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Review Article

MEDICINAL PLANTS USED AS ANTIMICROBIAL AGENTS: A REVIEW

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ABSTRACT
Infectious diseases are caused by pathogenic microorganisms, such as bacteria, viruses, parasites or fungi. Diseases can spread, directly or indirectly, from one person to another. Infectious diseases are the second leading cause of death worldwide. About one-fourth of all the medicines we use, come from rainforest plants. However, scientific studies have been conducted only to a limited extent with few medicinal plants. The development of bacterial resistance to presently available antibiotics has necessitated the search of new antibacterial agents. In rural and backward area of India, several plants are commonly used as herbal medicine for the treatment of infectious diseases. Four such plants commonly used by the people of the area were screened for potential antibacterial activity.
Keywords: Antimicrobial activity, Medicinal Plants, Infectious diseases

INTRODUCTION

Infectious diseases are the world's leading cause of premature deaths, killing almost 50 000 people every day. Morbidity and mortality due to diarrheoa continues to be a major problem in many developing countries, especially amongst children. Infections due to a variety of bacterial etiologic agents, such as pathogenic *Escherichia coli, Vibrio cholerae*, *Areomonas spp., Shigella spp., Salmonella spp., Pseudomonas spp*., *Klebsiella spp*., *Campylobacter spp*., and *Staphylococcus aureus* are most common. In recent years, drug resistance to human pathogenic bacteria has been commonly reported from all over the world.[1,2,3] With the continuous use of antibiotics, microorganisms have become resistant. In addition to this problem, antibiotics are sometimes associated with adverse effects on host which include hypersensitivity, depletion of beneficial gut and mucosal microorganism, immunosuppression and allergic reactions.[4] This has created immense clinical problem in the treatment of infections diseases.[5] Therefore, there is a need to develop alternative antimicrobial drugs for the treatment of infectious diseases, one approach is to screen local medicinal plants for possible antimicrobial properties. Plant materials remain an important resource to combat serious diseases in the world. According to WHO (1993), 80% of the world's population is dependent on the traditional medicine and a major part of the traditional therapies involves the use of plant extracts or their active constituents. Yet a scientific study of plants to determine their antimicrobial active compounds is a comparatively new field. The traditional medicinal methods, especially the use of medicinal plants, still play a vital role to cover the basic health needs in the developing countries.

Plants with antimicrobial activity

***Abutilon indicum* (Malvaceae)**

Abutilon indicum (Indian Abutilon, Indian Mallow; is a small shrub in the Malvaceae family, native to tropic and subtropical regions and sometimes cultivated as an ornamental. This plant is often used as a medicinal plant and is considered invasive on certain tropical islands.[6] The common names of *Abutilon indicum* are Jhampi [Bangladesh, Petari, Khangi, Atibala [India], Abutilon Atibala [US], Dong kui zi, Mi lan cao [China], Guimauve [Guadaloupe]. It is extensively grown in Bangladesh., India, Pakistan, Srilanka.[7] The plant is considered as astringent, antibacterial, anthelmintic, carminative and diuretic. It is used locally for colds, high fever, mumps, tuberculosis, bronchitis, diabetes, arbuncle, hemorrhoids, hernia, diarrhea and various types of worm infections. In traditional medicine, *A. indicum* is used as a demulcent, aphrodisiac, laxative, diuretic, pulmonary and sedative (leaves). The bark is astringent and diuretic; laxative, expectorant and demulcent (seeds); laxative and tonic, anti-inflammatory and anthelmintic (plant); analgesic (fixed oil); diuretic and for leprosy (roots). (Nishanta) The whole plant is uprooted, dried and is powdered. In ancient days, maidens were made to consume a spoonful of this powder with a spoonful of honey, once in a day, for 6 months until the day of marriage, for safe and quick pregnancy. The leaves can also be used to treat ulcers, headaches, gonorrhea & bladder infection. The plant is very much used in Siddha medicines. In fact, the root, bark, flowers, leaves and seeds are all used for medicinal purposes by Tamils. The leaves are used as adjunct to medicines used for pile complaints. The flowers are used to increase semen in men. Previous phytochemical investigation of the plant revealed the presence of chemical constituents namely luteolin, chrysoeriol, apigenin 7-O-beta rhamnopyranosyl, quercetin, triacontanoic acid, ursenol, methylstigmasterol, glucopyronoside etc.(Matalawska As a part of our continuing study on chemical and biological characterization of different plants, attempt was made this time to investigate the antimicrobial activity of *A. indicum* against different Gram-positive, Gram-negative bacteria and fungi species. A methanol extract of *A. indicum* had some antimicrobial properties. A chemical compound, β-sitosterol, which has been identified as the active ingredient in many medicinal plants, is present in *A. indicum* and a petroleum ether extract provided larvicidal properties against the mosquito larvae *Culex quinquefasciatus*. The cytotoxic activity of the

plant materials was performed by using brine shrimp lethality bioassay.[8] It showed moderate inhibitory activity against *Bacillus cereus* (8.0 mm), *Bacillus megaterium* (8.2 mm), *Sarcina lutea* (10.4 mm), *Shigella boydii* (8.4 mm), *Escherichia coli* (9.2 mm), S*almonella paratyphi* (8.4 mm), S*higella dysenteriae* (10.7 mm), *Vibrio mimicus* (8.4 mm), and *Aspergillus niger* (8.7 mm). ***Achyranthes aspera*** **(Amaranthaceae)**

Achyranthes aspera (Common name: Prickly Chaff Flower, Devil's Horsewhip, Sanskrit: *Apamarga*) is a species of plant in the Amaranthaceae family. It is distributed throughout the tropical world. It can be found in many places growing as an introduced species and a common weed. It is an annual, stiff erect herb, and found commonly as a weed throughout India and is one of the important medicinal plants having many theaurapetic uses as Odontalgic, Rheumatism, Bronchitis, skin disease and rabies.[9] It is an invasive species in some areas, including many Pacific Islands environments. In Uttar Pradesh the plant is used for a great many medicinal purposes, especially in obstetrics and gynecology, including abortion, induction of labor, and cessation of postpartum bleeding. The Maasai people of Kenya use the plant medicinally to ease the symptoms of malaria.[10] Achyranthes aspera contains triterpenoid saponins which possess oleanolic acid as the aglycone. Ecdysterone, an insect moulting hormone, and long chain alcohols are also found in *Achyranthes aspera*.[11] Plant shows significant abortifacient activity in mice and rabbits. A n-butanol extract has been found to possess contraceptive efficiency in rats which might be assigned to its potent estrogenicity. The aqueous solution of the base achyranthine as well as the entire plant of *Achyranthes aspera* Linn showed antibacterial activity against *staphylococcus aureus*, *streptococcus heamolyticus* and *Bacillus typhosus*.[12] While the alcoholic and aqueous extract of leaves showed antibacterial activity against *Staphylococcus aureus* and *E.coli.* Leaf extracts were reported to posses thyroid stimulating and antiperoxidative properties. The aqueous and methyl alcohol extracts of the plant also decreased blood glucose levels in normal and alloxan diabetic rabbits.[13] It is reported to contain Alkaloids, flavonoids, saponins, steroids and terpenoids. Flavonoids have a number of nutritional functions and have been described as biological response modifiers; most act as a anti-oxidant and some have a anti-inflamatory properties. Flavonoids have been shown to prevent or slows the development of some cancers.[14] Saponins have long been known to have strong biological activity. Saponins can bind to cholesterol and thus interfere with cell growth and division. While drugs have side effects, many of them serious, saponins are safe. The water soluble alkaloid achyranthine isolated from *Achyranthes aspera* possess anti-inflammatory activity.[15]

Acorus calamus **(Araceae)**

Acorus calamus Linn. (family Araceae) commonly known as "sweet flag" or Waan-Nam, is a well known medicinal plant. The rhizomes were utilized extensively by the Chinese, Indians and American Indians as well as by other cultures, and many of these uses continue to this day[16] including in Thai traditionalmedicine. *Calamus* has been an item of trade in many cultures for thousands of years. It has been used medicinally for a wide variety of ailments, and its aroma makes calamus essential oil valued in the perfume industry. In Britain the plant was also cut for use as a sweet smelling floor covering for the packed earth floors of medieval dwellings and churches, and stacks of rushes have been used as the centrepiece of rushbearing ceremonies for many hundreds of years.[17] It has also been used as a thatching material for English cottages. In antiquity in the Orient and Egypt, the rhizome was thought to be a powerful aphrodisiac. In Europe *Acorus calamus* was often added to wine, and the root is also one of the possible ingredients of absinthe. Among the northern Native Americans, it is used both medicinally and as a stimulant. It is believed by some that calamus is a hallucinogen. This urban legend is based solely on two pages of a book written by Hoffer and Osmund entitled *The Hallucinogens*. The information on these two pages came from anecdotal reports from two individuals (a husband and wife) who reported that they had ingested calamus on a few occasions. None of the components in calamus are converted to TMA (trimethoxyamphetamine) in the human organism. To date there is no solid evidence of any hallucinogenic substances in calamus. *Acorus calamus* shows neuroprotective effect against stroke and chemically induced neurodegeneration in rat. Specifically, it has protective effect against acrylamide induced neurotoxicity.[18]

Alangium salvifolium **(Alangiaceae)**

Alangium salvifolium Wang belongs to family Alangiaceae. Locally it called as Ankolam. Alangiaceae is a monogeneric family of trees and shrubs found in tropical and subtropical region. There are nearly twenty one species of Alangium grouped into four sections adequate health services and thus heavily resources to Alangium, Conostigma, Marlea and Rhytidendra.[19] Other two different varieties of this drug namely Angolam and widely used against many infectious diseases, but only Karaangolam. They correspond to *Alangium salvifolium,* subspecies *salvifolium* and *hexapetalum* respectively. The plant is distributed in dry regions, plains and lower hills in India, Africa, Srilanka, Indochina and China. Root is used in diarrhea, paralysis, piles and vomiting.[20] They are acrid, astringent, emollient, anthelmintic, thermogenic, diuretic and purgative. Root is useful for external application in acute case of rheumatism, leprosy and inflammation and internal application in cases of bites of rabbit and dogs. Antibacterial compound was isolated from the flower of *Alangium salvifolium.* Recent phytochemical studies of this plant resulted in the isolation of several flavanoids, phenolic compound, irridoid glycosides and oxyoglucoside. Methanolic extract of root has been studied for its analgesic and anti-inflammatory activities in animal model.[21] The aerial part of the plant was analyzed and compounds were isolated from chloroform extract employing chromatographic technique. New alkaloid, ankorine was isolated from leaves. Plant is rich in tetrahydroisoquinoline monoterpene glycoside, for e.g., alangiside-1 or ipecoside-2 whose structures are closely related to the ipecac alkaloid. Two sterol alangol (m.p. 296°) and alengol (m. p. 302-307°) were isolated from seed kernels.[22]

Allium cepa **(Alliacae)**

The onion (*Allium cepa*), which is also known as the bulb onion, common onion and garden onion, is the most widely cultivated species of the genus *Allium*. The name "wild onion" is applied to a number of *Allium* species. The vast majority of cultivars of *A. cepa* belong to the 'common onion

group' (*A. cepa* var. *cepa*) and are usually referred to simply as 'onions'. Wide-ranging claims have been made for the effectiveness of onions against conditions ranging from the common cold to heart disease, diabetes, osteoporosis, and other diseases. They contain chemical compounds believed to have anti-inflammatory, anticholesterol, anticancer, andantioxidant properties, such as quercetin. Preliminary studies have shown increased consumption of onions reduces the risk of head and neck cancers.[23] (Onion and garlic use) Among all varieties, Asian white onions have the most eye irritating chemical reaction. Regular use of white onion, if eaten raw, is claimed to be good due to its antioxidant and anti-inflammatory properties. In India some sects do not eat onions as they believe them to be an aphrodisiac[24] various schools of Buddhism also advise against eating onions and other vegetables of the Allium family. In many parts of the undeveloped world, onions are used to heal blisters and boils. A traditional Maltese remedy for sea urchin wounds is to tie half a baked onion to the afflicted area overnight. A similar traditional cure is known in Bulgaria. Half-baked onion with sugar is placed over the finger and fingernail in case of inflammation. An application of raw onion is also said to be helpful in reducing swelling from bee stings. In the United States, products that contain onion extract are used in the treatment of topical scars; some studies have found their action to be ineffective, while others found that they may act as an anti-inflammatory or bacteriostatic and can improve collagen organization in rabbits.[25] Onions may be beneficial for women, who are at increased risk for osteoporosis as they go through menopause, by destroying osteoclasts so they do not break down bone. An American chemist has stated the pleiomeric chemicals in onions have the potential to alleviate or prevent sore throat. Onion in combination with jaggery has been widely used as a traditional household remedy for sore throat in India. For all varieties of onions, the more phenols and flavonoids they contain, the more reputed antioxidant and anticancer activity they provide when tested against liver and colon cancer cells in laboratory studies. It is rich in proteins, carbohydrates, sodium, potassium and phosphorus. Traditionally onion has been used to treat intestinal infections. It has been reported to be an antibacterial, antiviral, antiparasitic, antifungal and has antihypertensive, hypoglycemic, antithrombotic, antihyperlipidemic, anti inflammatory and antioxidant activity. Recently in a study by Sharma *et al* in India in 2009, antibacterial activity of certain plants was evaluated against *V. cholerae*. In this study MIC was determined using disc diffusion method and revealed that *Allium sativum* was best vibriocidal among the plants used and had MIC of its aqueous extract is found to be 5–15 mg/dl and with acetone extract it was found to be 2.5–5 mg/dl.[26] The MIC was determined by disc diffusion method.

***Allium sativum* (Liliaceae)**

Allium sativum, commonly known as garlic. In *in vitro* studies, garlic has been found to have antibacterial, antiviral, and antifungal activity. However, these actions are less clear *in vivo*. Garlic is also claimed to help prevent heart disease (including atherosclerosis, high cholesterol, and high blood pressure) and cancer. Garlic is used to prevent certain types of cancer, including stomach and colon cancers. In fact, countries where garlic is consumed in higher amounts, because of traditional cuisine, have been found to have a lower prevalence of cancer.[27] Animal studies, and some early research studies in humans, have suggested possible cardiovascular benefits of garlic. A Czech study found garlic supplementation reduced accumulation of cholesterol on the vascular walls of animals. Another study had similar results, with garlic supplementation significantly reducing aortic plaque deposits of cholesterol-fed rabbits.[28] Another study showed supplementation with garlic extract inhibited vascular calcification in human patients with high blood cholesterol. The known vasodilative effect of garlic is possibly caused by catabolism of garlic-derived polysulfidesto hydrogen sulfide in red blood cells (RBCs), a reaction that is dependent on reduced thiols in or on the RBC membrane. Hydrogen sulfide is an endogenous cardioprotective vascular cell-signaling molecule. A randomized clinical trial funded by the National Institutes of Health (NIH) in the United States and published in the *Archives of Internal Medicine* in 2007 found the consumption of garlic in any form did not reduce blood cholesterol levels in patients with moderately high baseline cholesterol levels.[29] According to Heart.org, "despite decades of research suggesting that garlic can improve cholesterol profiles, a new NIH-funded trial found absolutely no effects of raw garlic or garlic supplements on LDL, HDL, or triglycerides. The findings underscore the hazards of meta-analyses made up of small, flawed studies and the value of rigorously studying popular herbal remedies". In an editorial regarding the initial report's findings, two physicians from Weill Cornell Medical College of Cornell University, pointed out that there may "be effects of garlic on atherosclerosis specifically that were not picked up in the study". *Allium sativum* has been found to reduce platelet aggregation and hyperlipidemia[30] the BBC reported *Allium sativum* may have other beneficial properties, such as preventing and fighting the common cold. This assertion has the backing of long tradition in herbal medicine, which has used garlic for hoarseness and coughs. The Cherokee also used it as an expectorant for coughs and croup.[31] Garlic is also alleged to help regulate blood sugar levels. Regular and prolonged use of therapeutic amounts of aged garlic extracts lower blood homocysteine levels and has been shown to prevent some complications of diabetes mellitus. People taking insulin should not consume medicinal amounts of garlic without consulting a physician. In 1858, Louis Pasteur observed garlic's antibacterial activity, and it was used as an antiseptic to prevent gangrene during World War I and World War II. More recently, it has been found from a clinical trial that a mouthwash containing 2.5% fresh garlic shows good antimicrobial activity, although the majority of the participants reported an unpleasant taste and halitosis.[32] Garlic cloves are used as a remedy for infections (especially chest problems), digestive disorders, and fungal infections such as thrush. Garlic can be used as a disinfectant because of its bacteriostatic and bacteriocidal properties. Garlic has been found to enhance thiamin absorption, and therefore reduces the likelihood for developing the thiamin deficiency beriberi.[33] In 1924, it was found to be an effective way to prevent scurvy, because of its high vitamin C content. Garlic has been used reasonably successfully in AIDS patients to treat *Cryptosporidium* in an uncontrolled study in China. It has also been used by at least one AIDS

patient to treat toxoplasmosis, another protozoal disease. Garlic supplementation has been shown to boost testosterone levels in rats fed a high protein diet. A 2010 double-blind, parallel, randomised, placebo-controlled trial, involving 50 patients whose routine clinical records in general practice documented treated but uncontrolled hypertension, concluded, trial suggests that aged garlic extract is superior to placebo in lowering systolic blood pressure similarly to current first line medications in patients with treated but uncontrolled hypertension.[34]

***Bergenia ligulata* (Saxifragaceae)**

Bergenia ligulata Wall. (Syn. *Saxifraga ligulata*), family *Saxifragaceae,* is found in South and East Asia. In India, it grows at high altitudes in the Himalayas usually in rocky areas and in the Kashmir valley where it is popularly known as *Paashaanbhed*. The rhizomes of *Paashaanbhed* have been used for centuries in Indian System of Medicine[35] and the effects of the herb on kidney stone formation and on influenza virus have been validated. Chemical investigations have shown the presence of β-sitosterol, β -sitosterol-D-glucoside, bergenin and paashaanolactone.[36] Bergenin and β-sitosterol are well known for pharmacological actions. In this study, the antiinflammatory, and antimicrobial activity of the crude plant extracts prepared from the rhizomes of *B. ligulata* is described. The role of free radicals that are important in inflammatory processes such as in the activation of NF-κB which induces the transcription of inflammatory cytokines and cyclooxygenase, is also investigated in this study in terms of biochemical parameters.

***Bombax ceiba* (Bombacaceae)**

Bombax ceiba is commonly known as cotton tree or tree cotton. This tropical tree has a straight tall trunk and its leaves are deciduous in winter. *Bombax ceiba* is an important medicinal plant of tropical and subtropical India and has number of traditional uses. It also occurs in Sri Lanka, Pakistan, Bangladesh, Myanmar, Malaysia, Java, Sumatra and Northern Australia. It is commonly known as silk cotton tree and semal in Hindi. Its medicinal usage has been reported in the Indian traditional systems of medicine such as Ayurveda, Siddha and Unani. The various parts of this tree has been extensively used as analgesic, hepatoprotective, antiulcer, antiangiogenic, antioxidant, hypotensive and hypoglycemic activities and for the treatment of sexual debility, bleeding wounds and vaginal infections.[37] It showed excellent antibacterial and antifungal activities of aqueous extract of *B. ceiba* which may be due to the presence of tannins and phenolic compounds. This *in vitro* study demonstrated that folk medicine can be as effective as modern medicine to kill the pathogenic microorganisms. Further work is needed to isolate the secondary metabolites from the extracts studied in order to test specific antibacterial and antifungal activities.

***Carica papaya* (Caricaceae)**

Carica papaya belongs to the family Caricaceae. It has the following common names; pawpaw tree, papaya, papayer, tinti, pepol, chich put, fan kua, wan shou kuo, kavunagaci, kepaya etc. The parts that are usually used include the leaves, fruit, seed, latex, and root. The plant is also described in a documented property forms and it act as analgesic, amebicide, antibacterial, cardiotonic, cholagogue, digestive, emenagogue, febrifuge, hypotensive, laxative, pectoral, stomachic and vermifuge. *Carica papaya* contains many biochemically active compounds. Two important compounds are chymopapain and papain, which are supposed to aid in digestion. Papain is used in the treatment of arthritis. The leaves of *Carica papaya* is used as soap substitute which are supposed to remove stains. The papain, the proteolytic enzyme has a wealth of industrial uses. It has milk-clotting (rennet) and protein digesting properties. Active over a wide pH range, papain is used in medicine, combating dyspepsia and other digestive orders. In liquid preparations, it has been used for reducing enlarged tonsils. Nearly 80% of American beer is treated with papain, which digests the precipitable protein fragmented and then the beer remains clear on cooling. Papain is also used for degumming natural silk. But most of the papin imported in the U.S is used for meat-tenderizers and chewing gums. Also used to extract the oil from tuna liver cosmetically, it is used in some dentifrices, shampoos and face-lifting preparations. Use to cleat silks and wools before dying and to remove hair from hides during tanning.[38] It is also used in the manufacture of rubber from heaven. Recently, FDA has cleared chymopapain for intradiscal injection in patients with documented herniated lumbar intervertebral discs whose signs and symptoms have not responded to conservative therapy over an adequate period of time. The medicinal folk use the leaves poultice onto nervous pains and elephantoid growths. The leaf smoked for asthma relief in various remote areas. Javanese believe that eating papaya prevent rheumatism. Dietary papaya does reduce urine acidity in humans while the flowers have been used for jaundice. The young leaves and to lesser degree other parts contain carpain an active bitter alkaloid which has a depressing action on heart. The plant is strong amoebicide.[39]

***Carum carvi* (Apiaceae)**

Carum carvi also known as meridian fennel or Persian cumin is a biennial plant in the family Apiaceae, native to western Asia, Europe and Northern Africa. The fruits, usually used whole, have a pungent, anise-like flavor and aroma that comes from essential oils, mostly carvone and limonene. They are used as a spice in breads, especially rye bread. *C. carvi* essential oil is used in liqueurs, mouthwashes, toothpastes, soaps, and perfumes. *C. carvi* is used as antispasmodic, carminative and appetite stimulant agents.[40] *C. carvi* essential oils inhibited the growth of *Aspergillus parasiticus* and yeasts and Gram-positive and Gram-negative bacteria.[41] Our research reveals the bactericide activity of the above oils against plant pathogenic bacteria including those pathogenic on cultivated mushrooms. Essential oils or their components appear promising for possible use as bactericides for the control of plant bacterial diseases. Furthermore, of particular interest is the possibility of these compounds for seed treatments against phytopathogenic bacteria to partially prevent long distance dissemination. The significant antibacterial activity of essential oils against bacterial pathogens of mushrooms appears promising as a control protocol. Other studies are necessary to evaluate the possible toxicity of essential oils to seeds, plants, and mushrooms.

***Centella asiatica* (Umbeliferae)**

Centella asiatica (Linn.) urban belonging to family Umbeliferae popularly knows as "Brahmi ",is very useful medicinal plant described by Charaka as an antiaging plant. is native to India, Sri Lanka, northern Australia, Indonesia, Iran, Malaysia, Melanesia, Papua New Guinea, and other

parts of Asia. It is used as a medicinal herb in Ayurvedic medicine, traditional African medicine, and traditional Chinese medicine. In common with most traditional phytotherapeutic agents, *C. asiatica* is claimed to possess a wide range of pharmacological effects, being used for human wounds healing, mental disorders, atherosclerosis, fungicidal, antibacterial, antioxidant and anticancer purposes. *C. asiatica* has also been reported to be useful in the treatment of inflammations, diarrhea, asthma, tuberculosis and various skin lesions and ailments like leprosy, lupus, psoriasis and keloid. In addition, numerous clinical reports verify the ulcer-preventive and antidepressive sedative effects of *C. asiatica* preparations, as well as their ability to improve venous insufficiency and microangiopathy.[42] Previously triterpenoid acids, volatile and fatty oils, alkaloids, glycosides, flavonoids, and steroids have been isolated from the different parts of the plant.[43] It is mainly used to treat mental and neurological disturbances. *C. asiatica* is used to re-vitalize the brain and nervous system, increase attention span and concentration and combat aging.[44]

***Coriandrum sativum* (Apiaceae)**

Coriandrum sativum contains antioxidants, which can delay or prevent the spoilage of food seasoned with this spice. A study found both the leaves and seed to contain antioxidants, but the leaves were found to have a stronger effect. Chemicals derived from coriander leaves were found to have antibacterial activity against *Salmonella choleraesuis*, and this activity was found to be caused in part by these chemicals acting as nonionic surfactants. Coriander has been used as a folk medicine for the relief of anxiety and insomnia in Iran. Experiments in mice support its use as an anxiolytic.[45] Coriander seeds are used in traditional Indian medicine as a diuretic by boiling equal amounts of coriander seeds and cumin seeds, then cooling and consuming the resulting liquid. In holistic and traditional medicine, it is used as a carminative and as a digestive aid. Coriander has been documented as a traditional treatment for diabetes. A study on mice found that coriander extract had both insulin-releasing and insulin-like activity.[46] Coriander seeds were found in a study on rats to have a significant hypolipidemic effect, resulting in lowering of levels of total cholesterol and triglycerides, and increasing levels of high-density lipoprotein. This effect appeared to be caused by increasing synthesis of bile by the liver and increasing the breakdown of cholesterol into other compounds.[47] Coriander juice (mixed with turmeric powder or mint juice) is used as a treatment for acne, applied to the face in the manner of toner. Coriander leaves (Cilantro) contain aldehydes, which are also found in soaps and lotions, leading some to complain of a mild to highly irritating soapy flavor. There appears to be a genetic component to the detection of "soapy" versus "herby" tastes.

***Curcuma longa* (Zingaberaceae)**

Curcuma longa is a rhizomatous herbaceous perennial plant of the ginger family, Zingiberaceae. It is native to tropical South Asia. Turmeric is currently being investigated for possible benefits in Alzheimer's disease, cancer, arthritis, and other clinical disorders.[48] As an example of preliminary laboratory research, turmeric ameliorated the severity of pancreatitis-associated lung injury in mice. Some research shows compounds in turmeric to have anti-fungal and anti-bacterial properties, however, curcumin is not one of them. Turmeric consists of 3-5% curcuminoids. Curcumin is the most important fraction which is responsible for the biological activities of turmeric. According to these studies, curcumin exhibits anti-inflammatory, antioxidant, anticarcinogenic, antiviral, antimicrobial activity.[49] Beside these, curcumin has a variety of potentially therapeutic properties, such as antineoplastic, antiapoptotic, antiangiogenic, cytotoxic, immunomodulatory, antithrombotic, wound healing, antidiabetogenic, antistressor and antilithogenic actions.[50] Turmeric was extracted from different curry and "zerdaçal" (*C. longa*) powders that were bought from local market and the main components were isolated. Their biological and antioxidant activities have been studied. The moderate antibacterial and antifungal activity have been determined for the turmeric extracts and pure curcumin. Antimycobacterial activities have been evaluated against *M. smegmatis, M. simiae, M. kansasii, M. terrae and M. szulgai* by MIC method and the antioxidant activity have been evaluated via CUPRAC method. All of the isolated turmeric extracts and pure curcumin showed very weak activity against the studied mycobacteria but showed very good antioxidant activity.

***Emblica officinalis* (Phyllanthaceae)**

Emblica officinalis commonly known as amla is highly valued in traditional Indian medicine. In Unani medicine the dried fruits of amla are used to treat haemorrhage, diarrhoea anddysentery.[51] It has undergone preliminary research, demo nstrating *in vitro* antiviral and antimicrobial properties.[52] It may prove to have potential activity against some cancers.[53] One recent animal study found treatment with *E. officinalis* reduced severity of acute pancreatitis (induced by L-arginine in rats). It also promoted the spontaneous repair and regeneration process of the pancreas occurring after an acute attack. Experimental preparations of leaves, bark or fruit have shown potential efficacy against laboratory models of disease, such as for inflammation,cancer, age-related renal disease, and diabetes. A human pilot study demonstrated a reduction of blood cholesterol levels in both normal and hypercholesterolemic men with treatment.[54] Another recent study with alloxan-induced diabetic rats given an aqueous amla fruit extract has shown significant decrease of the blood glucose, as well as triglyceridemic levels and an improvement of the liver function caused by a normalization of the liver-specific enzyme alanine transaminase activity. Although these fruits are reputed to contain high amounts of ascorbic acid (vitamin C), 445 mg/100g,[55] the specific contents are disputed, and the overall antioxidant strength of amla may derive instead from its high density of tannins. The fruit also contains other polyphenols: flavonoids, kaempferol, ellagic acid and gallic acid.[56]

***Ficus Bengalensis* (Moraceae)**

Ficus benghalensis, the banyan, is a large and extensive growing tree of the Indian subcontinent. *Ficus bengalensis* Linn. syn. *Ficus banyana* Oken. (Family-Moraceae).The plant is a large evergreen tree distributed all over India from sub Himalayan region and in the deciduous forest of Deccan and south India. It is a grown in gardens and road sides for shades.[57] This tree is considered to be sacred in many places in India. Earlier, glucoside, 20-tetratriaconthene-2-one,6-heptatriacontene-10-one,pentatriacontan-5-one, beta-sitosterol-alpha-Dglucose, and meso-inositol have been

isolated from the bark of the *Ficus bengalensis*. The fruit extracts exhibited antitumor activity in the potato disc bioassay.[58] The leaves contain 9.63% crude protein, 26.84% crude fibres, 2.53% CaO, and 0.4% Phosphorous. It yields latex containing Caoytchoue (2.4%), Resin, Albumin, Cerin, sugar, and Malic acid It is used in ayurveda for the treatment of diarrhea, dysentery, and piles and as a hypoglycemic. The bark extracts of *Ficus bengalensis* exhibited the anti-inflammatory activity.[59] The extracts of *Ficus bengalensis* were also reported to inhibit insulinase activity from the liver and kidney14. It was also found to inhibit the lipid peroxidation. Various extracts of *Ficus bengalensis* were screened for its antiallergic and anti-stress potential in asthma by milk-induced leucocytosis and milkinduced eosinophilia.[60]

***Glycyrrhiza glabra* (Fabaceae)**

Licorice (*Glycyrrhiza glabra* L.; Family: Fabaceae) is a traditional medicinal herb grows in the various parts of the world. It is a very sweet, moist, soothing herb that detoxifies and protects the liver and is also a powerful anti-inflammatory finds applications in arthritis and mouth ulcers. The compound glycyrrhizic acid, found in liquorice, is now routinely used throughout Japan for the treatment and control of chronic viral hepatitis, and there is a possible transaminase-lowering effect.[61] Hepatoprotective mechanisms have been demonstrated in mice. Recent studies indicate that glycyrrhizic acid disrupts latent Kaposi sarcoma (as also demonstrated with other herpesvirus infections in the active stage), exhibiting a strong anti-viral effect.[62] The Chinese use licorice to treat Tuberculosis. Liquorice affects the body's endocrine system as it contains isoflavones (phytoestrogens). It might lower the amount of serum testosterone slightly but whether it affects the amount of free testosterone is unclear. Consuming liquorice may prevent the development of hyperkalemiain persons on hemodialysis.[63] Large doses of glycyrrhizinic acid and glycyrrhetinic acid in liquorice extract can lead to hypokalemia and serious increases in blood pressure, a syndrome known as apparent mineralocorticoid excess. These side effects stem from the inhibition of the enzyme 11β-hydroxysteroid dehydrogenase (type 2) and subsequent increase in activity of cortisol on the kidney. 11β-hydroxysteroid dehydrogenase normally inactivates cortisol in the kidney; thus, liquorice's inhibition of this enzyme makes the concentration of cortisol appear to increase. Cortisol acts at the same receptor as the hormone aldosterone in the kidney and the effects mimic aldosterone excess, although aldosterone remains low or normal during liquorice overdose. To decrease the chances of these serious side effects, deglycyrrhizinated liquorice preparations are available. The disabling of similar enzymes in the gut by glycyrrhizinic acid and glycyrrhetinic acid also causes increased mucus and decreased acid secretion. As it inhibits *Helicobacter pylori*, is used as an aid for healing stomach and duodenal ulcers, and in moderate amounts may soothe an upset stomach. Liquorice can be used to treat ileitis, leaky gut syndrome, irritable bowel syndromeand Crohn's disease as it is antispasmodic in the bowels.[64] Studies of the use of liquorice extract (usually at 7%) in the treatment of melasma have shown that glabridin inhibits tyrosinase activity ofmelanocytes.[65] The compounded carbenoxolone is derived from liquorice. Some studies indicate that it inhibits 11β-Hydroxysteroid dehydrogenase type 1, an enzyme that is highly expressed in liver and fat tissues, where it plays a role in metabolism, and in the brain, where the same enzyme is involved in stress response that has been associated with age-related mental decline.[66]

***Mangifera indica* (Anacardiaceae)**

Mangifera indica is a species of mango in the Anacardiaceae family. *Mangifera indica* (Anacardiaceae) grows in the tropical and subtropical region and its parts are commonly used in folk medicine for a wide variety of remedies[67, 68] Different pharmacological activities like antioxidant, radioprotective, antiallergic, antiviral, antidiabetic etc from different parts of *M. indica* are reported. Mangiferin (a pharmacologically active flavonoid, a natural xanthone C-glycoside) is extracted from Mango at high concentrations from the young leaves (172 g/kg), bark (107 g/kg), and from old leaves (94 g/kg).[69] It has a number of pharmacological actions and possible health benefits. These include antidiabetic, antioxidant, antifungal, antimicrobal, antiinflamatory, antiviral, hepatoprotective, hypoglycemic, anti-allergic and anticancer activity.[70] Along with *Salacia* it is being investigated for its possible anti-obesity action.[71] In ayurveda, one of its uses is clearing digestion and acidity due to pitta (heat), sometimes with other mild sours and shatavari (Asparagus racemosus) and guduchi (Tinospora cordifolia).

***Mimosa pudica* (Mimosaceae)**

Mimosa pudica (from Latin: *pudica* "shy, bashful or shrinking"; also called sensitive plant and the touch-me-not), is a creeping annual or perennial herb often grown for its curiosity value: the compound leaves fold inward and droop when touched or shaken, re-opening minutes later. The species is native to South America and Central America, but is now a pantropical weed. *Mimosa pudica* contains the toxic alkaloid mimosine, which has been found to also have antiproliferative and apoptotic effects. The extracts of *Mimosa pudica* immobilize the filariform larvae of *Strongyloides stercoralis* in less than one hour.[72] Leaves also contain mucilage and root contains tannins. *Mimosa pudica* is used for its anti-hyperglycemic, anti-diarrhoeal, anti-convulsant and cytotoxic properties. Aqueous extracts of the roots of the plant have shown significant neutralizing effects in the lethality of the venom of the monocled cobra (*Naja Kaouthia*). It appears to inhibit the myotoxicity and enzyme activity of cobra venom.[73] The plant also contains turgorins, leaves and roots are used in the treatment of piles and fistula. Paste of leaves is applied to hydrocele. Cotton impregnated with juice of leaves is used for dressing sinus. Plant is also used in the treatment of sore gum and is used as a blood purifier. In ayurvedic and unani system of medicine, this plant has been used in diseases arising from corrupted blood and bile, billious fever, piles, jaundice, leprosy, ulcers, small pox. The present studies were performed to assess the antibacterial activity and to prove its claim in folklore practice against various disorders.

***Morinda citrifolia* (Rubiaceae)**

Morinda citrifolia, commonly known as great morinda, Indian mulberry, nunaakai (Tamil Nadu, India) , dog dumpling (Barbados), mengkudu (Indonesia and Malaysia), Kumudu (Balinese), pace (Javanese), beach mulberry, cheese fruit or noni (from Hawaiian) is a tree in the coffee

family, Rubiaceae. *Morinda citrifolia*'s native range extends through Southeast Asia and Australasia, and the species is now cultivated throughout the tropics and widely naturalised.[74] *M. citrifolia* fruit powder contains carbohydrates and dietary fibre in moderate amounts.[75] These macronutrients evidently reside in the fruit pulp, as *M. citrifolia* juice has sparse nutrient content. The main micronutrients of *M. citrifolia* pulp powder include vitamin C, niacin (vitamin B3), iron and potassium. Vitamin A, calcium and sodium are present in moderate amounts. When *M. citrifolia* juice alone is analyzed and compared to pulp powder, only vitamin C is retained in an amount that is about half the content of a raw navel orange. Sodium levels in *M. citrifolia* juice (about 3% of Dietary Reference Intake, DRI are high compared to an orange, and potassium content is moderate. *M. citrifolia*juice is otherwise similar in micronutrient content to a raw orange. *M. citrifolia* fruit contains a number of phytochemicals, including lignans, oligo-and polysaccharides, flavonoids, iridoids, fatty acids, scopoletin, catechin, beta-sitosterol, damnacanthal, and alkaloids. Although these substances have been studied for bioactivity, current research is insufficient to conclude anything about their effects on human health.[76] These phytochemicals are not unique to *M. citrifolia*, as they exist in various plants. The green fruit, leaves, and root/rhizome were traditionally used in Polynesian cultures to treat menstrual cramps, bowel irregularities, diabetes, liver diseases, and urinary tract infections.[77] The plant *Morinda citrifolia* has been used in folk remedies by Polynesians, Indians for over 2000 years, and is reported to have a broad range of therapeutic effects, including antibacterial, antiviral, antifungal, antitumor, analgesic, hypotensive, anti-inflammatory, and immune enhancing effects.[78]

***Ricinus communis* (Euphorbiaceae)**

The castor oil plant, *Ricinus communis*, is a species of flowering plant in the spurge family, Euphorbiaceae. It belongs to a monotypicgenus, *Ricinus*, and subtribe, *Ricininae*. The evolution of castor and its relation to other species are currently being studied. Castor seed is the source of castor oil, which has a wide variety of uses. The seeds contain between 40% and 60% oil that is rich intriglycerides, mainly ricinolein. The seed contains ricin, a toxin, which is also present in lower concentrations throughout the plant. is a soft wooden small tree, wide spread throughout tropics and warm temperature regions of the world.[79] In the Indian system of medicine, the leaf, root and seed oil of this plant have been used for the treatment of the inflammation and liver disorders, hypoglycemic and laxative.[80] Alcoholic extract of the leaf was hepatoprotective in rats.[81, 82] Methanolic extracts of the leaves of *Ricinus communis* were used in antimicrobial testing against eight pathogenic bacteria in rats and showed antimicrobial properties. The extract was not toxic.[83] The pericarp of castor bean showed central nervous system effects in mice at low doses. At lower doses, the extract improved memory consolidation. At high doses mice quickly died.[84] A water extract of the root bark showed analgesic activity in rats. Antihistamine and anti-inflammatory properties were found in ethanolic extract of *Ricinus communis* root bark.[85] Extract of *Ricinus communis*, exhibited acaricidal and insecticidal activities against the adult of Haemaphysalis bispinosa Neumann (Acarina: Ixodidae) and hematophagous fly Hippobosca maculata Leach (Diptera: Hippoboscidae).[86]

***Sida cordifolia* (Malvaceae)**

Sida cordifolia (bala, country mallow, heart-leaf sida or flannel weed) is a perennial subshrub of the mallow family Malvaceae native to India. It has naturalized throughout the world, and is considered an invasive weed in Africa, Australia, the southern United States, Hawaiian Islands, New Guinea, and French Polynesia.[87] The specific name, *cordifolia*, refers to the heart-shaped leaf. *S. cordifolia* is used in Ayurvedic medicine,[88] known as "malva branca", is a plant used in the folk medicine for the treatment of inflammation of the oral mucosa, blenorrhea, asthmatic bronchitis and nasal congestion, stomatits, of asthma and nasal congestion and in many parts of Africa for various ailments, particularly for respiratory problems.[89] It has been investigated as an anti-inflammatory, for treating cancer and for encouraging liver re-growth. Due to itsephedrine content, it possesses psychostimulant properties, affecting the central nervous systemand also the heart.[90] A 50% ethanolic extract of *Sida cordifolia* tested on rats showed potent antioxidant and antiinflammatory activity, activity comparable with the standard drug deprenyl. The plant has demonstrated anti-pyretic and anti-ulcerogenic properties.[91] The aqueous extract of *Sida cordifolia* stimulates liver regeneration in rats.[92] No tannin or glycosides have been identified from the plant. The roots and stems contain the alkaloid ephedrine, normally observed in the different varieties of the gymnosperm genus *Ephedra*. Recent analyses have revealed that ephedrine and pseudoephedrine constitute the major alkaloids from the aerial parts of the plant, which also show traces of sitosterol and palmitic, stearic and hexacosanoic acids. The flavones: 5,7-dihydroxy-3-isoprenyl flavone and 5-hydroxy-3-isoprenyl flavone, β-sitosterol and stigmasterol have been isolated from the plant.[93] The analgesic alkaloid (5′-Hydroxymethyl-1′-(1,2,3,9-tetrahydro-pyrrolo [2,1-b] quinazolin-1-yl)-heptan-1-one) has also been found. Sterculic, malvalic and coronaric acids have been isolated from the seed oil, along with other fatty acids.

Terminalia bellirica

Terminalia bellirica (Gaertn.) Roxb. (Sanskrit : Vibhitaka, Aksha), is a large deciduous tree common on plains and lower hills in Southeast Asia, where it is also grown as an avenue tree. In traditional Indian Ayurvedic medicine, Beleric is known as "Bibhitaki" (Marathi: *Behada*) (*Terminalia belerica*) in its fruit form it is used in the popular Indian herbal rasayana treatment triphala. It is routinely used as traditional medicine by tribal folk of visakhapatnam district, to get remedies from several ailments such as fever, cough, diarrhea, skin diseases and oral thrush. Chemical substances of β-sitosterol, gallic acid, ethyle gallate, galloyl glucose, a new triterpene, the belleric acid and chebulagic acid have been isolated from fruits of *T. bellerica.* Fruit extract of *T. bellerica* produced fall in blood pressure of rats at a concentration of 70 mg/kg body weight.[94] But reports on antimicrobial activity of *T. bellerica* were scanty, particularly on these strains of microorganisms and their biochemical processes. The compound 3,4,5-trihydroxy benzoic acid (gallic acid) isolated from *Terminalia belerica*was evaluated for its hepatoprotective activity against carbon tetrachloride (CCl4)-induced physiological and biochemical alterations in the liver. The main parameters studied were hexobarbitone-

induced sleep, zoxazolamine induced paralysis, serum levels of transaminases and bilirubin. Hepatic markers assessed were lipid peroxidation, drug metabolising enzymes, glucose-6-phosphatase and triglycerides. The administration of the compound led to a significant reversal of majority of the altered parameters, indicating a hepatoprotective activity. Four lignans (termilignan, thannilignan, hydroxy-3',4'-(methylenedioxy) flavan, and anolignan B) possessed demonstrable antifungal activity *in vitro*. Four lignans (termilignan, thannilignan, hydroxy-3',4'-[methylenedioxy] flavan, and anolignan B) possessed an antimalarial activity *in vitro*.

***Tinospora cordifolia* (Menispermaceae)**

Tinospora cordifolia which is known by the common name Guduchi, is an herbaceous vine of the family Menispermaceae indigenous to the tropical areas of India, Myanmar and Sri Lanka. The plant is a glabrous climbing shrub found throughout India, typically growing in deciduous and dry forests. The leaves are heart shaped. The succulent bark is creamy white to grey in color, with deep clefts spotted with lenticels. It puts out long, slender aerial roots, and is often grown on mango or neem trees.[95] It is one of the most valuable Traditional Indian medicinal herbs and has been used in Ayurvedic preparations for the treatment of various ailments throughout the centuries. It is generally prescribed in general debility, diabetes, fever, jaundice, skin diseases, rheumatism, urinary diseases, dyspepsia, gout, gonorrhoea and leucorrhoea.[96] A decoction of the stems, leaves and roots is used to treat fever, cholera, diabetes, rheumatism and snake-bites, an infusion of the stem is drunk as a vermifuge, A decoction of the stem is used for washing sore eyes and syphilitic sores. The stem is registered in the Thailand Pharmacopoeia, and commonly use in hospital to treat diabetes.[97] The stem decoction is considered antipyretic, useful as an antimalarial and a wash for skin ulcers. Traditionally an infusion is used to treat fever due to malaria and also in cases of jaundice and for use against intestinal worms.[98] The leaves are given for the cure of gonorrhoea and is said to soothe the smarting and scalding. The methanolic stem extract of Tinospora cordifolia possesses antifertility activity, which might be exploited to prevent unwanted pregnancy and control the ever increasing population explosion.[99] Decoction of the root in combination with ginger and sugar is given in cases of bilious dyspepsia and in cases of fevers with other bitters and aromatics. Roots rubbed with bonduc nuts in water are given for stomachache, especially in children. They can also be used to treat stomachache and jaundice. The infusion is also useful in fevers caused by smallpox and cholera. Another popular use of this infusion is in a mixture for treating indigestion. The leaves are beaten with honey and applied to ulcers. Stem, root, whole plant is used in the treatment of wound, anthrax, pneumonia, asthma, and cough.[100] The root of this plant is known for its anti-stress, anti-leprotic and anti-malarial activities. The stem of Tinospora cordifolia is one of the constituents of several Ayurvedic preparations used in general debility, dyspepsia, fever and urinary diseases.[101]

***Wedelia trilobata* (Asteraceae)**

Wedelia trilobata (Asteraceae) is a creeping evergreen perennial that roots at the leaf nodes and spreads widely. *W. trilobata* has been historically used for amenorrhea,[102] they contain the diterpene (kaurenoic acid), eudesmanolide lactones and luteolin (in leaves and stems).[102, 103] Kaurenoic acid has antibacterial, larvicidal and tripanocidal activity; it is also a potent stimulator of uterine contractions.[103] Luteolin exerts antitumoural, mutagenic and antioxidant effects, has depressant and a stimulant action. Antimicrobial activity was done using *W. trilobata* in other country.[104] Chemical and pharmacological examination of antinociceptive constituents of *Wedelia* sp was done.[103] The literature survey indicates that no reports are available from India regarding antimicrobial, antioxidant and anti-inflammatory activity of *W. trilobata*. In present study was aimed to examine the total phenolic content and phytochemical analysis of ethanol extract of stem, leaves and flower of *W. trilobata* were screened for antimicrobial, antioxidant and anti-inflammatory properties using standard methods. The findings from this work may add to the overall value of the medicinal potential of the plant.

***Woodfordia fruticosa* (Lythraceae)**

The dried flowers of *Woodfordia fruticosa* Kurz have been also used as an astringent tonic in disorders of mucous membranes, haemorrhoids and in derangements of the liver.[105] The original Sanskrit name *Agnijwala* or *Tamra-pushpi*. appears to be derived from the bright red color of flower and the bark. In India, it is much- used medicinal plant in Ayurvedic and Unani systems of medicine.[106] The leaves of *Woodfordia fruticosa* are used as a folk medicine in India and Nepal. In case of fever, decoction of *Dawai* (a popular name of this plant in this region) leaves in combination with sugar and dried ginger is recommended.[107] The extracts of *Woodfordia fruticosa* Kurz. flowers showed the presence of carbohydrates, gums, flavonoids, sterols and compounds/tannins.[108]

SUMMARY AND CONCLUSION

Emergence of multi-drug resistance in human and animal pathogenic bacteria as well as undesirable side effects of certain antibiotics has triggered immense interest in the search for new antimicrobial drugs of plant origin. Because of the side effects and the resistance that pathogenic microorganisms build against antibiotics, many scientists have recently paid attention to extracts and biologically active compounds isolated from plant species used in herbal medicines.[109] Antimicrobial properties of medicinal plants are being increasingly reported from different parts of the world.[110, 111, 112] Antimicrobials therefore, may have a significant clinical value in treatment of resistant microbial strains.[113] In particular, the antimicrobial activity of plant oils and extracts have formed the basis of many applications including raw and processed food preservation, pharmaceuticals, alternative medicine, and natural therapies. It has been reported that the higher plants have shown to be a potential source for the new antimicrobial agents. It is concluded that medicinal plants can be used as antimicrobial agents in new drugs for therapy of infectious diseases in human.

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