



Review Article

J. Ayu. Herb. Med.
2016; 2(1): 31-35
January- February
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Herbals as Antimicrobials: A Review

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ABSTRACT

We herein outline some traditional plants, their phytochemicals and uses in emerging health problems arise through microorganism. Herbal remedies in the form of antibacterial and antifungal are prepared from a variety of plant parts such as leaves, stem, root, bark or fruit. Herbal dosage forms advocate enhancing the immunity against the diseases through its noble preparation originated from plants, used in the treatment of various infectious diseases caused by a microorganism. Some antifungal herbals i.e. Guava (*Psidium guajava*), Orchid (*Bauhinia purpurea*), Turmeric (*Curcuma longa*), Neem (*Azadirachta Indica*), Pippali (*Piper longum*), Creeping cucumber (*Solena amplexicaulis*) and Amla (*Embelica officinalis*) are used to cure skin associated problems as itch, scabies, skin sores, wounds and dermatosis. Herbs as Hyacinth bean (*Lablab purpureus*), Purging nut (*Jatropha curcas*), Bitter melon (*Momordica Charantia*), Jangali palak (*Rumex nepalensis*) are extensively used in the treatment of a bacterial infection related with hookworm, chickenpox, chikungunya, cellulitis, enterococcus infection, fascioliasis and Moniliasis or thrush.

Keywords: Herbal remedies, Phytochemicals, Antifungals, Bacterial infections, Microorganism.

INTRODUCTION

Today herbal medicines are widely used and are in high demand in the developing countries for primary health care because of their inexpensiveness, cultural acceptance, compatibility with the human body followed by minimal side effects. Most herbal products on the market today have been subjected to drug approval process to demonstrate their safety and efficacy^[1]. Herbals for healing purpose predate ancient human history and form the origin of much modern medicine. The diverse climate of India offers rich collection of herbals, verified from many legends of Ayurveda, which could not have flourished for two thousand years without any rational scientific. Ayurveda approaches for remedies also reveal to the prevention and cure of microbial infectious diseases, and hence recommended herbal combinations and their extracts to improve health^[2]. It is also claimed that toxicity is reduced when whole herbs are used instead of isolated active ingredients^[3]. Plants are considered as the oldest source of pharmacologically active compounds and have provided humankind with many medicinally useful compounds from centuries^[4].

Fungal infections are associated with several species of *Aspergillus fumigatus*, *Aspergillus niger*, *Candida albicans*, *Paecilomyces lilacinus*, *Trichoderma viride*^[5]. Fungi are grouped in eukaryotes and are extremely diverse in aspect of morphology and function. Globally morbidity and mortality from various fungal infections are widely occurring in immunocompressed people^[6]. Topical fungal infections (caused by *Trichophyton*, *Microsporum* and *Epidermophyton*) are usually confined to the outer layers of skin, hair and nails where keratin is the major structural protein, leading to a wide variety of disease states. Whereas bacteria are categorized in prokaryotes, cause several pathogenic diseases caused by Gram positive and Gram negative pathogens (species of *Staphylococcus*, *Streptococci*, *Enterococcus*, *Haemophilus*, *Vibrio* and *Microbacterium* etc.). Gram-positive bacteria *Staphylococcus aureus* is responsible for the post operative wound infection, *Enterobacter faecalis* causes inflammation of inner layer of the heart whereas Gram-negative organisms *E. coli* is present in human intestine and causes lower urinary tract infection, coleocystis or septicemia [7].

We herein report traditional herbals, their chemical constituents and application in case of fungal and bacterial infection in living beings. To avoid and combat these infections caused by above cited microorganism, antimicrobials are used which can either produce toxicity or resistance after prolong treatment. Hence herbal remedies are preferred to get rid of unwanted effects and for better patient compliance. Herbal formulations as antimicrobials are prepared and formulated in suitable dosage form by the utilization of plant parts such as leaves, stem, root, bark or fruit.

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Herbals as antifungal

Phyllanthus fraternus, Euphorbiaceae commonly known as "Bhumymlaki" was reported. Their seed oil contains ricinoleic acid, linoleic acid and linolenic acid, externally applied on skin infection caused by fungus. Fruits are also used in the treatment of ulcers, wounds, sores, scabies, ringworm and other skin problem. A decoction of root and leaves was used to treat malaria and antifungal activity against strains *Aspergillus niger* and *Candida albicans*^[8].

The root extract of *Nannorrhops ritchiana*, Arecaceae contains alkaloids, phenols, polyphenol saponins, tannins, anthraquinones and sterols. Clinically isolated human fungal pathogens *Microsporum canis*, *Candida albicans*, *Candida glabrata*, *Aspergillus flavus*, *Trichophyton mentagrophytes*, *Fusarium moniliformus* and plant pathogens *Trichophyton longifusus*, *Fusarium solani lycopersici* and *Fusarium oxysporum lycopersici solanivar* and performed the antifungal activity of this plant in their study^[9].

Antifungal activity of leaves of plant *Psidium guajava*, Myrtaceae was reported due to the presence of tannins, phlobatannins, saponins, terpenoids, alkaloids and poly phenols. Guava fruits also contain vitamin C, iron, calcium and phosphorus, used to treat skin problem, ulcers, itch, scabies, skin sores, wounds and dermatosis associated with pathogenic fungal species i.e. *Trychophyton rubrum*, *Microsporum canis*, *Aspergillus niger* and *Candida albicans*^[10].

Antifungal activity of leaves of *Erythrina variegata*, Fabaceae is reported due to its phytochemicals alkaloids, flavonoids, pterocarpanes, triterpenes, steroids. Juice from the leaves is mixed with honey useful in ophthalmia and skin diseases caused by fungus *Aspergillus niger*, *Aspergillus fumigatus*, *Rhizopus* species and *Candida* species^[11].

Solena amplexicaulis, Cucurbitaceae is commonly called as creeping cucumber used for the treatment of inflammation, skin lesions and skin diseases associated with *Aspergillus fumigatus*, *Aspergillus niger*, *Candida albicans*, *Paecilomyces lilacinus*, *Trichoderma viride* and *Verticillium lecanii* attributed to the presence of cucurbitacin, triterpenes, sterols and alkaloids^[12].

Leaf extract of *Lablab purpureus* or *Hyacinth bean*, Fabaceae used to prevent mycoses such as athlete's foot, ringworm, candidiasis (thrush). Anti fungal activity on *Bacillus subtilis*, *Vibrio mimicus*, *Aspergillus niger*, *Candida albicans* and *Trichoderma viridae* and contains mainly sterols (including cholesterol and its derivatives), fatty acids, palmitic, palmitoleic, linoleic and linolenic acids, a pyridine alkaloid, trigonelline and sterols^[13].

Leaves and stem bark of *Moringa oleifera*, Moringaceae was studied antifungal activity against *Botryodiplodia theobromae*, *Sclerotium rolfsii*, *Penicillium oxalicum* and *Aspergillus niger* causing diseases in plants due to the presence of saponins, alkaloids and tannins^[14].

Leaf and stem extracts of *Pterospermum reticulate*, Sterculiaceae as antifungal activity reported against *Aspergillus niger*, *Candida albicans* and *Trichoderma viridae* due to the presence of phenols, glycosides, tannins, saponins and terpenoids^[15].

Hildegardia populifolia, Sterculiaceae was reported antifungal against *Aspergillus fumigatus*, *Aspergillus niger*, *Candida albicans*, *Paecilomyces lilacinus*, *Trichoderma viride*, *Mucor indicus*, *Fusarium oxysporum* and *Penicillium digitatum* and prescribed for the treatment of malaria and dog bite as traditional healers^[16].

Leaf and root extracts of *Hypochaeris radicata*, Asteraceae commonly known as cat's-ear, contains alkaloids, cardiac glycosides, phenols, tannin, terpenoid and triterpenoid. Antifungal activity against the species *Aspergillus fumigatus*, *Aspergillus niger*, *Candida albicans*,

Paecilomyces lilacinus, *Trichoderma viride*, *Mucor indicus*, *Fusarium oxysporum* and *Penicillium digitatum*^[17].

Bark extract of *Calotropis procera*, Asclepiadaceae was contains primary metabolites such as pentacyclic, ursane triterpenes, cardiolides, phytosterol, triterpenoid saponins and secondary metabolites uzarigenine, beta- anhydroepidigitoxigenin. Extract is used in treating vertigo, baldness, hair fall, tooth aches, intermittent fever, leprosy, eczema, elephantiasis, hepatic and splenic enlargement. Its bark is mainly used for the treatment of skin infection, ringworm infection, rotting nails and other fungal diseases of skin against *Candida albicans*, *Tinea capitis*, *Epidermophyton floccosum* and *Microsporum canis*^[18].

Punica granatum (Pomegranate), Punicaceae that contains phytoconstituent as ellagitannins, including punicalin, punicalagin, piperidine alkaloids and antifungal activity against the species, *Aspergillus fumigatus*, *A. niger*, *Candida albicans*, *Paecilomyces lilacinus*, *Trichoderma viride*, *Mucor indius*, *Fusarium oxysporum* and *Penicillium diguatum*^[19].

Bauhinia purpurea, Leguminosae also called as 'Orchid' antifungal activity of leaves of orchid contains lupeol, stigmasterol, lanosterol, ergosterol, beta- tocopherol and hexadeconic acids was analysed against *Aspergillus niger* and *Claviceps purpurea*^[20].

Fruit pulp of *Cassia fistula*, Leguminosae was analysed due to the presence of secondary metabolites anthraquinones, fistulic acid, rhein, rheinglucoside, sennosides A and B responsible for the inhibition of fungus and its growth^[21].

Physalis peruviana, Solanaceae used for the treatment of healing of skin diseases such as dermatitis. It contains alkaloids, withanolides, flavonoids, cuscohygrine (root). Antifungal activity against (*Candida albicans*, *Candida glabrata*, *Candida tropicalis* and dermatophyte species (*Trichophyton rubrum* and *Epidermophyton floccosum*)^[22].

Indian lilac or *Azadirachta indica*, Meliaceae commonly known as neem for anti-fungal activity against (*Aspergillus fumigatus* and *Candida albicans*, *enterococcus faecalis*). It is used to cure skin ulcer, ascariasis, trichuriasis, hookworm and used traditionally in Ayurveda both topically and internally. Oil of *Azadirachta indica* is useful in leprosy, scrofulas, skin diseases, ulcers, and wounds due to the presence of nimbidin and nimbidol^[23].

Leaf exact of *Cassia alata*, Caesalpiniaceae was commonly known as ringworm senna used for the treatment of ringworm scabies, ulcers and other skin diseases such as pruritis eczema and itching. It contains anthraquinones, chrysofenol and flavonoid glycoside. Antifungal activity against *Aspergillus flavus* and *Aspergillus parasiticus* plant pathogenic fungi *Fusarium oxysporum* and *Helminthosporium oryzae*^[24].

Leaf of *Senna alata*, Fabaceae is an ornamental shrub was locally used in Nigeria for the treatment of several infections associated with ringworm, parasitic skin diseases due to the presence of some chemical components such as phenols, and alkaloids. Showed high anti-fungal activity against dermatophytic fungi *Trichophyton mentagrophytes*, *Trichophyton rubrum* and *Microsporium gypseum* and *Microsporium canis*^[25].

Fruit of *Embellica officinalis*, Euphorbiaceae commonly known as Indian gooseberry chief dietary source of vitamin C, tannins, alkaloids, amino acid like glutamic acid, proline, aspartic acid, alanine, cystine and lysine used in ayurveda as a powerful rasayana and customary medicine for treatment of diarrhea, jaundice, inflammation. Anti-fungal activity against of dermatophytes which include *Microsporium canis*, *Microsporium audouinii*, *Trichophyton rubrum*, *Trichophyton*

mentagraphytes, *Trichophyton violaccum* and *epidermophyton floccosum*^[26].

Some herbs as *Cymbopogon citrates*, (Graminaeae, Lemmon grass), *Lanata camara* (Verbenaceae), *Nerium oleander* (Apocyanaceae), *Ocimum basilicum* (Labiataeae), *Oleo europaea* (oleaceae) olive were also studied for anti-fungal activity against dermatophytes^[27].

Herbals as Antibacterial

Leaves of *Lablab purpureus* or hyacinth bean, Fabaceae was considered which contain sterols, fatty acids, palmitic, palmitoleic, linoleic, linolenic acids, pyridine alkaloid, and trigonelline. They reported anti bacterial activity against strains such as *Escherichia coli*, *Bacillus subtilis*, *Vibrio mimicus*, *Staphylococcus aureus* and *Bacillus subtilis*. The plant plays versatile role as anticholesterolemic, antidote to most forms of poison and also in treatment of cholera, vomiting, diarrhea, leucorrhoea, alcoholic intoxication and globefish poisoning. The flowers are as alexiteric and carminative whereas the stem is used in the treatment of cholera, the juice from the pods used to treat inflamed ears and throats. The fully mature seeds are also used in conditions as anthelmintic, antispasmodic, aphrodisiac, astringent, digestive, febrifuge, stomachic and in the treatment of sunstroke, nausea, vomiting and diarrhea^[28].

Jatropha curcas, Euphorbiaceae also known as Physic nut or Purging nut contains alkaloids, flavonoids, leucoanthocyanins, saponins, tannins and phenolics as phytochemicals. Its seeds have been used as a purgative, antihelminthic and abortifacient as well as for treating ascites, gout, paralysis and skin disease in several kinds of literature. Anti bacterial activity of isolated phytochemicals is also reported against *Staphylococcus aureus* and *Escherichia coli*.^[29]

Leaf of *Gliricidia sepium*, Leguminosae native to the south India, was used in Mexico as shade for cocoa and coffee plantations and hence called as 'Madrecacao' (mother of cocoa). It is also used as a poison for rodents as its Latin name *Gliricidia* means rodent poison. The vital application of bioactive component against various pathogenic bacteria causes a fatal effect on human bodies^[30].

Momordica charantia, Cucurbitaceae widely occur in tropical areas (East Africa and Asia), contributed vital role in management of bacterial infection caused by *Staphylococcus aureus* (in boils), Staphylococcal scalded skin syndrome (SSSS) and in staphylococcal endocarditis (infection of the heart valves) due to presence of momordicolide, monordicophenolide A, guanosine, adenosine, uracil, and cytosine in its leaves^[31].

Leaf and flower of *Lpomoea cairica*, Convolvulaceae also called as Midnight horror, *Oroxylum*, Kampong or Indian trumpet flower, contain alkaloids, tannins, phenolic compounds, proteins and amino acid, terpenoids and sterols and saponins. This plant used to treat various infections related to blood disease, sterility in women, urinary infection, constipation and gynecological disorder^[32].

Leaves and flowers of *Lippia nodiflora*, Verbenaceae, contains primary metabolites protein and carbohydrates and secondary metabolites alkaloids, flavonoids, saponins, steroids, terpenoids and glycosides and show activities against bacteria. Flower of the plant contains flavones glycosides nepetin and batatifolin. The application of leaves and tops as carminative, diuretic, demulcent, in gonorrhoea and for wound healing, treatment of hookworms and reported for antibacterial activity against *Bacillus subtilis*, *Bacillus cereus*, *Micrococcus luteus*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Klebsiella oxytoca* and *Escherichia coli*^[33].

Root part of *Phyllanthus fraternus* Euphorbiaceae, root of this plant contains phyllanthosterol, phyllanthocosteryl ester,

phyllanthostigmasterol and fraternusterol. Decoction of roots are reported to manage malaria whereas its powder are applied to treat oedema and ulcers, wounds, sores, scabies, ringworm and other skin problem associated with bacterial infections of *Escherichia coli*, *Bacillus megaterium*, *Bacillus cereus*, *Bacillus subtilis*, *Corynebacterium glutamicum*, *Staphylococcus aureus*, *Salmonella typhi*, *Pseudomonas aeruginosa* and *Proteus vulgaris*^[34].

Thevetia peruviana also known as *Cascabela peruviana*, Apocynaceae was studied the phytoconstituent mainly present are cardenolides thevetin A and thevetin B cerebroside, peruvosides, neriifolin, thevetoxin and ruvosides possess antimicrobial activity against *Escherichia coli*, *Salmonella typhi*, *Klebsiella pneumoniae* and *Shigella flexneri*^[35].

Annual herb *Rumex nepalensis*, Polygonaceae, widely distributed in the temperate Himalayas, Western Ghat Nilgiri and Nainital hill. This plant is used in the Ayurvedic and Unani system of medicine as anti-pyretic, anthelmintic, to treat scabies, diarrhoea and in microbial infection^[36].

Plumbago zeylanica, Plumbaginaceae, grows like a garden plant in eastern and southern India and Ceylon. Roots and leaves of this plant are studied for antibacterial activity against *Escherichia coli* and species of *Salmonella*. Its chief chemical constituent quinine, artemisinin, shikonin and camptothecin are responsible for antimicrobial activity^[37].

Carica papaya, Caricaceae, commonly called pawpaw is used for the treatment of gastroenteritis, urethritis, otitis media, typhoid fever and wound infections due to the presence of phytoconstituent terpenes (triterpenoid) and quinines. Leaves are rich in anthraquinone and alkaloids like carpaine, flavonols, vitamin C and E. papaw leaf may therapeutically serve as a suitable therapeutic agent for protection against gastric ulcer and oxidative stress. Papaya fruit is rich in vitamin A and C and noted that ripe fruit has been used against ringworm, *Staphylococcus aureus*, *Streptococcus pyogenes*, *Streptococcus pneumoniae*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Proteus mirabilis*, *Salmonella typhi* and *Shigella flexneri*^[38].

The stem bark of *Saraca indica*, Caesalpiniaceae contains an estrogenic compound called ergosterol, tannin, catechol, essential oil, organic calcium and iron compounds. *Saraca indica* is considered highly effective against gynaecological ailments, uterine fibroids, burns, diarrhea and also for several infections bacteria (*Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Bacillus cereus*, *Klebsiella pneumoniae*, *Proteus mirabilis*, *Salmonella typhimurium* and *Streptococcus pneumoniae*)^[39].

Moringa oleifera commonly referred as Moringa Moringaceae contains alkaloids, flavonoids, anthocyanins, proanthocyanidins and cinnamates phytochemicals. Antibacterial activity was reported against potentially pathogenic microorganisms as *Pseudomonas aeruginosa*, *Klebsiella* and *Proteus* species. The root and bark are useful in the treatment of heart complaints, eye disease, inflammation, dyspepsia and enlargement of the spleen^[40].

Leaf and flower of *Spathodea campanulata*, Bignoniaceae, contains alkaloids and glycosides, applied management of infections associated with cholera, diarrhea and dysentery. The studies also find its use to combat Typhoid, a bacterial disease. Anti-bacterial activity against Gram positive and Gram negative organisms like *Escherichia coli*, *Klebsiella pneumoniae*, *Proteus vulgaris*, *Salmonella typhimurium*, *Bacillus subtilis*, *Staphylococcus aureus*, *Vibrio cholera*^[41].

Psidium guajava, Myrtaceae, also used for the treatment of gastrointestinal ailment and child diarrhea due to its ursolic acid, quercetin, 2 alpha-hydroxyursolic acid and hyperin present in its leaves. Antidiarrhoeal effect of guava leaf extract against *Staphylococcus aureus*, and *Escherichia coli* bacteria was found^[42].

Long pepper fruit (*Piper longum*) commonly called as pippali or pipplamul (root) Piperaceae contains piperine, piperlongumine, sylvatin, sesamin, diaeudesmin piperlonguminine, pipermonaline and piperundecalidine. It is most often used to treat chronic bronchitis asthma, constipation, gonorrhoea, paralysis of the tongue diarrhoea cholera, chronic malaria, viral hepatitis respiratory infection, stomachache, bronchitis, a disease of a spleen cough. It is used traditionally for colds, other microbial infections, and the removal of mucous and toxins associated with microbial infections^[43].

Some herbs as *Caesalpinia pulcherrima*, *Delonix regia*, *Cryptococcus neoformans*, *Peltaphorum ferrugineum* etc. were also studied for antibacterial activity against *Escherichia coli*, *Klebsiella pneumonia*, *Proteus vulgaris*, *Salmonella typhimurium*, *Bacillus subtilis*, *Staphylococcus aureus* and *Vibrio cholera*^[44].

Conclusion

Various traditional herbs were studied out, and their uses are outlined describing the treatment of infection caused by a micro-organism. Globally, several pharmaceutical industries are associated for utilization of nature's gift i.e. herbals and their formulations as safer and effective dosage forms for better patient compliance to living beings. Maximum scientific publications produced by WHO and other health regulatory bodies worldwide reported certain key problems associated with the use of herbal remedies and herbal formulation, which are being a newer area of thought for researchers.

ACKNOWLEDGMENT

Authors want to express their gratitude to University Institute of Pharmacy, C.S.J.M.U, Kanpur for the scientific environment.

CONFLICTS OF INTEREST

No conflicts of interest.

SOURCE OF FUNDING

Nil.

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HOW TO CITE THIS ARTICLE

Kumari P, Misra SK, Sharma N. Herbals as Antimicrobials: A Review. J Ayu Herb Med 2016;2(1):31-35.