A CRITICAL REVIEW ON NATURAL ANTIMICROBIAL AGENTS


*Associate Professor, Rao’s College of Pharmacy, Chamudugunta, Nellore, Andhra Pradesh, India.

1,2,3,4,5 Rao’s College of Pharmacy, Chamudugunta, Nellore, Andhra Pradesh, India.

ABSTRACT
Antimicrobial drugs either kill microbes or prevent the growth of microbes. Infectious diseases are caused by pathogenic microorganisms like bacteria, viruses, fungi, protozoa and multicellular parasites. The frequency of life-threatening infections caused by pathogenic microorganisms has increased worldwide and is becoming an important cause of morbidity and mortality. Due to a rapid increase in the rate of infections, antibiotic resistance in microorganisms and due to side effects of synthetic antibiotics, hence an alternative therapy is needed. Medicinal plants are gaining popularity over these drugs. These plants such as Asafoetida, Averrhoa Carambola, Bryophyllum Pinnatum, Bursera Penicillata, Buchanania Angustifolia, Calotropis Gigantea, Calotropis Gigantea, Colebrookea Oppositifolia, Corchorus Aestuans, Crossandra Infundibuliformis, Datura Stramonium, Nees Ficus Arnottiana Miq., Gymnema Sylvestre, Hemidesmus Indicus, Hibiscus Sabdariffa, Medicago Sativa, Merremia Dissecta, Merremia Aegyptia, Nelumbo Nucifera, Olea Europaea, Trichosanthes Cucumerina, Mangifera Indica Linn etc. These are found useful in the cure of a number of microbial diseases due to rich source of antimicrobial agents. Although medicinal plants produce slow recovery, the therapeutic use of medicinal plant is becoming popular because of their lesser side effects and low resistance in microorganisms.

KEYWORDS: Microbes, Bacteria, Mortality, Buchanania Angustifolia, Lesser side effects.
INTRODUCTION
Antimicrobial drugs either kill microbes (microbicidal) or prevent the growth of microbes (microbistatic). Disinfectants are antimicrobial substances used on non-living objects.[1] Infectious diseases are disorders caused by pathogenic microorganisms like bacteria, viruses, fungi, protozoa and multicellular parasites.

These diseases are also called as communicable or transmissible diseases since they can be transmitted from one person to another via a vector or replicating agent. Infectious diseases account for about half of the deaths in tropical countries. It is notable that majority of bacteria are non pathogenic and are not harmful to human health. Some bacteria are even helpful and necessary for the good health. Millions of bacteria normally live in the intestine, on the skin and the genitalia.

Bacterial diseases results when the harmful bacteria get into a body area, multiply their and thrash the body’s defensive mechanism.[2] The frequency of life-threatening infections caused by pathogenic microorganisms has increased worldwide and is becoming an important cause of morbidity and mortality in immune compromised patients in developing countries and many infectious microorganisms are resistant to synthetic drugs; hence an alternative therapy is very much needed.[3]

From ancient civilization various parts of different plants were used to eliminate pain, control suffering and counteract disease. Most of the drugs used in primitive medicine were obtained from plants and are the earliest and principal natural source of medicines.[4]

Recently, the global consumer started to demand high quality foods that are minimally processed and sustain more naturally occurring bioactive ingredients. Moreover, the consumer perception that the use of chemical antimicrobials could have further toxicological consequences has attracted the attention of national food agencies and the food industry.[5] However, with the development of antimicrobials, microorganisms have adapted and become resistant to previous antimicrobial agents. Medicinal plants are a rich source of antimicrobial agents.[6]

Due to a rapid increase in the rate of infections, antibiotic resistance in microorganisms and due to side effects of synthetic antibiotics, medicinal plants are gaining popularity over these drugs.[7] Although medicinal plants produce slow recovery, the therapeutic use of medicinal
plant is becoming popular because of their lesser side effects and low resistance in microorganisms.\[^8\] The other five categories are lacto, ovo, bacto, acid and phyto-antimicrobials which have been isolated from animals, plants or are microbial by-products and have been investigated thoroughly during the last 20 years. There are an estimated 250,000 to 500,000 species of plants known to man, of which more than 10% are used for medicinal purposes. The curative effects of plants have been extensively documented among different cultures throughout history. The beneficial medicinal effects of plant materials typically result from the combinations of secondary products present in the plant. These secondary metabolites such as alkaloids, steroids, tannins, and phenol compounds, deposited in specific parts or in all parts of the plant.\[^9\]

Herbal drugs constitute a major share of all the officially recognized systems of health in India viz. Ayurveda, Yoga, Unani, Siddha, Homeopathy and Naturopathy, except Allopathy. More than 70% of India’s 1.1 billion populations still use these non-allopathic systems of medicine. Currently, there is no separate category of herbal drugs or dietary supplements, as per the Indian Drugs Act.\[^10\]

However, there is a vast experiential-evidence base for many of the natural drugs. This offers immense opportunities for Observational Therapeutics and Reverse Pharmacology. Evidence-based herbals are widely used in the diverse systems and manufactured, as per the pharmacopoeial guidelines, by a well-organized industry. Despite of all the advances in modern and traditional medicine still plays a significant role in the lives of many people suffering with microbial diseases.\[^11\]

A number of medicinal plants such as Asafoetida, Averrhoa Carambola, Bryophyllum Pinnatum, Bursera Penicillata, Buchanania Angustifolia, Calotropis Gigantea, Calotropis Gigantea, Colebrookea Oppositifolia, Corchorus Aestuans, Crossandra Infundibuliformis, Datura Stramonium, Nees Ficus Arnottiana Miq., Gymnema Sylvestre, Hemidesmus Indicus, Hibiscus Sabdariffa, Medicago Sativa, Merremia Dissecta, Merremia Aegyptia, Nelumbo Nucifera, Olea Europaea, Trichosanthes Cucumerina, Mangifera Indica Linn etc. These are found useful in the cure of a number of microbial diseases due to rich source of antimicrobial agents. Although medicinal plants produce slow recovery, the therapeutic use of medicinal plant is becoming popular because of their lesser side effects and low resistance in microorganisms.
NATURAL ANTIMICROBIAL AGENTS

ASAFOETIDA\textsuperscript{[12]}

Botanical name: \textit{Ferula foeitida}

Family: Zingiberaceae

Part used- Rhizome or tap root

Extracted with- Chloroform, ethyl acetate, ethanol, methanol

Activity tested- Anti microbial activity

Method used- Diffusion method and evaluation was done by detecting zone of inhibition (in mm) and minimum inhibitory concentration (MIC).

Test organisms- Bacillus subtilis, Staphylococcus aureus, Klebsiella pneumonia, E. coli

Result reported- The results showed that ethyl acetate, ethanol, and methanol extract has significant antimicrobial activity and highest activity was reported with methanolic extract

AVERRHOA CARAMBOLA\textsuperscript{[13]}

Part used- Leaves

Extracted with- Ethanol

Activity tested- Anti microbial activity

Method used- Diffusion and Soxhlet extraction

Test organisms- S.Aureus, Klebsiella sp, E. coli and P.Aeruginosa, C.Albicans

Result reported- The results of the present study revealed the antimicrobial activity of the leaf ethanolic extract of A.Carrambola.

BRYOPHYLLUM PINNATUM\textsuperscript{[14]}

Part used- Roots.

Extracted with- Methanol and Ethanol.

Activity tested- Anti microbial activity.

Method used- Methanolic and Ethanolic extracts of this plant was examined using a standard antimicrobial disk diffusion method.

Test organisms- Gram negative (Escherichia coli, Vibrio cholerae, Salmonella typhi and Pseudomonas aeruginosa) & Gram positive (Bacillus cereus & Staphylococcus aureus) bacteria.

Result reported- In vitro regenerated roots showed higher inhibition zone against all bacterial species while natural growing plant root extract showed minimum inhibition.
BURSERA PENICILLATA\textsuperscript{[15]}

Part used- Leaf

Extracted with- Pet ether, Chloroform, Ethyl acetate

Activity tested- Anti microbial activity

Method used- Disc Diffusion method

Test organisms- Staphylococcus aureus, Escherichia coli, Proteus vulgaris, Klebsiella pneumoniae, Staphylococcus saprophyticus, Enterococcus faecalis and Enterobacter cloacae

Result reported- The results showed fruits and leaves from Bursera penicillata possessed inhibitory activity against the tested bacteria. Methanolic extracts of leaf showed almost comparable antibacterial activity, which support their traditional use against infectious diseases.

BUCHANANIA ANGUSTIFOLIA\textsuperscript{[16]}

Family: ANACARDIACEAE

Part used- Seed

Extracted with- Methanol

Activity tested- Anti microbial activity

Method used- Disc Diffusion method

Test organisms- Staphylococcus aureus, Escherichia coli, Proteus vulgaris, Klebsiella pneumoniae, Staphylococcus saprophyticus.

Result reported- The results showed seeds from Buchanania Angustifolia, possessed inhibitory activity against the tested bacteria. Methanolic extracts of seed showed almost comparable antibacterial activity, which support their traditional use against infectious diseases.

CALOTROPIS GIGANTEA\textsuperscript{[17]}

Part used- leaves

Extracted with- Acetone, Chloroform and Petroleum ether

Activity tested- Anti microbial activity

Method used- the Agar well diffusion method

Test organisms- human pathogenic organisms.

Result reported- The plant leaf extracts in different solvents were screened for the presence of various bioactive phytochemical compounds. The analysis revealed the presence of cardiac glycosides, saponins, flavonoids, steroids, and terpenoids in most prominent amount while
alkaloids and tannins is fewer amounts. Resins are absent in organic solvents.

**COLEBROOKEA OPPOSITIFOLIA**[^18]

**Part used**- leaves

**Extracted with**- ethyl acetate

**Activity tested**- Anti microbial activity

**Method used**- liquid-liquid extraction

**Test organisms**- Staphylococcus aureus and Bacillus and E. coli and Shigella and Salmonella and Proteus and Pseudomonas

**Result reported**- The flavonoid isolated from C. oppositifolia was found to inhibit majority of Gram positive and Gram negative bacteria screened, when tested at different concentrations.

**CORCHORUS AESTUANS**[^19]

**Part used**- leaf, capsule and root

**Extracted with**- petroleum ether, chloroform and methanolic extracts

**Activity tested**- Anti microbial activity

**Method used**- Cup-Plate Method / Well-Plate Method

**Test organisms**- fungi

**Result reported**- The chloroform and methanolic extracts of the leaf, capsule and roots of Corchorus aestuans were screened for antimicrobial activity against a wide spectrum of micro-organisms and the activity was compared with reference standards (Chloramphenicol for both Gram (+Ve) positive and Gram (-Ve) organisms and Nystatin for fungal strains).

**CROSSANDRA INFUNDIBULIFORMIS**[^20]

**Part used**- flower

**Extracted with**- chloroform, acetone, methanol and water by cold maceration.

**Activity tested**- Anti microbial activity

**Method used**- Diffusion

**Test organisms**- Staphylococcus aureus, Bacillus subtilis, Bacillus megaterium, Enterococcus faecalis, Streptococcus mutans, Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa and fungi like Aspergillus niger, Aspergillus flavus, Trichoderma viridae and C.albicans.

**Result reported**- The present study shows the evaluation of in vitro antimicrobial activity of Crossandra infundibuliformis against Gram-positive, Gram-negative and fungi, using agar
well diffusion method.

**DATURA STRAMONIUM**[21]

**Part used**- seeds

**Extracted with**- Nitric oxide and methanolic extract and Gallic acid.

**Activity tested**- Anti microbial activity

**Method used**- Soxhlet apparatus.

**Test organisms**- Bacillus subtilis, Escherichia coli, Pseudomonas aeruginosa and Staphyloceceus aureus.

**Result reported**- The phytochemical screening of methanolic extract of Datura stramonium seeds was performed by using various tests. The DPPH free radical scavenging activity of methanolic extract of seeds of *Datura stramonium* at various concentrations was determined and compared with that of the standard BHT and Gallic acid.

**FICUS ARNOTTIANA MIQ**[22]

**Part used**- leaves

**Extracted with**- hexane, chloroform, methanol, ethyl acetate

**Activity tested**- Anti microbial activity

**Method used**- soxhlet apparatus,

**Test organisms**- Gram-positive Staphylococcus aureus, Bacillus subtilis; two Gram-negative Escherichia coli, Pseudomonas aeruginosa

**Result reported**- Preliminary phytochemical screening: It was found that ethyl acetate, methanol and aqueous extracts of Ficus arnottiana leaves contained tannins, flavonoids, saponins, triterpenoids, steroids, glycosides, anthraquinones, reducing sugars, carbohydrates, proteins, and amino acids.

**GYMNEMA SYLVESTRE**[23]

**Part used**- leaves

**Extracted with**- ethanol

**Activity tested**- Anti microbial activity

**Method used**- pulverization

**Test organisms**- gram-positive Bacillus cereus, Bacillus subtilis, Streptococcus cremoris, Streptococcus fecalis, Staphylococcus aureus. gram-negative Klebsiella pneumoniae, Proteus vulgaris, Salmonella paratyphi, Shigella boydi, Shigella dysentriae

**Result reported**- the results of preliminary phytochemical screening of leaves extracts of G.
The phytochemical screening of G. sylvester leaf ethanol extract revealed the presence of alkaloids, Tannins, flavonoids, saponins, phenols, anthraquinones, quinones, carbohydrate and glycosides.

HEMIDESMUS INDICUS\textsuperscript{[24]}

**Part used**- roots

**Extracted with**- methanol, hexane, ethyl acetate, n-butanol and water

**Activity tested**- Anti microbial activity

**Method used**- diffusion method

**Test organisms**- Gram-positive Staphylococcus aureus, Bacillus subtilis; two Gram-negative E. coli, Pseudomonas aeruginosafungi- Aspergillus niger, Aspergillusfla

**Result reported**- The n-hexane and ethyl acetate extracts of the roots of the H. indicus were repeatedly fractionated using column chromatography over silica gel and led to the isolation of three known compounds. The known compounds were identified by comparisons of their physical and spectral data.

HIBISCUS SABDARIFFA\textsuperscript{[25]}

**Part used**- seeds

**Extracted with**- methanol

**Activity tested**- Anti microbial activity

**Method used**- diffusion method.

**Test organisms**- Gram-positive organisms: Staphylococcus aureus and Bacillus subtilis. Gram-negative organisms: Escherichia coli and Pseudomonas aeruginosaa

**Result reported**- All extracts of selected plant at concentrations of 50 µg and 100 µg per each cup exhibited considerable antibacterial activity against tested bacterial species (gram +ve and gram–ve). The bacillus subtilis showed potent activity when compared to staphylococcus aureus. And for Gram negative E. coli showed moderate activity when compared to Pseudomonas aeruginosaa. All extracts showed better anti-bacterial activity against gram +ve bacteria than gram -ve bacteria. The results of antibacterial activity are shown.

MEDICAGO SATIVA\textsuperscript{[26]}

**Part used**- alfalfa leaf and stem bark extract

**Extracted with**- soyasapogenols, hederagenin, medicagenic acid

**Activity tested**- Anti microbial activity.
Method used- diffusion method.

Test organisms- Bacillus subtilis, Pseudomonas aeruginosa, Staphylococcus aureas, E.coli

Result reported- The plates were incubated overnight at 370°C. Antimicrobial activity was determined by measuring the diameter of zone of inhibition around the colonies. For each bacterial strain, controls were maintained where pure solvents were used instead of the extract.

MERREMIA DISSECTA AND MERREMIA AEGYPTIA\cite{27}

Part used- in vivo (leaf, stem and seed) and in vitro (callus).

Extraction- Aqueous, Methanol, Ethanol, and Petroleum Ether.

Activity tested- Antimicrobial activity.

Method used- diffusion method.

Test organisms- bacterial viz. Bacillus thuringiensis, Bacillus subtilis, Eschrechia coli and Pseudomonas putida and two fungal strains viz. Candida albicans and Aspergillus niger was studied.

Result reported- The leaf, stem, seed and callus extracts of the Merremia aegyptia and Merremia dissecta have been tested for their antimicrobial and antifungal activities against E. coli, Pseudomonas putida, Bacillus thuringiensis, Bacillus subtilis, Candida albicans, Aspergillus niger. All the extracts showed sustained activity against all bacteria and fungi tested.

NELUMBO NUCIFERA\cite{28}

Part used- leaves

Extracted with- ethanol, methanol and water

Activity tested- Anti microbial activity.

Method used- diffusion method.

Test organisms- gram (-) bacteria such as E. coli, P. aeruginosa, K. pneumonia and gram (+) bacteria such as Staphylococcus aures.

Result reported- The antibacterial activity of the ethanolic extract of pink Nelumbo nucifera leaf extracts. Ethanolic extract at two different concentrations such as 1500 &1000μg were performed antibacterial activity against four bacterial strains by the streaking method.

OLEA EUROPAEA (OLIVE TREE)\cite{29}

Part used- leaves

Extracted with- Ether, Chloroform and Alcoholic extracts
Activity tested- Anti microbial activity.

Method used- diffusion method.

Test organisms- Pseudomonas aeruginosa.

Result reported- Antibacterial activities of old and young leaves of olive tree from Aljouf, Kingdom of Saudi Arabia against P.aeruginosa were analyzed. Antibacterial activities were determined by using a technique known as agar diffusion cavity method. Polar solvents i.e. Ether, chloroform and Alcoholic crude extracts of leaves mentioned above were poured in the 10mm wells and inhibition zone around the well were measured in millimeter.

TRICHOSANTHES CUCUMERINA-L[30]

Part used- stem, leaf, flower and seed

Extracted with- Aqueous, Methanol, Chloroform, Petroleum ether, Acetone.

Activity tested- Anti microbial activity.

Method used- diffusion method.

Test organisms- Bacillus cereus, Micrococcus luteus, Escherichia coli, Proteus vulgaris, Klebsiella pneumonia, Bacillus sphericus, Salmonella typhimurium, Pseudomonas aeruginosa and Staphylococcus aureus.

Result reported- The results obtained from the investigations showed that almost all the extracts exhibited considerable antibacterial activity against gram positive and negative bacteria. The obtained data on stem, leaf, flower and seed are presented.

MANGIFERA INDICA LINN[31]

Part used- leaves and root bark.

Extracted with- ethanol.

Activity tested- Anti microbial activity.

Method used- diffusion method.

Test organisms- Salmonella typhi, Escherichia coli and Pseudomonas aeroginosa.

Result reported- The result of antibacterial activity of S. longepedunculata which showed significant effect (P < 0.05) on the tested bacteria at all the concentrations of the aqueous and ethanol leaves extract. Root bark extracts showed no significance effect (P > 0.05) in the concentrations of the tested isolates.

CONCLUSION

Antimicrobial drugs either kill microbes or prevent the growth of microbes. These diseases are also called as communicable or transmissible diseases since they can be transmitted from
one person to another via a vector or replicating agent. Many infectious microorganisms are resistant to synthetic drugs; hence an alternative therapy is must be needed. Medicinal plants are a rich source of antimicrobial agents useful in the cure of a number of microbial diseases. Medicinal plants have a wide range of antimicrobial activity and support the traditional use of these plants as medicines. More number of new active principles obtained from plant sources can results in novel and effective pattern of treatment of microbial diseases. These plants provide leads to find therapeutically useful compounds, thus more efforts should be made towards isolation and characterization of the active principles and their structure activity relationship. The combination of traditional and modern knowledge can produce better drugs for the treatment of microbial diseases with lower side effects.

REFERENCES


