

# Antimicrobial Activity of Natural Products from Medicinal Plants

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## Abstract

This paper attempts to study how various **medicinal plants** have been used for years in daily life to treat disease all over the world. Also they have been used as a source of **Antimicrobial** medicine. The number of multi-drug resistant microbial strains and the appearance of strains with reduced susceptibility to antibiotics are continuously increasing. This increase has been attributed to indiscriminate use of broad-spectrum antibiotics, immunosuppressive agent, intravenous catheters, organ transplantation and ongoing epidemics of HIV infection (Graybill, 1988; Ng, 1994; Dean and Burchard, 1996; Gonzalez et al, 1996). In addition, in developing countries, synthetic drugs are not only expensive and inadequate for the treatment of diseases but also often with adulterations and side effects. Therefore, there is need to search new infection-fighting strategies to control microbial infections (Sieradzki et al, 1999). Plants are prospective source of antimicrobial agents in different countries .

Plants are rich in a variety of phytochemicals including tannins, terpenoids, alkaloids, and flavonoids which have been found in vitro to have antimicrobial properties . Although the mechanism of action and efficacy of these herbal extracts in most cases is still needed to be validated scientifically, these preparations mediate important host responses . Global prevalence of infectious diseases caused by bacteria is a major public health problem . The bacterial agents including *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Bacillus subtilis*, and *Proteus vulgaris* cause several human infections . Recent emergence of antibiotic resistance and related toxicity issues limit the use of antimicrobial agents and is prompting a revival in research of the antimicrobial role of plants against resistant strains due to comparable safety and efficacy . Global burden of infectious diseases caused by bacterial agents is a serious threat to public health . Antibiotic treatment is a preferred choice to treat bacterial infections; however, emergence of antimicrobial resistance and toxicity issues subside the use of antibacterial agents . Safety- and efficacy-related limitations to antibiotics augment biological research on the antimicrobial role of plants due to comparable toxicity and efficacy . There is a continuous and urgent need to discover new antimicrobial compounds with diverse chemical structures and novel mechanisms of action because there has been an alarming increase in the incidence of new and re-emerging infectious diseases. In recent years, drug resistance to human pathogenic bacteria has been commonly reported from all over the world.

*Key words: Antibacterial; Antifungal; Medicinal Plants; Microbroth dilution assay, Antimicrobial*

## Introduction

Medicinal plants are part and parcel of human society to combat diseases, from the dawn of civilization 1 . They usually contain many biologically active ingredients and are used primarily for treating mild or chronic ailments. According to World Health Organization (WHO), about 80% of the world population relies chiefly on the plant based traditional medicine especially for their primary healthcare needs. Herbal medicines are in great demand in the developed as well as developing countries for primary healthcare because of their wide biological and medicinal activities, higher safety margins and lesser costs 2, 3.

Infectious diseases are a major cause of morbidity and mortality worldwide. The number of multi-drug resistant microbial strains and the appearance of strains with reduced susceptibility to antibiotics are continuously increasing. This increase has been attributed to indiscriminate use of broad-spectrum antibiotics, immunosuppressive agents, intravenous catheters, organ transplantation and ongoing epidemics of human immunodeficiency virus (HIV) infections 4, 5. This situation provided the impetus to the search for new antimicrobial substances from various sources like medicinal plants. Synthetic drugs are not only expensive and inadequate for the treatment of diseases but are also often with adulterations and side effects. Therefore, there is a need to search for new infection-fighting strategies to control microbial infections .

Plant medicines are used on a worldwide scale to prevent and treat infectious diseases<sup>7</sup> . Plants are rich in a wide variety of secondary metabolites such as tannins, alkaloids, terpenoids and flavonoids having been found in vitro since they have antimicrobial properties and may serve as an alternative, effective, cheap and safe antimicrobial for the treatment of microbial infections 8 . Plant based antimicrobial compounds have great therapeutic potential as they have lesser side effects as compared with synthetic drugs and also little chance of development of resistance. Therefore an attempt has been made to study the antibacterial activity of ten medicinally important plants viz. *Artocarpus heterophyllus*, *Berberis aristata*, *Chromolaena odorata*, *Embelia ribes*, *Jasminum angustifolia*, *Mahonia leschenaultii*, *Pluchea lanceolata*, *Plumbago indica*, *Terminalia chebula*, *Vitex negundo*. About 60 to 90% of populations in the developing countries use plant-derived medicine. Traditionally, crude plant extracts are used as herbal medicine for the treatment of human infectious diseases . In the present scenario of emergence of multiple drug resistance to human pathogenic organisms, this has necessitated a search for new antimicrobial substances from other sources including plants.

**Objective:**

This paper intends to explore and analyze many medicinal plants grown in India and around the world are reported to be used by the people for treating various health related problems. Screened for their antimicrobial/antibacterial properties against bacterial strains.

**Medicinal plants : Subculturing of bacterial strains**

The medical plants were in use since ages, Indian subcontinent uses plants for curing diseases, and the stream of science which deals with plants and its therapeutic effects were governed by Ayurveda. Ayurveda remains an important system of medicine and drug therapy in India. Today the pharmacologically active ingredients of many Ayurvedic medicines have been identified, and their usefulness in drug therapy is being determined. It is roughly estimated that of the discovered 17,000 species, nearly 3,000 species are used in the medicinal field. As believed that Ayurveda exists in India for thousands of years. It employs various techniques to cure diseases. Ayurveda is totally dependent on herbal plants and its derivatives. According to World Health Organization, medicinal plants are the best source to obtain newer herbal drugs. About 80% of individuals from developed countries use traditional medicine, which has compounds derived from medicinal plants. Therefore, such plants should be investigated for a better understanding of their properties, safety, and efficacy. The use of plant extracts and phytochemicals, both with known antimicrobial properties, can be of great significance in therapeutic treatments. In the last few years, a number of studies have been conducted in different countries to prove such efficiency.

Many plants have been used because of their antimicrobial traits. In the present review we have tried to include some of the antibacterial and antifungal effects of medicinal plants, the methanol leaf extracts of *Tinospora cordifolia*, *Ziziphus mauritiana*, *Sida cordifolia*, *Acacia nilotica*, *Withania somnifer* have showed potent antibacterial activity against *Bacillus subtilis*, *E. coli*, *Pseudomonas fluorescens*, *Staphalococcus aureus* and *Xanthomonas axonopodis* and antifungal activity against *Aspergillus flavus*, *Dreschlera turcica*, and *Fusarium verticillioides*. *Withania somnifer* is recognized as strong antibacterial, Methanol extract of *Withania somnifer* is effective against *Candida albicans*. Organic extracts of *Cassia fistula* and *Acacia aroma* shows potent antibacterial and antifungal activities against various gram-positive bacteria. *Azadirachta indica* popularly known as neem is effective against various infections and diseases, Neem shows antibacterial activity strongly against *Vibrio cholera* Essential oil and organic extracts of *Ziziphora clinopodioides* shows antibacterial activity against a huge class of bacteria including *Acidovorax facilis*, *Bacillus flexus*, *Bacillus sphaericus*, *Brevibacillus brevis*, *Corynebacterium*, ammonia genes, *Enterobacter sakazakii*, *Moraxella catarrhalis* and *Xanthomonas*. *Argemone mexicana* is reported to reduce bacterial infections of *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* when used as a crude extract with chloroform.

As reported *Nephelium lappaceum* methanolic extracts is effective against *Streptococcus epidermidis*. *Punica granatum* is used as an effective agent against various antibacterial, anti-inflammatory and anti-allergic reactions against *Streptococcus aureus* and *Streptococcus epidermidis*. In Asia, people use plant extract of *Ruta*

graveolens and Zingiber officinale, and it inhibits the growth of Bacillus cereus species . Oil extracted from Achillea millefolium's leaves and stem represent higher antimicrobial activity compared to its organic extracts. Essential oil from the plant inhibits the growth of Streptococcus pneumonia, Clostridium perfringes and Candida albicans and it inhibits Mycobacterium smegmatis, Acinetobacter lwoffii and Candida krusei . 70% methanol extract from leaves of Mikania glomerata ("guaco"), mguava, Baccharis trimera (carqueja), Mentha piperita (peppermint) and Cymbopogon citratus (lemongrass), and A. sativum (garlic), Syzygium aromaticum (clove) and Zingiber officinale (ginger) worked as an antimicrobial, all showed action against Staphylococcus aureus and satisfactory result in clove at the concentration of 0.36 mg/ml and guava at 0.56 mg/ml. According to a study the hydroalcoholic extracts from Vernonia polyanthes ("assa-peixe"), Aristolochia triangularis ("cipó mil-homens"), Tabebuia avellanedae (purple trumpet tree) and Stryphnodendron adstringens ("barbatimão") shows antimycobacterial activity . Vernonia Polyanthes extract shows potent inhibitory activity against Leishmania strains. In the same way, under same condition Baccharis dracunculifolia oil ("alecrim-do-campo") at a concentration of 10-µL inhibits the microbial growth of E coli, Staphylococcus aureus and P. aeruginosa . Alkaloid extract of Phyllanthus discoideus inhibits the growth of many pathogenic bacteria including E. coli, E. faecium, P. aeruginosa, S. aureus and M. smegmatis. Nutrient broth was used for subculturing of bacterial strains. The media was prepared according to manufacturer's instructions (Oxoid, UK). Bacterial cultures were inoculated on nutrient broth and incubated overnight at 37 °C.

Plant species	Family	Common name	Parts used	Therapeutic use
<i>Artocarpus heterophyllus</i> Lam.	Moraceae	Jack fruit tree	Roots, leaves, fruits, seeds	Antidiarrhoeal, boil, wound, skin diseases, dyspepsia, ulcer, convulsions, dyspepsia ophthalmitis, pharyngitis
<i>Berberis aristata</i> , DC.	Berberidaceae	Indian barberry	Root bark	Skin disease, menorrhagia, diarrhoea, jaundice
<i>Chromolaena odorata</i> L.	Asteraceae	Eupatorium	Leaf	Leaf juice used as antiseptic in cuts and wounds
<i>Embelia ribes</i> Burm.f.	Myrsinaceae	Embelia	Fruit, root, bark	Anthelmintic, diuretic, carminative, contraceptive dyspepsia, skin diseases, piles, leprosy, pruritis.
<i>Jasminum angustifolia</i> L.	Oleacea	Wild jasmine	Leaf, root	Poison, herpes, ophthalmology, leprosy, pruritis, wounds, ring worm.
<i>Mahonia leschenaultii</i> Wall.ex.wt & Arn.	Berberidaceae	Mahonia	Root	Diuretic, demulcent
<i>Pluchea lanceolata</i> , DC.	Asteraceae	Rasna	Stem, root	Thermogenic, carminative, rheumatic disorders, nervous diseases, anorexia, cough, asthma, bronchitis.
<i>Plumbago indica</i> L.	Plumbaginaceae	Fire plant	Root	Leprosy, oedema. Piles, worm infestation, anaemia, anorexia, fever, bronchial asthma, leucoderma, diabetes.
<i>Terminalia chebula</i> , Retz.	Combretaceae	Black myrobalan	Fruit	Promote digestive power, heals wounds and ulcers, skin & eye disease, diabetes, chronic & recurrent fever, anaemia, cardiac disorders, diarrhoea, spleen enlargement, piles.
<i>Vitex negundo</i> L.	Verbenaceae	Chaste tree	Leaf, root	Nervous & eye, ear diseases, cough, intestinal worms, rheumatoid arthritis, leprosy, wounds, oedema, bronchial asthma

## Collection of plant material and preparation of powder

Plant materials from three medicinal plants including *B. ciliata* (roots), *J. officinale* (leaves), and *S. album* (wood) were obtained from different locations of Hazara division. The ethnobotanical study of these plants was studied and confirmed by botany expert at Hazara University Herbarium, Mansehra. The collected plant materials were dried under shade and then mashed with the help of mortar and pestle.

## Extraction procedure and antibacterial activity of plant extracts

The powder of plants was processed for cold and hot water extraction. For cold water, 10 g dried powder of each plant was soaked in 100 ml distilled water and rotated on shaker at 150 rpm for 24 h. For hot water, 10 g of dried powder was soaked in 100 ml distilled water and then heated at 60 °C in incubator for 24 h. The extracts were sieved through a muslin cloth and then centrifuged at 4400 rpm for 7 min. The supernatant was collected and then filtered. Centrifugation and filtration process were repeated three times. Following plant extraction, antibacterial activity of these extracts against *B. subtilis*, *E. coli*, *P. vulgaris*, *P. Aeruginosa*, and *S. aureus* was determined by agar well diffusion method as described . Ceftriaxone (CRO) and erythromycin (E) were incorporated as positive control while cold and hot water without plant extract was incorporated as negative control.

Leaves of some medicinal plants including *Achyranthes aspera*, *Artemisia parviflora*, *Azadirachta indica*, *Calotropis gigantean*, *Lawsonia inermis*, *Mimosa pudica*, *Ixora coccinea*, *Parthenium hysterophorus* and *Chromolaena odorata* were examined for antimicrobial activity against various bacteria in different solvents, and they show their maximum inhibition against *E. coli*, *S. aureus*, *X. vesicatoria*. Chloroform extract of *Curcuma amada* was effective against *Bacillus cereus* and *Bacillus subtilis* bacteria , a novel product named amadan numen from *Curcuma amada* inhibits the bacterial growth. Crude methanolic extract of *Mallotus peltatus* is reported to be effective against the bacterial growth of *Staphylococcus*, *Streptococcus*, *Bacillus* species . *Embllica officinalis* and *Nymphae odorata* extract together is used to suppress the bacterial growth of *Staphylococcus aureus*. *Gallium Sativum* , commonly known as garlic is useful against various disease; it is rich in anti-oxidant. *Eucalyptus Globulus* is also known as eucalyptus is used to treat disorders of the urinary and respiratory tract, it shows a high level of antibacterial and antifungal properties. *Bidens pilosa* L extract is used as anthelmintic and protozoaide agent, used for its antiseptic properties . It is rich in flavonoid , The ethanol leaf extract of *Bixa orellana* L shows antimicrobial activity against gram-positive bacteria *Candida albicans* is also used against malaria and leishmaniasis , Its seed contain carotenoids . The ethanol leaf extract of *Cecropia peltata* L was effective as anti-bilious, cardiotoxic and diuretic agent and leafs are valuable as medicine against lenorrhoea and warts . Decoction of Leaf from *Cinchona officinalis* is found effective against amebiasis. Dried bark is used to treat diseases caused by a pathogenic strain of *P. falciparum*, and herpes . This extract is a rich source of quinoline alkaloid .

## Antimicrobial properties of certain medicinal plants

Medicinal plant *Gliricidia sepium* is rich in antioxidant, Its branches and leafs are effective against fever, employed against infections caused by *Microsporium canis*, *Trichophyton menta* agrophytes, and *Neisseria gonorrhoeae*. Aqueous extract of *Jacaranda mimosifolia* is effective against *Pseudomonas aeruginosa*; the flowers of the plant contain flavones and flavonoids. The leafs of the plants are known to have triterpenes, flavones, and steroids. *Justicia secunda* is used as a disinfectant to treat scorpion wounds while *Piper pulchrum* is found effective against snake bite. Flowers from medicinal plant *Spilanthes Americana* is effective against infections of mouth and variety of herpes; they possess spilantol. Carbazole alkaloid extracted from the stem bark of *clausena anisata* contains antibacterial and antifungal properties. Alcoholic and acetonic leaf extract of *Cassia alata* is reported with antibacterial activity against *Staphylococcus aureus*, coagulase positive *Staphylococcus aureus*, *Bacillus subtilis*, *Bacillus stearothermophilus*, *Escherichia coli*, *Salmonella typhi* and *Salmonella dysmetriae* while the alcoholic leaf extract of the same inhibits the growth of *Klebsiella pneumonia* and acetone extract inhibits the growth of *Vibrio cholerae*. Dry nuts of *semecarpus anacardium* is effective against various bacteria including 3- gram negative bacteria (*Escherichia coli*, *Salmonella typhi* and *proteus vulgaris* and gram positive strain (*Staphylococcus aureus* and *Corynebacterium diphtheriae*). Medicinal plant *amona glabra* shows potent antibacterial, antifungal modest insecticidal, sporicidal and cytotoxic activity. The hexane extract of the plant is used for the procedure. Antibacterial activity of plants like *Eugenia caryophyllus*, *Thymus vulgaris*, *Cinnamomum zeylanium* and *Cuminum cyminum*, hexane extract of these plants were examined on various gram negative and gram positive bacteria, and *Thymus vulgaris* shows best antibacterial activity among all.

S. No.	Plant species	Family	Local name (Gujarati)	Part of plant used
1	<i>Adansonia digitata</i> L.	Bombacaceae	Gorakh ambali	Leaves
2	<i>Aristolochia longa</i> L.	Aristolochiaceae	Kidamari	Leaves
3	<i>Bauhinia variegata</i> L.	Caesalpiniaceae	Kachnar	Stem bark
4	<i>Bauhinia variegata</i> L.	Caesalpiniaceae	Kachnar	Leaves
5	<i>Bryophyllum pinnatum</i> (Lam.) Oken	Crassulaceae	Paanfuti	Leaves
6	<i>Cassia tora</i> L.	Calsalpiniaceae	Kuvadiyo	Leaves, seed
7	<i>Centratherum anthelminticum</i> (L.) Kuntze	Asteraceae	Kali-jiri	Seed
8	<i>Euphorbia nivulia</i> Buch.-Ham.	Euphorbiaceae	Dandaliyo thor	Stem
9	<i>Ficus racemosa</i> L.	Moraceae	Umaro	Stem bark
10	<i>Moringa oleifera</i> Lam.	Moringaceae	Saragavo	Leaves
11	<i>Psoralea corylifolia</i> L.	Fabaceae	Bavchi	Seed
12	<i>Peltophorum pterocarpum</i> (DC.) K. Heyne	Caesalpiniaceae	Pilo-gulmohar	Leaves, Stem bark
13	<i>Pueraria tuberosa</i> (Willd.) DC.	Fabaceae	Fagiyo	Tuber
14	<i>Solanum xanthocarpum</i> Schrad. & H. Wendl.	Solanaceae	Bho-ringani	Aerial Part
15	<i>Syzygium cuminii</i> (L.) Skeels	Myrtaceae	Kala-jambu	Leaves
16	<i>Tecomella undulata</i> (Sm.) Seem.	Bignoniaceae	Ragat rohido	Stem bark

*Cuminum Cuminum* popularly known as cumin reported showing high antibacterial and antifungal properties. Extracts from the bark of Walnut are effective against *pseudomonas* and *candida* microorganisms; it is active against all microbial infections. *Thymus Vulgaris* used against the antibacterial activity because it is rich in phenol, *Achillea Millefolium* reported to show effectiveness in healing properties against antibacterial and antifungal infections, commonly it is used to cure wound, it is used as an extract in an organic solvent. *Pinus*

Silvestris commonly known as pine used widely for its antiseptic activities, because of the presence of turpentine it is widely used against urinary tract infections and can be used against fungal infections. Organic extract from *Peumus boldus*, *Agathosma betulina*, *Echinacea angustifolia*, *Humulus lupulus*, *Glycyrrhiza glabra*, *Mahonia aquifolium*, *Usnea barbata* and *Anemopsis californica* shown activity against various microbial and fungal infections. Rural communities, in particular paliyar tribes, depend on plant resources mainly for herbal medicines, food, forage, construction of dwellings, making household implements, sleeping mats, and for fire and shade. The use of medicinal plants as traditional medicines is well known in rural areas of many developing countries. Traditional healers claim that their medicine is cheaper and more effective than modern medicine. In developing countries, low-income people such as farmers, people of small isolate villages and native communities use folk medicine for the treatment of common infections.

## Conclusion

According to World Health Organization (WHO) more than 80% of the world's population relies on traditional medicine for their primary healthcare needs. Use of herbal medicines in Asia represents a long history of human interactions with the environment. Plants used for traditional medicine contain a wide range of substances that can be used to treat chronic as well as infectious diseases. A vast knowledge of how to use the plants against different illnesses may be expected to have accumulated in areas where the use of plants is still of great importance. The medicinal value of plants lies in some chemical substances that produce a definite physiological action on the human body. The most important of these bioactive compounds of plants are alkaloids, flavanoids, tannins and phenolic compounds. The antimicrobial activity of the some ethnomedicinal plants used in folkloric medicine. Compared to hexane extract, methanol extract showed significant activity against tested organisms. This study also showed that *Anemopsis californica* could be potential sources of new antimicrobial agents. The above-mentioned review clearly shows that medicinal plants are an important link between diseases and drugs; they play an active role in curing all disease and infections. Almost all plants have medicinal belongings; the main aim of the article was to consider few therapeutic plants of Indian origin.

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