SOME MEDICINAL PLANTS OF UTTARAKHAND (INDIA) WITH ANTIMICROBIAL ACTIVITY- A REVIEW

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Summary

Since ancient times, plants have been an exemplary source of medicines. Ayurveda and other Indian literature mention the use of plants in treatment of various human ailments. India has about 45,000 plant species and among them, several thousands have been claimed to possess medicinal properties. Research conducted in last few decades on plants mentioned in ancient literature or used traditionally for infection has shown antimicrobial property. The Himalayas have a great wealth of medicinal plants and traditional medicinal knowledge. Ethnic communities in the state of Uttarakhand (India) rely, to a large extent, on native plant species for sustenance of their traditional health-care system. The present paper reviews various plants of Uttarakhand that have been mentioned/used in the Indian traditional system of medicine and have shown experimental or clinical antimicrobial activity.

Key words: Antimicrobial activity, Infection, Medicinal plants

Long before mankind discovered the existence of microbes, the idea that certain plants had healing potential, indeed, that they contained what we would currently characterize as antimicrobial principles, was well accepted. Since antiquity, man has used plants to treat common infectious diseases and some of these traditional medicines are still included as part of the habitual treatment of various maladies. For example species such as lemon balm (*Melissa officinalis*), garlic (*Allium sativum*) and tee tree (*Melaleuca alternifolia*) are described as broad-spectrum antimicrobial agents **(1)**. Natural products perform various functions, and many of them have interesting and useful biological activities. There are more than 35,000 plant species being used in various human cultures around the world for medicinal purposes **(2).** Researchers are increasingly turning their attention to natural products and looking for new leads to develop better drugs against cancer, as well as viral and microbial infections **(3, 4, 5).**

Infectious diseases are second leading cause of death worldwide. Treatment of infections continuous to be problematic in modern time because of the severe side effects of antimicrobials and the growing resistance to these life saving drugs due to their intensive use **(6, 7)**. The problem of microbial resistance has become a global issue of concern, as about 70 % of the bacteria that cause infections in hospitals are resistant to at least one of the antibiotic most commonly used for treatment **(8, 9).** Because of this drug resistance, the search for new antibiotics continues unabated. The increasing failure of chemotherapeutics and antibiotic resistance exhibited by pathogenic microbial infectious agents has lead to the screening of several medicinal plants for their potential antimicrobial activity **(10).** In this connection plants continue to be a rich source of therapeutic drugs. The active principles of many drugs are found in plants or are produced as secondary metabolites. The remarkable contribution of plants to the drug industries was possible, because of the large number of the phytochemical and biological studies all over the world.

In India, medicinal plants are widely used by all sections of people either directly as folk remedies or in different indigenous systems of medicine or indirectly in the pharmaceutical preparation of modern medicines. According to National Health Experts, 2000 different plants are used for medicinal preparations in India alone. Among them only 200 are of animal origin, and 300 of mineral origin, while 1500 drugs are extracted from various plants **(5)**.

The Himalayas have a great wealth of medicinal plants and traditional medicinal knowledge. Uttarakhand, which includes the major divisions of Kumaun and

Garhwal, is a part of Indian Himalayan region and hence is endowed with rich biodiversity. The state has old tradition of using medicinal and aromatic plants. The region supports about 1,386 medicinal plant species, out of which 1,338 are used to treat human diseases and disorders and about 364 plant species are used for veterinary diseases by the people of Uttarakhand **(11).** As elsewhere, in the Indian Himalayan Region, ethnic communities in the state of Uttarakhand rely, to a large extent, on native plant species for sustenance of their traditional health-care system, both logistically as well as economically **(12).**

Plants of Uttarakhand with antimicrobial activity

***Abrus precatorius* L.:** Ratti (Local), Jequerity/crab's eye/Rosary pea (English)

It is medicinally important plant from *Fabaceae* family. The plant is native to Indonesia and grows in tropical and subtropical areas of the world. *A. precatorius* is found throughout India. The seed paste is applied locally against skin diseases. Leaves are used as substitute for licqorice (mulethi) considered useful in biliousness, leucoderma, itching and other skin diseases. Roots are used as diuretics and also used in preparations prescribed for gonorrhea, jaundice and haemoglobinuea bile **(13).** The antimicrobial effect of the extracts of *A. precatorius* from leaves, stem and the seed oil against *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Enterococcus faecalis, Streptococcus anginosus*, *Bacillus subtilis, Corynebacterium spp*, *Escherichia coli, Klebsiella pneumoniae, Proteus mirabilis, Pseudomonas aeruginosa* was observed and the results of the study revealed that the leaf extract showed best activity against *Staphylococcus aureus*. Extracts from the stem and seed oil were potent against some of the gram-positive bacteria and *Candida albicans* **(14)**. In another study, root extract of *A. precatorius* was found to be active against the gram positive organism *Staphylococcus aureus* with the minimum inhibitory concentration (MIC) of 440 μg/ml (petroleum ether extract) and 400 μg/ml (methanolic extract) **(13).**

***Aegle marmelos* L Corr:** Bael/Sirphal (Hindi), Holy fruit tree (English)

Aegle marmelos (L.) Corr., belongs to the family *Rutaceae*, and is popularly known as Bael tree. *C. Rajasekaran et al.,* evaluated the antimicrobial activity of leaf extracts from *A. marmelos* (L.) Corr. Ethanol and chloroform leaf extracts of *A. marmelos* were found to be more active against the bacterial species tested. The leaf extracts inhibited the growth of both gram-positive and gram-negative bacterial species **(15)**.

Asparagus racemosus: Satavar/ Satmuli (Hindi), Asparagus (English)

A.racemosus belongs to the family *Asparagaceae*. The plant grows throughout the tropical and subtropical parts of India up to an altitude of 1500 m. **(16)**. *A.racemosus* has been used in Ayurveda as a galactagogue, aphrodisiac, diuretic, antispasmodic and nervine tonic since time immemorial **(17).** In a study, different concentrations (50, 100, 150 µg/ml) of the methanol extract of the roots of *A. racemosus* exhibited considerable antibacterial activity under *in vitro* conditions against *Escherichia coli*, *Shigella dysenteriae*, *Shigella sonnei*, *Shigella flexneri*, *Vibrio cholerae*, *Salmonella typhi*, *Salmonella typhimurium*, *Pseudomonas putida*, *Bacillus subtilis* and *Staphylococcus aureus* **(18).**

***Berberis* species (*B. aristata, B. asiatica, B. chitria, B. lycium*):** Kilmora (Local)

It belongs to the family *Berberidaceae* **(19).** The roots are used for treating a variety of ailments such as eye and ear diseases, rheumatism, jaundice, diabetes, fever, stomach disorders, skin diseases, and malarial fever **(20, 21).** *Sharad Srivastava et al.,* reported that the hydroalcoholic extracts of root and stem of the *Berberis* species. were effective against various microorganisms. *B. aristata* root extract gave low MICs values against *Bacillus cereu*s, *Escherichia coli*, and *Staphylococcus aureus* and *Aspergillus flavus* while stem extract against *B. cereus* and *Streptococcus pneumoniae. B. lycium, B. aristata* and *B. asiatica* root extract showed significant antifungal activity against *A. terreus* and *A. flavus* **(22).**

***Betula utilis* D.don**: Bhoj patar/Bhoj (Hindi), Himalayan silver birch/ Jacquemon tree (English)

B. utilis belongs to the family *betulaceae*. It occurs in forests from 3000 to 4300 meters above sea level. Infusion of bark is used as antiseptic and carminative. It is also used as contraceptive **(19, 23).** Methanol extract of bark of *B. utilis* showed significant activity against all the tested bacteria followed by ethanol and aqueous extract. *Shigella boydii* was highly susceptible to methanol extract. *Pseudomonas aeruginosa* was found highly susceptible to ethanol extract. The inhibitory activity of methanol extracts of the *Betula utilis* was found to be significantly higher than that of the standard drug (**23)**.

***Cinnamomum tamala* Nees.** Dalchini/ Kirkina (Local name), Tejpat (Hindi), Indian Bay-leaf (English)

C. tamala is an evergreen tropical tree, belonging to *Lauracea* family. It is mainly used for flavoring food, widely used in pharmaceutical preparation because of its

hypoglycemic, stimulant and carminative properties. Bark is used in gonorrhea. Leaves are used in rheumatism, colic, diarrhea and in scorpion sting **(19, 24).** A study reported that methanol, ethanol, iso-octane and carbon tetrachloride oleoresins exhibited strong inhibition against *E.coli* at 3000 ppm. Essential oil and oleoresins showed good to moderate activity against other tested bacteria, i.e., *Staphylococcus aureus, Pseudomonas aeruginosa, Proteus vulgaris, Klebsiella pneumoniae* and *Bacillus cereus*, suggested that volatile oil and oleoresins of Tejpat leaf possess excellent antibacterial properties even at very low concentration **(24).**

***Michelia champaca* L.:** Champa (Hindi**),** Golden Champak/Champak (English)

M. champaca L. (*Magnoliaceae*) occurs in forests from 300 meters to 1200 meters above sea level. *M. champaca* is used as antipyretic, anti-inflammatory, stimulant, expectorant, astringent, antispasmodic, tonic, carminative and bitter. It is also used in dyspepsia, nausea, fever, renal diseases, gonorrhea, leprosy, post partum protection, in childbirth and as febrifuge **(19, 25, 26)**. The results of a study reported that the methanol extracts of leaves, seeds, stems and root barks, stem and root heart-woods of *M. champaca* and the obtained fractions (petrol, dichloromethane, ethyl acetate, butanol) exhibited a broad spectrum of antibacterial activity. Liriodenine was the active constituent of the root bark, with a broader and, in some cases, better level of activity as compared to the standard (chloramphenicol 10mg/disc). Dichloromethane and butanol fraction of leaves exhibited significant antifungal activity against *Trychophyton tronsurum and Aspergillus vitis* respectively. Petrol, dichloromethane and butanol fraction of stem bark exhibited significant antifungal activity against *Aspergillus vericolor, Trychophyton tronsurum*, *Aspergillus niger* and *Aspergillus vitis* respectively. Petrol and butanol fraction of root bark showed significant antifungal activity against *Trychophyton tronsurum* and *Aspergillus vitis* respectively **(26)**.

Myrica esculenta: Kafal (Local), Kaiphal (Hindi), Box Myrtle (English)

M. esculenta belongs to the family *Myricaceae*. It occurs in forests from 1600 to 2400 meters above sea level **(19).** *M. esculenta* fruits are wild edible species of Indian Himalayan Region. Species is distributed from Ravi Eastward to Assam, Khasi, Jaintia, Naga and Lushi hills and extends to Malaya, Singapore, China and Japan **(27)**. It is popular among local inhabitants for its delicious fruits and processed products **(28)**. A study was carried out to evaluate the antibacterial activity of *M. esculenta* along with 24 different plants of Nepal. The results of the study revealed that the *M. esculenta* showed significant antibacterial activity

against *Pseudomonas aeruginosa, Staphylococcus aureus, Bacillus subtilis and Escherichia coli* **(29)**.

***Prunus armeniaca* L.:** Khumani/ Khubani/Chilu/Chulu (Hindi), The Apricot (English)

P. armeniaca L. (*Rosaceae)* include many varieties of cultivated and wild apricots which grow in the Western Himalayas up to an elevation of 3000 amsl (**30)**. Plant is used as antidote, expectorant, tonic, anthelmintic. It is also used in traditional medicine for the treatment of fever, cold, cough, asthma, bronchitis, laryngitis, constipation, anemia, hemorrhages and certain tumors **(31).** Investigations on the chemical constituents of the fruits of *P. armeniaca* have led to the isolation of two new flavonoid glycosides from the butanolic fraction of the fruits. The butanolic extract exhibited antibacterial activity against both gram positive and gram negative bacteria **(32).** In another study, the most effective antibacterial activity was observed in the methanol and water extracts of bitter kernels and in the methanol extract of sweet kernels against the gram-positive bacteria *Staphylococcus aureus*. Additionally, the methanol extract of the bitter kernels were very potent against the gram-negative bacteria *Escherichia coli* (0.312 mg/mL MIC value). Significant anti-candida activity was also observed with the methanol extract of bitter apricot kernels against *Candida albicans*, consisting of a 14 mm in diameter of inhibition zone and a 0.625 mg/mL MIC value **(33).**

Psidium guajava: Amrud (Hindi/Local), Guava (English)

P. guajava belongs to the family *Myrtaceae* and occurs in the forest up to 1600 meters above sea level **(19).** *P. guajava* is an evergreen shrub native to tropical America that has naturalized in South East Asia. *K. Anas et al.,* evaluated the in-vitro antibacterial activity of *P. guajava* Linn. leaf extract on clinical isolates of multidrug resistant *Staphylococcus aureus* and the results of the study indicated that the strong bactericidal activity exhibited by leaf extract of *P. guajava* was possibly due to protein degrading activity of the extract and human RBC based haemolytic assay showed absence of haemolysis even at concentration higher than that of MBC, advocating thereby its safety in therapeutic use **(34)**. In a study, acetone extract exhibited good activity against gram positive and fungal strains (**35).** Some flavonoid compounds (quercetin and its glycosides) have been isolated from the leaves of *P.guajava* which showed strong antibacterial activity against *S. aureus, E. coli* and *P. aeruginosa*. They also showed antifungal activity against *C. albicans* **(36).**

***Rubus ellipticus* Sm**.: Hisalu/Hisaloo/ Hisab (Local), Asian wild raspberry (English)

It occurs in forest from 800 to 2400 meters above sea level and belongs to the family *Rosaceae* **(19)**. Ethanolic root extract of *R. ellipticus* at concentration 500µg/ml and 1000µg/ml showed significant antibacterial activity against *Staphylococcus aureus*, *Bacillus subtilis*, and *Escherichia coli* but there was no significant antifungal activity against *Aspergillus niger*, *Saccharomyces cerevisiae*, *Candida albicans* and *Rhizopus nigricans* **(37)**.

Ricinus communis: Arandi, Bherenda, Haralu (Common), Castor oil (English)

R. communis is a plant commonly found in both the tropical and temperate climates of the world. It belongs to the family *Euphorbiaceae* (38, 39). The evaluation of various solvent extracts of *R .communis* leaves against *Bacillus subtilis, Escherichia coli, Klebsiella pneumoniae* and *Pseudomonas aeruginosa* revealed positive antibacterial effect (39). A study reported that *Klebsiella pneumoniae, Escherichia coli, Proteus vulgaris, and Staphylococcus aureus* were highly susceptible to both the methanol and water extracts of the fermented seed of *R. communis* (40).

Sapindus mukorossi: Ritha (Hindi), Soapnut (English)

S. mukorossi Gaertn., a member of the family *Sapindaceae*, is commonly known by several names such as soapnut, soapberry, washnut, ritha, reetha, aritha, dodan and doadni. It is a deciduous tree widely grown in upper reaches of Indo-Gangetic plains, Shivaliks and sub Himalayan tracts at altitudes from 200 m to 1500 m (**20).** The powdered seeds are employed in the treatment of dental caries, arthritis, common cold, constipation and nausea. It cleanses the skin of oily secretion and is even used as a cleanser for washing hair and as hair tonic **(41, 42)**. The *in vitro* antimicrobial activity of *S. mukorossi* fruit extract was studied against dental caries pathogens such as *Streptococcus mutans, Staphylococcus aureus, Lactobacillus acidophilus, Candida albicans* and *Saccharomyces cerevisiae*. The acetone, ethanol, methanol, hot water and cold water extracts of *S. mukorossi* exhibited antimicrobial activity against one of the tested microorganisms i.e., *S. cerevisiae*. This study depicts that the fruits of *S. mukorossi* possess very good antifungal and antibacterial activities respectively and can be used as a potential source of novel antimicrobial agents used to cure dental caries **(41).** *Mohammed Ibrahim et al.,* found that ethanol and chloroform extracts of *S. mukorossi* inhibited *H. pylori* at very low concentrations (10 µg/ml) **(42).**

Stephania glabra (Roxb) Miers.: Nimilahara/Tamarke (local)

S. glabra (Menispermaceae) is a tuberous rooted climbing shrub. It occurs in forests from 900 to 1800 meters above sea level. Roots are used for pulmonary tuberculosis, asthma, dysentery and fever **(19)**. A study on antimicrobial activity of *S. glabara* showed that its extract exhibited best activity against *Streptococcus mutans*, *Staphylococcus epidermidis*, and hospital strains of *S. aureus*. Most of the fungus pathogens including *T. rubrum, M. gypseum* and *M. canis* were inhibited by the extract *S. glabara* with MIC of 25 µg/ml **(43)**. A novel hasubanalactam alkaloid, named glabradine, isolated from the tubers of *S. glabra*, was found to possess potent antimicrobial activity against *Staphylococcus aureus*, *S. mutans*, *Microsporum gypseum*, *M. canis* and *Trichophyton rubrum* **(44).**

Taxus baccata Linn: Thuner (Local), Yew (English)

T. baccata belongs to the family *Taxaceae*. It occurs in forest from 1800 meters to 3400 meters above sea level. Though *T. baccata* has been mainly known since ancient times for its poisonous properties as it is use as fish poison, the leaves have been used in traditional medicine as abortifacient, antimalarial, antirheumatic and in bronchitis (**19, 46)**. An in-vitro antimicrobial study of the ethanolic extract of *T. baccata* heartwood at 2mg/ml showed significant antibacterial activity against some gram negative bacteria, *Pseudomonas pseudomalli, Salmonella typhi*, *Enterobacter cloacca.* It also showed good antifungal activity against *N. oryzae*, *M. canis*, *E. floceasum*, *C. lunata*, and *P. astreatus* **(46).** In a follow-up study, a chloroform-soluble portion of the ethanol extract from the heartwood of *T. baccata* exhibited moderate antibacterial activity against gram-negative bacterium *P. aeruginosa* at 1 mg/ml concentration compared to imipenem at 10 µg/ml. Liganan derivatives, Taxiresinol showed moderate antifungal activity against *Trichophyton longifusus*, *Microsporum canis*, and *Fusarium solani.* 3- Demethylisolariciresinol exhibited good activity against *T. longifusus*. The chloroform-soluble extract of *T. baccata* displayed moderate antifungal activity against *T. longifusus* and *M. canis* **(47).**

Conclusion

Many medicinal plants have been found effective in the cure of bacterial diseases. Due to increasing antibiotic resistance in microorganisms and side effects of synthetic antibiotics medicinal plants are now gaining popularity in the treatment of bacterial infections. Medicinal plants are considered as clinically effective and safer alternatives to the synthetic antibiotics. Extensive research in the area of

isolation and characterization of the active principles of these plants are required so that better, safer and cost effective drugs for treating bacterial infections can be developed.

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