Chapter II

REVIEW OF LITERATURE

2.1 Ayurveda and Modern Drug Development: From Traditional Science to Modern Science

Ayurveda is one of the most ancient traditional systems of medicine widely practiced in India. Ayurveda has a vast literature in Sanskrit and various Indian languages, covering all aspects of diseases, therapeutics and pharmacy. Earliest mention of the use of medicinal plants is found in 'Rigveda' which were written between 400 and 1600 BC. Then Ayurveda Samhita also known as Bramha Samhita was compiled. This forms an important part of Atharva Veda (around 1200 BC), an ancient treatise on Indian Medicine. The Ayurveda Samhita is a systemised compilation, divided in 1000 chapters each containing 100 verses which record definite properties of drugs. 'Charak Samhita' is one of the important text for study of ayurveda. In the very first chapter of this text, an account of World's first symposium on "Medicinal plants in relation to diseases" is given. It was held on the sacred slopes of Himalayas before the period of Mahabharata. It was presided over by the great sage Bhardwaj "The Father of Indian Medicine" (Janaki Ammal, 1977). Hallmark of Charak Samhita is Kayachikitsa (therapeutics). The work consists of eight sections divided into 150 chapters, and lists 341 plants and plant products for use in medicine (Charak Samhita, 1949, Sharma S.P., 1981).

Other important ancient works are Dhanvantari Samhita and Sushrut Samhita (Bhagawan Dash and Sharma, 2001). This was the period
arround 1000 - 500 BC. Sushrut Samhita has special emphasis on surgery. It
contains 21 chapters, and describes 393 medicinals plants, 57
drugs of animal origin, and 64 minerals and metals as therapeutic agents.
Sushruta, the father of surgery, lived and practised surgery in Varanasi some
2500 years ago. Charak Samhita and Sushrut Samhita are considered devine
and beyond criticism by the practitioners of ayurveda. These two are the main
classics that give detailed descriptions of over 700 herbs.

Asthanga Sangraha and Ashtanga Hridaya Samhita are the
concise books compiled by Vagbhat (7th century) taking the fundamentals from
Charak and Sushruta Samhitras (Jaggi, 1974). Ashtanga Hridaya consists of six
sections covering 120 chapters, and contains 7444 verses; the entire book is in
verse. Madhav Nidana (800 to 900 AD), consisting of 1552 verses in 69 chapters,
is the next important milestone. It is the most famous ayurvedic work on
diagnosis of diseases. Sarangadhara (14th Century) systematized ayurvedic
materia medica, and his work Sarangadhara Samhita consists of three parts, 32
chapters and 25000 verses. "Bhava Prakasha", another book that includes
materia media, was composed by Bhavmishra of Magadh arround 1550 A.D. It
has three sections containing 10831 verses and approximately 470 medicinal
plants are described. Among the contributions of early period, mentions may
be made of Madanpal’s Nighantu by Madanpala, Raj Nighantu by Narhari
Pandita and several other Nighantu on dravya guna, mostly written between
7th and 16th century.

India is bestowed with a very rich botanical wealth because
of wide variation in climatic and topographic conditions. There are about 45,000
plant species, several thousands of which have been assigned medicinal values.

The enormous traditional knowledge about medicinal uses of plants, present in the ayurvedic literature, coupled with the rich diversity of medicinal plants in nature forms the basis for the plant based drug development. Since plants represent an unparallel source of molecular diversity, the R & D thrust in medicine field is focussed on prospection of new potential pharmaceuticals from plants. For treatment of a variety of chronic and difficult-to-treat diseases such as cancers, cardiovascular diseases, diabetes, rheumatism and AIDS, new effective drugs are required. Problems with drug resistant microorganisms, adverse side effects of modern drugs, and emerging diseases where no medicine are available have triggered interest in plants as a source of new drugs.

Numerous drugs have come out of ayurvedic experimental base. The first discovery which drew international attention was isolation of an alkaloid reserpine from Rauwolfia serpentina (Sarpagandha). This was
considered a revolutionary event (Sukh Dev. 1997). CIBA of Switzerland
developed this drug for treatment of hyper tension. Ajmalicine from *Rauwolfa
canescens* L. and *Catharanthus roseus* G. Pon (Singh *et al.*, 1982), derpidin
from *R. canescens*, rescinnamine from *R. canescens* and *R. vomitoria* and
ajamaline from *R. vomitoria* are other chemotherapeutic drugs derived from
plants that are used for treatment of hypertension (Mallavarapa, 2001).

Guggul obtained from *Commiphora wightii* had been widely
used for conditions like arthritis in Ayurveda since the *Samhita* period. Guggul
resin is a complex mixture of compounds such as lignans, lipids, diterpenoids
and steroids. This resin is developed as hypolipidemic drug (Satyawati, 1991;
Valiathan, 1998). The drug has been marketed in India and international market
as Guglip (Valiathan, 1998).

Many anticancer agents have been developed from plants.
The alkaloids vinblastine and vincristine obtained from *Catharanthus roseus*
are used for the treatment of Hodgkin’s disease, lymphosarcoma and leukemia in
children (Deconti and Creasby, 1975). Polophyllotoxin, a lignan obtained from
*Podophyllum emodi* and *P. peltatum* used for synthesis of teniposide and
etoposide that are used for treatment of testicular cancer, small cell lung cancer
and lymphomas. Palitaxel, a diterpenoid obtained from *Taxus* species, is the
drug given for metastatic ovarian and breast cancer and melanoma. Other
important anticancer drugs are irinotecan and topotecan obtained from quinoline
alkaloid camptothecine mostly obtained from *Nathupodytes nimmoniana*
Mebberrilly used for lung, ovarian and cervical cancers (Sukh Dev, 1997).

Silymarine, a mixture of three flavonolignans obtained from
the fruits of *Silybum marianum* (Shah, 1982). It is a hepatoprotective agent used for treatment of various liver disorders. Another hepatoprotective drug is Gomishin, a lignan obtained from the fruits of the Chinese herb *Schizandra chinensis* (Mallavarapu, 2001).

Few other plant based drugs that are used in modern medicine are sennosides from *Cassia angustifolia* used as laxative, atropine from *Atropa belladona* having parasymptholetic action, digoxine and idanatosides from *Digitalis lanitona* a cardioic, glycyrrhetic acid from *Glycyrrhiza glabra* used as antiinflammatory and antiulcerogenic, godeine and morphine from *Papaver somniferum* and valpotriates from *Valeriana wallachi* that are used as sedatives. Besides these, mucuna puriens are used for Pankinson's disease, baccosides improve mental retentions, curcumine is used for inflammation and withanolides are used as immunomodulators (Patwardhan, 2000).

The above are some of the important plant based drugs that are of therapeutic importance for diseases other than those caused by microorganisms. Drugs for diseases of microbial etiology are dealt with in following few paragraphs.

### 2.2 Major Developments in the Discovery of Herbal Antimicrobial Drugs

A variety of diseases in human beings are caused by bacteria, fungi, protozoa and viruses. A range of antibiotics and other chemotherapeutic agents has been developed that made it possible to control these diseases. However, due to indiscriminate use of these drugs, various pathogenic bacteria and fungi have developed resistant strains. Moreover many of these drugs cause serious side effects. This has created a need for developing
new antimicrobial drugs.

Since higher plants offer immense possibilities of discovering potent drugs, much attention has been focusses on prospecting botanical resources to introduce new therapeutic drugs for treatment of infections diseases. Many research institutions and companies are currently engaged in discovery and development of drugs for tropical diseases such as maleria, filariasis, leishmaniasis, tuberculosis and also for fungal infections, bacterial infections and viral infections including AIDS. Some of the major achievements are enlisted in following few paragraphs.

Malaria claims 2000 millian patients and kills nearly 2 million annually. A number of natural products has been found to have antimalerial activity. Quinine, the original antimalerial drug was derived from *Cinchona spp.* It was isolated in 1820 and introduced as drug in 1825 (Bhattacharjee, 2001). However resistance of *Plasmodium falciparum* has now become a global problem (WHO, 2000). Search undertaken to overcome this problem has lead to the isolation of artemisinin from the chinese plant *Kwing hasavu* or *Artemisia annua*. Artemisinin represents a completely new chemical series of antimalerial compounds with strong schizontocidal activity against strains of parasites resistant to all known antimalerials (Valiathan 1998). Artemethers A and B derived from artemisinin had shown promise in clinical trials as better antimalerials than artemisinin (Bhakuni *et.al.*1995; Ziffer *et.al.*1997).

Febrifugine and isofebrifugine isolated from *Dichora febrifuga* are two other antimalerial compounds, the former being 50-100 times stronger than quinine. However febrifugine show high gastrointestinal toxicity.
This has led to the synthesis of lower toxicity congeners such as methylene dioxy analogues and amino ketones of 4-quinazolone. Recently a tetranortriterpene called gedunine has been isolated from *Azadirachta indica* that is active against some clones of *Plasmodium falciparum* (Singh et al. 2001).

Leishmaniasis is an other insect born disease that is showing resistance to highly toxic, heavy metal based antimonials at the rates of 64% in some developing countries. In the state of Bihar upto 70% of Leishmania cases are non-responsive to current treatments (WHO, 2000). Some of the plant products have been found to have antileishmanic activity. These are berberine from *Berberis spp.*, harmaline from *Peganum harmala*, diospyrin from *Diospyros monata* and rivin from *Ricinus communis* (Singh et al., 2001).

Some plants are emerging as source of antiviral drugs. Some of the compounds viz, macrolactins, glycyrrhizine, euglobals terpenoids and tannins etc. have shown great potential as antivirals. *Hypericum perforatum* and *Saponaria officinalis* have shown activity against influenza A and B virus. Since resistance to zidovudine (AZT) and protease inhibitors has been observed in HIV (WHO, 2000), efforts have been directed to discover new anti HIV drugs. A reverse transcriptase inhibitor Calanolide A has been isolated from *Calophyllum lanigerum* by NCI (USA). This has been found to be effective against AZT resistant strains of HIV-1.

Continuously increasing multidrug resistance is a serious problem of the new millenium. Formerly curable diseases with bacterial etiology are rapidly becoming difficult to treat. Considering the urgent need for developing novel antimicrobial drugs, investigations are being carried out
throughout the world for searching plant based antibacterial agents.

Although a large number of plants have been shown to possess antibacterial activity including the commonly used plants like Neem, Garlic, Onion, Haldi, Pudina, Tulsi, Ginger, etc. (Choudhari, 1996), significant leads have been obtained in a very few of them. Some of these have yielded clinically useful drugs. Andrographolids and neoandrographolide obtained from Andrographis paniculata (Kalmegh) has clinical use in bacillary dysentery; Sapogenic glycosides isolated from Asparagus recemosus are applied on wounds and burns, and alkaloids (berberine) derived from Coscinium fenestratum (Daruhaldi) are used in cholera and gastroenteritis (Singh et.al. 2001).

Connexine present in Holarrhena antidysenteric showing antidysentric action and psoraline in Psoralea corylifolia having antibacterial nature are two other ayurvedic drugs that have received pharmacological/clinical support for their claims (Sukh Dev, 1997).

2.3 Antimicrobial Compounds in Plant Extracts

Since the past two decades, efforts have been intensified all over the world for screening of the plants for antimicrobial activity and isolation and characterization of the active antimicrobial constituents. As a result numerous plant extracts and essential oils have displayed antimicrobial activity against several organisms. The list of such plants is continuously growing and there is a special section of 'Medicinal and Aromatic Plant Abstracts' allotted for the antimicrobial activity. Bioactivity guided fractionations of the active plant extracts have yielded a variety of antimicrobial chemicals belonging to different classes such as terpenes, steroids, saponins, flavones, xanthones, caumarins,
chalones, alkaloids and phenolic dirvatives (Shrivastava et al., 2000). Some of the compounds discovered during last few years are mentioned here in brief.

Hufford et al., (1980) had isolated liriodenin, an oxoaporphine alkaloid, from heartwood of Liriodendron tulipifera. It showed good activity against Irichophyson mentagrophytes and Syncephalestrum sacemosum and some bacteria.

Adawadkar and Sohly, (1981) had purified anucardic acid from ethanol extract of fruits of Ginkgo biloba. It was active against Mycobacterium smegmatis.

Al-Shammat et al., (1982) had identified crypopleurine, 3,4-dinethoxy -w-(2'-piperidyl) auto phenone and the known alkaloids possessing antimicrobial activity against Candida albicans from the entanolic extracts of whole plant of B. cylindrica.

Haruna et al., (1981) had isolated a sesquiterpene lactone, angeloyleumambrin - B from Chrysanthemum ornatum Var. spontanum which was active against E. coli, Staphylococcus pygenes, Mycobacterium smegmatis and Candida albicans.

Ayafor et al., (1982) had isolated an alkaloid viz, veprisinium salt from the water soluble alkaloid fraction of the stem bark of V. loutisii which showed significant antibacterial activity against S. aureus.

Mitscher et al., (1983) had done the bioassay directed fractionation of Glycyrrhiza lepidata extracts resulted in isolation of glepidotin A and glepidotin B which exhibited antimicrobial activity.
Takagi et al., (1983) had isolated three bibenzyls and two dihydrophenanthrones from tubers of Bletilla striata. These were found to possess antimicrobial activity.

Hejtmankova et al., (1984) had isolated chelerythr ine and a mixute of chelerythr ine and sanguinarine from Chelidonium majus which has antifungal effect on some Trichophyton strains, Microsporum canis, Epidermophyton floccosum and Aspergillus fumigatus.

Mitscher et al., (1984) had isolated the p.terocarpene erycristagallin from Erythrina crista-galli which was shown to be antmiicrobial.

Lwande et al., (1985) had isolated three kaurene diterpenoids from Aspilia pluriseta, a Kenyan folk medicinal plants that is widely used for cure of wounds. These were active against Gram positive and Gram negative bacteria.

Hattori et al., (1986) had isolated Glycyrol glycin, isoglycyrol and glycycoumarin from methanolic extract of Glycyrrhiza uralensis. It has potent antibacterial action against cariogenic bacterium, Streptococcus mutans.

Hufford and Oguntimein, (1987) had studied the antibacterial activity of the dihydrochalcone, viz. angoluvarin obtained from Uvaria angolensis. It has MIC values of 0.7, 1.56 and 3.12 µg/ml against B.subtilis, S. aureus and Mycobacterium smegmatis respectively.

Rwangobo et al., (1988) had isolated Umbengerin, a poly methoxylated flavone, from methanol extract of dried leaves of Lantana trifolia.
This compound exhibited *in vitro* antibacterial and antifungal activity in concentrations up to 200 µg/ml against various pathogens.

Musui *et al.*, (1989) had isolated an antifungal compound 9, 12, 13 trihydroxy - (E) - octadecanoic acid from the tubers of *Colocasia antiquorum* inoculated with black rot fungus *Ceratocystis fimbriata*.

De Goday *et al.*, (1991) had isolated xanthohylin from the leaves of *Sebastiania schottiana*. It was a phenolic derivative showing antibacterial activity against *E. coli, Enterobacter cloacae, E. aerogenes, S. aureus, S. saprophyticus, Proteus mirabilis, Klebsiella pneumoniae and Morganella morganii*.

De Morais *et al.*, (1991) had purified 2- (2'-Hydroxy-U'-Methoxy-phenyl)-3-methyl-6-methoxy-benzo(b) furan from the leaves of *Indigofera microcarpa*. This compound exhibited activity against *B. anthracis, B. mycoides, B. subtilis, Brucella melitensis, Neisseria catarrhalis and Sarcina lutea*.

Ferdous *et al.*, (1992) had studied the antimicrobial activity of the alkaloids, viz. lanuginosins and oxostephanine from bark of *Polyalthia longifolia* var. pendulla. Both the compounds were found to be active against *B. subtilis, B. cereus, S. aureus, Salmonella paratyphi* and *V. cholerae*. The former also showed activity against *Shigella boydii, S. flexneri, Rhizopus oryzae, R. oligosporum and Trichoderma sp.*

El. Sebarkhy *et al.*, (1994) had isolated two isoflavans from *Astragalus* species. Astragalaluquinone I was isolated from the roots of *A. alexandrinus* and 8-Methoxyvestitol was isolated from the roots of *A. trigonus*. 

25
These compounds exhibited antibacterial activity against *B. subtilis*, *S. aureus*, *M. luteus* and *K. pneumoniae* and antifungal activity against *S. cerevisiae* and *C. albicans*.

Bolanle A. L. (1994) had studied the antibacterial activity of compound identified as diosquinone from the roots of *Diopyros tricolor*. It was shown to be active against sixteen bacteria which include *S. asureus*, *S. albus*, *B. subtilis*, *E. coli*, *P. aeruginosa*, *P. mirabilis*, *S. typhi*, *Staph. saprophyticus*, *Streptococcus pyogenes*, *C. diphtheriae*, *Enterococcus aerogenes*, *Litseria monocytogenes*, *Klebsiella sp.*, *Yersina sp.* and *H. influenzae*.

Ratsimamanga *et. al.*, (1994) had purified two flavonoids, euchrestaflava-non A and abyssinone V from aerial parts of *Tephrosia linearis* and abyssinone V from the aerial parts of *T. linearis* and *Mundulea monatha*. These compounds were found to be active against *S. aureus*, *S. epidermidis*, *S. hominis*, *Streptococcus agalacticus*, *S. haemolyticus*, *S. pneumoniae* and *Pseudomonas maltophilia*.

Muhammad *et. al.*, (1995) had isolated a diterpene totarol from the bark and leaves of *Juniperus procera*. Study of its antibacterial action revealed the activity of this compound against *Pseudomonas aeruginosa*, *B. subtilis*, *S. aureus*, *Streptococcus durans*, *Enterococcus faecium*, *Mycobacterium chelonei*, *M. interacellulare*, *M. smegmatis* and *M. xenopei*.

Matsuura *et. al.*, (1995) had investigated antibacterial and antifungal compounds from the branches of *Empetrum nigrum*. A phenolic derivative called Batatasin-III was found to be active against *P. aeruginosa*, *E. coli*, *S. aureus*, *B. subtilis* and *C. albicans*. 
Sato et al., (1996) had found that atrocarpin, a flavanoid from *Artocarpus heterophyllus* was active against cariogenic bacteria viz., *Streptococcus mutans, S. mitis, S. oralis, S. salivarius and Actinomyces viscosus.*

Kirimizigul et al., (1996) had tested the antimicrobial activity of three triterpenoid glycosides. Transsylvanaside A, B and C from flowers of *Cephalaria transsylvanica.* Antimicrobial activity was recorded against *S. aureus, E.coli, P. vulgaris, P. aeruginosa, K. pneumoniae, Corynebacterium xerosis, Candida utilis, Kluyveromyces fragilis, Aspergillus flavus, and A. oryzae.*

Artizzu et al., (1996) had carried out the investigations on the essential oil of *Cynodon dactylon.* The essential oil prepared from aerial parts contained agropyrene as active constituent which inhibited the growth of *S. aureus, S. epidermidis, Streptococcus agalacties, S. faecalis, B. subtilis, B. thuringiensis, E. coli, P. aeruginosa, K. pneumoniae, P. mirabilis and S. typhi.*

Cimanga et al., (1996) had studied the antimicrobial activity of some alkaloids, cryptolepine, cryptoquindoline, cryptoheptine and quindoline isolated from the roots of *Cryptolepis sanguinolenta.* Out of the four alkaloids, cryptolepine was most active and showed the activity against *E. coli, Shigella dysenteriae, Salmonella typhimurium, S. aureus, K. pneumoniae, Streptococcus faecalis, Vibrio cholerae, Streptococcus pyogenes, P. vulgaris, P. aeruginosa, S. aureus and Candida albicans.* Quindoline showed a good range of antimicrobial action being active against *B. cereus, E.coli, Enterobacter cloacae, K. pneumoniae, Mycobacterium sp., Streptococcus pyogenes, P. vulgaris, P. aeruginosa, S. typhimurium, S. aureus and C. albicans.*

27
Zheng et al., (1996) had isolated two flavones from the aerial parts of *Artemisia giraltdii*. These compounds exhibited antimicrobial activity against *S. aureus*, *E. coli*, *P. aeruginosa*, *Proteus sp.*, *Sarcina lutea*, *Aspergillus flavus* and *Trichoderma viridae*.

Verma et al., (1997) had performed the investigations on the active antimicrobial principle from *Lantana camara*. They isolated pectolinarigenin-7-0-β-0-glucoside C, a flavone glucoside, from the leaves of *L. camara*. This compound displayed a broad range of antibacterial activity. It was found to be active against *S. aureus*, *S. albus*, *Streptococcus pyogenes*, *Streptococcus pneumoniae*, *Shigella dysenteriae*, *E.coli*, *P. mirabilis*, *K. pneumoniae*, *P. aeruginosa* and *Staphylococcus viridans*.

Okunade et al., (1997) had purified a compound 2,6-dihydroxy-4-methoxy chalcone from the leaves of *Piper aduncum*. Antimicrobial activity of this compound was recorded against *P. aeruginosa*, *S. aureus*, *B. subtilis*, *Cryptococcus neoformans* and *Candida albicans*.

Smirnov et al., (1998) had studied the antimicrobial activity of *Bidens cernua*. They isolated a sesquiterpene phenol, Cernuol from the aerial parts of *Bidens cernua*. Significant antibacterial activity of this compound was observed against *S. aureus*, *Streptococcus pyogenes*, *S. faecalis*, *B. subtilis*, *B. cereus*, *Mycobacterium tuberculosis* and *Corynebacterium diphtheriae*. This compound was also active against some fungi viz. *Microsporum canis*, *Trichopyton rubrum*, *Epidermphyton floccosum* and *Candida albicans*. 
Citoglu et al., (1998) had isolated a diterpenoid hispanolone from the leaves of *Ballota saxatilis*, showing activity against *S. aureus*, *Streptococcus faecalis*, *P. aeruginosa*, *E. coli*, *K. pneumoniae* and *Candida albicans*.

Didry et al., (1999) had investigated the antibacterial properties of three phenylpropanoid derivatives from the aerial parts of *Ballota nigra*. Among these, verbascoside exhibited activity against *S. aureus*, *E. coli* and *P. mirabilis*. Whereas Forsythoside B and Arenarioside were active against *S. aureus* and *P. mirabilis*.

Dharmaratne et al., (1999) had found that calozejyloxanthone derived from *Calophyllum moonii* and *C. lankensis* was active against methicillin resistant *S. aureus*.

Lemma et al. (2002) had isolated a compound 5-hydroxy-2 methyl-1, 4-naptho quinone, plumbagin, by activity guided chromatographic purification of the petroleum ether extract of roots of *Plumbago zeylanica*. This compound was found to be active against some pneumonia causing pathogens. Minimum Inhibitory Concentration (MIC) value of this particular compound showed comparative activity resembling the commonly used broad spectrum antibiotic, tetracycline.
2.4 Ayurvedic Medicinal uses of Selected Plants Concerned with Infections Diseases

<table>
<thead>
<tr>
<th>Plant</th>
<th>Abrus precatorius Linn.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
<td>Fabaceae</td>
</tr>
<tr>
<td>Sanskrit name</td>
<td>Goonja</td>
</tr>
<tr>
<td>Marathi name</td>
<td>Goonja</td>
</tr>
<tr>
<td>Medicinally useful parts</td>
<td>Roots, leaves and seeds</td>
</tr>
</tbody>
</table>

Three types of Goonja are mentioned in ayurveda (Gogte, 1997). These are Raktagoonja, Swetgoonja & Krishnagoonja. Raktagoonja is the one with scarlet red seed with black eye. It is considered more potent than the other two. Goonja is considered antiseptic and is useful for diseases of eye and skin and for destruction of worms (Shivarajan & Bhalchandra 1994). Its use is also mentioned for sore throat (Dastur, 1970). According to BhavaPrakash goonja is useful for skin diseases (Sharma, 1981). In Dhanvantari Nighantu use of its leaves is mentioned for stomatitis (Warrier et al., 1998). Roots are used for cough (Naik, 1998; Warrier et al., 1998) and pharyngodynia. Seeds are used for wounds, tubercular glands and fever (Warrier et al., 1998).

<table>
<thead>
<tr>
<th>Plant</th>
<th>Adina cordifolia (Roxb.) Hook F.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
<td>Rubiaceae</td>
</tr>
<tr>
<td>Sanskrit name</td>
<td>Haridru</td>
</tr>
<tr>
<td>Marathi name</td>
<td>Hed, Haldu</td>
</tr>
<tr>
<td>Medicinally useful parts</td>
<td>Bark</td>
</tr>
</tbody>
</table>

Bark paste is applied on wounds. According to Raj Nighantu it is useful for skin diseases and is antihelmintic. (Naik, 1998, Sharma, 1981).
<table>
<thead>
<tr>
<th>Plant</th>
<th>Annona squamosa Linn.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
<td>Annonaceae</td>
</tr>
<tr>
<td>Sanskrit name</td>
<td>Sitaphalam</td>
</tr>
<tr>
<td>Marathi name</td>
<td>Sitaphal</td>
</tr>
<tr>
<td>Medicinally useful parts</td>
<td>Leaves and seeds</td>
</tr>
</tbody>
</table>

These parts are mentioned as *jantughna* in Ayurveda (Gogte, 1997). Leaves are suppurrative and insecticidal. They are used as paulice (Naik, 1998, Gogte, 1997).

<table>
<thead>
<tr>
<th>Plant</th>
<th>Anogeissus latifolia (Roxb. ex. DC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
<td>Combretaceae</td>
</tr>
<tr>
<td>Sanskrit name</td>
<td>Dhav</td>
</tr>
<tr>
<td>Marathi name</td>
<td>Dhawada</td>
</tr>
<tr>
<td>Medicinally useful parts</td>
<td>Roots, bark, leaves and Fruits</td>
</tr>
</tbody>
</table>

Roots are used for abdominal disorders and vitiated condition of *kapha* and *vata*. Bark is anti-inflammatory and is used for wounds, ulcers, diarrhoea, dysentery, skin diseases, leprosy and erysipelas (Warrier et al., 1998, Sharma, 1981, Agharkar, 1991).

<table>
<thead>
<tr>
<th>Plant</th>
<th>Baliospermum montanum (willd)Muell,Arg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
<td>Euphorbiaceae</td>
</tr>
<tr>
<td>Sanskrit name</td>
<td>Danti</td>
</tr>
<tr>
<td>Marathi name</td>
<td>Danti</td>
</tr>
<tr>
<td>Medicinally useful parts</td>
<td>Roots, leaves and Seeds</td>
</tr>
</tbody>
</table>

According to *Bhavprakash* and *Sushruta* *Sutrasathan* bark is useful for skin diseases, roots and seeds are anti-inflammatory and leaves have applications in branchitis and on wounds (Sharma, 1981). Danti is useful for scabbies (Naik, 1998). Its roots are useful in jaundice, leprosy, skindiseases and on wounds (Warrier, 1998). Leaves have wound curing properties.
Plant - Bauhenia recemosa L.
Family - Caesalpiniaeece
Sanskrit name - Ashmantak
Marathi name - Aapta
Medicinally useful parts - Flowers

Juice of leaves is given with milk and sugar for urinary disorders. It is also given for diarrhoea and dysentery along with black pepper. Decoction of its bark is used for wounds, diarrhoea, mumps, diseases of throat (Naik, 1998). Its bark and fruits are mentioned as krumighna in Ayurveda (Sharma, 1981).

Plant - Boswellia serrata Roxb. ex. Colebr.
Family - Buseraceae
Sanskrit name - Sallaki
Marathi name - Salai
Medicinally useful parts - Bark and gum-resin

According to Bhavprakash its bark is mentioned as jantughna and is useful in skin diseases, dysentery and diarrhoea (Naik, 1998; Sharma, 1981).

Plant - Butea monosperma (Lamk.) Taub.
Family - Fabaceae
Sanskrit name - Kinshuk
Marathi name - Palash
Medicinally useful parts - Bark, flowers, gum, and seeds

Its bark is used for worms, diarrhoea, dysentery, gonorrhoea and ulcers; leaves are useful for diarrhoea, leprosy and skin diseases; seeds are antihelmintic and used for herpes, skin diseases and ring worms (Warrier, 1998).
Its flowers are useful in vaginal diseases and its gum is used for diarrhoea (Naik, 1998). Use of seeds for ringworms and flowers and seeds in skin diseases is mentioned in *Bhava Prakash* (Sharma, 1981).

<table>
<thead>
<tr>
<th>Plant</th>
<th>Careya arborea Roxb.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
<td>Lecythidaceae</td>
</tr>
<tr>
<td>Sanskrit name</td>
<td>---</td>
</tr>
<tr>
<td>Marathi name</td>
<td>Kumbhi</td>
</tr>
<tr>
<td>Medicinaly useful parts</td>
<td>Bark, flowers and leaves</td>
</tr>
</tbody>
</table>

Bark is used in dry cough and for washing wounds (Naik, 1998). It is also useful for bronchitis, worms and dysentery. Leaves are useful in ulcers. Flowers are used for healing vaginal ruptures caused by childbirth (Warrier, 1998). Bark is also effective in skin diseases and its decoction is used to wash and clear boils, abscesses and ulcers (Agharkar, 1991).

_Juice of bark has applications on burns and dental diseases* (Savant, 1974).

<table>
<thead>
<tr>
<th>Plant</th>
<th>Cassia fistula L.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
<td>Caesalpiniaceae</td>
</tr>
<tr>
<td>Sanskrit name</td>
<td>Aaragwadh</td>
</tr>
<tr>
<td>Marathi name</td>
<td>Amaltas</td>
</tr>
<tr>
<td>Medicinaly useful parts</td>
<td>Roots, leaves, pulp of legumes</td>
</tr>
</tbody>
</table>

Bark is used for skin diseases. Pulp is also used for wounds, skin diseases. Its use is also mentioned for stomatitis (Sharma, 1981). *Cassia fistula* is described as antipyretic and antiinflammatory (Kirtikar and Basu, 1975).
Although root, bark and leaves of this plant are medicinally important, their medicinal use is not directly concerned with diseases of microbial etiology. However the root bark is mentioned as antiinflammatory (Naik, 1998).

Its leaves are antiinflammatory (Naik, 1998). According to Dhanvantari Nighantu, the leaves are considered useful for skin diseases and they are mentioned as jantughna. Dhotra has particular importance for the diseases of lungs including asthama.

Awala fruit is well known for its high vitamin C content and antioxidant activity. However some medicinal uses cited in ayurvedic literature indicate its antimicrobial action. Fruits are used for respiratory
disorders (Naik, 1998). They are also considered useful for skin diseases and dandruff according to Bhava Prakash. Juice of fruit is useful in diseases of eye. Washing of eyes with aqueous extract of fruits is also recommended (Gogte, 1997). Paste of leaves with honey or buttermilk is used for the treatment of diarrhoea (Naik, 1998). Juice of leaves has medicinal uses for dysentery (Gogte, 1997).

**Plant** - *Erythrina suberosa* Roxb.

Family - Fabaceae (Papilionaceae)

Sanskrit name - *Paribhadra*

Marathi name - *Pangra*

Medicinally useful parts - Bark and leaves

Bark is considered antiinflammatory and is useful for dysentery and conjunctivitis (Naik, 1998). It has antiseptic action and is used for wounds (Sharma, 1981). Leaves have medicinal application in toothache and otitis media (Naik, 1998). They are useful in skin diseases and are antihelmintic according to Bhava Prakash (Sharma, 1981).

**Plant** - *Ficus recemosa* L.

Family - Moraceae

Sanskrit name - *Udumber*

Marathi name - *Umber*

Medicinally useful parts - Milky exudate, raw fruits, bark and leaves

Milky exudate is used in conjunctivitis and mumps (Naik, 1998). It is also useful in diarrhoea of infants. Raw fruits are given for diarrhoea in adults. Bark has application in leucorrhoea. Decoction of leaves is recommended for washing wounds and gargles (Sharma, 1981). These properties are mentioned in Bhava Prakash and Dhanvantari Nighantu.
<table>
<thead>
<tr>
<th>Plant</th>
<th>-</th>
<th><em>Helicteres isora</em> L.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
<td>-</td>
<td>Sterculiaceae</td>
</tr>
<tr>
<td>Sanskrit name</td>
<td>-</td>
<td><em>Avartani</em></td>
</tr>
<tr>
<td>Marathi name</td>
<td>-</td>
<td><em>Muradsheng</em></td>
</tr>
<tr>
<td>Medicinaly useful parts</td>
<td>-</td>
<td>Fruits and roots</td>
</tr>
</tbody>
</table>

Legumes are useful for scabies in infants and otitis media (Naik, 1998). Powder of legumes is sprinkled on wounds. It is also given for diarrhoea, dysentery and worms (Sharma, 1981).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
<td>-</td>
<td>Euphorbiaceae</td>
</tr>
<tr>
<td>Sanskrit name</td>
<td>-</td>
<td><em>Kampillak</em></td>
</tr>
<tr>
<td>Marathi name</td>
<td>-</td>
<td><em>Kapila</em></td>
</tr>
<tr>
<td>Medicinaly useful parts</td>
<td>-</td>
<td>Red dust from fruit capsule</td>
</tr>
</tbody>
</table>

Kapila powder is antihelmintic and especially used against tapeworms. It has antiseptic action and is applied on wounds with oil (Naik, 1998). It is also recommended for treatment of skin diseases in *Bhava Prakash* and *Dhanvantari Nighantu* (Sharma, 1981).

<table>
<thead>
<tr>
<th>Plant</th>
<th>-</th>
<th><em>Pangania pinnata</em> (L.) Pierre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
<td>-</td>
<td>Fabaceae</td>
</tr>
<tr>
<td>Sanskrit name</td>
<td>-</td>
<td><em>Karanj</em></td>
</tr>
<tr>
<td>Marathi name</td>
<td>-</td>
<td><em>Karanji</em></td>
</tr>
<tr>
<td>Medicinaly useful parts</td>
<td>-</td>
<td>Seeds, Bark and leaves</td>
</tr>
</tbody>
</table>

Oil of seeds is useful for skin diseases (Naik, 1998). It is also antihelmintic. Powder of seeds is recommended for whooping cough. Bark and leaves are mentioned as 'jantughna' and are antiinflammatory. These properties are mentioned in *Bhava Prakash, Sushrut Sutrasthan-45, Kaiyadeva Nighantu* and *Dhanvantari Nighantu* (Sharma, 1981).

**Family** - Solanaceae

**Sanskrit name** - *Bruhati*

**Marathi name** - *Dorti*

**Medicinaly useful parts** - Fruits, leaves and roots

Roots are used for treatment of cough and skin diseases. Use of leaves is also mentioned for skin diseases. Fruits are useful for vaginal diseases (Naik, 1998, Sharma, 1981).

**Plant** - *Soymida febrifuga* (Roxb) A. Juss

**Family** - Meliaceae

**Sanskrit name** - *Mansrohini*

**Marathi name** - *Rohan*

**Parts useful** - Bark and roots

Bark has medicinal importance for the treatment of chronic dysentery, diarrhoea, for washing wounds and gargles. Roots are used for treating leukorrhea (Naik, 1998). Bark is antiseptic and its use is recommended in stomatitis, toothache, dysentery, diarrhoea and malaria (Sharma, 1981).

**Plant** - *Syzygium cumini* (L.) Skeels

**Family** - Myrtaceae

**Sanskrit name** - *Jambu*

**Marathi name** - *Jambhul*

**Medicinaly useful parts** - Fruits, leaves and bark

Juice of leaves is given with honey for treatment of diarrhoea. Juice of young leaves is given along with goat milk in infant diarrhoea. Bark is useful for mouth ulcers and seeds are used for pimples (Naik, 1998). Use of oil extract of leaves is mentioned for syphilis. According to *Raj Nighantu*, decoction of bark and powder of seeds have applications in diarrhoea and dysentery (Sharma, 1981).
Plant - *Woodfordia fruticosa* (L.) Kurtz
Family - Lythraceae
Sanskrit name - Dhataki
Marathi name - Dhayati
Medicinally useful parts - Flowers

Flowers are added while preparation of *Aasav* (Ayurvedic Medicines prepared by Fermentations). It prevents the development of acidity in 'Aasav'. 'Avaleha' prepared from the flowers is useful for diarrhoea and chronic dysentery (Naik, 1998). According to *Bhava Prakash* and *Raj Nighantu* flowers are described as 'jantughna'. They are useful for skin diseases for curing wounds and burns (Sharma, 1981). *Woodfordia fruticosa* is also recommended for diseases associated with teething trouble in children (Jain, 1994).

Plant - *Plumbago zeylanica* L.
Family - Plumbaginaceae
Sanskrit name - Chitrak
Marathi name - Chitrak
Medicinally useful parts - Roots

Roots of this plant are used for treatment of skin diseases. They are used as poultice. They are antihemintic. They are also useful in cough (Naik, 1998, Shrama, 1981). It is used in many ayurvedic preparations for treatment of skin diseases and leprosy.

Plant - *Terminalia bellirica* (Gaertn.) Roxb
Family - Combretaceae
Sanskrit name - Vibhuitak
Marathi name - Behada
Medicinally useful parts - Fruits
Fruits are useful for treating diarrhoea. They are antihelmintic. Their use is recommended for diseases of eye (Naik, 1998). In *Bhava Prakash* and *Sushrut Sutrasthan-46*, *Vibhitak* is described as antiinflammatory. Its applications are mentioned for skin diseases and conjunctivitis. It is commonly used in cough (Sharma, 1981).

<table>
<thead>
<tr>
<th>Plant</th>
<th>Terminalia chebula (Retz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
<td>Combretaceae</td>
</tr>
<tr>
<td>Sanskrit name</td>
<td>Haritaki</td>
</tr>
<tr>
<td>Marathi name</td>
<td>Hirda</td>
</tr>
<tr>
<td>Medicinaly useful parts</td>
<td>Fruits</td>
</tr>
</tbody>
</table>

Fruits are useful for abscess, wounds, mouth ulcers and mumps. According to *Bhava Prakash*, the fruits are described as antiinflammatory, antiseptic and antihelmintic. Their use in recommended for skin diseases, and are commonly used for cough (Sharma, 1981).

<table>
<thead>
<tr>
<th>Plant</th>
<th>Hardwickia binata (Roxb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
<td>Caesalpiniaceae</td>
</tr>
<tr>
<td>Sanskrit name</td>
<td>---</td>
</tr>
<tr>
<td>Marathi name</td>
<td>Anjan</td>
</tr>
<tr>
<td>Parts useful</td>
<td>Viscus juice from tree</td>
</tr>
</tbody>
</table>

This is not a plant commonly used in Ayurveda.

<table>
<thead>
<tr>
<th>Plant</th>
<th>Maytenus emerginata (Willd) D. Hou.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
<td>Calestraceae</td>
</tr>
<tr>
<td>Sanskrit name</td>
<td>---</td>
</tr>
<tr>
<td>Marathi name</td>
<td>Bharati</td>
</tr>
<tr>
<td>Medicinaly useful parts</td>
<td>Roots and leaves</td>
</tr>
</tbody>
</table>

This is not a plant commonly used in Ayurveda.
Plant - *Ixora arborea* (Roxb. ex. Sm.)
Family - Rubiaceae
Sanskrit name - ---
Marathi name - Lokhandi
Medicinally useful parts - Whole plant

This plant is not commonly used in Ayurveda. Its folk medicinal use is mentioned for urinary disorders (Savant, 1974)

### 2.5 Modern Scientific Investigations on the Selected Plants

Agina *et al.*, (2000) had tested the ethanolic extract of seed testas of *A. precatorius* against *E. coli, K. aerogenes, P. aeruginosa, S. aureus* and *S. faecalis*. No antibacterial activity was detected. Yadava and Reddy, (2002) had isolated a flavonol glycoside from the chloroform soluble fraction of the 80% methanolic extract of seeds of *A. precatorius*. The extract was reported to exhibit antibacterial activity against *S. aureus, K. pneumoniae* and *E. coli* and antifungal activity against *A. niger* and *F. oxysporum*.

Vijayalakshmi and Amirthaveni, (2002) had studied the effect of *Siddha* medicine containing *A. precatorius* as one of the components on patients and found that the *Siddha* treatment reduced the occurrence of symptoms associated with worm infections. Incidence of *E. coli, Ascaris lumbricoides* and *Entamoeba histolytica* was also reported to be significantly reduced. Fungitoxic effects of ethanolic extracts of roots of *A. precatorius* was studied by Kumaran *et al.*, (2003) fungitoxic effect was evaluated against anthracnose in chilli caused by *Colletotrichum capsici*. Their findings indicate significant inhibitory effects on conidial germination and radial growth of the fungus.
So far there have not been any reports on the antimicrobial activity of *Adina cordifolia*. However, alcoholic extracts of leaves of this plants were found to posses insecticidal properties (Ahmad *et al.*, 1996) and antifeedant potency (Mukhtar Ahmad *et al.*, 1997).

Bettarini *et al.*, (1993) had isolated a compound 'anomone' from *A. squamosa* that showed fungicidal activity against *Fusarium moniliforme* and *Aspergillus niger*. Wu-Yang Chang *et al.*, (1996) had isolated a kaurane derivative from the extract of *A. squamosa* plant showing significant activity against HIV replication.

Babu *et al.*, (2000) had studied the fungitoxic effect of *A. squamosa* seed extract on the mycelial growth and spore germination of *Alternaria solani*, the causal agent of tomato leaf blight. The extract was reported to be effective. Bhaskar *et al.*, (2002) had conducted a study to determine the efficacy of different botanical extracts for the management of dry corn rot disease caused by *Rhizoctonia solani* Kuhn. No disease incidence was observed for treatment receiving 100 g/litre leaves extract of *A. squamosa*. Umesh Dimri *et al.*, (2001) had reported the activity of an indegenous preparation containing *A. squamosa* as one of the component on ring-worm infection of sheep. All the dermatomycotic sheep recovered after treatment with the indigenous preparation.

Adhav, (2000) had studied the antimicrobial properties of organic and aqueous extracts of *Baliospermum montanum*. In her investigations ethanol and water extracts of leaves of this plant showed activity against *S. aureus*, *E. coli*, *S. dysenteriae* and *P. aeruginosa*. No activity was shown by
petroleum ether, chloroform and benzene extracts. None of the extracts were found to possess any antifungal activity.

Ali et al. (1999) had performed the antimicrobial screening of some plants of Caeselpiniaceae. They had tested hexan and methanol extracts of whole plant of Bauhinia recemosa against some bacteria and fungi. Hexane extract was found to be active only against S. aureus and some fungi viz. Trichophyton longifuses, Pseudallescheria boydii, Aspergillus niger and Microsporum canis. Methanol extracts had shown activity against S. aureus, Salmonella typhi, Streptococcus pyogenes, P. aeruginosa, Shigella boydii and Shigella sonnei, T. longifuses, P. boydii, M. canis, T. simii, T. schoenleinii and Fusarium solani.

Garg. (1974) had tested the antifungal activity of oils derived from leaves B. serrata. The oil had shown the inhibitory effect on several fungi. Review of literature for B. serrata indicated that extensive pharmacological and clinical studies were performed on gum-resin, known as salai guggul, obtained from this plant. A special symposium was held on salai guggul in Germany during 3-7 Sep. 1995. These studies were aimed at investigating the antiinflammatory nature of boswellic acids present in the gum resin of B. serrata, that has therapeutic value in the treatment of rheumatoid arthritis. Alcoholic extract of the gum resin and boswellic acids isolated from the gum resin were shown to be a new type of non-steroidal antiinflammatory drug that inhibits the formation of leukotriene (LTB4) (Ammon, 1996; Trubestein, 1999; Wildfeuer et al., 1998; Singh et al., 1996). Gum resin of this plant was also investigated for its anticancer effects (Duran and Duran, 2002; Park et al., 2002).
Porwal et. al., (1998) had studied the antibacterial and antifungal activity of extracts of outer seed coat of *Butea monosperma*. Hexan extract was found to be active against some bacteria whereas ethanolic extract was found to be active against some fungi. Zafar et. al., (1989) had worked on the antibacterial activity of chloroform, methanol and aqueous extracts of the leaves of *B. monosperma* against *S. aureus, B. pumilus and E. coli*. Strongest activity was found in the methanolic extract.

Umesh Dimri et. al., (2001) had tested the potency of an indigogenous herbal preparation containing *B. monosperma* as one of the constituent along with *Argemone maxicana, Annona squamosa* and *Melia azardirachta* against ringworm infection of sheep. Recovery of all the dermatomycotic sheeps after a month was reported. Vijayalakshmi and Amirhaveni, (2002), had studied the effect of capsules of *Siddha* medicines containing *B. monosperma* as one of the component on the patients with *E. histolytica, E. coli, Ascaris lumbricoides* infection. The drug was found to be effective.

Mishra et. al., (1996) had reported that the hexane fraction of the fruits of *Cassia fistula* exhibited activity against *Klebsiella sp.* Wongkaew et. al., (1997) had studied the crude leaf extract of *C. fistula* against *Erwinia caratovora, Pseudomonas solanacearum* and *Xanthomonas campestris*. They observed the suppression of these bacteria with ED 50 of about 100,000 ppm. Samy et.al., (1998) had reported significant activity in *C. fistula* against *E. coli, K. aerogenes, P. vulgaris and P. aeruginosa*. Yadava et. al., (2003) had isolated a new flavone glycoside from the acetone soluble fraction of seeds of *C. fistula*. This compound showed antimicrobial activity against *S. aureus, B. subtilis,*
K. pneumoniae, E. coli, A. niger and F. oxysporum.

Kaushik et al., (2003) had screened 41 plant species for biocidal activity against B. megatherium, E. coli, P. fluorescence, Sarcina lutea, Staphylococcus spp. and Xanthomonas spp.. In their study, aqueous leaf extract of C. fistula was found to be effective against all test bacteria. High potency was observed for fresh cold water and fresh hot water extracts of C. fistula against B. megatherium and S. lutea. Sundriyal, (1991) had studied the fungitoxic properties of flower extracts of some wild plants of Garhwal Himalaya. They observed inhibition of spore germination and germ tube growth of Alternaria solani by the flower extract of C. fistula.

Ganguli, (1994) had studied the fungitoxic effect of some plant extracts against Pyricularia oryzae and Helminthosporium oryzae. Among all the extracts tested lowest antifungal activity was detected in Datura metel extracts. Thakur et al., (1995) had tested some plant extracts for inhibition of some cotton pathogens including Myrothecium roridum, Alternaria tenuis, and Xanthomonas campestris. Antifungal and antibacterial activity was detected in D. metel extracts. Bambawale et al., (1995) also had studied the efficacy of some medicinal plants against cotton pathogens. In their investigations extracts of D. metel was found to be inhibitory for the spore germination and mycelial growth of Alternaria macrospora and for Xanthomonas campestris.

Datar, (1994) had performed the investigations on purple blotch of onion. Significant reduction in the conidial germination of Alternaria porri, the causative agent, was observed with aqueous extract of D. alba (D. metel). Sindhan et al., (1999) had worked on the effect of leaf extracts of
certain plants including *D. metel* on growth of root rot causing fungi *Rhizoctonia solani* and *R. bataticola*. They found more than 60% inhibition of mycelial growth of both the fungi by extract of *D. metel*.

Kishore *et. al.*, (2001) had evaluated the effect of some plant extracts for the control of late leaf spot of groundnut (*Arachis hypogaea*). Aquous and ethanol leaf extracts of *D. metel* were found to completely inhibit the conidial germination of *Phaeoisariopsis personata*. Aquous leaf extract of *D. metel* at 2% concentration effectively reduced the development of late leaf spot by more than 60%. Gnanamani *et. al.*, (2003) had tested the antibacterial activity of crude alcoholic extract of *D. alba* leaves against pathogens isolated from infected burn patients. Considerable antibacterial activity was present in the extract that was comparable to the silver sulphadiazine cream.

Priya *et. al.*, (2002) had studied the healing potential of *D. alba* on burn wounds in albino rats. Crude alcoholic extract exhibited antimicrobial effect against all the pathogen tested. When 10% formulation of alcoholic extract was topically applied on thermal wounds, complete wound closure was observed within 12 days in treated rats.

Rajesh and Sharma, (2002) had investigated the antymycotic properties of *D. metel* against pathogenic species of *Aspergillus*. Out of hexane, chloroform, acetone and methanol fractions, chloroform fractions showed antymycotic activity with MIC of 625 μg/ml. by microbroth dilution and percent spore germination assays. The MIC by the disc diffusion assay was observed to be 12.5 μg/disc. The chloroform fraction was 9.2 times less active than amphotericin B. However its cytotoxicity was 117.8 times less than that of
amphotericin B. Antifungal activity of D. metel had also been reported by Gomathi and Kannabiran, (2000), and Achala Shrivastava et al., (1998).

Ray and Mujumdar, (1976) had checked the antimicrobial activity of 105 Indian species. Fruits of Emblica officinalis had shown both antibacterial and antifungal activity. Akhtar (1997) had tested 208 diffusates of various plants against Xanthomonas campestris pv. citri. Diffusates of various parts of E. officinalis exhibited inhibition zones measuring 4.8 to 6 mm at 50 g/litre concentration. Iqbal Ahmad et al., (1998) had screened 82 Indian medicinal plants for activity against various pathogenic and opportunistic bacteria at 200 mg/ml concentration. Alcoholic extracts of E. officinalis, Terminalia bellirica, T. chebula and Plumbago zeylanica showed potentially interesting activity.

Dutta et al., (1998) had studied the antifungal activity of plant extracts. Water extracts of T. chebula (leaf, bark and dry fruits), E. officinalis (bark) and Syzygium cumini leaves demonstrated antifungal activity against some species of Trichophyton and Microsporum. Complete inhibition of growth of C. albicans was not obtained with any of these extracts.

Zafar Mehmood et al., (1999) had evaluated the potential of 37 Indian medicinal plants against C. albicans and some dermatophytes. Strong anticanidial activity was observed in alcoholic extracts of E. officinalis (MIC-7 mg/ml), P. zeylanica (MIC-4 mg/ml), T. bellirica (MIC-7 mg/ml) and T. chebula (MIC-9 mg/ml). Zafar Mehmood et al., (2000) had studied the activity of 'Triphala' against C. albicans. Hexane, water and ethanolic extracts were tested at 200 mg/ml concentration. Hexane extract was found to be ineffective whereas ethanolic extract of triphala and its components E. officinalis, T. bellirica and T. chebula exhibited strong anticanidial activity.
Sharma and Bhardwaj, (2000) had performed a study on the management of storage scab (*Venturia inaequalis*) of apple fruits using plant extracts and yeast antagonists. Study revealed that the water extract of *E. officinalis* leaves (15%) was highly effective and provided complete control upto 60 days of storage. Iqbal Ahmad and Beg (2001) had conducted a study to test the antimicrobial activity of 45 Indian medicinal plants against multi-drug resistant human pathogens. Broad spectrum antimicrobial activity was observed for ethanolic extracts of 12 plants including *E. officinalis*, *T. bellirica*, *T. chebula*.

Mandal *et. al.*, (2000) had tested the antibacterial potential of extracts of *Ficus recemosa* leaves against standard cultures of *E. coli*, *B. pumilus*, *B. subtilis*, *P. aeruginosa* and *S. aureus*. Significant inhibition was obtained especially with petroleum ether extracts. Otake *et. al.*, (1995) had screened 30 Indonesian plant extracts for the inhibitory activity against HIV-I. Water extract of *Helicteres isora* was found effective along with 5 other plant extracts. There ED 50 values ranged from 42 to 175 µg/ml. Ray and Majumdar (1976) had screened 105 Indian plant species. Few species showed antibacterial and antifungal activity which include seeds of *Mallotus philippensis*, fruits of *E. officinalis*, *T. bellirica* and *T. chebula*.

Bhaskar *et. al.*, (2002) had conducted a study on the effectiveness of different plant extracts on dry corn root disease of *Amorphophallus* caused by *Rhizoctonia solani* Kuhn. *Pongania pinnata* leaves extract was found to be effective along with *Alium sativum* (bulb), *Annona squamosa* (leaves) and *Azardirachta indica* (seed kernel). No disease incidence was observed for treatments receiving 100 g/litre of these extracts. Kishore *et. al.*, (2001) while studying the control of late leaf spot of groundnut
(Arachis hypogaea) by extracts of non-host plant species, observed that aqueous leaf extract of *P. pinnata* inhibited the conidial germination by more than 90%.

Meena *et. al.*, (2002) had investigated effect of some plant extracts on sheath blight of rice caused by *Rhizoctonia solani*. According to their study, no significant inhibition of the fungus was obtained with *Solanum indicum* leaf extract.

Gond, (2000) had tested the antibacterial activity of *Soymida febrifuga* against various pathogenic bacteria. Aquous and methanol extracts were active against *S. aureus, E. coli, B. subtilis, S. typhi, P. aeruginosa, P. vulgaris, Sh. dysenteriae and V. cholerae*. No antifungal activity against *A. niger* was detected. Phytochemical investigations of the methanol extract revealed the presence of alkaloids, saponins and tannins. Minimum inhibitory concentration values for all the organisms ranged between 0.5 - 2 mg/ml.

Kusumoto *et. al.*, (1995) had noted the inhibitory effect of methanol extract of *Syzygium cumini* bark on HIV-1 protease. Dutta *et. al.*, (1998) had studied the activity of aqueous extracts of *S. cumini* (leaves and bark), *Terminalia chebula* (leaves, bark and fruits) and *E. officinalis* bark and some other plants against some dermatophytes. These extracts showed antifungal activity against some species of *Trichophyton* and *Microsporum*. No inhibition was obtained for *C. albicans*.

Chattopadhyay *et. al.*, (1998) had investigated the antibacterial activity of *Syzygium* species. Extracts of stem, bark and/or leaves of *S. andamonicum, S. cumini* and *S. samarangense* were tested against 10 bacterial strains. Significant antibacterial activity was recorded for extracts of
S. cumini. Shafi et al., (2002) had evaluated the antibacterial activity of essential oil of S. cumini and S. travancoricum leaves. Considerable antibacterial activity was noted in these oils especially against Salmonella typhimurium.

Woodfordia fruticosa flowers are added during fermentation for preparation of Asav and Arista. Kroes et al., (1993) had investigated the effect of addition of W. fruticosa flowers during preparation of "Nimba arishta". They concluded that flowers of W. fruticosa contribute to the preservation of Nimba arishta. Gallic acid released by the flowers acts as antioxidant. Furthermore they found that there was increase in the immunomodulatory activity of the drug because of immunoactive constituents released from flowers. Suhail F. et al., (2000) carried out the clinical evaluation of some unani drugs on inflammatory vaginal discharge. Vaginal tablets containing W. fruticosa were given intra-vaginally for 15 days. Significant improvement was observed.

Dama et al., (1998) had studied the antimicrobial activity of napthoquinonic compounds isolated from Plumbago zeylanica, Juglans regia and Lawsonia alba. All three napthoquinones inhibited the growth of E. coli, K. pneumoniae, Campylobacter jejuni, Staphylococcus sp., Bacillus sp., Mycobacterial sp., Corynebacterium diphtheriae, Aspergillus sp., Helminthosporium sp. and C. albicans. Iqbal Ahmad (1998) had screened 82 Indian medicinal plants for this antimicrobial properties. Potentially interesting activity against the test bacteria was observed in ethanolic extracts of P. zeylanica, Terminalia bellirica, T. chebula, E. officinalis and Holarrhena antidysenterica.
Beg *et al.*, (2000) had tested the effect of alcoholic extract of *P. zeylanica* against multidrug resistant clinical isolates of *S. paratyphi, S. aureus, E. coli, S. dysenteriae* and an R-plasmid harbouring strain of *E. coli X4* (pUK 651). The extract exhibited strong antibacterial activity against all test bacteria irrespective of their antibiotic resistance behaviour. The plant extract could eliminate R-plasmid from *E. coli*. Plasmid curing with this plant extract was 14% as compared to pefloxacin (88%) and acidine arange (14%). Phytochemical analysis of the crude extract revealed the presence of flavonoids, saponins and naphthoquinone.

Iqbal Alunad *et al.*, (2001) had evaluated the antimicrobial potency of *P. zeylanica, T. belirica, T. chebula, E. officinalis* and *Holarrhena antidysenterica* in terms of their MIC against several organisms. MIC values ranged from 950 to 9000 mg/ml for *T. chebula, 1000 to 8000 mg/ml for H. antidysenterica, 3000 to 5000 for Plumbago zeylanica and 4000 to 8000 mg/ml for T. belirica*. Maximum anticandidial potency was recorded for *P. zeylanica* extract and minimum for *T. chebula* extract.

Zafar Mehmood *et al.*, (2001) had tested 25 combinations of five alcoholic plant extracts which include *P. zeylanica, T. belirica, T. chebula, E. officinalis* and *H. antidysenterica* extracts against *E. coli, S. aureus* and *C. albicans*. Total 10 formulations showed good synergistic activities leading to a significant reduction in the MIC values.

Lemma *et al.*, (2002) had studied the antibacterial activity of polar and non polar extract of *P. zeylanica* roots. Aqueous extract did not exhibit any activity. Whereas petroleum ether extract possessed strong
antibacterial activity against some pneumonia causing pathogens. Ethanol extract also showed significant activity. They isolated a compound 5-hydroxy-2 methyl-1, 4-naphtho- quinone (plumbagin) from the petroleum ether extract by activity guided chromatographic purification. MIC value of this compound was comparable with MIC of tetracycline.

Gowda et al., (1975) had studied the antimicrobial activity of T. chebula fruit extract and found it inhibitory to Pseudomonas solanacearum, the causal agent of bacterial wilt of tomatoes, capsicums and eggplants. None of the fungi tested was inhibited.

Sato et al., (1997) had isolated two potent antimicrobial compounds, gallic acid and its ethyl ester from the ethanol extract of fruits of Terminalia chebula. These were found to be effective against methicillin resistant strains of S. aureus.

Nandy et al., (1997) had studied the antimicrobial activity of constituents from stem bark of Terminalia bellerica. Eleven triterpenoids were isolated. Of these, methyl esters of arjungenin showed marked inhibitory activity against Gram positive and Gram negative bacteria. Arjungenin, belliric acid bellericagenin and their corresponding ester glycosides and methyl ester of belleric acid showed moderate antimicrobial activity.

Valsaraj et al., (1997) had performed a bioactivity guided fractionation of an extract of fruit rind of T. bellerica. Two lignans named termilignan and thannilignan together with 7-hydroxy-3', 4'- (methyleneedioxy) flavan and anolignan B exhibited anti-HIV, antimalarial (against Plasmodium falciparum strain 3D7) and antifungal (against Penicillium expansum and Candida albicans) activities in vitro.
Jagtap and Karkare, (1999) had evaluated the potential of aqueous extract of *T. chebula* fruits as an anticaries agent. The extract strongly inhibited the growth, sucrose induced adherence and glucan induced aggregation of *Streptococcus mutans*. Mouth rinsing with extract significantly reduced total bacterial counts and the total streptococcal counts in the saliva samples obtained upto 3 hrs. after rinsing, compared with the counts obtained prerinsing or after placebo rinsing.

Malekzadeh *et. al.*, (2001) had studied the effect of ether, alcoholic and water extracts of *T. chebula* on 10 clinical isolates of *Helicobacter pylori*. Water extract showed significant antibacterial activity and had minimum inhibitory concentration of 125 mg/lit. and minimum bacteriocidal concentration 150 mg/litre. The antimicrobial activity of the extract was heat stable.

Sugana *et. al.*, (2002) had assessed the effect of topical administration of an alcohol extract of the leaves of *T. chebula* on the healing of rat dermal wounds. *T. chebula* treated wounds healed much faster as indicated by improved rates of contraction and a decreased period of epithelialization. Reduced lipid peroxidase leavels in treated wounds, as well as ESR measurement of antioxident activity by DPPH radical quenching suggested that *T. chebula* possessed antioxidant activities. This activity together with its antimicrobial activity were proposed to be responsible for the beneficial effects of *T. chebula* in the acceleration of the healing process.

Cao-KeQiang *et.al.*, (2003) had developed a semi-field screening system to determine the effectiveness of plant compounds against
potato blight (*Phytophthora infestans*) under varying climatic conditions in Switzerland. Extracts of *T. chebula* along with some other plant extracts and copper hydroxide were sprayed on potato plants in the field, leaves were detached at different times and infected in laboratory. The protective effects of *T. chebula* were found similar to that of 100g copper hydroxide. The effectiveness of the plant extracts was strongly reduced by exposure for more than 48 hrs. under field conditions as well as rainfall.