A review on antimicrobial and phytochemical screening of traditionally used Himalayan medicinal plants

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Abstract

Plant drug Rasayana has always played an essential role to treat several diseases of human beings. Moreover, medicinal plants are the prime source of potentially useful structures for the development of novel chemotherapeutic agents. Historically, plants have provided a basis of the development for novel drugs and plant derived drugs which have made large contributions to human health and well being. Till now few plants have been scientifically proved by different researchers for their medicinal potential but the therapeutic ability of number of plants are still unknown. The regeneration of medicinal potential of such plants is thus strongly required. Several researchers have carried out bioassay for antimicrobial, antioxidant and phytochemical screening of various extracts of certain plants. Such works should be brought in the knowledge of every concern man. Present study is therefore an attempt for review on some of such medicinal plants.

Keywords: Medicinal plants, Herbs, Antibacterial, Antimicrobial, Phytochemical

Introduction

Plants are the roadway bricks of all the living organisms on the earth. They transform solar energy into chemical energy and supply it to different tropic levels to carry on all kind of life activities. Human and civilization developed through ages in the lap of nature and flourished with plants.

“The essence of all being is earth. The essence of the earth is water. The essence of water is plants. The essence of plants is the human being.”

(Chandogya Upanisad, 1.12)

Plant based drug has always played a vital role to treat several diseases of human beings. According to World health organization (WHO) more than 80% of the world population relies on traditional medicine for their primary health care needs (Diallo et al.,1999). The use of medicinal plants as a source for relief from illness can be traced back over five millennia to written documents of the early civilization in India, china and the north east, but it is thoughtless as art as old as mankind (Mahesh et al.,2008). The potential of higher plants as a source for new drugs is still largely unexplored. Among the estimated 250,000-500,000 plant species, only a small percentage have been investigated phytochemically and the fraction submitted to biological or pharmacological screening. Compound of natural or synthetic origin has been the source of innumerable therapeutic agents (Gerhartz et al., 1985 and Kroschwitz et al., 1992).

Antimicrobial potential of medicinal plants

Medicinal plants are rich sources of antimicrobial agents. Plants are used medicinally in different countries are the source of potential and powerful drugs (Shrivastava and Lambart,1997). A wide range of medicinal parts are used to get different rasayanas (Chemicals) which possess different medicinal properties against different microbes. Although hundred of plants species have been tested for antimicrobial properties, the majority of these have not been adequately evaluated (Balandrine et al., 1985). There is evidence of medicinal plants have been used in the treatment of diseases and for revitalizing body systems in Indian, the Egyptian, the Chinese, the Greek and the Roman civilizations. Plants have a vast potential for their use as curative medicine. In India, medicinal plants are widely used by all sections of people both directly as folk medicines in different indigenous systems of medicine like...
Siddha, Ayurveda and Unani and indirectly in the pharmaceutical preparations (Srinivasan et al., 2001). India has about 4.5 million plant species and among them, several thousands have been claimed to possess medicinal properties against human diseases. Although traditional medicinal healers have used medicinal plants for treatment of ailments for hundreds of years, there has always been a lingering question in scientific circles about their therapeutic efficacy. As a consequence, the pharmacological activity of many medicinal plants has been studied, even though the vast majority of medicinal plants remain to be studied for their phytochemical components and pharmacological effects.In the past few decades, the search for new anti-bacterial agents has occupied many research groups in the field of ethno pharmacology (Recio et al., 1989). Reviewed the most relevant articles on this subject published between 1978 and 1988, compiling a list of 75 species. Approximately 115 articles published on the antimicrobial activity of medicinal plants in online website PubMed during the period between 1966 and 1994, however, in the following decade between 1995 and 2004, this number doubled to 307. Focusing the search specifically on the antimicrobial activity of essential oils and crude extract, 187 references appeared in PubMed between 1971 and 2005; however, in a search processed by the ISI web of knowledge, the number of references for essential oils was much higher 323 between 1986 and 2005. These figures demonstrate the increased interest for this type of research among that portion of the scientific community dedicated to the investigation of the medicinal properties of plants. Many focus on determining the antimicrobial activity of plant extracts found in folk medicine (Ngwenson et al., 2003), essential oils (Alma et al., 2003) or isolated compounds such as alkaloids (Klausmeyer et al., 2004), flavonoids (Sohnet et al., 2004), sesquiterpene lactones (Lin et al., 2003), diterpenes (El-Seedi et al., 2002), triter-penes (Katerere et al., 2003) or naphtoquinones (Machado et al., 2003) among others. Some of these compounds were isolated or obtained by bio-guided isolation after previously detecting antimicrobial activity on the part of the plant. The second block of studies focus on the natural flora of a specific region or country. There are many examples of such articles that have been published recently. In 2005, Duarte et al. reported anti-Candida activity of Brazilian medicinal plants. Similar studies include determination of antibacterial properties of essential oils from Thai medicinal plants (Wannissorn et al., 2005). Likewise, Lopez et al. (2001) also described antiviral and antimicrobial activities of Colombian medicinal plants. In India, Jeevan Ram et al. (2004) reported in vitro antimicrobial activity of certain medicinal plants from Eastern Ghats, India, used for skin diseases. Worldwide, a lot of work is done to determine antimicrobial activity of medicinal plants. For example determination of antimicrobial activity of six medicinal plants traditionally used for the treatment of dysentery and diarrhoea in Congo (Otshudi et al., 2000), Mahasneh (2002) screened some indigenous Qatari medicinal plants for antimicrobial activity and Atindehou et al. (2002) worked on evaluation of the antimicrobial potential of medicinal plants from the Ivory Coast. Tshibangu et al. (2002) screened African medicinal plants for antimicrobial and enzyme inhibitory activity. Kokoska et al. (2002) and Tosun et al. (2006) described antimicrobial activity of medicinal plants from Siberia and Turkey respectively. Yogesh et al. (2007) demonstrated potential antibacterial activity of medicinal plants against Staphylococcus and Salmonella spp. The antibacterial activity of methanol extract and its petroleum ether, chloroform and ethyl acetate fractions from the root bark of Akanda (Calotropis gigantea) was investigated by Ashraful et al. (2008). The use of plant extracts and phytochemicals, both with known antimicrobial properties, are of great significance for therapeutic treatments (Nagesh and Shanthamma, 2009). The effect of plant extracts on bacteria has been studied by a large number of researchers in different parts of the world (Reddy et al., 2001; Ateb and Erdö, 2003). Agarry et al. (2005) have shown the potent antimicrobial activities of the gel and leaf of Aloe vera against a wide range of bacteria and fungi. Bearberry and cranberry juice have been used to treat urinary infections while plant species such as lemon balm, garlic and tea tree are described as broad-spectrum antimicrobial agents (Rios and Recio, 2005). Mathabe et al. (2006) reported that methanol, ethanol, acetone and hot water extracts from different plant parts (leaves, roots, bark and stem rhizome), of Elephantorrhiza burkei, Elephantorrhiza elephanta, Gymnosporia...
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...senegalensis, Indigofera fedaloides, Ozoora insignis, Punica granatum, Schotia brachypetala, Spirostachys africana, Syzygium cordatum and Ximenia caffra showed remarkable antibacterial activity against Escherichia coli, Salmonella typhi, Shigella species, Staphylococcus aureus, and Vibrio cholera. Crude extracts of some well known medicinal plants are used to control plant pathogens (Kubo et al., 2001). Many species of Acacia caesia are found to have diverse phytochemical compounds having medicinal properties (Lee et al., 2000). The methanol extracts of forty nine different plant extracts were screened for antifungal activity, out of which forty three plant extracts exhibited varying degrees of inhibition activity against the fungi (Varaprasad et al., 2009). Girish and Satish (2008) reported the antibacterial activities of aqueous and methanol extracts of some medicinal plants against some human pathogenic bacteria. The methanol extracts exhibited more activity against these organisms than the aqueous extracts, which indicate that the methanol extracts of all selected plants may contain the active components. Senthilkumar and Reetha (2009) reported that methanol extract of Aegle marmelos and Cassia auriculata extract showed higher antibacterial activity to a group of bacterial pathogens. The functions of triterpenesaponin in plants for its antifungal, fungicidal, antibacterial, antiviral, analgesic, anti-inflammatory, antitumor, cytotoxic, immunostimulant, antihelmintic, expectorant and antitussive activities, have been known for many years (Hostettmann and Marston, 1995). In vitro anti-bacterial activity of a glycoside, phenyl ethyl β-D-glucopyranoside from the plant Siderolobidi folia was studied by Ekramul et al. (2002). These compounds exhibited significant anti-bacterial activity against most of the tested bacteria. In vitro antifungal activity of saponins from Tribulusterr estris L. against Candida albicans, C. glabrata, C. parapsilosis, C. tropicalis and Cryptococcus neoformans was studied using micro broth dilution assay. The saponins exhibited significant antifungal activity by weakening the virulence of C. albicans and killing fungi by destroying the cell membrane (Zhang et al., 2006). The compounds isolated from Verbes cumulanshundum V. pterocyclinummutens were evaluated for their in vitro antifungal activity by TLC bioautographic assay and the triterpenoidsaponins, were found to exhibit potent in vitro antifungal activity against Colletotrichum acutatum, C. fragariae and C. gloeosporioides. Some saponins and phenylethanol glycosides possessed a dose-dependent antimicrobial activity against several bacteria and fungi (Zhang et al., 2006). Mandalet et al. (2005) investigated the potent antimicrobial activity of two triterpenesaponins isolated from the funicles of Acacia auriculiformis against various pathogenic organisms. Flavonoids may act through inhibiting cytoplasmic membrane function as well as by inhibition of DNA gyrase and β-hydroxycyclacyl carrier protein dehydratase activities (Cushnie and Lamb, 2005; Zhang et al., 2008). A phytochemical like isoflavonogenistein was able to change cell morphology (formation of filamentous cells) and inhibited the synthesis of DNA and RNA of Vibrio harveyi (Ulanowska et al., 2006). It has been suggested that terpenes promote membrane disruption, coumarins cause reduction in cell respiration and tannins act on the membranes of microorganism as well as bind to polysaccharides or enzymes promoting inactivation (Ya et al., 1988; Chung et al., 1998; Cowan 1999). Extracts of plants were used for the treatment of various diseases and this forms the basis for all Indian systems of Medicine. However, this area is not much developed when compared to modern system of medicine, mainly because of the lack of scientific documentation in this field. Mostly the pharmacological activity of medicinal plants resides in its secondary metabolites which are comparatively smaller molecules in contrast to the primary molecules such as proteins, carbohydrates and lipids. These natural products provide clues to synthesize new structural types of antimicrobial and antifungal chemicals that are relatively safe to man (Kalimuthuet al., 2010). Antimicrobial activity of plants like Adhatoda vasika, Bacopa monnieri, Bident splosoa, Boswellia (Luban) Species, Carica papaya, Cissampelo spaleira, Combretum micranthum Cynodondactylon, Harunganana dagascariensis, Ocimum gratissimum and Phyllanthus niruri, has been demonstrated against various pathogenic micro-organisms (Hasson et al., 2011; T Selvamohan et al., 2012; Yaobua et al., 2012; Hema et al., 2013). Gautam et al. (2012) reported antibacterial and phytochemical aspects of Viola odorata Linn, against respiratory tract pathogens. They also screened Nepeta ciliaris

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Emerging infectious diseases and population in developing countries is suffering from this problem. Many plants showed tremendous hypoglycemic potential. *Allium cepa, Allium sativum, Eugenia jambolana* and *Trigonella foenum*, are some famous hypoglycemic plants (Grover et al., 2002; Vats et al., 2002). Cardiovascular diseases have become the number one cause of death throughout the world (Thippeswamy et al., 2009); can be controlled by herbal medicines. Many immune modulatory agents are of plant origin (Arul Kumar et al., 2007). Hepatic and arthritis are painful diseases and no satisfactory cure of these diseases is present in modern medicines. Many plants have shown their marvelous capability to lower the raised level of liver enzymes in viral hepatitis (Oshima et al., 1995; Bhawna and Kumar, 2009). Many plants have shown immense potential as anti-peptic ulcer (Ibrahim et al., 2006), antimicrobial and antioxidant properties (Ali et al., 2008). With widespread interest in the research of the herbal medicines, these have become an alternate health care system to solve the health problems of world in today’s synthetic allopathic era. India is blessed with rich herbal sources which are being used for medicinal and aromatic purposes. The proper medicinal use of some of plants is well known, and many more have to be still explored (Khan, 2003). There is a need to facilitate the herbal research and its application to solve the problem of health seeking population. With the advancement of research in medicine, it was concluded that plants are Biosynthetic laboratories for chemical compounds, which are responsible for curative action of plants. Table 1 describes some Himalayan folk medicinal important plants.

The scientists isolate phytochemicals from medicinal plants and many of them are found very active against many diseases. Aconitine, atisine, nicotine, atropine, and morphine are some famous examples of such phytochemicals. Infectious diseases resulting from the presence of pathogenic microbial agents including bacteria, fungi, and viruses have become a major healthcare problem in current century. Infectious diseases are the main reason of deaths in developing countries (Okusa et al., 2007; Mojab et al., 2008). Incidence of new and re-emerging infectious diseases and development of resistance to antibiotic is alarmingly increasing. In modern time treatment of infectious diseases

**Herbal Drugs**

Medicinal plants have been found as important contributors to the pharmaceutical, agriculture and food industries. With the onset of the synthetic era, pharmaceutical industries are producing a lot of synthetic drugs that help to alleviate the chronic diseases. With the passage of time many problems associated with frequent use of synthetic drugs are becoming prominent like severe side effects and resistance of microbes against these drugs. On the other side synthetic drugs are expensive and a large population cannot afford these drugs. In recent times research on medicinal plants has been intensified all over the world. The natural pharmaceuticals are receiving extra ordinary importance and popularity as safe, efficacious and cost effective medicines with extraordinary benefits due to combination of medicinal ingredients with vitamins and minerals (Ahmad and Husain, 2008).

Recently there is an emerging trend in research to support the biological activities of medicinal plants. Many scientific researchers have been reported about the efficacious and chemotherapeutic role of medicinal plants in the treatment of diverse diseases. Cancer is one of such field where scientists are expecting new molecules from herbs that can provide an important tool for fighting against this dreaded disease. *Terminalia arjuna* (Vaidya et al., 2008) and flavonoids extracted from different sources have shown significant inhibiting effect on cancer cells (Jiangrong and Jiang, 2007; Zhao et al., 2007). Diabetes mellitus is another area for herbal research, as large number of the population in developing countries is suffering from this problem. Many plants showed...
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Table 1- Some important medicinal plants traditionally used for health care system

<table>
<thead>
<tr>
<th>Local name</th>
<th>Botanical name</th>
<th>Part used</th>
<th>Used to cure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jhilla, Rai, Rei</td>
<td><em>Abies pindrow</em></td>
<td>Leaf, Rasin, Bark</td>
<td>Cough, cold, rheumatism, ulcer</td>
</tr>
<tr>
<td>Bhindi</td>
<td><em>Abelmoschus esculentus</em></td>
<td>Root</td>
<td>Venereal diseases</td>
</tr>
<tr>
<td>Khair</td>
<td><em>Acacia catechu</em></td>
<td>Bark</td>
<td>Diarrhoea</td>
</tr>
<tr>
<td>Pyaz</td>
<td><em>Allium cepa</em></td>
<td>Bulb, Leaf</td>
<td>Ear trouble, earache, vomiting, piles, jaundice, anthelmintic, asthma, nose bleeding, blisters, boils, bronchitis, diuretic, expectorant, eye trouble, giddiness, insect bites, itching, skin diseases, wounds</td>
</tr>
<tr>
<td>MeethaAties, Bhuaa</td>
<td><em>Aconitum voilaceum</em></td>
<td>Tuber, Tuber</td>
<td>Stomachache, fever, abdominal pain, bronchitis, cough, epilepsy, headache, inflammation, neck pain, snake-bite, lice killer, Gastrointestinal troubles, renal pain, rheumatism</td>
</tr>
<tr>
<td>Atees</td>
<td><em>Aconitum heterophyllum</em></td>
<td>Root, Tuber</td>
<td>Diarrhoea, fever, vomiting, cough, chills, stomach ache, gastrointestinal disorders, digestive disorders, fever, colic pain, wormicide headache, dyspepsia, piles, gastric, dysentery</td>
</tr>
<tr>
<td>Kala Bansha, Bansa, Adosa, Banfasha</td>
<td><em>Adhatoda vasica</em></td>
<td>Leaf, Root, Whole plant</td>
<td>Fever, Cough, eye diseases, blood diseases</td>
</tr>
<tr>
<td>Chukalai</td>
<td><em>Alysicarpus vaginalis</em></td>
<td>Root</td>
<td>Cough, Asthma, Bronchitis, Skin problem</td>
</tr>
<tr>
<td>Kumari, Ghirita, Gawarpaltra</td>
<td><em>Aloe vera</em></td>
<td>Pulp</td>
<td>Inflammation of the body</td>
</tr>
<tr>
<td>Choru</td>
<td><em>Angelica glauca</em></td>
<td>Root, Stem, Fruit</td>
<td>Flatulence, colic, constipation, digestive disorder, stomachache, constipation, dyspepsia, cough, indigestion, vomiting, eye diseases, power tonic, dysentery, gastric troubles, menorrhrea</td>
</tr>
<tr>
<td>Babool</td>
<td><em>Acacia nilotica</em></td>
<td>Flower</td>
<td>Urinary trouble</td>
</tr>
<tr>
<td>Lahsun (Garlic)</td>
<td><em>Allium sativum</em></td>
<td>Bulb</td>
<td>Cholera, treat abscesses, rheumatic pain, gout, scorpion, bruises</td>
</tr>
<tr>
<td>Dhatara</td>
<td><em>Dhatura stramonium</em></td>
<td>Leaves and fruits</td>
<td>Asthma, cardiac pains</td>
</tr>
<tr>
<td>Amla</td>
<td><em>Emblica officinalis</em></td>
<td>fruit</td>
<td>As Purgative, diuretic, digestive trouble, Hair problems</td>
</tr>
<tr>
<td>Peepal</td>
<td><em>Ficus religiosa</em></td>
<td>Bark, leaves, fruit, seeds, latex</td>
<td>Skin diseases, neuralgia, constipation and gynecological diseases</td>
</tr>
<tr>
<td>Gurhal</td>
<td><em>Hibiscus rosa-sinensis</em></td>
<td>Flower</td>
<td>Delivery</td>
</tr>
<tr>
<td>Lantana</td>
<td><em>Lantana indica</em></td>
<td>Leaf</td>
<td>Chicken pox, cuts, wounds</td>
</tr>
<tr>
<td>Pudina</td>
<td><em>Mentha longifolia</em></td>
<td>Leaf</td>
<td>Cholera, dysentery</td>
</tr>
</tbody>
</table>

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Emerging and is of principal need (Khan et al., 2009). However previous records showed that even new antibiotic sources that can act either by direct antimicrobial activity or by preventing resistance of microbial strains; many bacterial strains have developed resistance against antibiotics, such as penicillin resistant *streptococcus pneumoniae*, methicillin resistant *staphylococcus aureus*. Due to the development of bacterial super resistant strains, currently used antibiotic failed to cure the infectious diseases (Sieradzki et al., 1999; Janovyska et al., 2003; Karaman et al., 2003; Turkoglu, et al., 2007). Solution of antibiotic resistance is the development of new drugs from synthetic or natural sources. Therefore discovery of new antibiotic sources that can act either by direct antimicrobial activity or by preventing resistance of microorganism with minimal side effects is emerging and is of principal need (Khan et al., 2009). However previous records showed that even new families of synthetic antimicrobial agent will have short life expectancy. Researchers turned their attention towards herbal drugs, which is most promising area in search of new biologically active compounds with better activity against multi drug resistant strains and reduced antibiotic related side effects (Nickavar et al., 2002; Cock, 2008; Khan et al., 2009). Antimicrobial potential of some plants had been accepted long before mankind discovered the presence of microbes (Anwar et al., 2006). The healing power of plants is usually due to presence of secondary metabolites. Plant extracts and large number of phytochemicals exhibited strong inhibiting effect on a broad spectrum of microorganisms (Fungi, bacteria) (Cowan, 1999; Nascimento et al., 2000; Anwar et al., 2009). Bacterial and fungal infections are also a big threat to the life of the human beings. Only few antifungal drugs are available and long use of these drugs caused resistance. Plant might contain antifungal component not yet explored. Plants produce a great variety of chemical compound (phytoconstituents) as in their defense system these defense molecules are secondary metabolites, and used in formulation of herbal drugs.

<table>
<thead>
<tr>
<th>Jatamansi, Muskroot</th>
<th><em>Nardostachys jatamansi</em></th>
<th>Root</th>
<th>Epilepsy, hysteria, skin diseases, throat trouble, lumbaro, ulcers, rheumatism, paralysis, cough, diuretic, snake-bite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kalonji</td>
<td><em>Nigella sativa</em></td>
<td>Seeds</td>
<td>Diarrhoea, dysentery</td>
</tr>
<tr>
<td>Tulsi</td>
<td><em>Ocimum sanctum</em></td>
<td>Leaves</td>
<td>Antiallergic, antidiabetic</td>
</tr>
<tr>
<td>Kaknada</td>
<td><em>Peristrophbe calyculata</em></td>
<td>Leaf</td>
<td>Skin disorder, Anti cancerous, Asthma, Antidote, Bronchitis, Cough</td>
</tr>
<tr>
<td>Paiya</td>
<td><em>Prunus cerasoides</em></td>
<td>Bark, fruit</td>
<td>Antipyretic, leprosy</td>
</tr>
<tr>
<td>Anar</td>
<td><em>Punica granatum</em></td>
<td>Seeds, flowers</td>
<td>Syphilis, bronchitis, stomachic</td>
</tr>
<tr>
<td>Chir</td>
<td><em>Pinus roxburghii</em></td>
<td>Resin</td>
<td>Swelling, sprains, boils, bone fractures, urine trouble, concussions, heel cracks, eye, bone fracture</td>
</tr>
<tr>
<td>Chilla, Pine, Kail</td>
<td><em>Pinus wallichiana</em></td>
<td>Resin, Bark, Leaf</td>
<td>Hurt, bone fracture, headache, waist pains, internal injury, heel crack, skin diseases abscess, ulcers</td>
</tr>
<tr>
<td>Burans, Bras</td>
<td><em>Rhododendron arboreum</em></td>
<td>Flower</td>
<td>Mental retardation, dysentery, headache, eye cataract, wounds, rhematism</td>
</tr>
<tr>
<td>Thuner, Talispatta, Talispatr</td>
<td><em>Taxusbaccata</em></td>
<td>Leaf</td>
<td>Asthma, bronchitis, lumbaro, indigestion, cancer</td>
</tr>
<tr>
<td>Methi</td>
<td><em>Trigonella foenum</em></td>
<td>Seeds</td>
<td>Constipation, diabetes</td>
</tr>
<tr>
<td>Ajwain</td>
<td><em>Thymus vulgaris</em></td>
<td>Seeds</td>
<td>Antiseptic, antispasmodic</td>
</tr>
</tbody>
</table>

becomes a big problem due to the side effects of some antibiotics which includes hypersensitivity allergic reaction and immune suppression. There is need of time to discover new paramount antimicrobial compounds with different chemical structures and novel mechanism of action. Diverse antibiotics of synthetic and microbial origins have been produced. Indiscriminate use of antimicrobial drugs has created very dangerous drug resistance to microbial strains; many bacterial strains have developed resistance against antibiotics, such as penicillin resistant *streptococcus pneumoniae*, methicillin resistant *staphylococcus aureus*.
Phytochemical screening of medicinal plants (Bioactive compounds):
The medicinal value of plants lies in some chemical substances that produce a definite physiological action on the human body and these chemical substances are called phytochemicals. These phytochemicals were used to cure the disease in herbal and homeopathic Medicines (Chitravadivu et al., 2009). These are non-nutritive substances, have protective or disease preventive property (Ahmed et al., 2009). There arises a need and therefore to screen medicinal plants for bioactive compounds as a basis for further pharmacological studies. With advances in phytochemical techniques, several active principles of many medicinal plants have been isolated and introduced as valuable drug in modern systems of medicine. The most important of these bioactive compounds are alkaloids, flavonoids, tannins and phenolic compounds (Purkayastha et al., 2012). These are the important raw materials for drug production (Tullanithi et al., 2010). Most plants contain several compounds with antimicrobial properties for protection against attacker agents, especially microorganisms (Silva et al., 2010). Plants are rich in secondary metabolites such as tannins, alkaloids, saponins and flavones, which have been shown antimicrobial properties. Plant’s antimicrobials are categorized into two classes:

Phytoalexins: These are lower molecular weight compounds which are produced in response to microbial, herbivorous and environmental stimuli. Phytoalexins are including simple phenylpropanoid derivative, flavonoids, isoflavonoids and terpenoids (Bailey and Mansfield, 1982; Grayer and Harborne, 1994).

Phytoanticipins: These include phenolic glycosides and saponins which are stored in vacuoles of plant cells. When the microorganisms disturb the integrity of the cell, glycosides react with hydrolyzing enzymes and release toxic aglycones (Osbourn, 1996). The plants derived compounds with antimicrobial effect are described below:

(1) Polyphenols- Simple phenolics such as caffeic acid (Bowles and Miller, 2006), cinnamic acid, chlorogenic acid, gallic acid and hydroxyl benzoic acid, catechol, pyrogallol are known antimicrobial agents (Noriaki et al., 2005). Phenolic compounds showed their inhibitory effect by enzyme inhibition through oxidation reaction with sulphhydril groups, or through more non specific interaction with proteins. The site and number of hydroxyl groups on phenols are directly related to their toxicity to microorganism. Phenol with greater number of -OH groups showed high inhibitory effect (Mason and Wasserman, 1987; Cowan, 1999). Many studies have been reported about the antimicrobial potential of phenolic acids. Caffeic acid was quantified in sweet potato HPLC. High caffeic acid content inhibited the growth of sweet potato pathogenic fungi (Harrison et al., 2003). Seven phenolic compounds were identified and quantified by reverse by HPLC in olive leaves, caffeic acid, verbascoside, oleanopine, luteolin,7-O-glucoside, rutin, apigenin 7-O-glucoside and luteolin 4’,O-glucoside were present in the leaves extract, which showed very good combined antibacterial as well as antifungal effect, and which suggested the great nutraceutical potential of Phenolic acids (Pereira et al., 2007). High yield of caffeic acid and rosemaric acid in leaves of Basilicum polystachyon extract inhibited growth of five bacterial strains and three fungal strains. Highest activity was observed against gram positive strain, amongst the fungal strains maximum activity was observed against Aspergillus niger (Chakrabortty et al., 2007). Many studies are reported about the antimicrobial potential of Polyphenolics like; caffeic acid from coffee (Amelia et al., 2006), phenolic acid fraction of scrophulariafrutescens and scrophularia sambucifolia (Fernandez et al., 1996). Ferrazzano et al., 2009 showed antimicrobial activity of Mangiferin is major polyphenol of mango (Magnifera indica) and showed broad spectrum antimicrobial activity against bacterial and fungal strains (Stoilova et al., 2005). Some studies have reported the relationship between the antioxidant and antimicrobial activity (Wang et al., 2013; Reddy et al., 2010; Turkoglu, et al., 2007; Hamid et al., 2010; Mokbel and Hashinaga, 2005). Phenolic compounds with C3 side chain at lower level of oxidation and containing no oxygen are known as essential oils. Essential oils of many plant showed strong antimicrobial potential and have been used for treatment of infectious diseases all over the word. Essential oils showed broad spectrum biological activity which increased the interest of scientist. Extensive research has been conducted on...
essential oil to explore their antimicrobial activity. Most important essential oils with antimicrobial activity are extracted from clove (Eugenol) and *Thymus vulgaris* (Thyme) (Imelouane et al., 2009; Faleiro et al., 2003). Essential oils of many other species of plants have been also explored for antimicrobial activity against fungi and bacteria which includes, *Origanum* sp. and *Schinus molle* (Bayramoglu et al., 2008), *Ageratum fastigiatum* (Vieira et al., 2009), *Allium sativum* (Garlic) *Myristica fragrans* (nutmeg), *Zingiber officinale* (ginger), *Allium capa* (Onion) *Piper nigrum* (pepper) (Indu et al., 2006), yellow pine (Yang and Clausen, 2007).

(2) **Flavonoids**- Flavonoids are phenolic substances which exist as C6-C3-C6 system. They are synthesized by plants in response to microbial infections (Dixon, 2001). They have been form complexed with proteins of cell walls and found to be very effective against microorganism (Cowan, 1999). Flavonoids showed broad spectrum antimicrobial activity. Catechin is reduced form of C3 unit, and has gained special attention, and is one of the most important extensively studied flavonoids. Different types of teas are major sources of mixture of catechins. Tea catechin inhibited microbial growth and are very effective against *Staphylococcus aureus* (MRSA) and fungal strains (*Candida albicans*) (Hirasawa and Takada, 2004). Quercetin is also proven as a potential antimicrobial agent for many microorganisms. Quercetin extracted from lotus leaves showed inhibitory effect on bacterial strains (Li and Xu, 2008). Many flavonoids showed a synergic effect with conventional antibacterial and with combination of different flavonoids and flavones (Alvarez et al., 2008).

(3) **Tannins**- The tannins name is given to polymeric phenolic substances which are capable of tanning leather or precipitate proteins. They are divided as hydrolysable and condensed tannin. Hydrolysable tannin contains gallic acid usually as an ester with D-glucose and condensed tannins are derived from a flavonoids monomer (Proanthocyanidin). Tannins have the ability to inactivate microbial adhesions, enzymes, cell envelop transport proteins and form complexes with polysaccharides. Many studies have been reported about the antimicrobial activity of tannins. Five isolated tannins from the fruit of *Terminalia citrina* showed inhibitory effect on microbial strains (Burapadaja and Bunchoo, 1995). *Helicobacter pylori* bacteria are a major disease causing agent in gastrointestinal disorders. Hydrolysable tannins have a potential as a new and safe therapeutic agent against *H. pylori* infections (Funatogawa et al., 2004).

(4) **Alkaloids**- Alkaloids are heterocyclic nitrogen compounds having very good antimicrobial potential. Aqueous extract, different solvents and isolated fractions of alkaloids from *Samanea saman* showed highly significant antibacterial activity against human pathogenic bacterial strains (Raghavendra et al., 2008). Four isolated alkaloids from *Chelidonium majus* lin. inhibited the growth of methicillin-resistant *Staphylococcus aureus* (Zuo et al., 2008). Alkaloids from *sida acuta* (Karou et al., 2006), *Lupinus angustifolius* alkaloid (Erdemoglu et al., 2006), pyrrolizidine alkaloids from *Heliotropium subulatum* (Singh et al., 2002) showed significant inhibitory effect on a large number of microbes. Water is the most universally used solvent. Alcoholic extraction followed by various organic solvents can also be used. Mostly antimicrobial compounds are aromatic and saturated organic compounds. They may often extracted with ethanol or methanol (Erdenmgil et al., 2004) and purified compounds are obtained by active fractions of different solvents (Chloroform, acetone, dichloromethane, butanol) (Parekh and Chandra, 2006; Morales et al., 2008). Different methods may be used for assessment of antimicrobial activity. Two most commonly used methods are the disc diffusion method (Pelttari et al., 2002; Khan et al., 2009), and the agar well diffusion method (Ahmad et al., 1998). It is common to use medicinal plants as such, without isolating the active ingredients. Now a day interest is again diverted toward the use of crude plant extracts, since plants contain many secondary metabolite which act synergistically and may not show good activity with compounds isolated in pure form (Eloff, 2004 and McGraw, 2008). Isolation and purification of alkaloids from medicinal plants by HPLC techniques methanolic extracts of medicinal plants Gujpatta (*Abrus precabrius*), Sadapatta, shankhapushpi (*Canscorade cussate*) and makka (*Zea mays*) were concentrated and use for purification of secondary metabolites were purified by HPLC (Borde et al., 2002).
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2014). It has been observed that the plant is very rich in alkaloids and the modified method employed for the extraction of alkaloid is efficient and selective, where the interference of other secondary metabolites is negligible. The identification of each compound was made through gas chromatography-mass spectrometry (GC-MS). A total of twenty six structurally different alkaloids were identified for the first time from this medicinal plant. E. aureum is highly rich in alkaloids and twenty six different alkaloids were characterized (Meshram et al., 2015).

Summary and Conclusion:
Since ancient times, plants have been used by several communities to treat a large number of diseases, including infections. Numerous studies on the pharmacology of medicinal plants have been accomplished, since they constitute a potential source for the production of new medicines and may enhance the effects of conventional antimicrobials, which will probably decrease costs and improve the treatment quality. However, several plants may present antagonistic effects during antibiotic therapy. An important aspect comprises the search for new compounds that have antimicrobial action and synergism with currently available antimicrobial drugs, since bacteria resistant to conventional medicines are increasingly frequent; consequently, medicinal plants constitute an alternative for infection treatment. The antimicrobial activity of plants was proven by various examples, in the form of both essential oils and extracts. Thus, this property can be a promising ally in the development of medicines necessary to combat the increasing number of bacterial strains that become resistant to conventional antibiotics. Therefore, given that the literature on tests for the antimicrobial action of plant products is broad, including an increasing number of publications per year, it is highly difficult to relate the countless reports on the antimicrobial action of these products in this review article about a subject of such a great complexity, which requires a multidisciplinary approach.

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