A review on medicinal plants and herbs of Uttrakhand (India): its traditional, ethanomedicinal and antimicrobial potential

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Abstract: India has a rich heritage of knowledge on plant based drugs both for exploit in preventive and curative medicine. Aromatic plants have played key roles in the lives of tribal peoples living in the Uttarakhand (India) by providing products for both food and medicine. Their primary health care system is depending on traditional knowledge of medical practices and medicinal herbs. It has a wealthy knowledge of traditional system of medicine since time immemorial. The results of various herbal researchers also indicated that scientific studies carried out on medicinal plants having traditional claims of effectiveness might deserve successful results. These plants could serve as useful source of many types of ailments and new antimicrobial agents. In this progress many medicinal plants e.g. *Terminalia arjuna, Kaempferia rotunda, Olea europaea, Lagenaria vulgaris, Nepeta ciliaris, Viola odorata, Cyperus rotundus, Onosma bracteatum, Barleria prionitis, Citrus maxima, Tinospora cardifolia* and *Asparagus racemosus* etc are significantly utilized by the local peoples of Uttarakhand. There is urgent need to document the medicinal and aromatic plants associated traditional knowledge which is vulnerable to minimize. Present study is an attempt to document the traditional system of medicine; used by the native communities of Uttarakhand, India and underlines the importance of traditional knowledge associated with medicinal and aromatic plants and herbs used for the treatment of different diseases.

[Ajeet Singh and Navneet. **A review on medicinal plants and herbs of Uttrakhand (India): its traditional, ethanomedicinal and antimicrobial potential.** *Nat Sci* 2016;14(12):90-107]. ISSN 1545-0740 (print); ISSN 2375-7167 (online). http://www.sciencepub.net/nature. 16. doi:10.7537/marsnsj141216.16.

Key words- Medicinal plants, Uttarakhand (India), ethanobotanical use, antimicrobial potential

Introduction

The use of the traditional plants combating microbial diseases is becoming the focus of numerous studies (Bhavnani and Ballow, 2000; Chariandy *et al*., 1999). About 3.4 billion peoples in the developing world depend on plant based traditional medicines natural products have been an integral part of the ancient traditional medicine systems (e.g. Chinese, Egyptian and Ayurvedic) (Doughari *et al*., 2009; Sarkar and Nahar, 2007). Plants have unlimited ability to synthesize secondary metabolites such as tannins, terpenoids, alkaloids, glycosides and phenols which have been found to have antimicrobial properties (Cowan, 1999; Sher, 2009; Das, 2010; Singh and Navneet, 2016). It has been estimated that 14- 28 % of higher plant species are used in medicinal purposes and that 74 % of pharmacologically active plant derived components were discovered after following up on ethnobotanical uses of the plants (Borah *et al.*, 2012). In the last couple of decades, it is manifest that there is a new progress in the research and promotion of plants based drugs. The interest of peoples has become increasingly in the direction of the herbal medicines (Bisset, 1994; Tyler, 1997; Singh *et al*., 2016).

Uttarakhand occupies 17.3% of India's total land area with 53,483 km^2 of which 92.57% is under hills and 7.43% under plains. It is situated between 77˚34′27″ to 81˚02′22″E longitude and 28˚53′24″ to 31˚27′50″N latitude. Uttarakhant is a hilly state, having international borders with China (Tibet) in the north and Nepal in the east. On its north-west lies Himanchal Pradesh and while on the south is Uttar Pradesh. Uttarakhand has different kind of geographical condition and vast biodiversity ranging from the snow bound peaks of the Himalayas with the highest Nanda Devi (7817m) to the sub-tropical Terai region. The border of state touches with Nepal in the East and China in the North. The flora of Garhwal (Uttarakhant) has been already extensively explored and studied by several botanists (Gaur, 1999; Naithani 1984-85; Bawa 1993; Bhatt *et al* 2007). Out of 15,000 species of flowering plants found in India, about 17% have their medicinal value (Nadkarni, 1954; Pei, 2001) several species are from the Indian Himalayan region, and many of these are found in Uttarakhand (Bentley, 1980; Kirtikar and Basu, 1933). Local people of this state are partially or completely dependent on forest resources for medicine, food, and fuel (Gaur, 1999) and medicinal species are progressively deteriorating due to anthropogenic activities (Chhetri *et al.*, 2005).

Therefore, present study is aimed to manuscript and underlines the importance of traditional

knowledge used for the treatment of different diseases in the Uttarakhand, India.

***Terminalia arjuna* (Family Combretaceae)**

Terminalia arjuna is called arjuna in Hindi. It is a deciduous and evergreen tree distributed throughout India and also found in Burma, Sri Lanka and Mauritius, growing up to a height of 60 to 90 feet. Leaves of arjuna are simple, oblong or elliptic with pale and dark green upper surface and pale brown lower surface. Flowers are bisexual, sessile and white arranged in short axillary spikes or in terminal pannicule. The bark is smooth, pinkish outside and flakes off in large, curved and rather flat pieces (Dwivedi *et al*., 2007; Jain *et al*., 2009; Kumar *et al*., 2014).

Medicinal and Ethanobotanical use

The bark and leaves of this plant have been used in indigenous system of medicine for curing different diseases, the bark in the treatment for angina, expectorant, antidysentric, purgative, laxative, leucoderma, anaemia, hyperhidrosis, asthama, tumors and other cardiovascular disorders (Udupa, 1986). Literature search revealed that bark possesses anticancer, antiviral and antimicrobial activities (Tripathi and Singh, 1996; Cooper, 2005; Singh *et al*., 2008). Plants have unlimited capacity to synthesize secondary metabolites such as tannins, terpenoids, alkaloids, glycosides and phenols which have been found to have antimicrobial properties (Cowan, 1999; Sher, 2009; Das 2010).

Antimicrobial activity

Antibacterial activity of *T. arjuna* leaf extract showed antibacterial activity followed in petroleum ether (PET), acetone (ACE) and H_2O (water) extract. The maximum inhibition was found against *S. pneumoniae* (17.3±0.57 mm) followed by *H. influenzae* (16.6±0.57mm), *P. aeruginosa* (14.6±0.76 mm) and *S. pyogenes* (13.6±0.28 mm), *S. aureus* (12.6±0.28 mm) respectively. The minimum inhibition was noted against *C. albicans* (11.3±0.28 mm) (Kumar *et al*., 2014).

In a study antimicrobial potential of *T. arjuna* has been found effective against selected bacterial and fungal species. *T. arjuna* ACE leaf extract was found most effective against *S. aureus* (28 mm) followed by *Proteus mirabilis* (27.6 mm), *Acinetobacter* sp. (16.6 mm) and *P. aeruginosa* (16 mm) (Aneja *et al*., 2012). Different pathogenic bacteria such as *Escherichia coli, Klebsiella pneumoniae,* and *Salmonella* spp. are widely distributed in the hospitals and in community thus creating serious health problems (Khan, 2004; Akram *et al*., 2007).

***Kaempferia rotunda* Linn. (Family *Zingiberaceae*)**

K. rotunda is a perennial rhizomatous herb which has been described in *Ayurveda* for its stomachic, anti-inflammatory, antitumour, antiulcer, wound healing, emetic and vulnerary actions (Nambiar, 1993). *K. rotunda* is also known as Bhumi-Champaka, Bhuu-Champaka or Hallakam and widely distributed throughout India in wet and shaded regions (Khare, 2007).

Medicinal use

In *Ayurveda K. rotunda* is known for its stomachic, anti-inflammatory, antitumour, antiulcer, wound healing, emetic and vulnerary actions (Nambiar, 1993).

Antimicrobial activity

The antimicrobial studies of different solvent extracts showed that *K. rotunda* possess significant antimicrobial activity against respiratory tract pathogens. Among the four solvent extracts tested, ethyl acetate extract showed maximum zone of inhibition against the *L. acidophilus (MTCC 447)* (17.3±0.57mm), *S. pneumoniae* (16.6±0.28mm), *S. pyogenes* (16.6±0.28 mm) and *P. aeruginosa,* (15.3±0.28 mm). The methanol extract exhibited moderate activity against *P. aeruginosa,* (15.6±0.28 mm), *S. pneumoniae* (15.3±0.57 mm) and S. *pyogenes* (15.3±0.28mm) (Kumar *et al*., 2015). In addition, methanolic extract of *K. rotunda* reportedly showed potential antiplatelet aggregation (Jantan *et al*., 2008), antihyperglycemic and antinociceptive properties (Sultana *et al.,* 2012).

***Olea europaea* (Family Oleaceae)**

Olea europaea is commonly known as olive tree. It is a tree bearing silvery green leaves and small white, feathery flowers. It is globally distributed especially in the tropical region (Ross, 2005).

Medicinal and Ethanobotanical use

O. europaea possess broad spectrum of antimicrobial properties and extensively used to treat various diseases. This herb is used orally for sore throat, kidney problems and backache. Leaf infusions are used elsewhere as a lotion to treat eye infections or a gargle to relieve sore throat (Ross, 2005; Kumar *et al*., 2014).

Antimicrobial activity

O. europaea extracts showed broad spectrum activity against selected pathogens. Our results are significantly correlated with other workers regarding this plant. Literature survey showed that major parts of *O. europaea* that is flowers, stems, leaves and fruits had good antimicrobial activity. The fruit extract of *O. europaea* exhibited antibacterial activity against *S. aureus* (18 mm) at concentration 800 µg/ml (Gupta *et al*., 2008). *O. europaea* aqueous (H_2O) extracts were screened for their antimicrobial activity against six bacteria that is, *B. cereus*, *B. subtilis*, *S. aureus*, *E. coli*, *P. aeruginosa*, *K. pneumoniae* and two fungi that is, *C. albicans* and *C. neoformans* (Pereira *et al*., 2007). According to Anesini and Perez (1993), aqueous extract of dried fruit was inactive against *E.*

coli and *S. aureus* at a concentration of 62.5 mg/ml. Kumar *et al*., (2014) reported antimicrobial potential of crude extracts (methanol, acetone, water and petroleum ether) of *O. europaea* against dental pathogens (*S. aureus, S. mutans, S. sanguinis, S. sobrinus, S. salivarius, L. acidophilus and C. albicans*). The isolated phenolic components of *O. europaea* showed inhibitory effect against some foodborne pathogens such as *Campylobacter jejuni*, *Helicobacter pylori* and *S. aureus* (Ahmed *et al*., 2014).

***Lagenaria vulgaris* Ser.** (Family Cucurbitaceae)

Lagenaria vulgaris Ser. is commonly known as "Unnab". The young fruit is used as vegetables, the large, strong, hard-shelled, and buoyant fruits have long been used as containers for water and food, musical instruments (Kirtikar, 2001; Gautam *et al*., 2013).

Medicinal and Ethanobotanical use

Traditionally, the vegetable is claimed to possess antipyretic activity, cardioprotective, cardiotonic, aphrodisiac, diuretic, nutritive properties (Kirtikar, 2001).

Antimicrobial activity

Gautam *et al*., (2013) reported that the crude extract of *L. vulgaris* was found active and exhibited moderate antibacterial activities against test bacterial organisms. The maximum inhibition by ACE (acetone) extract was found against *H. influenzae* (16 mm), *S. pneumoniae* (14 mm) and *S. pyogenes* (14 mm) respectively. The minimum activity was found against *S. aureus* (12 mm) followed by MeOH (methanol), H_2O (water) and PET (petroleum ether) (Gautam *et al*., 2013).

***Nepeta ciliaris* Benth (Family Lamiaceae or Labiatae)**

The genus *Nepeta* comprises about 250 species. Locally, plant is known as Nueet (Dobhal *et al*., 2006) and Jufa yabis (Punjabi) (Torkelson, 1999). The plant is sub-shrub, perennial, around 40-70 cm high. *N. ciliaris* used for preparation of joshandah, extensively used by the masses in India for treatment of common cold, catarrh, cough and associated respiratory distress and fever (Vohora, 1986).

Medicinal and Ethanobotanical use

The decoction of leaves and seeds is taken in fever (Dobhal *et al*., 2006). *N. ciliaris* is used as antipyretic and antitussive agent (Handa *et al*., 1957; Israili, 1980). The pharmaceutical cough syrups and drugs use it as principle ingredient. The liquid extract (Araq-e-Zuufaa) and squash (Sharbat-e-Zuufaa) prepared from *N. ciliaris* is prescribed when phlegm is thick and sticky and chest is congested (Khare, 2004; Gautam *et al*., 2012).

Antimicrobial activity

This study looks into the *in vitro* antibacterial activity of *N. ciliaris* against four respiratory pathogens that usually cause upper and lower respiratory tract infections. The plant showed broad spectrum antibacterial activity. The acetone, water, methanol and petroleum ether extracts were active against all the selected respiratory pathogens. The *N. ciliaris* extracts were found to be less effective as compared to erythromycin. In case of *S. aureus*, *S. pneumoniae* and *S. pyogenes* acetone extract exhibited the highest degree of antimicrobial activity as compared to aqueous, methanol and petroleum ether extracts. The maximum inhibition by acetone extract was found against *S. pneumoniae* and *S. aureus* were 17 mm and 14 mm respectively. While in case of *P. aeruginosa* the methanol extract was most active and showed maximum inhibition (15 mm) following by aqueous, acetone and petroleum ether (Gautam *et al*., 2012).

***Viola odorata* Linn. (Family Violaceae)**

Viola odorata Linn. is commonly known as Sweet Violet, English Violet, Common Violet, or Garden Violet and Gulbanafsa in Hindi. *V. odorata* is a native of Mediterranean countries and Asia Minor. The plant is a perennial herb, spreading with stolons (above-ground shoots). Flowers have dark violet or white colour (Gautam *et al*., 2012).

Medicinal and Ethanobotanical use

It is commonly used as remedy for coughs and sore throat, hoarseness and tonsillitis. The herb is valued as an expectorant, diaphoretic, antipyretic, diuretic and as a laxative, in bilious affections (Vishal *et al*., 2009). It is used either alone or in mixture with other herbs for catarrhal and pulmonary troubles and for calculous affections (Pullaiah, 2006). The study about antimicrobial activity of aqueous extract has been reported against certain opportunistic/secondary invaders and pathogenic bacteria of respiratory tract region (Khan *et al*., 2011; Khatibi *et al*., 1989; Ramezani *et al*., 2012; Gautam *et al*., 2012).

Antimicrobial activity

V. odorata showed the promising activity against tested microorganisms. Methanol extracts exhibited a higher degree of antibacterial activity as compared to aqueous, acetone and petroleum ether extracts. Maximum inhibition by methanol extract was found against *H. influenzae* (24 mm) and *S. pneumoniae* (19 mm) and lowest inhibition against *P. aeruginosa* (13 mm) followed by aqueous, acetone and petroleum ether (Gautam *et al*., 2012). The susceptibility of *H. influenzae* for extracts of this plant is very interesting considering the widespread phenomena of antibiotic resistance of the organism (Tristram *et al*., 2007). *V. odorata* possessed 5.2 % of triterpene saponins which constituted of ursolic acid as a glycone and galactose or galacturonic acid (Rastogi, 1980-1984).

Antibacterial activity may be indicative of presence of some metabolic toxins or broad-spectrum antibiotic compounds. Khan *et al*., (2011) reported that, H_2O extract of *V. odorata* (flowers) showed strong antibacterial action against *B. subtilis, E. coli and S. aureus*. Khatibi *et al*., (1989) documented the antimicrobial activity of aqueous extract of *V. odorata* (aerial part) against *S. aureus, B. subtilis, E. coli* and *S. flexneri* at a concentration of 3 mg, 2 mg and 1 mg. Ramezani *et al*.,(2012) assessed the effect of cold and warm environmental temperature on antibacterial activity of aqueous extracts of different parts of *V. odorata* against bacteria e.g. *S. aureus, E. coli* and *P. aeruginosa* and concluded its maximum effect on *S. aureus* (concentration of 1 lg/ml) and minimum effect on *P. aeruginosa* (concentration of 8 lg/ ml). In focus of potential novel and future antibacterial drugs, biologically active plant proteins can play an intensive role. Cyclotides are such type of small disulfide rich peptides isolated from plants. Cyclotide cycloviolacin O_2 is a cyclotide isolated from dried aerial parts of *V. odorata* which efficiently inhibited the growth of *S. enteric serovar Typhimurium LT2, E. coli, K. Pneumoniae* and *P. aeruginosa* and no activity against *S. aureus* (Pranting *et al*., 1964-1971). The positive control (erythromycin) was found much effective as compared to *V. odorata* extracts. Erythromycin is a macrolide antibiotic with wide spectrum antimicrobial nature (Gautam *et al*., 2012).

***Cyperus rotundus* Linn. (Family Cyperaceae)**

Cyperus rotundus Linn. is a perennial weed grows in small clump, up to 140 cm height. It is known as Nagar motha in Hindi, Coco-grass, Java grass and Nut grass in English (Sivapalan, 2013).

Medicinal and Ethnobotanical use

C. rotundus has wide range of medicinal and pharmacological properties. The rhizomes exhibit astringent, diaphoretic, diuretic, analgesic, antispasmodic, aromatic, carminative, antitussive, emmenagogue, litholytic, sedative, stimulant, stomachic and vermifuge properties (Sivapalan, 2013; Kumar *et al*., 2014).

The decoction of *C. rotundus* tubers also showed antidiarrhoeal activity and effect on adherence of enteropathogenic *E. coli* and enteroinvasive *E. coli* and *Shigella flexneri* to Hep-2 cells (Daswani *et al*, 2011; Kumar *et al*., 2014).

Antimicrobial activity

Kumar *et al*., (2014) reported good antibacterial activity against selected respiratory tract pathogens. After extraction, yield of petroleum ether (PET) extract was 3.55 %, acetone (ACE) extract 4.85 %, methanol (MeOH) extract 5.6 % and H_2O extract 5.2 % respectively. MeOH extract was found most active against all test pathogens in comparison to other extracts. The maximum inhibition was found against *H. Influenzae* (18.4±0.07 mm) followed by *S. pyogenes* (17.3±0.13 mm), *P. aeruginosa* (16.2±0.07 mm) and *S. pneumoniae* (15.5±0.15 mm) respectively. The lowest inhibition was noted against *S. aureus* (15.3±0.05 mm). The root extract of *C. rotundus* therefore had notable antibacterial activity against selected pathogens i.e. *H. influenzae*, *P. aeruginosa, S. aureus*, *S. pneumoniae* and *S. pyogens* (Kumar *et al*., 2014).

In a similar study, an inhibitory effect of *C. rotundus* was observed against selected bacterial strains including *S. aureus, Salmonella enteritidis* and *Enterococcus faecalis* with total oligomers flavonoids and ethyl acetate extracts (Kilani *et al*, 2008). Tambekar *et al.*, (2009) also reported that MeOH extract of the rhizomes of *C. rotundus* showed considerable antibacterial potential against *S. aureus, K. pneumoniae, S. typhi, S. paratyphi, S. typhimurium, P. aeruginosa, E. aerogenes.*

***Althaea officinalis* Linn. (Family Malvaceae)**

Althaea officinalis Linn. is commonly known as Khatmi in Hindi and Marshmallow in English. It is native of British Isles and found in temperate regions of India, currently it is distributed throughout Europe and some parts of America (Ross, 2001). *A. officinalis* is a perennial herb 60-120 cm high. Leaves are short-petioled with an ovate and acute leaf blade. The reddish-white flowers are usually in axillary or terminal cluster. Compressed dark brown kidney-shaped seeds are glabrous (Ozkan and Uzunhisarcikli, 2009).

Medicinal and Ethanobotanical use

A. officinalis is used in irritation of oral, pharyngeal mucosa and associated dry cough, mild gastritis, skin burns, insect bites, catarrh of the mouth, throat, gastrointestinal tract and urinary tract, inflammation, ulcers, abscesses, burns, constipation and diarrhoea. Seeds are diuretic and febrifuge (Shah, 2011). It has been used as an aid in promoting coughing up of phlegm and respiratory problems. Due to high contents of polysaccharides, it is used in relieving dryness and chest and throat irritation happened by colds and persistent coughing (Sutovska *et al*., 2007).

Antimicrobial activity

A. officinalis has a broader spectrum of antibacterial as well as antifungal activity. The antibacterial activity of *A. officinalis* roots were tested against anaerobic and facultative aerobic periodontal bacteria (Lauk *et al*., 2003). Many researches showed that *A. officinalis* possessed antimicrobial, antiinflammatory, immunomodulatory, demulcent and soothing, antittusive and many other pharmacological effects (Naovi *et al*., 1991; Rouhi and Ganji, 2007). Gautam *et al*., (2015) showed that *A. officinalis* possess good antimicrobial activity against selected

respiratory tract pathogens. The zone of inhibition above 7 mm in diameter is considered positive result. The maximum inhibition by essential oil was noted against *S. pyogenes* (21.3±0.28 mm) and *H. influenzae* (19.0±0.50 mm) and by MeOH extract against *P. aeruginosa* (23.3±0.76 mm) and lowest against *S. aureus* (11.3±0.76 mm) in comparison to other extracts. The acetone and water extracts were moderately active against *H. influenzae*, *S. pneumoniae* and *S. pyogenes* respectively (Gautam *et al*., 2015).

In a study, crude methanol (MeOH) and water (H_2O) extracts of aerial parts of *A. officinalis* were tested against 137 strains belonging to 52 bacterial species and found that MeOH extract was most active especially against *Acidovorax facilis*, *Bacillus* sp., *Enterobacter hormachei* and *Kocuria rosea*. The H_2O extract had no antibacterial effect (Ozturk and Ercisli, 2007). MeOH extract of *A. officinalis* root had been reported to possess an inhibitory activity against periodontal pathogen including *Porphyromonas gingivalis*, *Prevotella* spp., *Actinomyces odontolyticus*, *Veilonella parvula*, *Eikenella corrodens*, *Fusobacterium nucleatum*, and *Peptostreptococcus* spp. respectively. In a recent report by Rezaei *et al*. (2015), *A. officinalis* had reported wound healing properties with antimicrobial role against *S. aureus*, *P aeruginosa*, *E. coli* and *L. monocytogenes*. The hydroalcoholic extract of *A. officinalis* flowers screened for antimicrobial activity against *P. aeruginosa*, *S. aureus*, *L. monocytogenes* and *C. albicans* (Shakib *et al*., 2013). The MIC values of *A. officinalis* were reported for 80% ethanolic extract at 50-100 mg/ml concentration (Al-Snafi, 2013).

The percentage inhibition was noted highest with 41.28% by essential oil against *A. niger*, H_2O extract with 36.27% and MeOH extract with 23.89% of inhibition respectively. The control mycelial growth diameter was 33.6±0.57- 37.6±0.28 mm. The potency of plants were compared with reference antibiotic (erythromycin) showed 63.45% inhibition at similar (250 mg/ml) concentration. The ED_{50} value for H_2O extract was observed at 320 mg/ml concentration represented by dose response (DR) curve (Gautam *et al*., 2015).

***Onosma bracteatum* Wall. (Family Boraginaceae)**

Onosma bracteatum Wall. is commonly known as Gaozaban, Gojihva in India. The genus *Onosma* includes about 150 species distributed worldwide. *O. bracteatum* is native to the Mediterranean and Western Asia. In India, it is found abundantly in North-western Himalayas to Kashmir. It is a biennial herb (Badruddeen *et al.,* 2012).

Medicinal and Ethanobotanical use

O. bracteatum is a key ingredient in a number of Ayurvedic and Unani formulations (Badruddeen *et al.,* 2012). It is prescribed in bronchial asthma and rheumatoid arthritis. Reports suggest its demulcent, diuretic, anti-inflammatory, antileprotic, spasmolytic, and tonic nature (Chopra *et al.,* 1986). It is used in the preparation of Joshandah generally imposed in the treatment of common cold, catarrh, cough and associated respiratory distress, and fever (Vohora, 1986). *O. bracteatum* contains alkannin and shikonin, flavonoids, ferulic, and vanillic acids which represent its pharmacological values (Kumar *et al.,* 2013). The roots are used for colouring food stuffs, oils and dying wool and in medicinal preparations.

Antimicrobial activity

O. bracteatum exhibited broad spectrum antibacterial activity against Gram-positive and negative bacteria causing gastrointestinal, respiratory, and dermatological disorders (Walter *et al.,* 2011). The methanol (MeOH) extract was found most active followed by water (H_2O), acetone (ACE), and petroleum ether (PET). It showed maximum activity against *S. pneumoniae* (20.6 ± 0.28 mm) and lowest against *S. pyogenes* (12.6 ± 0.28 mm). The ACE and H_2O extracts were most active against *S. pneumoniae*, *P. aeruginosa,* and *S. aureus*.

The antifungal activity of crude extracts showed significant inhibition effects on the mycelial growth of *A. niger* at 250 mg/ml. The most inhibition was noted by MeOH extract (25.3 ± 0.57 mm) with 24.74% and H_2O extract (27.6 ± 0.76 mm) with 17.82%, respectively. The control mycelial growth diameter was 33.6 ± 0.57 mm. The potency of crude extracts were compared with reference drug (erythromycin) showed 63.45% inhibition (Gautam *et al*., 2015). In a study, Walter *et al*. (2011) observed the antibacterial effect of MeOH extracts of *O. bracteatum* leaves against *S. aureus*, *Escherichia coli,* and *P. aeruginosa*. The ranking of antibacterial activity against bacteria was *S. aureus* > *P. aeruginosa* > *E. coli*. In our study, *O. bracteatum* MeOH extract was found most effective against *S. pneumoniae* followed by *P. aeruginosa* and *H. influenzae*. *O. bracteatum* has been reported as major constituent used in the preparation of joshanda (Azmi *et al.,* 2010; Abdullah *et al.,* 2014) and Ayurvedic syrup (Sheikh *et al.,* 2014).

***Cassia occidentalis* Linn. (Family Caesalpiniaceae)**

Cassia occidentalis L. commonly known as *Kasondi* in Hindi, *Kasmard* in Sanskrit and Coffee Senna in English. It is a shrub, grows erect to a height of 1.8 m approximately. *Cassia* species have been used as traditional medicine in rain forest and other tropical areas for centuries and is a native plant of southern India (Kirtikar and Basu, 1999; Rajni *et al*., 2014).

Medicinal and Ethanobotanical use

C. occidentalis is used to cure various diseases e.g. fever, menstrual problems, tuberculosis, and liver

complaints and as a tonic for general weakness and illness (Kirtikar and Basu, 1999). The roots, leaves, flowers and seeds have been employed in herbal medicine around the world (Burkill, 1995). An infusion of *C. occidentalis* bark is used in folklore for diabetes treatment (The Wealth of India, 1998).

Antimicrobial activity

C. occidentalis showed promising activity against tested microorganisms. MeOH extract was found most effective followed by water (H2O), acetone (ACE) and petroleum ether (PET). It was highly active against *S. aureus* (23.1±0.15 mm) and lowest inhibition against *S. pneumoniae* (20.9±0.21 mm) in comparison to other solvent extracts (Rajni *et al.*, 2013). Vaghasiya and Chanda, (2007) reported the antimicrobial activity of the MeOH and ACE extracts of fourteen plants belonging to different families against five Gram-positive bacteria (*S. aureus*, *S. epidermidis*, *B. cereus*, *B. subtilis*, *M. flavus*), seven Gram-negative bacteria (*P. aeruginosa*, *E. coli*, *K. pneumoniae*, *P. mirabilis*, *P. vulgaris*, *S. typhimurium*, *C. freundei*) and three fungi (*Candida albicans*, *C. tropicalis* and *Cryptococcus luteolus*). Sadiq *et al.*, (2012) reported the *in vitro* antimicrobial screening of *C. occidentalis* against *S. aureus, P. aeruginosa, E. coli, S. typhi* and *Shigella* spp.

***Quercus infectoria* (Family Fabaceae)**

Quercus infectoria is a small tree. The galls arise on young branches of this tree as a result of attack by the gall-wasp, Adleria gallae. Tinctoria (Samuelsoon, 1999). The plant is known as Mayaphal and Majufal in Hindi (Vermani *et al*., 2013)

Medicinal and Ethanobotanical use

The galls of *Qurercus infectoria* have been pharmacologically documented to possess astringent, antibacterial (Fatima *et al*., 2001), antifungal (Digraki, *et al*., 1993), larvicidal (Redwane *et al*., 2002), antidiabetic (Hwang *et al*., 2000), local anaesthetic (Dar *et al.*, 1976), antiviral (Hussein *et al*., 2000), and anti-inflammatory (Kaur *et al*., 2004) activities. The main constituents found in the galls of *Q. infectoria* are tannin (50-70%) and small amount of free gallic acid and ellagic acid (Ikram and Nowshad, 1977; Bate-Smith *et al*., 1962). Tannins are commonly defined as water–soluble polyphenolic compounds ranging in molecular weight from 500 to 3000 Daltons that have the ability to precipitate proteins (Varra, 1992).

Antimicrobial activity

Vermani *et al*., (2013) reported that all the four extracts inhibited the growth of all pathogens and methanol (MeOH) extract was the most effective. The minimum inhibitory concentration (MIC) value of MeOH and water extracts against *S. sanguis* in comparison to *S. aureus* concludes that *S. sanguis* showed greater sensitivity towards the MeOH extract. Successful prediction of botanical compounds from plant material is largely dependent on the type of solvent used in the extraction procedure. Traditional healers use primarily water as the solvent (Ahmed *et al*., 1998). Researchers have found that plant extract in methanol provided more consistent antimicrobial activity as compared to those extracted in water. It is probably because various organic compounds can be leached more in this solvent. Ethanolic extract of *Q. infectoria* also demonstrated significant activity against resistant bacteria (Voravuthikunchai and Kitpipit, 2005; Chusri and Voravuthikunchai, 2008).

***Asparagus racemosus* (Family Asparagaceae)**

Asparagus racemosus is commonly known as Satavari in Hindi (Sinha and Biswas, 2011) (Kumar *et al*., 2013).

Medicinal and Ethanobotanical use

A. racemosus is recommended in traditional medicine for the prevention treatment of gastric ulcers, dyspepsia, diarrhoea, nervous disorders (Sinha and Biswas, 2011). Besides use in the treatment of and dysentery, the plant also has antioxidant, immunostimulant, antidyspepsia and antitussive effects (Goyal *et al*., 2003).

Antimicrobial activity

Kumar *et al*., (2013) reported that the MeOH extract was found most active against all test pathogens in comparison to other extracts. The maximum inhibition was found against *H. influenzae* (19 mm) followed by *S. pneumoniae* (18 mm), *S. pyogenes* (17 mm) and *S. aureus* (17 mm) respectively. The minimum inhibition was noted against *P. aruginosa* (15 mm). *A. racemosus* crude extracts was found less active in comparison to positive control (erythromycin). The root extract of *A. racemosus* has significant antibacterial activity against selected pathogens i.e. *H. influenzae*, *P. aeruginosa, S. aureus*, *S. pneumoniae* and *S. pyogens* (Kumar *et al*., 2013). In a similar study, Uddin *et al*., (2012) assayed the antibacterial susceptibility pattern of MeOH root extract of *A. racemosus* against bacterial strains including *K. pneumoniae*, *E. coli*, *P. alkaligenes*, *Proteus* sp., *S. typhi*, *V. cholerae* and *S. aureus* (Uddin *et al*., 2012). Mandal *et al*., (2000) reported the MeOH extract of the roots of *A. racemosus* showed considerable *in vitro* antibacterial efficacy against *E. coli*, *S. dysenteriae*, *S. sonnei*, *S. flexneri*, *V. cholerae*, *S. typhi*, *S. typhimurium, P. putida*, *B. subtilis* and *S. aureus* (Mandal *et al*., 2000).

***Jasminum sambac* Linn. (Family Oleaceae)**

J. sambac Linn. commonly known as Chameli, is a shrub, about 1.5-2.0 m long, bearing small white flower. It is commonly distributed in all over tropical region of India (Abdoul-Latif *et al*., 2010).

Medicinal and Ethanobotanical use

Its various parts are used in preparation of medicine, perfumes and aromatizing products (Abdoul-Latif *et al*., 2010). Other medicinal applications of *J. sambac* have been reported in curing insanity, skin diseases, ulcers, sight weakness, leprosy and suppression of puerperal lactation (Mittal *et al*., 2011; Kumar *et al*., 2015).

Antimicrobial activity

The antimicrobial activity of PET extract observed lower compared to other extracts. According to Al-Hussaini and Mahasneh (2011), ACE extract of *J. sambac* leaf extract was reported most active against six bacteria i.e. *S. aureus*, *Bacillus subtilis, B. cereus, E. coli, P. aeruginosa, Chromobacterium violaceum* and one fungi i.e. *C. albicans*. The leaf extracts were also reported active against *Xanthomonas campestris* (Gracelin *et al*., 2012), *C. albicans* (18.0±0.50 mm) and *A. niger* (10.0±0.30 mm) (Nandhini *et al*., 2015). Abdoul-Latif *et al.* (2010) reported the antimicrobial activity of essential oil and MeOH extract of *J. sambac* against *S. pyogenes*, *S. enterica*, *E. coli*, *S. dysenteriae*, *L. innocua* and *E. facealis*. Kumar *et al*., (2015) assayed antimicrobial potential of J. sambac leaf extract against dental pathogens (*S. aureus, S. mutans, S. pyogens, S. sobrinus, S. sanguinis and L. acidophilus*).

***Salvodara persica* Linn. (Family Salvadoraceae)**

Salvodara persica Linn. is a branched, evergreen shrub. It is commonly known as Jhak, Miswak, Kharjal in Hindi, Brihatpilu in Sanskrit and Tooth brush tree in English (Kumar *et al*., 2016).

Medicinal and Ethanobotanical use

Stem and bark is used as a dental diseases and stimulant in low fevers. Root decoction is used against gonorrhoea and vesicle-catarrh. Root extract is used to relieve the pain due to spleen troubles. Leaves are used in treatment of asthma, cough and piles. Fruits possess carminative and diuretically properties and used in treatment of rheumatisms (Pullaiah, 2002; Benson, 1990). Various components of *S. persica* have been reported to have beneficial biological properties, including significant antibacterial and antifungal activity (Almas *et al*., 1997). In addition, *S. persica* extracts are reported effective against some periodontal pathogens involved in dental plaque development (Rotimi and Mosadomi, 1987). Kumar et al., (2016) assayed the phytochemical and antimicrobial activity of *S. persica* crude extract against oral pathogens.

Antimicrobial activity

Kumar *et al*., (2016) reported plant extracts of *S. persica* showed significant antimicrobial activity against all the selected pathogens at 200 mg/ml. Methanol (MeOH) extract showed the maximum antimicrobial activity against the *L. acidophilus* and *S. mutans* followed by H_2O (water), ACE (acetone) and PET (petroleum ether) extract. MeOH extract showed best activity against *L. acidophilus* (22.3 ± 0.76 mm) and *S. mutans* (21.6 ± 0.76 mm) followed by *S. aureus* (19.3 ± 0.28 mm), S. *sobrinus* (19.3 ± 0.76 mm), *S. salivarius* (18.0 ± 0.50 mm), *S. sanguinis* (18.6 ± 0.76 mm) and *C. albicans* (14.0 ± 0.50 mm). According to Al-Bayati and Sulaman (Al-Bayati and Sulaman, 2008). H_2O and MeOH extracts of *S. persica* were investigated for its antimicrobial activities against seven isolated oral pathogens including *S. aureus, S. mutans, S. faecalis, S. pyogens, L. acidophilus*, *P. aeruginosa* and *C. albicans*. The ethanol (EtOH) and methanol (MeOH) extracts of *S. persica* extracts showed antibacterial activity against *S. aureus, E. faecalis* and *K. pneumoniae* (El-Latif Hesham and Alrumman, 2014).

***Citrus maxima* (Burm.) Merr. (Family Rutaceae)**

C. maxima Burm. (syn. *C. grandis*) commonly known as shaddock or pummelo or chakotra is a perennial tree and edible fruit. In traditional medicine, the fruit peel has been widely used for cough, swelling and epilepsy, because of the efficiency of the volatile oil. Citrus is one of the most important mercantile fruit crops grown in all continents of the world (Guo *et al*., 2008; Singh and Navneet, 2016; Shah, 2015; Mortan, 1987; Scora, 1975).

Medicinal and Ethanobotanical use

C. maxima have been recommended in traditional herbal medicine as source of diabetic medication for diabetes. It is well recognized for their various ethno medicinal uses. It has been used as a folk medicine in many countries as antimicrobial, antioxidant, larvicidal, hepatoprotective, anticancer, antiplatelet, antidiabetic and antiinflammatory (Barrion *et al*; 2013; Kundunsen *et al.*; 2011; Jadhav *et al*., 2013). It can cure fever, gout, arthritis, kidney disorders and ulcers (Orwa *et al*., 2011). The fruits pulp and peels are used as an appetizer, stomach-tonic, inflammation and cough. The fruits juice has potential in influencing weight loss and promoting cholesterol reduction (Thavanapong *et al*., 2010). The fruit juice is used in stomach tubules. The fruit is nutritive, cardiotonic and refrigent (Nadkarni, 1954; Chopra, 1956; Dagar and Dagar, 1996; Singh and Navneet, 2016).

Antimicrobial Activity

Borah *et al*., (2012) studied antibacterial activity of ethanol (EtOH) extracts of *C. maxima* against *S. aureus*, *E. coli* and *P. aeruginosa*. Antibacterial activities of the pericarp, mesocarp and segment membrane crude EtOH extracts of *C. maxima* fruit were tested against *E. coli* and *S. typhimurium*. The antibacterial activity of the EtOH extract of *C. maxima* leaves against *E. coli* and *P. aeruginosa* was investigated by Das *et al.,* (2013). Abirami *et al*., (2013) reported the *in vitro* antibacterial activity of

MeOH extracts of *C. maxima* (red and white fruit) extract against *S. aureus, K. penumoniae, P. aeruginosa, S. typhi* and *E. coli*. MeOH extract of leaves and pulp were found to have maximum activity as compared to peel extracts against all tested microorganisms. The antimicrobial activities of five different extract of peel and pulp of *C. maxima* fruits have also been investigated against isolated *E. faecalis* and *P. putida*. Kinnow peel and pulp showed maximum antimicrobial activity in MeOH extracts form, against *P. putida*, which was ~73% and ~64% respectively comparatively to gentamicin. The orange peel and pulp show maximum antimicrobial activity in MeOH and EtOH extracts form respectively, against *P. putida*, corresponding to about 75% to 80% antimicrobial activity of positive control i.e. gentamicin (Mehra *et al*., 2015).

Singh and Navneet (2016) reported the antibacterial activities of seeds extracts of *C. maxima*. MeOH extract showed highest antibacterial activity among all solvents followed by ACE, H_2O and PET. Maximum inhibition zone was found against *S. aureus* (24±0.88 mm) followed by *S. pneumoniae* (21.78±0.36 mm), *H. influenzae* (19.74±0.22 mm), *P. aeruginosa* (18.54±0.62), *S. pyogens* (10.93±0.69 mm) and *C. albicans* (7.66±0.32 mm) (Singh and Navneet, 2016).

The oils may be recommended as safe plant based antimicrobials as well as antioxidants for enhancement of shelf life of food commodities by checking their fungal infestation, aflatoxin production. In another study antifungal activity of seeds extracts in percentage inhibition was observed maximum with 37.01% of H_2O extract followed by MeOH (22.47%), PET (8.36%) and ACE (1.56%). The control mycelia growth diameter was determined between 34.23±0.46 to 35.4±0.28 mm. amphotericin B showed 67.08% inhibition used for comparison of seed extract (Singh and Navneet, 2016).

***Baleria prionitis* Linn. (Family Acanthaceae)**

B. prionitis Linn is distributed throughout Africa, India, Sri Lanka and tropical Asia. The height of the plant is about 1.5 metres. *B. prionitis* is a shrub and flowers are yellow in colour. Flowering occurs during August-October (Kirtikar and Basu, 1999; Kaushik and Dhiman, 2000). In Ayurveda it is known by various names like kuranta, kurantaka, kuranda, kurandaka, sachachara, shiriya. In folk medicine it is popularly known as piyaabansa, jhinti and ketsariyaa. It is known as vajradanti because of its antidontalgic property (Khare, 2007; Banerjee *et al*., 2012; Singh *et al*., 2016).

Medicinal and Ethanobotanical use

Whole plant, root, leaves and bark of the plant reside in a significant place in the indigenous system of medicine in India. It is used in inflammations, swellings, boils, whopping coups (Singh *et al*., 2016). The whole plant, root, leaves and bark of the *B. prionitis* Linn. be present in a crucial place in the indigenous system of medicine (Ayurveda) in India for controlling the different types of ailments such as inflammations, swellings, boils, glandular etc (Khare, 2004; Daniel, 2006; Aneja *et al*., 2010). The juice of *B. prionitis* has been reported to use for cure of whooping cough in Uttar Pradesh and Madhya Pradesh states of India, and leaves are use for the treatment of toothache, rheumatism, and root powder to cure fever (Mahajan, 2007; Singh, *et al*., 2002; Jadhav, 2006).

Antimicrobial activity

The antibacterial of *B. prionitis* leaf extract were showed against *S. typhi, V. cholerae, M. Luteus, L. sporogens, Citrobacter, B. subtilis, B. cereus* and *Providencia* (Paul and Saha, 2012). The antibacterial activity of different parts of *B. prionitis* has been reported. It was also reported that among the extracts, MeOH bark extract showed potential antibacterial activity against all the pathogens. Crude MeOH extract revealed good antibacterial activity against MDR (multidrug resistance) *E. coli* with 12 mm of inhibition zone (Aneja et al., 2010; Khobragade and Bhande, 2012). Chetan et al., 2010 were reported the antibacterial activity of EtOH (ethanol) leaf extract of *B. prionitis* against *S. aureus, B. subtilis, P. vulgaris, K. pneumoniae, E. coli* and *P. aeruginosa.* Antibacterial activity of H_2O (water), PET (petroleum ether), $CHCl_3$ (chloroform) and ACE (acetone) extracts *B. prionitis* were reported against *L. rhamnosus* (MTCC1408), *S. mutans* (MTCC 890), *S.* aureus MTCC 3408), *A. viscoscus* (MTCC 7345), *S. epidermidis* (MTCC 3639), *E. coli* (MTCC 732) and *B. subtilis* (MTCC 3160).

Ficus species [*Ficus religiosa* Linn., *Ficus benghalensis* Linn., and *Ficus gloomerata* Linn.]

Genus *Ficus* (family Moraceae) consists of over 800 species. *Ficus religiosa* (Linn.), *Ficus benghalensis* (Linn.), and *Ficus gloomerata* (Linn.) are large deciduous trees distributed throughout India. Various parts of this plant like bark, leaves, tender shoots, fruits, seeds and latex are medicinally important (Bhandari, 1993).

Medicinal and Ethanobotanical use

The bark is used in inflammations, swelling of neck, gonorrhoea, scabies, and mouth wash for strengthening gums (Bhandari, 1993).

Antimicrobial activity

Shivani and Navneet (2010), reported the antimicrobial activity of *Ficus religiosa* Linn., *Ficus benghalensis* Linn., and *Ficus gloomerata* Linn.

The *F. religiosa*, methanol extract showed the maximum antibacterial activity against the *E. coli* (24 mm) followed by aqueous, petroleum ether and

chloroform extract and minimum against *Candida albicans* (20 mm).

F. benghalensis maximum antimicrobial activity was showed by methanol extract against *S. aureus* (24 mm) and minimum against isolated and ATCC strain of *C. albicans* (19 mm) followed by petroleum ether, H_2O and chloroform extract.

F. gloomerata also methanol extract showed good activity the isolated culture of *E. coli* (25 mm) and least against ATCC strain of *C. albicans* (19 mm) followed by H_2O, chloroform and petroleum ether (Shivani and Navneet, 2010).

***Tinospora cardifolia* Miers. (Family Menispermaceae)**

T. cardifolia Miers. is commonly known as Giloe or Amrita (Hindi), guduchi (Sanskrit) and *Tinospora* (English), respectively (Ayurvedic Pharmacopoeia of India, 1999; Srinivasan *et al*., 2008). It is a climbing shrub. The leaves are petioled, membranous and cordate with broad sinus.

Medicinal and Ethanobotanical use

The plant is used as immunomodulator (Jagetia and Rao, 2006), anticancerous (Kavitha *et al.*, 2011), antidiarroel (Mathew and Kuttan, 1997), antioxidant (Sivakumar *et al*., 2011; Premnath and Lakshmidevi, 2010; Wani *et al.*, 2011), aphrodisiac (Tiwari *et al*.,2011), antihelmintic (Nagaprashanthi *et al*., 2012; Jain *et al*.,2010), antipsychotic (Stanley *et al.*, 2000) and hypoglycaemic (Sinha *et al.*, 2004).

Antimicrobial activity

Various crude extracts of *T. cardifolia* were studied against enteric bacteria, respiratory tract pathogens, peritonitis infection and bacteraemia (Thatte *et al*., 1992).

Vermani *et al*., (2013), reported that methanol extract of this plant was most effective against all tested bacterial pathogens followed by water (H_2O), chloroform ($CHCl_3$), and petroleum ether (PET). The maximum antibacterial activity was observed against *S. sanguinis* (23 mm) and lowest activity was detected against S. *salivarius* (17 mm). Moderate antibacterial activity was noted against S. *aureus* (21 mm), L. *acidophilus* (21 mm) and S. *mutans* (19 mm), respectively (Vermani *et al*., 2013). Samy and Ignacimuthu (2000) reported good antimicrobial activity of various extracts (hexane, dichloromethane, ethyl acetate, diethyl ether and methanol) of leaves against *B. subtilis, E. coli, P. vulgaris* and *S. aureus*. Samy (2005) also reported antibacterial activity of methanolic extract of stem against *E. aerogenes, P. vulgaris and P. mirabilis*. PET extract of the stem has inhibited in vitro growth of *M. Tuberculosis* (Singh *et al*., 2003).

***Anacyclus pyrethrum* Linn. (Family Asteraceae)**

A. pyrethrum commonly known as pellitory and Akarkara in hindi local languages is a herbal medicine.

Medicinal and Ethanobotanical use

A. pyrethrum roots and leaf have important role in traditional ayurvedic and unnani system of medicine.

Antimicrobial activity

The methanol extract of *A. pyrethrum* showed the maximum antibacterial activity against the *L. acidophilus* (20 mm) followed by petroleum ether, acetone and H_2O extract and minimum activity against isolated strain of *Streptococcus sobrinus* (12 mm) (Sanjay *et al*., 2010).

***Sida spinosa Linn.* (Family Malvaceae)**

S. spinosa (syn. *S. alba*) is an annual or perennial, erect and herbs or under shrubs, upto 60 cm in height. Leaves are demulcent and refrigerant and are useful for gonorrhoea and scalding urine. Decoction of root-bark and root is used in mild cases of debility and fever (Selvadurai *et al.*, 2011).

Antimicrobial activity

Ahmed *et al*., (2012) assayed that *S. spinosa* has potential activity against *S. aureus* and *E. coli* and fungi (*Alternaria alternata* and *fusarium oxysporum*. The antimicrobial activity of ethanolic extract was carried out against *S. aureus, B. subtilis, P. aeruginosa, E. coli, C. albicans* and *A. niger* (Navnanethakrishnan *et al*., 2011).

***Trichosanthes anguina* Linn. Syn. *T. Cucumerina* (Family Cucurbitaceae)**

It is an annual climber belonging to the. It has a prominent place in alternative systems of medicine like Ayurveda and Siddha due to its various pharmacological activities like antidiabetic, hepatoprotective, cytotoxic and anti-inflammatory (Reddy *et al*., 2010).

Medicinal and Ethanobotanical use

It is reported pharmacological activities like antidiabetic, hepatoprotective, cytotoxic and anti-inflammatory (Reddy *et al*., 2010).

Antimicrobial activity

Sayeed *et al*., (2011) assayed antimicrobial potential against *Penecillum* sp., *Aspergillus niger, Trichoderma viride, Aspergillus flavus, Candida albicans* and *Helminthosporium sativum*.

***Jasminum grandiflorum* Linn (Family Oleaceae)**

Jasminum is a genus of shrubs and vines. It contains around 200 species which are native to tropical and warm temperate regions of the Eurasia, Australasia and Oceania. Jasmines are cultivated throughout the country. However, the largest area under Jasmine flower production is in Tamil Nadu followed by Karnataka. The annual production of jasmine is more than 15 tonnes in India (Shekhar and Prashad, 2015; Sanjay *et al*., 2010).

Antibacterial activity

J. grandiflorum the maximum antibacterial activity was showed by methanol extract against

isolated strain of *Staphylococcus aureus* (24 mm) followed by petroleum ether, acetone and H_2O extract and minimum activity against *S. sobrinus* (13 mm) (Sanjay *et al*., 2010).

Medicinal and Ethanobotanical use

The leaves and flower of *J. grandiflorum* are reported to heal wounds in rat and to have anti-hepatitis B virus efficacy particularly of iridoid glycosides from buds. It also contains secoiridoids, triterpenoid saponins and some other glycosides. It has antiulcer and antioxidant properties (Shekhar and Prashad, 2015).

Table- 1. Ethanopharmacology, biological activity, antimicrobial potential of medicinal plants and herbs of Uttarakhand

Plant(s) name	Part(s) used	Solvents used	traditional/ pharmacological/ antimicrobial potential uses	Reference(s)
Terminalia arjuna	Leaf	Methanol, acetone, petroleum ether, water	Antibacterial	Kumar *et al*., 2014; Aneja *et al*., 2012
Kaempferia rotunda (Linn.)	Rhizome	Ethyl acetate, methanol, acetone, petroleum ether	Antibacterial, anti-inflammatory, antitumour, antiulcer, wound healing	Khare, 2007; Kumar *et al*., 2015; Nambiar, 1993
Olea europaea	Fruit, flowers, stems	Aqueous	Antibacterial	Gupta *et al*., 2008; Pereira *et al*., 2007
Lagenaria vulgaris Ser.	Whole plant	Petroleum ether, acetone, methanol, water	Antibacterial	Gautam *et al*., 2013;
Nepeta ciliaris Benth.	Whole plant	Petroleum ether, acetone, methanol, water	Cold, catarrh, respiratory distress, fever, antimicrobial	Gautam *et al.,* 2012
Viola odorata Linn.	Aerial parts	Petroleum ether, acetone, methanol, water	Antibacterial	Gautam *et al*., 2012
Cuscuta europaea Linn.	plant	Plant extract	Skin diseases	Bisht *et al*., 2013
Cyperus rotundus Linn.	Roots	Petroleum ether, acetone, methanol, water	Antimicrobial	Kumar *et al*., 2014
Althaea officinalis Linn.	Seeds	Petroleum ether, acetone, methanol, water	Anti-inflammatory, immunomodulatory, demulcent, soothing, antimicrobial	Naobi *et al.,* 1991; Rouhi and Ganji, 2007; Gautam *et al*., 2015
Onosma bracteatum Wall.	Fruits	Petroleum ether, acetone, methanol, water	Antibacterial, antifungal, fever	Gautam *et al*., 2015; Vohara, 1986
Cassia occidentalis Linn.	Seeds	Petroleum ether, acetone, methanol, water	Antimicrobial, fever, tuberculosis	Rajni *et al*., 2013
Quercus infectoria	Gall extract	Ethanol,	Antibacterial	Voravuthikunchai and Kitpipit, 2005; Vermani *et al.,* 2013
Asparagus racemosus	Aerial parts	Petroleum ether, acetone, methanol, water	Antibacterial	Kumar *et al.,* 2013; Uddin *et al*., 2012
Jasminum sambac Linn.	Leaf	Acetone, Petroleum ether, acetone, methanol, water	Antibacterial	Al-Hussaini and Mahasneh, 2011;
Cannabis sativa Linn.	Seeds, leaves extract	Extract	Curing fever, bronchitis	Bisht *et al.,* 2013
Salvodara persica Linn.	Stem and bark	Petroleum ether, acetone, methanol, water	Antibacterial	Al-Bayati and Sulaman, 2008; Kumar et al., 2016
Citrus maxima (burm) merr.	Seeds	Petroleum ether, acetone, methanol, water	Antibacterial, antimicrobial, cough, swelling, epilepsy	Singh and Navneet, 2016;

Citrus limon Linn. Burm. F.	Fruits		Gastric disorders, vomiting, acidity	Bisht *et al*., 2013
Barleria prionitis Linn.	Aerial parts	Petroleum ether, acetone, methanol, water	Antibacterial	Singh *et al*., 2016
Tinospora cardifolia Miers.	Stem	Petroleum ether, chloroform, methanol, water	Antibacterial	Vermani et al., 2013; Thatte *et al*., 1992; Singh *et al.,* 2003
Anacyclus pyrethrum Linn.	Root	Petroleum ether, acetone, methanol, water	Antibacterial	Sanjay *et al.,* 2010
Jasminum grandiflorum Linn.	Leaf	Petroleum ether, acetone, methanol, water	Antibacterial	Sanjay *et al*., 2010
Sida spinosa	Root, bark	Decoction	Debility, fever, antibacterial, antifungal	Selvadurai *et al.,* 2011; Ahmed *et al.,* 2012
Trichosanthes cucumerina			Antidiabetic, hepatoprotective, cytotoxic, antifungal	Reddy *et al*., 2010, Sayeed *et al*., 2011
Ocimum gratissimum	Root	Petroleum ether, diethyl ether, acetone, distilled water	Antibacterial, antifungal	Shukla *et al*., 2015
Tephrosia purpurea Linn.	root,	Ethanolic	Antibacterial	Rangama *et al*., 2009
Sonchus asper Linn.	Leaves	Methanolic	Antibacterial and antifungal	Upadhyay *et al*., 2013
Leucas indica Linn.	Whole plant	Water, ethanol, chloroform, acetone and petroleum ether	Antibacterial, antifungal	Babu *et al*., 2014
Glycine max (Linn.) Merr.	Seeds paste	Paste	Eye tonic, eyesores	Bisht *et al*., 2013
Mimusops elengi Linn.	Bark,	Ethanolic	Antibacterial	Rangama *et al*., 2009
Biden pilosa Linn.	Root	Methanol	Antimicrobial	Ashata and Afolayan, 2009
Euphorbia royleana Boiss.	Bark	Extract	Eye problem	Bisht *et al*., 2013
Erythrina indica Linn.	Stem, root, leaves	Methanol, ethyl acetate	Antimicrobial	Aggarwal and Sarin, 2014
Combretum indicum Linn.	Flower	Methanol, ethyl acetate, water	Antibacterial	Kumar, 2012
Abrus precatorious Linn.		Methanol	Antimicrobial	Hussain and Kumarasn, 2014
Hemidesmus indicus	Root	Methanol	Antibacterial	Mohan *et al*., 2015
Pongamia pinnata	Bark, leaves, seeds		Antioxidant, antibacterial	Sajid *et al.,* 2012
Sida cardifolia	Seeds, leafs	Water, methanol	Antimicrobial	Reddy *et al.,* 2012
Euphorbia hirta	Root, bark, leaves (aerial parts)		Antibacterial	Patel and Patel, 2014
Butea monosperma	Leafs	Hexane and ethanol (1:1)	Antimicrobial	Lohita *et al.,* 2011
Punica granatum Linn.			Antimicrobial	Prakash, 2014
Abina cordifolia Hook. F.			Wound, fever	Prakash, 2014
Acacia catechu Will.	Root paste		Anti-ulcer	Bisht *et al*., 2013
Aegle marmelos Linn.	Dry fruits, leaf	Ethanol, chloroform extracts	Fever and cold; antibacterial	Bisht *et al.,* 2013; Rajasekaran and

				Meignanam, 2008
Ajuga parviflora Benth.	Leaves extract		Gastric problem	Bisht *et al.,* 2013
Allium sativum Linn.	Extract (bulb)		Joint pain	Bisht *et al.,* 2013
Barleria cristata Linn.	Root paste		Skin diseases, pyorrhoea	Bisht *et al*., 2013
Berberis osmastonii Dunn.	Root decoction		Eyes infection	Bisht *et al.,* 2013
Ficus religiosa Linn.	Bark	Petroleum ether, acetone, methanol, water	Antimicrobial	Shivani and Navneet, 2010; Bhandari *et al*., 1993
Ficus benghalensis Linn.	Bark	Petroleum ether, acetone, methanol, water	Antimicrobial	Shivani and Navneet, 2010; Bhandari *et al*., 1993
Ficus gloomerata Linn.	Bark	Petroleum ether, acetone, methanol, water	Antimicrobial	Shivani and Navneet, 2010; Bhandari *et al*., 1993
Betula utilis D.don	Bark	Ethanol, methanol extracts	Antibacterial, antiseptic, carminative and contraceptive	Kumaraswamy *et al*., 2008
Rubus ellipticus Sm.	Root	Ethanol extract	Antibacterial and antifungal	Lakshmamma and Prayaga, 2006
Ricinus communis		Methanol and water extract	Antibacterial	Parameshwari and Tulsi, 2001; Jombo and Enenebeaku, 2008
Sapindus mukorossi	Powdered seeds	Acetone, hot water, methanol, cold water extracts	Dental carries, arthritis, common cold, antimicrobial	Dhar *et al*., 1989; Aneja *et al*., 2010
Stephania globra Roxb (Miers)	Roots, tubers		Pulmonary tuberculosis, asthma, dysentery and fever and antimicrobial	Ibrahim and Khan, 2006; Semwal *et al*., 2009
Taxus baccata Linn. *Thuner*	Heartwood	Ethanol extract	Antimalarial, antirhematic and used in bronchitis, antimicrobial	Erdemoglu and Sener, 2001; Kucukboyaci and Sener, 2010
Prunus armeniaca Linn.		Methanol, butanol, water extract	Fever, cold, asthma, bronchitis and antimicrobial	Rashid *et al*., 2007; Yigit *et al*., 2009; Annas *et al.*, 2008

Conclusion

In conclusion, various studies on traditional, ethanobotanical use and antimicrobial activities of medicinal plants and herbs of Uttarakhand (India) showed that the various plants and herbs are used in the traditional system of medicine by the peoples of this state. Different solvents extracts showed promising antimicrobial potential against many human pathogenic microbes. The results of various herbal researchers also indicated that scientific studies carried out on medicinal plants having traditional claims of effectiveness might deserve successful results. These plants could serve as useful source of new antimicrobial agents. Extensive researches in the area of isolation of these plants are required so that better, safer and cost effective drugs for the treatment of various kinds of diseases.

Acknowledgement

Authors are grateful to the Head, Department of Botany and Microbiology, Gurukul Kangri University, Haridwar to provide necessary library facilities to pursue this review data.

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11/20/2016