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A brief review on some medicinal plants of Uttarakhand

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Abstract
Uttarakhand State endowed with a rich diversity of medicinal plants as well as a rich heritage of traditional medicine system. Medicinal plants acquired a dominant role in agronomy production, pharmacy and exportation because of their increased use as a raw material for the pharmaceutical industry and in the everyday life. The present article aims at reviewing the most remarkable reports on pharmacology, phytochemistry and biological activities of some medicinal plant of Uttarakhand.

Keywords: Uttarakhand, Medicinal, Antioxidant, Traditional, Drugs

Introduction
India has great wealth of medicinal plants and their traditional uses. Plants are used medicinally in different countries and are a source of many potent and powerful drugs [1]. Plant as sources of medicinal compounds has continued to play a major role in the maintenance of human health since ancient times. Uttarakhand state is famous for its rich medicinal plants resources. The climatic, topographic and soil diversity of this state has resulted in the occurrence of several valuable and economically important medicinal herbs of great therapeutic potential. Uttarakhand supports a large number of medicinal plants curing a wide range of disorders, which are extensively used by the pharmaceutical industry for preparation of drugs used in Indian System of Medicine [2].
Medicinal plant is a chief element of indigenous medical systems in all over the world. Natural products have played an important role throughout the world in treating and preventing human diseases. In recent times, there have been increased waves of interest in the field of research in natural products chemistry. This level of interest can be attributed to several factors, including unmet therapeutic needs, the remarkable diversity of both chemical structure and biological activities of naturally occurring secondary metabolites, the utility of novel bioactive natural compounds as biochemical probes, the development of novel and sensitive techniques to detect biologically active natural products, improved techniques to isolate, purify, and structurally characterize these active constituents, and advances in solving the demand for supply of complex natural products [3]. The aim of this study is to review salient reports on pharmacology, phytochemistry and biological activities of some medicinal plant of Uttarakhand.

Acorus calamus
Acorus calamus, Sweet flag, is a semi-aquatic herbaceous plant growing in temperate to subtemperate regions and traditionally used to treat appetite loss, bronchitis, chest pain, colic, cramps, diarrhea, digestive disorders, flatulence, gas, indigestion, nervous disorders, rheumatism, sedative, and vascular disorders. Leaves, rhizomes and essential oil of *Acorus calamus* has many biological activities like antispasmodic, carminative, insecticidal, antifungal, antibacterial, tranquilizing, antidiarrhoeal, antidyslipidemic, neuroprotective, antioxidant, anticholinesterase, spasmolytic, vascular modulator activities. One of the study revealed that ethanolic extract of *A. calamus* rhizomes display anticellular and immunomodulatory properties [4]. Ethanolic extracts of *A.calamus* inhibits proliferation of mitogen (phytohaemagglutinin; PHA) and antigen (purified protein derivative; PPD)-stimulated human Peripheral Blood Mononuclear Cells (PBMCs). Earlier research on anti-adipogenic properties of *Acorus sp.* supported hypo-lipidemic activity in rats [5]. Ethanol extract devoid of α-asarone has been reported to enhance differentiation in adipocytes in mouse [6]. The property of *A. calamus* to enhance differentiations in adipocytes is most likely very useful in the treatment of type 2 diabetes. The major anti-adipogenic component of

Acorus sp. oil was purified and identified as α-asarone also having inhibitory effect on adipogenesis in 3T3-LJ cells [7, 8].
The radio protective effects were evaluated by measuring the degree of lipid peroxidation caused using thiobarbituric acid reacting substances. *In vitro* DNA damage was measured by assessing the radiation induced relaxation of supercoiled plasmid DNA (PBR322) whereas alkaline single cell gel electrophoresis or comet assay was used to monitor any damage to cellular DNA induced by gamma-radiation [9]. The properties of scavenging free radical of *A. calamus* has been found to be useful to overcome excess production of oxygen free radicals generated due to continuous exposure to loud noise which pose a serious health problem [10]. β-asarone found in *A. calamus* possess antioxidant activity by counteracting the stress in the rat brain due to continuous exposure to noise. Another study reported that *A. calamus* helped in preventing the development of ferric chloride-induced epileptogenesis in rats by modulating antioxidant enzymes [11]. β-asarone compound fraction obtained from the crude methanolic extract of *Acorus calamus* rhizomes has been reported to possess the antifungal activity against the yeast strain of *Candida Albicans, Cryptococcus Neoformans, Saccharomyces Cerevisae* and also against *Aspergillus Niger* [12].

Aegle marmelos
Aegle marmelos commonly known as Bael tree, belonging to the family Rutaceae is indigenous to Indian subcontinent, mainly found in tropical and subtropical regions and has been widely used due to its medicinal property. Unripe fruit alcoholic extract have found to produce cardioprotective effect in isoproterenol induced myocardial infarction due to the presence of a potent compound known as aurapten [13]. Methanol and aqueous extract of *A. marmelos* fruit pulp was screened for antioxidant activity by DPPH radical scavenging method, reducing power assay, nitric oxide scavenging assay, superoxide radical scavenging assay, ABTS radical scavenging assay and H_2O_2 radical scavenging assay. Both of the aqueous and alcoholic extract exhibited good antioxidant activity [14]. The aqueous, petroleum ether and ethanol extract of the leaves of *Aegle marmelos* exhibited efficient antimicrobial activity against *Escherichia coli, Streptococcus pneumoniae, Salmonella typhi, Klebsiella pneumoniae* and *Proteus vulgaris.* The ethanolic extract shows activity against *Penicillium chrysogenum* and the petroleum ether and aqueous extract shows activity against *Fusarium oxysporum* [15]. The antifungal activity of the leaves of *Aegle marmelos* was reported against clinical isolates of dermatophytes. *A. marmelos* leaf extracts and fractions were found to have fungicidal activity against *Trichophyton mentagrophytes, T. rubrum, Microsporum canis, M. gypseum, Epidermophyton floccosum* [16].
Earlier study reported the hypoglycaemic and antioxidant activity of aqueous extract of *Aegle marmelos* leaves by analyzing the glucose, urea & GST (glutathione-S-transferase) levels in plasma and GSH (glutathione) and MDA (malondialdehyde) levels in erythrocytes of alloxan induced diabetic rats [17]. Eugenol ($C_{10}H_{12}O_2$), present in *Aegle marmelos* leaf extract, found to exhibit potent antioxidant property [18, 19]. The anti-diabetic activity of the leaves of *Aegle marmelos* was reported in alloxan diabetic rats [20]. The hepatoprotective effect of the leaves of *A. marmelos* were reported in alcohol induced liver injury in Albino rats. Rats were administered with 30% ethyl alcohol for a period of 40 days. The induced rats were fed with leaves of *A. marmelos* for 21 days. The TBARS values of healthy, alcohol intoxicated and herbal drug treated animals were 123.35, 235.68 and 141.85 µg/g tissue respectively. This indicates the excellent hepatoprotective effect of the leaves of *A. marmelos* [21]. Essential oil from the leaves of *A. marmelos* was investigated for insect repellent activity against *Sitophilous oryzae* and *Tribolium castaneum* [22].

Betula utilis
Betula utilis of family Betulaceae commonly known as Bhojpatra is a significant medicinal plant which is widespread throughout the Himalayan region, widely used in traditional medicine and is well known for its therapeutic values. Bark of *B.utilis* is widely used in Ayurveda and Unani system of medicine, in the treatment of various ailments and diseases like wound healing, skin disinfectant, bronchitis, convulsions, leprosy and diseases of the blood and the ear.
The plant and its active constituents are frequently used as an anti-inflammatory, hepatoprotective, antimicrobial and anti-tumour agent. Anticancer agents with different modes of action have been reported to trigger apoptosis in chemoselective cells [23]. Alterations of mitochondrial functions such as permeability transition (PT) have been found to play a major role in the apoptosis process including cell death induced by chemotherapeutic agents [24]. Studies revealed that betulinic acid formed by botulin in *Betula utilis* inhibits growth of malignant melanoma and cancers of the liver and the lung [25]. Betulanic acid was identified as a highly selective growth inhibitor of human melanoma, neuroectodermal and malignant tumour cells and was reported to induce apoptosis in these cells. A dried stored sample of bark of *Betula utilis* (Bhojpatra) has been found to be active against *Aspergillus niger* and *Aspergillus flavus* [26].

Centella asiatica
Centella asiatica belongs to the family Apiaceae, commonly known as Indian Pennywort, has been used as a medicinal herb for thousands of years in India, China, Srilanka, Nepal and Madagascar is valued as an ethnomedicine as well as in Ayurveda and Unani, for different ailments like asthma, skin disorders, ulcers and body aches, for improving memory, as a nervine tonic and in treatment of dropsy, elephantiasis, gastric catarrh, kidney troubles, leprosy, leucorrhoea and urethritis, in maternal health care, in treatment of stomach disorders and also as a vegetable [27-35].
In vivo studies have shown that the aqueous extract of the leaves of the *C. asiatica* revitalize the brain and nervous system thus exhibit significant effect on learning and memory process by increasing the level of norepinephrine, dopamine and 5- HT in the brain [36]. Clinical studies have reported that *C. asiatica* found its efficacy in giving protection to neurons against oxidative damage by giving exposure to excess glutamate [37]. Likewise, other preclinical studies have reported the use of *C. asiatica* leaf extract enhanced hippocampal CA3 neuronal dendritic arborization in rats during the growth spurt period [38].
C. asiatica extract (0.05, 0.25 and 0.50 g/kg) protects gastric mucosa by inhibiting ethanol- induced gastric lesions and by decreasing mucosal myeloperoxidase due to its free radical scavenging activity in a dose dependent manner [39]. Preclinical studies have shown that methanolic extract of *C. asiatica* causes inhibition in breast cancer cells by inducing apoptosis in different cancer cell lines HeLa, HepG2 and SW48 and MCF-7. Out of which MCF-7 found to be most sensitive line for *in vitro* growth inhibitory activity which is

marked by decrease in cell viability that is concentration dependent based on MTT assay [40]. Earlier, studies have also investigated that the polyphenolic polymers present in *C. asiatica* serve as antioxidants, potentiate insulin action and thus is advantageous in regulating glucose intolerance and diabetes [41].

Ullah *et al*., 2009 observed antibacterial activity of n-hexane, carbon tetrachloride, chloroform soluble fractions of methanol extract of *Centella asiatica* against gram positive bacteria (*Bacillus cereus, Bacillus megaterium, Bacillus subtilis, Staphylococcus aureus* and *Sarcinalutea*) and gram negative bacteria (*Escherichia coli, Pseudomonas aeruginosa, Salmonella paratyphi, Salmonella typhi, Shigella boydii, Shigella dysenteriae, Vibrio mimicus* and *Vibrio parahemolyticus*) [42]. Earlier it was observed that methanol extract of *C. asiatica* whole plant showed inhibition zone against *V. alginolyticus, V. vulnificus* and *Streptococcus sp.* [43].

Phyllanthus amarus

Phyllanthus amarus "Jamgli amla" an annual herb of family Euphorbiaceae widely spread throughout the tropical and subtropical countries including India, has found its traditional usefulness in several health problems such as diarrhoea, dysentery, dropsy, jaundice, intermittent fevers, urinogenital disorders, scabies and wounds. The anticarcinogenic and anti-tumour activity of *Phyllanthus amarus* proposed to be inhibition of metabolic activation of carcinogen as well as the inhibition of cell cycle regulators responsible for cancerous growth and DNA repair [44]. Antiamnesic activity of aqueous extract of leaves and stems of *Phyllanthus amarus* were evaluated for nootropic effects and brain cholinesterase activity in male Swiss albino mice. Scopolamine and diazepam were used as standard drugs to produce amnesia and elevated plus maze and passive avoidance paradigm as models for evaluation of cognitive functions. The result reveals a dose dependent attenuation of diazepam and scopolamine induced amnesic deficits and reduction in brain cholinesterase activity. Since the reduction in cholinesterase in linked with increase acetylcholine concentration in brain which further is responsible for improving memory, provide a rationale to use this therapeutic potential in the management of patients with cognitive disorders [45].

The antiinflammatory potential of two different extracts of *Phyllanthus amarus* (hexane and ethanol/water extracts) was evaluated using different models such as rat Kupffer cells, macrophages RAW264.7, human whole blood and in mice. The results revealed ethanol/water extracts and hexane extracts effective in inhibition of liopolysaccharide induced production of nitric oxide (NO) and prostaglandin E2 (PGE2) in Kupffer cells and in macrophages RAW264.7. The extracts also attenuated the lipopolysaccharide induced secretion of tumor necrosis factor (TNF-α) in macrophages RAW264.7 as well as in human whole blood. Hexane and ethanol/water extracts of *Phyllanthus amarus* reduced expression of endotoxin-induced nitric oxide synthase iNOS and cyclooxygenase COX-2 and inhibited activation of nuclear factor NF-κB. *Phyllanthus amarus* also inhibited induction of interferon-γ (IFN-γ), interleukin (IL)-1β and interleukin (IL)-10 in human whole blood and reduced tumor necrosis factor (TNF-α) production in-vivo [46].

Hepatoprotective effects of aqueous extract from *Phyllanthus amarus* on ethanol-induced rat hepatic injury were studied in *in vitro* study where *Phyllanthus amarus* increases the percentage 3[4,5-dimethylthiazol-2-yl]-2,5 diphenyl tetrazolium bromide (MTT) reduction assay and decreased the release of aspartate transaminase (AST) and alanine transaminase (ALT) in rat primary cultured hepatocytes treated with ethanol. *Phyllanthus amarus* possess antifungal, antiviral and anticancerous properties [47].

Tinospora cordifolia

Tinospora cordifolia (Guduchi) is one of the important dioecious plants belongs to the family Menispermaceae, found abundantly as a shrub throughout India, Srilanka, Bangladesh, and Nepal. Methanolic extract of stem of *T. cordifolia* has been reported to possess anti-oxidant activity, by increasing the erythrocytes membrane lipid peroxide and catalase activity. It also decreases the activity of SOD, GPx in alloxan induced diabetic rats [48, 49]. Leaf extract of *T. cordifolia* reported to have an alpha-glucosidase inhibitor, characterized as saponarin was found to be also significant antioxidant and hydroxyl radical scavenging activity [50]. Hypoglycemic action of aqueous extract of T. cordifolia was earlier studied at different time intervals from 21-120 days in mice [51].

The aqueous extract of *T. cordifolia* exerted a significant anti-inflammatory effect on cotton pellet granuloma and formalin induced arthritis models. The dried stem of *T. cordifolia* produced significant antiinflammatory effect in both acute and subacute models of inflammation. *T. cordifolia* has been found to be more effective than acetylsalicylic acid in acute inflammation but in sub acute inflammation, the drug is inferior to phenylbutazone [52]. The antiangiogenic activity of *T. cordifolia* has been studied using *in vivo* as well as *in vitro* models. *In vivo* study done using B16F10 melanoma cell-induced capillary formation inanimals [53]. The modulation effect of the *Tinospora* lotion on interleukin levels reinforces its anti-scabies activity [54]. *Tinospora cordifolia* has the ability to scavenge free radicals generated during aflatoxicosis. *Tinospora cordifolia* showed protection against aflatoxin-induced nephrotoxicity due to the presence of alkaloids such as a choline, tinosporin, isocolumbin, palmatine, tetrahydropalmatine, and magnoflorine [55].

Withania somnifera

Withania somnifera. is a shrub commonly known as ''Ashwagandha'', Winter Cherry, Indian ginseng, belongs to the family Solanaceae, found in the drier parts of India, Sri Lanka, Afghanistan, parts of Africa and also found in high altitude ascending to 5,500 feet in the Himalayas. Ashwagandha possesses anticancer properties against prostate, colon, lung, breast, leukemia, pancreatic, renal, head and neck cancer cells of humans, forestomach and skin cancer cells in mice [56-60]. Recently the anticancerous potential of *W. somnifera* and its bioactive withanolides has been extensively studied by several research groups all around the world, which have discovered diverse mechanisms such as cytotoxicity, cell differentiation induction, cancer chemoprevention, cyclooxygenase-2 (COX-2) inhibition and a potential to inhibit the enzyme quinine reductase. These withanolides are highly oxygenated natural bioactive constituents which are responsible for ashwagandha's biological properties including antitumor activity [57, 61].

W. somnifera was also found to improve the cognitive capabilities of the brain by increasing the cortical muscarinic acetylcholine capacity in lateral septum and frontal cortex, which suggest their capacity to affect events in the cortical cholinergic-signal transduction cascade [62]. The pharmacological studies suggested that *W. somnifera*

improves the athletic performance via increasing the heamoglobin count and red blood cell count, which leads to an increase in the capacity of blood to transport oxygen at a greater capacity to the peripheral system [63].

Isolated flavonoids and alkaloids from *W. somnifera* show growth inhibitory activity against *Enterobacter aerogens, Proteus mirabilis, Pseudomonas aeruginosa, Staphylococcus aureus, Bacillus subtilis, Klebsiella pneumoniae, Raoultella planticola and Agrobacterium tumefaciens* at concentration 0.039 mg/ml [64, 65]. It was also shown that *W. somnifera* at dose 100 mg/kg significantly reduces the blood glucose and lipid levels [66]. It was also found that *W. somnifera* and its glycowithanolides induce the transport of glucose into the cells, stimulate the release of insulin and increase the activity of GLUT transporters activity [67-69]. Root extract of *W. somnifera* has immunomodulatory effects in three myelosuppression models in mice: cyclophosphamide, azathioprin, or prednisolone and significant increases in hemoglobin concentration, red blood cell count, white blood cell count, platelet count, and body weight were observed in Wistar rats were used to evaluate the cardio protective mechanisms of *W. somnifera*, in the setting of ischemia and reperfusion (IR) injury [70].

Bauhinia variegata

Medicinal plant *Bauhinia variegata* as Raktakanchanara is identified as a member of caesalpinaceae family which is distributed in the tropical regions throughout the world and widely used plant in Ayurvedic medicine for the treatment of several illnesses such as leucoderma, leprosy, menorrhagia, asthma, wounds and ulcers. Rajkapoor *et al*., 2003 studied antitumor activity of ethanolic extract of *Bauhinia variegata* against Dalton's acytic lymphoma in swiss albino mice [71]. Sharma *et al*., 2010 evaluated the ethanolic and aqueous extracts of root of *Bauhinia variegata* for nephroprotective effect in Gentamicin-induced nephrotoxicity in rats [72]. Phytochemical screening and *in vitro* free radical scavenging activity of aqueous and ethanolic bark extracts of *Bauhinia variegata* was assessed by studying its ability to scavenge DPPH, Nitric oxide, hydroxyl radical and reducing power. Phytochemical analysis revealed the presence of steroid, phenol/ tannin, glycoside/ sugar, carbohydrate and terpenoids. Ethanolic extract showed significant nitric oxide scavenging activity, whereas aqueous extract was comparatively more potent against both ROS (Reactive Oxygen Species) and RNS (Reactive Nitrogen Species) generation systems. The results support its traditional use in curing various diseases and as a source of natural antioxidants which protect cells against oxidative stress [73].

Oral administration of ethanolic, aqueous and hydro-alcoholic extract of leaves and stem bark of *Bauhinia variegata* at different doses i.e 200 and 400 mg/kg in streptozotocin (STZ) and alloxan-induced diabetic rats reduced the elevated blood glucose level by increasing glucose metabolism [74]. Pahwa *et al*., 2011 investigated antimicrobial activity of methanolic extracts of leaf, bark and flower of Bauhinia variegata studied against various standard reference bacterial and fungal strains and clinical isolates collected from various parts of India and abroad [75].

Ziziphus mauritiana

Ziziphus mauritiana also known as chine apple, jujube, Indian jujube, is a tropical fruit tree available in all parts of india belonging to the family Rhamnaceae. The various parts of *Z. mauritiana* Lam. like leaves, fruits and seeds also used in folk medicine for various purposes. Balaka *et al*., 2010, investigated the antimicrobial activity of ethanolic extract of *Ziziphus mauritiana* leaves against various microbial species like, *Escherichia coli, Staphylococcus aureus, Streptococcus pyogenes, Aspergillus Niger* and *Candida albicans* [76]. Mishra *et al*., 2007, investigated the anticancer activity of aqueous-ethanolic extract of *Ziziphus mauritiana* by Ehrlich Ascites Carcinoma (EAC) bearing male albino mice at different dosses, which significantly decreased tumor volume and viable cell count and enhanced the mean survival time in a dose dependent manner [77].

Dahirul *et al*., 2007, investigated the hepatoprotective activity of aqueous extract of *Ziziphus mauritiana* leaves by alcohol induced liver damage. 40% of alcohol solution is administrated orally in rats which can produce toxicity to the liver. In the experiment, rats that receive alcohol only showed elevated level of ALT, AST, bilirubin, and hepatic lipid peroxidation while reduced glutathione, total antioxidant status and body weight significantly ($p<0.05$) decreased compared to control rats [78]. Deshpande *et al*., 2011 investigated the anti- obesity activity of *Ziziphus mauritiana* bark powder on high fat induced obesity in rats [79, 80].

Andrographis paniculata

Andrographis paniculata of Acanthacae also known as Kalmegh is one of the important herb grows abundantly in Asian countries like India, Sri Lanka, Pakistan, Java, Malaysia and Indonesi and used in ayurvedic formulations. The whole plant is used for medicinal purposes. *Andrographis paniculata* has a broad spectrum of pharmacological effects and some of them are extremely beneficial such as hepatoprotective, antimicrobial, antifungal, antioxidant, anti-inflammatory, antipyretic, anticancer and antidiarrhoeal effects. Antidiabetic property of *A. paniculata* was confirmed by Borhanuddin *et al*., 1994 and Husen *et al*., 2000 in aqueous extract and by Zhang *et al*., 2004 in ethanolic extract [81-83]. Along with antihyperglycaemic property, the ethanolic extract may also reduce oxidative stress in diabetic rats as studied by Zhang *et al*., 2000 [84].

A. paniculata can also inhibit the production of inflammatory mediators and alleviate acute hazards at its optimal dosages [85]. Shen *et al*., 2002 observed that the andrographolide, an active component of *A. paniculata*, inhibits inflammatory responses by rat Neutrophils [86]. It was also found to inhibit the tumor specific angiogenesis by regulating the production of various pro and antiangiogenic factors by *in vivo* and *in vitro* studies [87]. In a study by Wang *et al*, 1993, *A. paniculata* was found to alleviate atherosclerotic artery stenosis induced by deendothelialization and high cholesterol diet as well as lower restenosis rate after experimental angioplasty [88]. Verma and Vinayak, 2008 related the antioxidant effects of the aqueous extract on liver defense systems in lymphoma bearing mice [89]. The aqueous extract and hydro alcoholic extract of the medicinal plant *A. paniculata* showed the increase in activities such as catalase, superoxide dismutase and glutathione-S transferase enzymes and reduced lactate dehydrogenase activity. The results performed with that of aqueous extract of *A. paniculata* exhibited a greater antioxidant activity than the ethanol extract in all model systems tested. The function of hydroalcoholic extract of *A. paniculata* possesses oxidative alterations in myocardium and confers substantial cardioprotective activity by facilitating in retaining the cardiac function in a norma manner [90]. Inhibitory effect of *Andrographis paniculata* extract and its active diterpenoids on platelet aggregation was studied by

Thisoda *et al*., 2006 [91]. Antifungal activity was studied for dichloromethane and methanol extracts of *A. paniculata* by broth micro dilution method against seven pathogenic fungal species [92].

Urtica dioica

Urtica dioica of family Urticaceae, is a perennial growing in temperate and tropical wasteland areas around the world, commonly known as stinging nettle. The plant has been reported to have various pharmacological activities such as antioxidant anti‑inflammatory, antiulcer, anti‑colitis, antiviral, anticancer, antibacterial, antimicrobial, antifungal, immunomodulatory, hypocholesterolemic, hypoglycemic, cardiovascular effects, analgesic, natriuretic, hypotensive and hepatoprotective. The leaf extract was administered in perfused islets of langerhans both in normal and streptozotocin induced diabetic rats which showed a significant enhancement of insulin secretion thereby decreasing the blood sugar level [93]. The cold methanolic extract of leaves (250 mg/kg) has also shown significant antihyperglycemic effect in alloxan induced diabetes [94].

The leaves extract of plant has shown maximum hepatoprotective activity at dose 400 mg/kg as suggested by decreased level of serum alanine transaminase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), total bilirubin levels and significant decrease in malonyldehyde (MDA) level as well as a significant increase in superoxide dismutase (SOD) level. In CCl4 induced hepatotoxicity plant extract has shown significant hepatoprotective effect in isolated rat hepatocytes (in‑vitro) and same in rabbits (in‑vivo) with protective effect against hepatocellular degeneration and necrotic changes [95-97].

The antimicrobial activity of stinging nettle extract has been reported for *S. areus, Enterococcus faecalis, B. subtilis* and *E. coli* [98, 99]. Carceres *et al*., 1987, reported an increase in urine production by 20% after 1g/kg oral dose in 10% decoction in rats. The diuretic effect of stinging nettle was approximately 25% of that achieved with hydrochlorothiazine (25 mg/kg) [100]. Treatment with *U. dioica* reduced oxidative stress resulting in a decrease in ceruloplasmin levels. Also, it was found that treatment with *U. dioica* decreased the lipid hydroperoxide activity, indicating that the antioxidant effect of *U. dioica* had prevented the emergence of an oxidant agent such as LOOH with creation of hepatic ischemia-reperfusion [101]. The aqueous extract of *U. dioica* leaves also caused significant inhibition on ADA activities in prostate tissues from prostate cancer patients [102].

Reported phytoconstitutents of various medicinal plants

Plant	Phytoconstituents	References
Acorus calamus	Calamenone	[103]
	Asaronic acid, Eugenol, Asarylic acid, Calamine	[104]
	Calamenol	[105]
	Shyobunone, Iso shyobunone, Epi isoshyobunone	[106]
	Asarone and its isomers	[107]
Aegle Marmelos	Marmesin, Marmelosin, Imperatorin, Scoparone, Scopoletin, Umbelliferone, Aegeline, Marmeline	[108]
	O-3,3-(dimethylallyl)halfordinol (1), N-2-ethoxy-2-(4-methoxyphenyl) ethylcinnamamide	[109]
	Anhydromarmeline	[110,111]
	Aegelinosides	
	α-and β-amyrin and β-sitosterol	[112]
Betula utilis	Betulin, Betulinic acid	[113, 114]
	Lupeol, Oleanolic acid, Oleanolic acid-3-acetate	[115,116]
Centella asiatica	Asiatcoside, Centelloside, Madecossoside, Thankuniside, Isothankunic acid, Centellose, Asiatic, Centellic, Madecassic acids	[117,118]
	Brahmic acid, Brahmoside	[119,120]
Phyllanthus amarus	Niranthin, Nirtetralin, Phyltetralin, Hypophyllanthin, Phyllanthin, demethylenedioxy-niranthin, 5-demethoxy-niranthin, Isolintetralin	[121-124]
	Amariin, 1-galloyl-2,3-dehydrohexahydroxydiphenyl (DHHDP)glucose, Repandusinic acid, Geraniin, Corilagin, Phyllanthusiin D, Rutin, Quercetin 3-O-glucoside, 1-Ogalloyl-2,4-dehydrohexahydroxydiphenoyl-glucopyranose elaeocarpusin, Repandusinic acid A and Geraniinic acid	[125,126]
Tinospora cordifolia	Berberine, Choline, Tembetarine, Magnoflorine, Tinosporin, Palmetine, Isocolumbin, Aporphine Jatrorrhizine, Tetrahydropalmatine	[127-131]
	β–sitosterol, δ-sitosterol, 20 β-hydroxyecdysone, Ecdysterone, Makisterone A, Giloinsterol	[132-134]
	Tinocordifolin	[135]
Withania somnifera	Somniferine, Somnine, Withamine, Pseudowithamine, Withanaminine	[136]
Bauhinia variegata	β-sitosterol, lupeol, kaempferol-3- glucoside and a 5, 7-dimethoxyflavonone-4–o-α–L–rhamnopyranosyl-β-D glucopyranoside	[137,138]
	Germacrene D, Spathulenol, δ- and γ- cadinen	[139]
Ziziphus mauritiana	Mauritine L, mauritine M, Nummularines H, B and Hemsine A	[140]
Andrographis paniculata	Didehydro andrographolide/andrographlide D, 14 deoxyandrographolide, Neo andrographolide, Homoandrographolide	[141-145]
Urtica dioica	Rutin, Kaempferol-3-O-rutinoside, Isorhamnetin-3-O-glucoside, Caffeic acid and its esters, Ferulic acid, Chlorogenic, citric, Fumaric and Phosphoric acids, Carvacol, Carvone	[146-149]

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