HERBAL SOURCES OF ANTIBACTERIAL POTENTIAL: A REVIEW

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SUMMARY/ ABSTRACT

A major part of the total population in world still uses traditional folk medicine obtained from plant resources With an estimation of WHO that as many as 80% of world population living in rural areas rely on herbal traditional medicines as their primary health care. In recent years this interest to evaluate the properties and uses of medicinal plants are getting growing interests now. Plants possessing antibacterial activity for various diseases are being studied by various methods to evaluate their antibacterial property. Different solvent extracts (aqueous, alcohol and ethanol) of leaves, flower and seeds of various plants were subjected to in vitro antibacterial activity assay against gram-positive and Gram-negative bacteria employing different diffusion method. Based on common use and ethno botanical knowledge, an attempt has been made to assess the the antibacterial properties of selected medicinal plants viz. Azadirachta indica, Allium sativum, Holarrhena antidysenterica and more for potential antibacterial activity against some important bacterial strains, namely Bacillus subtilis, Bacillus cereus, Staphylococcus aureus, Salmonella Typhi, Escherichia coli and Klebsiella pneumonia. The plant extract were more active against Gram-positive bacteria than against Gram- negative.

Key words - Antibacterial, Medicinal plants, Traditional medicine.

INTRODUCTION

The plant kingdom harbors an inexhaustible source of active ingredients invaluable in the management of many intractable diseases. Infectious diseases are the leading cause of death.
world-wide. Various studies have identified compounds from herbal plants that are effective antibiotics (Basile et al., 2000). Many infectious diseases have been known to be treated with herbal remedies throughout the history of mankind. The herbal remedies of traditional healing systems around the world can be utilized as an important source for the discovery of new antibiotics (Okpekon et al., 2004); some traditional remedies have already produced compounds that are effective against clinically important strains of bacteria (Kone et al., 2004). They have been proved effective in the treatment of infectious diseases simultaneously mitigating many side effects which are often associated with synthetic antibiotics [1]. In the past few decades have seen increasing failure of chemotherapeutics and antibiotic resistance exhibited by pathogenic microbial infectious agents (2) has lead to repeated use of antibiotics and insufficient control of the disease (NCID, 2002). This prompted us to evaluate some plants as source of potential chemotherapeutic agents based on their ethnomedical use. The antimicrobial activity of plants was judged by microbial in vitro studies by different researchers. This may also facilitate pharmacological studies leading to synthesis of a more potent drug with reduced toxicity against common infectious diseases. (Ebana et al., 1991; Manna and Abalaka, 2000).

**Table no:1. A brief description of pants having Antibacterial property**

<table>
<thead>
<tr>
<th>SR.NO.</th>
<th>PLANT SPECIES</th>
<th>FAMILY</th>
<th>COMMON NAME</th>
<th>PART USED</th>
<th>ACTIVE INGREDIENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Azadirachta indica</em></td>
<td>Meliaceae</td>
<td>Neem</td>
<td>leaf, bark</td>
<td>azadirachtin, nimbin salannin</td>
</tr>
<tr>
<td>2</td>
<td><em>Allium sativum</em></td>
<td>Liliaceae</td>
<td>Garlic</td>
<td>bulb, oil</td>
<td>Allicin, diallyl trisulfide</td>
</tr>
<tr>
<td>3</td>
<td><em>Cinnamomum zeylanicum</em></td>
<td>Lauraceae</td>
<td>Dalchini</td>
<td>stem bark, oil</td>
<td>cinnamaldehyde</td>
</tr>
<tr>
<td>4</td>
<td><em>Dorema Ammoniacum</em></td>
<td>(Umbelliferae)</td>
<td>Gum ammoniacum</td>
<td>Oleo gum resin fruit</td>
<td>ocimenone</td>
</tr>
<tr>
<td>5</td>
<td><em>Ficus religiosa</em></td>
<td>Moraceae</td>
<td>Pepal tree</td>
<td>leaves, roots</td>
<td>beta-sitosterol, saponins and tannins</td>
</tr>
<tr>
<td>6</td>
<td><em>Bahunia varigeta</em></td>
<td>Caecalpinoideae</td>
<td>kanchanara</td>
<td>stem bark</td>
<td>roseoside</td>
</tr>
<tr>
<td>7</td>
<td><em>Holarrhena antidysenterica</em></td>
<td>Apocynaceae)</td>
<td>Kutaaja</td>
<td>bark</td>
<td>Conessine and related alkaloids</td>
</tr>
<tr>
<td>8</td>
<td><em>Nardostachys Jatamansi</em></td>
<td>Valerianaceae</td>
<td>Nard</td>
<td>root</td>
<td>Valerian</td>
</tr>
<tr>
<td>9</td>
<td><em>Tribuus terrestris</em></td>
<td>Zygophyllaceae</td>
<td>Goksur</td>
<td>root fruit</td>
<td>Alkaloids and saponins.</td>
</tr>
</tbody>
</table>
Azadirachta indica

Pure neem extract is active against bacterial strains i.e. *Escherichia coli, Bacillus subtilius, Salmonella typhi, Pseudomonas, Staphylococcus aureus, Klebsiella pneumoniae* and *Staphylococcus epidermitis* by using agar disc-diffusion assay but acetone extract is more active [13]. Chloform extract of neem showed zone of inhibition of 16mm and 12mm against skin pathogens *Streptococcus pyogenes Staphylococcus aureus* in disc diffusion method [14]. Oil from the leaves, seeds and bark possesses a wide spectrum of antibacterial action against Gram-negative and Gram-positive bacterias, including *M. tuberculosis* and streptomycin resistant strains. *In vitro*, it inhibits *Vibrio cholerae, Klebsiella pneumoniae, M. tuberculosis* and *M. pyogenes* [15].

Allium sativum

The garlic has been proven to be effective against a plethora of gram-positive, gram-negative bacteria including species of *Escherichia, Salmonella, Staphylococcus, Streptococcus, Klebsiella, Proteus, Bacillus*, and *Clostridium*. Acid-fast bacteria such as *Mycobacterium tuberculosis* are sensitive to garlic [16]. In a microbial study the crude extract of *A. sativum*
exhibited antibacterial activity against *Chromobacterium violaceum*, *Bacillus subtilis*, *Escherichia coli*, *Staphylococcus aureus*, *Enterobacter faecalis* and *Klebsiella pneumonia*[17]. The study done to assess the in vivo anti H. pylori potential of garlic validated substantial anti H-pylori effects of pure garlic oil and garlic powder [18]. The antibacterial activity of garlic is widely attributed to allicin. The main antimicrobial effect of allicin is due to its chemical reaction with thiol groups of various enzymes, e.g. alcohol dehydrogenase, thioredoxin reductase, and RNA polymerase, which can affect essential metabolism of bacteria [19].

**Holarrhena antidysenterica**

The microbial assay was done for screening of antibacterial activity by agar disc diffusion method and agar well diffusion method. The results obtained showed the methanol extracts of *Holarrhena antidysenterica* active against *Pseudomonas pseudoalcaligenes*, *Klebsiella pneumoniae*, *Bacillus cereus* and *Staphylococcus aureus* with inhibition zone of 22mm, 21mm, 14mm and 12mm respectively[20]. A study done with aqueous, hexane and alcoholic extracts for the antibacterial activity using agar well diffusion method at sample concentration of 200 mg/ml. concluded that aqueous extract of *H. antidysenterica*, produced outstanding antimicrobial effect with inhibition zone greater than 20 mm against *Staph. aureus*, *E. coli*, *Pseudomonas aeruginosa*, *Salmonella typhimurium* and *Proteus vulgaris* and alcoholic extract against *Staph. Aureus* and *Pseudomonas aeruginosa*[21]. Ethanol extract exhibited broad-spectrum antibacterial activity against certain multi drug-resistant bacteria including *Staphylococcus aureus*, *Salmonella paratyphi*, *Escherichia coli*, *Shigella dysenteriae* and *Candida albicans*[22].

**Tribulus terrestris**

The in vitro study by broth dilution assay and agar diffusion assay showed the MIC value of the methanolic extracts of all parts of the plant against *Staphylococcus aureus*, *Enterococcus faecalis*, *Escherichia coli* and *Pseudomonas aeruginosa* was 2 mg/mL and the MIC value of roots against *S. aureus*, *E. faecalis* and *E. coli* was 4 mg/mL[23]. The antibacterial property of synthesized silver nanoparticles was observed by Kirby–Bauer method with clinically isolated multi-drug resistant bacteria such as *Streptococcus pyogens*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Bacillus subtilis* and *Staphylococcus aureus*[24]. Chloroform extracts of *T. terrestris* fruits demonstrated very close activities against *B. subtilis*, *B. cereus*, *C. diphertheriae* and *P. vulgaris* extract (MIC=0.31 mg/ml), while *B. subtilis*, *B. cereus*, *C.
diphtheriae and *P. vulgaris* were the most sensitive bacteria to ethanol extracts extract \((MIC=0.15 \text{ mg/ml})[25].\)

**Origanum majorana**

The microorganisms viz., *Staphylococcus aureus, Bacillus subtilis, Bacillus cereus* and *Bacillus thuringiensis* were the most susceptible bacteria to crude ethanolic extract of *Origanum majorana* as evident by the zone of inhibition of 12mm, 14mm, 10mm and 8mm respectively as seen evident by in vitro study[26] and the methanolic extract showed the considerable activity against *Bacillus subtilis, Staphylococcus aureus, Proteus vulgaris, E.coli, Pseudomonas aeruginosa* [27].

**Ocimum sanctum**

Evaluation of antimicrobial activities crude ethanol extract of *Ocimum sanctum* performed by agar well diffusion method and two fold broth dilution method zone of inhibition was produced against *Staphylococcus aureus Bacillus subtilis Bacillus cereus, Bacillus thuringiensis* and *Salmonella Typhi*[28] and moreover ethanol extract exhibited broad-spectrum antibacterial activity against certain multi drug-resistant bacteria including *Staphylococcus aureus, Escherichia coli, and Shigella dysenteriae*[29]. The combination of Orientin and Vicenin flavanoids were isolated from the aqueous extract of fresh plant was found to be most active against many bacterial strains. The highest zone of inhibition (20.12, 20.75, 20.95, 19.55 and 20.1 mm) was observed in concentration of 400 mg/ml against *Escherichia coli, Proteus, Staphylococcus aureus, Staphylococcus cohnii* and *Klebsiella pneumonia* respectively[30].

**Plumbago zeylanica**

The aqueous extract of plant found to be strongly active against *Staph. aureus, Bacillus subtilis, E. coli, Pseudomonas aeruginosa, Palmonella typhimurium* and *Proteus vulgaris* in an antimicrobial assay done using soyabean casein digest agar (SCDA)[31]. Anti-H pylori activity of *P. zeylanica* was screened using different organic solvents The ethyl acetate extract exhibited the lowest minimum inhibitory concentrations against five *H. pylori* strains followed, in ascending order, by the acetone, ethanol and water analogs[32]. Ethanol extract has broad-spectrum antibacterial activity against certain multi drug-resistant bacteria including *Staphylococcus aureus, Salmonella paratyphi, Escherichia coli, Shigella dysenteriae*[33]. While dichloromethane and methane extract are active against *Klebsiella aerogenes*[34].
Bahunia varigeta
The different extracts of Bauhinia variegata L. (B1-B11) had a concentration dependent antibacterial activity against tested gram negative bacterial strains viz. *K. pneumoniae*, *E. coli* and *P. pseudoalcaligenes*. Maximum activity was observed at the concentration 10 mg/ml followed by concentrations 5mg/ml and 2.5 mg/ml[35]. The antibacterial activity of methanol extract determined by photometric microtiter broth dilution protocol using ELISA reader showed maximum sensitivity for *Pseudomonas aeruginosa followed by Salmonella typhi, Shigella sonii, Staphylococcus pyogenes, Shigella boydii* and *Staphylococcus aureus* in an decreasing order as observed by inhibition of bacterial growth at a concentration of 400 µg/ml (incubation: 1 day at 37°C) [36]. The alcohol leaf extracts of *B. variegata* exhibited good activity against *E. coli* 10 mm was recorded as diameter zone of inhibition [37].

Piper longum
The ethanol extract fruit and leaf of the plant inhibited the growth of *E. coli, Pseudomonas aeruginosa, Bacillus subtilis and Staphylococcus aureus* at 25mg/ml and 12.5mg/ml concentration in antibacterial screening by agar dilution method [38]. ethyl acetate, chloroform and methanol extracts were found to be strongly active against gram-positive *Streptococcus aureus* (15-17 mm) and gram-negative *Shigella boydii* (17-20 mm) [39]. Three isolates of black pepper were active against gram-positive bacteria *Bacillus subtilis, Staphylococcus aureus* and *Bacillus sphaericus* moderately active against Gram-negative bacteria [40].

Curcuma longa
Crude extract of Curcuma longa which exhibited the broadest spectra of activity against *Escherichia coli* (ZOI= 27mm) followed by *S. typhi* (24mm), *Enterobacter faecalis* (23mm), *Staphylococcus aureus* 20mm, *Salmonella paratyphi Chromobacterium violaceum 19mm* and *Pseudomonas aeruginosa Proteus mirabilis18mm* [41]. Different extracts of plant such as steam distilled essential oil, choloform, methanol and water when tested in vitro system showed that essential oil and water extracts was active against *S. aureus* though essential oil showed more activity than standard antibiotic gentamycin and displayed moderate activity against gram negative *E.coli* and *S.typhimurium* [42]. When used in combination ethyl acetate extract of *C. longa* may have antibacterial activity and the potential to restore the effectiveness of β-lactams against MRSA(methicillin-resistant *Staphylococcus aureus*) , and inhibit the MRSA invasion of HMFs. human mucosal fibroblasts [43].
Cassia fistula
The crude extracts of Cassia fistula exhibited significant antimicrobial activity at 1000 µg/ml as evident by complete inhibition of Bacillus cereus, Bacillus pumilus, Bacillus subtilis, Bordetella bronchiseptica, Micrococcus luteus, Staphylococcus aureus, Staphylococcus epidermidis, Klebsiella pneumonia and partial inhibition of Escherichia coli. [44] The different leaf extracts showed promising antibacterial activity against test bacterial species as Escherichia coli, Salmonella typhimurium, Shigella sonnei, Bacillus subtilis Bacillus licheniformis Staphylococcus aureus and Staphylococcus epidermidis, yet maximum activity was observed in ethanol extract. The minimum inhibitory concentration ranged in between 94 to 1500 µg/ml. [45]. The antibacterial activities of the C. fistula were due to the presence of various secondary metabolites. Methanolic extract and Chloroform extract of Cassia fistula fruit pulp against four pathogenic bacterial strains two Gram positive S. aureus, S. pyogenes, two Gram negative E. coli, P. aeruginosa.

Bc- Bacillus cereus, Bt- Bacillus thuringiensis, Bs - Bacillus subtilis, Sa - Staphylococcus aureus, Ml - Micrococcus luteus, Ec - Escherichia coli, Kp - Klebsiella pneumonia, Pa - Pseudomonas aeruginosa, Pv - Proteus vulgaris, St - Salmonella typhi, Sf - Streptococcus faecalis.

CONCLUSION
The antibiotic drugs are the greatest contribution of 20th century to the therapeutics. Their importance is magnified in developing countries where infective diseases are predominant. But these drugs are sometimes associated with adverse effects on host including hypersensitivity, immune-suppression and allergic reactions. 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 alternative antimicrobial drugs of plant origin. Plant-based antimicrobials have enormous therapeutic potential as they can serve the purpose with lesser side effects that are often associated with synthetic antibacterial (Iwu et al., 1999).

The presence of antibacterial substances in the higher plants is well established (Srinivasan, 2001). This review gives a bird’s eye view on pharmacological activity of some plants extracts on clinically important species of bacteria. In the present work twenty two different medicinal plants each belonging to different families was studied for their antibacterial properties. The results of in vivo studies done by different workers were encouraging as these
22 plants show remarkable activity against the investigated bacterial strains that are largely responsible for respiratory and gastrointestinal infections. Seven plants namely \textit{Allium sativum}, \textit{H.antidysenterica}, \textit{Plumbago zeylanica}, \textit{Curcuma longa}, \textit{Cassia fistula}, \textit{Tribuus terrestris} and \textit{Ocimum sanctum} demonstrated broad spectrum antibacterial activity. \textit{Staphylococcus aureus}, \textit{Bacillus subtilis}, \textit{Bacillus cereus} and \textit{Escherichia coli} are most susceptible bacteria to different plant extracts. The traditional therapeutic indications of some plants studied appear to have fairly good degree of correlation with antimicrobial activity. Although the precise mechanism of the antimicrobial action of plant extracts remains speculative, the extract may be acting by inhibiting bacterial wall synthesis and/or combines with 50s ribosome and interferes with translocation thus inhibits bacterial protein synthesis at the cellular level. The study also mentions the fact that gram positive bacteria are more susceptible towards plants extracts as compared to gram negative.

The basis for their differences in susceptibility might be due to the differences in the cell wall composition of Gram negative bacteria which is single layered. Since some of the plants appears to have broad spectrum of action and are non-cytotoxic, they hold promising future to be used as antibiotic formulations. The antibacterial activities of the plants are particularly noteworthy, considering the importance of these organisms in hospital acquired infections. The indiscriminate use of synthetic antibiotic drugs has given alarming incidence of antibiotic resistance. Some of the herbs are shown active against beta lactam resistant \textit{Staphylococcus aureus}. The preliminary results of this study appears to indicate that a number of Indian medicinal plants have high potential of antimicrobial activity and the need for further research into traditional health systems. It may give new direction to further studies studies leading to synthesis of a more potent drug with reduced toxicity.

**ACKNOWLEDGEMENTS**

Author (Dr.Mamta Tiwari) wish to thanks Honorable Prof.G.P.Dubey Sir, Distinguished professor, Faculty of Ayurveda, Institute of medical Sciences for giving me a chance to be part of renowned institute and Dr. Aruna Agrawal, Professor Faculty of Ayurveda IMS BHU for her kind support and give me intelligent guidelines time to time and Department of Swasthavritta, Faculty of Ayurveda, Institute of medical Sciences, Banaras Hindu University, Varanasi for giving me required support.
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