A REVIEW ON PHYTOCONSTITUENTS FOR NEPHROPROTECTIVE
ACTIVITY

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ABSTRACT

Kidney harm is most vital health issues and lots of herbal medicines are involved in case of kidney injury. World health organization (WHO) estimate that eightieth of total population used herbal drugs for some characteristic of primary health care while not any facet effects. Herbal medicine has emerged as a skilled approach with sensible values in handling various diseases and developing an affordable phytotherapy to treat severe kidney diseases. The use of herbs as nephroprotective is a major avenue in Indian perspectives particularly for treating kidneys damage, which require to be explored more successfully as there are many literatures available on these aspects. The current review is aimed toward collecting information on promising active phytoconstituents like alkaloids, benzoquinones, catechols, carotenoids, flavonoids, glycosides, flavonol glycosides, steroid glycosides, glycoalkaloids, terpenoids, monoterpenoids, diterpenoids, triterpene saponins, sterols and polyphenols from medicinal plants that are tested in nephroprotective models exploitation fashionable scientific system.

Keywords: Kidney, Nephrotoxic, Nephroprotective, Medicinal plants, Phytoconstituents.

INTRODUCTION

The incidence of kidney failure or chronic kidney failure has doubled over the last 15 years. It is estimated that currently, there are over one million people worldwide who are alive on dialysis or with a functioning graft. Nephrotoxicity is one of the most common kidney problems and occurs when body is exposed to a drug or toxin (Porter et al., 1981). The crisis of kidney shortage is a global phenomenon and it is worst in Asian countries (Surekha et al., 2010). Kidney disease is the ninth leading cause of death. Approximately, 19 million adults have chronic kidney disease and an estimated 80,000 persons have chronic kidney failure diagnosed annually in India. Till date for end stage renal failure, renal replacement is the only therapy. In case, of non-availability of kidney, dialysis is the only alternative, which unfortunately is severely limited by several constraints including a good amount of expenditure. A number of potent therapeutic drugs like aminoglycoside antibiotics, NSAID’s, chemotherapeutic agents and chemical reagents like ethylene glycol, carbon tetrachloride, sodium oxalate and heavy metals such as lead, mercury, cadmium and arsenic can adversely affect the kidney resulting in acute renal failure, chronic interstitial nephritis and nephritic syndrome, rapid decline in renal function resulting in abnormal retention of serum creatinine and blood urea, which must be excreted. According to WHO survey 80% of the population living in the developing countries relies almost exclusively on traditional medicine for their primary health care needs. The chemical constituents obtained from plants may be

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160
pharmacological screened for developing novel agents. Phytochemicals are compounds found in plants that are not required for normal functioning of the body, but have a beneficial effect on health or play an active role in amelioration of diseases (Cordeiro et al., 2011). From different regions, varied plant species having potent nephroprotective activity area unit portrayed at intervals the subsequent section. This review highlights on the chemo profiles from totally different regions of world for treating excretory organ diseases with major thrust on their active constituents.

Nephroprotective Phytoconstituents from Different Medicinal Plants

**Aerva lanata**

Aerva lanata (Linn.) belongs to the Amaranthaceae. Plant is prostate to decumbent, generally erect herb, 30-60 cm tall, wooly, tomentose throughout. It is distributed throughout Tropical India as a common weed in fields and is additionally found in Africa, Sri Lanka and Philippines. In traditional system of medicine, it is used as diuretic and anthelmintic, expectorant and in the treatment of pathology. The leaves of *Aerva lanata* are used as sap for eye-complaints; an infusion is given to cure diarrhea and kidney stone; and also the root is employed in snake bite treatment (Juss 2011). The foremost important bioactive a compounds of the plant includes alkaloids, flavonoids, tannins and phenolic compounds. The plant is employed for arresting hemorrhage during pregnancy, burn healing, as an anti-inflammatory, headache, skin diseases, to dissolve kidney and gall bladder stones, for uterus clearance after delivery and to forestall lactation (Anita et al., 2013). The ethanolic extract of *Aerva lanata* possesses marked nephroprotective activity with stripped toxicity because of the flavonol glycoside like kaempferol-3-rhamnoside & kaempferol-3-rhamnogalactoside which supplied a promising role within the treatment of acute nephritic injury caused by nephrotoxins like cisplatin and antibiotics (Shirwaikar et al., 2004) was cited in table 1 and table 2.

**Andrographis paniculata**

*Andrographis paniculata* belongs to the family Acanthaceae, is a tracheophyte ordinarily referred to as ‘King of bitters’, and is wide cultivated in Southern Asia. Most leaves and roots are historically used over the centuries for various medicinal purposes in Asia and Europe as folklore remedy for wide spectrum of ailment or as herbal supplement for treatment of common cold. It is a rich source of diterpenoids and 2'-oxygenated flavonoids as well as andrographolide, neoandrographolide and stigmasterol. Extensive research has revealed that it has a broad range of pharmacological activities like anti-tumor, anti-inflammatory, anti-viral, anti-diarrhoeal, anti-malarial, hepatoprotective, cardiovascular and immunostimulatory activities (Jarukamjorn & Nemoto 2008). The protective effect of chloroform extract of *Andrographis paniculata* against nephrotoxicity because of diterpenoid like Andrographidoids (Rao, 2006) was specified in table 1 and 2.

**Artemisia annua**

*Artemisia annua* (Asteraceae) is native to China, where it is referred to as qinghao (green herb) and has been used for over a period of 500 years to treat symptoms related to fever and protozoal infection. In China, it was traditionally used to treat fever and hemorrhoids. It is conjointly utilized in the crafting of aromatic wreaths, as a flavoring for spirits like vermouth, and as essential oil for the fragrance business. Sweet wormwood is that the main supply of artemisinin, a crucial natural sesquiterpene lactone with antiprotozoal drug impact against inclined and multi-drug resistant plasmodium species. Sweet wormwood leaves (Zheng and Wang, 2001) and crude extracts are a good supply of antioxidants (Cai et al., 2004). This high antioxidant capability is perhaps due to the high content (Bilia et al., 2006) and variety of its leaf flavonoids, together with the recently reported C-glycosyl flavonoids as possible component of the antioxidant and antiviral activity (Han et al., 2008). The nephroprotective effect of ethanol extract is due to the terpenoids like artemisia ketone, α-pinene, 1,8-cineole (Randjelovic et al., 2013) of *Artemisia annua L* (table 1 and 2).

**Berberis vulgaris**

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Berberis vulgaris is a woody plant of Berberidaceae family, native to central and southern Europe, northwest continent and western Asia. It is been used extensively as a medicative plant in ancient drugs. It contains organic acids and phenol compounds that contain anthocyanin and antioxidant pigments as well as phenolase, polyphenolase and glycosidase enzymes. Berbamin is an iso-kinolin alkaloid and exists in bark of its root, which is a strong antioxidant and is helpful in treating fibrosis caused by anti-cancer medicines like bleomycin (Minaiyia et al., 2011). Pharmacologic properties embrace tonic, antimicrobial, antiinflammatory, antipyretic, antipruritic and cholangogue actions and it has been used in some cases like cholecystitis, choledolithiasis, jaundice, dysentery, leishmaniasis, malaria and gall stones (Javadzadeh et al., 2012). Berberine, an alkaloid is one of the active principles in Berberis vulgaris possessing the nephroprotective activity (Jyothilakshmi et al., 2013), was stated in table 1 and 2.

Camellia sinensis
The tea plant, Camellia sinensis, is a member of the Theaceae family, and black, oolong, and green tea are produced from its leaves. Chinese Camellia sinensis is native to mainland china, south and southeast Asia, however it is nowadays cultivated across the planet in tropical and subtropical areas especially green tea. The chemical constituents found in tea are flavanols or catechins. The main catechins in green tea are epicatechin, epicatechin-3-gallate, epigallocatechin, and epigallocatechin-3-gallate. They are demonstrated to possess vital antioxidant, anticarcinogenic, anti-inflammatory, thermogenic, probiotic, and antimicrobial properties in various human, animal, and in vitro studies (Namita et al., 2012). The protective effect of catechins against nephrotoxicity (Bhattacharya et al., 2013) was mentioned in table 1 and 2.

Cassia auriculata
Cassia auriculata Linn. commonly called tanner's cassia, belongs to the family Fabaceae. It is a common plant in Asia, profoundly employed in Ayurvedic medicine as a tonic, astringent and as a remedy for diabetes, conjunctivitis and ophthalmia (Joy et al., 2012). It contains chemical constituents like fatty acid esters, fatty acid amide, triterpene, diterpene alcohols and phytol in the leaf part, terpenoids, tannin, flavanoids, saponin, cardiac glycosides and steroids within the flower and Grape seed oil, n-Hexadecanoic acid, 9-Octadecenoic acid, (E)-, E, Z 1, 3, 12-Nonadecatriene, stearic acid in its seeds (Raj et al., 2012). The shrub is extremely popular for its attractive yellow flowers which are used in the treatment of skin disorders and body odor. Its bark is used as an astringent, leaves and fruits as anthelmintic, seeds accustomed treat in eye troubles and roots are utilized in skin diseases (Sushma et al., 2012). Its pharmacologic activities embrace antidiabetic and anti-pyretic (Pari & Latha, 2002), hepatoprotective (Ganapathy et al., 2011), bactericidal (Maneemegalai et al., 2010), anti-oxidant (Kumaran et al., 2007), and anthelmintic (Satish et al., 2009). Quercetin and Rutin are the two flavonoids in Cassia auriculata (Annie et al., 2005) that play a key role in nephroprotection (Table 1 & 2).

Ceratonia siliqua
Ceratonia siliqua belongs to the Leguminosae is an evergreen shrub or tree up to 10 m high, crown broad semi-spherical, thick trunk, brown rough bark and sturdy branches. It is a durable evergreen and thermophilic tree thriving in habitats with delicate Mediterranean climates. It grows well in warm temperate and semitropical areas, tolerates hot and humid coastal areas. Its chemical constituents embrace carob polyphenols, tannins etc. Tannins extracted from the pulp act as antidiarrhoeic. Ground pulp and seed endosperm are employed in the preparation of pharmaceutical product. Technical applications of carob bean gum include cosmetics, pharmaceuticals, film emulsions, paints, polishes, ceramics and adhesives (Konate et al., 2007). Carob polyphenols are the important phytoconstituents in Ceratonia siliqua that shows defensive effect in nephrotoxicity (Ben et al., 2011) was mentioned below table 1.
Cordyceps cicadae is an Ascomycetes fungus belonging to the family Clavicipitaceae. In nature, it is found solely at high altitudes on the himalayan plateau and is therefore difficult to harvest. Due to such difficulties, Cordyceps has always been one amongst the most expensive medicative ‘herbs’. It has been used in ancient Chinese medicine ever since to treat kidney, lung, and heart ailments, male and female sexual dysfunction, fatigue, cancer, hiccups, and heavy injury, to relieve pain, and the symptoms of tuberculosis and hemorrhoids, to restore general health and appetite, and to promote longevity (Holliday & Wasser, 2005). The chemical constituents embody cordycepin (3’-deoxyadenosine) and its derivatives, ergosterol, polysaccharides, a glycoprotein and peptides containing α-amino isobutyric acid. Scientifically pharmacologic activities embrace anti-cancer, immunomodulatory, insecticidal, anti-microbial, hypolipidaemic, hypoglycemic, anti-arrhythmic, anti-hypolipidinism, anti-aging, neuroprotective and renoprotection (Paterson, 2008). A sterol called ergosterol is present in Cordyceps cicadae (Paterson, 2008) which is responsible for nephroprotective action (table 1 and 2).

Crocus sativus

Crocus sativus Linn. (Family: Iridaceae) is a flowering plant in the crocus family and is commonly known as saffron. It is widely used as spice and as a coloring and flavoring agent in the preparation of various foods and cosmetics. It is native to Iran and Greece. It is now cultivated largely in Southern Europe, Tibet and other countries. It is a grass like tuber plant with purple or lilac colored flowers. The stigmas of the plant are mainly used for its medicinal properties extensively in traditional medicine for various purposes, as an aphrodisiac, antispasmodic, expectorant, for treatment of stomach ailments, reducing stomachache and for relieving tension. Chemical studies on stigmas of Crocus reported that it possesses carotenoids like crocetin, its glycosidic forms are digentiobioside (crocin), gentiobioside, glucoside, gentioglucoside and diglucoside. Carotenoids, anthocyanins, flavonoids, vitamins are also found in it. Crocin is reported to have anti-carcinogenic activity, antioxidant activity, anti-tussive activity and anti-hyperlipidemic acivity (Bhargava, 2011). Crocin is a glycoside which plays a significant role in treatment of cisplatin-Induced acute renal failure (Naghizadeh et al., 2010) was given below in table 1 and 2.

Curcuma longa

Curcuma longa, a perennial herb and member of the family Zingiberaceae (ginger) family, grows to a height of 3 to 5 feet and is cultivated extensively in Asia, India, China, and different countries with a tropical climate. Curcumin is that the principal curcuminoid of the popular Indian spice turmeric, which is a member of the ginger family. The other two curcuminoids are desmethoxycurcumin and bisdesmethoxycurcumin. The curcuminoids are polyphenols and are liable for the yellow color of turmeric. Dried Curcuma longa is the supply of the spice turmeric. Turmeric is employed extensively in foods for its flavor and color, still as having an extended tradition of use within the Chinese and ayurvedic systems of medication for the treatment of flatulence, jaundice, expelling difficulties, hematuria, hemorrhage, and colic. Curcumin has antioxidant, anti-inflammatory, antiviral and antifungal actions (Bush et al., 2001). Scientific studies showed that curcumin exhibits nephroprotective action (Venkatesan et al., 2000), which was stated in table 1 and 2.

Nigella sativa

Nigella sativa belongs to the family Ranunculaceae is a little elegant herb, largely found and cultivated in Syrian Arab Republic, Lebanon, Israel and Southern Europe. Historically the seeds and its oil are employed in many diseases. The seeds are considered as bitter, appetizer, stimulant, diuretic, thermogenic, carminative, deodont, expectorant and purgative (Paarakh, 2010). Oil is a local anaesthetic. The foremost necessary active compounds are Thymoquinone, Thymohydroquinone, dithymoquinone, p-cymene, carvacrol, 4-terpinol, t-anethol, sesquiterpene longifolene and phenol (Aftab Ahmad et al., 2013). It has a wide spectrum of its pharmacological actions that
embrace antidiabetic, anticancer, immunomodulator, analgesic, antimicrobial, anti-inflammatory, spasmolytic, bronchodilator, hepatoprotective, gastroprotective, anti-oxidant properties (Nickavar et al., 2003). Thymoquinone is one of the important phytoconstituents constituent in Nigella sativa that plays a major role in the treatment of gentamicin induced nephrotoxicity (Aftab Ahmad, 2013) which was cited in table 1 and 2.

**Panax ginseng**

Panax ginseng belongs to Araliaceae family and is found everywhere in East Asia and Russia. It is over-harvested in different areas of Asia. It is cultivated in Korea, China, and Japan for use as a medicinal herb. It is a shade-loving, deciduous perennial plant with five-fingered leaves, tiny white flowers and yellowish-brown roots (Ernst, 2010). Its chemical constituents embody triterpene glycosides, or saponins, usually called ginsenosides. Though ginseng has been employed by Asian cultures for thousands of years for conditions like fatigue, mental stress, blood sugar regulation, improving libido, and supporting longevity, modern clinical studies have targeted on the making use of of ginseng in cancer prevention, blood sugar regulation, fatigue, and immunomodulation in human health and disease (Yun, 2001). Ginsenosides Rh4 and Rk3 significantly abridged the cisplatin-induced nephrotoxicity (Aek et al., 2006) was additionally mentioned in table 1 and 2.

**Phoenix dactylifera**

Date palm (Phoenix dactylifera L.) is a monocotyledon plant within the palm tree family and is one in all the oldest fruit crops fully grown within the arid regions of the Arabian Peninsula, North Africa, and the Middle East. Later they were also introduced to new production areas in Australia, India, Pakistan, Mexico, southern Africa, South America, and the United States. Dates are main income basis and staple food for local populations in many countries in which they are cultivated (Chao; Krueger 2007). Its medicine activities embody antiviral, antifungal, antioxidant, antihyperlipidimic and hepatoprotective activity. These activities are as result of the high contents of antioxidant in date fruit such as the coumaric acid and ferulic acid. It also contains flavonoids, sterols, procyanidins, carotenoids, anthocyanins, sugar (Ismail et al., 2013). Quercetin is one of the active principles in date palm, which possess protective effects against thegentamicin-induced nephrotoxicity (Abdel-Raheem et al., 2009) in rats is mentioned more in table 1 and 2.

**Picrorhiza kurroa**

Picrorhiza kurroa (family: Scrophulariaceae) is a little perennial herb that grows in northwest India on the slopes of the Himalayas between 3000 and 5000 meters. It is found in Southeast Tibet, North Burma and West China. It is a very important herb in the traditional Ayurvedic system of medicine, and has been used to treat liver troubles and bronchial problems, dyspepsia, bilious fever, chronic dysentery, and scorpion sting. Kutkin is the active principal of Picrorhiza kurroa and is comprised of kutkoid and iridoid organic compound picrosides I, II, and III. Different known active constituents are apocynin, drosin, and nine cucurbitacin glycosides. It is scientifically evidenced to possess hepatoprotective, anticholestatic, antioxidant and immune-modulating activity (Yadav & Khandelwal, 2009). Kutkoid and Picroids are the active constituents in Picorrhizakurroa that are responsible for nephroprotective action (Yadav & Khandelwal, 2009), were cited in table 1 and 2.

**Polyporus umbellatus**

Polyporus umbellatus (family: Polyporaceae) is one of the commonly used and precious medicinal fungi, with sclerotia being widely used for many years as an anti-diuretic agent as well as an antidote in oriental countries, especially in China, Korea and Japan. In ancient medication, it was used to cure edema and had a high effect. It’s mainly compositions contain phytosterol, polysaccharides, protein, etc. Phytosterols of Polyporus umbellatus include ergosterol, 22-tetren-3-one (ergone), ergosta-7, 22-dien-3-one, ergosta-7 and 22-dien-3-ol. It also contains some other compounds belonging to different classes of
natural products, such as long chain fatty acids, anthraquinones, nucleosides, etc. It polysaccharides has good effect to to anti-tumor, prevent radiation, help to cure rheumatism, edema, lung or stomach cancer, enhancing immune function, reducing transaminase, inhibition of virus replication, and repair of liver damage (Liu & Guom, 2009). Ergone exhibited a fine nephroprotective effect against aristolochic acid or adenine-induced nephrotoxicity in rats (Zhao, 2013), was indicated in table 1 and 2.

**Ramulus mori**

*Ramulus mori* (young twigs of mulberry tree L.) belongs to Moraceae is a fast-growing deciduous plant that grows under completely different climate like tropical, semitropic and temperate. Mulberry is valued for its foliage that constitutes the foremost important feed for silkworms. In ancient Chinese medicine it is used for the treatment of joint pain. Chemical constituents of this plant are stilbenes, cis-mulberosideA, resveratrol and flavonoids like rutin, quercetin and morin. The pharmacological actions of this plant are found to be anti-inflammatory, potential analgesic activity and anti-rheumatoid activity (Zhang & Shi, 2010). Ethanolic extract of *Ramulus mori* showed nephroprotective effect because of active constituents like Rutin, Quercetin (Zhu et al., 2004), Morin (Wang et al., 2010) and mulberoside A (Wang et al., 2011), which were mentioned in table 1 and 2.

**Satureja khuzestanica**

*Satureja khuzestanica* is an endemic plant of Iran that is widely distributed in the Southern part of Iran (Jamzad Z, 1994). It is notable for its medical uses as analgesic and antiseptic in folk medication (Zargari, 1990). Carvacrol is that the major active constituent in genus *Satureja khuzestanica*. The other vital constituents are myrcene, para-cymene, terpinene, linalool, 4-terpineol, eugenol and caryophyllene compounds. Pharmacological activities embrace antiviral (Abad et al., 1999), antinociceptive (Hajhashemi et al., 2000), anti-inflammatory (Amanlou et al., 2005), antibacterial (Yamasaki et al., 1998), antifungal (Azaz et al., 2002), antimicrobial (Amanlou et al., 2004), antispasmodic and antidiarrhea (Hajhashemi et al., 2002). Nephroprotective action of this plant is a result of monoterpenoid like Carvacrol in it (Tavafi et al., 2011), which is mentioned in table 1 and 2.

**Solanum xanthocarpum**

*Solanum xanthocarpum* belongs to the family Solanaceae. It is an annual herbaceous plant comprising 90 genera and 2000-3000 species. In ancient systems of medicine, different parts like leaves, stem, flower, root, seeds of *Solanum xanthocarpum* or the plant as a whole are used (Singh & Singh, 2010). The reported chemical constituents are carpersterol, gluco alkaloid solanocarpine, solanine-S, solasodine, solasonine, stigmasterol, campesterol, cholesterol, sitosteryl-glucoside, solasurine. It also contains methyl ester of caffeic acid, isochlorogenic acid, neochlorogenic acid, chlorogenic acids (fruit), apigenin, sitosterol (flower), solanocarpine and amino acids (seeds); coumarins etc.. The drug of this plant is used as anti-asthmatic, hypoglycaemic, anti-inflammatory, antitumor, anti-tussive, antipyretic, antispasmodic, anti-histaminic, hypotensive and cytotoxic activity (Roshy Joseph et al., 2012). Ethanol, butanol and water extracts of *Solanum xanthocarpum* showed nephroprotective activity which is because of a glycoalkaloid called Solasodine (Patel et al., 2012), which is cited in table 1 and 2.

**Zingiber officinale**

Ginger (*Zingiber officinale Roscoe, Zingiberaceae*) is one amongst the vital medicinal plant that naturally occurs in several country like Asian country, China, South East Asia, West Indies, Mexico and other parts of the planet (Ghosh et al., 2011). The pungency of ginger is due to gingerol, an oily liquid consisting of homologous phenols, which is produced in the plant from phenylalanine, malonate and hexonate. The British Herbal Compendium reported its action as carminative, antiemetic, spasmylytic, peripheral circulatory stimulant and anti-inflammatory (Malhotra et al., 2003). Aqueous and ethanolic extracts of *Zingiber officinale* contains Gingerols, which showed protective effect against anticancer drug doxorubicin-induced acute nephrotoxicity (Ajith et al., 2008), and was mentioned in table 1.
and 2. Phytoconstituents and their structures were further mentioned in table 2.

Miscellaneous Phytoconstituents for Nephroprotective Activity

Ascorbic acid (Vitamin C)
Vitamin C is a vitamin, which means the human body does not store it. It is found in foods like citrus fruits, broccoli, and tomatoes. It is an antioxidant that blocks a number of the harm caused by free radicals, substances that harm deoxyribonucleic acid. The build-up of free radicals over time could contribute to the aging method and therefore the development of health conditions like cancer, heart condition, and inflammatory disease (Davies et al., 1991). Scientific studies discovered that Ascorbic acid is also found to have Nephroprotective activity (Huang et al., 2000).

Caffeic acid phenylethyl ester
Caffeic acid phenylethyl organic compound is a vigorous part of propolis from bee hives. It is better-known to own antimitogenic, anticarcinogenic, medicine, and immunomodulatory properties. It is a potent and specific inhibitor of nuclear transcription factor (NF-κB) activation (Sudina et al., 1993). Recent studies revealed that it also exhibits nephroprotective activity (Ozen et al., 2006).

Capsaicin
Capsaicin is the ingredient found in numerous sorts of hot peppers, like cayenne peppers, that creates the peppers spicy hot. Once a chemical irritant capsaicin cream or ointment is employed on the skin (topical use), it helps relieve pain. If hot peppers are taken as dietary supplements, the chemical irritant could improve the digestion by increasing the organic process fluids within the abdomen associated by fighting microorganism that would cause an infection. It facilitates forestall cardiovascular disease. It also stimulates the circulatory system and lowers blood cholesterol levels. It additionally helps forestall natural action and hardening of arteries (atherosclerosis). It acts as associate inhibitor, protects the cells of the body from harm by harmful molecules referred to as free radicals. It obstructs microbial infections. It also strengthens respiratory organ tissues and facilitates to treat respiratory disorder (Nelson, 1919). Modern research showed that capsaicin is also proven to have nephroprotective activity (Shimeda et al., 2005).

Desferoxamine
Deferoxamine (also referred to as desferrioxamine B, desferoxamine B, DFO-B, DFOA, DFB or desferal) is being a microorganism siderophore created by the action of bacteria Actinomycetes. Its medical applications as a chelating agent accustomed take away excess iron from the body (Miller et al., 1989). By removing excess iron, the agent reduces the injury done to varied organs and tissues, like the liver (Lee et al., 2007). This agent is additionally of times accustomed treat hemochromatosis, an illness of iron accumulation which will be either genetic or uninheritable. Deferoxamine has conjointly been utilized in the treatment of a patient with aceruloplasminemia (Miyajima et al., 1997). Scientific research showed that Deferoxamine also has nephroprotective activity (Kadikoylu et al., 2004).

DL-α- Lipoic acid
Lipoic acid (LA) is associate organosulfur compound derived from octanoic acid (Reljanovic et al., 1999). Lipoic acid is found in the majority of foods and slightly in kidney, heart, liver, spinach, broccoli, and yeast extract (Durrani et al., 2010). Lipoic acid is used in clinical trials like accelerate chronic wound healing (Alleva et al., 2005), reduce levels of asymmetric dimethylarginine (ADMA) in diabetic end-stage urinal disease patients on hemodialysis (Chang et al., 2007), prevent or slow the progression of Alzheimer’s sickness (Holmquist et al., 2007), and reducing the inflammation (Zhang et al., 2007). Studies showed that DL-α- Lipoic acid also has nephroprotective activity (Obrosova et al., 2003).

Edarabone
Edarabone (3-methyl-1-phenyl-2-pyrazolin-5-one), a strong antioxidative radical scavenger, is that the exclusively drug presently out there in
clinical practice for the treatment of cerebral infarction (Satoh et al., 2002). But, later on scientific studies manifested that it also possess nephroprotective activity (Satoh et al., 2003).

Lupeol
Lupeol, a triterpene, is that the principal constituent found in edible vegetables and fruits such as white cabbage, pepper, cucumber, tomato, carrot, pea, bitter root, soy bean, ivy gourd, black tea, figs, strawberries red grapes, mulberries, date palm and guava. Lupeol has been found to possess a large vary of medicative properties that embrace conditions like inflammation, arthritis, diabetes, cardiovascular ailments, kidney disease, hepatic toxicity, microbial infections and cancer (Al-Rehaily et al., 2001; Fernández et al., 2001; Chaturvedi et al., 2008; Sudhahar et al., 2008). Scientific studies revealed that lupeol is a possessor of nephroprotective activity (Nagaraj et al., 2000).

Lycopene
Lycopene (from the Neo-Latin word *Lycopersicum*, touching on the tomato species) is a bright red carotene and carotenoid pigment and phytochemical found in tomatoes and other red fruits and vegetables, like red carrots, red bell peppers, watermelons and papayas. In line with one preliminary study, consumption tomato paste for 3 months decreases sun injury by U.V radiation by 30 minutes through the action of lycopene (Rizwan et al., 2011). Scientific research on lycopene showed that it also exhibits nephroprotective action (Atessahin et al., 2005).

Pyridoxamine
Pyridoxamine is a vitamer within the B-complex vitamin family, which incorporates B-complex vitamin and pyridoxamine (Roje, 2007). Pyridoxamine is transformed to the biologically active form of B-complex vitamin, B-complex vitamin 5-phosphate, through the B-complex vitamin salvage pathway. Pyridoxamine inhibits the Maillard reaction and can block the formation of advanced glycation endproducts, which are related to medical complications of diabetes (Ahmed et al., 2007). In alternative diagnosis analysis, pyridoxamine is also effective in treating diabetic neuropathy and retinopathy associated with diabetes and kidney stone disease (Voziyan et al., 2005). Studies proved that pyridoxamine has nephroprotective activity (Metz et al., 2003).

Resveratrol
Resveratrol is a stilbenoid, a polyphenolic compound found in grapes, red wine, purple grape juice, peanuts, and some berries (Soleas et al., 1997). Most analysis on resveratrol has been done on animals, not people. Research in mice given resveratrol suggests that the antioxidant may additionally facilitate protect them from fat and diabetes, both of that are which sturdy risk factors for cardiopathy. In mouse and rat experiments, telomere lengthening, telomerase activity enhancement, anti-inflammatory, blood sugar-lowering and different beneficial cardiovascular effects of resveratrol have been reported (Strong et al., 2003). Most recent research manifested that resveratrol also has nephroprotective activity (Mannari et al., 2010).

Taurine
Taurine, or 2-aminoethanesulfonic acid, was originally discovered in ox (Bostaurus) bile and was named after taurus, or bull. A nonessential amino acid-like compound, taurine is found in high abundance within the tissues of many animals, particularly ocean animals, and in much lower concentrations in plants, fungi, and in a few microorganisms. As an amine, taurine is vital in several metabolic processes of the body, as well as stabilizing cell membranes in electrically active tissues, like the brain and heart. It conjointly has functions within the gallbladder, eyes, and blood vessels, and may have some inhibitor and detoxifying properties (Huxtable RJ, 1992). Scientific studies revealed that taurine is possessor of nephroprotective activities (Trachtman et al., 1993).

Vitamin E
Vitamin E is fat-soluble compound that includes both tocopherols and tocotrienols (Brigelius et al., 1999). As a fat-soluble antioxidant, it stops the assembly of reactive oxygen species shaped when fat undergoes oxidation (Herrera et al., 2001).
Vitamin E has several biological functions, the antioxidant operate being the foremost vital and best known. Its alternative functions embody enzymatic activities, gene expression, and neurological functions. The most vital function of vitamin E has been suggested to be in cell signaling (Azzi, 2007). Deficiency vitamin E causes spinocerebellar ataxia, myopathies, peripheral neuropathy, ataxia, skeletal myopathy, retinopathy, impairment of the immune response and red blood cell destruction (Traber et al., 2007). Scientific research on vitamin E showed that it is also has a power of nephroprotective activity (Bursell et al., 1999).

**Xanthorrhizol**

Xanthorrhizol may be a sesquiterpenoid compound extracted from *Curcuma xanthorrhiza*. Historically, it absolutely was found to possess antibacterial, anticancer and anti-inflammatory activity (Ismail et al., 2005). The stem has additionally been used to treat inflammation in postpartum uterine bleeding. Recent studies also proved that it possess nephroprotective activity (Kim et al., 2005). Miscellaneous phytoconstituents compounds and their structures were further mentioned in table 4.

### Table 1: Phytoconstituents from Medicinal plants for Nephroprotective activity

<table>
<thead>
<tr>
<th>Name and family</th>
<th>Family</th>
<th>Major constituent</th>
<th>Specific constituent</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Aerva lanata</em></td>
<td>Amaranthaceae</td>
<td>Flavonol glycoside</td>
<td>Kaempferol-3-rhamnoside &amp; kaempferol-3-rhamnogalactoside</td>
<td>Shirwaikar et al., 2004</td>
</tr>
<tr>
<td><em>Andrographis paniculata</em></td>
<td>Acanthaceae</td>
<td>Diterpenoid</td>
<td>Andrographidoids</td>
<td>Rao, 2006</td>
</tr>
<tr>
<td><em>Artemisia annua L.</em></td>
<td>Asteraceae</td>
<td>Terpenoid</td>
<td>Artemisiaketone, α-pinene &amp;1,8-cineole</td>
<td>Randjelovic et al., 2013</td>
</tr>
<tr>
<td><em>Berberis vulgaris</em></td>
<td>Berberidaceae</td>
<td>Alkaloids</td>
<td>Berberine</td>
<td>Jyothilakshmi et al., 2013</td>
</tr>
<tr>
<td><em>Camellia sinensis</em></td>
<td>Theaceae</td>
<td>Flavonoids</td>
<td>Epicatechin, epicatechingallate, epigallocatechin, epigallocatechingallate</td>
<td>Bhattacharya et al., 2013</td>
</tr>
<tr>
<td><em>Cassia auriculata</em></td>
<td>Fabaceae</td>
<td>Flavonoids</td>
<td>Quercetin &amp; Rutin</td>
<td>Annie et al., 2005</td>
</tr>
<tr>
<td><em>Ceratonia siliqua</em></td>
<td>Leguminosae</td>
<td>Polyphenol</td>
<td>Carob polyphenols</td>
<td>Ben et al., 2011</td>
</tr>
</tbody>
</table>

### CONCLUSION

From this study, it is clear that the so many herbal plants active constituents play an important role against nephrotoxicity caused by numerous agents (drugs, chemicals etc.). The nephroprotective activity is in all probably due to the presence of assorted active constituents like alkaloids, benzoquinones, catechols, carotenoids, flavonoids, glycosides, flavonol glycosides, steroid glycosides, glycoalkaloids, terpenoids, monoterpenoids, diterpenoids, triterpene saponins, sterols and polyphenols in all few herbal plants have been reported for its significant nephroprotective activity in animal models. The results of this study indicate that extracts of leaves and other parts of some medicinal plants have good potentials for use in kidney damage. The present review study gives evidential nature of nephroprotection in some medicinal plants against experimentally induced nephrotoxicity. Hence, the review of the study concluded that the plants containing these phytoconstituents possesses nephroprotective activity and it has been proven by different animal models which gives many links to develop the future trials.
<table>
<thead>
<tr>
<th>Source</th>
<th>Active constituent</th>
<th>Chemical name (IUPAC name)</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aerva lanata</strong></td>
<td>Kaempferol</td>
<td>5,7-Dihydroxy-2-(4-hydroxyphenyl)-3-[(2S,3R,4R,5R,6S)-3,4,5-trihydroxy-6-methyloxan-2-yl]oxychromen-4-one</td>
<td><img src="structure1.png" alt="Structure" /></td>
</tr>
<tr>
<td><strong>Andrographis paniculata</strong></td>
<td>Andrographiloid</td>
<td>(S,E)-dihydro-3-((1R,2R,4aS,5R,8aS)-decahydro-2-hydroxy-1-(hydroxymethyl)-1,4a-dimethyl-6-methyl enenapthalen-5-yl) ethylidene)-4-hydroxyfuran-2(3H)-one</td>
<td><img src="structure2.png" alt="Structure" /></td>
</tr>
<tr>
<td>Plant</td>
<td>Compound</td>
<td>Chemical Structure</td>
<td></td>
</tr>
<tr>
<td>---------------------------</td>
<td>-----------------------------------</td>
<td>------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><em>Artemisia annua</em> L.</td>
<td>Artemisia ketone</td>
<td>2,5,5-Trimethyl-2,6-heptadien-4-one</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><img src="image-url" alt="Artemisia ketone" /></td>
<td></td>
</tr>
<tr>
<td><em>Artemisia annua</em> L.</td>
<td>alpha-pinene</td>
<td>(1S, 5S)-2,6,6-Trimethyl bicyclo[3.1.1]hept-2-ene ((−)-α-Pinene)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><img src="image-url" alt="alpha-pinene" /></td>
<td></td>
</tr>
<tr>
<td><em>Artemisia annua</em> L.</td>
<td>1, 8-cineole</td>
<td>1,3,3-Trimethyl-2-oxabicyclo-[2,2,2]-octane</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><img src="image-url" alt="1,8-cineole" /></td>
<td></td>
</tr>
<tr>
<td><em>Berberis vulgaris</em></td>
<td>Berberine</td>
<td>5,6-dihydro-9,10dimethoxybenzo[g]-1,3-benzodioxolo[5,6-a]quinolizinium</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><img src="image-url" alt="Berberine" /></td>
<td></td>
</tr>
<tr>
<td><em>Camellia sinensis</em></td>
<td>Epicatechin</td>
<td>(2R,3R)-2-(3,4-dihydroxyphenyl)-3,4-dihydro-2H-1-benzopyran-3,5,7-triol</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><img src="image-url" alt="Epicatechin" /></td>
<td></td>
</tr>
<tr>
<td><em>Camellia sinensis</em></td>
<td>Epicatechingallate</td>
<td>[(2R,3R)-2-(3,4-dihydroxyphenyl)-5,7-dihydroxy-3,4-dihydro-2H-chromen-3-yl]3,4,5-trihydroxy benzoate</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><img src="image-url" alt="Epicatechingallate" /></td>
<td></td>
</tr>
<tr>
<td>Plant</td>
<td>Compound</td>
<td>Structure</td>
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</tr>
<tr>
<td>--------------------------</td>
<td>---------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><em>Camellia sinensis</em></td>
<td>Epigallocatechin (EGC)</td>
<td><img src="image1" alt="Structure of Epigallocatechin" /></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2R,3R)-2-(3,4,5-trihydroxy phenyl)3,4-dihydro-2H-1 benzopyran-3,5,7-triol</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Cassia auriculata</em></td>
<td>Quercetin</td>
<td><img src="image2" alt="Structure of Quercetin" /></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxy-4H-chromen-4-one</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Cassia auriculata</em></td>
<td>Rutin</td>
<td><img src="image3" alt="Structure of Rutin" /></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2-(3,4-dihydroxyphenyl)-5,7 dihydroxy-3-[α-L-rhamnopyranosyl-(1→6)-β-D-glucopyranosyloxy]-4H-chromen-4-one</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Cordyceps cicadae</em></td>
<td>Ergosterol</td>
<td><img src="image4" alt="Structure of Ergosterol" /></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ergosta-5,7,22-trien-3β-ol</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Crocus sativus L.</em></td>
<td>Crocin</td>
<td><img src="image5" alt="Structure of Crocin" /></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bis<a href="2E,4E,6E,8E,10E,12E,14E">(2S,3R,4S,5S,6R)-3,4,5 trihydroxy-6-({[(2R,3R,4S,5S,6R)-3,4,5-trihydroxy-6(hydroxymethyl)tetrahydro-2H-pyran-2-yl]oxy}methyl)tetrahydro-2H-pyran-2-yl</a>2,6,11,15-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant</td>
<td>Compound</td>
<td>Chemical Structure</td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><em>Curcuma longa</em></td>
<td>Curcumin</td>
<td>(1E,6E)-1,7-Bis(4-hydroxy-3-methoxyphenyl)-1,6-heptadiene-3,5-dione</td>
<td></td>
</tr>
<tr>
<td><em>Nigella sativa</em></td>
<td>Thymoquinone (TQ)</td>
<td>2-Isopropyl-5-methylbenzo-1,4-quinone</td>
<td></td>
</tr>
<tr>
<td><em>Panax ginseng</em></td>
<td>Ginsenosides Rh3</td>
<td>(2R,3S,4S,5R,6R)-2((8R,10R,12S,13R,14S,17S)-12-hydroxy-4,4,8,10,14-pentamethyl-17-[(2Z)-6-methylhepta-2,5-dien-2-yl]-2,3,5,6,7,9,11,12,13,15,16,17-dodecahydro-1H-cyclopenta[a]phenanthen-3-yl]oxy]oxane-3,4,5-triol</td>
<td></td>
</tr>
<tr>
<td><em>Panax ginseng</em></td>
<td>Ginsenosides Rh4</td>
<td>2-((5,16-dihydroxy-2,6,6,10,11-pentamethyl-14-[(2E)-6-methylhepta-2,5-dien-2-yl]tetracyclo[8.7.0.0^{2.0}^{11}.1^{5}]heptadecan-8-yl)oxyl-6(hydroxymethyl)oxane-3,4,5-triol</td>
<td></td>
</tr>
<tr>
<td><em>Picrorhiza kurroa</em></td>
<td>Kutkin</td>
<td>beta-d-Glucopyranoside, 1a,1b,2,5a,6,6a hexahydro-6-hydroxy-1a(hydroxymethyl)oxireno[4,5]cyclopenta[1,2-c]pyran-2-yl,6-(3-phenyl-2-propenoate),[1aS1aalpha,1bbeta,2beta(E),5abeta,6aalpha]</td>
<td></td>
</tr>
<tr>
<td><strong>Polyporus umbellatus</strong></td>
<td>Ergone</td>
<td>Tetrasodium-2-[2-[bis(2-oxido-2-oxoethyl)amino]ethyl-(2-oxido-2-oxoethyl)amino]acetate</td>
<td></td>
</tr>
<tr>
<td>--------------------------</td>
<td>--------</td>
<td>---------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Satureja khuzestanica</strong></td>
<td>Carvacrol</td>
<td>5-isopropyl-2-methylenophenol-2-Methyl-5-(1-methylethyl)-phenol</td>
<td></td>
</tr>
<tr>
<td><strong>Solanum xanthocarpum</strong></td>
<td>Solasodine</td>
<td>(3β,22α,25R)-Spirosol-5-en-3-ol</td>
<td></td>
</tr>
<tr>
<td><strong>Zingiber officinale</strong></td>
<td>Gingerols(polyphenols)</td>
<td>(S)-5-hydroxy-1-(4-hydroxy-3-methoxyphenyl)-3-decanone</td>
<td></td>
</tr>
<tr>
<td><strong>Ramulus mori</strong></td>
<td>Morin</td>
<td>3,5,7-trihydroxy-2-(2,4-dihydroxy phenyl)-4H-chromen-4-one</td>
<td></td>
</tr>
</tbody>
</table>
Table 3: Miscellaneous phytoconstituents for nephroprotective activity

<table>
<thead>
<tr>
<th>Source</th>
<th>Compound</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-methyl-1-phenyl-2-pyrazolin-5-one</td>
<td>Edarabone</td>
<td>Satoh et al., 2003</td>
</tr>
<tr>
<td><em>Acacia visco</em></td>
<td>Lycopene</td>
<td>Atessahin et al., 2005</td>
</tr>
<tr>
<td><em>Capsicum annuum</em></td>
<td>Capsaicin</td>
<td>Shimeeda et al., 2005</td>
</tr>
<tr>
<td>Carrots, walnuts, chicken and fish</td>
<td>Pyridoxamine</td>
<td>Metz et al., 2003</td>
</tr>
<tr>
<td><em>Curcuma xanthorrhiza</em></td>
<td>Xanthorrhizol</td>
<td>Kim et al., 2005</td>
</tr>
<tr>
<td>Kakadu plum and Camucamu Fruit</td>
<td>Ascorbic acid</td>
<td>Huang et al., 2000</td>
</tr>
<tr>
<td><em>Mango, Acacia visco or Abronia villosa</em></td>
<td>Lupeol</td>
<td>Nagaraj et al., 2000</td>
</tr>
<tr>
<td>Metabolic product of the amino acid cysteine</td>
<td>Taurine</td>
<td>Trachtman et al., 1993</td>
</tr>
<tr>
<td><em>Propolis</em></td>
<td>Caffeic acid</td>
<td>Ozen et al., 2004</td>
</tr>
<tr>
<td><em>Ramulus mori</em></td>
<td>Resveratrol</td>
<td>Mannari et al., 2010</td>
</tr>
<tr>
<td>Spinach, broccoli, yeast extract.</td>
<td>DL-α-lipoic acid</td>
<td>Obrosova et al., 2003</td>
</tr>
<tr>
<td>Spinach, chard, and turnip greens, mustard</td>
<td>Vitamin E</td>
<td>Bursell et al., 1999</td>
</tr>
<tr>
<td>greens, pepper, almonds, sunflower seeds,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>asparagus.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Streptomyces pilosus</em></td>
<td>Desferioxamine</td>
<td>Kadikoylu et al., 2004</td>
</tr>
</tbody>
</table>

Table 4: Structure of miscellaneous phytoconstituents with IUPAC name

<table>
<thead>
<tr>
<th>Source</th>
<th>Phytoconstituent name</th>
<th>IUPAC Name</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>Edaravone</td>
<td>3-methyl-1-phenyl-1H-pyrazol-5(4H)-one</td>
<td><img src="image" alt="Structure" /></td>
</tr>
<tr>
<td><em>Acacia visco</em></td>
<td>Lycopene</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Selected phytoconstituents with IUPAC name:

- **Edaravone**: 3-methyl-1-phenyl-1H-pyrazol-5(4H)-one
- **Lycopene**: (6E,8E,10E,12E,14E,16E,18E,20E,22E,24E,26E)-2,6,10,14,19,23,27,31-Octamethyldotriaconta-2,6,8,10,12,14,16,18,20,22,24,26,30-tridecaene

http://www.pharmacophorejournal.com
<table>
<thead>
<tr>
<th><strong>Capsicum annuum</strong></th>
<th><strong>Capsaicin</strong></th>
<th>(E)-N-(4-hydroxy-3-methoxybenzyl)-8-methylnon-6-enamide</th>
<th><img src="image" alt="Capsaicin" /></th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrots, walnuts, chicken and fish</td>
<td>Pyridoxamine</td>
<td>4-(aminomethyl)-5-(hydroxymethyl)-2-methylpyridin-3-ol</td>
<td><img src="image" alt="Pyridoxamine" /></td>
</tr>
<tr>
<td><strong>Curcuma xanthorrhiza</strong></td>
<td><strong>Xanthorrhizol</strong></td>
<td>2-methyl-5-(6-methylhept-5-en-2-yl)phenol</td>
<td><img src="image" alt="Xanthorrhizol" /></td>
</tr>
<tr>
<td>Kakadu plum and Camucamu Fruit</td>
<td>Ascorbic acid</td>
<td>(R)-3,4-dihydroxy-5-(2,2-dihydroxyethyl)furan-2-(5H)-one</td>
<td><img src="image" alt="Ascorbic acid" /></td>
</tr>
<tr>
<td>Mango, <em>Acacia visco or Abronia villosa</em></td>
<td>Lupeol</td>
<td>(1R,3aR,5aR,5bR,7aR,9S,11aR,11bR,13aR,13bR)-3a,5a,5b,8,8,11a-hexamethyl-1-prop-1-en-2-yl-1,2,3,4,5,6,7,7a,9,10,11,11b,12,13,13a,13b-hexadecahydrocyclopenta[a]chrysene-9-ol</td>
<td><img src="image" alt="Lupeol" /></td>
</tr>
<tr>
<td>Metabolic product of the amino acid Cysteine</td>
<td>Taurine</td>
<td>2-aminoethanesulfonic acid</td>
<td><img src="image" alt="Taurine" /></td>
</tr>
<tr>
<td><strong>Propolis</strong></td>
<td>Caffeic acid phenethyl ester</td>
<td>(E)-phenethyl 3-(3,4-dihydroxyphenyl)acrylate</td>
<td><img src="image" alt="Caffeic acid ester" /></td>
</tr>
<tr>
<td><strong>Ramulus mori</strong></td>
<td>Resveratrol</td>
<td>5-[(E)-2-(4-hydroxyphenyl)ethenyl] benzene-1,3-diol</td>
<td><img src="image" alt="Resveratrol" /></td>
</tr>
<tr>
<td>Spinach, brocoli, yeast extract.</td>
<td>DL-α-lipoic acid</td>
<td>5-(1,2-dithiolan-3-yl) pentanoic acid</td>
<td></td>
</tr>
<tr>
<td>----------------------------------</td>
<td>------------------</td>
<td>-------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Spinach, chard, and turnip greens, mustard greens, pepper, almonds, sunflower seeds, asparagus</td>
<td>Vitamin E</td>
<td>(S)-3,4-dihydro-2,5,7,8-tetramethyl-2-(4,4,8,12-pentamethyltridecyl)-2H-chromen-6-ol</td>
<td></td>
</tr>
<tr>
<td><em>Streptomyces pilosus</em></td>
<td>Desferoxamine</td>
<td>N'-{5-[Acetyl(hydroxy)aminopentyl]-N-[5-[(5-aminopentyl)(hydroxy)amino]-4-oxobutanoyl]amino}pentyl]-N-hydroxysuccinamide</td>
<td></td>
</tr>
</tbody>
</table>

**REFERENCES**

6. Ajith, TA; Aswathy, MS; & Hema, U (2008), "Protective effect of *Zingiber officinale* roscoe against anticancer drug doxorubicin-induced acute nephrotoxicity", Food and Chemical Toxicology, 46 (9), 3178–3181.
8. Ali, BH; Moundhri MS Al (2006), "Agents ameliorating or augmenting the nephrotoxicity of cisplatin and other platinum compounds", A review of some recent research. Food and Chemical Toxicology, 44 (8), 1173–1183.
9. Al-Rehaily, AJ; El-Tahir, Kamal EH; Mossa, JS; Rafaullah, S (2001), "Pharmacological studies of various extracts and the major constituent Lupeol obtained from hexane extract of Tecleanobilis in rodents", Natural Product Sciences, 7 (3), 76–82.


18. Bhattacharya, S; Gachhui, R; Sil, PC (2013), "Effect of Kombucha, a fermented black tea in attenuating oxidative stress mediated tissue damage in alloxan induced diabetic rats", *Food and Chemical Toxicology*, 60, 328-40.


20. Billia, AR; Melillo de Malgalhaes, P; Bergonzì, MC; Vincieri, FF (2006), "Simultaneous analysis of artemisinin and flavonoids of several extracts of Artemisia annua L. obtained from a commercial sample and a selected cultivar", *Phytotherapy*, 13 (7), 487–493.


22. Bursell, SE; Clermont, AC; Aiello, LP; Aiello, LM; Schlossman, DK; Feener, EP; Laffel, L; King, GL (1999), "High-dose vitamin E supplementation normalizes retinal blood flow and creatinine clearance in patients with type 1 diabetes", *Diabetes Care*, 22 (8), 1245–51.


32. Fernández, A; Alvarez, A; García, MD; Sáenz, MT (2001), "Anti-inflammatory effect of Pimenta racemosa var. ozua and isolation
of the triterpenelupeol", *Farmacologiche*, 56 (4), 335–8.


34. Ghazal Ghazanfari; Bagher Minaie; Narges Yasa (1990), "Biochemical and Histopathological Evidences for Beneficial Effects of *Satureja Khuzestanica Jamzad* Essential Oil on the Mouse Model of Inflammatory Bowel Diseases", *Toxicology Mechanisms and Methods*, 16, 365–372.


36. Han, J; Ye, M; Qiao, X; Xu, M; Wang, BR; Guo, DA (2008), "Characterization of phenolic compounds in the Chinese herbal drug Artemisia annua by liquid chromatography coupled to electrospray ionization mass spectrometry", *Journal of Pharmaceutical and Biomedical Analysis*, 47 (3), 516–525.


40. Holmquist, L; Stuchbury, G; Berbaum, K; Muscat, S; Young, S; Hager, K; Engel, J; Münch, G (2007), "Lipoic acid as a novel treatment for Alzheimer's disease and related dementias", *Pharmacology & therapeutics*, 113 (1), 154–64.

41. Hsouna, AB; Saoudi, M; Trigui, M; Jamoussi, K; Boudawara, T; Jaoua, S; Feki, AE (2011) "Characterization of bioactive compounds and ameliorative effects of *Ceratonia siliqua* leaf extract against CCl4 induced hepatic oxidative damage and renal failure in rats", *Food and Chemical Toxicology*, 49(12), 3183–3191.


46. Ismail, N; Pihie, AH; Nallapan, M (2005), "Xanthorrhizol induces apoptosis via the up-regulation of bax and p53 in HeLa cells", *Anticancer Research*, 25 (3B), 2221-7.


53. Kadikoylu, G; Bolaman, Z; Demir, S; Balkaya, M; Akalin, N; Enli, Y (2004), "The effects of desferrioxamine on cisplatin-
induced lipid peroxidation and the activities of antioxidant enzymes in rat kidneys", *Human & Experimental Toxicology*, 23 (1), 29–34.

54. Kim, SH; Hong, KO; Hwang, JK; Park, KK (2005), "Xanthorrhizol has a potential to attenuate the high dose cisplatin-induced", *Food & Chemical Toxicology*, 43, 117–122.


66. Murad, MH; Altayar, O; Bennett, M; Wei, JC; Claus, PL; Asi, N; Prokop, LJ; Montori, VM; Guyatt, GH (2014), "Using GRADE for evaluating the quality of evidence in hyperbaric oxygen therapy clarifies evidence limitations", *Journal of Clinical Epidemiology*, 67 (1), 65-72.


68. Naghizadeh, B; Mansouri, SM; Mashedian, NV (2010), "Crocin attenuates cisplatin-induced renal oxidative stress in rats", *Food and Chemical Toxicology*, 48 (10), 2650–2655.


71. Nickavar, B; Mojab, F; Javidnia, K; Amoli, MA (2003), "Chemical composition of the fixed and volatile oils of *Nigella sativa* L. from Iran", *Zeitschrift für Naturforschung*, 58c, 629-631.


73. Ozen, S; Akyol, O; Iraz, M; Söğüt, S; Ozuğurlu, F; Ozyurt, H; Odaci, E; Yildirim, Z (2004), "Role of caffeic acid phenethyl ester, an active component of propolis, against cisplatin-induced nephrotoxicity in rats", *Journal of Applied Toxicology*, 24 (1), 27–35.


76. Patel, PK; Patel, MA; Vyas, BA; Shah, DR; Gandhi, TR (2012), "Antiulotliiathic activity of saponin rich fraction from the fruits of Solanum xanthocarpum (Solanaceae) against ethylene glycol induced urolithiasis in rats", *Journal of Ethnopharmacology*, 144(1), 160–170.


80. Radulović, NS; Randjelović, PJ; Stojanović, NM; Blagojević, PD; Stojanović-Radić, ZZ; Ilić IR; Djordjević, VB (2013), "Toxic essential oils. Part II: Chemical, toxicological, pharmacological and microbiological profiles of Artemisia annua L. volatiles", *Food and Chemical Toxicology*, 58, 37–49.


82. Reljanović, M; Reichel, G; Rett, K; Lobisch, M; Schuette, K; Möller, W; Tritzschler, HJ; Mehnert, H (1999), "Treatment of diabetic polynephropathy with the antioxidant thiotic acid (alpha-lipoic acid): a two year multicenter randomized double-blind placebo-controlled trial (Aladin II). Alpha Lipoic Acid in Diabetic Neuropathy", *Free Radical Research*, 31 (3), 171–9.


89. Shimeda, Y; Hirotani, Y; Akimoto, Y; Shindou, K; Ijiri, Y; Nishihori, T; Tanaka, K (2005), "Protective effects of capsaicin against cisplatin induced nephrotoxicity in rats", *Biological & Pharmaceutical Bulletin*, 28 (9), 1635–1638.


93. Strong, R; Miller, RA; Astle, CM; Baur, JA; de Cabo, R; Fernandez, E; Guo, W; Javors, M; Kirkland, JL; Nelson, JF; Sinclair, DA; Teter, B; Williams, D; Zaveri, N; Nadon, NL; Harrison, DE (2013), "Evaluation of resveratrol, green tea extract, curcumin, oxaloacetic acid, and medium-chain triglyceride oil on life span of genetically heterogeneous mice", *Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, 68 (1), 6–16.

94. Surekha, Y; Lalit, S; Rashmi, S; Naveen kumar, J; Chhaya, H; Gadgoli (2010), "Studies on nephroprotective and nephrocurative activity of ethanolic extract of Picirirhiza kurroa royale and arogyawardhinibati in rats", *International


98. Sudina, GF; Mirzoeva, OK; Pushkareva, MA; Korshunova, GA; Sumbatyan, NV; Varfolomeev, SD (1993) "Caffeic acid phenethyl ester as a lipooxygenase inhibitor with antioxidant properties", FEBS Letters, 329 (1–2), 21–24.


100. Trachtman, H; Futterweit, S; Bienkowski, RS (1993), "Taurine prevents glucose-induced lipid peroxidation and increased collagen production in cultured rat mesangial cells". Biochemical and Biophysical Research Communications, 191 (2), 759–65.


103. Ulu, R; Dogukan, A; Tuzcu, M; Gencoglu, H; Ulas, M; Ilhan, N; Muqbil, I; Mohammad, RM; Kucuk, O; Sahin, K (2012), "Regulation of renal organic anion and cation transporters by thymoquinone in cisplatin induced kidney injury", Food and Chemical Toxicology, 50 (5), 1675–1679.


105. Voziyan, PA; Hudson, BG (2005), "Pyridoxamine as a multifunctional pharmaceutical: targeting pathogenic glycation and oxidative damage", Cellular and Molecular Life Sciences, 62 (15), 1671–81.


114. Zhang, WJ; Wei, H; Hagen, T; Frei, B (2007), “α-Lipoic acid attenuates LPS-induced inflammatory responses by activating the phosphoinositide 3-kinase/Akt signaling pathway”, Proceedings of the
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