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Biological Activities of Some Indian medicinal plants

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ABSTRACT:

There is an increasing demand for the herbal drug treatment of various ailments and many plant drugs from Ayurvedic system are being explored globally. The biological activities from various clinical and preclinical studies have been included along with some patents arising from these plants. The original report acts as a quick reference for extracting the biological activities, specially the newly reported effects, of the following selected Indian medicinal plants *Adhatoda vasica, Aegle marmelos, Aloe vera, Andrographis paniculata, Asparagus adscendents, Cinnamomum tamala, Coriandrum sativum, Cuminum cyminum, Curcuma longa, Emblica officinalis, Glycyrrhiza glabra, Hemidesmus indicus, Mucuna pruriens, Phyllanthus niruri, Solanum nigrum, Syzygium aromaticum, Terminalia chebula, Tinospora cordifolia, Withania somnifera, Zingiber officinale.*

Keywords: Ayurveda, alternative medicine, biological activity, herbal drug, patent, pharmacology, plant extract.

INTRODUCTION:

It is a well known fact that the demand for the herbal drug treatment of various ailments is increasing and plant drugs from the ayurvedic system are being explored more, not only in India but also globally. As a result, many research studies are being undertaken and there is a need for an update and to put them together. This article aims to give a quick reference to the biological activities of few Indian medicinal plants. We have tried to summarize most of the reported activities directly from the recent original research papers, but the list is not exhaustive. The biological activities from various clinical and preclinical studies have been included, while other uses of plants like herbicidal or insecticidal use have not been included. The main use of all these

studies is commercial utilization, so we have tried to include few patents arising from these plants, it should be noted that most of the patents are formulations and their uses. Usually the formulations are poly herbal and may contain one or more of the mentioned plants, so to avoid repetition, the formulations are included under any one plant detail only.

Adhatoda vasica

Adhatoda vasica is a well-known in Ayurvedic and Unani medicine. It has been used for the treatment of various diseases and disorders, particularly for the respiratory tract ailments. Many studies have been conducted on Adhatoda vasica and some of the reported activities of the plant include anti-diabetic [1], anti-implantation [2], anti-phlogistic, anti-allergic [3], anti-tussive [4], anti-ulcer [5], antioxidant, anti-genotoxicity [6], anti-tubercular [7], abortifacient [8], radioprotective [9], bronchodilator [10], hepatoprotective [11]. Pahwa et.al, [12] studied the chronic toxicity of some compounds of *Adhatoda vasica*. The patents consisting Adhatoda vasica are used for treating asthma (US 6746694), allergy (US 6746694), malnutrition, chronic cough, cold (US 7247322).

Aegle marmelos

Aegle marmelos has been widely used and studied for various activities like, anti-genotoxicity [13], analgesic [14], anti-cancer [15], anti-diarrhoeal [16], anti-fungal [17], anti-dyslipidemic [18], anti-inflammatory, anti-pyretic [19], anti-bacterial: Salmonella typhi, Shigella dysenteriae [20, 21], anti-viral: coxsackieviruses [22], anti-diabetic, antioxidant [23], anti-thyroid [24], anti-diarrhoeal, anti-ulcer [25], anti-asthmatic: Histamine antagonist H1 [26], immunostimulant [27], cardioprotective [28], radioprotective [29], treatment of ascites carcinoma [30], irritable bowel syndrome [31]. Acute and subacute toxicity studies have been studied by Veerappan et al. [32]. The patented formulations containing Aegle marmelos are used for treatment of HIV/AIDS and fungal infections secondary to HIV (PCT IN2004/000367), hyperglycemia (US 6989160), gastric ulcer (US 6855347).

Aloe vera

Aloe vera is one of the greatly known herbs for its cosmetic use, and it has been studied for its use in other major complications like cancer [33], myocardial ischemia [34], ulcer, diabetes [35, 36], hemorrhagic shock [37], hepatotoxicity [38], inflammation [39], allergic rhinitis [40] and oxidative stress [41]. Moreover, Aloe posses various effects like hypotensive [42], neuroprotective [43], radioprotective [44], anti-leishmanial [45], anti-

fungal [46], immunomodulatory [47], wound healing [48], cathartic [49], anti-viral: herpes simplex virus type 2 [50], angiogenic [51], anti-angiogenic [52], as a vaginal contraceptive [53], and protection against sunburn and suntan [54]. Subchronic toxicity has been studied by Zhou et.al. [55]. Some adverse effects of Aloe are cytotoxicity [56], Henoch-Schonlein purpura [57], acute toxic hepatitis [58]. There are many patented formulations available for Aloe vera specially for cosmetic use, few other patents include Aloe vera gel for the treatment of dry eye syndrome (US 6013259), ointment for skin irritations and healing of wounds (US 4725438), nasal spray for cold (US 5840278), topical treatment of pseudofolliculitis barbae (US 5034221).

Andrographis paniculata

Andrographis paniculata has been reported to encompass activities like cardioprotective [59], anti-hyperglycemic, antioxidant [60], anti-angiogenic [61], anti-cancer, immunostimulatory [62], anti-inflammatory [63], anti-malarial [64], anti-microbial [65], anti-viral: herpes simplex virus type 1 [66], upper respiratory tract infection [67], cyclophosphamide-induced toxicity [68], hepatoprotective [69], filaricidal [70], hypotensive [71], activation of TRPV4 channels [72], induction of uterus relaxation [73], inhibition of platelet aggregation [74], prevention of atherosclerotic stenosis and restenosis [75], reduction of the symptoms of common cold [76]. Andrographis paniculata has produced male anti-fertility effects [77], while another study did not find any adverse effect on fertility [78]. The patents include formulations, which are used for cancer (US 6486196), autoimmune diseases, Alzheimer's disease (PCT EP2004/005516), and improvement of liver function (US 6759061).

Asparagus adscendens

Asparagus adscendens is known for its activities like anti-cancer [79], anti-filarial [80], anti-fungal [81], anti-stress and anti-inflammatory [82]. Geriforte is a herbal formulation with Asparagus adscendens as one of the main constituents and has been widely studied for its use gastric ulcer [83], menopausal syndrome [84], neurological disorders [85], radioprotection [86], senile dermatoses [87], for stimulation of insulin secretion [88].

Cinnamomum tamala

The important studies conducted on Cinnamomum tamala are for its hypolipidemic effects [89], anti-diabetic and antioxidant [90], anti-ulcer [91], anti-inflammatory [92], anti-diarrhoeal [93], immunosuppressive [94] and anti-bacterial [95]. Few formulations

containing Cinnamomum tamala has been patented and are used for the treatment of diabetes (US 5886029) and antidote to tobacco (US 20060137702).

Coriandrum sativum

Various activities of Coriandrum sativum include anthelmintic [96], anti-implantation [97], anti-microbial [98], anti-mutagenicity [99], antioxidant and hepatoprotective [100], anxiolytic, sedative, muscle relaxant [101], hypoglycemic, hypolipidemic, cardioprotective [102], anti-dote for lead intoxication [103]. It has produced anaphylaxis in a patient [104]. Some interesting uses of patented formulations containing Coriandrum sativum are cigarettes which aid to stop smoking (EP1201142), hair coloring (US 7172632), sleep inducing antacid (US 20030013639), treatment of HIV-associated conditions (US 20020182272), and gastric ulcer (US 20050089583).

Cuminum cyminum

Cuminum cyminum has varied biological activities, which include anti-diabetic, antioxidant [105], anti-bacterial [106], anti-fungal [107], bronchodilatory [108], hepatoprotective, renoprotective [109], chemopreventive [110], anti-epileptic [111], galactagogue [112], hypolipidemic [113], male anti-fertility [114], memory-enhancing and anti-stress [115]. Toxicity of Cuminum cyminum has been studied by Haroun et al. [116]. Few patents of Cuminum cyminum are used for potentiation of bioefficacy of anti- infectives (PCT IN2003/000110), relieve inflammation and smooth muscle contraction (US 20060188588), cigarette for controlling body weight (PCT IB2006/000936), management of gynecological disorders and to prevent/treat anemia due to excessive bleeding associated with menstrual disorders (US 6455077), treating hepatitis B virus or hepatitis C virus (US 20020160065).

Curcuma longa

Curcuma longa is one of the most commonly used ayurvedic drugs with many of the following activities like antioxidant [117], apoptotic [118], anti-depressant [119], anti-fungal [120], anti-platelet [121], anti-spasmodic [122], anti-arthritic [123], hypoglycemic [124], hypotensive [125], anti-bacterial [126], leishmaniacidal [127], anti-genotoxicity [128], cardioprotective [129], neuroprotective [130], wound healing [131], cytoprotective by induction of heat shock protein [132]. It is also known to be effective for the treatment of pulmonary fibrosis [133], diabetic nephropathy [134], hyperlipidemia [135], encephalomyelitis [136], cancer [137], gastric ulcers by blocking H2 receptors [138], excitotoxicity by modulation of NMDA receptors [139]. Among the adverse effects, Curcuma longa has been reported to arrest spermatogenesis [140] and has produced

toxicity [123] and contact urticaria [141]. The patented pharmaceutical compositions are used for reducing hyperlipidemia, anti-platelet aggregation (US 4842859), wound healing (US 5401504), control of hypertension and hypercholesterolemia (US 6162438), hepatic and splenic disorders (US 20050074507), and for the treatment of osteoarthritis (US 6492429).

Emblica officinalis

Emblica officinalis has been known for its use against acute pancreatitis [142], age related dyslipidaemia [143], memory loss [144], atherosclerosis [145], metabolic syndrome [146], inflammation [147], cancer [148], cadmium induced toxicity [149], genotoxicity [150], oxidative stress [151], hyperthyroidism [152], ulcer [153] snake venom [154], tardive dyskinesia [155], wound healing [156]. It also possesses following activities like anti-pyretic, analgesic [157], anti-microbial [158], anti-fungal [159], anti-tussive [160], chemopreventive [161], immunostimulatory [162], hepatoprotective [163], cardioprotective [164], radioprotective [165], increase haemoglobin [166]. Few of the interesting polyherbal formulations available are EuMil, Panchagavya, Hyponidd, Kalpaamruthaa, Triphala, Pepticare, Immu-21, Ophthacare. Patented formulations are used as antioxidant (US 6124268), anti-migraine (EP1284744), anti-allergic (US 20030194452), hepatoprotective (CA 2480334), for treatment of iron-deficiency anemia (US 20030198695), protection of skin against sun-induced damage (US 20050089590), inhibition of platelet aggregation (US 6290996), topical anti-inflammatory/analgesic (PCT IB2002/001306), preventing alcohol-induced hangover (PCT IN2005/000186).

Glycyrrhiza glabra

Glycyrrhiza glabra has been studied for its biological actions, including hypocholesterolaemic [167], anti-cancer [168], anti-diabetic: PPAR-γ ligand binding [169], anti-allergic [170], anti-depressive [171], anti-arthritic [172], anti-ulcer: inhibit adhesion of Helicobacter pylori [173], antioxidant, anti-genotoxic, anti-inflammatory [174], anti-viral: encephalitis [175], anti-microbial [176], anti-nephritis [177], anti-thrombotic [178], anti-atopic dermatitis [179], radioprotective [180], memory enhancing [181]. The herbal formulation DHC-1 has been studied for its cardio and renoprotective activities [182], other polyherbal formulations available are Revitonil, Pepticare. Few of the patented formulations containing Glycyrrhiza glabra are used for treating AIDS (US 5683697), prostate carcinoma (US 5665393), arthritis (US 7416748), liver associated ailments (EP1207894), as a skin whitening composition (US 5609875).

Hemidesmus indicus

Various effects of HI, such as hypoglycemic, hypolipidemic [183], antioxidant, anti-thrombotic [184], tranquilizer [185], anti-inflammatory, anti-pyretic [186], anti-ulcerogenic [187], cardioprotective [188, 189], hepatoprotective [190], renoprotective [191], genotoxic and anti-genotoxic [192], radioprotective [193], neutralization of viper venom [194], anti-bacterial and larvicidal [195], have been reported. Patented formulations with Hemidesmus indicus as an ingredient is used for skin disorders (US 5693327) viral infections (US 6841174), inflammation (PCT/IN2004/000148), renoprotection, and lipid lowering (PCT/IN2004/000300).

Mucuna pruriens

Some of the reported activities include hypoglycemic [196], hypocholesterolemic [197], antioxidant [198], aphrodisiac [199], neuroprotective [200], anti-Asiatic cobra venom [201], inhibition of hyperprolactinemia in man [202], management of Parkinson's disease [203]. Adverse effects like acute toxic psychosis [204], pruritus [205], has been reported. The patents of Mucuna pruriens are used for treatment of the nervous system, including Parkinson's disease (US 6106839) and potentiation of growth hormone (US 6340474).

Phyllanthus niruri

The known activities of Phyllanthus niruri are anti-babesial, anti-plasmodial [206], anti-hyperuricemic [207], anti-nociceptive [208], anti-HIV [209], antioxidant, hepatoprotective [210], vasorelaxant [211] and lipid lowering [212]. It is also used for inhibition of platelet aggregation [213], urolithiasis [214], hepatitis B virus, Woodchuck hepatitis virus [215]. The patents are pharmaceutical preparations for treating infections caused by hepatitis B virus (US 4673575), hepatitis C virus (EP1294387), adenoviruses (US 20060193907) and for treating chronic inflammatory, fibrotic processes (US 6586015).

Solanum nigrum

Solanum nigrum has been studied for its acetylcholine-like activity [216], anti-nociceptive, anti-inflammatory, anti-pyretic [217], antioxidant [218], anti-tumor [219], anti-ulcerogenic [220], anti-viral [221], hepatoprotective [222], cytoprotective [223], hypocholesterolemic [224], hypotensive [225], anti-convulsant [226]. Some alkaloids of Solanum nigrum have been shown to produce teratogenesis in frog [227]. The patents of Solanum nigrum comprise a skin treatment composition (US 20050152867), hepatoprotective and weight gain promoter (PCT IN2001/000178), formula providing

symptomatic relief for various diseases and especially for patients diagnosed with AIDS/ARC (US 20070041993).

Syzygium aromaticum

Few of the activities of Syzygium aromaticum are anti-carcinogenic effects [228], antioxidant [229], anti-herpesvirus [230], anti-thrombotic [231], anti-cytomegalovirus infection [232], anti-candidial [233], aphrodisiac [234], chemopreventive in lung cancer [235], inhibition of immediate hypersensitivity [236]. Syzygium aromaticum has been found to be cytotoxic to human skin cells [237]. A good antioxidant activity of a polyherbal composition containing Syzygium aromaticum has been observed in our lab [238]. Syzygium aromaticum is a composition of the following patents which are used for lowering cholesterol, treating arthritis, reducing blood pressure and Alzheimer's disease (US 5707631), bronchial asthma (PCT IN2002/000041), HIV infection (US 7160561).

Terminalia chebula

Terminalia chebula is also one of the widely used plants in Ayurvedic medicine. Few of the reported activities include anti-cancer [239], Immunosuppressive [240], hepatoprotective [241], cardioprotective [242], radioprotective [243], anti-diabetic, renoprotective effects [244], anti- HIV [245], purgative [246], antioxidant [247], anti-aging [248], anti-ulcer: Helicobacter pylori [249], anti-typhoid [250], anti-caries [251], for wound healing [252], increasing gastric emptying [253]. Triphala is a widely used polyherbal formulation for its varied effects, which include hypolipidemic [254], immunomodulatory [255], anti-mutagenic [256], anti-bacterial [257], anti-diabetic, antioxidant [258]. Terminalia chebula has adverse effects like hepatic and renal toxicity [259], while it has also been shown to be hepato and renoprotective [241, 244]. Other polyherbal compositions containing Terminalia chebula are Arogh, Rhinax, Triphala. The patented compositions are used for the treatment of AIDS, flu, TB (US 5529778; US 5980903), immunocompromised conditions (US 20070122496).

Tinospora cordifolia

Tinospora cordifolia has been studied for its actions like immunomodulatory, [260], anti-allergic rhinitis [261], anti-ulcer [262], cardioprotective [263], chemopreventive [264], hepatoprotective [265], adjuvant therapy in hyperreactive malarious splenomegaly [266], hypolipidaemic [267], neuroprotective [268], obstructive jaundice [269], oxidative stress [270], radioprotective [271]. Anti-fertility effects in male rats have been reported by Gupta et al. [272]. Pepticare a polyherbal formulation has shown a

good anti-ulcer and antioxidant activity [273], other formulations are Hyponidd, Immu-21. There are number of patents for Tinospora cordifolia and are used for the treatment of renal disorders (PCT IB2005/051103), cancer (US 6780441), AIDS (PCT IN2004/000180), immune system-modulated disorders (CA 2432488), retroviral infections (PCT IN2005/000246), adenocarcinoma of the prostate (PCT IB2003/001885), allergy (US 20060141067), as anti-anxiolytic, tranquilizer, and non-narcotic sedative (US 20070122495), anti-pyretic (US 20060141069), as a health protective herbal soft drink (PCT IB2002/005555), herbal biscuits - dietary supplement for lactating mothers (US 6517861).

Withania somnifera

The biological activities of Withania somnifera are anxiolytic-anti-depressive [274], anti-fungal [275], anti-malarial [276], apoptotic [277], chondroprotective [278], cardioprotective [279], immunomodulatory [280], neuroprotective [281], inhibition of COX-2 enzyme [282], promoter of learning and memory in Alzheimer's disease [283]. Sharada et.al. [284] have studied toxicity of Withania somnifera root extract in rats and mice. The patents of the formulations containing Withania somnifera are used for increasing male sperm count (US 6866872), for rapid weight loss, controlling appetite, managing stress, supporting relaxation, combating fatigue and supporting mental well-being (US 20060286183), for refractory leukemias and lymphomas (US 20050058722), for cyclooxygenase-2 inhibition (US 20060247182), recovering hypofertility (EP1208845), for treatment and maintenance of hormone dependent conditions, immunostimulation (US 20070122494), as memory enhancer in Alzheimer's condition (PCT IN2004/000402), as a protection against UV irradiation (US 20060292094).

Zingiber officinale

Zingiber officinale is widely used by pregnant women for nausea and vomiting. It has been studied for various activities like cardioprotective [285], anti-convulsant, anxiolytic, anti-emetic [286], anti-diabetic, hypolipidaemic [287], anti-inflammatory [288], anti-thrombotic [289], anti-obesity [290], antioxidant [291], anti-tumor [288], anti-atherosclerotic [292], radioprotective [293], hypotensive [294], renoprotective [295], anti-reproductive toxicity [296], anti-ulcer [297], hepatoprotective [298], androgenic [299], anti-fouling [300], prokinetic [301]. inhibition of angiogenesis [302], increasing insulin sensitivity [303], molluscicidal, anti-schistosomal [304], nootropic [305], for treatment of gastrointestinal disorders [306], migraine [307], morning sickness [308]. Ginger is also non teratogenic [309]. The patented formulations of Zingiber officinale are used for alleviating symptoms associated with arthritis (US 5683698), inflammation,

platelet aggregation (US 6274177), relief of menopausal symptoms (US 5707630), treatment of migraine (US 6967033).

CONCLUSION:

As a consequence of increasing demand for the herbal drug treatment of various ailments, plant drugs from Ayurvedic system are being explored globally. This has resulted in many research studies with varied results, and hence there is a need to summarize them together. This review acts as a ready reference for biological activities of some Indian medicinal plants to the scientific community, in specific to researchers and students looking for sources of knowledge of medicinal plants and leads for new bioactive compounds. It is to be kept in mind that the reported activity may be shown by either the whole plant, or a part of the plant, or a particular extract, or isolated compounds. To know further about a biological action of a plant, it is advised to refer the individual research article.

We hope the article will be of immense use to the researchers and students, and result in increased interest in these medicinal plants.

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