

A Review on Anti-Tubercular Plants

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Abstract: Tuberculosis (TB) is a disease that has affected mankind from very ancient times. Anti-TB allopathic medications have been prescribed to control symptoms of this disease but results into side effects like hepatitis, hypersensitivity reactions, nausea, vomiting *etc.* The use of herbal medicine becoming popular due to toxicity and side effects of allopathic medicines. Medicinal plants from Ayurveda (Indian traditional medicine system) and from foreign origin have been successfully employed to treat TB. The aim of this review is to highlight the work on anti-tubercular plants. About 48 plants have been explained in this particular review which have the potential of anti-tubercular activity are identified from various sources in the literature. The present paper involves various plant drugs along with their chemical constituents responsible for anti-tubercular activity. This review work stimulates various researchers for further research on the potential use of medicinal plants having anti-tubercular activity.

Keywords: Tuberculosis, anti-tubercular, natural, ayurveda.

Introduction

Tuberculosis

Tuberculosis (TB) is principally a disease of poverty, with 95 per cent of cases and 98 per cent of deaths occurring in developing countries¹. Tuberculosis (TB) is a bacterial infection caused mainly by *Mycobacterium tuberculosis* (MTB). The development of paleopathology and paleoepidemiology in infectious diseases has proven the very ancient origin of this disease². TB is the most common cause of death due to a single infectious agent worldwide in adults. In 1993, the World Health Organization (WHO) took an unprecedented step and declared TB to be a global emergency¹. The exact cause of this is unknown, although it is thought that it could be because of the resurgence of TB due to HIV infection as well as Multiple Drug Resistant Tuberculosis (MDR-TB) due to inefficient management. Each year an estimated eight million new cases and two million deaths occur due to TB world wide³.

Tuberculosis is the major opportunistic infection of HIV/AIDS in developing countries⁴. Anti-tuberculosis

drugs are a two-edged sword. While they destroy pathogenic *M. tuberculosis* they also select for drug resistant bacteria against which those drugs are then ineffective. Global surveillance has shown that drug resistant tuberculosis is widespread and is now a threat to tuberculosis control programs in many countries⁵. The drugs now available for the treatment of tuberculosis were discovered in a period of two decades (1944-1965), during which a relatively intensive search was carried out in various industrial and nonindustrial laboratories. There are many reasons for the decreased interest in research on new anti-tuberculosis drugs. First, success attained with short-course chemotherapy involving combinations of the available powerful drugs led to the incorrect assumption that there was no real need for other products. Second, large-scale screening systems for the detection of new anti-tuberculosis agents are particularly time-consuming and entail some problems related to the handling of the pathogen. Third, the development of an anti-tuberculosis drug takes more time and human resources than the development of other antimicrobial agents. Finally, and probably most

important, tuberculosis is predominant in developing countries with few economic resources and industrial laboratories are reluctant to invest in research for new products to be used in those geographic areas, where an additional drawback is the lack of patent protection⁶.

Anti-TB drugs consist of two groups: essential or first-line drugs, which are usually used for the treatment of TB patients with susceptible *Mycobacterium tuberculosis*; and reserve or second-line anti-TB drugs used for the treatment of multidrug-resistant TB (MDR-TB). Second-line drugs have many more adverse effects than the first-line anti-TB drugs⁷. The adverse effects of anti-TB drugs are given in table 1⁸⁻¹⁴.

Natural products as Anti-TB agents

Natural products including plants, animals and minerals have been the basis of treatment of human diseases. History of medicine dates back practically to the existence of human civilization. The current accepted modern medicine or allopathy has gradually developed over the years by scientific and observational efforts of scientists¹⁵.

Natural products as crude materials with efficacy against various diseases have been selected by humans over many generations of practical experience. Such experiential evaluation is different from the scientific

evaluation of western medicines and is underestimated sometimes. However many effective medicines, including as morphine, aspirin, atropine, ephedrine, reserpine and digitoxin were developed from natural products¹⁶.

Medicinal plants, since times immemorial, have been used in virtually all cultures as a source of medicine. The widespread use of herbal remedies and healthcare preparations, as those described in ancient texts such as the Vedas and the Bible, and obtained from commonly used traditional herbs and medicinal plants, has been traced to the occurrence of natural products with medicinal properties¹⁷.

Ayurveda, literally meaning the "Science of life and longevity" in ancient Sanskrit, is the one of the oldest healing systems of India based on lifestyle, diet and herbs¹⁸. In Ayurveda tuberculosis is known as *Rajayakshma*, *Yakshma*, *Shosha*, *Kshaya*¹⁹. List of plants from Ayurveda has been discussed in Table 2 given below²⁰⁻³⁹.

Anti-tubercular plants from foreign origin

Not only in India, anti-tubercular plants were found all over the world including South Africa, New Zealand, Malaysia, Nigeria, Tibet *etc.* A list of anti-tubercular plants from foreign origin has been shown in Table 3 given below⁴⁰⁻⁶².

Table 1: Adverse effects of Anti-TB drugs⁷⁻¹⁴

Drug	Adverse effects
Isoniazid	Skin rash, hepatitis
Rifampicin	Abdominal pain, nausea, vomiting, hepatitis, thrombocytopenic purpura
Pyrazinamide	Arthralgia, hepatitis
Streptomycin	Vestibular and auditory nerve damage, renal damage
Ethambutol	Retrolubar neuritis, ocular side effects
Thioacetazone	Skin rash, Exfoliative dermatitis
Para-aminosalicylic acid	Anorexia, nausea, vomiting, hypersensitivity reactions
Kanamycin	Vertigo, auditory nerve damage, nephrotoxicity
Ethionamide	Diarrhoea, abdominal pain, hepatotoxicity
Cycloserine	Dizziness, headache, depression, psychosis, convulsions

Table 2: A brief description of common anti-tubercular plants from Ayurveda²⁰⁻³⁹

S.no.	Botanical/family name	Ayurvedic name	Part used	Chemical constituents	Other biological activities
1	<i>Acalypha indica</i> , Euphorbiaceae	Kuppi	Leaves	Kaempferol, acalyphamide and other amides, quinone, sterols, cyanogenic glycoside	Antibacterial, used in bronchitis, asthma
2	<i>Adhatoda vasica</i> . Acanthaceae	Vaasaa	Leaves	Quinazoline alkaloid	Expectorant (used in bronchial asthma)
3	<i>Allium cepa</i> , Liliaceae	Palaandu	Bulbs	Volatile oil with sulphurous constituents, including allylpropyl disulphide, sulphurcontaining compounds, including allicin, alliin, flavonoids; phenolic acids and sterols	Antibiotic, antibacterial, antisclerotic, anticoagulant
4	<i>Allium sativum</i> , Liliaceae	Lashuna	Bulbs	Sulphurcontaining amino acids known as alliin	Antibiotic, bacteriostatic, fungicide, anthelmintic, antithrombic, hypotensive, hypoglycaemic, hypocholesterolaemic
5	<i>Aloe vera</i> , Liliaceae	Ghritkumaarika	Leaves, gel from leaves	Anthraquinone glycosides, known as aloin	Purgative
6	<i>Vitex negundo</i> , Verbenaceae	Nirgundi	Leaves, seeds	Iridoid glycosides, isomeric flavanones and flavonoids	Anti-inflammatory, analgesic
7	<i>Trichosanthes dioica</i> , Cucurbitaceae	Patola	Roots, fruits	Free amino acids, nicotinic acid, riboflavin, vitamin C, thiamine, 5-hydroxytryptamine	Cathartic, febrifuge
8	<i>Tinospora cordifolia</i> , Menispermaceae	Guduuchi	Stem, leaves	Alkaloidal constituents, including berberine; bitter principles, including columbin, chasmanthin, palmarin and tinosporon, tinosporic acid and tinosporol	Antipyretic, antiperiodic, anti-inflammatory
9	<i>Caesalpinia pulcherrima</i> , Caesalpinaceae	Padangam	Leaves, flowers	Flavonoid, myricitroside	Laxative, antipyretic
10	<i>Prunus armeniaca</i> , Rosaceae	Peetaalu	Kernels	Salicylic acid, organic acids tannins and potassium salts. Protocatechuic, <i>p</i> -coumaric, ferulic and diferulic acids	Antitussive, antiasthmatic

11	<i>Ocimum sanctum</i> , Labiatae	Tulasi	Leaves, flowers, Seeds	Ursolic acid, apigenin, orientin luteolin, apigenin-7- Oglucuronide, luteolin-7-O- glucuronide	Carminative, stomachic, antispasmodic, antiasthmatic, antirheumatic, expectorant, hepatoprotective, antiperiodic,
12	<i>Morinda citrifolia</i> , Rubiaceae	Ashyuka	Leaves, roots, fruits	Anthraquinones- alizarin and its glycosides, <i>nor</i> - damnacanthol. Ursolic acid and β - sitosterol. asperuloside and caproic acid	Antileucorrhoeic,antid ysenteric emmenagogue
13	<i>Myrtus communis</i> , Myrtaceae	Muurad- daan	Fruits	Tannins (pyrogallol derivative), flavonoids (including myricetin, kaempferol, quercetin glycosides; volatile oil containing α -pinene, cineole, myrtenol, nerol, geraniol and dipentene	Antimicrobial, antiparasitic antiseptic
14	<i>Canscora decussate</i> , Gentianaceae	Daakuni	Roots	β -amyrin, friedelin,genianine mangiferin, Xanthones	Anticonvulsant, CNS depressant, anti- inflammatory, hepatoprotective.
15	<i>Piper species</i> , Piperaceae	Pippali	Fruits	Aristolactams, dioxoaporphines long chain isobutyl amide, lignans, longamide, pluviatilol, methyl pluviatilol (fargesin), sesamin, asarinine, piperine	Digestive, appetizer and carminative
16	<i>Vitex trifolia</i> , Verbenaceae	Sinduvaara	Leaves, roots, fruits	Flavonoids-artemetin, luteolin, orientin, casticin; and iridoid glycosides, aucubin and agnuside. alkaloid, vitricin	Febrifuge, antibacterial, anthelmintic, cytotoxic
17	<i>Mallotus philippensis</i> , Euphorbiaceae	Kampillaka	Gland and hair of fruit	Phloroglucinol derivatives; rottlerin, isorottlerin, iso allorottlerin	Purgative, anthelmintic, styptic
18	<i>Colebrookea oppositifolia</i> , Lamiaceae	Binda	Leaves, fruits, roots	Flavonoids	Antiinflammatory
19	<i>Rumex hastatus</i> , Polygonaceae	Katambal	Root and bark	Tannins	Astringent
20	<i>Mimosa pudica</i> , Mimosaceae	Laajavanti	Leaves, roots	Mimosine and turgorin	Astringent, alterative
21	<i>Kalanchoe integra</i> , Crassulaceae	Parnabija	Leaves	Triterpenoids-friedelin, taraxerol and glutinol and a mixture of long chain hydrocarbons	Hypotensive, antiarrhythmic.

22	<i>Flacourtia ramontchii</i> , Flacourtiaceae	Vikankata	Leaves, roots, bark, fruits	Phenolic glucoside ester, (-)-flacourtin, ramontoside, β -sitosterol and its β -D-glucopyranoside	Anticholerin
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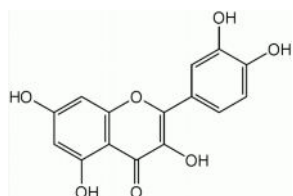
Table 3: List of Anti-Tubercular plants of foreign origin⁴⁰⁻⁶²

S. no.	Botanical name	Family	Extract	Chemical constituents
1	<i>Clavija procera</i>	Theophrastaceae	Ethanolic	Oleanane triterpenoid (aegicerin)
2	<i>Rhodomyrtus tomentosa</i>	Myrtaceae	Alcoholic	Rhodomyrtone
3	<i>Aristolochia taliscana</i>	Aristolochiaceae	Hexane	Neolignans
4	<i>Astraeus peridis</i>	Astraeaceae	Ethanolic	Lanostane triterpenes and phenylalanine
5	<i>Byrsonima crassa</i>	Malpighiaceae	Chloroform	Triterpenes: α -amyrin, β -amyrin and their acetates, lupeol, oleanolic acid, ursolic acid and α -amyrinone
6	<i>Galenia africana</i>	Asteraceae	Ethanolic	Flavonoids
7	<i>Gentianopsis paludosa</i>	Gentianaceae	Ethanolic	1,7,8-Trihydroxy-3-methoxyxanthone, luteolin-7-O-glucoside
8	<i>Cryptocarya latifolia</i>	Lauraceae	Acetone, water	Coumarins
9	<i>Euclea natalensis</i>	Ebenaceae	Acetone, water	Naphthoquinones
10	<i>Helichrysum melanacme</i>	Asteraceae	Acetone, water	Essential oils
11	<i>Nidorella anomala</i>	Asteraceae	Acetone, water	Naphthoquinones
12	<i>Thymus vulgaris</i>	Lamiaceae	Acetone, water	Flavonoids, essential oils
13	<i>Buddleja saligna</i>	Scrophulariaceae	Alcoholic	Non-cytotoxic triterpenoids oleanolic
14	<i>Leysera gnaphalodes</i>	Asteraceae	Alcoholic	Non-cytotoxic triterpenoids oleanolic
15	<i>Laggera pterodonta</i>	Asteraceae	Methanolic	Flavonoids
16	<i>Laggera aurita</i>	Asteraceae	Methanolic	Flavonoids
17	<i>Salvia hypargeia</i>	Lamiaceae	Alcoholic	Diterpene
18	<i>Salvia sclarea</i>	Lamiaceae	Alcoholic	Diterpene
19	<i>Angiopteris evecta</i>	Marattiaceae	-	Lactones, coumarins
20	<i>Costus speciosus</i>	Costaceae	-	Flavonoids
21	<i>Pluchea indica</i>	Asteraceae	-	Phenolics
22	<i>Tabernaemontana coronaria</i>	Apocynaceae	-	Alkaloids
23	<i>Pelargonium reniforme</i>	Geraniaceae	Ethanolic, acetone	Phenolics
24	<i>Pelargonium sidoides</i>	Geraniaceae	Ethanolic, acetone	Phenolics
25	<i>Quinchamalium majus</i>	Santalaceae	Methanolic	Triterpenes
26	<i>Senecio chionophilus</i>	Asteraceae	Hexane, dichloromethane	Sesquiterpenoids
27	<i>Evodia elleryana</i>	Rutaceae	Hexane, ethyl acetate, methanol	Alkaloid, quinoline

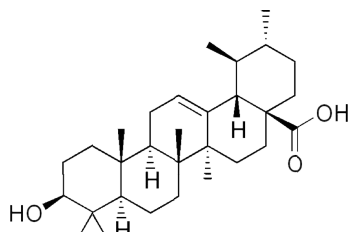
Chemistry of Natural Anti-Tubercular Plants¹⁰⁻⁶²

Wide ranges of phytoconstituents were responsible for anti-tubercular activity includes alkaloids, glycosides,

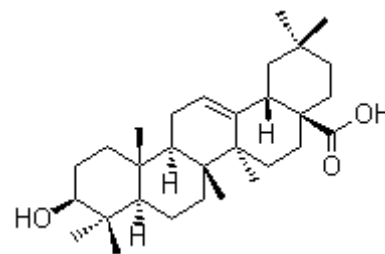
tannins, phenolics, xanthenes, quinones, sterols, triterpenoids *etc.* These phytoconstituents present in plant exert desired pharmacological effect on body and thus act as natural anti-tubercular agents.



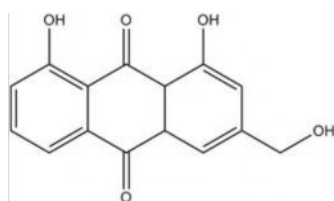
Quercetin



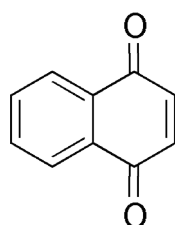
Ursolic acid



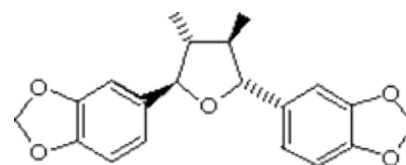
Oleanolic acid



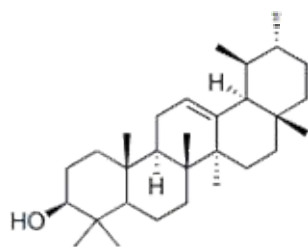
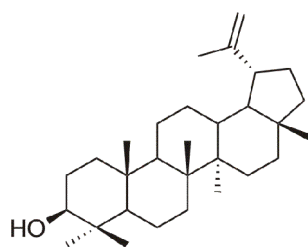
Aloe emodin



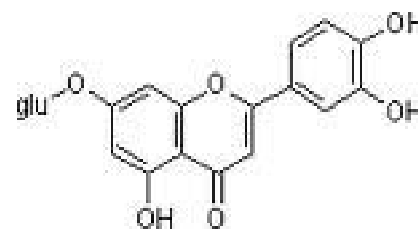
Naphthoquinone



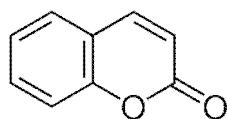
Lignans

 α - Amyrin

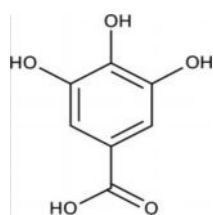
Lupeol



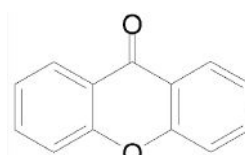
Luteolin-7-O-glucoside



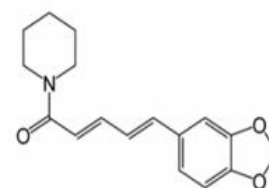
Coumarin



Gallic acid



Xanthone



Piperine

Figure 1: Chemical structures of various phytoconstituents

Conclusion

There has been an increase in demand for the phytopharmaceuticals all over the world because of the fact that the allopathic drugs have more side effects. This review makes an attempt to compile some of anti-tubercular plants from Ayurveda as well as from foreign origin so as to give scientific account on

usage of anti-tubercular plants. Various phytoconstituents like alkaloids, flavonoids, tannins, xanthenes, triterpenes, quinones *etc.* were involved in anti-tubercular activity. This review makes an attempt to give scientific account of use of medicinal plants extracts in tuberculosis treatment.

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