World Journal of Pharmaceutical research

Volume 1. Issue 4. 964-974. Review Article ISSN 2277 – 7105

A REVIEW ON ANTIBACTERIAL ACTIVITY OF SOME MEDICINAL PLANTS OF WESTERN GHAT

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Article Received on
29 June 2012,

Revised on 15 July 2012,
Accepted on 29 July 2012

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ABSTRACT

Numerous naturally occurring antimicrobials are present in animal and plant tissues where they probably evolved as part of the defense mechanisms of the host against microbial invasion. There are many plants that demonstrate antimicrobial activity and these plants have found application in the food industry as antibacterial and antifungal agents. Plants with possible antimicrobial activity should be tested against an appropriate microbial model to confirm the activity and to ascertain the parameters associated with it. Bacterial infections are one of the prominent causes of health problems, physical disabilities and mortalities around the world. This article describes the antibacterial properties of *Boerhaavia diffusa* Linn, *Aerva lanata, Aegle marmelos, Butea monosperma, Tinospora cordifolia, Hemidesmus indicus, Adhatoda vasica, Alstonia schlolaris, Mimosa pudica, Tabernaemantana coronariae* and *Asperagus racemosus* medicinal plants.

Key words: Antifungal, Bacteria, Infections, Medicinal plants.

INTRODUCTION

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 [1]. Clinical microbiologists have two reasons to be interested in the topic of antimicrobial plant extracts. First, it is very likely that these phytochemicals will find their way into the arsenal of antimicrobial drugs prescribed by physicians; several are already being tested in humans. The people are aware of over prescription and unsure of traditional antibiotics. There are several reports on antimicrobial activity of different herbal extracts [2, 3, 4, and 5]. Plants are known to produce some chemicals that are naturally toxic to bacteria [6]**.** Plant based natural constituents can be derived from any part of the plant [7]. Hence making antibacterial drug therapy effective, safe and affordable has been the focus of interest during recent years [8]. Phytomedicines represent a vast untapped source of drugs. They are effective in treating infectious diseases simultaneously mitigating many of the side effects that are often associated with synthetic antimicrobials [9]. Over last 20 years a large number of plant species have been evaluated for their antimicrobial activity [10].

Pathogenic bacteria can invade in the body through various routes like inhalation into nose and lungs, ingestion in food or through sexual contact. Once bacteria enter the body, the immune system of the body recognizes the bacteria as foreign intruder and tries to kill or stop them from multiplying. However, even a healthy immune system is not always able to stop the bacteria from reproducing and spreading. As a result bacteria thrive in the body and emit toxins which damage cells and tissues that consequently results in the symptoms of bacterial disease [1]. Commonly occurring pathogenic bacteria are *Neisseria meningitidis*, which can cause meningitis, *Streptococcus pneumoniae*, which can cause pneumonia, *Helicobacter pylori*, which can cause gastric ulcers, *Escherichia coli* which can cause food poisoning, *Salmonella typhi*, which can cause typhoid, and *Staphylococcus aureus*, which can cause skin and other infections [11].

Some medicinal plants useful in treating bacterial diseases:

Medicinal plants have been found useful in the cure of a number of diseases including bacterial diseases. Medicinal plants are a rich source of antimicrobial agents [12]. 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 [13]. Plants have an almost limitless ability to synthesize aromatic substances, most of which are phenols or their oxygen substituted derivatives. Most are secondary metabolites, of which at least 12,000 have been isolated. The antimicrobial phytochemicals can be divided into several categories as phenolics, polyphenols, quinones, flavones, flavonoids, flavonols, tannins, terpenoids, coumarines, essential oils, alkaloids, lectin and polypeptides. Antimicrobial activities of many plants have been reported by the researchers. Recent studies with significant findings in this area involving *Boerhaavia diffusa* Linn, *Aerva lanata*, *Aegle marmelos, Butea monosperma*, *Tinospora cordifolia, Hemidesmus indicus, Adhatoda vasica, Alstonea schlolaris*, *Mimosa pudica*, *Tabernaemantana coronariae* and *Asperagus racemosus* are discussed here.

Boerhaavia diffusa **Linn:** Antibacterial and antifungal activities of the aerial parts and root of *B. diffusa* were examined. The petroleum ether and methanol extracts of aerial parts and root of *B. diffusa* whole plant exhibited significant wide spectrum of antibacterial activity against both Gram's positive and Gram's negative bacteria and methanol crude extract of aerial part of plant exhibited strong antibacterial activity compared to petroleum ether extract. The zone of inhibition is varying between 13.99 ± 0.22mm to 19.46 ± 0.26mm. The most susceptible bacteria were E coli (7.76 ± 0.43mm). Methanol extract of root showed maximum activity against *S. aureus* (17.49 ± 0.42mm), *P. aeruginosa* (15.61 ± 0.42 mm) and *K. pneumoniae* (15.22 ± 0.40mm). All the three extracts of root showed less activity against *E. coli*. Abo and Ashidi (1999) reported antimicrobial potential of *B. diffusa, Bridelia micrantha, Alchornea cordifolia* and sourced from traditional healers through an ethnobotanical survey of anti-infective plants in Egbado South in Ogun State, Nigeria [14]. Extracts of aerial parts did not show any noticeable antifungal activity. Ethyl acetate extract of root part of the plant was found to be most effective of against target fungal species [15].

Aerva lanata: Chowdhury *et al*., (2002) [16] reported interesting antimicrobial activities (ethyl acetate and methanol extracts) and significant cytotoxic properties (petroleum ether, ethyl acetate and methanol extracts) of a whole plant *A. lanata*. On the basis of the reports, Abo and Ashidi, (1999) [14] and Chowdhury *et al.*, (2002) [16], in the present study pet ether, chloroform and methanol crude extracts of aerial parts, root and isolated phytconstiuents of *A. lanata* were tested against both Gram positive and Gram negative bacteria by agar well method. The result revealed that, the zone of inhibition of Petroleum ether extract (16.83 ± 0.12mm), chloroform (13.99 ± 0.22mm), methanol extract (19.46 ± 0.26mm), the zone of inhibition is varying between 13.99 ± 0.22mm to 19.46 ± 0.26mm. These data indicated that methanol crude extract of aerial part of plant exhibited strong antibacterial activity compared to petroleum ether extract and methanol extract was quite active against *Pseudomonas* *aeruginosa, Staphylococcus aureus, Bacillus subtilis* and *Agrobacterium tumifacience* and chloroform extract was active against *Pseudomonas aeruginosa* and *Klebsiella pneumoniae* [17].

Aegle marmelos: *Aegle marmelos belongs* to the family Rutaceae. Its common name is Bilwa. The essential oil obtained from the leaves has shown a broad spectrum of anti-bacterial and anti-fungal activities [18, 19, and 20]. Considering the folkloric use of this species to treat infectious diseases stimulated the investigation of the antibacterial activity of the different polar solvent extracts from *A. marmelos* leaves against standard Gram-positive and Gram-negative human pathogenic bacteria including multi resistant strains. Among the different solvent extracts of *A. marmelos*, the petroleum ether extracts of leaf, stem and root showed maximum zone of inhibition when compared to the reference standard drug Amoxycillin. The result showed that the antibiotic efficacy of petroleum ether of leaf was significant and nearer to the standard antibiotic streptomycin tested [21]. The leaf extract showed maximum zone of inhibition against *Staphylococcus aureus* (16.38 ± 0.01), followed by *Proteus vulgaris* (14.50 ± 0.52), *Pseudomonas aeruginosa* (14.16 ± 0.85), *Bacillus subtilis* (14.15 ± 0.03), *Salmonella typhi* (13.58 ± 0.58), *E. coli* (13.48 ± 0.06) where as the root extract showed maximum zone of inhibition against *Klebsiella pneumoniae* (13.62 ± 0.9).

Butea monosperma: *Butea monosperma* (Lam) Taub belongs to the family Fabaceae. In English it is commonly called as “Flame of the Forest”. Among the different solvent extracts of leaf, stem and root of *B. monosperma*, the ethanol extracts of stem and root showed maximum zone of inhibition when compared to the reference standard. The stem extract showed maximum zone of inhibition against Staphylococcus *aureus* (15.09 ± 0.07), followed by *Salmonella typhi* (14.03 ± 0.44), *Pseudomonas aeruginosa* (13.85 ± 0.02), *Klebsiella pneumoniae* (13.47 ± 0.02), *Bacillus subtilis* (12.94 ± 0.03), *E coli* (12.28 ± 0.04) where as the root extract showed maximum zone of inhibition against *Proteus vulgaris* (13.83 ± 0.01).

Tinospora cordifolia: *Tinospora cordifolia* belongs to the family Menispermaceae, used in several indigenous drug preparations for general health and other disease conditions. Thatte *et al.*, (1987) [22] have observed protective effects of an Indian medicinal plant *T. cordifolia* as compared to gentamicin in *E coli* induced peritonitis. Their results suggested that *T. cordifolia* exhibited no *in vitro* antibacterial effect at any strength. Similarly, the serum from treated animals also showed no antimicrobial effects but in our data ethanol extract of root of *T. cordifolia* exhibited significant zone of inhibition against *Bacillus subtilis, Escherichia* *coli, Bacillus cereus, Pseudomonas aeruginosa* and *Staphylococcus aureus*. Extract of plants has also exhibited in vitro inactivating property against Hepatitis B and E surface antigen [23]. This extract showed maximum zone of inhibition than reference standard drug Amoxycillin and Cloxacillin.

Hemidesmus indicus: *Hemidesmus indicus* root is commonly known under the name of Indian Sarsaparilla; and also in India as Nunnari root. Syrup of *Hemidesmus* is used for flavoring medicinal mixtures. Aqueous extract of root used as Bacteriostatic against *Mycobacterium leprae*. Among the different solvent extracts, ethanol extract of leaf, and root of *H. indicus* showed maximum zone of inhibition against *Escherichia coli* (11.60 ± 0.005; 14.67 ± 0.33), and stem extract showed (12.93 ± 0,005) against *Bacillus subtilis* and root extract against *Pseudomonas aeruginosa* (14.02 ± 0.005). *Hemidesmus indicus* root extract recorded highly significant zone of inhibition on *E. coli* (75mm), *B. subtilis* (56mm), and *P. aeruginosa* (54mm) respectively [24]. It is also clear that, *H. indicus* possesses bioactive compounds which inhibit the growth of *E. coli*, *B. subtilis*, *P. aeruginosa* microorganisms under laboratory conditions compared to reference antibiotics. The results were compared with standard drug Amoxycillin and Cloxacillin. The earlier investigator Ahmad *et al*., (2005) [25] have worked on antibacterial activity of *H. indicus*, *Terminalia belerica*, *Termalia chebula* and *Syzygium aromaticum* and reported, significant broad spectrum for antibacterial and antifungal activity against *Escherichia coli*, *Bacillus subtilis*, *Staphylococcus aureus* and *Streptococcus pneumoniae*. The similar results were observed in our study where, significant broad spectrum of antibacterial activity was exhibited not only in ethanol extract of root but also in leaf of *H. indicus* for bacteria viz., *Escherichia coli*, *Bacillus subtilis*, *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Bacillus cereus*.

***Adhatoda vasica*:** The plant extract of Adhatoda vasica showed higher activity for different clinical pathogens in the order of *Klebsiella pneumoniae>Staphylococcus aureus* > *Proteus valgaris* > *Pseudomonas aeroginosa* > *Streptococcus Pyogens* [26]. Water, ethanolic and petroleum ether extracts of *Adhatoda* leaves were tested by Karthikeyan *et al.* (2009) [27] for their antibacterial activity against *S. epidermidis, S. aureus B. subtilis, E. faecalis, E. coli, P aeroginosa, P. vulgaris, K. pneumoniae and C. albicans.* The methanolic extracts of *Adhatoda vasica* showed maximum zone of inhibition (17.33 ± 0.67 mm) on *Agrobacterium tumifacience* followed by (15.67± 1.20 mm) *Bacillus subtilis*, (15.33 ± 0.33 mm) *Klebseilla pneumonia*, (13.67± 1.20 mm) *Stapylococcus aureus* and (12.33± 0.33 mm) *Escherichia coli*.

And the hexane extracts showed maximum zone of inhibition (16.33± 0.33 mm) on *Agrobacterium tumifacience* followed by (14.33 ± 0.67 mm) *Klebseilla pneumonia*, (14.00 ± 0.58 mm), *Stapylococcus aureus*, (13.33± 1.53 mm) *Escherichia coli* and (11.67 ± 0.33 mm) *Bacillus subtilis* exhibited which is almost equal to the reference standard drug Redclox (Amphicillin and Cloxacellin) and gentamycin.

***Alstonia schlolaris*:** The ethyl acetate extracts of *Alstonia scholaris* showed maximum zone of inhibition (15.33 ± 1.33 mm) on *Bacillus subtilis* followed by (13.00± 0.58 mm) *Stapylococcus aureus*, (12.67 ± 0.88 mm) *Escherichia coli*, (12.33 ± 0.33 mm) *Klebseilla pneumonia* and (12.00 ± 0.58 mm) *Agrobacterium tumifacience*. The hexane extract showed maximum zone of inhibition (14.33 ± 0.33) on *Klebseilla pneumonia* followed by (14.00 ± 0.58 mm) *Bacillus subtilis*, (13.00 ± 0.00 mm) *Escherichia coli*, (12.67 ± 0.67 mm) *Agrobacterium tumifacience*, and (12.00 ± 0.58 mm) *Stapylococcus aureus*. Methanolic extracts of leaf stem and root bark extracts have been reported as potent antimicrobial agents [28]. According to Khyade MS *et al.*, 2009 [29] the methanol leaves extract exhibited broad-spectrum antibacterial activity against tested organisms. Maximum activity was exhibited against *Bacillus subtilis* followed by *Escherichia coli* and *Staphylococcus aureus*. Chloroform and acetone leaf extracts exhibited lesser activity, while petroleum ether extract showed no inhibition and the bark extract of dichloromethane-ether-methanol (1:1:1) has shown maximum antimicrobial and spermicidal activity [30].

***Mimosa pudica*:** Several research works have been carried out to study about the phytochemical components of *Mimosa pudica* [31, 32 and 33] and also about the antimicrobial activity of the plant [34, 35].The diethyl ether extracts of *Mimosa pudica* showed maximum zone of inhibition (19.00 ± 1.00 mm) on *Bacillus subtilis* followed by (14.00 ± 0.00 mm) on *Klebseilla pneumonia* and the minimum zone of inhibition was observed (11.67± 1.45 mm) on *Stapylococcus aureus*. According to Tamilarasi T *et al.,* 2012 [36] the maximum zone of inhibition was obtained for *B.subtilis* and *A. flavus* at a concentration of 100 µl. The minimum zone of inhibition was observed in all tested organisms at a concentration of 25µl and the phytochemical analysis of the extract revealed that the antimicrobial activity of the plant materials is due to the presence of active constituents like alkaloids or tannins and in another report the maximum zone of inhibition was obtained for *E. coli* and *S. aureus* at a concentration of 35 mg/ml. While *P. aeruginosa* exhibited good sensitivity against both the concentrations [37].

Tabernaemantana coronariae: The methanolic extracts of *Tabernaemontana coronariae* showed maximum zone of inhibition (18.00 ± 2.08 mm) on *Bacillus subtilis* followed by (16.67 ± 1.67 mm) *Agrobacterium tumifacience*, (16.33 ± 0.67 mm) *Klebseilla pneumonia*, (15.33 ± 1.86 mm) *Stapylococcus aureus* and (12.33 ± 0.88 mm) *Escherichia coli*. The diethyl ether extracts of *Asparagus racemosus* showed maximum zone of inhibition (17.00 ± 1.53 mm) on *Agrobacterium tumifacience* followed by (15.67 ± 1.20 mm) *Bacillus subtilis*, (14.67 ± 0.88 mm) *Klebseilla pneumonia* (13.67 ± 0.67 mm) *Stapylococcus aureus* and (13.33 ± 1.45 mm) *Escherichia coli*.

Asperagus racemosus: Methanol extract of the roots & rhizome of *A. racemosus* at different concentrations (50, 100, 150 µg/mL) showed significant antibacterial activity against *Escherichia coli, Shigella dysenteriae, Shigella sonnei, Shigella flexneri, Vibrio cholerae, Salmonella typhi, Salmonella typhimurium, Pseudomonas putida, Bacillus subtilis and Staphylococcus aureus comparable to chloramphenicol* [38]. The antibacterial activity of the leaf extracts of *A. racemosus* was assessed by disc diffusion method and by measuring the diameter of growth of inhibition zone. When the crude extract was separated in petroleum ether and chloroform in the ration 60:40 and 40:60, very large zone of inhibition ranging from 11.0 to 19.0 were observed [39]. The diethyl ether extracts of *Asparagus racemosus* showed maximum zone of inhibition (17.00 ± 1.53 mm) on *Agrobacterium tumifacience* followed by (15.67 ± 1.20 mm) *Bacillus subtilis*, (14.67 ± 0.88 mm) *Klebseiilla pneumonia* the minimum zone of inhibition (13.33 ± 1.45 mm) in *Escherichia coli*. Both *Bacillus subtilis* and *Pseudomonas aeruginosa* are more sensitive to the leaf extract, in a mixture of petroleum ether and chloroform, in consistent with our work, Bai (1990) [40] has reported the antibacterial activity of plant extracts is due to combined action of compounds. A methanolic extract of Asparagus racemosus showed significant in vitro antibacterial efficacy against Escherichia coli, Staphylococcus aureus, Staphylococcus epidermis, Basillus subtilis and Shigella flexneri [41] and Ethanolic extract showed that both chloroform and ethanolic extract of *Asparagus racemosus* root have potent antibacterial activity. Gram positive and Gram negative bacteria were equally affected by the root extract of *A.racemosus* indicating the presence of broad spectrum antibacterial substance in the plant [42].

CONCLUSION

It is revealed that herbal drugs are relatively safe and exhibit a remarkable efficacy in the treatment. Medicinal plants are considered as clinically effective and safer alternatives to the synthetic antibiotics. The therapeutic properties of the medicinal plants are due to the presence of active principles, which has to be extracted and screened for medicinal properties. Extensive research in the area of isolation and characterization of the active principles of these plants are required so that better, safer and cost effective drugs for treating bacterial infections can be developed.

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