International Journal of
Life Sciences
International Peer Reviewed Open Access Refereed Journal

Int. J. of Life Sciences, 2024; 12 (1): 87-92
ISSN:2320-7817(p) | 2320-964X(o)

Review Article Open Access

Review of antimicrobial properties of medicinal plants

Rajbhoj BG[1] and Waghmare JM[2]

[1]Department of Botany, Sundarrao More College of Arts, Commerce & Science College, Poladpur-402 303 Dist Raigad, Maharashtra, India

[2]Department of Botany, Gokhale Education Society's Arts, Commerce & Science College, Shreewardhan-402 110, Dist. Raigad Maharashtra, India

Manuscript details:

Received: 21.10.2023
Accepted: 23.02.2024
Published: 31.03.2024

Cite this article as:
Rajbhoj BG and Waghmare JM (2024) Review of antimicrobial properties of medicinal plants, *Int. J. of Life Sciences*, 12 (1): 87-92.

Available online on http://www.ijlsci.in
ISSN: 2320-964X (Online)
ISSN: 2320-7817 (Print)

ABSTRACT

The pharmacological effects of medicinal herbs essentially result from the chemical products present in the plant although, it is usually not attributed to a one chemical compound but a combination of the chemical compounds. The medicinal actions of plant parts are unique to a particular plant species or group, consistent with the concept that the combination of chemical compounds in a particular plant is taxonomically distinct. The screening of plant parts usually involves several approaches; ethno-botanical approach is one of the common methods that are employed in choosing the plant for medicinal study. In the present review paper, antimicrobial properties of various medicinal plants were reviewed. The present review deals with the antibacterial activity of various medicinal plants.

Keywords: Antimicrobial Activity, Medicinal Plants.

INTRODUCTION

Medicinal plants are finding their way into pharmaceuticals, cosmetics along with nutraceuticals. In the pharmaceutical field, medicinal plants are mostly used for the wide range of constituents present in plants which have been used to treat chronic as well as infectious diseases. Long before mankind discovered the existence of microbes, the idea that certain plants had healing potential, indeed, that they contained what we would currently characterize as antimicrobial principles, was well accepted. Man has used plants to treat common infectious diseases and some of these traditional medicines are still included as part of the habitual treatment of various diseases (Ernest and Kuppan, 2013). Medicinal plants are rich sources of antimicrobial agents (Jindal and Vashist, 2012). According to the World Health Organization (WHO) medicinal plants would be the best source to obtain a variety of drugs and 80% of the world population is dependent on traditional medicine and a major part of traditional therapies involves the use of plant extracts or their active constituents. Yet a scientific study to determine their antimicrobial active compounds is a comparatively new field (Parmar and Rawat, 2012).

Infectious diseases, particularly skin and mucosal infections, are common. An important group of these skin pathogens are the fungi and bacteria (Bhakshu et al. 2004). Infectious dermatological conditions are of common occurrence including dermal inflammation, folliculitis, skin abuses, acne, dermatitis, rosacea etc. Multidrug resistant bacteria have become an important cause for higher skin care products. Multiple drug resistance has developed due to the indiscriminate use of commercial antimicrobial drugs commonly used in the treatment of infectious disease (Jaitalkar et al. 2012). Immuno-compromised individuals are frequently found suffering from skin infections that are difficult to cure. A novel compound with difference in mode of activity of antibiotics against microbes is an attractive alternative against multidrug resistant bacteria (Harsulkar et al. 2009). The drugs already in use to treat infectious disease are of concern also because drug safety remains an enormous global issue.

Most of the synthetic drugs cause side effects. To alleviate this problem, antimicrobial compounds from potential plants should be explored. These drugs from plants are less toxic; side effects are scanty and also cost effective. They are effective in the treatment of infectious diseases while simultaneously mitigating many of the side effects that are often associated with synthetic antimicrobials (Ernest and Kuppan, 2013). Topical drug administration is a localized drug delivery system anywhere in the body through ophthalmic, rectal, vaginal, and skin as topical routes. Skin is one of the most accessible organs of the human body for topical administration and the main route of topical drug delivery systems. Number of medicated products are applied to the skin or mucous membrane that either enhances or restores a fundamental function of a skin or pharmacologically alters an action in the underlined tissues. Such products are referred to as topical or dermatological products. At the skin surface, drug molecules come in contact with cellular debris, microorganisms, and other materials, which affect permeation. The applied medicinal substance has three pathways to the viable tissue- 1) through hair follicles, 2) via sweat ducts and 3) across continuous stratum corneum between the appendages (hair follicles, sebaceous glands, eccrine, apocrine glands and nails). This route of drug delivery has gained popularity because it avoids first-pass effect, gastrointestinal irritation and metabolic degradation associated with oral administration. The topical route of administration has been utilized either to produce local effects for treating skin disorder or to produce systemic drug effects (Basha et al. 2011).

Plant based antimicrobials represent a vast untapped source of medicines and further exploration of plant antimicrobials is the need of the hour. Antimicrobials of plant origin have enormous therapeutic potential. Plant- derived antimicrobials have a long history of providing the much-needed novel therapeutics. Although hundreds of plant species have been tested for antimicrobial properties, the majority of these have not been adequately evaluated. Considering the vast potentiality of plants as sources for antimicrobial drugs the present study is based on the review of such plants (Jindal and Vashist, 2013).

RESEARCH ON ANTIBACTERIAL ACTIVITY OF MEDICINAL PLANTS

Antimicrobials of plant origin have enormous therapeutic potential. They are effective in the treatment of infectious diseases while simultaneously mitigating many of the side effects that are often associated with synthetic antimicrobials. The beneficial medicinal effects of plant materials typically result from the combinations of secondary products present in the plant. In plants, these compounds are mostly secondary metabolites such as alkaloids, steroids, tannins and phenol compounds, flavonoids, steroids, resins and fatty acids gums which are capable of producing definite physiological action on the body. Compounds extracted from different parts of the plants can be used to cure diarrhea, dysentery, cough, cold, cholera, fever, bronchitis, etc.

Dagmar *et al.* (2003) tested the antimicrobial activity of crude ethanolic extracts of ten medicinal plants used in traditional medicine against five species of microorganisms: *Bacillus cereus*, *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Candida albicans* and found that most active antimicrobial plants were *Chelidonium majus*, *Sanguisorba officinalis* and *Tussilago farfara*.

Nair *et al*. (2005) screened nine plants such as *Sapindus emarginatus*, *Hibiscus rosa sinensis*, *Mirabilis jalapa*, *Rhoeo discolor*, *Nyctanthes arbor-tristis*, *Colocasia esculenta*, *Gracilaria corticata*, *Dictyota* sp. and *Pulicaria wightiana* for antibacterial activity against 6 bacterial strains viz *Pseudomonas testosteroni*, *Staphylococcus epidermidis*, *Klebsiella* *pneumoniae*, *Bacillus subtilis*, *Proteus morganii* and *Micrococcus flavus*. And found that *Pseudomonas testosteroni* and *Klebsiella pneumonia* were the most resistant bacterial strains.

Ramasamy and Charles (2004)found the antibacterial activity of valuable compounds from various solvent extracts of *Anosomeles indica*, *Blumea lacera* and *Melia azadirachta* against *Escherichia coli*, *Pseudomonas aeruginosa*, *Serratia maraceseuns* and *Staphylococcus aureus* by tube diffusion method. Acetone and methanol extracts of all plants showed strong antibacterial effect, whereas petroleum ether and aqueous did not exhibit any effect.

Kabir *et al*. (2005) stated that both water and ethanol extracts of *Terminalia avicennioides*, *Phyllanthus discoideus*, *Ocimum gratissimum* and *Acalypha wilkesiana* were effective on MRSA. The MIC and MBC of the ethanol extract of these plants range from 18.2 to 24.0mcg/ml were recorded for ethanol and water extracts of *Bridella ferriginea* and *Ageratum conyzoides*.

Poonkothai *et al*. (2005) pointed out that petroleum ether, benzene ethyl acetate and acetone extract of *Galinisoga ciliate* leaves displays higher activity against Gram positive bacteria (*Staphylococcus aureus* and *Bacillus subtilis*) rather than Gram the negative bacteria (*Pseudomonas aeruginosa* and *Escherichia coli*).

Deshpande *et al*. (2005) isolated that petroleum ether, acetone and methanol extracts of *Abrus precatorius, Boswellia serrata, Careya arborea, Emblica officinalis, Syzygium cumini*, Woodf*ordia fruticosa* and *Sphaeranthus indicus* shows appreciable antibacterial activity against Gram positive bacteria (*Staphylococcus aureus* and *Bacillus cereus*) and Gram-negative bacteria (*Escherichia coli*, *Proteus vulgaris* and *Pseudomonas aeruginosa*).

Tambekatr and Kharate *et al.* (2005) *Ocimum sanctum* showed inhibitory effect on *Escherichia coli*, *Staphylococcus aureus*, *Proteus mirabilis*, *Salmonella typhi*, *Enterococcus faecalis*, *Pseudomonas aeruginosa* and *Yersinia enterocolitica*. The leaves extract of various plants such as Tulsi, Pudina and Beetle showed antimicrobial activity of *Escherichia coli*, *Staphylococcus aureus*, *Enterococcus faecalis*, *Salmonella typhi*, *Vibrio cholerae*, *Proteus mirablis*, *Pseudomonas aeruginosa*, *Yersinia enterocolitica* while piper betel showed resistance to *Streptococcus pneumoniae*.

Panthi and Chaudhary *et al.* (2006) tested eighteen plant species used in folklore medicine for their antibacterial activity by the disk diffusion method. The bacteria employed were Gram positive (*Staphylococcus aureus*) and Gram negative (*Escherichia coli, Pseudomonas aeruginosa* and *Shigella boydii*). Extracts of eight plants showed encouraging results against three strains of bacteria, while others showed activity against one or two strains.

Balakrishnan *et al*. (2006) performed antibacterial activity of *Mimosa pudica*, *Aegle marmelos* and *Sida cordifolia* against *Bacillus subtilis*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Escherichia coli* and *Salmonella* typhi. The maximum inhibitory zone of inhibition *Sida cordifolia* was against *Bacillus subtilis* (35 mm) and *Salmonella typhi* (26 mm). *Minosa pudica* and *Aegle marmelos* were found to be active against all the microorganisms tested and the maximum activity was noted against *Pseudomonas aeruginosa* and *Salmonella typhi*.

Chauhan *et al*. (2006) screened Sea buckthorn (*Hippophae rhamnoides*) seeds aqueous extract for antioxidant and antibacterial activities. The antioxidant activities (Reducing power, DPPH and liposome model system) showed a good antioxidant activity. The extract was also found to possess antibacterial activity with a MIC value with respect to *Listeria monocytogenes* and *Yersinia enterocolitica* found to be 750 ppm and 1000 ppm respectively. The antioxidant and antimicrobial effects of the extract implicate its potential for natural preservation.

Bupesh *et al*. (2007) evaluated the antibacterial activity in the leaf extracts of *Mentha piperita* against pathogenic bacteria like *Bacillus subtilis, Pseudomonas aureus, Pseudomonas aeruginosa, Serratia marcescens* and *Streptococcus aureus*. The aqueous as well as organic extracts of the leaves were found to possess strong antibacterial activity against a range of pathogenic bacteria as revealed by *in vitro* agar well diffusion method. The ethyl acetate leaf extract of *Mentha piperita* showed pronounced inhibition than chloroform, petroleum ether and water, leaf extracts being more on *Bacillus subtilis, Pseudomonas* *aeruginosa* than *Streptococcus aureus, Pseudomonas aureus* and *Serratia marcescens.*

Mohammad Ahanjan *et al*. (2007) tested ethanol, methanol, chloroform, petroleum ether and aqueous extracts of leaves of *Parrotia persica* for antibacterial activity. The zone of inhibition varied from 13 mm to 22 mm. The highest inhibition was obtained with methanol and ethanol. Chloroform and petroleum ether extracts did not show any activity. The MIC value of the methanol extract for the test bacteria ranged between 3.12 mg/ml and 6.25 mg/ml and that of ethanol extract ranged between 6.25 mg/ml and 12.5 mg/ml. The results scientifically validate the use of this plant in traditional medicine.

Saha *et al*. (2007) tested the antibacterial activity of different solvent extracts of the air-dried bark of *Parkia javanica*, against five antibiotic resistant bacteria *viz*, *Bacillus subtilis*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Micrococcus luteus* and *Escherichia coli* by cup-plate diffusion method. MIC values of each active extract were determined. The results showed dose dependent positive activity against all the bacteria except *Escherichia coli*.

Bin Shah *et al*. (2007) investigated the *in vitro* antibacterial activities of a total of 46 extracts from dietary spices and medicinal herbs agar-well diffusion method against five food borne bacteria (*Bacillus cereus*, *Listeria monocytogenes*, *Staphylococcus aureus*, *Escherichia coli* and *Salmonella anatum*). Many herb and spice extracts contained high levels of phenolics and exhibited antibacterial activity against food borne pathogens. Gram-positive bacteria were generally more sensitive to the tested extracts than Gram negative ones. *Staphylococcus aureus* was the most sensitive, while *Escherichia coli* was the most resistant.

Cock *et al.* (2008) reported the antimicrobial activity of *Ocimum sanctum* leaves against bacteria and yeast. The diameter of inhibition zone recorded in *Escherichia coli* was 18 mm for 22 µl of oil. These differences may be attributed due to presence of antibacterial component in high concentration in local variety enhancing the medicinal importance of indigenous essential oil.

Roopashree *et al*. (2008) studied the antibacterial activity with respect to their traditional use as anti-psoriatic agents. The herbs were subjected to successive extraction using different solvents and the extracts were subjected to antibacterial evaluation against both Gram positive and Gram-negative organisms by Cup plate technique. Among the various extracts, aqueous extracts were found to be more effective against all the bacteria. *Staphylococcus aureus* was more susceptible to the aqueous extracts among the tested organisms.

Koshy Philip *et al*. (2009) screened 32 extracts from eight selected medicinal plants, namely *Pereskia bleo*, *Pereskia grandifolia*, *Curcuma aeruginosa*, *Curcuma zedoria*, *Curcuma mangga*, *Curcuma inodora*, *Zingiber officinale* and *Zingiber officinale* for their antimicrobial activity against both Gram-positive bacteria and Gram-negative bacteria using agar disc diffusion assay. The efficacy of the extracts was compared to the commercially prepared antibiotic diffusion discs. No inhibition was observed with the water fractions. None of the plants tested showed inhibition against *Escherichia coli*. *Curcuma mangga* showed some remarkable inhibition against the bacteria.

Warda *et al*. (2009) tested four plants (*Marrubium vulgare, Thymus pallidus*, *Eryngiumilicifolium* and *Lavandulastoechas*) against *Streptococcus pneumonia* responsible for pharyngitis, rhinitis, otitis and sinusitis infections. Aqueous and methanol extracts have been prepared and tested on *Streptococcus pneumoniae* collected in four regions. A significant activity has been observed with methanol extracts of three plants; *Marrubiumvulgare, Thymus pallidus*and*Lavandula stoechas*.

Ajayi and Akintola *et al*. (2010) screened the leaf extracts from medicinal plants *in vitro* in the laboratory for their antibacterial activity against two prominent enteric bacteria, *Escherichia coli* and *Salmonella typhimurium* using the agar disc diffusion method. The tyndalized leave extract of *C. zambesicus* showing antibacterial inhibition zone of 4 and 2 mm against *Salmonella typhimurium* and *Escherichia coli* exhibited highest activity than the autoclaved samples and other plant sources tested independently or combined, showing that the combinations of the extract samples do not exhibit synergistic effects.

Murugan and Saranraj *et al*. (2011) tested the herbal plant *Acalypha indica* for its antibacterial activity against Nosocomial infection causing bacteria. The

Acalypha indica was shade dried and the antimicrobial principles were extracted with Methanol, Acetone, Chloroform, Petroleum Ether and Hexane. The antibacterial activity of *Acalypha indica* was determined by the Agar Well Diffusion Method. It was found that 50mg/ml of methanolic extract of the plant was able to inhibit the growth of nosocomial infection causing bacteria when compared to other solvent extracts. From this it was concluded that the solvent methanol was able to leach out antimicrobial principles more effectively from the plant than the other solvents. The phytochemicals present in the *Acalypha indica* were tested and it conferred that the possible antibacterial principle resided in tannins and alkaloids.

Saranraj and Sivasakthivelan *et al*. (2012) tested the antibacterial activity of *Phyllanthus amarus* was tested against Urinary tract infection causing bacterial isolates *viz*., *Staphylococcus aureus*, *Serratia marcescens*, *Escherichia coli*, *Enterobacter* sp., *Streptococcus faecalis*, *Klebsiella pneumoniae*, *Proteus mirabilis* and *Pseudomonas aeruginosa*. The *Phyllanthus amarus* wasshade dried and the antimicrobial principles were extracted with methanol, acetone, chloroform, petroleum ether and hexane. The antibacterial activity of *Phyllanthus amarus* was determined by the Agar Well Diffusion Method. It was found that methanol extract of *Phyllanthus amarus* showed more inhibitory activity against UTI causing bacterial pathogens when compared to other solvent extracts.

CONCLUSION

In conclusion, various studies on antimicrobial activity of herbal plant extracts showed that the various solvent extracts showed promising antimicrobial activity against bacterial and fungal human pathogens. The results of various herbal researchers also indicated that scientific studies carried out on medicinal plants having traditional claims of effectiveness might warrant fruitful results. These plants could serve as useful source of new antimicrobial agents

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Conflict of interest: The authors declare that they have no conflict of interest.

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Correspondence and requests for materials should be addressed to Rajbhoj BG.

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