Chapter - II

Review of Literature
A number of reports are available on the antimicrobial effect of plants. Gupta (1974) showed antifungal activity of *Juniperus communis*, *Euphorbia thymifolia* and *Wedelia calendulacea* *in vitro* and *in vivo* and performed clinical trials of these plants on calves, buffaloes and goats.

Gayaprasad (1979) studied antifungal property of garlic (*Allium sativum*) *in vitro* and *in vivo*. *In vivo* he used *Aspergillus*, *Candida*, *Cryptococcus*, *Neoformans*, *Trichophyton* and *Histoplasma*. All fungi tested were found sensitive to the extract. The minimum inhibitory concentration (MIC) ranged between 1:20 and 1:160 where as the minimum lethal concentration (MLC) varied from 1:10 to 1:80. The MIC was approximately two times more than MLC. He also reported the effect of storage at different temperature on the antifungal property of garlic extract. The extract completely lost its antifungal activity after 8th day of storage at 30°C. Garlic extract was subjected to heat treatment at 45°C, 60°C, 75°C, 85°C and 100°C for 5, 10 and 15 minutes. The activity of the extract was found to be completely lost within 5 minutes at 100°C and revealed a significant loss in its antifungal activity, which was proportional to the duration of the heat treatment. *In vivo* trial, it was reported that chick fed on ration containing 2.0 per cent or 4.0 per cent extract had no evidence of candidiasis.
Pandy et al. (1982) reported that *Lawsonia innermis* showed antibacterial activity against *Proteus* and *Staphylococcus aureus* and the plant possesses analgesic, anti-inflammatory and antipyretic properties.

Thaker (1983) studied antimicrobial activities of *Azadirachta indica*, *Annona squamosa* and *Ocimum sanctum* *in vitro* by using chloroformic plant extract against *Staphylococcus aureus*, *Streptococcus pyogenes*, *Corynebacterium* spp., *E. coli* and *Pseudomonas aeruginosa* by 10-fold serial dilution of incubated 5 ml glucose broth containing 0.1 ml extract and 0.1 ml inoculum of each organism and subsequent plating by standard plate count method (SPC) and found variable inhibition ranging from 75 per cent to 99 per cent with most of the organism.

Farnsworth et al. (1985) furnished a WHO statement that 80 per cent of the world population use herbal medicine for some aspect of primary health care.

Anjaria (1986) reported the antimicrobial properties of *Annona squamosa*, *Azadirachta indica*, *Ocimum sanctum* and *Bergia odorata*. The chloroformic extract of the leaves of *Ocimum sanctum* have shown very encouraging activity *in vitro*. The leaves extracts were found to be sensitive to gram positive and gram negative bacteria and reported successful clinical trial on wound healing.
Giron et al. (1988) made a clinical trial of plant antimicrobials in human cases of C. albicans induced vaginitis and compared the efficacy of Solanum nigrecens with nystatin by giving both as intravaginal suppositories in women, and the plant extract proved to be as effective as nystatin.

Tinkey et al. (1988) have shown the ectoparasitidal activity of aqueous extract of Ipomoea cairnea and reported that the results were similar to malathion.

Charles and Charles (1991) studied the efficacy of crude preparation of neem and turmeric in healing of chronic ulcers and scabies and reported 97 per cent efficacy in clinical trials.

Sarvaiya (1991) studied antibacterial properties of Prosopis juliflora, Azadirachta indica and Adhatoda vasica utilizing alcoholic and methanolic extract in vitro by disc diffusion method against Staphylococcus aureus, Streptococcus, Corynebacterium, E. coli, Pseudomonas, Proteus and Klebsiella spp. and found that P. juliflora leaves possessed antibacterial activity against Staphylococcus, Streptococcus, Corynebacterium and Proteus spp. The alcoholic extract was more potent than chloroformic extract. However, Pseudomonas was resistant. Crude juice prepared from P. juliflora leaves was effective against Staphylococcus, Bacillus, Diplococcus, Corynebacterium, E. coli and Pasteurella multocida where as Klebsiella and Proteus spp. were resistant. The supernatant obtained after centrifugation had slightly better antibacterial activity against
Staphylococcus, Streptococcus and Pasteurella multocida. The activity remained effective even after autoclaving. Minimum lethal concentration (MLC) of autoclaved juice and minimum inhibitory concentration (MIC) against Staphylococcus, Streptococcus and Diplococcus were found to be 0.39, 0.078 and 1.56 per cent respectively. However, E. coli and Proteus spp. were found resistant.


Naqvi et al. (1994) reported the antibacterial activity of two plants, viz. Nerium indicum and Hibiscus rosasinensis. They used ethanolic extracts for antibacterial assay.

Sadekar et al. (1995) studied immuno-potentiating effect of Ocimum sanctum by feeding dry powder to a group of birds survived after natural infection of IBD virus and reported enhanced HI titre.

Haslam (1996) assigned vegetable tannins for many physiological activities such as stimulation of phagocytic cells, host mediated tumor activity and a wide range of anti-infectivity. Phenolic compounds possessing a C3 side chain at a lower level of oxidation and containing no oxygen are classified as
essential oils and often cited as antimicrobial. Catechol and Pyrogallol both hydroxylated phenols are shown to be toxic to microorganisms. Catechol has two OH group and pyrogallol has three. The site (3) and number of hydroxyl groups on the phenol group are thought to be related to their relative toxicity to microbes, with evidence that increased hydroxylation results in increased toxicity (Geissman, 1963).

Silva et al. (1996) reported the active principle of *Ceytolepsis sanguinolenta* and the antimicrobial activity has been contributed to its constituent of quinoline alkaloid.

Pandian (1996) studied the efficacy of indigenous plant *Azadirachta indica* in canine dermatitis. Treatment with topical application of neem leaves mixed with liquid paraffin was found to be very effective.

Shah (1997) has shown tremendous healing potential of *Argyeria speciosa* under clinical evaluation on chronic non-healing ulcers like bed sores, leg ulcers etc. and intractable skin condition like infected pimples and chronic follicular infection in human patients.

Eloff (1998) examined a variety of extractants for their ability to solubilize antimicrobials from plant as well as other factors of biohazards and suitability for removal of solvent from the fraction in order to provide a more standardized extraction method for the wide variety of plants and suggested
acetone as the best one. He ranked other extractants in the following order-methylene dichloride >methanol > ethanol > water.

Anon (1998) reported that neem significantly enhanced antibodies against the Newcastle disease virus. The chickens in the study had been naturally infected with infectious bursal disease (IBD) a devastating virus that causes an immuno-suppressive disease in chickens. It also reported that neem is a highly effective immune system booster.

Perry et al. (1999) while studied the constituent of Salvia muticaulis observed a variation in constituents and considered local, climatic and seasonal factors for these variation.

Iwu et al. (1999) classified major antimicrobial compounds obtained from plant into 7 major class, namely Phenolics, Terpenoids, essential oils, alkaloid, lectins and polypeptides and polyacetylenes. They included simple phenols, phonolic acids, quinines, flavonoids, flavones, flavonols and tannins and coumarins as subclass to phenolic class.

Iwu et al. (1999) reviewed the mechanism of antimicrobial properties of phytochemicals and reported that most of the antimicrobial phytochemicals belong to simple phenols, exert substrate deprivation and membrane disruption while the quinines group bind to adhesins, complex with cell wall and inactive enzymes, flavonoids bind to adhesins; flavones inactivate enzymes and
some inhibit HIV reverse transcriptase, and tannins bind to proteins, bind to adhesins, enzyme inhibition, substrate deprivation, complex with cell wall, membrane disruption and metal ion complexation.

Khan et al. (2001) and Somchit et al. (2003) studied the plant extracts of *Cassia alata* for antibacterial activity and reported that the plant showed antibacterial activity to several bacterial strains and protozoa while *Bacillus* and *Staphylococcus* were predominantly sensitive to the said plant.

Ogurtan et al. (2002) studied the antimicrobial activity of *Alkena tintoria* on burn wound and found acceleration of wound healing.

Shrivastava et al. (2002) studied the efficacy of *Calendula officinalis* and *Grewia tenax* in experimental wound and reported marked granulation with apparent epithelization and contraction of peripheral edge by day 13 with *Grewia tenax* while wound treated with *Calendula officinalis* appeared pinking on day 4 to 13 and the control wound healed completely by day 25.

Girao (2003) made a clinical trial to study the efficacy of a mouth rinse prepared with *Lippia sidoidis* and obtained satisfactory results with mild gingival diseases in dog.

Urbanczyk et al. (2003) studied the efficacy of herbs mixture as an antibiotic substitute in pig feeding and found increase of meat content by 6.7 per
cent, and confirmed possibility of using herbs mixture on an antibiotic feed substitute in pig feeds.

Bhuvaneswari et al. (2002) studied the antimicrobial activity of *Lawsonia innermis* and used disc diffusion method for evaluation of antibacterial activity and read the antibiotic activity by ranking procedure as follows:

<table>
<thead>
<tr>
<th>Diameter of Zone of Inhibition</th>
<th>Activity</th>
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<tbody>
<tr>
<td>&lt;10 mm</td>
<td>(+)</td>
</tr>
<tr>
<td>10 mm - 14 mm</td>
<td>(++)</td>
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<tr>
<td>15 mm - 20 mm</td>
<td>(+++)</td>
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</table>

They reported the MIC value of *L. innermis* against *E. coli*, *Klebsiella*, *Proteus*, *Pseudomonas* and *Staphylococcus* as 55, 55, 75, 85 and 95 mcg respectively.

Baregama et al. (2004) read the zone of inhibition as follows: 

- (-) = absence of inhibition
- (+) = zone of inhibition up to 10 mm
- (++) = zone of inhibition >10 and ≥ 15 mm
- (+++) = zone of inhibition >15 and ≥ 20 mm

Bonjar (2004) reported antibacterial activity of 29 plant families used in the traditional medicine by Iranian people and added that all extracts showed the same activity 18 months later.

Dutta (2004) stated that curry prepared from fruits of *S. magnifera* is specially useful for diarrhoea and dysentery.
Mosehos et al. (2004) studied antimicrobial properties of the essential oil and methanoic extract of *Salvia cryptantha* and *S. multicaulis* and found no antimicrobial activity in polar subfraction of either plant extracts. On the other hand, they found moderate activity of *S. cryptantha* and broader activity of *S. multicaulis* against tested micro-organism *in vitro* to the non-polar subfraction of both the extracts and reported MIC values ranging from 2.25 to 18 mg/ml to the *S. cryptantha* and 2.25 to 36 mg/ml to *S. multicaulis*. They used agar disc diffusion and broth microdilution method of NCCLS (1997) and used amikacin, ciprofloxacin in parallel experiments in order to control the sensitivity of the test microorganisms.

Park and Back (2004) reported an antibacterial compound—Isopanduratin A isolated from *Kaempferia pandura* which was active against *S. mutans* at MIC 4 mg/ml.

Suffredini et al. (2004) evaluated 705 organic and aqueous extracts of plants obtained from different Amazon Rain forest for antibacterial activity at 100 microgram/ml using a microdilution broth assay against four microbial species.

Adomi (2006) used water and ethanol for extraction of two traditional plants viz. *Alstonia* and *Morinda* species and tested against clinical isolates of two Gram-positive and five Gram-negative bacteria. He reported that
antibacterial activities of these plants were comparable to those of the standard antibiotics and the extent of the inhibition was found to be related to the concentration of the plant extracts.

Balakrishnan et al. (2006) studied the antibacterial activity of *Mimosa pudica, Aegle marmelos* and *Sida cordifolia* against *Bacillus subtilis, Staphylococcus aureus, Klebsiella pneumoniae, Pseudomonas aeruginosa, Escherichia coli* and *Salmonella typhi* at the inoculation concentration of $3.0 \times 10$ cfu/ml and disc concentration of 0.1 ml (3 mg). The maximum zone of inhibition of *S. cordifolia* was against *B. subtilis* (35 mm) and *S. typhi* (26 mm). *M. pudica* and *A. marmelos* were found to be active against all the microorganisms tested and the maximum activity was noted against *P. aeruginosa* and *S. typhi* respectively.

Duraipandiyan et al. (2006) studied antibacterial activity of 18 ethnomedicinal plants extract against nine bacterial strains. They obtained hexane and methanol extracts by cold percolation method and the antimicrobial activity was evaluated by using paper disc diffusion method. 10 plants were found to exhibit antibacterial activity against one or more of the tested microorganisms at three different concentrations of 1.25, 2.25 and 5.0 mg/disc. Among the tested plants, *Acalypha fruticosa, Peltophorum pterocarpum, Toddalia asiatica, Cassia auriculata, Punica granatum* and *Syzygium lineare* were found to be most active.
Parekh et al. (2006) carried out screening for the preliminary antibacterial activity of 12 different plants used in Indian folk medicine by using both aqueous and methanolic extracts. They reported that methanol extracts were more potent than the aqueous extracts and the plant extracts were more active against Gram-positive than Gram-negative bacteria. They reported that Bauhinia variegata exhibited remarkable antibacterial activity amongst all the 12 plants species and the plant was recommended for further studies.

Rojas et al. (2006) studied the antibacterial activity and MIC of the extracts of Bidens pilosa, Bixa orellana, Cecropia peltata and other 7 plants against five bacteria and reported that all the plant extracts showed varying degrees of antimicrobial activity on the micro-organisms tested. They also added that the chance to find antibacterial activity was more apparent in ethanol than water extracts.

Ahanjan and Raveesha (2008) reported the phytochemical analysis and antifungal activity of Parrotia persica against some important human pathogenic fungi viz Candida albicans (MTCC 183) and Trichophyton rubrum (MTCC 296) by poisoned food technique. Results showed significant activity against the test pathogen at 1000 ppm concentration. The phytochemical analysis of the methanol extract indicated the presence of carbohydrate, tannin, saponin, phenol and flavonoid.
Bhardwaj and Laura (2008) studied the antifungal effect of some plant-extracts against *Aspergillus oryzae* and reported differential activity of the plant extracts against the mycelium growth. They reported that the maximum inhibitory effect was shown by rhizome extracts of *Curcuma domestica* while root extract of *Acacia catechu* showed appreciable inhibitory affect against the test fungi. Some of the other plants showed intermediate inhibition i.e. *Azadirachta indica, Adhatoda vasica* and *Aegle marmelos*. 