to have a considerable positive impact on renal function as well as associated parameters in people with kidney disorders, including those who are advised to undergo dialysis.

Addresses renal stones and urinary tract infections

Consider nettle tea as your body's sympathetic partner, always willing to assist in preserving your inner balance. It's like a soothing elixir, known for its gentle diuretic properties, delicately clearing the path for a smoother urinary flow. This herbal friend steps in not just as a beverage but as a formidable defender, actively preventing urinary tract infections by removing excess uric acid and unwanted bacteria.

But its generosity doesn't stop there. Nettle leaf tea becomes a renal detox master, giving your kidneys a revitalising cleaning. Imagine it as a kind of spa day for your important organs, removing debris from the bladder and diluting kidney stones. The tea encourages your kidneys to work a bit harder, not just flushing out water but also bidding farewell to creatinine, toxic waste, and metabolic leftovers from your body. It's like giving your kidneys a well-deserved break, reducing their load and championing a natural purification process. Some even suggest it could lessen the need for dialysis – a testament to nature's support. And that's not the end of its benevolence. As a natural substitute for gallbladder procedures intended to remove kidney stones, nettle leaf tea can be used. It acts as a kind mentor by gently eliminating extra fluid from the body, avoiding edoema and preserving the delicate equilibrium of your body. Nettle leaf is far more than simply a tea in the assortment of herb teas; it's a dependable friend that improves your health with each sips.

Traditional medicine has employed U. Dioica as a diuretic. Experiments have demonstrated that U. Dioica (hydrous extract) exhibits diuretic action in rabbits while having no effect on the rate of K. Urinary tract infections can be prevented by U. Dioica. Methanol extract, which is its aerial portion, also has anti-kidney stone properties. By lessening the urinary deposition of ca and oxalate, it also lowers elevated levels of creatinine and calcium in the urine. [25].

In the complex landscape of nephropathy, where individuals confront the challenges of kidney issues and the demanding routine of dialysis, nettle leaf tea emerges as a true companion, extending support and potential relief. Beyond being a mere beverage, it stands as a potential shield against the damaging effects of IgA deposits and inflammatory factors that can disrupt kidney function, impacting creatinine clearance. Visualize nettle leaf tea as a nurturing ally,

rich in iron content, actively contributing to haemoglobin production. This becomes particularly vital for patients dealing with haematuria, where blood cells find their way into urine, even amidst dialysis. Tea provides constant support in the fight against renal anaemia by encouraging the synthesis of haemoglobin. Like a rejuvenating potion, it restores crucial vitamins and nutrients that may have been lost as a result of kidney-related issues. Still, its kindness goes beyond. Zinc-rich nettle leaf assumes the mantle of nutritional champion. Zinc deficiency is a common issue for patients with kidney disease, particularly those on dialysis, and can cause symptoms including hair loss. With its high zinc content, nettle tea comes to the rescue, filling up nutritional deficiencies and providing a whole-person approach to health. In the lives of those navigating the intricate terrain of kidney health challenges, nettle leaf tea transcends its role as a mere beverage; it transforms into a comforting ally, weaving support, nourishment, and a touch of wellness into their daily journey. [26]

2. Abelmoschus manihot (Sunset musk mallow, Sunset hibiscus, Hibiscus manihot)

Fig.2: A.Manihot [27]

Taxonomy

Kingdom	Plantae
Phylum	Spermatophytes
Class	Class
Order	Malvales
Family	Malvaceae
Genus	Abelmoschus
Species	Manihot

Table no.3 :Taxonomy of A.Manihot [28]

Botanical Description

A.Manihot, a perennial herbaceous plant or shrub, demonstrates botanical elegance with its stout, terete stems and broad, alternately arranged leaves, orbicular to widely ovate. These leaves, 10–40 cm in length, often palmately-lobed, feature 3–7 lobes variable in depth.

Filiform, linear, or lanceolate stipules accompany the leaves on petioles measuring 3–25 cm. During the flowering phase, 4-to 5-fascicled inflorescences give rise to hermaphrodite that have five white or yellow petals and are sometimes speckled with red or purple. The flowers have a diameter of 4–8 cm. There are four uneven lobes on the calyx, and there are four stamens in a pair on the staminal column. The ovary is bicellular with four ovules in each cell, maturing into an oblong-ovoid capsule, 5–20 cm long, with seeds that are globular to reniform, 3–4 mm in diameter. [29]

Geographical Distribution

A. Manihot, a botanical wanderer, graces the landscapes of India, Southern and Eastern China, Southeast Asia, and beyond. Its vibrant presence weaves through the rich tapestry of these regions, creating a harmonious dance with local cultures. It comes into focus as a crucial cash crop that improves populations' livelihoods everywhere from the highlands of the nation of New Guinea to the Solomon Islands, Vanuatu, Fiji, and New Caledonia, to name a few. Its influence extends to eastern Indonesia, where it becomes a cherished part of agricultural traditions. Across tropical Africa, from Guinea to Uganda, A. Manihot finds a home, contributing not just as a plant but as a vibrant thread in the diverse fabric of cultures and landscapes. [30]

Phytochemical Constituents

Table no.4: Phytochemical constituents [31]

Compound name
FLAVANOIDS
1.Myricetin
2.Quercetin
3.Gossypetin
AMINOACIDS
1.Leucine
2.Isoleucine
3.Tryphophan
POLLYSACCHARIDES
1.Mannose
2.Galactose
3.Glucose
ORGANIC ACIDS
1.Gallic Acid
2.Palmitic Acid
3.Caffeic Acid
STEROLS
1.Docosane
2.Octadecane
3.Tetracosane

General Uses

- Antioxidant and antiadipogenic
- Anti-inflammatory and analgesic
- Nephropathy not associated with diabetes
- Antidepressants and anticonvulsants
- Neuroprotective
- Anti -Virulent
- Tumor Prevention
- Immunomodulatory
- Hepatoprotective
- Cardioprotective
- Proangiogenic
- Effect on cerebral infarction
- Anti-Crohn's disease activity
- Effect on bone loss
- Antiplatelet activity

Nephro Protective Action

Renal Fibrosis

Abelmoschus Manihot, also referred to as A. Manihot, appears to be a possible ally in the fight against unilateral ureteral obstruction (UUO) and chronic renal failure (CRF). A. Manihot therapy resulted in significant reductions in key indicators such as Scr, BUN, NADPH oxidases, α-smooth muscle actin, and phosphorylated-extracellular signal-regulated kinase (p-ERK1/2) in rat models of CRF induced by adenine. Quercetin and hyperoside, two of A. Manihot active ingredients, showed inhibitory effects on the epithelial-mesenchymal transition (EMT) in cells stimulated with high glucose levels, indicating a potential protective role against tubular interstitial fibrosis.

Another study explored A. Manihot's impact on CRF through a rat model, revealing that the total flavones of A. Manihot inhibited inflammatory proteins in vivo and promoted the polarization of macrophages towards a beneficial M2 phenotype. The findings hinted at a potential regulation of autophagy-mediated macrophage polarization, showcasing A. Manihot's anti-inflammatory properties.

In models of UUO in mice, A. Manihot exhibited dose-dependent reduction in renal tubular interstitial injury, suppressed expression of fibrotic markers, and elevated anti-fibrotic proteins. The study indicated that A. Manihot might prevent renal fibrosis by inhibiting the TRPC6/CnA/NFAT signaling pathway.

Quercetin, an essential ingredient of A. Manihot, shown its ability to alleviate renal fibrosis in animal models, and this narrative was further developed there. Through regulation of the TLR4/MyD88 signalling pathway and reduction of macrophage polarisation, quercetin reduced kidney damage, inflammation, and fibrosis markers in UUO mice. Quercetin has been shown

in further research to enhance kidney function, control lipid metabolism, and prevent pathological alterations in rats with glomerulosclerosis (GS).

These findings, both in vivo and in vitro, unveil A. Manihot and its active components as promising players in the intricate landscape of kidney health, offering potential therapeutic avenues against renal fibrosis and associated complications[32].

3. Kalanchoe Pinnata(Bryophyllum germinans Blanco Bryophyllum pinnatum (Lam.Oken)

Fig. 3: Kalanchoe Pinnata [33]

Taxonomy

Kingdom	Plantae
Phylum	Angiosperms
Class	Eudicots
Order	Saxifragales
Family	Crassulaceae
Genus	Kalanchoe
Species	K.Pinnata

Table no. 5: Taxonomy of Kalanchoe Pinnata

Botanical Description

Kalanchoe pinnate is also referred to as cathedral bells, air plant, life plant, miracle leaf, Goethe plant, and love bush. This succulent perennial plant grows to be about 1m (39in) tall, with mushy cylindrical stems and reddish new growth. It blooms throughout the year [34].The leaves have a remarkable ability to create bulbils. Adventitious buds emerge at the teeth's margins, producing roots, stalks, and leaves. As the plantlets descend to the ground's surface, they root and may develop into bigger shrubs. This is a common characteristic in the bryophyllum section. Fruits are follicles (10-15 mm) located in the prolonged calyx and corolla[35].

The terminal inflorescence is a panicle with several dangling, red-orange blooms. The calyx is a long tube with a red base, yellowish green veins (or green speckled with reddish brown), and four little trapezoidal lobes at the end. The tubular corolla, with a prominent constriction dividing the subspherical and ovoid parts, is ended by four lobes that exceed 5 cm (2.0 in) in

length. It has a yellowish colour with red-purple streaks. The corolla has two whorls of eight stamens, each measuring approximately 4 cm (1.6 in) in length. The ovary consists of four joined carpels with slender styles[36].

Geographical Distribution

Kalanchoe pinnata grows naturally in Madagascar. This species has become naturalised in tropical and subtropical places, thriving in warm and temperate conditions from sea level to 2,600 m (8,500 ft). It can be found on rocks in tropical evergreen and dry deciduous forests, as well as montane forests. This species can be found in Asia, Africa, Australia, New Zealand, the West Indies, Bermuda, Macaronesia, the Mascarenes, Brazil, Suriname, the Galapagos Islands, Melanesia, Polynesia, and Hawaii[37].Many places, including Hawaii, consider it an invasive species[38].This plant's prominence as a garden plant accounts for a large portion of its broad naturalisation.

Phytochemical Constituents

Kalanchoe pinnata contains a variety of phytochemicals, including triterpenes, steroids, phenanthrene, flavonoids, flavones, chalcones, tartaric acid, aurones, phenolic acid, caffeine, syringic acid, malic acid, oxalic acid, and ferulic acid. Bryophillin A, bersaldegenin-3-acetate, and bryophillin C are bufadienolide chemicals found in Bryophyllum pinnatum plants[39].

General Uses

In Trinidad and Tobago, Bryophyllum pinnatum is utilised as a traditional hypertension remedy[40].Kalanchoe pinnata, also known as zeb maltet in the French Antilles, is traditionally used to treat headaches. Kalanchoe is used in various ways by Amazonians, including roasted treatment for inflammation and cancer, a tea made from it, and a popular fever medicine. Palikur people in Brazil and French Guiana relieve headaches using a mixture of Kalanchoe leaf juice and coconut oil applied to the forehead[41].It is also utilised as an insecticide and antibacterial agent[42,43].

Nephroprotective Actions

The plant’s leaves are commonly used by indigenous and other groups to treat stones.In Ayurveda, the herb is also known as Pāṣāṇabheda, which means “dissolver of stones”.Tribes in Muzaffarnagar (Uttar Pradesh), Midnapur and Murshidabad districts of West Bengal, Aurangabad (Maharashtra), Nath people, and Sonowal kacharis of Bhekulajan village in Dibrugarh district of Assam use fresh leaf juice or powder of 2-3 black peppers (Piper nigrum Linn.) as folklore medicine for kidney and gall bladder stones.The leaves have been shown to have neurosedative and muscle relaxant, antibacterial, antiulcer, placental contractility, ant nociceptive, anti-inflammatory, antidiabetic, antihypertensive, and nephroprotective properties. Bryophyllum pinnatum extracts contain saponins, flavonoids, and polyphenols, which may aid in antilithiatic activity by dissolving stones and acting as antioxidants[44,45].

Conclusion :

Kidney disease can be caused by a variety of variables or diseases, which are classed as pre-renal, intrinsic, or post-renal based on the physiological process by which they cause kidney damage. In most situations, the pharmacological therapies for the disorders discussed in this study cause side effects and result in nephrotoxicities. Plants and their bioactive compounds, on the other hand, provide nephroprotective effects by functioning as antioxidants, anti-inflammatory drugs, antibiotics, anti-cancer agents, and diuretics, among other things. The reviewed studies clearly support the use of plants and their bioactive components to reduce risk factors and drug-induced kidney injury. Furthermore, these findings shed light on how plants serve as molecular modulators to treat pre-renal and post-renal illnesses that, indirectly or directly, can lead to the emergence of intrinsic kidney disease. A wide range of plants have been shown to have indirect nephroprotective benefits, comprising every component (roots, herbs, leaves, flowers, fruits, and seeds), in addition to by-products such as medicinal plant residue, fruit peels, and pulps, etc. The key conclusion from this review is that it expands the range of nephroprotective plants by taking into account not just plants with intrinsic properties or that can cure nephrotoxicity, but also herbs with favourable effects on kidney disease.

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