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Antidiabetic, Antioxidant, Antimicrobial and Antidepressant Properties of Medicinal Plants: A Review

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ABSTRACT

Medicinal plants are most significant in Ayurvedic, Unani, and Siddha medical system. Medicinal plants have been used for thousands of years in curing diseases. These plants have been always an important part of public health in every culture, civilization, and tradition. These plants contain phytochemicals which act against diseases and provide goodness for health. These plants like aloe vera (*Aloe barbadensis*), basil (*Ocimum basilicum)*, turmeric (*Curcuma longa*), ginger (*Zingiber officinale*), garlic (*Allium sativum*), cinnamon (*Cinnamomum verum*), black cumin (*Nigella sativa*), mustard (*Brassica nigra*), clove (*Syzygium aromaticum*), black pepper (*Piper nigrum*), rosemary (*Salvia rosmarinus*), thyme (*Thymus vulgaris*), fennel (*Foeniculum vulgare*), sandal wood (*Santalum album*), cardamom (*Elletaria cardamomum*), coriander (*Coriandrum sativum*), chamomile (*Matricaria chamomilla*), peppermint (*Mintha piperita*) and neem (*Azadirachta indica*) etc. have been used since ancient times. Medicinal plants and their products possess effective antibacterial, antifungal, antioxidant, antidepressant and antidiabetic properties. These are very essential in the development of healthcare and resources for herbal products which are effective at low-cost, have valuable and unique properties.

Keywords: Antibacterial, Antidepressant, Antidiabetic, Antifungal, Antioxidant, Medicinal Plants, Phytochemicals

INTRODUCTION

Plants that contain one or more parts or their products that are used in the healing of diseases are called medicinal plants [1]. According to WHO, about 80% of the developing countries rely on traditional medicines for primary treatment [2]. Medicines that are obtained by plants are usually popular because these are easily available, safe and low priced [3]. India has been used traditional medicinal plants, spices, herbs and products of plants from ancient times. Different types of medicinal plants are found in India based on geographical diversity. In India, medicinal plants are used in indigenous medicinal systems such as Ayurvedic, Unani and Siddha as well as pharmaceutical production [4]. Traditional medicines are formulated with the use of these plants and are potentially strong as antimicrobial, antidiabetic, antioxidant, antidepressant and anti-inflammatory. Medicinal plants contribute in the prevention of various diseases and disorders like reduce swelling, relieves body pains, improve digestion, cough, fever, cold, enhance memory, relieves nausea, used as hair oil, insomnia, relieves anxiety, maintains blood pressure, control sugar level, stimulates immunity, prevents heart problems, maintain intestinal microbiota, protects from liver toxicity, maintain cholesterol level, skin irritation, cure burns, respiratory disorders, useful in gynecological problem, enhance blood circulatory system, recovery of illness, stimulates nervous system, prevents allergies and allergic bronchitis etc. The most useful domestic plants are chamomile, willow, garlic, onion, ivy, nettle, marshmallow, sage, common centaury, parsley, sea onion, coriander and false hellebore. Generally, human beings depend on plant substance to find their medical requirement for health and disease treatment [5]. Phytochemicals are natural biomolecule obtained from medicinal plants, fruits and vegetables and act against diseases. These molecules are categorized into two groups, primary compound and secondary compound. Primary compounds comprise proteins, carbohydrates, amino acids and chlorophylls and secondary compounds contain alkaloids, phenolic compounds, saponins and tannins etc. [6]. Phytochemicals are introduced in research and development for pharmaceutical productions as a new compound to develop novel drugs [7].

These possess medicinal properties including antioxidative, anticarcinogenic, antiallergic etc. These phytochemicals protect the cell from the destruction of free radicals [8]. Thus, the bioactive molecules found by the screening of plant extracts are very essential in the treatment of human diseases [9]. Most of the world population depends on herbal medicines in case of

their physical, sexual and psychological health issues due to financial problem and still rely on traditional medicines because synthetic pharmaceutical products are expensive and may cause side effects. Medicinal plants are used since time immemorial as an herbal medicine aspirin, opium, quinine and digitalis. Since last decades dietary supplements and drugs derived from valuable plants are highly in demand. In India, about 3000 plant species are acknowledged for their medicinal properties [10]. The ethnobotany offers essential compounds for the progress and research of natural medicine [11]. These plants possess medicinal tendencies. Medicinal plants are used in drug formations which are a rich source of compounds. Pharmacologist, botanist, chemists, microbiologists are developing the treatment for various diseases and disorders and working on phytochemicals which are different types such as polyphenols, flavanones, flavones, flavanols, alkaloids, anthocyanins, carotenoids, flavonoids, monophenols, monoterpenes, organ sulfides, phenolic acid, phytosterols, saponins, xanthophylls, phytic acid, beta-carotene, lycopene, lutein and zeaxanthin. Moreover, many plants are considered as a valuable source of nutrition and are recommended for therapeutic potential. These medicinal plants include green tea, walnuts, ginger and various other medicinal plants. Some plants derivatives are used as essential source for bioactive ingredients which can be used in toothpaste and aspirin [12].

Antimicrobial properties

The term pathogen is derived from the Greek words pathos ("suffering", "passion") and genes ("producer of"), and pathogens are infectious microorganisms or parasites that cause disease in living organisms [13, 14]. These infectious microorganisms, like bacteria, fungi, viruses, and protozoa, cause diseases in animals, humans, and plants. The study of their identification, detection, and diagnosis is called pathology. Many microorganisms cause serious diseases and can be harmful to living beings. Literally, we are interconnected with microbes throughout our entire life. Microorganisms possess both beneficial and detrimental characteristics for human beings. The predominant locations for host–microorganism interactions are the skin and mucosal surfaces [15]. Infectious microbes such as bacteria, fungi, and viruses cause severe infections and diseases when conditions are favorable. Medicinal plants have a potent treasure of antimicrobial compounds. Several herbal extracts have been used to treat various microbial infections and have demonstrated strong antimicrobial properties [16]. The bioactive ingredients are screened and applied in herbal manufacturing [17]. Herbal medicines are used throughout the world because they are safe, convenient, and less expensive than synthetic medicines [18]. Medicinal plants offer a rich source of antimicrobial compounds and serve as an alternative to synthetic antibiotics [19].

More than 35,000 medicinal plant species are utilized as medicines globally [20]. Microbial pathogens have been inhibited by several medicinal plants and their extracts, such as cinnamon (*Cinnamomum verum*) [21,22], clove (*Syzygium aromaticum*) [23,24], ginger (*Zingiber officinale)* [25], moonseed (*Tinospora cordifolia*) [26], holy basil (*Ocimum sanctum*) [27], black cumin (*Nigella sativa*) [28], garlic (*Allium sativum*) [29], yellow oleander (*Thevetia peruviana*) [30], Malabar nut (*Adhatoda vasica*) [31–33], chamber bitter (*Phyllanthus urinaria*) [34], wild indigo (*Tephrosia purpurea*) [35–38], white bark acacia (*Acacia leucophloea*) [39,40], yellow-barried nightshade (*Solanum surattense*) [41], black nightshade (*Solanum nigrum*) [42,43], cotton-leaf physic nut (*Jatropha gossypifolia*) [44,45], sweet tamarind (*Pithecellobium dulce*) [46–48], lantana (*Lantana camara*) [49,50], Ashoka tree (*Saraca asoca*) [51,52], tamarind (*Tamarindus indica*) [53,54], stone apple (*Aegle marmelos*) [55–57], Indian gooseberry (*Phyllanthus emblica*) [58–60], and water hyssop (*Bacopa monnieri*) [61]. Traditional plants are a powerful source of antimicrobial agents [62]. Medicinal plants have been used in the treatment of pathogenic infections since ancient times and provide novel antimicrobial compounds [63]. The antimicrobial activities of medicinal plants are often more effective against infectious diseases caused by bacteria, fungi, and viruses [64]. Medicinal plants contain bioactive molecules such as alkaloids, terpenoids, tannins, flavonoids, carbohydrates, and steroids, which have the capacity to influence physiological processes in the body [65,66]. Extracts of various medicinal plants are used to treat dysentery, fever, cold, cough, diarrhea, cholera, bronchitis, and more [67].

Staphylococcus aureus secretes enterotoxins that cause food poisoning [68,69], and Clostridium botulinum causes botulism, a severe and often fatal form of food poisoning [70,71]. The antifungal properties of medicinal plants have been reported to be highly effective against both human and plant fungal pathogens. Numerous studies have explored the antimicrobial activities of different parts of medicinal plants including roots, leaves, flowers, and stems [72,73]. Medicinal plants have been shown to inhibit several pathogenic microorganisms such as *Candida albicans* [74], *Aspergillus fumigatus* [75], *Aspergillus niger* [75], *Aspergillus flavus* [76], *Mucor indicus* [76], *Candida parapsilosis* [76], *Pythium debaryanum* [77], *Fusarium solani* [78], *Alternaria solani* [79], *Rhizoctonia solani* [79], *Staphylococcus aureus* [80–83], *Pseudomonas aeruginosa* [80–83], *Bacillus cereus* [80,82], *Bacillus subtilis* [80,82,83], *Escherichia coli* [81–83], *Salmonella typhi* [81,82], and *Proteus vulgaris* [83].

Antioxidant properties

Antioxidants are molecules capable of fighting against free radicals or inhibiting oxidation in the body. Oxidation is a reaction that produces free radicals, which tend to accept or donate an electron from another compound [84]. Biological elements such as carbohydrates, lipids, proteins, and DNA molecules are damaged by these reactive species [85]. Free radical reactions are a major cause of human disorders, including heart disease, inflammation, atherosclerosis, aging, diabetes [86], Alzheimer's disease [87], Parkinson's disease [88], asthma [89], cardiovascular disease, neurodegenerative disorders, and eye disorders [90–92]. It has been indicated that antioxidants play a crucial role in preventing oxidative stress and degenerative diseases. It has been reported that approximately 80% of the world's population cannot afford modern medicines; therefore, medicinal plants provide essential natural antioxidant compounds that are valuable in suppressing various diseases and disorders. These medicinal

plants are valuable sources of antioxidant compounds such as box myrtle (*Myrica esculenta*) [93], ginger (*Zingiber officinale*) [94], Indian valerian (*Valeriana jatamansi*) [95], sweet flag (*Acorus calamus*) [96], barberry (*Berberis asiatica*) [97], turmeric (*Curcuma longa*) [94], kutki (*Picrorhiza kurrooa*) [98], and buttermilk root (*Asparagus racemosus*) [99].

Medicinal plants are great sources of bioactive compounds such as alkaloids, terpenoids, and phenolic compounds [100], flavonoids and tannins [101,102], ascorbic acid [102], and carotenoids [103]. Natural antioxidants, especially phenolics, are obtained from all parts of plants [104], including vegetables, fruits, seeds, bark, roots, and leaves. Citrus family fruits are a well-known source of vitamin C, such as orange (*Citrus × sinensis*), lemon (*Citrus × limon*), strawberries (*Fragaria × ananassa*), grapes (*Vitis vinifera*), plums (*Prunus subg. Prunus*), blueberries (*Vaccinium corymbosum*), and prunes (*Prunus domestica*), all of which contain essential amounts of antioxidants [105]. Most vegetables are also good sources of antioxidants, including pea (*Pisum sativum*), spinach (*Spinacia oleracea*), tomato (*Solanum lycopersicum*), white onion (*Allium cepa* 'White onion'), carrot (*Daucus carota*), cauliflower (*Brassica oleracea var. botrytis*), white cabbage (*Brassica oleracea var. capitata*) [106], potato (*Solanum tuberosum*), and cucumber (*Cucumis sativus*) [107]. Antioxidants have been shown to be effective in several disorders, such as schizophrenia, leukemia, depression, diabetes, asthma, and rheumatoid arthritis [108]. Flavonoids also exhibit antiviral, anticarcinogenic, antiallergic, anti-inflammatory, and anti-aging properties [109].

Anti-diabetic properties

Blood sugar is the main energy source obtained from the consumption of food. Diabetes is a chronic disease related to metabolic disorders that occurs due to high blood sugar or glucose levels (hyperglycemia). It results from a lack of insulin, resistance to insulin, or both. Insulin is secreted by the β-cells of the pancreas and plays a crucial role in maintaining blood sugar levels [110]. Common symptoms in diabetic patients include excessive thirst, fatigue, frequent urination, increased hunger, weight loss, and blurred vision. Diabetes mellitus is characterized by the loss of glucose homeostasis, which affects the metabolism of carbohydrates, fats, and proteins due to deficiencies in insulin secretion, activity, or regulation. Individuals with diabetes mellitus are at increased risk of developing atherosclerotic cardiovascular, peripheral arterial, and cerebrovascular diseases [111].

Insulin acts as a regulatory hormone for blood sugar. Type 1 diabetes, also known as juvenile diabetes, is insulin-dependent and affects about 5% of diabetic patients. Type 2 diabetes, which is non-insulin-dependent, typically develops in adults over the age of 40. Medicinal plants have shown significant effectiveness in managing diabetes, including species such as stone mango (*Alangium lamarckii*) [112], black siris (*Albizia odoratissima*) [113], tropical carpet grass (*Axonopus compressus*) [114], teri pods (Caesalpinia digyna) [115], laurel sapphire berry (*Symplocos cochinchinensis*) [116], Indian whitehead (*Enicostemma littorale*) [117], marking nut (*Semecarpus anacardium*) [118], honey mesquite (*Prosopisglandulosa*) [119], kinkeliba (*Combretum micranthum*) [120], java plum (*Syzygium cumini*) [121], woodland sage (*Salvia nemorosa*) [122], and bitter gourd (*Momordica charantia*) [123]. Ethnobotanical reports have documented that approximately 800 medicinal plants possess antidiabetic properties [124].

Recently, herbal medicines have become widely used in both developing and developed countries for the prevention of diabetes due to their natural origin and minimal side effects [125–127]. In many regions, including Asia, Central America, and West Africa, herbal drugs are commonly used to prevent or treat diabetes mellitus [128,129]. Among various phytochemicals, saponins exhibit multiple biological activities, including antidiabetic effects, and are being explored as potential novel drugs for diabetes treatment [130,131].

Effective treatment and management of diabetes remain a global challenge [132]. Several plant-derived phytochemicals such as tannins, lignans, cinnamic acid, flavonoids, monoterpenes, diterpenes, triterpenes, coumarins, and phenylpropanoids are found in high concentrations in different plant parts including stems, leaves, roots, bark, wood, seeds, fruits, flowers, and pollens. Studies have shown that these compounds are effective against oxidative stress-mediated disorders, including diabetes [133]. Diabetes mellitus is currently the third leading cause of death worldwide and affects several vital organs [134].

Anti-depressant properties

Depression is a chronic psychiatric disorder that affects approximately 21% of the global population [135,136]. Common symptoms include feelings of disappointment, frustration, intense sadness, loss of interest in daily activities, fatigue, disturbed sleep and appetite, and suicidal ideation [137]. Mental depression is a severe condition that impacts human behavior, mood, desires, emotions, concentration, self-confidence, and physical health, and may manifest as headaches, hopelessness, irritability, anger, social withdrawal, risk of heart disease, constipation, fatigue, and negative thoughts. The primary causes of depression include biological, social, and emotional factors. Depression is associated with disturbances in brain neurochemistry, particularly involving serotonin, dopamine, norepinephrine, and other monoamine neurotransmitters [141]. According to the World Health Organization (WHO), approximately 450 million people globally suffer from mental or psychological disorders [138–140]. Significant changes in brain function and neurotransmitter imbalances are hallmarks of depressive disorders. There are two main types of depression: unipolar and bipolar.

Medicinal plants have emerged as promising alternative therapies for managing depression and have shown increasing effectiveness over the past decade [142]. Numerous plant species have demonstrated antidepressant activity, including cinnamon (*Cinnamomum zeylanicum*) [143], lavender (*Lavandula angustifolia*) [144], wood violet (*Viola odorata*) [145], Echium amoenum [146], lemon verbena (*Aloysia triphylla*) [147], valerian (*Valeriana officinalis*) [148], bitter orange (*Citrus aurantium*) [149], lemon balm (*Melissa officinalis*) [150], Salix aegyptica [151], sword-leaf dogbane (*Apocynum venetum Linn.*) [152], water hyssop (*Bacopa*

monnieri) [153], blue pea (*Clitoria ternatea*) [154], barbicou bean (*Canavalia brasiliensis*) [155], turmeric (*Curcuma longa*) [156], black cohosh (*Cimicifuga racemosa*) [157], maca (*Lepidium meyenii*) [158], houpu magnolia (*Magnolia officinalis*) [159], sensitive plant (*Mimosa pudica Linn.*) [160], and Indian gooseberry (*Emblica officinalis*) [161].

Phytochemicals extracted from these plants exhibit neuroprotective effects and may alleviate depressive symptoms. Key bioactive compounds include carvacrol [162,163], curcumin [164–166], ferulic acid [167], L-theanine [168], proanthocyanidins [169], quercetin [170], and resveratrol [171].

CONCLUSION

Medicinal plants have been reported very effective for the treatment of major diseases. These are used in different types of traditional medicine formulation including Ayurvedic, Unani and Siddha etc. According to the report of world health organization 80% developing countries of the world depend on traditional system of herbal medicines. Herbal are potentially very effective such as Antidiabetic, Antioxidant, Antimicrobial and Antidepressant etc. Herbal medicines provide better treatment on low cost to human. Pharmacologists, chemists and drug researchers are working on phytochemicals for the development of effective system of herbal drugs against various diseases and disorders.

CONFLICT OF INTEREST

The authors declared no conflict of interest.

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