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Medicinal Plants and Their Pharmacological Aspects

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Abstract: This review focuses on the various pharmacological activities and properties possessed by the medicinal plants in general as well as the advantages and disadvantages of herbal medicines. Plants have been the traditional source of raw materials for medicines since long time. These medicinal properties are due to their content known as phytochemicals. The basic uses of plants in medicine will continue in the coming future as a source of therapeutic agents and as basic raw material for cosmetics, perfumes and food industries.

Key words: Medicinal plants; herbal medicines; pharmacological activities; phytochemicals.

Introduction

India, China, Greek, Egypt infact the whole world has been utilizing plants for basic preventive and curative health care since time immemorial. Several plants have been search by the human race for the control of diseases. Plants have been the traditional source of raw materials for medicines since long time. A rich heritage of knowledge on preventive and curative medicines was available in ancient scholastic work included in the Atharva veda, Charaka, Sushruta, etc. Infact the old records of Rigveda is filled with praise of plants. Description of medicinal plants can be traced in China from 4000 B.C. old records. In the ancient time Greek and Egypt used plants in the form of medicines. Aristotle (380 B.C.) and Theophrastus (380 B.C.) described medicinal plants in their book, "Historia deplantarum". An estimate suggests that about 13,000 plant species worldwide are known to have use as drugs [1]. According to the World Health Organization, over 80% of the world's population, or 4.3 billion people, rely upon traditional plant-based systems of medicine to provide them with primary health care [2]. Medicinal plants are used at the household level by women taking care of their families, at the village level by medicine men or tribal shamans, and by the practitioners of classical traditional systems of medicine such as Ayurveda, Chinese medicine, or the Japanese Kampo system.

Medicinal plants play a vital role in the development of new drugs. During 1950-1970 approximately 100 plants based new drugs were introduced in the USA drug market including deserpidine, reseinnamine, reserpine, vinblastine and vincristine which are derived from higher plants. From 1971 to 1990 new drugs such as ectoposide, E-guggulsterone, Z-guggulsterone, teniposide, nabilone, plaunotol, lectinan, artemisinin and ginkgolides appeared all over the world. 2 % of drugs were introduced from 1991 to 1995 including paciltaxel, toptecan, gomishin, irinotecan etc.

Several pharmacological activities including the treatment of cancer, immunomodulation, nervous system activation, antipyretic, analgesic, hepatoprotection, antidiabetic nature etc have been possessed by plants and their products. Scientists have even started correlating phytochemical constitu-

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ents of a plant with its pharmacological activity as well as the botanical properties of plants with their pharmacological activity. Correlation of botanical and phytochemical properties to specific pharmacological activities i.e. more co-ordinated multidimensional research is expected in the coming future. In terms of pharmacological activity, more attention has been paid to Central Nervous System-active, cytoprotective, immunomodulators and chemotherapeutic plant products. At the same time a decreasing trend has been noticed towards evaluation of plants for their effects on the autonomic nervous system or fertility control. This review is focusing on the various activities and properties possessed by the medicinal plants in general as well as advantages and disadvantages of herbal medicines.

Phytomedicines

Nowadays phytomedicine is based on traditional medicine (which exists in every continent and in every cultural area of the world). The traditional Ayurvedic medicine in India and Chinese medicine in East Asia are well known and having same resemblance to each other [3]. Herbs are staging a comeback and herbal 'renaissance' is happening all over the globe. The herbal products today symbolize safety in contrast to the synthetics that are regarded as unsafe to human and environment. Although, herbs had been priced for their medicinal, flavoring and aromatic qualities for centuries, the synthetic products of the modern age surpassed their importance, for a while. However, the blind dependence on synthetics is over and now people are returning to the naturals with hope of safety and security. Over three-quarters of the world population relies mainly on plants and plant extracts for health care.

Various activities possessed by medicinal plants

Antimicrobial activity

Medicinal plants have been used as remedies for human diseases because they contain components of therapeutic value. The problem of microbial resistance is growing and the outlook for the use of antimicrobial drugs in the future is still uncertain. Therefore, for a long period of time, plants have been a valuable source of natural products for maintaining human health, with more intensive studies for natural therapies.

Andrographolide ex-hibited antidiarrheal activity similar to antidiarrheal drug, loperamide [4], while *A. paniculata* showed significant antidiarrhoeal activity against *Escherichia coli* associated diarrhea [5,6]. The methanol extract of leaf of *Acacia nilotica, Sida cordifolia, Tinospora cordifolia, Withania somnifer* and *Ziziphus mauritiana* showed significant antibacterial activity against *Bacillus subtilis, Escherichia coli*, *Pseudomonas fluorescens, Staphylococcus aureus* and *Xanthomonas axonopodis* and antifungal activity against *Aspergillus flavus, Dreschlera turcica* and *Fusarium verticillioides* when compare to root/ bark extracts. *A. nilotica* and *S. cordifolia* leaf extract showed highest antibacterial activity against *B. subtilis*. Root and leaf extract of *S. cordifolia* recorded significant activity against all the test bacteria. *A. nilotica* bark and leaf extract showed significant antifungal activity against *A. flavus, Z. mauritiana* and *T. cordifolia recorded* significant antifungal activity against *D. turcica.* The methanol extract of *S. cordifolia* exhibited significant antifungal activity against *F. verticillioides* [7].

Ethanolic and aqueous extract of *A. paniculata* was investigated for its antimicrobial activity against nine bacterial species including *Salmonella typhimurium, Escherichia coli, Shigella sonnei, Staphylococcus aureus, Pseudomonas aeruginosa, Streptococcus pneumoniae, Streptococcus pyogenes, Legionella pneumophila* and *Bordetella pertussis*. Of all tested concentrations, the plant showed activity against *L. pneumophila* and *B. pertussi* [8]. The antibacterial studies of methanolic extract of *Murraya koenigii* leaf confirmed its effectiveness for *S.typhi* and *E.coli* at 100 µg/ ml resulting in moderate zone of inhibition [9]. Ethanol and aqueous extract of *Cajanus cajan, Garcinia kola* and *Xylopia aethiopica* were tested on *Staphylococcus aureus, Pseudomonas aeruginosa, Escherichia coli* and *Candida albicans by* Ezeifeka *et al*.[10]. They found that the plant extracts produced 3 to 22 mm inhibition zones against the test microorganisms and the ethanol extracts of the test plants were more effective. Further, the extracts of *Cajanus cajan* was found to be more effective producing wider zones

of inhibition against *Candida albicans*.

Aqueous and ethanolic extract of *Sapindus emarginatus, Hibiscus rosa-sinensis, Mirabilis jalapa, Rheo discolor, Nyctanthes arbortristis, Colocasia esculenta, Gracilaria corticata, Dictyota* spps., and *Pulicaria wightiana* were evaluated by Nair *et al.*[11] for antibacterial activity against *Pseudomonas testosteroni, Staphylococcus epidermidis, Klebsiella pneumoniae, Bacillus subtilis, Proteus morganii,* and *Micrococcus flavus*. They found that *P. testosteroni* and *K. pneumoniae* were the most resistant bacterial strains. *S. emarginatus* showed strong activity against the tested bacterial strains.

Anthelmintic activity

Worms belonging to various zoological groups can parasitise humans. Some worms have a simple development and transmission; others undergo a quite complicated cycle which may include several hosts.

Yoganandam *et al.*[12] screened the alcoholic and aqueous extracts of roots of *Wedelia biflora* for anthelmintic activity against adult Indian earthworm (*Pheretima posthuma)* using Piperazine citrate as a reference standard. Both the extracts exhibited significant anthelmintic activity at higher concentration and the ethanolic extract was found to be more potent than the reference control. Anthelmintic activity of aqueous extract of *Thespesia lampas* roots was investigated using earthworm (*Pheretima posthuma*), tapeworm (*Raillietina spiralis*) and roundworms (*Ascaridia galli*) by Satish and Ravindra [13]. They found that the plant possesses vermicidal activity.

Mounnissamy *et al.*[14] used the ethanol, water and chloroform extracts of the aerial parts of *Cansjera rheedii* for activity against Indian earthworms (*Pheretima posthuma).* All three extracts exhibited considerable anthelmintic activity. Hydroalcoholic extracts of aerial parts of *Andrographis paniculata, Cajanus cajan* and *Silybum marianum* and their combinations were evaluated for anthelmintic properties using Indian adult earthworms (*Pheretima posthuma*) as a model. *A. paniculata* showed better activity while its combination with *S. marianum* extract was found to be the most potent. This property is supposed to be due to the presence of phenolics (flavonoids and tannins) which are reported to have anthelmintic property [15].

Egg hatch test (EHT) was conducted on *Haemonchus contortus* ova to investigate the *in vitro* ovicidal effect of methanolic extract of *Trachyspermum ammi* seeds which proved toxic to the eggs [16]. Ethanolic extracts of *Moringa oleifera* and *Vitex negundo* showed dose dependent activity against Indian adult earthworm and *Moringa oleifera* showed more activity as compared to *Vitex negundo* [17]. Methanolic extract and its ethyl acetate fraction of *Cassia tora* leaves were evaluated for anthelmintic property using *Pheretima posthuma* as a model. The results were compared with a standard drug, albendazole and ethyl acetate fraction was found to be more potent. The phytochemical analysis of both extracts showed the presence of phenolics like flavonoids and tannins as well as anthraquinones, which may be the active principle [18].

Anticancer property

Cancer is a major public health problem in both developed and developing countries and one of the leading causes of death worldwide. According to WHO, 2004 12.5 % of the population dies due to cancer. It is characterised by uncontrolled and abnormal growth of cells in the human body, forming tumours of malignant cells with the potential to be metastatic [19,20]. Major causes of cancer may be physical inactivity, heridity, unbalanced diet and various environmental factors [21]. Several chemical agents are used to treat cancer, but they cause toxicity that prevents their usage [22]. Currently chemotherapy, radiotherapy, immunotherapy treatments, surgery causes several toxic effects on non-targeted cells/tissues. This arouses the need of using alternative treatments and therapies against cancer [19,23]. Numerous cancer research studies have been conducted using traditional medicinal plants in an effort to discover new therapeutic agents that lack the toxic side effects associated with the present chemotherapeutic agents.[24] Over the past decades, Herbal plants/medicines have been proven to cause fewer side effects in the treatment of cancer and have been well accepted worldwide [25,26]. Medicinal plants continue

to play an important role in the healthcare system of a majority of the world's population. Among several medicinal plants all over the world, including India, only a few medicinal plants have attracted the interest of scientists to investigate the remedy for the prevention and treatment of cancer [24]. Natural bioactive compounds such as phenol and flavonoids occurring in the medicinal plants protect the biological systems against harmful effect. They have been studied for their antitumor, proapoptotic and antiangiogenic effe-cts [27,28]. In history, plant secondary metabolite derives anticancer constituents such as vincristine, vinblastine, campothecin, podophyllotoxin, flavofiridol, silvestrol etc which are used worldwide [29]. Medicinal plants possess good immunomodulatory and antioxidant properties, leading to anticancer activities. These antioxidant phytochemicals protect the cells against oxidative damage [30].

AP9-cd, a standardized lignan composition from *Cedrus deodara* showed cytotoxicity in several human cancer cell lines. Its mechanism of cell death in human leukemia Molt-4 and HL-60 cells was also investigated. It inhibited Molt-4 cell proliferation and produced apoptotic bodies and induced DNA ladder formation. Flow cytometric analysis of cells showed time-related increase in apoptosis and post-apoptotic necrosis [31]. The anticancer-cytotoxic activities of isolated saponins, gymnemagenol from *Gymnema sylvestre* and dasyscyphin C from *Eclipta prostrata* leaves were tested under *in vitro* conditions in HeLa cells. The gymnemagenol and dayscyphin C showed a good cytotoxic activity. 5-Fluorouracil (5-FU) was used as a positive control. It can be concluded that the saponins, gymnemagenol, and dayscyphin C have significant anticancer-cytotoxic activity on HeLa cells under *in vitro* conditions [32].

Vinca alkaloids, vinblastine and vincristine from *Catharanthus roseus* were the first agents to advance into clinical use for the treatment of cancer. These are primarily used in combination with other cancer chemotherapeutic drugs for the treatment of a variety of cancers, including leukemias, lymphomas, advanced testicular cancer, breast and lung cancers, and Kaposi's sarcoma. Similarly, synthetic agent roscovitine which is derived from natural product olomucine, isolated from *Raphanus sativus* is also a proven anticancer agent [33,34]. Triterpenediol (TPD) from *Boswellia serrata* induces apoptosis in human leukemia HL-60 cells. It inhibited cell proliferation and produced apoptosis as measured by increased sub-G0 DNA fraction, DNA ladder formation and enhanced AnnexinV- FITC binding of the cells [35]. The natural antioxidant gallic acid (GA) was isolated from *Phaleria macrocarpa* and demonstrated a significant inhibition of cell proliferation in a series of cancer cell lines and induced apoptosis in esophageal cancer cells TE-2 but not in noncancerous cells CHEK-1 [36]. The chemopreventive action of silymarin inhibit the carcinogenic action of many chemicals. It significantly inhibited azoxymethane-induced colon carcinogenesis in rats. Skin carcinogenesis induced by benzoyl peroxide was also inhibited by silymarin [37,38,39].

Antioxidant activity

Oxygen is a highly reactive atom that is capable of becoming part of potentially damaging molecules commonly called free radicals such as Reactive oxy gen species (ROS). When ROS are present at certain levels, they greatly overwhelm the capacity of endogenous cellular antiox-idant defense system, thus cause oxidative stress. The resulting damage to cells and organs may induce and/or accelerate disease processes. Oxidative stress has been implicated in cancer, aging, atherosclerosis, ischemic injury, inflammation, and neurodegenerative diseases [40,41]. Free radicals are capable of attacking the healthy cells of the body, causing them to lose their structure and function. Antioxidants are capable of stabilizing, or deactivating, free radicals before they attack cells. Antioxidants are absolutely critical for maintaining optimal cellular and systemic health and well-being [42].

In-vitro antioxidant activity of methanolic leaves and flowers extract of *Lippia alba* was determined by DPPH free radical scavenging assay using ascorbic acid as standard. UV-Visible Spectrophotometer analysis showed that the extracts have significant DPPH radical scavenging activity compared to standard antioxidant. Moringa pterigosperma leaves were evaluated and compared for antioxidant activity, total phenolics,

flavonoids content of aqueous and ethanolic extract. The antioxidant activity was assessed by DPPH, nitric oxide and superoxide radical scavenging assay. Aqueous extract was the most potent and showed higher antioxidant activity.[43] In vivo antioxidant activity of queous extract of Vernonia amygdalina leaves was analysed for oxidative stress in mice. Catalase activity, lipid peroxidation products, thiobarbituric acid-reactive substances (TBARS), iron and total protein concentrations were measured in liver homogenate. The extract showed antioxidant as well as hepatoprotective activity [44].

The protective mechanisms of methanol extract of Oldenlandia umbellata in carbon tetrachloride intoxicated rats was analysed for antioxidant and hepatoprotective activity. Treatment of rats with CCl4 led to a marked increase in lipid peroxidation as measured by malondialde-hyde (MDA). This was associated with a significant reduction of the hepatic antioxidant system e.g. glutathione (GSH) and catalase. These biochemical alterations resulting from CCl4 administration were significantly inhibited by pretreatment with methanol extract of *O. umbellate* [45]. Paracetamol toxicity in rats produced a significant decrease in the hepatic levels of glutathione S-transferases when compared with the control. Alchornea cordifolia significantly reduced the level of hepatic glutathione S-transferase which suggests that it is a potent antioxidant since the detoxification of paracetamol can be mediated by glutathione S-transferase (GST) catalyzed conjugation with glutathione (GSH) in the liver [46.]

Antioxidant activity of methanolic extract of Grangea maderaspatana was evaluated using five in vitro assays and was compared to standard antioxidant (Ascorbic acid). The extract exhibited significant reducing power ability, 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity, nitric oxide radical scavenging activity, hydrogen peroxide scavenging activity and inhibition of â-carotene bleaching [47]. *Andrographis paniculata* prevented hexachlorocyclohex-ane induced increase in the activities of y-glutamyl transpeptidase, glutathione-S-transferase and lipid peroxidation in mouse liver, this is an indication of antioxidant and hepatoprotective effects of *A. paniculata* [48,49]. *A. paniculata* considerably inhibit the multiplication of *Plasmodium berghei* [50]. The protective action was due to reactivation of the antioxidant enzyme superoxide dismutase [51]. The andrographolide, andrographiside, diterpenes and neoandrographolide, isolated from *A. paniculata* demonstrated anti-oxidant effects in CCl_4 treated mice. Neoandrographolide was as effective as silymarin with respect to its effects on reduced glutathione, glutathione 5-transferase, glutathione peroxidase and superoxide dismutase and lipid peroxidation whereas andrographiside had mainly anti-lipoperoxidant activity [52].

Hepatoprotective activity

Liver, the key organ of metabolism and excretion, is constantly endowed with the task of detoxification of xenobiotics, environmental pollutants and chemotherapeutic agents. Thus, disorders associated with this organ are numerous and varied. While a curative agent has not yet been found in modern medicine, the current usage of corticosteroids and immunosuppressive agents only brought about symptomatic relief [53]. Furthermore,their usage is associated with risk of relapses and danger of side effects. On the other hand, Ayurveda, an indigenous system of medicine in India, has a long tradition of treating liver disorders with plant drugs [54]. Enhanced lipid peroxidation produced during the liver microsomal metabolism of ethanol may result in hepatitis and cirrhosis [55]. There are numerous medicinal plants which have shown high efficiency for the hepatoprotective activity and have shown great potential as a natural remedy for the treatment of acute liver diseases and damages. Summary of some of the plants with proven hepatoprotective activity are discussed below.

Apium graveolens and Hygrophila auriculata pretreatment of rats with the methanolic extracts of the seeds against paracetamol induced damage in the liver exhibited a significant reduction in the paracetamol induced increase in the levels of different SGOT, SGPT and serum bilirubin. *Ginkgo biloba* is one of the oldest known trees and is widely distributed all over the world is reported to have hepatoprotective activity as there was a significant increase in the serum hepatic

enzyme levels and significant decrease in the TP and Alb levels after CCl_4 treatment in rats, which was reversed with *G.biloba* [56]. CCl_4 treated animals showed significant increase in serum levels of bilirubin, alanine transaminase, aspartate transaminase and alkaline phosphatase with a decrease in total protein level, reflecting liver injury. In the aqueous and ethanol extracts of *Pterocarpus santalinus* treated animals there was a decrease in serum levels of the markers and significant increase in total protein, indicating the recovery of hepatic cells. Histological study of aqueous extract treated group exhibited moderate accumulation of fatty lobules and cellular necrosis where as ethanol extract treated animals revealed normal hepatic cords without any cellular necrosis and fatty infiltration [57].

Hepatoprotective effect of alcoholic extract of *Pergularia daemia* was carried out using carbon tetrachloride induced liver damage in wistar albino rats. Acetone sub fraction showed significant protective effect by lowering serum levels of various biochemical parameters. These biochemical observations were supplemented by histopathological examination of liver sections. Silymarin was used as positive control [58]. Aqueous seed extract of *Cleome viscosa* has hepatoprotective activity against carbon tetrachloride (CCl_4) induced liver damage in wistar rats. The extract was administered orally to the animals with hepatotoxicity induced by CCl_4. Silymarin was given as reference standard. There was significant reduction in serum enzyme aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase, Y-glutamyl transpeptidase and lipid peroxidase and increase in reduced glutathione [59]. The hepatoprotective study of *Picrorhiza kurrooa* was evaluated against alcohol-CCl_4, induced liver damage in rat. It showed a significant hepatoprotective activity by lowering of the elevated levels of glutamate oxaloacetate transaminase, glutamate pyruvate transaminase, acid phosphatase, alkaline phosphatase, glutamate dehydrogenase and bilirubin in the serum of alcohol-CCl_4 induced liver damage models [60].

Silymarin a flavonoid present in the *Sylibum marianum* extract has been shown to prevent carbon tetrachloride-induced lipid peroxidation and hepatotoxicity. This effect of silymarin is attributed to its ability to normalize the levels of the transaminases that are elevated in hepatotoxicity [61,62]. Silymarin has also been found to reduce the increased collagen content in the carbon tertrachloride-induced chronic liver damage.[63] Studies have shown that silymarin is effective in the treatment of both acute and chronic hepatitis. Oral administration of silymarin shortened treatment time and lowered the elevated serum bilirubin, AST, and ALT [64]. Silymarin given to rats with diet-induced hypercholesterolemia demonstrated an anticholesterolemic effect similar to probucol, with an increase in HDL cholesterol and a decrease in total and biliary cholesterol [65].

Nervous system activity

The **C**entral **N**ervous **S**ystem consists of the brain, spinal cord and millions of neurons (nerve cells). The abnormality in nervous system results in malfunctioning of the body organs. Sometimes Neurodegenerative disorders also occurs which are characterized by progressive and irreversible loss of neurons from specific regions of the brain. Neurodegenerative disorders include Parkinson's disease (PD) and Huntington's disease (HD), where loss of neurons from structures of the basal ganglia results in abnormalities in the control of movement; Alzheimer's disease (AD), where the loss of hippocampal and cortical neurons leads to impairment of memory; and amyotrophic lateral sclerosis (ALS), where muscular weakness results from the degeneration of spinal, bulbar, and cortical motor neurons. At present, the pharmacological therapy of neurodegenerative disorders is limited mostly to symptomatic treatments that do not alter the course of the underlying disease. There are several medicinal plants which have helped in moderating the nervous system activity.

Ethanol extract of *Vitex leucoxylon* leaf depressed spontaneous motor activity which reduces psycoactivity [66]. *Azadirachta indica* showed analgesic properties in mice by acting on neurotransmitter system of the body [67]. Root and seed extract of *Pongamia pinnata* stimulates hepatic microsomal enzyme system [68]. The bacosides A and B present in the alcoholic extract of *Bacopa*

monniera facilitated the consolidation and retention of memory [69]. *Hibiscus vitifolius* has shown to have anti-nociceptive activity, similar to morphine and involving multineurotransmitter systems, gossypin a bioflavonoid was responsible for this activity [70]. Hydroalcoholic extract of roots of *Argyreia speciosa* at the fractions of 500 mg/kg was evaluated for neuro-pharmacological activity using spontaneous motor activity and pentobarbital-induced sleeping time in mice which showed central nervous depressant activity [71]. The central nervous system depressant activity of the crude methanol extract (REC) and fractions (RE1, RE2, and RE3) of *Russelia equisetiformis* were evaluated in mice using the following amphetamine-induced stereotypy, picrotoxin-induced convulsion and phenobarbitone sleeping time. REC significantly increased phenobarbitone-sleeping time and also reduced the sleep latency significantly. The fractions, RE1, RE2 and RE3 also significantly prolonged Phenobarbitone sleeping time and sleep latency. A significant reduction in amphetamine-induced stereotype behavior was observed with REC, but there was no protection against amphetamine-induced mortality. The results suggested that *Russelia equisetiformis* methanol extract possesses central nervous system depressant activities [72].

Anti-inflammatory activity

Inflammation is a response of a tissue to injury often caused by invading parasites. It is characterized by increased blood flow to the tissue causing increased temperature, redness, swelling and pain. Inflammation is a secret killer and is been linked with asthma, heart attacks cancer, Alzheimer's and other diseases.

Several plants have the ability to inhibit inflammation which is practically proved. The anti-infammatory effect of andrographolide is explained by its ability to inhibit neu-trophil adhesion through suppres-sion of macrophage adhesion molecule-1 (Mac-1) upregulation which could be mediated by down regulation of reactive oxygen species (ROS) produc-tion via a protein kinase C (PKC)-dependent mech-anism [73,74]. An-drographolide also exerted anti-inflammatory effects by inhibiting nuclear factor (NF)-icB binding to DNA, and thus reducing the expression of pro-inflammatory proteins, such as cyclooxygenase-2 (COX-2) [75]. The ethanolic extract of the leaf of *Vitex leucoxylon* showed significant inhibition of carrageenan paw oedema and granulation tissue formation in rats [66]. The aqueous suspension of dried latex of *Calotropis procera* showed anti-inflammatory property when tested in the carrageenan and formalin induced rat paw oedema models [76]. The roots and leaves of *Butea frondosa* were evaluated for ocular anti-inflammatory activity in rabbits. The results showed that the gel formulation of *B. frondosa* leaves, prepared using a commercially available, pluronic F-127, reduced the intra-ocular pressure, decreased leucocytosis and was comparable to flubiproten gel [77]. The triglyceride fraction of oil of *Ocimum sanctum* offered higher protection against carrageenan induced paw oedema in rats and acetic acid induced writhing in mice, as compared to the fixed oil [68]. Alcoholic extract of *Ochna obtusata* stem bark demonstrated potent anti-inflammatory effects in the rat paw oedema and cotton pellet granuloma models [78]. Similarly, all extracts of the root of *Pongamia pinnata* showed significant anti-inflammatory activity compared to phenylbutazone in carrageenan and PGE_1 induced oedema models [79].

The alcoholic extract of *S. marianum* when given orally reduced the food pad abscesses in carrageenan-induced paw oedema in Wistar rats. Leukocyte migration is a key process in the inflammatory process; silymarin had a greater inhibitory effect on the leukocyte migration induced by carrageenan in mice and produced a dose-dependent inhibition of leukocyte accumulation in inflammatory exudates. It also possesses antiarthritic activity when tested in mycobacterial adjuvant-induced arthritis in rats [80,81].

Antipyretic activity

Plants used as antipyretic agent helps to prevent or reduce fever by lowering body temperature from a raised state. An antipyretic is a type of medication that will prevent or reduce fever by lowering body temperature from a raised state. The antipyretic activity of JU-RU-01, a polyherbal formulation which consists of *Andro-*

graphis paniculata, *Adhathoda vasica* and *Moringa oliefera* was evaluated in Brewers Yeast induced pyrexia in Wistar rats.

The formulation showed very significant reduction of yeast induced pyrexia in rats [82]. The ethanolic extracts of *Ailanthus excels*, *Toddalia asiatica* and *Araucaria bidwilli* showed moderate antipyretic activity in rat model of yeast suspension induced hyperthermia [83]. Both *Andrographis elongata* and *Andro-graphis paniculata* showed antipyretic activity but *A. elongata* was more potent [84]. Methanolic extract of *Nelumbo nucifera* and *Rhynchosia cana* also showed antipyretic effect in rat models [85,86]. Chloroform and alcoholic extracts of leaves of *Hygrophila spinosa* produced significant anti-inflammatory and antipyretic activities in a dose-dependent manner. These two extracts also reduced elevated body temperature in rats throughout the observation period of 6 hours [87] .

Antiallergic

An allergy refers to an exaggerated reaction by our immune system in response to bodily contact with certain foreign substances. It is exaggerated because these foreign substances are usually seen by the body as harmless and no response occurs in non- allergic people.

Along with synthetic drugs, herbal drugs are also in demand as anti allergens due to their fewer side effects. Ethanolic extract of *Vitex negundo* was found to inhibit immunologically induced degranulation of mast cells better than that with compound 40/80. It also inhibited oedema during active paw anaphylaxis in mice. The extract also inhibited both the initial and later sustained phases of tracheal contractions. The initial phase was primarily due to histamine release which was blocked by the extract and the latter phase was due to release of lipid mediators from arachidonic acid [11]. Alcoholic extract of the seeds of *Nyctanthus arbortristis* and *Andrographis paniculata*, hexane soluble extract of the wood of *Cedrus deodara* and aqueous extract of the bark of *Albizzia lebbeck* were found to possess significant anti-allergic activity when tested in the experimental models of anaphylaxis and mast cell degranulation in rats [88,89].

Antidiabetic activity

Diabetes is a condition of the body in which it does not produce enough insulin or does not use it properly. Insulin is a hormone which converts sugar and other food items into energy. Hereditary reasons and the lifestyles of the people play an important role in causing diabetes. When the pancreas gland does not produces enough insulin, the blood glucose level rises and results in the diabetic condition. This condition is termed as Diabetes Mellitus.

Water extract of *A. paniculata* significantly prevented induction of hyperglycemia in-duced by oral administration of glucose in rabbits [90]. A preparation from whole plant of *Phyllanthus amarus* was found to have hypoglycemic effects against the subject of diabetes [91]. *In vitro* studies have shown that epicatechin, an active constituent of *Pterocarpus marsupium* exerted a protective effect on erythrocyte osmotic fragility, similar to insulin, but by a different mechanism of action. In streptozotocin induced diabetic rats, marsupin and pterostilbene (important phenolic constituents of the heartwood of *Pterocarpus marsupium)* significantly lowered the blood glucose levels and the effects were comparable to metformin [92]. The hypoglycemic efficacy of *Inula racemosa* lowered blood glucose and enhanced liver glycogen in rats. However, there was neither increase in plasma insulin levels nor an increase in the degree of degranulation of beta cells of pancreas. Its action may be at the peripheral level by potentiating insulin sensitivity [93]. Hot water extract of *Camellia sinensis* significantly reduced the blood glucose level and was found to possess both preventive and curative effects in streptozotocin induced diabetic rats [94]. Leaf extract of *Aegle marmelos* was found to significantly reverse the raised Km values of the enzyme malate dehydrogenase (an important enzyme in glucose metabolism) in streptozotocin induced diabetic rats. Alteration in the qualitative and quantitative nature of the enzyme has been suggested to contribute to the pathological state of diabetes. The leaf extract was also effective in restoring blood glucose and body weight to normal values.[95] Oral administration of the methanolic extract of aerial parts of *Artemisia pallens* led to significant low-

ering of blood glucose in glucose fed hyperglycemic and alloxan induced diabetic rats. Inhibition of renal proximal tubular reabsorption of glucose and increased peripheral utilisation of glucose is probably the mechanism responsible.[96] The effect of three structurally different hypoglycemic agents, tolbutamide, centpiperalon and a swerchirin- containing fraction from the plant *Swertia chirata* were tested in normal and streptozotocin induced mild and severe diabetes in rats. Except in rats with severe pancreatic damage, it showed better blood glucose lowering effect compared to tolbutamide [97].

Immunomodulatory activity

Immunomodulators are substances that help regulate or normalize the immune system they may be natural or synthetic. They correct weak immune systems and temper immune systems that are overactive. The immunomodulators stimulate natural and adaptive defense mechanisms, such as cytokines, which enables the body to help itself. Plant based immune stimulation also contribute to the therapy of the autoimmune diseases. Ethanolic extract of *A. panicu-lata* and andrographolide showed promising immunostimulant activity [98]. Andrographolide also modulate both antigen specific and nonspecific immune function by means of its natural killer cells and macrophage and cytokines induction [99].

Modulation of the immune response through stimulation or suppression may help in maintaining a disease free state. *Asparagus racemosus*, *Tinospora cordifolia* and *Withania somnifera* protected animals against infections in normal and immunosuppressed states induced by hemisplenectomy or surgery. These plants also produced leucocytosis with predominant neutrophilia and prevented, to varying degrees, the leucopenia induced by cyclophosphomide. They were found to activate the polymorphonuclear and monocyte-macrophage systems [100]. Ovalbumin immunized mice treated with *Azadirachta indica* leaf extract had higher IgG and IgM levels and anti-ovalbumin antibody titres as compared to control (humoral response). *A. indica* also induced cell mediated response as seen from the enhancement of macrophage migration inhibition and footpad thickness [101]. Root suspension of *Janakia arayalpathra* was found to have immunostimulatory properties in mice. It stimulated an increase in humoral antibody titres and also of antibody secreting spleen cells in the plaque forming cells assay following immunisation with sheep erythrocytes. It also increased the number of peritoneal macrophages and produced an increase in delayed hypersensitivity reaction in mice [96]. The alkaloidal fraction of *Boerrhiva diffusa* significantly restored the suppressed humoral response in stressed rats [102] .

Herbal and modern medicine

Two systems of medicine are available: Conventional Western (Allopathic) Medicine and Alternative or Complementary Medicine. Conventional medicine is comprised of drugs that suppress the body's natural immune responses. Alternative Medicine, which is more cost effective over the long term, works better than the conventional medicine, especially for diseases like cancer, heart disease, rheumatoid arthritis, asthma, gastrointestinal disorders, headaches, sinusitis, etc. Alternative methods work by assisting the body to heal itself instead of introducing strong drugs.

Advantages of herbal medicines

Herbal medicines tend to be more effective for long-standing health complaints that don't respond well to traditional medicine. Herbs typically have fewer side effects, and may be safer to use over time. An example may be seen with herbs and alternative remedies used to treat arthritis. Viox, a well-known prescription drug uses to treat arthritis, was recalled due to increased risk of cardiovascular complications. On the other hand, alternative treatment for arthritis has few side effects.

Another advantage to herbal medicine is cost. Herbs cost much less than prescription medications. Research, testing, and marketing add considerably to the cost of prescription medicines. Herbs tend to be inexpensive compared to drugs. Yet another advantage of herbal medicines is their availability. Herbs are available without a prescription, and some simple herbs, such as pep-

permint and chamomile, can be grown at home. In some remote parts of the world, herbs may be the only treatment available to the majority of people.

Disadvantages of herbal medicines

An herbalist would not be able to treat serious trauma, such as a broken leg, nor would he be able to heal appendicitis or a heart attack as effectively as a conventional doctor using modern diagnostic tests, surgery, and drugs. Modern medicine treats sudden illness and accidents much more effectively than herbal or alternative treatments. Another disadvantage of herbal medicine is the very real risks of doing oneself harm through self-dosing with herbs. While one can argue that the same thing can happen with medications, such as accidentally overdosing on cold remedies, many herbs do not come with instructions or package inserts. There's a very real risk of overdose. Harvesting herbs in the wild is risky, if not foolhardy, yet some people try to identify and pick wild herbs. Because herbal products are not tightly regulated, consumers also run the risk of buying inferior quality herbs. The quality of herbal products may vary among batches, brands or manufacturers. This can make it much more difficult to prescribe the proper dose of the herb.

Future prospects of herbal medicine market

According to WHO about 25 % of modern medicines are descended from plants first used traditionally. Many others are synthetic analogues built on prototype compounds isolated from plants. Almost, 70 % modern medicines in India are derived from natural products. The basic uses of plants in medicine will continue in the coming future as a source of therapeutic agents and as basic raw material for cosmetics, perfumes and food industries.

In the dual role as a source of healthcare and income, medicinal plants make an important contribution to the larger development process. Though the efficacy of herbal requires development of quality consciousness in respect of the evaluation related evidences, supplying the demand for botanicals and herbals is a booming business. Recently even developed countries, are using medicinal systems that involve the use of herbal drugs and remedies. Undoubtedly the demand for plant derived products has increased worldwide. The demand is estimated to grow in the years to come fuelled by the growth of sales of herbal supplements and remedies [103].

With the advances in cellular biology, a shift towards studying changes in cytosolic enzyme activities, DNA patterns and genetic control has been observed rather than concentrating merely on the gross effects induced by the plant drugs. In addition to the proper utilization of technological advances, a logical interpretation of the codified language of traditional medicine also becomes a necessity in order to further promote research in this field.

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